European Commission

ROLLING PLAN FOR ICT STANDARDISATION 2025

Introduction

The Rolling Plan for ICT Standardisation provides a unique bridge between EU policies and standardisation activities concerning information and communication technologies (ICT). This helps to increase convergence of standards makers' efforts towards achieving EU policy goals. This document is the result of an annual dialogue involving a wide-range of interested parties as represented by the European multi-stakeholder platform on ICT standardisation (MSP). The Rolling Plan focuses on actions that can support EU policies and does not claim to be as complete as the work programmes of the different standardisation bodies.

Standardisation actions identified in this document to support EU policies are complementary to other instruments, in particular the Annual Union Work Programme (AUWP). The Rolling Plan attempts to list all known areas where ICT standardisation could support EU policy objectives. It also details the requirements for ICT standardisation, translates them into actions and provides a follow-up mechanism for the actions.

The Rolling Plan 2025 identifies around 260 actions grouped into 40 technological or application domains under foundational drivers and four thematic areas: key enablers, societal challenges, innovation for the single market and sustainable growth. Particular prominence is given to three horizontal "foundational drivers" under section 3.0, including updated chapters on data economy, cybersecurity and e-privacy. These are all technology areas for standardisation that go right across the spectrum of standards-making, and may need to be referenced by many, even most, specific activities. Their challenges arise at every step of digitalisation and policy makers need to be more aware that ICT standardisation is the tool to tackle them.

What's new in the 2025 Edition?

As every year, the European Commission services and the Multi Stakeholder Platform (MSP) reviewed and updated all chapters of the Rolling Plan. The updates in each chapter include new developments on policy initiatives and related objectives (provided in the parts A.1, A.2, and A.3 of each chapter), and the latest information on completed and ongoing standardisation work related to the respective topic area (parts C of each chapter). The actions (part B) in each chapter are updated and completed actions removed. The driver for refreshing the chapters is to make sure they continue to relate to the European Standardisation Strategy, support EU strategic objectives, and associate EU strategic objectives with global ICT standardisation activities.

As a result, the 2025 edition includes a number of substantial revisions. There is a new chapter on Media (3.2.8) based on the European Media Freedom Act. The chapters on Data Economy (3.0.1) and Data Interoperability (3.1.3) were extensively revised and aligned with progress on the EU data strategy. The chapter on Electronic Identification and trust services including e-signatures (3.1.5) has been extensively revised in line with the new eIDAS Regulation. Other chapters that underwent substantial revisions were the chapters on Cybersecurity / Network and Information Security (3.0.2), Web 4.0, Virtual Worlds (3.3.7), e-Procurement (3.3.1) and e-Invoicing (3.3.2).

What are the trends?

The Rolling Plan is reviewed and updated each year. The changes from one year to the next occur mostly in specific chapters, but one can also discern wider trends over the years.

Digitalisation in Europe must fully respect European fundamental rights and values. The Rolling Plan reflects this policy by introducing a chapter **Foundational Drivers** in 2022 which has three fundamental topics: **Cybersecurity**, **Privacy** and **Data Economy**. The topic on **Data Economy** was new in 2022.

The focus on societal values is also visible in the introduction of the topic **Safety, transparency, due process online** in 2021, standards for ensuring a safe online environment and the respect of fundamental rights online. And as part of the effort to support the Green Deal, the Rolling Plan includes chapters on standardisation for **ICT environmental impact** and for the **Circular Economy** as of 2021. **In 2024**, Circular economy has been renamed to **Circular economy and sustainability**.

Standards for **Artificial Intelligence** (AI) have been an important topic in the Rolling Plan for more than 5 years. The information in the Rolling Plan has been instrumental in the publication of the Standardisation Request by the European Commission issued in support of the AI Act. As a result, we will see increased activity on standardisation for AI in the years to come, which will continue to be reflected in the Rolling Plan.

Standardisation for the **Data Economy** and **Data Interoperability** is gaining traction fast. The Data Act, Data Governance Act, Cyber Resilience Act are driving forces behind this trend, and the European economy as a whole increasingly relies on the uninhibited flow and exchange of data.

An area receiving increasing attention by mainstream standards developers is accessibility, critical to allow equal distribution of the benefits of technological advancement in society. The European Accessibility Act (EAA; Directive (EU) 2019/882) requires a high level of accessibility to be ensured in a very large range of ICT related products and services. Dedicated standardisation is getting under way in advance of the EAA entering into force and is referenced in chapter 3.1.8. But accessibility aspects, addressed where possible on a design-for-all basis, will need to be taken into account in standardisation work under many other chapters of the Rolling Plan.

The Rolling Plan also keeps in line with technological advances. The 2023 edition of the Rolling Plan looks **beyond 5G** and addresses also standardisation to facilitate the transition to 6G. And as from 2021, the chapter on **Cloud Computing** also take into account standardisation for **Edge Computing**. As of 2021, the Rolling Plan also includes a chapter on standardisation for U-Space, the European traffic control space for drones. **Intelligent Transport Systems** received particular attention in 2024.

In the years to come we'll continue to see the Rolling Plan focus increasingly on supporting EU strategic objectives. Following the standardisation request for **AI**, more standardisation requests are imminent for current and future European digital regulations. This may include standardisation actions to enable implementation of the Data Governance Act, Data Act, Digital Services Act, Digital Markets Act, Cyber Resilience Act and Digital Europe Act. New technologies such as **Quantum** Technologies, **6G** and **Digital Twins** will receive more attention in future editions of the Rolling Plan.

The Commission would like to thank all members of the European multi-stakeholder platform on ICT Standardisation for their active collaboration and for making this document possible: the EU Member States, EFTA States, standards developing organisations (CEN, CENELEC, Ecma, ETSI, GS1, IEC, IEEE, IETF/IAB, ISO, ITU, OASIS, UN/CEFACT, W3C/ERCIM), industry associations (Business Europe, CER, Digitaleurope, ECIS, ECSO, ETNO, Eurosmart, Free ICT Europe, German Insurance Association, GSMA, OFE, Orgalim) and stakeholder associations (ANEC, ECOS, EDF, ETUC, SBS).

About the Rolling Plan for ICT Standardisation

Standards (1) play a critical role in supporting EU policies and legislation. The European standardisation system is governed by the Regulation on European standardisation (2) and implemented through the public-private-partnership with the European Standardisation Organisations (ESOs) and their members. Its uniqueness lies in the use of harmonised European Standards. When referenced in the Official Journal and when used, harmonised European Standards may provide manufacturers across the Single Market with a presumption of conformity with the requirements of harmonised EU legislation. The Commission stressed the importance of standardisation in the Communication "Shaping Europe's Digital Future"(3) issued in February 2020, and in the Communication "An EU Strategy on Standardisation. Setting global standards in support of a resilient, green and digital EU single market" issued in February 2022. The recently adopted strategy focuses on five pillars for action, including strengthening and leveraging the EU standardisation system; improving the governance of the ESOs; supporting the EU's leading position as global standards-setter; exploiting cutting-edge innovation to foster standardisation; and ensuring future standardisation expertise through education and skills.

Innovation and technology adoption provide critical support to the EU to face the challenges of a changing geo-political landscape, ageing society, digital transformation and climate change. EU policy making relies on standards and technical specifications to reap the benefits of broader, more interoperable markets and systems, and greater network effects. ICT technical specifications ensure the interoperability of digital technologies and form the cornerstone of an effective Digital Single Market.

ICT standardisation has dramatically changed over the last decades. Alongside the traditional standardisation organisations, specialised and mostly global fora and consortia have emerged as world-leading ICT standard development bodies that have developed the vast majority of standards for the internet, the World Wide Web and more recently for cloud computing, data processing and analysis and blockchain.

The Rolling Plan points to where ICT standardisation is needed

The Rolling Plan is part of the EU Standardisation Strategy (4). It addresses technology areas in need of ICT standards and explores the role that standards and technical specifications can play in achieving the policy objectives. It reaches out to the ESOs, CEN, CENELEC and ETSI and the global standard development organisations that can respond to the proposed actions and support the respective policy objectives with standardisation deliverables. The Commission publishes the Rolling Plan for ICT Standardisation to consolidate the different ICT standardisation needs and activities in support of EU policies into a single document.

The Annual Union Work Programme (AUWP) for European standardisation is another EU planning tool that is more high-level and not only focused on ICT. It is adopted by a Commission Decision in accordance with Article 8 of the EU regulation 1025/2012 and "shall identify strategic priorities for European standardisation, taking into account Union long-term strategies for growth. It shall indicate the European standards and European standardisation deliverables that the Commission intends to request from the European standardisation organisations in accordance with Article 10".

The European multi-stakeholder platform on ICT standardisation (MSP) is a group of experts set-up by Commission Decision 2011/C349/04 to advise the Commission on all matters related to ICT standardisation. The MSP comprises representatives of EU Member States and EFTA countries, together with other relevant stakeholders, including standards developing organisations, industry, SMEs and societal stakeholders in the area of ICT standardisation. Its tasks include, among other things, providing advice on the content of the Rolling Plan and on the ICT technical specifications to be identified by the Commission for referencing in public procurement (Regulation EU 1025/2012, Art. 13 and 14).

In addition there are a number of other Commission technical advisory groups that are involved in standardisation In a number of cases they come under sectorial regulation (e.g. energy, environment, trade and transport) and these are referenced in the Rolling Plan as appropriate.

The Rolling Plan facilitates the implementation of policy objectives

A key objective of the Rolling Plan is to create awareness of the importance of ICT standards in the context of policy making. Another objective is to promote the use and uptake of standards in general in order to increase ICT interoperability in those policy areas identified as needing ICT standardisation activities. Standards and technical specifications in ICT ensure interoperability and promote open ICT ecosystems. Standardisation may therefore play an important role in promoting the uptake of new technologies or the transformation of technologies and systems into new, innovative complex systems, including ICT technologies, and combining them with other technologies and technology layers.

With the emergence of new technologies and ICT domains like artificial intelligence, big data, robotics, blockchain/DLT, cloud computing and IoT, the importance of standardisation goes beyond interoperability required for completing the Digital Single Market. Given the fast pace of change in our world and its possible implications for our societies and work force, EU policymaking aims to reap the maximum benefits from digital transformation, while protecting our European values from possible adverse effects. In some instances, the availability of standards can become a precondition for implementing policy or legislation. The safety and security of 'smart' products, automated devices, and IoT, together with the reliability and validity of artificial intelligence, data and privacy protection, are all challenges that may require standards to be developed and used for regulatory or public policy purposes.

Currently, ICT standards have played a paramount role in fighting the pandemic. They are also at the heart of the digital transformation that is needed to convert our economy to a low emission, circular one.

Once the relevant standardisation activities, specific standards or technical specifications needed to support a policy or legislation have been developed, it is important that they are widely disseminated, used and implemented. It is also important that the policy contexts, in which specific standards are to be used, are highlighted with broad stakeholder involvement, and that there is awareness of the importance, benefit and need of using the standards within the policy contexts. All this is essential to maintaining the continuous community conversation of innovation and improvement cycles that this living document is intended to facilitate.

The Rolling Plan bridges between research and standardisation

Research is a rich source for new standards or standards components and for applying available standards in advanced technology contexts. The new knowledge resulting from publicly funded research and innovation programmes can be included in new or improved standards, contributing both to the implementation of the research outcomes and the usage of standards. Over the years, many European ICT research and pilot projects under EU R&D Framework Programmes have used standards or contributed to their development. EU funded pilot projects are also an important tool to test standards and provide feedback to SDOs for improvement. Initiatives linking ICT standardisation and ICT R&I appear to be most effective when carried out at the research planning stage. Standardisation awareness is therefore essential in the research life cycle. Standardisation bodies have partially set up links into research activities for facilitating the uptake of standardisation deliverables in research projects and the transfer of research results into standardisation. Research support actions can also contribute to support standardisation activities, liaison between R&I projects and standardisation organisations, awareness and international cooperation.

With this in mind, each chapter of the Rolling Plan references current R&I projects that are relevant for ongoing standards efforts.

How the Rolling Plan is compiled and maintained

The Rolling Plan is a living document. It aims to cover as much as possible the broad range of standardisation activities, technical specifications and standards relevant for the respective policy objectives and topic areas.

The Rolling Plan is reviewed each year based on the input from different Commission services and the advice from the MSP. In the interim periods between published versions of the Rolling Plan, factual updates are provided as needed in the form of specific addenda.

The Rolling Plan is based on broad stakeholder input on ICT standardisation topics and strategies. All stakeholders represented in the MSP provide regular input and feedback. They therefore help to paint a detailed picture on ongoing standardisation activities as well as standardisation needs and market/policy needs with a focus on public administration.

The Rolling Plan does not claim to be comprehensive or complete. It provides a perspective at a given point in time and relies on the contributions received and incorporated into it. The Commission services welcome feedback on any specific topics that may be missing or need correction.

(1) The term "standards" is used in this document in a generic way for all such deliverables from both recognised standards organisations and from standardisation fora and consortia – or the terms "standards and technical specifications" are used. Yet, whenever required in this document the terms are specified in a more detailed way drawing on the definitions given in the Regulation on European standardisation (1025/2012/EU).

(2) Regulation (EU) No 1025/2012 of the European Parliament and of the Council of 25 October 2012 on European standardisation

(3) COM/2018/764 final: Harmonised standards: Enhancing transparency and legal certainty for a fully functioning Single Market

(4) COM/2022/31 final: An EU Strategy on Standardisation Setting global standards in support of a resilient, green and digital EU single market

EU policy areas supported by ITCw standardisation

ICT standardisation can support European policies. Together with the MSP, the Commission services have identified the following clusters of topics. Each activity within the topic is set out in the same way: with an outline of the policy objectives, the legal base, (new or ongoing) standardisation actions, and an overview of the situation.

This rolling plan does not claim completeness or seek to be exhaustive; it focuses on those activities with a link to EU policy. The reader must rely on standardisation-related websites for information on other activities.

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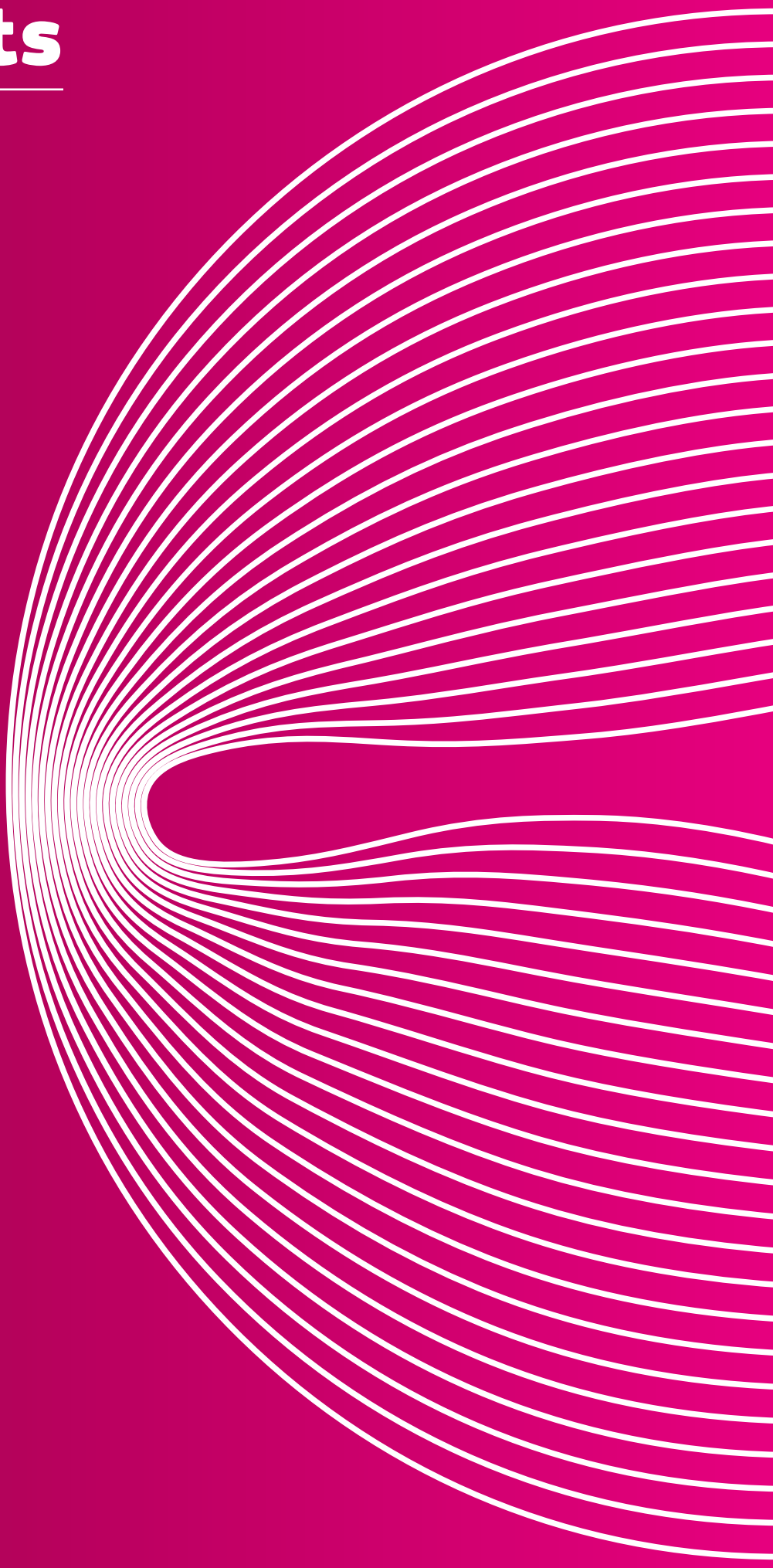
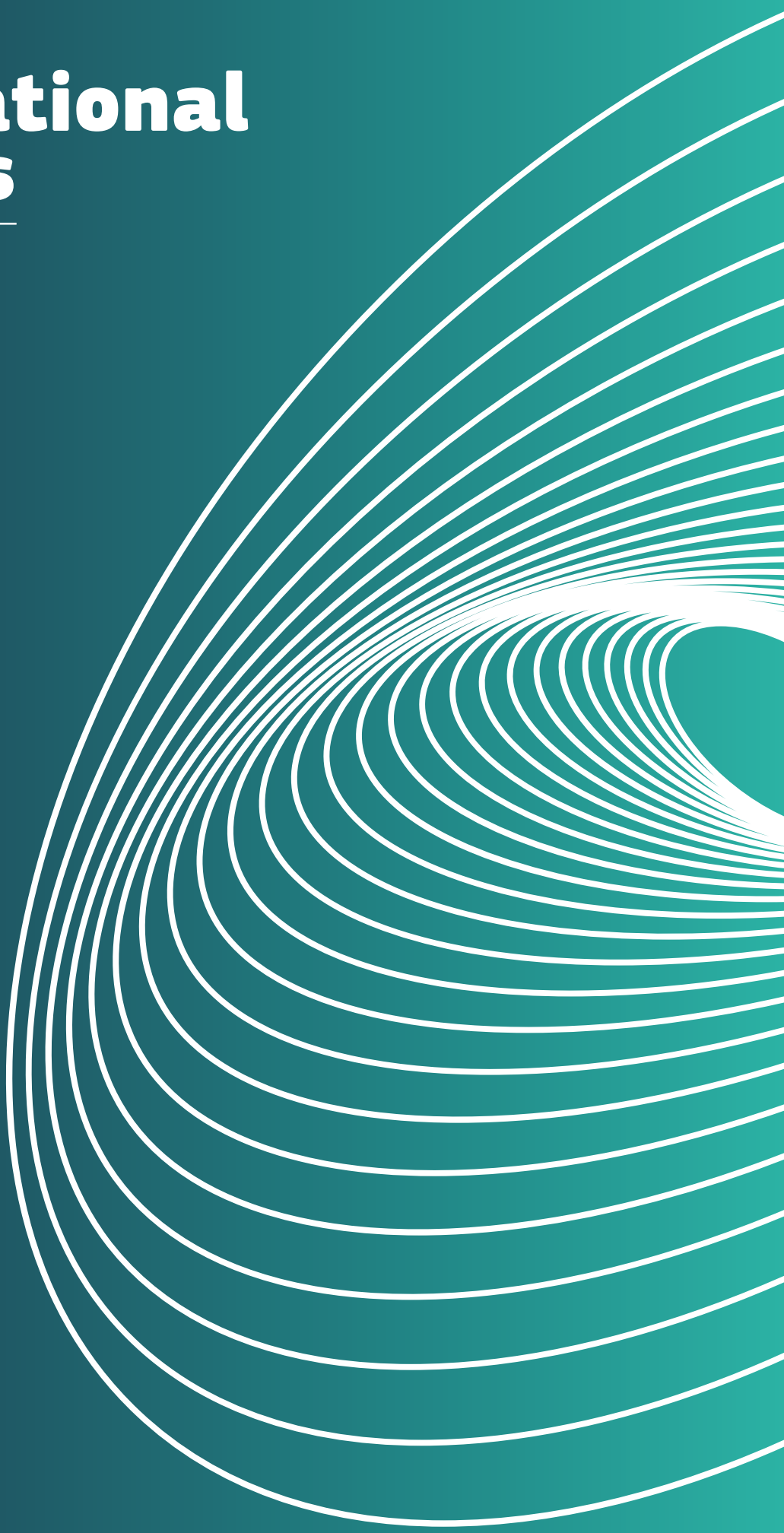


3.0 Foundational Drivers



3.0.1 Data Economy

A Policy and legislation

(A.1) POLICY OBJECTIVES

Digital technologies are transforming the economy and society, and data is at the centre of this transformation. Data-driven innovation has the potential of bringing enormous benefits for citizens and organisations, for example in support to health, mobility, and sustainability. The key role of data is reflected in many chapters of the rolling plan outlining the respective sector specific aspects. On top of that, and addressed in this chapter, data is of foundational and horizontal relevance.

As stated in the Communication "A European strategy for data", the aim is to "*create a single European data space – a genuine single market for data, open to data from across the world – where personal as well as non-personal data, including sensitive business data, are secure and businesses also have easy access to an almost infinite amount of high-quality industrial data, boosting growth and creating value, while minimising the human carbon and environmental footprint … [and] where EU law can be enforced effectively, and where all data-driven products and services comply with the relevant norms of the EU's single market*".

The following aspects are being addressed in the policy initiatives:

- Availability of data
- Imbalances in market power
- Data interoperability
- Data quality
- Data governance
- Data infrastructures and technologies
- Data lifecycle: collection, record keeping, archival and long-term preservation of information
- data space interoperability

Looking at each of the policy initiatives in more detail:

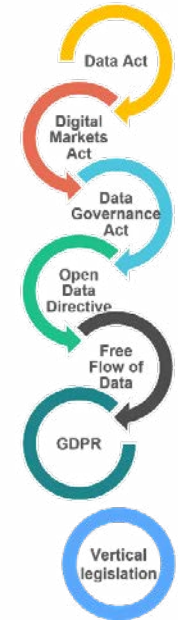
Two foundational laws establish common ground rules that apply to all data being shared in the EU. Wherever personal data is concerned, the General Data Protection Regulation (GDPR) sets the ground rules. The GDPR sets out detailed requirements for companies and organisations on collecting, storing and managing personal data. It applies to organisations based in the EU as well as organisations outside the EU that deal with personal data related to individuals in the EU. For non-personal data, the Regulation on a framework for the free flow of non-personal data in the European Union contributes to the free movement of data in the EU by limiting the situations in which data localisation requirements can be imposed by Member States.

The Data Governance Act **(DGA)** provides a framework to enhance trust in voluntary data sharing for the benefit of businesses and citizens. The Data Governance Act is a cross-sectoral instrument that aims to make more data available by regulating the re-use of publicly held, protected data, by enhancing trust in data sharing through data intermediaries and in the sharing of data for altruistic purposes. See the Data Governance Explained for more information.

The **European Data Innovation Board (EDIB)**, announced in the DGA, started its work at the end of 2023. The goals of the EDIB are to facilitate the sharing of best practices, in particular on data intermediation, data altruism and the use of public data that cannot be made available as open data, as well as on the prioritisation of cross-sectoral interoperability standards.

To harness the value of data for the benefit of the European economy and society, the Commission supports the development of common **European data spaces** in strategic economic sectors and domains of public interest. Common European data spaces bring together relevant data infrastructures and governance frameworks in order to facilitate data pooling and sharing. Coordination & Support Actions (Horizon Europe) and Deployment Projects (Digital Europe) are helping to make the common European data spaces a reality. The "Data Spaces Support Centre" (DSSC) is a Digital Europe project that aims to facilitate data sharing and link the expertise of data sharing practitioners and researchers. The Commission Staff Working Document on Common European Data Spaces published in 2022 provided a first overview of the state of play. An update was provided in the Second staff working document on data spaces, published in 2024.

The European Commission is committed to ensuring fairness in how the value from using data is shared among businesses, consumers and accountable public bodies. The Data Act is addressing the fairness aspect, and includes measures related to the access to data on smart devices and related services, measures to provide protection from unfair contractual terms, measures to enable customers to switch between data processing services, and various other measures. See the Data Act Explained for more information.



Aim	Data Covered	Regulated Actors
Ensure FAIRNESS in the allocation of data value among the actors of the data economy	Private sector data, personal and non-personal data, and co-generated (IoT) data	Businesses, public sector bodies, cloud and other data processing service providers
Tackle imbalances caused by the MARKET POWER of gatekeepers	Personal data and private sector data held by online platforms and originating from the users	Cloud and other data processing service providers, large data platforms
Ensure TRUST in data transactions	Public and private non-personal data, and personal data voluntarily made available by data holders	Data intermediation service providers, public sector bodies, (Recognised) Data Altruism Organisations
Promote use of OPEN DATA	Data in an open format that can be freely used, re-used and shared by anyone for any purpose	Public sector bodies, bodies governed by public law, public undertakings, universities
Ensure FREE FLOW OF DATA other than personal data within the Union	Non-personal data	Member States, competent authorities, professional users
Ensures a high-level of DATA PROTECTION and free flow of personal data in the Union	Personal data	Data controller, data processor, data subject, DPO, supervisory authorities, EDPB
Promote a competitive market according to SECTOR-SPECIFIC rules where necessary, e.g. automotive	Personal and non-personal data	Individuals and private and public sector bodies

Open data, including data from public institutions, is the final pillar in the European Strategy for Data. As stated in the EU Data Strategy, "*Opening up government-held information is a long-standing EU policy. This data has been produced with public money and should therefore benefit society.*" Open public sector data should be Findable, Accessible, Interoperable and Reusable (FAIR). The revised Open Data Directive **(2019)** aims to ensure that the public sector leads by example when it comes to sharing data. The High-Value Data Sets implementing act takes it a step further by specifying the data elements and level of granularity for six categories of open public sector data.

Public institutions also possess sensitive data, not suitable for sharing as open data. The Data Governance Act includes rules on the way such data can be shared in a trusted manner.

In summary, the European data economy - a European single market for data - is a foundational driver, built on European values and governed by European law. The EU data policies establish the general conditions for the trusted sharing of data, including data access rights and the fair allocation of value generated through the re-use of data. Where applicable, the horizontal legislation will be enhanced with vertical legislation to address sector-specific challenges.

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

Interoperability standards for data and data sharing services will be key enablers for the single market for data. Standards will enable the cost-efficient sharing of data and also provide common mechanisms for organisations to comply with the European law.

The chapter 3.1.3 Data interoperability (RP2024) provides more detail on the data and data spaces interoperability requirements and supporting standards.

This section provides more background on the data sharing scenarios that will need to be supported.

EUROPEAN DATA PORTALS

Open data from public institutions can effectively be shared via data portals. The data.europa.eu portal provides a central point of access to European open data from international, European Union, national, regional, local and geodata portals. By making the metadata available in a standard format, Member States can make data sets from their local portals findable, accessible and reusable to citizens and organisations.

Data portals enable the Findability and Accessibility of data sets, the first two elements of the FAIR principles.

The other two elements, Interoperability and Reusability, can further be enhanced by the use of common data standards for the data sets and by applying good data governance practices, in particular to ensure data quality.

Interoperability aspects:

- harvesting of catalogues
- open data licences
- metadata

COMMON EUROPEAN DATA SPACES

To harness the value of data for the benefit of the European economy and society, the Commission supports the development of common European data spaces in strategic economic sectors and domains of public interest. Common European data spaces bring together relevant data infrastructures and governance frameworks in order to facilitate trusted sharing.

They:

1. deploy data-sharing tools and services for the pooling, processing and sharing of data by an open number of organisations, as well as federate energy-efficient and trustworthy cloud capacities and related services;
2. include data governance structures, compatible with relevant EU legislation, which determine, in a transparent and fair way, the rights concerning access to and processing of the data;
3. improve the availability, quality and interoperability of data – both in domain-specific settings and across sectors.

Specific aspects related to the set-up of data spaces that will require standardisation:

- data governance principles (cross-domain)
- infrastructure requirements (cross-domain)
- data interoperability requirements (cross-domain)
- facilitate cross-sectoral interoperable frameworks for common standards and practices

DATA INTERMEDIATION

Article 2(11) of the Data Governance Act defines a 'data intermediation service' as a service aiming to establish commercial relationships for data sharing between an undetermined number of individuals or companies on the one hand and data users (both individuals or entities) on the other. This can be done through technical means (platforms/apps where data can be stored), legal or other means.

Details regarding the understanding of "data intermediation services" are outlined in Data Governance Act explained | Shaping Europe's digital future (europa.eu).

Specific aspects that may require standardisation:

- interoperability between data intermediation services
- methods for efficient exchange of information relating to the notification procedure for data intermediation services providers.

INDUSTRIAL DATA / DATA FROM CONNECTED DEVICES

The Data Act establishes data access and data rights for the users of connected devices. This is expected to unlock innovations in many areas:

- When you buy a 'traditional' product, you acquire all parts and accessories of that product. However, when you buy a connected product that generates data, it is often not clear who can do what with the data. By empowering users to transfer ('port') their data more easily, the Data Act will give both individuals and businesses more control over the data they generate through their use of smart objects, machines and devices, thereby allowing them to enjoy the advantages of the digitisation of products.
- By having access to the relevant data, aftermarket services providers will be able to improve and innovate their services and compete on an equal footing with comparable services offered by manufacturers. Therefore, users of connected products could opt for a cheaper repair and maintenance provider – or maintain and repair it themselves. This way, they would benefit from lower prices on that market. This could extend the lifespan of connected products, thus contributing to the Green Deal objectives.
- Availability of data about the functioning of industrial equipment will allow for factory shop-floor optimisation: factories, farms and construction companies will be able to optimise operational cycles, production lines and supply chain management, including based on machine learning.
- In precision agriculture, IoT analytics of data from connected equipment can help farmers analyse real-time data like weather, temperature, moisture, prices or GPS signals and provide insights on how to optimise and increase yield. This will improve farm planning and help farmers make decisions about the level of resources needed.
- For the sharing of such user-generated data, data spaces and data intermediation services will play an important role.

Specific aspects that may require standardisation:

- data portability
- protection of trade secrets
- protection of personal data
- data usage rights

DATA ALTRUISM

Data altruism is about individuals and companies giving their consent or permission to make available data that they generate – voluntarily and without reward – to be used for objectives of general interest.

Entities that make available relevant data based on data altruism will be able to register as 'data altruism organisations recognised in the Union'. Such entities must comply with a Rulebook, which will lay down certain requirements. In addition, the Commission will develop a European data altruism consent form to allow the collection of data across Member States in a uniform format.

Specific aspects that may require standardisation:

- tools for obtaining and withdrawing consent
- data privacy and consent metadata
- methods for registration and monitoring of recognised data altruism organisations

RE-USE OF PROTECTED DATA HELD BY PUBLIC SECTOR BODIES

The Open Data Directive regulates the re-use of publicly available information held by the public sector. However, the public sector also holds vast amounts of protected data (e.g. personal data and commercially confidential data) that cannot be re-used as open data but that could be re-used under specific EU or national legislation.

The DGA includes rules that enable the sharing of such protected data, which apply to the following categories of data (held by public sector bodies):

- commercially confidential data such as trade secrets or know-how,
- statistically confidential data,
- IPR protected data of third parties, and
- personal data.

Other than with open data, the sharing of restricted data is on request and bilateral. The request conditions must be non-discriminatory, transparent, proportionate and objective, and they shall not be used to restrict competition.

Specific aspects that may require standardisation:

- single access points
- findability of data (data catalogue)
- data protection
- anonymisation
- data aggregation
- secure processing environment

SWITCHING BETWEEN DATA PROCESSING SERVICES

The Data Act includes rules setting the right framework conditions for customers to effectively switch between different providers of data-processing services to unlock the EU cloud market. These will also contribute to an overall framework for efficient data interoperability.

Specific aspects that may require standardisation:

- portability of data assets

EARCHIVING

The European Interoperability Framework (EIF) recommends that a long-term preservation policy is formulated for records and information in electronic form held by public administrations for the purpose of documenting procedures and decisions, to keep their legibility, reliability and integrity for as long as need be accessed.

Data lifecycle, including data collection, record keeping, archival and - when necessary - long term preservation of information, supports society's demand for trustworthy records and legal certainty associated with Data Strategy key instruments and application of AI algorithms. Important information should be kept accessible and reusable for years to come, regardless of the system used to store it. eArchiving (in the Digital Europe Programme eArchiving) provides core specifications, software, training and knowledge to help people preserve and reuse information over the long-term.

SMART CONTRACTS

Smart contracts are mentioned in several places as a way to automate aspects of trusted data sharing agreements, for example related to the management of consent. Smart contracts are listed under needs since they cut across legal, organisational, semantic and technical layers. See Smart contracts and the digital single market through the lens of a "law plus technology" approach | Shaping Europe's digital future (europa.eu) for more background.

OPEN SOURCE SOFTWARE

Open source software is expected to play an important role in establishing trusted data sharing connections. Projects such as the EU-funded SIMPL project aim to help establish the infrastructure. To ensure interoperability, a close alignment between standardisation developments and open source developments will be needed.

(A.3) REFERENCES

This section provides relevant references related to sections A.1 and A.2.

- Regulation (EU) 2023/2854 of the European Parliament and of the Council of 13 December 2023 on harmonised rules on fair access to and use of data and amending Regulation (EU) 2017/2394 and Directive (EU) 2020/1828 (Data Act)
- Regulation (EU) 2024/903 of the European Parliament and of the Council of 13 March 2024 laying down measures for a high level of public sector interoperability across the Union (Interoperable Europe Act)
- COM(2020) 66 final Communication from the Commission "A European strategy for data"
- Proposal for a Regulation concerning the respect for private life and the protection of personal data in electronic communications and repealing Directive 2002/58/EC (Regulation on Privacy and Electronic Communications)

Regulation (EU) 2016/679 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation)

Regulation (EU) 2018/1807 on a framework for the free flow of non-personal data in the European Union

Regulation (EU) 2019/881 on ENISA (the European Union Agency for Cybersecurity) and on information and communications technology cybersecurity certification and repealing Regulation (EU) No 526/2013 (Cybersecurity Act)

Directive (EU) 2019/1024 on open data and the re-use of public sector information

- Regulation (EU) 2022/868 of the European Parliament and of the Council of 30 May 2022 on European data governance (Data Governance Act)
- Regulation (EU) 2022/2065 of the European Parliament and of the Council of 19 October 2022 on a Single Market For Digital Services and amending Directive 2000/31/EC (Digital Services Act)
- Regulation (EU) 2022/1925 of the European Parliament and of the Council of 14 September 2022 on contestable and fair markets in the digital sector and amending Directives (EU) 2019/1937 and (EU) 2020/1828 (Digital Markets Act)

Decision (EU) 2015/2240 on interoperability solutions and common frameworks for European public administrations, businesses and citizens (ISA2 programme) as a means for modernising the public sector (ISA2)

- COUNCIL RECOMMENDATION of 14 November 2005 on priority actions to increase cooperation in the field of arc hives in Europe:
- New European interoperability framework - Promoting seamless services and data flows for European public administrations

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

The actions proposed focus on fields where ICT standardisation can support horizontal and high-level policy objectives in the area of data economy. Actions that address sector specific needs and objectives are included in the respective chapters addressing the different sectors and technology areas.

ACTION 1: SDOs to support the work on a European trusted data framework

ACTION 2: Stock-taking and collaboration:

> **ACTION 2.1:** SDOs to identify, map and inform about standards that are available or under development that are of relevance in supporting the scenarios listed in section A2 above. StandICT.eu to contribute to this activity.
>
> **ACTION 2.2:** SDOs to collaborate on addressing standardisation needs around all the data lifecycle, from data collection to record keeping, archiving and long term preservation of information and start the respective standardisation activities, including taking into account the results of ISA2 program, the privacy by design principles, and other relevant activities (see for example section C.2).
>
> **ACTION 2.3:** Following an analysis of standards available or under development (Action 1 above) and of possible standardisation needs (Action 2 above), SDOs to develop, in collaboration when appropriate, specific standards in support of the scenarios outlined in section A.2 above, taking into account EU legislation.

ACTION 3: In the context of the MSP, start an analysis on the role of open source software complementing

standardisation in the support of the scenarios listed in section A.2 above, e.g. with APIs, protocols, service delivery and other applications.

ACTION 4: In collaboration with the Data Spaces Support Centre (DSSC), and considering the policy objectives outlined in the chapter on Data Interoperability as well as the work of the EU High-Level Forum, stakeholders to address the topic of gathering and processing data from different sources across domains and develop proposals for respective standardisation projects.

ACTION 5: Coordinate and support the standardization of data spaces by identifying cross-sectoral and cross-border projects, use cases, and pilots that implement data spaces extending beyond domain and geographic boundaries. This will help define and test the interoperability standards for data spaces

ACTION 6: SDOs to establish an exchange with relevant open source foundations for identifying open source technologies that are available or under way and that can be of relevance for supporting the upcoming EU Data Act and EU policy objectives around the EU data strategy.

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

CEN & CENELEC

CEN/CLC JTC 25 'Data management, Dataspaces, Cloud and Edge' was established in September 2024 to address standardization in these areas including:

- Data governance, data quality and data lifecycle management
- Interoperability, portability and switchability
- Organizational frameworks and methodologies, including IT management systems
- Processes and products evaluation schemes
- Guidelines
- Smart technology, objects, distributed computing devices, data services

The JTC 25 is structured into four Working Groups:

- WG 1: Advisory Group
- WG 2: Dataspaces
- WG 3: Data Management and Governance
- WG 4: Cloud and Edge

The committee aims to identify and develop standards that support the European data strategy implementation and, in particular, the Data Act standardization activities, working in close connection with the CEN Workshop 'Trusted Data Transactions', that developed and published CEN/CWA 18125 :2024 "Trusted Data Transaction". It took over the activities of the CEN/CLC Focus Group on Data, Dataspaces, Cloud and Edge, which was disbanded on December 31, 2024

CEN/TC 468 'Preservation of digital information' works on standardisation of the functional and technical aspects of the preservation of digital information.

This committee is developing a TR 'Mapping of existing standardisation deliverables on European digital archiving and preservation' and a TS 'Policy and functional requirements for the electronic archiving services'.

The TC has established WG 1 'General concepts for preservation of digital information'.

CEN-CLC/WS DS 'Digital sovereignty'

The CEN-CLC Workshop on Digital Sovereignty has produced a CWA (CWA 17995) that defines the concept of digital sovereignty with its associated terminology and framework of components, capabilities and capacities. Transforming the CWA into one or more standards is under consideration.

ECLIPSE FOUNDATION

The Eclipse Dataspace Components (EDC) is a comprehensive framework (concept, architecture, code, samples) providing a basic set of features (functional and non-functional) that dataspace implementations can re-use and customize by leveraging the framework's defined APIs and ensure interoperability by design. It is powered by the specifications of the Eclipse Dataspace Protocol (with IDSA as project lead) and the Eclipse Conformity Assessment

Policy and Credential Profile (a pivotal part of the Gaia-X AISBL Trust Framework is now).

In addition, a number of relevant activities take place within the Eclipse Dataspace WG. A comprehensive list of the projects is available on the dataspace website of the Eclipse Foundation.

ETSI

TC ESI works on smart contracts for data sharing in support of the Data Act regulation and has developed the following standards supporting long term data preservation:

- ETSI TS 119 511 Electronic Signatures and Infrastructures (ESI); Policy and security requirements for trust service providers providing long-term preservation of digital signatures or general data using digital signature techniques
- ETSI TS 119 512 Electronic Signatures and Infrastructures (ESI); Protocols for trust service providers providing long-term data preservation services

ISG CIM (Industry Specification Group on cross-cutting Context Information Management) has published Group Specifications (GSs) for an interface and underlying information model called NGSI-LD.

- ETSI GS CIM 009 V1.7.1 NGSI-LD enables applications to publish, discover, update and access context information for a broad range of application areas.
- ETSI GS CIM 006 V1.2.1 NGS-LD is based on a high-level information model for capturing the structure of physical environments as. a graph which can be efficiently serialized as linked data.

NGSI-LD provides a common basis for interoperable data and it provides an interface for implementing data sharing services to exchange data across different sector and domains.

ISG PDL (Industry Specification Group on Permissioned distributed ledgers, and Distributed Ledger technology) has published Group Reports and Specifications (GRs & GSs) for smart contracts and a GS for DAOs (Distributed Autonomous Organisations) among other subjects' non-repudiation, redactability, digital identity, etc... these have many Security and integrity related matters:

- ETSI GR PDL 004v1.1.1 - PDL Smart Contracts System Architecture and Functional Specification.
- ETSI GS PDL 011v2.1.1 - Specification of Requirements for Smart Contracts' architecture and security.
- ETSI GR PDL 014v1.1.1 Study on non-repudiation techniques.
- ETSI GS PDL 015v1.1.1 Reputation Management.
- ETSI GS PDL 026v1.1.1 Settlement of usage-based services
- ETSI GR PDL 017v1.1.1 eIDAS2, in cooperation with TC ESI.
- ETSI GS PDL 018v1.2.1 Redactable Distributed Ledgers.
- ETSI GR PDL 019v1.1.1 PDL Services for Identity and Trust Management.
- ETSI GR PDL 020v1.1.1 Wireless Concensus
- ETSI GR PDL 021v1.1.1 3GPP use cases
- ETSI GS PDL 023v1.1.1 DID - Decentralized identifiers Framework
- ETSI GS PDL 024v1.1.1 3GPP/native telecom Architecture
- ETSI GS PDL 027v1.1.1 SSI in Telecom Networks (draft)
- ETSI GR PDL 028v1.1.1 PDL in ineM2M IoT standards (draft)
- ETSI GS PDL 029v1.1.1 Distributed Autonomous Organization (in approval)
- ETSI GR PDL 030v1.1.1 Trust in Telecom System (draft)
- ETSI GS PDL 031v1.1.1Energy Consumption Data Sharing based on PDL Service (draft)

ISG CIM (Industry Specification Group on cross-cutting Context Information Management) : please change:

- ETSI GS CIM 009 V1.7.1 to ETSI GS CIM 009 V1.**8**.1; and
- ETSI GS CIM 006 V1.2.1 to ETSI GS CIM 006 V1.**3**.1

IEEE

IEEE has developed the "Report: Big Data Governance and Metadata Management: Standards Roadmap." IEEE has a collection of related standards that are active or under development, including:

- Standard for a Reference Architecture for Big Data Governance and Metadata Management (IEEE 2957)
- Cryptographic Protection Of Data (IEEE 1619)
- Data-Trading Systems (IEEE P3800)
- Standard Taxonomy for Responsible Trading of Human-Generated Data (P2895)
- Standard For Open Data: Open Data Ontology (P2896)
- Recommended Practice For Data Engineering With Heterogeneous Ecosystems And Data Sources For Efficient Data Processing, Management, And Consumption (P3131)
- Standard On Child And Student Data Governance (IEEE P7004)
- Standard On Employer Data Governance (IEEE 7005)
- Standard for Data & AI Literacy (IEEE P7015)

These pre-standardization activities support work in the Digital Economy:

- Open Data
- Synthetic Data
- Enabling a Smart and Equitable Agriculture Ecosystem with Accessible Tech and Data Tools

For more information, see: https://ieee-sa.imeetcentral.com/eurollingplan/.

IETF

The Building Blocks for HTTP APIs (httpapi) Working Group will standardise HTTP protocol extensions for use when HTTP is used for machine-to-machine communication, facilitated by HTTP APIs. Output can include the following:

- Specifications for HTTP extensions that relate to HTTP APIs (typically, new HTTP header and/or trailer fields)
- Specifications for new message body formats, or conventions for their use in HTTP APIs (e.g., patterns of JSON objects)
- Best practices and other documentation for HTTP API designers, consumers, implementers, operators, etc.

https://wiki.ietf.org/en/group/iab/Multi-Stake-Holder-Platform#h-301-data-economy

IDSA

Dataspace Protocol - The Dataspace Protocol is a set of specifications designed to facilitate interoperable data sharing between entities governed by usage control and based on Web technologies. These specifications define the schemas and protocols required for entities to publish data, negotiate Agreements, and access data as part of a federation of technical systems termed a Dataspace. See the protocol: https://docs.internationaldataspaces.org/ids-knowledgebase/v/dataspace-protocol

ISO

ISO 14721:2012 Space data and information transfer systems — Open archival information system (OAIS) — Reference model

ISO 20614:2017 Information and documentation — Data exchange protocol for interoperability and preservation

ISO 15489 Information and documentation — Records management (multipart)

ISO 20104:2015 Space data and information transfer systems — Producer-Archive Interface Specification (PAIS)

ISO 20652:2006 Space data and information transfer systems — Producer-archive interface — Methodology abstract standard

ISO 16363:2012 "Space data and information transfer systems — Audit and certification of trustworthy digital repositories"

ISO 24143:2022 "Information and documentation — Information Governance — Concept and principles"

ISO/IEC 19987 - EPC Information Services

ISO/IEC 15459 - Information technology — Automatic identification and data capture techniques — Unique identification

ISO/CD TR 24332 Blockchain and Distributed Ledger Technology in relation to authoritative records, records systems, and records management (Joint activity between ISO/TC 46/SC11 and ISO/TC 307)

ISO/IEC JTC 1

ISO/IEC JTC 1/SC 31 - Automatic identification and data capture techniques

ISO/IEC JTC 1/SC 32 *Data management and interchange*

Standards for data management within and among local and distributed information systems environments

ISO/IEC JTC 1/SC 7 *Software and systems engineering*

ISO/IEC 25012 "Data quality model" defines a quality model for data in structured format, which can be used to establish requirements, to define measures or to plan and perform data quality assessments. The concept of "data quality" refers to the usefulness of the information derived from data.

ISO/IEC JTC 1/SC 40 *IT Service Management and IT Governance*

Published standards:

ISO/IEC 38500:2015 Information technology - Governance of IT for the Organization

ISO/IEC TS 38501:2015 Information technology - Governance of IT - Implementation Guide

ISO/IEC TR 38502:2017 Information technology - Governance of IT - Framework and Model

ISO/IEC TR 38504:2016 Governance of information technology — Guidance for principles-based standards in the governance of information technology

ISO/IEC 38505-1:2017 Information technology — Governance of data — Part 1: Application of ISO/IEC 38500 to the governance of data

ISO/IEC 38505-2:2018 Information technology — Governance of data — Part 2: Implications of ISO/IEC 38505-1 for data management

Standards under development:

ISO/IEC FDIS 38503 Information technology — Governance of IT — Assessment of the governance of IT

ISO/IEC PRF TS 38505-3 Information technology — Governance of data — Part 3: Guidelines for data classification

ISO/IEC WD TS 38508 Information technology— Governance of IT— Governance implications of the Use of Shared Digital Service Platform among Ecosystem Organizations

ISO/IEC JTC 1/SC38 - WG 5 – Data in Cloud Computing and related technologies

AWI 20151 Dataspaces. Dataspace concepts and characteristics

ISO/IEC TS 10866 - Organizational Autonomy and Digital Sovereignty. Covers Use Cases which describe the need for organisational autonomy and digital sovereignty.

ISO/IEC JTC 1 SC 27 WG 4 *Security controls and services*

Published standards:

ISO/IEC 20547-4:2020 "Big data reference architecture — Part 4: Security and privacy"

Addresses the privacy and security issues in the context of big data

Standards under development:

ISO/IEC NP 27045 "Big data security and privacy — Guidelines for data security management framework" Guides data strategy and management with respect to security

ISO/IEC PWI 5181 "Data Provenance – Security and privacy" Highlights security and privacy issues with respect to data provenance

ISO/IEC PWI 6109 "Data life cycle log audit guidelines" Supports data strategies with respect to audit

ISO/IEC JTC 1 SC 27 WG 5 *Identity management and privacy technologies:* Please see the **chapter on** cybersecurity

Relevant standards for data security and privacy are developed. Please see the respective chapters on cybersecurity **and on** ePrivacy **in this Foundational Drivers section.**

ITU

ITU-T SG20 approved several Recommendations and Technical Report relevant to data in the context of smart cities and communities, which will influence digital transformation of sectors in smart cities, for example: Recommendation ITU-T Y.4472 "Open data application programming interface (APIs) for IoT data in smart cities and communities", Recommendation ITU-T Y.4498 "Framework for city-level energy data sharing and analytics among buildings", Recommendation ITU-T Y.4488 "Requirements and functional architecture of data services provided via IoT-based technologies for the safety of manufacturing-related working environments" and Recommendation ITU-T Y.4505 "Minimal Interoperability Mechanisms for smart and sustainable cities and communities".

ITU-T SG20 also approved by Technical Report ITU-T YSTR. DataModelling-Agri "Data processing, management and analytics with AI for digital agriculture"

Additionally, ITU-T is also progressing draft Recommendations in this field, including a Draft Recommendation ITU-T Y.AIoT-dpsm "Requirements and framework of data processing for smart manufacturing with Artificial Intelligence of Things" and Draft Recommendation ITU-T Y.Evaluation-dfp "Quality evaluation framework of data as a factor of production for smart sustainable cities"

More info: https://itu.int/go/tsg20 / https://u4ssc.itu.int/

ITU-T SG11 approved several new ITU-T Recommendations and Technical Report related to requirements for signalling protocols and testing with regard to data exchange and/or its management, including Recommendation ITU-T Q.3648 "Signalling architecture of data channel enhanced IMS network"; Recommendation ITU-T Q.3742 "Signalling requirements and data models for SD-DCI service"; Recommendation ITU-T Q.5029 "Data management interfaces in digital twin smart aquaculture system with intelligent edge computing"; Recommendation ITU-T Q.5030 "Data management interfaces for intelligent edge computing-based flowing-water smart aquaculture system";Recommendation ITU-T Q.4104 "Hybrid peer-to-peer communications: Signalling requirements for data streaming service".

Currently, there are eight ongoing data-related work items within ITU-T SG11.

More info: https://itu.int/go/tsg11

ITU-T FG-AI4AD finalized its mandate and reported to ITU-T SG16 the suggestion to study an automated driving (AD) safety data protocol, specifically designed for post-hoc monitoring of driving behavior. The specification (draft provided in FGAI4AD-TR01) defines the minimum set of data elements and data frames required for analyzing the safe interaction of road users over space and time. It provides a standardized way for automated and assisted driving systems to expose data required for safety monitoring in an open, interoperable manner. This study is currently underway as H.ADSDP-spec.

More info:
https://itu.int/go/FGAI4AD

OASIS

The OASIS Open Data Protocol (Odata) standards support querying and sharing and re-use of data across disparate applications and multiple stakeholders. OASIS OData standards have been approved as ISO/IEC 20802-1:2016 and ISO/IEC 20802-2:2016.

The OASIS ebXML RegRep standards define service interfaces, protocols and information model for an integrated registry and repository. The repository stores digital content while the registry stores metadata that describes the content in the repository.

W3C

Selected List:

The Web of Things (WoT)

Data Catalog Vocabulary (DCAT) - Version 3 (2024-08-22) Recommendation

JSON-LD 1.1 (2020-07-16)

Open Digital Rights Language (ODRL) Version 2.2. (2018-02-15)

Shapes Constraint Language (SHACL) (2017-07-20)

Web Annotation Data Model (2017-02-23)

Data on the Web Best Practices (2017-01-31)

Provenance (Overview with links to standards of the provenance familiy 2013-04-30)

Data Privacy Vocabularies and Controls CG

RDF-DEV CG developing RDFstar extends RDF with a compact way of annotating triples (and creates interoperability with property graphs)

See Data Activity Page for an overview.

(C.2) OTHER ACTIVITIES RELATED TO STANDARDISATION

THE EUROPEAN INTEROPERABILITY FRAMEWORK (EIF)

The European Interoperability Framework (EIF) adopted on 23 March 2017 provides specific guidance on how to set up interoperable digital public services. EIF is undertaken in the context of the Commission priority to create a Digital Single Market in Europe. It offers public administrations 47 concrete recommendations on how to improve governance of their interoperability activities, establish cross-organisational relationships, streamline processes supporting end-to-end digital services, and ensure that both existing and new legislation do not compromise interoperability efforts.

A related on going framework is under development i.e. the Smart Cities and Communities European Interoperability Framework (EIF4SCC). EIF4SCC aims to support local administrations and other actors with challenges that relate to providing interoperability services to citizens and businesses. The Framework intends to support primarily local administrations and, in particular, local policy makers. This work in progress is jointly managed by DG DIGIT as part of the ISA² Programme (2016-2020), and by DG CONNECT in the framework of the Living-in.eu movement.

DILCIS BOARD

The Digital Information LifeCycle Interoperability Standards Board (DILCIS Board) develops, publishes and supports standards which provide practical interoperability in digital archiving. SIARD (Software Independent Archiving of Relational Databases) v2.2, August 31, 2021) https://dilcis.eu/content-types/siard

EARCHIVING INITIATIVE

Based on the outcomes of the E-ARK project (2014 - 2017) and the eArchiving Building Block (2018-2021) the eArchiving Initiative provides core specifications, software, training and knowledge for information preservation and reuse over the long-term.

More information: https://digital-strategy.ec.europa.eu/en/activities/earchiving

FAIR

Project on FAIR data principes ,

SWIPO

SWIPO (Switching Cloud Providers and Porting Data), is a multi-stakeholder association facilitated by the European Commission, in order to develop voluntary Codes of Conduct for

the proper application of the EU Free Flow of Non-Personal Data Regulation / Article 6 "Porting of Data". See https://swipo.eu

GAIA-X

Gaia-X is the European Association for Data and Cloud AISBL founded with the goal to develop technical solutions and regulatory frameworks and ensure that necessary central facilities as well key federation services to guarantee the envisaged data infrastructure are made available. See https://www.gaia-x.eu/

THE OFFICIAL PORTAL FOR EUROPEAN DATA
HTTPS://DATA.EUROPA.EU/EN

https://dataspaces4.eu/

https://i4trust.org/about/

3.0.2 Cybersecurity / network and information security

A Policy and legislation

(A.1) POLICY OBJECTIVES

The **EU's Cybersecurity Strategy for the Digital Decade** (JOIN/2020/18 final), aims to ensure a global and open Internet with strong guardrails to address the risks to the security and fundamental rights and freedoms of people in Europe. Following the progress achieved under the previous strategies, it contains concrete proposals for deploying three principal instruments – regulatory, investment and policy instruments – to address three areas of EU action – (1) resilience, technological sovereignty and leadership, (2) building operational capacity to prevent, deter and respond, and (3) advancing a global and open cyberspace. Furthermore, Cybersecurity must be integrated into all digital investments, particularly key technologies like Artificial Intelligence (AI), encryption and quantum computing, using incentives, obligations and benchmarks.

The communication setting up ICT standardisation priorities for the DSM refers to cybersecurity as a priority domain for Europe.

The **NIS 2 Directive (Directive (EU) 2022/2555)** lays down measures that aim to achieve a high common level of cybersecurity across the EU. To that end, the NIS 2 Directive lays down cybersecurity risk-management measures and reporting obligations for entities operating in critical and highly critical sectors. The obligation on entities to appropriately manage cybersecurity risks includes measures for supply chain security. Furthermore, the NIS 2 Directive provides for closer cooperation and capacity building among the Member States and the relevant entities. In order to promote a convergent implementation of the cybersecurity risk-management measures across the EU, Member States should encourage the use of European or international standards and technical specifications relevant to the security of network and information systems, without imposing or discriminating in favour of the use of a particular type of technology.

The NIS 2 Directive amends the eIDAS Regulation and includes the requirements concerning cybersecurity risk-management and incident reporting for the trust service providers.

The **EU Cybersecurity Act (Regulation EU 2019/881**) established the European Cybersecurity Certification Framework in order to improve the conditions for the functioning of the internal market by increasing the level of cybersecurity within the Union and enabling a harmonised approach at Union level to European cybersecurity certification schemes, with a view to creating a digital single market for ICT products, ICT services and ICT processes. As laid down in the mandate provided by the EU Cybersecurity Act, the European Union Agency for Cybersecurity (ENISA) can be requested to prepare candidate EU cybersecurity certification schemes. All schemes must contain references to the international, European or national standards applied in the evaluation of ICT products, ICT services and ICT processes. There is a close linkage between the tasks assigned by ENISA to that purpose, and the Rolling Plan for ICT Standardisation.

On 18 April 2023, the Commission proposed an amendment to the Cybersecurity Act, setting forth provisions for the adoption of certification schemes for managed security services.

In February 2024, the Commission has adopted the first-ever European cybersecurity certification scheme, based on the tried and tested Common Criteria (ISO/IEC 15408) and Common Evaluation Methodology (ISO/IEC 18045). The scheme offers a Union-wide set of rules and procedures on how to certify ICT products in their lifecycle and thus make them more trustworthy for users. The voluntary scheme will complement the Cyber Resilience Act that introduces binding cybersecurity requirements for all hardware and software products in the EU.

Finally, a few days later, the Commission has also published Union Rolling Work Programme for European cybersecurity certification (URWP). URWP outlines strategic priorities for future European cybersecurity certification schemes. It includes general considerations for European cybersecurity certification, such as the importance of standard development activities and coherence and composability of schemes. Furthermore, the URWP lists areas for possible future certification. This includes areas where European cybersecurity certification schemes are envisaged linked to legislative developments, such as European Digital Identity Wallets and managed security services. Furthermore, areas for future reflection regarding cybersecurity certification include Industrial Automation and Control Systems and Security Lifecycle Development building on the CRA requirements as well as cryptographic mechanisms.

Commission Recommendation (EU) 2019/534 of 26 March 2019 on the Cybersecurity of 5G networks identifies a series of actions in order to support the development of a Union approach to ensuring the cybersecurity of 5G networks. The EU Toolbox on 5G cybersecurity (EU Toolbox) published in January 2020 aims to address risks related to the cybersecurity of 5G networks. It identifies and describes a set of strategic and technical measures, as well as corresponding supporting actions to reinforce their effectiveness, which may be put in place in order to mitigate the identified risks. One of the supporting actions focuses on Supporting and shaping 5G standardization.

As a result of the above-mentioned policy initiatives, the European Commission has requested the European Union Agency for Cybersecurity (ENISA) to prepare a candidate EU cybersecurity certification scheme for the certification of ICT products based on Common Criteria (EUCC), of ICT cloud services (EUCS) and the certification of key 5G mobile network components and suppliers' processes (EU5G).

The **Cyber Resilience Act (CRA), Regulation (EU) 2024/2847**, adopted on 23rd October 2024 relies on harmonised standards to support the implementation of the essential requirements it sets out, building on existing European and International standards.

The AI Act (Regulation (EU) 2024/1689) and the revised **Regulation (EU) No 910/2014 on electronic identification and trust services (eIDAS)** both add to the trust in digital services. Their implementation may require further standardisation activities, including in the area of cybersecurity.

Post-Quantum Cryptography (PQC) represents the most promising technology to ensure our communications and data at rest remain secure in the new digital quantum era. PQC algorithms are based on mathematical problems that are difficult to solve even by quantum computers, and is in principle a software-only based solution almost fully compatible with our current digital infrastructure.

Commission Recommendation (EU) C(2024) 2393 of 11 April 2024 on a Coordinated Implementation Roadmap for the transition to Post-Quantum Cryptography (PQC) represents a stepping stone for EU policy in the field of digital technologies, in line with the EU Security Union Strategy and the EU Cybersecurity Strategy, which both highlight encryption as a key technology for achieving resilience, technological sovereignty and for

building operational capacity to prevent cyberattacks. The ongoing development at a considerable pace of quantum computers represents a risk for current public key cryptography algorithms, which are used to secure and keep intact most of our communications ad transactions, and authenticate individuals and entities, and thus a transition to a quantum resistant digital infrastructure is needed. The already existing threat of so-called "harvest now, decrypt later attacks", in which malicious actors could store data now and decrypt them when a cryptographically relevant quantum computers will be present, and the fact that many devices currently in production could have lifetimes spanning 10 years or more—extending into the period when quantum computers are expected to be available, both call for initiating a transition to quantum-safe solutions now.

The Recommendation encourages Member States to develop a roadmap for a coordinated adoption and implementation of PQC across the EU, synchronising the efforts of Member States to design and implement national transition plans while ensuring cross-border interoperability. The Recommendation also encourages the evaluation and selection of relevant PQC EU algorithms with the help of cybersecurity experts, and the further adoption of such algorithms as Union standards that should be implemented across the Union as part of the Coordinated Implementation Roadmap.

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

The Communication on ICT standardisation priorities for the digital single market identified as challenges – among others – the increasing reliance of the economy on digital technologies, along with the complexity across the value chain in many of its applications, as well as access rights to standards that call for improved cooperation in the growing ecosystem of existing and emerging standardisation bodies and organisations. The EU Cybersecurity Strategy and Standardisation Strategy emphasise the need to foster broader multi-stakeholder participation and international cooperation in the area of standardisation in support of the resilience of the EU digital single market but also for reaping the benefits from the investments in standardisation and certification. Work towards addressing these challenges is ongoing.

The newly adopted European Common Criteria-based cybersecurity certification scheme and other candidate cybersecurity certification schemes in preparation (such as European cybersecurity certification scheme on cloud services (EUCS) and European 5G cybersecurity scheme) stand example for the extensive body of standards being utilized in conformity assessment and certification to improve and make transparent the effectiveness of the risk controls pertained in the use of ICT products, services and process.

The Communication on ICT standardisation priorities for the digital single market resonates with the past policy instruments mentioned above for the priority domain cybersecurity, the "bedrock of trust and reliability", with the following focus:

- A very high quality of cybersecurity, as specified in standards, to be built into any new technology or service ("security-by-design") helps to mainstream cybersecurity requirements into ICT products, services and processes as well as operators to manage their cybersecurity risks out-of-the-box and during the lifecycle by means of evaluation and certification methodologies as employed in EU cybersecurity certification schemes.
- Communication enabled distributed digital devices and services in IoT, AI, and eIDAS require seamless and interoperable secure authentication and processors across all involved subjects and objects to enable secure and transparent access to, exchange and processing of data ("protection-by-design").
- Encouraging the coherent adoption of standardisation practices across the EU to support the cybersecurity risk- management and reporting obligations for essential and important entities, which are one of the key pillars of the NIS2 Directive.
- Collaboration and multi-stakeholder governance remains key in standardisation as stressed in the EU Cybersecurity Strategy and EU Standardisation Strategy.
- Develop methods to give reasonable assurance for the security of products and services in a much shorter timeframe.

The essential cybersecurity requirements set out in the Cyber Resilience Act (CRA) are designed to ensure an adequate security protection for products with digital elements used by European citizens, business and critical infrastructures. The CRA and the standards underpinning its implementation, will create synergies with the EU Cybersecurity Act. As the next step, following the adoption of the CRA, the Commission will prepare a formal standardisation request to support its implementation.

European cybersecurity certification schemes will support the building blocks of ICT standard setting

and will increasingly rely upon standardisation to establish and harmonise the cybersecurity functional and assessment requirements applied to cybersecurity certification.

Assessments and certification of ICT products, services and processes helps consumers making informed decisions as a means technological autonomy. Certification further helps identifying such products and services on the grounds of a solid assessment of the cybersecurity requirements by a proficient evaluator. Transparent standards and specifications for the definition and verification of cybersecurity requirements form the very foundation of the "cybersecurity-by-design-and-default" proposition the European Union aims for, such as the continuous monitoring of the threat landscape for the purpose of aftermarket improvements to the sold ICT and the support with threat intelligence to remain resilient in the next wave of cyberattacks.

Further progress across technologies that are currently available to a limited set of users, such as quantum key distribution and artificial intelligence, could permit for more ways to improve the European Union's cybersecurity, i.e. for instance through the application of quantum key distribution or machine learning respectively.

It is important that *all levels of an organisation* – particularly the strategic level, business owners and the management board - are aware of the need for standards and frameworks for cybersecurity. Moreover, between organisations that are partners in (vital) online chains, clear agreements will have to be made on the standards applicable to sectors. The need for security to be ensured throughout the lifetime of the ICT product, ICT service or ICT process by design and development processes that constantly evolve to reduce the risk of harm from malicious exploitation should also be considered in the context of relevant standardisation activities. It is therefore important to undergo an analysis of the existing standards that can mitigate the current risks and map the current and presumed future risks that still need to be addressed by specific standards.

'Cybersecurity-by-design-and-default' as engendered in European policy instruments like certification schemes as well as the European Union's move towards resilience over the lifecycle of digital technologies show the way for standardisation activities. Collaboration on European and international level and broad participation in the multi-stakeholder ecosystem of standardisation further reinforce the European Union's cybersecurity posture.

The transparency of standards should not stop at the preparation phase but also leverage on their accessibility for a wide reception and adoption by the audience concerned. In particular, evaluation methodologies used in certification schemes should be quotable and available in machine readable format.

(A.3) REFERENCES

- JOIN/2020/18 final – Joint Communication The EU's Cybersecurity Strategy for the Digital Decade
- Joint Communication on Resilience, Deterrence and Defence: Building strong cybersecurity for the EU, JOIN(2017) 450 final
- JOIN(2013) 1 final Cybersecurity Strategy of the European Union: An Open, Safe and Secure Cyberspace
- Regulation (EU) 2024/2847 of the European Parliament and of the Council of 23 October 2024 on horizontal cybersecurity requirements for products with digital elements and amending Regulations (EU) No 168/2013 and (EU) 2019/1020 and Directive (EU) 2020/1828 (Cyber Resilience Act).
- Regulation (EU) 2019/881 of the European Parliament and of the Council of 17 April 2019 on ENISA (the European Union Agency for Cybersecurity) and on information and communications technology cybersecurity certification and repealing Regulation (EU) No 526/2013 (Cybersecurity Act).
- Commission Recommendation (EU) 2019/553 of 3 April 2019 on cybersecurity in the energy sector (notified under document C(2019) 2400)
- Directive (EU) 2018/1972 of the European Parliament and of the Council of 11 December 2018 establishing the European Electronic Communications Code (Recast)
- Directive 2002/58/EC of the European Parliament and of the Council of 12 July 2002 concerning the processing of personal data and the protection of privacy in the electronic communications sector (Directive on privacy and electronic communications)
- Regulation (EU) 2018/1807 of the European Parliament and of the Council of 14 November 2018 on a framework for the free flow of non-personal data in the European Union
- Directive (EU) 2016/1148 of the European Parliament and of the Council of 6 July 2016 concerning measures for a high common level of security of network and information systems across the EU (NIS Directive)

- Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to personal data processing and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation)
- Commission Recommendation (EU) 2017/1584 of 13 September 2017 on coordinated response to large-scale cybersecurity incidents and crises - C/2017/6100
- Commission Recommendation (EU) 2019/534 of 26 March 2019 on the Cybersecurity of 5G networks - C/2019/2335
- COM(2016)176 ICT Standardisation Priorities for the Digital Single Market
- COM(2015)192 A Digital single market strategy for Europe
- COM(2017)228 Communication on the Mid-Term Review on the implementation of the Digital Single Market Strategy - A Connected Digital Single Market for All and accompanying Staff Working Document SWD(2017)155
- Cybersecurity of 5G networks - EU Toolbox of risk mitigating measures (01/2020)
- COM/2020/795 Communication on A Counter-Terrorism Agenda for the EU: Anticipate, Prevent, Protect, Respond.
- Regulation (EU) 2024/1689 of the European Parliament and of the Council of 13 June 2024 laying down harmonised rules on artificial intelligence (Artificial Intelligence Act)
- Regulation (EU) 2024/1183 of the European Parliament and of the Council of 11 April 2024 amending Regulation (EU) No 910/2014 as regards establishing the European Digital Identity Framework (eIDAS 2.0)
- COM/2022/197 final Proposal for a Regulation of the European Parliament and of the Council on the European Health Data Space. The co-legislators reached an agreement on 15 March 2024, endorsed by the Council on 22 March 2024 and voted by EP plenary on 24 April 2024. The act is now undergoing the final stages of the adoption process.
- COM(2022) 454 final Proposal for a Regulation of the European Parliament and of the Council on horizontal cybersecurity requirements for products with digital elements and amending Regulation (EU) 2019/1020. The co-legislators reached an agreement on 30 November 2023, endorsed by the Council on 20 December 2023 and voted by EP plenary on 12 March 2024. The act is now undergoing the final stages of the adoption process.
- Directive (EU) 2022/2555 of the European Parliament and of the Council of 14 December 2022 on measures for a high common level of cybersecurity across the Union, amending Regulation (EU) No 910/2014 and Directive (EU) 2018/1972, and repealing Directive (EU) 2016/1148 (NIS 2 Directive).
- The EU Toolbox on 5G cybersecurity, EU Toolbox of risk mitigating measures, NIS Cooperation Group, Cybersecurity of 5G networks, 29 January 2020.
- Commission Recommendation (EU) C(2024) 2393 of 11 April 2024 on a Coordinated Implementation Roadmap for the transition to Post-Quantum Cryptography

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

ACTION 1: ESOs to develop standards in support of the cybersecurity essential requirements set out in the Cyber Resilience Act. Furthermore, SDOs to develop standards and sectorial specifications for critical infrastructure protection in support of and responding to the requirements in anticipation of the NIS2 Directive. Foster the application of EN 62443 series (base on IEC 62443 series) for the firm establishment of EU regulatory requirement operational technology (OT) security including critical infrastructures.

ACTION 2: SDOs to assess the content of existing standards and specifications applied under the European Cybersecurity Certification Framework (including both the present and planned schemes as well as initiatives under the Union Rolling Work Programme for European cybersecurity certification (URWP)) in order to revise existing documents or create new standards. It should be ensured that these standards are gradually and timely made available for providing support to any certification activity, particularly as the preparation of candidate certification schemes has come under the remit of ENISA. In particular, SDOs are encouraged to develop and harmonise standards related to the specification and assessment of security properties in ICT products and services (including cloud services), as well as those

related to security in processes related to the design, development, delivery and maintenance of an ICT product or service, as well as methodologies concerning assurance levels for industry sectors.

ACTION 3: SDOs to investigate and prepare harmonised evaluation methodologies of cybersecurity risks, controls and interfaces as required by EU policy instruments such as the Certification Framework of the EU Cybersecurity Act, the Cyber Resilience Act and others for their horizontal application into trusted products such as semiconductors, the European Digital Identity Wallet, and other digital technologies.

ACTION 4: SDOs to assess European cybersecurity policies, such as the upcoming Cyber Resilience Act, but also in relation to other policy instruments, such as the Machinery Directive, the Radio Equipment Directive or to the machine learning component for the AI Act.

ACTION 5: SDOs to investigate requirements for secure and interoperable communication protocols for mobile and fixed networks of distributed devices and services that may in addition rely upon limited resources and interfaces. Requirements should address relevant mechanisms of authenticating, registering, and processing user identities seamlessly across devices, services and applications.

ACTION 6: SDOs to assess the availability of standards and technical specifications in general or for business sectors relevant for the requirements relating to cybersecurity risk-management, including those pertaining to supply chain, incident notifications for entities in line with the NIS 2 Directive, or in support of the upcoming Cyber Resilience Act and other potential EU legislation, including as regards certification schemes as defined in the Cybersecurity Act.

ACTION 7: SDOs to assess gaps and develop standards on cybersecurity of products in support of possible certification schemes completed under the European Cybersecurity Act and in support of the upcoming Cyber Resilience Act.

ACTION 8: SDOs to explore options for the composition and matching of assurance statements as issued under the Certification Framework of the Cybersecurity Act also in conjunction to the provisions of related EU regulatory instruments like the Cyber Resilience Act, the NIS2 Directive or the new eIDAS regulation.

ACTION 9: SDOs should develop standards necessary to fulfil the objectives of the EU Cybersecurity Strategy i.e by support the European Cybersecurity Coordination Center's (ECCC) strategic agenda, including Post-Quantum Cryptography (PQC). SDOs should foster/ establish cooperation with the ECCC and national Cybersecurity Centres order to facilitate the results of current research and outputs from the funding programmes Horizon Europe and Digital Europe.

ACTION 10: SDOs to assess gaps and develop standards in support of trust services under the NIS2 Directive and other possible instruments of EU law.

ACTION 11: ESOs to work with global SDOs and the open-source community to identify available or ongoing technologies of relevance for supporting EU regulation, in particular the upcoming Cyber Resilience Act.

ACTION 12: ESOs and SDOs to evaluate the need and feasibility of sector-specific cybersecurity standards for healthcare (for e.g. electronic health record systems, digital health applications, software as medical device, medical devices software, IoMT) that would complement relevant horizontal cybersecurity standards with the view of supporting the implementation of the upcoming Cyber Resilience Act and the European Health Data Space regulation.

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

CEN & CENELEC

CEN-CLC/JTC 13 '*Cybersecurity and Data Protection*' focuses on Information Technology (IT) and develops European standards for data protection, information protection and security techniques, including: Organizational frameworks and methodologies; IT management systems; Data protection and privacy guidelines; Processes and products evaluation schemes; ICT security and physical security technical guidelines; smart technology, objects, distributed computing devices, data services, product security, support to the EU 5G Certification scheme, Radio Equipment Directive (Directive 2014/53/EU) and Cyber Resilience Act. The ISO/IEC 27000 standards, the Common Criteria for Information Technology Evaluation ISO/IEC 15408 and the Common Methodology for Information Technology Evaluation ISO/IEC 18045are adopted as European Standards by this Joint Technical Committee. The CEN CENELEC JTC 13 has established a dedicated Special Working Group on Cyber Resilience Act (CEN/CLC/JTC 13/WG 9) to start preparation for the standardisation needs of the CRA. This working group is building on the experience of the Special Working Group RED Standardization Request (CEN/CLC/JTC 13/WG 8). A new WG10 cryptography has been created to act as mirror of ISO/IEC JTC1/SC27/WG2 and focus on new topics like PQC.

CLC/TC 65X '*Industrial-process measurement, control and automation*' coordinates the preparation of European Standards for industrial process measurement, control and automation (e.g. EN IEC 62443-4-1 *Security for industrial automation and control*

systems – Secure product development lifecycle requirements). The EN IEC 62443 series address Operational Technology (OT) found in industrial and critical infrastructure, including but not restricted to power utilities, water management systems, healthcare and transport systems. These are sectorial standards, which can also be applied across many technical areas.

CLC/TC 9X provides standards on electrical and electronic systems, equipment and software for use in railway applications. CLC/TS 50701 'Railway applications – Cybersecurity' provides a specification that can be used to demonstrate that the system is cyber secured, has set Target Security Levels and achieved them during operation and maintenance. Technical Committee IEC TC 9 'Electrical equipment and systems for railways' develops international standards for the railways field which includes rolling stock, fixed installations, management systems (including supervision, information, communication, signalling and processing systems) for railway operation. The project team 63452 'Railway applications – Cybersecurity' is currently developing a standard which maps and adapts IEC 62443 requirements to the railway application domain and its operational environment.

Cybersecurity standards are also being developed in several vertical sectors, for example: CEN/TC 301 '*Road Vehicles*', CEN/TC 377 '*Air-traffic management*', CLC/TC 9X '*Electrical and electronic applications for railways*', CLC/TC 57 '*Power systems management and associated information exchange*', CEN-CLC/JTC 19 '*Blockchain and Distributed Ledger Technologies*', CEN/TC 224 '*Personal identification and related personal devices*', CLC/TC 45AX '*Instrumentation, control and electrical power systems of nuclear facilities*'.

CEN/CLC/JTC 22 WG4 is working on PQC, in particular on equitable analysis of and comparison between PQC and Quantum Cryptography (more specifically Quantum Key Distribution, QKD) progresses, which would be applicable to Actions 1 through 11.

ETSI

TC CYBER, is the ETSI centre of expertise for cybersecurity and produces standards for the cybersecurity ecosystem, consumer IoT/devices, protection of personal data and communication, network security, cybersecurity tools and guides, and in support of EU legislation (GDPR, CSA, RED, NIS/NIS2) (details in the CYBER Roadmap). TC CYBER work already supports Actions 2, 4 and 7 with EN 303 645 and complementary deliverables on consumer IoT devices (e.g. Smart Door Locks), and Action 2 with TS 103 732, protection profile for consumer mobile device which is being submitted to certification against Common Criteria to assist the manufacturers in the security certification of their products. (TC CYBER publications and TC CYBER work programme). As of Sept 2024 a new enhanced version of EN 303 645 is awaiting final publication having completed ENAP, which will provide enhanced coverage of CRA requirements.

ETSI (TC CYBER) has been working with GSMA and 3GPP in support of Action 2 on the enhancement of existing standards and assessment schemes (NESAS and SAS) for EU5G. ETSI is also working with O-RAN alliance to make O-RAN specifications including assurance specifications available, including for use with CRA. TC CYBER has also produced further standards such as Privileged Access Workstation Security TS 103 994 which supports Action 1 & 10.

ETSI CYBER QSC continue to track the work of NIST on standardisation of post-quantum algorithms. ETSI will both update and extend ETSI CYBER QSC specification as the NIST work

ETSI is following closely the work on PQC and has already published a number of relevant guidelines and documents on the migration to PQC - ETSI TR 103 949 (2023-05), on State Management for Stateful Authentication Mechanisms - ETSI TR 103 692 (2021-11), on Quantum-safe Hybrid Key Exchanges - ETSI TS 103 744 V1.1.1 (2020-12), on Migration strategies for Quantum Safe schemes - ETSI TR 103 619 V1.1.1 (2020-07). Guidelines and reports on the migration to PQC have been published by NSAs, such as ANSSI in France and BSI in Germany, ENISA (anssi-avis-migration-vers-la-cryptographie-post-quantique.pdf; Migration zu Post-Quanten-Kryptografie - Handlungsempfehlungen des BSI (bund.de); Post-Quantum Cryptography - Integration study — ENISA (europa.eu).; Post-Quantum Cryptography - Integration study — ENISA (europa.eu)....

The work by ETSI on migrating from a non-quantum safe cryptographic state to a fully quantum safe cryptographic state (Migration strategies for Quantum Safe schemes - ETSI TR 103 619 V1.1.1 (2020-07)) builds on a combination of approaches for the transition to a quantum safe digital infrastructure. It indeed also builds on the work by TC CYBER QSC: works on Quantum Cryptography with a focus on the practical implementation of quantum safe primitives, including performance considerations, implementation capabilities, protocols, benchmarking and practical architectural considerations for specific applications.
Work covers the migration towards a post-quantum world (TR 103 619) and extending that knowledge to other sectors to assist in migration (e.g. for ITS in the development of DTR/CYBER-QSC-0018) and the specification of Quantum-Safe Hybrid Key Exchanges.ISG QKD (Quantum Key Distribution): works to support the industrialisation of QKD technology to secure ICT networks.
Its publications cover requirements for security proofs of QKD protocols and authentication, precise characterisation of QKD modules and components, and approaches to integrate QKD into networks. Work considers the security of system implementations and aims to assist the certification of QKD systems using the Common Criteria.

Work covers the migration towards a post-quantum world (TR 103 619) and extending that knowledge to other sectors to assist in migration (e.g. for ITS in the development of DTR/CYBER-QSC-0018) and the specification of Quantum-Safe Hybrid Key Exchanges. ISG QKD (Quantum Key Distribution): works to support the industrialisation of QKD technology to secure ICT networks.

ISG PDL (Industry Specification Group on Permissioned distributed ledgers, and Distributed Ledger technology) has published Group Reports and Specifications (GRs & GSs) for smart contracts and a GS for DAOs (Distributed Autonomous Organisations) among other subjects' non-repudiation, redactability, digital identity, etc... these have many Security and integrity related matters:

- ETSI GR PDL 004v1.1.1 - PDL Smart Contracts System Architecture and Functional Specification.
- ETSI GS PDL 011v2.1.1 - Specification of Requirements for Smart Contracts' architecture and security.
- ETSI GR PDL 014v1.1.1 Study on non-repudiation techniques.
- ETSI GR PDL 017v1.1.1 eIDAS2, in cooperation with TC ESI.
- ETSI GS PDL 018v1.2.1 Redactable Distributed Ledgers.
- ETSI GR PDL 019v1.1.1 PDL Services for Identity and Trust Management.

- ETSI GS PDL 023v1.1.1 DID - Decentralized identifiers Framework
- ETSI GS PDL 027v1.1.1 SSI in Telecom Networks (draft)
- ETSI GR PDL 028v1.1.1 PDL in ineM2M IoT standards (draft)
- ETSI GS PDL 029v1.1.1 Distributed Autonomous Organization (in approval)
- ETSI GR PDL 030v1.1.1 Trust in Telecom System (draft)

ISG MEC (Multi-access Edge Computing): led the publication of a White Paper on "MEC security: Status of standards support and future evolutions" written by several authors participating in ETSI ISG MEC, ETSI ISG NFV SEC and ETSI TC CYBER. The work identified aspects of security where the nature of edge computing leaves typical industry approaches to cloud security insufficient. As a follow-up, the MEC group started a related study on MEC Security in (ETSI GR MEC041) and has commenced associated normative work, including API Gateway for Client Applications (ETSI GS MEC 060) with architectural impacts captured in the latest draft of the Framework and Reference Architecture specification (ETSI GS MEC 003)

ETSI also works on other specific security topics including the security of mobile communications including the 5G network equipment security assurance specifications (3GPP SA3), network functions virtualisation (ETSI NFV ISG), intelligent transport systems (ITS WG5), digital enhanced cordless telecommunications (DECT™), M2M/IoT communications (oneM2M published standards, latest drafts), reconfigurable radio systems (ETSI TC RRS), IPv6 based secure internet protocol best practices, IPv4 sunsetting guidelines (ETSI ISG IPE) and emergency telecommunications (including terrestrial trunked radio (TETRA) and electronic signatures and trust service providers with a set of standards for the certification of trust services TC ESI (ESI activities) More recently ISG ETI (Encrypted Traffic Integration) has been expanding development of the Zero Trust Architecture to address the problems cited in ETSI GR ETI 001.

TC SET, is producing the standard for 2 secure element platforms: the UICC which is the most widely deployed secure element with billions of pieces going into the market every year just as SIM cards and the SSP which is a disruptive TC SET proposal for high end, high security secure element. TC SET and some of its members are involved in the development the EU5G certification process with the development of the eUICC certification scheme based on EUCC and is committed to continue cooperation with ENISA to add an EU scheme for production and personalisation site certification. In addition, TC SET has standardized a major evolution of the UICC platform allowing the support of EU digital identity compliant with the eIDAS requirements. Regulation. TC SET has started to work on migration to PQC technologies.

IEC

Project team IEC/TC 9/PT 63452 'Railway applications – Cybersecurity' is responsible to adapt IEC 62443 requirements to the railway application domain and its operational environment, and details how the requirements are applied in that context. It provides guidance on how the security process can be interfaced with the generic RAMS life cycle of IEC 62278. It is in charge of defining the cybersecurity activities and cybersecurity deliverables needed to identify, monitor and manage cybersecurity risks within a railway application

Committee IEC/TC 65 '*Industrial-process measurement, control and automation'* develops International Standards for systems and elements used for industrial-process measurement and control concerning continuous and batch processes.

Working Group IEC/TC 65/WG 10 *'Security for industrial process measurement and control - network and system security'* is responsible for the IEC 62443 series on Industrial communication networks, which addresses the prevention of illegal or unwanted penetration, intentional or unintentional interference with the proper and intended operation, or inappropriate access to confidential information in industrial automation and control systems.

IEC 62443-4-2:2019 *'Security for industrial automation and control systems - Part 4-2: Technical security requirements for IACS components'* was published in 2019 and IEC 62443-3-2:2020 '*Security for industrial automation and control systems - Part 3-2: Security risk assessment and system design*' was published in 2020. The publication of International Standard IEC 62443-2-1 (edition 2) '*Security for industrial automation and control systems - Part 2-1: Security program requirements for IACS asset owners*' is expected in 2021.

In Europe, IEC/TC 65 is mirrored by CLC/TC 65X *'Industrial-process measurement, control and automation'*. This CENELEC standardisation work is carried out for equipment and systems, and closely coordinated with IEC/TC 65.

Technical Committee IEC/TC 57 *'Power systems management and associated information exchange*' is responsible for the IEC 62351 standards series '*Power systems management and associated information exchange - Data and communications security*'. The different security objectives of this series include authentication of data transfer through digital signatures, ensuring only authenticated access, prevention of eavesdropping, prevention of playback and spoofing, and intrusion detection.

IECEE/ICAB

Conformity Assessment (CA) is any activity, which results in determining whether a product or other object corresponds to the requirements contained in a standard or specification. The IEC runs four CA systems, each of which operates Schemes based on third-party conformity assessment certification. They establish that a product is reliable and meets expectations in terms of performance, safety, efficiency, durability, etc. This is especially crucial for Cybersecurity.

IECEE, the IEC system for Conformity Assessment Schemes for Electrotechnical Equipment and Components, which issues internationally recognized certification on Cybersecurity, operates the CB scheme, facilitating cooperation among accepted National Certification Bodies (NCBs) worldwide. NCBs perform market surveillance functions, which ensure that the overall production line is constantly compliant with the initial testing/certification.

The IECEE Full Certification Scheme is an extension of the IECEE CB Scheme, where initial and/or periodic surveillance of production is performed. The Scheme provides the evidence that each certified product offers the same quality/safety level as type-tested sample.

The CAB (Conformity Assessment Board) is responsible for setting the IEC's conformity assessment policy, promoting and maintaining relations with international organizations on conformity assessment matters.

OASIS

The OASIS Cyber Threat Intelligence (CTI) TC defines a set of information representations and protocols to support automated information sharing for cybersecurity situational awareness, real-time network defence, and sophisticated threat analysis. The Structured Threat Information eXpression (STIX), launched in 2014 and most recently issued as STIX v2.1 in 2021, language provides a common set of descriptors for security threats and events. The Trusted Automated Exchange of Indicator Information (TAXII), launched in 2014 and most recently issued as TAXII v2.1 in 2020, specification provides common message exchange patterns.

The OASIS Open Services for Lifecycle Collaboration (OSLC) project issues tools and specifications to support shared software configuration and change management, under open source licenses and using W3C Linked Data methods. In 2023 OSLC issued OSLC OSLC Configuration Management v1.0, an RDF vocabulary and a set of REST APIs for managing versions and configurations of linked data resources from multiple domains, and OSLC Tracked Resource Set v3.0, methods to track additions to and removals from a set of resources, components or code sets, as well as track state changes.

The OASIS OpenEoX technical committee will publish a unified, machine-readable approach to managing and sharing End-of-Life (EOL) and End-of-Support (EOS) information for commercial and open source software and hardware. Shareable, interoperable and widely-consumable notices of this kind will power and simplify widespread software security management frameworks.

The Open Supply-Chain Information Modeling (OSIM) TC was launched in 2024 to integrate and model information relevant to software provenance, re-use, safety, and compliance certification, in a sufficiently structured and formal structure that will permit accurate computational conclusions and responsive actions. A formal informational model is particularly relevant to policy requirements such as the Cyber Resilience Act and Software Bill of Materials (SBOM) rules. which may require the aggregation of safety and interoperability metadata from multiple sources, standards and certification sources. These are likely to incorporate or model other standards or taxonomies such as the CycloneDX standard ratified by ECMA International. the ISO/IEC 5962:2021 SPDX standard for licensing information, the OASIS Vulnerability Exploitability Exchange (VEX) profile (see CSAF in this section), and other work in progress such as IETF's Supply Chain Integrity, Transparency, and Trust (SCITT) program.

OASIS' Computing Ecosystem Supply-Chain (CES-TC) committee defines a multi-tier, cross-vendor supply chain data sharing system, using data schemas and ontologies, APIs, and smart contracts, to enable planning, enhanced visibility, enhanced resilience, and deeper traceability in order to build trusted, secure, and sustainable products and services. Digital transformation is driving more industries to build intelligent systems, using harmonized and sustainable supply chain methods to maintain resilient capacity for secure, trusted hardware and software.

The OASIS Heimdall Data Format (OHDF) committee is establishing standard data formats for exchanging normalized security data between cybersecurity tools (which today often each emit different notices, warnings and identifiers), to allow for ease of mapping and enrichment of security data to relevant compliance standards such as GDPR, PCI-DSS, etc.

The OASIS Defending Against Disinformation Common Data Model (DAD-CDM) project applies cybersecurity methods to detect, track and mitigate information quality issues. The project will extend existing object models and defence methods, including the STIX standard, to address misinformation, domestic and foreign manipulation and interference influence operations, and online harm campaigns. Defense in this context includes enabling effective remediation in real time, as well as building strategies, plans and capabilities to manage information quality risks.

The OASIS Open Command and Control (OpenC2) TC provides a suite of specifications to administer command and control of cyber defence functions across diverse devices and systems, as well as specific security protocols for transmitting those commands in potentially hostile, vulnerable, or high-latency (IoT) environments. The base standard is the OpenC2 Language Specification v1.0 published in 2019; the committee also issued a JSON Abstract Data Notation (JADN) v1.0 in 2021 for simple formal semantic expressions. See also the OpenC2 overview. In addition, the TC issued the OpenC2 Profile for Stateless Packet Filtering v1.0 in 2019, and a Specification for Transfer of OpenC2 Messages via HTTPS v1.1 and Specification for Transfer of OpenC2 Messages via MQTT v1.0 in 2021.

The Collaborative Automated Course of Action Operations (CACAO) for Cybersecurity TC provides a standard to describe the prevention, mitigation, and remediation steps in a course of action "playbooks" in a structured machine-readable format that can be shared across organizational boundaries and technology solutions. The CACAO Security Playbooks Version 2.0 specification was published in 2023.

The OASIS Common Security Advisory Framework (CSAF) TC provides standard structured machine-readable formats for security vulnerability-related advisories in JSON format, as well as secure distribution mechanisms for discovery and disclosure. Its Vulnerability Exploitability Exchange (VEX) profile adds secure methods and actionable metadata for Software Bills of Materials (SBOMs), specifying correlations to global databases of known vulnerabilities. The TC delivered CSAF Common Vulnerability Reporting Framework (#CVRF) V1.2 in 2017 and and published the version 2.0 of the framework in 2022. CSAF 2.0 has been submitted to ISO/IEC JTC 1 for further approval.

The OASIS Threat Actor Context (TAC) TC establishes a common knowledge framework that enables semantic interoperability of threat actor contextual information. This framework allows organizations to strategically correlate and analyze attack data, using a formal model relying on the W3C Ontology Web Language (OWL) specification. This formalism allows high-volume automated or AI analysis and threat response, as well as manual response, and enables a better understanding of their adversary's goals, capabilities, and trends in targeting and techniques.

The Open Cybersecurity Alliance OASIS Open Project aims to bring together vendors and end users in an open cybersecurity ecosystem where products can freely exchange information, insights, analytics, and orchestrated response. The OCA supports commonly developed code and tooling and the use of mutually agreed upon technologies, data standards, and procedures.

OASIS launched the Space Automated Threat Intelligence Sharing (SATIS) TC in 2024 to extend OASIS STIX and other cybersecurity threat sharing and response standards to space sector use cases, including satellites, ground stations, and other space infrastructure.

ISO/IEC JTC 1

Technical Committee ISO/IEC JTC 1/SC 27 *'Information security, cybersecurity and privacy protection'* produces the International Standards for the protection of electronic information assets and ICT. This includes generic methods, techniques and guidelines to address both security and privacy aspects, such as:

- Security requirements capture methodology;
- Management of information and ICT security; in particular information security management systems, security processes, and security controls and services;
- Cryptographic and other security mechanisms, including but not limited to mechanisms for protecting the accountability, availability, integrity and confidentiality of information;
- Security management support documentation including terminology, guidelines as well as procedures for the registration of security components;
- Security aspects of identity management, biometrics and privacy;
- Conformance assessment, accreditation and auditing requirements in the area of information security management systems;
- Security evaluation criteria and methodology.

Included in the 198 published International Standards are the ISO 27000 *Information Security Management* Standards series as well as the Common Criteria for Information Technology Evaluation ISO/IEC 15408 and the Common Methodology for Information Technology Evaluation ISO/IEC 18045.

Concerning Post-Quantum Cryptography (PQC), the evaluation of algorithms as candidates for standards is being done in the context of the competition led by NIST, supported by the EU through EU-funded research. Such candidate standards are meant for both key exchange and digital signatures. NIST is coordinating with ISO/IEC JTC1 SC27 (https://committee.iso.org/home/jtc1sc27) and will standardize through it. At present, one standard for stateful hash-based signatures has been approved and are specified in ISO/IEC 14888-4 (at the stage of draft information standard). The first standards are expected to be published by mid 2024. SC 27 engages in active liaison and collaboration with appropriate bodies to ensure the proper development and application of SC 27 standards and technical reports in relevant areas. ISO/IEC standards can be fast-tracked to CEN/CENELEC through the Vienna and Frankfurt agreements. CEN/CENELEC Cyber-Security Technical Committee (JTC 13) is currently working on PQC.

http://www.iso.org/iso/iso_technical_committee?commid=45306

ITU-T

ITU-T SG2 developed a new Supplement on Countering Spoofing (E.sup.spoofing to E.157). Its purpose is not the development of anti-fraud and identity verification platforms, but rather it provides information that could assist in implementing measures to counter spoofing. It should be noted that Calling Party Number authentication mechanisms are not a global solution against fraud or spoofing, the study of which is covered in various technical standardization bodies.
https://www.itu.int/ITU-T/workprog/wp_item.aspx?isn=15044

ITU-T SG17 (Security) develops globally harmonized standards on telecommunication and information security, application security, cyberspace security, identity management and authentication, data security including privacy-reserving technologies such as de-identification and multi-party computation. On application security, ITU-T SG17 works specifically on software defined networking, cloud computing, intelligent transport systems, distributed ledger technologies, quantum key distribution networks etc. Nearly 300 ITU-T Recommendations have been developed including the security Recommendations under the ITU-T X-series. ITU-T SG17 is carrying out work on key management with hybrid approaches with QKD and PQC compared to current key management of QKD networks for quantum-safe communications to consider the possible use cases and the scenarios with available technologies to find additional requirements for the scenarios and gaps to fill.

More info: http://itu.int/ITU-T/go/tsg17

http://www.itu.int/ITU-T/recommendations/index_sg.aspx?sg=17

ITU-T SG20 under question Q6/20 studies aspects related to Security, privacy, trust and identification for IoT and SC&C. ITU-T SG20 approved Recommendation ITU-T Y.4805 "Identifier service requirements for the interoperability of Smart City applications", Recommendation ITU-T Y.4459 "Digital entity architecture framework for IoT interoperability", Recommendation ITU-T Y.4807 "Agility by design for Telecommunications/ICT Systems Security used in the Internet of Things", Recommendation ITU-T Y.4808 "Digital entity architecture framework to combat counterfeiting in IoT", Recommendation ITU-T Y.4809 "Unified IoT Identifiers for intelligent transport systems", Recommendation ITU-T Y.4810 "Requirements of data security for the heterogeneous IoT devices", Recommendation ITU-T Y.4811 "Reference framework of converged service for identification and authentication for IoT devices in decentralized environment" and Recommendation ITU-T Y.4500.3 "oneM2M – Security solutions". In addition, ITU-T SG20 agreed Technical Report YSTR-IADIoT "Intelligent Anomaly Detection System for IoT".

ITU-T SG20 is working on draft Recommendation "Functional requirements and architecture of access control service of IoT platform enabled by zero trust technology in decentralized environments" (Y.IoT-acs-fra), draft Recommendation "Reference framework of cybersecurity risk management of IoT ecosystems on smart cities" (Y.IoT-Smartcity-Risk), draft Technical Report "Requirements and capability framework for identification management service of IoT device" (YSTR.IoT-IMS), draft Recommendation "Security requirements and capabilities of base station inspection services using unmanned aerial vehicles" (Y.bsis-sec), draft Supplement "Supplement to ITU-T Y.4120 - Security threats and requirements of IoT applications for smart retail stores" (Y.Sup.SRS-SR) and draft Supplement "Use cases and security requirements for sensing devices to access IoT-based electric power infrastructure monitoring system" (Y.sup.access-sec).

More info: https://itu.int/go/tsg20

Since 2016, ITU-T SG11 has been continuing its studies on implementation of security measures on signalling level in order to cope with different types of attacks on existing ICT infrastructure and services (e.g. OTP intercept, calls intercept, spoofing numbers, robocalls, etc.). Validating the calling party could help prevent such attacks. Only calls that have been successfully validated by the network would be allowed to pass through the network and reach the terminating party. The validation can be based on signing sensitive information in the signalling exchange (e.g., CLI) to guarantee the trustworthiness of the information and the caller's identity. This would involve using digital public-key certificates (ITU-T X.509) issued by dedicated Certification Authorities (CAs)

specifically for use in the telecommunications environment, not internet-based certificates.

ITU-T SG11 has been developing a series of standards defining the procedure for incorporating and validating digital public-key certificates at the signalling level, including signing the CLI in SS7-based networks (ITU-T Q.3057, Q.3062, Q.3063, Amd.2 to Q.931, Amd.6 to Q.1902.3, Amd.7 to Q.763).

Currently, ITU-T SG11 is developing ITU-T Q.TSCA "Requirements for issuing End-Entity and Certification Authority certificates for enabling trustable signalling interconnection between network entities," which defines requirements for the verification of information elements in certificate signing requests.

In addition, ITU-T SG2 has started a new work item ITU-T E.RAA4Q. TSCA "Registration Authority Assignment criteria to issue digital public certificates for use by Q.TSCA" which defines the criteria for the selection of registration authorities for use in relation to Q.TSCA, and the process by which the criteria would be used to select registration authorities to support the allocation of digital public certificates that will facilitate implementation in support of Q.TSCA.

In addition, SG11 approved Technical Report QSTR-SS7-DFS "SS7 vulnerabilities and mitigation measures for digital financial services transactions" and Technical Report QSTR-USSD (2021) "Low resource requirement, quantum resistant, encryption of USSD messages for use in financial services".

SG11 organized series of events on signalling security.

More info: https://itu.int/go/SIG-SECURITY

ITU-T SG13 develops standards for quantum key distribution networks (QKDN) and related technologies. It further studies the concepts and mechanisms to enable trusted ICT, including framework, requirements, capabilities, architectures and implementation scenarios of trusted network infrastructures and trusted cloud solutions.

ITU-T SG13 produced Y.3800-series Recommendations related to quantum key distribution networks. ITU-T SG13 is also carrying out work on trust in telecommunication and approved Y.2073 "Standardization roadmap on Trustworthy Networking and Services", Y.3058 "Functional architecture for trust enabled service provisioning", Y.3059 "Trust Registry for Devices: requirements, architectural framework" and Y.3060 "Autonomous networks - overview on trust".

W3C

W3C approaches Security in three main activities

- Develop security technology standards
- Review and increase the security of web standards
- Guide Web Developers to design and develop in a secure manner

Developing security standards

- The Web Application Security Working Group develops security and policy mechanisms to improve the security of Web Applications, and enable secure cross-site communication.
- The Web Authentication Working Group defined a client-side API providing strong authentication functionality to Web Applications.
- The Federated Identity Working Group supports authentication and authorization flows without compromising security and privacy principles.
- The Web Payment Security Working Group enhances the security and interoperability of various Web payments technologies.
- The Web Incubation Community Group is a group that incubates new Web APIs, there are some interesting and promising proposal for Cyber Security, such as: Device Bound Session Credentials, Digital Credentials API, Realms Initialization Control to virtualise web environment.

Reviewing the security of web standards

- The Security Interest Group's (SING) mission is to improve Security on the Web by advising groups developing standards on how to avoid and mitigate security issues with their technologies, the group will also suggest changes to existing standards and technologies to improve security.
- To guide Web Developers to design and develop in a secure manner, W3C created a cross-organization group to guide web developers and ensure a holistic approach to security.
- The Security Web Application Guidelines (SWAG) Community Group increases the overall security of web application development, thereby making the web a more secure platform for web users, through the edition of web creators security best practices and providing a platform for stakeholder collaboration (e.g., OpenSSF, OWASP, Open Web Docs, etc.)

More information at https://www.w3.org/Security

IEEE

IEEE has standardisation activities in the cybersecurity/network and information security space and also addresses anti-malware technologies, encryption, fixed and removable storage, and hard copy devices, as well as applications of these technologies for smart grids or in healthcare.

IEEE standards for Secure Computing include:

- IEEE 2952, Secure Computing Based on Trusted Execution Environment
- IEEE P2834, Secure and Trusted Learning Systems
- IEEE P3167, Secure Biometrics Device Interface
- IEEE P3169, Security Requirement of Privacy-Preserving Computation

IEEE Standards for cryptographic and data authentication procedures for storage devices include:

- IEEE 1619 Cryptographic Protection of Data in Block-Oriented Storage Devices
- IEEE 1619.1 Authenticated Encryption with Length Expansion for Storage Devices
- IEEE 1619.2, Wide-Block Encryption for Shared Storage Media
- IEEE 2883, Sanitizing Storage

For securing wired LANs WG 802.1 of the IEEE LAN/MAN Standards Committee has developed the IEEE 802.1AE standard which defines a Layer 2 security protocol called Medium Access Control Security (MACSec) that provides point-to-point security on Ethernet links between nodes.

IEEE actively develops security standards for healthcare and medical devices as well as wearables.

- IEEE 11073-40101 defines processes for vulnerability assessment as part of the medical device interoperability series of standards.
- The IEEE 2621 family of standards addresses wirelessly connected diabetes devices.

IEEE P2989, focuses on Authentication in Multi-Server Environment.

IEEE 1609.2.1 specifies certificate management protocols to support provisioning and management of digital certificates to end entities, that is, an actor that uses digital certificates to authorize application activities, according to IEEE Std 1609.2(TM).

IEEE SA is taking a holistic view on cybersecurity and initiated several critical pre-standardisation Industry Connections programs in this area:

- IC20-011 IoT Ecosystem Security
- IC20-021 Meta Issues in Cybersecurity
- IC21-001 Cybersecurity in Agile Cloud Computing

A new area of work focused on "Human Augmentation" is also working on issues such as security, privacy and identity: IEEE P2049.2, Standard for Human Augmentation: Privacy and Security and IEEE P2049.3, Standard for Human Augmentation: Identity.

The IEEE Computer Society AI Standards committee is working on IEEE P2986, Recommended Practice for Privacy and Security for Federated Machine Learning.

The "Privacy and Security Architecture for Consumer Wireless Devices" Working Group standardizes a privacy and security architecture for wireless consumer devices (P1912).

IEEE standards for security in the Energy Sector include:

- IEEE C37.240, Cyber Security Requirements for Substation Automation, Protection and Control Systems
- IEEE 1402, Physical Security of Electric Power Substations
- IEEE 1686, Intelligent Electronic Devices Cyber Security Capabilities
- IEEE 1711, Cryptographic Protocol for Cyber Security of Substation Serial Links
- IEEE 2030.102.1, Interoperability of Secure IP Protocols Utilized within Utility Control Systems

For more information visit https://ieee-sa.imeetcentral.com/eurollingplan/

IETF

The following IETF WGs are active in this area:

With specific reference to Commission Recommendation (EU) C(2024) 2393 of 11 April 2024 on a Coordinated Implementation Roadmap for the transition to Post-Quantum Cryptography (PQC), the IETF has established the Post-Quantum Use In Protocols Working Group which provides a standing venue to discuss PQC (operational and engineering) transition issues and experiences to date relevant to work in the IETF. The WG will document operational and design guidance which supports PQC transition. The IETF Security Area is the home for working groups focused on security protocols. They provide one or more of the security services: integrity, authentication, non-repudiation, confidentiality, and access control. Since many of the security mechanisms needed to provide these security services employ cryptography, key management is also vital.

The Security Area intersects with all other IETF Areas, and the participants are frequently involved with activities in the working groups from other areas. This involvement focuses upon practical application of Security Area protocols and technologies to the protocols of other Areas.

The full list of IETF Working Groups in the Security Area is available here: https://datatracker.ietf.org/wg#sec

https://wiki.ietf.org/en/group/iab/Multi-Stake-Holder-Platform#h-302-cybersecurity-network-and-information-security

3GPP

SA WG3 is responsible for security and privacy in 3GPP systems, determining the security and privacy requirements, and specifying the security architectures and protocols. The WG also ensures the availability of cryptographic algorithms which need to be part of the specifications.

http://www.3gpp.org/specifications-groups/sa-plenary/sa3-security

ECMA

Secure ECMAScript (SES) is a runtime environment for running ECMAScript (JavaScript) strict-mode code under object-capability (ocap) rules. ECMA Technical Committee TC39 maintains and updates the general purpose, cross platform, vendor-neutral programming language ECMAScript (JavaScript).

The programme of work in TC54 focuses on developing standards for software transparency, starting with the CycloneDX Bill of Materials specification and the Transparency Exchange API (Project Koala) for sharing software transparency information. It also aims to establish standards and guidance for multiple BOM merging algorithms and explore future directions for standards in the software transparency space. The current standard defines the CycloneDX v1.6 Bill of materials specification. CycloneDX is a standard designed to address the complexities of the software and system supply chain.

https://ecma-international.org/publications-and-standards/standards/ecma-424/

ONEM2M

oneM2M's architecture defines a common middleware technology in a horizontal layer between devices and communications networks and IoT applications. This standardizes secure links between connected devices, gateways, communications networks and cloud infrastructure. The oneM2M SDS – System Design and Security working group is also responsible for security and privacy. The following non-exhaustive list highlights some specifications which define and describe security features in oneM2M:

- TS-0001 Functional Architecture
- TS-0003 Security Solutions
- TS-0016 Secure Environment Abstraction
- TS-0032 MAF and MEF Interface Specification (MAF = M2M Authentication Framework; MEF = M2M Enrolment Function)

ITU-T SG20 transposed oneM2M specifications in their Y.450x series. See also Y.oneM2M.SEC.SOL.

All specifications are openly accessible at https://www.onem2m.org/technical.

(C.2) OTHER ACTIVITIES RELATED TO STANDARDISATION

ECSO

The European Cyber Security Organisation (ECSO) represents the contractual counterpart to the European Commission for the implementation of the Cyber Security contractual Public-Private Partnership (cPPP).

WG1 focuses on standardisation, certification, labelling and supply chain management.

https://www.ecs-org.eu/

OIDF

Risk and incident sharing and coordination working group [RISC]

RISC (chartered 2015) provides data sharing schemas, privacy recommendations and protocols to share information about important security events in order to thwart attackers from using compromised accounts with one service provider to gain access with other service providers. RISC focuses on peer to peer sharing of information related to the state of individual accounts. http://openid.net/wg/risc/charter/

NIST

NIST works on cybersecurity standards, guidelines, best practices, and other resources to first of all meet the needs of federal agencies and secondly the broader public as well as industry. The Executive Order (EO) 14028 on Improving the Nation's Cybersecurity issued on May 12, 2021 assigns NIST (among other US agencies) to work on two labelling efforts related to consumer Internet of Things (IoT) devices and consumer software with the goal of encouraging manufacturers to produce and purchasers to be informed about products created with greater consideration of cybersecurity risks and capabilities. On 19 July, the US formally announced the launch of an IoT cybersecurity labelling programme called "US Cyber Trustmark", to which NIST will be contributing.

NIST has published guidance outlining security measures for critical software, guidelines recommending minimum standards for vendors' testing of their software source code, preliminary guidelines for enhancing software supply chain security and additional guidance that identifies practices that enhance software supply chain security, with references to standards, procedures, and criteria.

Other areas of work include critical infrastructure protection:

Cyber-Physical Systems for Global Cities Project http://www.nist.gov/el/smartgrid/cpsforglobalcities.cfm

Cybersecurity for Smart Grid Systems http://www.nist.gov/el/smartgrid/cybersg.cfm

Cybersecurity for Smart Manufacturing Systems http://www.nist.gov/el/isd/cs/csms.cfm

Development of New Cybersecurity http://www.nist.gov/itl/cybersecurity-framework-021313.cfm

Reference Architecture for Cyber-Physical Systems Project Framework http://www.nist.gov/el/smartgrid/cpsarchitecture.cfm

NIST's work on PQC is focused on the organization of the internationally open competition for submission of PQC algorithms and their selection as algorithms candidate for standardization, for key exchange, digital signatures, and stateful hash-based signatures (for the latter, two schemes have been already standardized). At present, one algorithm for key encapsulation , and two algorithms for digital signatures have been standardized, specifications for one additional digital signature algorithm are being written, three reserve algorithms are being considered as additional potential standards for key agreement, an additional call for digital signatures is ongoing, with now 14 candidate algorithms having passed to round 2, and specifications for an additional open call on multiparty threshold cryptography are being developed.

Post-Quantum Cryptography | CSRC (nist.gov)

Post-Quantum Cryptography FIPS Approved | CSRC (nist.gov)

PQC Digital Signature Second Round Announcement | CSRC (nist.gov)

Multi-Party Threshold Cryptography | CSRC (nist.gov)

NIST also publishes guidelines on deprecation timeline for algorithms (NIST IR 8547 initial public draft, Transition to Post-Quantum Cryptography Standards) and on specific aspects of the implementation of PQC (NIST SP 800-227 initial public draft, Recommendations for Key-Encapsulation Mechanisms)

(C.3) ADDITIONAL INFORMATION

The Danish business community in May 2022 launched a data ethics and cybersecurity seal for companies. The seal aims to create transparency for consumers and help ambitious companies gain a competitive advantage.

In the **Netherlands**, the national government has selected a group of security specifications for its comply-or-explain policy (e.g. DNSSEC, DKIM, TLS, SPF, DMARC, STARTTLS, DANE, RPKI), and is actively using various adoption strategies to get the specifications implemented. An effective tool that was developed to drive adoption is the website www.internet.nl (available in English). Organisations and individuals can easily test whether websites offer support for modern Internet Specifications, and the code is open source.

Also in the **Netherlands**, a method to help improve secure software lifecycle management, including software development, was developed under the title Secure Software Framework (SSF). The framework is applied by software developers in innovative projects, where security of software is of the utmost importance. The framework was published by the Secure Software Alliance (SSA), a public-private program in which developers of software, end users, professional bodies, institutes for research and education and the Dutch Ministry of Economic Affairs and Climate cooperate to promote secure software and connect initiatives in this area. The SSF is part of the Roadmap for Digital

Hard- and Software Security of the Ministry of Economic Affairs and Climate.

In September 2020 in the **Netherlands**, a public-private coalition called the Online Trust Coalition (OTC) was launched, with the purpose to provide an unambiguous, efficient method for cloud service providers to demonstrate that their services are reliable and secure. And by doing so, to help to implement the relevant laws and regulations (e.g. EU Cybersecurity Act)."

In **Germany**, the Federal Agency for Information Security (BSI) bases several national cyber-security standards -concerning both critical infrastructures and SMEs- on the ISO/IEC EN 270xx family and the Federal Network Agency (BNetzA) mandates the use of ISO/IEC 27019 (with a few additional requirements in the national IT Security catalogue) for grid network operators with mandatory certification.

In **Spain** the National Security Framework (ENS), updated in May 2022, is based in current information security and Cybersecurity standards. The ENS promotes the procurement, under the principle of proportionality, of those products and services which have certified security functionality, considering the availability in the near future of the EUCC and the EUCS. Besides, in the ENS, the protection of cloud services also refers to the requirement of security certification in view of the coming EUCS.

ENISA and the European Computer Security Incident Response Team (CSIRT) community have jointly set up a task force with the goal of reaching a consensus on a 'Reference Security Incident Classification Taxonomy'. Following a discussion among the CSIRT community during the '51st TF-CSIRT meeting' (15 May 2017 in The Hague, Netherlands), it was concluded that there is an urgent need for a taxonomy list and name that serves as a fixed reference for everyone. This is where the so-called 'Reference Incident Classification Taxonomy Task Force' comes into play. The aim of this task force is to enable the CSIRT community in reaching a consensus on a universal reference taxonomy. Additionally, the task force covers the following objectives:

- Develop a reference document
- Define and develop an update and versioning mechanism
- Host the reference document
- Organise regular physical meetings with stakeholders

The ENISA NCSS Interactive Map lists all the documents of National Cyber Security Strategies in the EU: https://www.enisa.europa.eu/topics/national-cyber-security-strategies/ncss-map/national-cyber-security-strategies-interactive-map

For Post Quantum Cryptography (PQC), in the Netherlands, the General Intelligence and Security Service (AIVD), TNO and Centrum Wiskunde & Informatica (CWI) published a handbook for the migration to PQC (TNO-2024-pqc-en.pdf). The handbook is intended for the Dutch government, businesses, vital sectors and knowledge institutions that work with important information that is being encrypted, such as trade secrets.

The BSI in Germany has issued guidelines on how to implement the migration to a quantum-safe digital infrastructure (Migration zu Post-Quanten-Kryptografie - Handlungsempfehlungen des BSI (bund.de)). The recommendations encourage to implement hybrid solutions with both PQC and current asymmetric cryptography, to start with conservative choices for key exchange which ensures a high level of security even if not optimal performance (algorithms FrodoKEM, Classic McEliece from the NIST competition), to use the already standardized hash-based signature for firmware updates, to test the pre-standardized general post-quantum signature schemes for authentication (Dilithium, Falcon, Sphincs+), to consider implementing QKD only in combination with PQC.

France has issued guidelines, recommending a transition plan, in which PQC algorithms must be hybridized with well-known pre-quantum algorithms and systems must be crypto-agile, i.e. able to update its crypto algorithms (anssi-avis-migration-vers-la-cryptographie-post-quantique.pdf). Only after 2030 PQC algorithms can be introduced standalone with good confidence.

ENISA has also issued reports on PQC, on an overview of the current state of affairs on the standardization process of PQC (https://www.enisa.europa.eu/publications/post-quantum-cryptography-current-state-and-quantum-mitigation) and on the necessity to design new cryptographic protocols and integrate post-quantum systems into existing protocols (https://www.enisa.europa.eu/publications/post-quantum-cryptography-integration-study).

3.0.3 ePrivacy

A Policy and legislation

(A.1) POLICY OBJECTIVES

The ePrivacy Directive and the General Data Protection Regulation provide the legal framework to ensure digital privacy for EU citizens. The European Commission proposed a Regulation in 2017 to modernise the ePrivacy Directive and provide stronger **privacy** protection to users of all electronic communications services. The EU General Data Protection Regulation ensures that personal data can only be gathered under strict conditions and for legitimate purposes. Organisations that collect and manage your personal information must also protect it from misuse and respect certain rights.

The ePrivacy Directive builds on the Charter of Fundamental Rights of the European Union and protects the privacy and confidentiality of electronic communications and the terminal equipment of the user of electronic communications networks and any information stored on such equipment.

The enforcement of the EU data protection and privacy legal framework would be made easier if data processing products and processes were designed and built from the beginning with legal requirements in mind. This is referred to as 'data protection by design'. Standards may lay out the basic requirements for data protection by design for products and processes, minimising the risk of (i) divergent national approaches, with their related risks to freedom of movement of products and services, and (ii) the development of several, potentially conflicting, private de-facto standards.

This could be combined with the emergence of certification services: businesses who want their products and processes audited as being "privacy by design"-compliant, would have to fulfil a set of requirements defined through appropriate EU standards and robust, independent third-party certification mechanisms.

The principles of data protection by design and by default, as well as the need to undergo a data protection and privacy impact assessment are included in the General Data Protection Regulation 2016/679/EU (GDPR). This regulation replaced the Data Protection Directive 95/46/EC and has applied since 25 May 2018.

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

The focus will be on establishing a number of reference standards and/or specifications relevant to privacy in the electronic communications environment to serve as a basis for encouraging the consistent adoption of standardised practices across the EU and, where relevant, on developing harmonised standards.

The Commission has issued a standardisation request to European standards organisations seeking to routinely include privacy management methodologies in both the design and production phases of security technologies generally. (Privacy by design).

(A.3) REFERENCES

The following legal instrument should be considered at European level:

- Regulation (EU) 2016/679 on the protection of natural persons with regard to personal data processing and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation). Article 253 calls for data protection by design and by default.
- COM/2017/010 final: Proposal for a regulation of the European Parliament and of the Council concerning the respect for private life and the protection of personal data in electronic communications and repealing Directive 2002/58/EC (Regulation on Privacy and Electronic Communications)
- The Directive 2014/53/EU on the harmonization of the laws of the Member States relating to the making available on the market of radio equipment and repealing the Radio Equipment and Telecommunications Terminal Equipment (R&TTE) Directive 1999/5/EC. Article 3(3)(e) of this Directive requires that *radio equipment within certain categories or classes shall be so constructed that it [...] incorporates safeguards to ensure that the personal data and privacy of the user and of the subscriber are protected*". The Commission is empowered to adopt delegated acts specifying which categories or classes of radio equipment are concerned by each of the requirements and there is ongoing work on the matter.

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

In the light of the accountability and privacy by design principles, ICT standards generally should be created in order to ensure a high-level of protection of individuals with regard to personal data processing, and the free movement of such data, and the application of privacy by design methodologies. Privacy and data protection standards should thus be examined, developed or improved if necessary, so as to provide standardised methods that support that review and improvement in due respect of EU data protection rules.

Proposed specific areas for SDOs to focus on are:

ACTION 1: Continuing work on standardising browser functionalities and defaults to enable users to easily control whether they want to be tracked.

ACTION 2: SDOs to work on standardised solutions for location data used by mobile applications. ISO/IEC 29184 Information technology - Online privacy notices and consent is adopted unmodified as EN ISO/IEC 29184.

ACTION 3: SDOs to investigate standards for supporting compliance and certification of compliance with GDPR and possible other EU data privacy requirements. Also a gap analysis should be run so to understand needed future work that may have to be prioritised.

ACTION 4: Promote EU-wide attention to standardisation of privacy statements and terms & conditions, given that there is mandatory acceptance of diverse, ambiguous and far-reaching online privacy conditions, and taking into account the GDPR. The Kantara CIS work and the data use statements described in ISO/IEC 19944 could be used as a basis for this action.

ACTION 5: SDOs to continue investigating technical measures apt to make personal data anonymous or pseudonymised (and therefore unintelligible by those who are not authorised to access them).

ACTION 6: SDOs to continue investigating how to warrant a user-centric approach in privacy & access management: see http://www.laceproject.eu/blog/give-students-control-data/ and http://www.lvm.fi/julkaisu/4440204/mydata-a-nordic-model-for-human-centred-personal-data-management-and-processing.

ACTION 7: SDOs to prevent unwarranted pervasive monitoring by default when developing standards. This is not only relevant in the context the internet but also the IoT.

ACTION 8: SDOs to develop secure coding standards for secure application development: EU-wide attention to standardisation of privacy statements and terms & conditions as far as possible, given the existing state of mandatory acceptance of diverse, ambiguous and far-reaching online privacy conditions, taking into account the GDPR and the emergence of the IoT, where (embedded) devices process the device owner's personal data and possible different device users' personal data, creating additional challenges to transparency and informed consent.

ACTION 9: SDOs to develop standards addressing assurance on the management of data protection controls (e.g. comparable to SOC 2 Type 2 or ISAE 3402). In general SDOs should continue to focus on privacy by design principles and on Privacy Enhancing Technologies (PETs) and their standardisation as a horizontal matter.

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

ETSI

ETSI TC CYBER (TC CYBER work programme) is the main committee in ETSI that develops standards for security and privacy. TC CYBER published standards on cryptography for protecting personal data securely, with fine-grained access controls (Attribute-Based Encryption) and a practical introductory guide to Technical Standards for Privacy as well as mechanisms for privacy assurance. More generally, TC CYBER works on mechanisms for IoT discovery that prevent and restrict superfluous disclosure of device identity information to form a connection, which protects user and device privacy. TC CYBER's series on Middlebox Security Protocols creates protocols for a new generation of more privacy-focused proxies, whilst also providing robust security. Consumer IoT security and privacy EN 303 645, the first globally applicable standard for IoT security, covers data protection; the TS version (TS 103 645) is being enhanced to expand, amongst other things, the data protection provisions. TC CYBER has published work on the misuse of IoT home devices by perpetrators of domestic abuse, with a first step in the Guide to Cyber Security for Consumer Internet of Things (TR 103 621 V1.2.1) which now contains text on coercive control.

ETSI's security and privacy work is presented here https://www.etsi.org/technologies-clusters/technologies/cyber-security

ETSI ISG CIM has published requirements and recommendation for enabling privacy and security when registering/exchanging context

information, in particular using the NGSI-LD interface (ETSI GS CIM 009 V1.87.1), which may contain identification of natural persons The relevant specifications are:

- ETSI GS CIM 019 V1.1.1 (2022-08): Handling of provenance information in NGSI-LD
- ETSI GR CIM 018 V1.1.1 (2022-09): Enabling chain of trust from Content Sources to Content Consumers
- ETSI GR CIM 007 V1.1.2 (2022-03): Security and Privacy

3GPP TS 33.501 "Security architecture and procedures for 5G System" covers privacy for mobile.

CEN & CENELEC

CEN-CLC/JTC 13 'Cybersecurity and Data protection' develops standards for data protection, information protection and security techniques with specific focus on cybersecurity covering all concurrent aspects of the evolving information society, including privacy guidelines. The JTC adopts international standards (such as JTC 1) as ENs, with additional specific European requirements in the context of specific European legislative and policy context (Cybersecurity Act, GDPR, NIS, sectoral legislation), to support privacy protection in the European context.

EN 17529 'Data protection and privacy by design and by default has been published in the meantime. Furthermore JTC13 develops prEN 17926 Privacy Information Management System per ISO/IEC 27701 - Refinements in European context to respect European requirements for Privacy Information Management Systems.

Moreover, CEN/TC 224 'Personal identification and related personal devices with secure element, systems, operations and privacy in a multi sectorial environment' develops standards for strengthening the interoperability, security and privacy of personal identification and its related personal devices and systems.

IEEE

IEEE has several standards and pre-standards (IC) activities in the ePrivacy space:

- Under the LAN/MAN Standards Committee a Recommended Practice (IEEE 802E) has been developed to specify a privacy threat model for IEEE 802 technologies and provide recommendations on how to protect against privacy threats, which is important as IEEE 802 technologies play a major role in Internet connectivity.
- Several projects are ongoing in the area of personal data privacy, as an outcome of the IEEE Global Initiative for Ethical Considerations in Autonomous and Intelligent Systems, including:
  - IEEE 7002, Standard for Data Privacy Process
  - IEEE P7012, Standard for Machine Readable Personal Privacy Terms
- Other relevant standards and pre-standards activities include:
  - IEEE 2410, Standard for Biometric Privacy
  - IEEE P1912, Privacy and Security Framework for Consumer Devices
  - IEEE P2876, Privacy in Online Gaming
  - IEEE P3117, Standard for Interworking Framework for Privacy-Preserving Computation
  - IEEE P3156, Standard for Requirements of Privacy-preserving Computation Integrated Platforms
  - IEEE P3169, Standard for Security Requirement of Privacy-Preserving Computation

Pre-standards activities include:

- IC Cyber Security for Next Generation Connectivity Systems, with the aim to evaluate and rethink architectures that enhance Cyber Security in digital systems and also addressing privacy aspects.
- IC Synthetic Data.

Some standards activities address privacy for children and youth, including:

- IEEE 2089, Standard for an Age Appropriate Digital Services Framework Based on the 5Rights Principles for Children
- IEEE P7004, Child and Student Data Governance

Another area is privacy of data in healthcare:

- IEEE P2049.2, Standard for Human Augmentation: Privacy and Security
- IEEE P2933, Standard for Clinical Internet of Things (IoT) Data and Device Interoperability with TIPPSS - Trust, Identity, Privacy, Protection, Safety, Security
- IEEE P2968.2, Trial Use Recommended Practice for Decentralized Clinical Trials Threat Modeling, Cybersecurity, and Data Privacy
- Industry Connections, Transforming the Telehealth Paradigm: Sustainable Connectivity, Accessibility, Privacy, and Security for All

IEEE also has other new standardisation projects for privacy in consumer wireless devices and drones.

For more information, see: https://ieee-sa.imeetcentral.com/eurollingplan/.

W3C

The Federated Identity Working Group develops specifications to allow a website to request a federated identity credential or assertion with the purpose of authenticating a user and/or requesting a set of claims in a compatible way to OIDC or SAML.

The Privacy Interest Group's mission is to improve privacy on the Web by advising groups developing standards on how to avoid and mitigate privacy issues with their technologies. PING also suggests changes to existing standards and technologies to improve the privacy of existing systems.

The W3C Data Privacy Vocabularies and Controls CG (DPVCG) develops a taxonomy of privacy terms, which includes in particular terms from the new European General Data Protection Regulation (GDPR), such as a taxonomy of personal data as well as a classification of purposes (i.e., purposes for data collection), and events of disclosures, consent, and processing such personal data. This will help to create data protection aware data handling policies for systems based on linked data such as the Web of Things.

The W3C Data Privacy Vocabularies and Controls CG (DPVCG) develops a taxonomy of privacy terms, which includes in particular terms from the new European General Data Protection Regulation (GDPR), such as a taxonomy of personal data as well as a classification of purposes (i.e., purposes for data collection), and events of disclosures, consent, and processing such personal data. This will help to create data protection aware data handling policies for systems based on linked data such as the Web of Things.

The mission of the Private Advertising Technology Community Group is to incubate web features and APIs that support

advertising while acting in the interests of users, in particular providing strong privacy assurances. The transition to a Working Group is currently under discussion.

The Note on Privacy Principles by the Technical Advisory Group (TAG) is not yet endorsed by the W3C.

OASIS

The OASIS Privacy Management Reference Model (PMRM) TC provides a guideline or template for developing operational solutions to privacy issues. It also serves as an analytical tool for assessing the completeness of proposed solutions and as the basis for establishing categories and groupings of privacy management controls. One of its outputs is a Quick Start Guide for Data Protection to Support Regulatory Compliance.

The OASIS Classification of Everyday Living (COEL) TC provides a privacy-by-design framework for behavioral data collection and reporting. It provides a framework for implementing a distributed system capable of capturing data relating to an individual as discrete events.

The OASIS Context Server (CXS) TC was chartered to create specifications for Customer Data Platforms as a core technology for enabling the delivery of personalized user experiences. A CDP not only aggregates personal data from various sources, but can also manage consents and profiles. In specific cases, CDP may act as the source-of-truth across systems, and enable effective privacy management.

The OASIS Privacy by Design Documentation for Software Engineers (PbD-SE) TC provided privacy governance and documentation standards for software engineers. It enables software organizations to embed privacy into the design and architecture of IT systems, without diminishing system functionality.

IETF

The DNS PRIVate Exchange (dprive) WG develops mechanisms to provide confidentiality to DNS transactions, to address concerns surrounding pervasive monitoring (RFC 7258). The set of DNS requests that an individual makes can provide an attacker with a large amount of information about that individual. DPRIVE aims to deprive the attacker of this information.

The Privacy Pass (privacypass) WG is standardising a protocol that provides a performant, application-layer mechanism for token creation and anonymous redemption. Servers (Issuers) create and later verify tokens that are redeemed by an ecosystem of clients, such that:

- An Issuer cannot link a redeemed token to one of N previously created tokens using the same key with probability non-negligibly larger than 1/N.
- Clients can verify that a token created by an Issuer corresponds to a committed keypair.
- Tokens are unforgeable.

The token issuance and redemption mechanisms are efficient.

The QUIC (quic) WG is developing the QUIC protocol which provides end-to-end security for transport connections, including protection of header fields that are left unprotected by TLS. The QUIC working group's specifications are currently in last call, and will soon become recognised standards. The use of QUIC in the Internet is already quite high and growing.

Many network topologies lead to situations where transport protocol proxying is beneficial. For example, proxying enables endpoints to communicate when end-to-end connectivity is not possible, or to apply additional encryption where desirable (such as a VPN). Proxying can also improve client privacy, e.g., by hiding a client's IP address from a target server. The Multiplexed Application Substrate over QUIC Encryption (masque) WG is developing mechanism(s) that allow configuring and concurrently running multiple proxied stream- and datagram-based flows inside an HTTPS connection. These mechanism(s) are collectively called MASQUE.

The MAC address Device Identification for Network and Application Services (madinas) Working Group is documenting recommended means to reduce the impact of randomized and changing MAC addresses (RCM) while ensuring that the privacy achieved with RCM is not compromised. The Working Group will liaise with other relevant organizations, such as IEEE 802 and the Wireless Broadband Alliance (WBA), by coordinating on the different recommendations, as well as potential follow-up activities within or outside the IETF.

There are many situations in which it is desirable to take measurements of data which people consider sensitive. For instance, a browser company might want to measure web sites that do not render properly without learning which users visit those sites, or a public health authority might want to measure exposure to some disease without learning the identities of those exposed. In these cases, the entity taking the measurement is not interested in people's individual responses but rather in aggregated data (e.g., how many users had errors on site X). Conventional methods require collecting individual measurements in plaintext and then aggregating them, thus representing a threat to user privacy and rendering many such measurements difficult and impractical.

New cryptographic techniques address this gap through a variety of approaches, all of which aim to ensure that the server (or multiple, non-colluding servers) can compute the aggregated value without learning the value of individual measurements. The Privacy Preserving Measurement (ppm) Working Group will standardize protocols for deployment of these techniques on the Internet.

The Oblivious HTTP Application Intermediation (ohai) Working Group will define a protocol for anonymization of HTTP requests using a partly-trusted intermediary, a method of encapsulating HTTP requests and responses that provides protected, low-latency exchanges. Applications and use cases best suited for this protocol are those that have discrete, transactional queries that might reveal small amounts of information that accumulate over time. Examples include DNS queries, telemetry submission, and certificate revocation checking.

The Privacy Enhancements and Assessments Research Group (PEARG) in the IRTF is a general forum for discussing and reviewing privacy enhancing technologies for network protocols and distributed systems in general, and for the IETF in particular.

https://wiki.ietf.org/en/group/iab/Multi-Stake-Holder-Platform#h-303-eprivacy

The Detecting Unwanted Location Trackers (dult) Working Group will standardize an application protocol for information exchange between location-tracking accessories and nearby devices, along with actions that these accessories and devices should take once unwanted tracking is detected. This protocol is intended to protect people against being unknowingly tracked. The intent of this WG is

to make it easier for arbitrary devices to detect unwanted tracking by these accessories. The protocols and interactions between devices may be limited to certain states or modes, such as the accessory being separated from a paired/owner device.

The working group will define privacy and security properties of its solution, including privacy and security protections for accessory owners when accessories are used appropriately, and evaluate the tradeoffs. The mechanisms specified by the WG will be designed to not create new vectors for user tracking.

ISO/IEC JTC 1

ISO/IEC JTC 1 SC 7 on System and software engineering published a set of standards (ISO/IEC 25000 series and specifically 25024) that includes the possibility to design specific privacy measures.
https://www.iso.org/committee/45086.html

ISO/IEC JTC 1 SC 27 on IT Security Technologies published a Code of Practice for the protection of personally identifiable information (PII) in the public cloud (ISO/IEC 27018:2014), and is developing a draft international standard privacy capability assessment model (ISO/IEC DIS 29190). Another relevant working item is ISO/IEC 27552 - Enhancement to ISO/IEC 27001 for privacy management - Requirements.
http://www.iso.org/iso/iso_technical_committee?commid=45306

ISO/IEC JTC 1 SC 27 *WG 5 Identity management and privacy technologies*

Published standards:

- ISO/IEC 29100:2011"Privacy framework"
  - Provides a general conceptual framework on the topic of privacy and personal data
- ISO/IEC 24760 "IT Security and Privacy — A framework for identity management" (3 parts from 2019, 2015, and 2016)
  - Gives a framework to assess and influence, who individuals can be identified or not identified in the context of data and who can how influence and control this
- ISO/IEC 29101:2018 "Privacy architecture framework"
  - Provides a conceptual framework on the handling of privacy and personal data
- ISO/IEC 20889:2018 "Privacy enhancing data de-identification terminology and classification of techniques"
  - Defines a terminology and classifies techniques to assess whether data are personal data or not
- ISO/IEC 29134:2017 "Guidelines for privacy impact assessment"
  - Provides a conceptual framework to assess the impact of data (processing) on privacy and how data strategies can consider that
- ISO/IEC 29146:2016 "A framework for access management"
  - Provides a conceptual framework to manage and strategize access to data
- ISO/IEC JTC 1/SC 27/WG 5 SD4 "Standard Privacy Assessment (SPA)"
  - Provides guidance to consider privacy when and while developing standards, especially standards on handling data, freely available at https://www.din.de/en/meta/jtc1sc27/downloads
- ISO 31700-1:2023 Consumer protection — Privacy by design for consumer goods and services. Part 1: High-level requirements
- ISO/TR 31700-2:2023 Consumer protection — Privacy by design for consumer goods and services. Part 2: Use cases

Standards under development:

- ISO/IEC DIS 27559 "Privacy enhancing data de-identification framework"
- Provides a conceptual framework to assess whether data are personal data or not

ITU-T

ITU-T SG17 works on data security privacy-reserving technologies such as de-identification and multi-party computation.

It has approved Recommendations:

- ITU-T X.1058 "Information technology - Security techniques - Code of practice for Personally Identifiable Information protection"
- ITU-T X.1087 "Technical and operational countermeasures for telebiometric applications using mobile devices"
- ITU-T X.1148 "Framework of de-identification process for telecommunication service providers"
- ITU-T X.1171 "Threats and requirements for protection of personally identifiable information in applications using tag-based identification"
- ITU-T X.1212 "Design considerations for improved end-user perception of trustworthiness indicators"
- ITU-T X.1250 "Baseline capabilities for enhanced global identity management and interoperability"
- ITU-T X.1252 "Baseline identity management terms and definitions"
- ITU-T X.1275 "Guidelines on protection of personally identifiable information in the application of RFID technology"
- ITU-T X.1403 "Security considerations for using distributed ledger technology data in identity management"
- ITU-T X.1451 "Risk identification to optimize authentication"
- ITU-T X.1363 "Technical framework of personally identifiable information (PII) handling system in IoT environment"
- ITU-T X.1770 "Technical guidelines for secure multi-party computation" (under approval as of Sept 2021).

More info: http://itu.int/ITU-T/go/tsg17

ITU-T SG20 is currently working on Draft Supplement ITU-T Y.Supp-Imp-CSIADE "Supplement to ITU-T Y.4811 - Implementation of converged service for identification and authentication for IoT devices in decentralized environment".

More info: https://itu.int/go/tsg20

ITU-T SG11 is currently developing the following draft Recommendations on Q.SI-SAN "Signalling requirements for service identification in service aware network"; and Q.CPI "Signalling requirements for computing power identification in computing power network".

More info: http://itu.int/go/tsg11

ONEM2M

Standardize secure links between connected devices, gateways, communications networks and cloud infrastructure. The oneM2M SDS – System Design and Security working group is also responsible for security and privacy.

Potential required enhancements to oneM2M specifications, to support regulations like GDPR or PIPA, are investigated and defined in the current oneM2M work item: WI-0095 - oneM2M System Enhancements to Support Data Protection Regulations.
All oneM2M Specifications are openly accessible under Specifications (onem2m.org).

(C.2) OTHER ACTIVITIES RELATED TO STANDARDISATION

KANTARA

User-Managed Access (UMA)
UMA is an OAuth-based protocol designed to ensure the privacy of websites by giving web users a unified control point for authorising access to online personal data, content, and services, no matter where they are hosted.
http://kantarainitiative.org/confluence/display/uma/Home

Consent & Information Sharing Workgroup (CIS)
People's capacity to manage their privacy is increased if they are able to aggregate and manage consent & information sharing relationships with consent receipts. Standardised consent receipts also provide the opportunity for organisations to advertise trust. The core receipt specification addresses general, or regulatory, consent requirements. More elaborate consent receipts can become a vehicle for trust networks, federations, trust marks, privacy icons, assurances, certifications and self-asserted community and industry reputations.
https://kantarainitiative.org/confluence/display/infosharing/Home

(C.3) ADDITIONAL INFORMATION

Management of controls over the access to and ownership of data should be considered essential for effective implementation of privacy measurements.

3.1 Key Enablers

3.1.1 5G and beyond

A Policy and legislation

(A.1) POLICY OBJECTIVES

The 2015 digital single market (DSM) strategy and the communication "*Towards connectivity for a European gigabit society*" identify very high-capacity networks like 5G as a key asset for global competitiveness. In addition to fibre-like performance for mobile networks, the benefits of adopting 5G go beyond the telecom sector to enable a fully mobile and connected society and to empower socioeconomic transformations in a variety of ways (many of which are not possible at present. These transformations include higher productivity, sustainability, well-being and innovation opportunities for smaller actors and start-ups. 5G makes a new wave of convergence possible through digital business models reaching non-ICT-native industrial sectors. In that context, the EU sees 5G as a core infrastructure to support the DSM strategy's wider objectives for the digitisation of the industry.

The strategy for *Digitising European Industry* and the Communication on *ICT standardisation priorities for the digital single market* announced the European Commission's intention to develop a 5G action plan for EU-wide deployment, which was adopted in September 2016. The communication drew on multiple consultations, events[4] with stakeholders, a targeted survey[5] , several studies , a 5G industry manifesto[6] and early results of the 5G-PPP. It presented a set of targeted actions for a timely and coordinated deployment of 5G networks in Europe through a partnership between the Commission, Member States, and industry. It leveraged the new opportunities offered by the revised telecommunication regulatory framework by putting it in the context of a concrete European project of high added value for businesses and citizen.

Furthermore, Member States, in the Ministerial Declaration of Tallinn of July 2017[7] have identified the objective of preserving 5G global interoperability as key in order to make 5G a success for Europe. Standards are of paramount importance to ensure the competitiveness and interoperability of global telecommunication networks. Therefore, Member States endorsed a "comprehensive and inclusive approach to 5G standardisation as a priority for the DSM". Member States promoted "cross-industry partnerships to support the timely definition of standards backed by industrial user experiments, including through the leveraging of international cooperation partnerships, in particular for the digitisation of industry. Encouraging innovation and development of products and services making use of 5G networks across the EU should be a priority".

In addition, the EU toolbox for 5G security constitutes an important milestone as it puts in place an EU coordinated approach to secure 5G networks calling notably on implementation of 5G standards across Europe as part of relevant tools.

Following the publication of the EU toolbox for 5G cybersecurity, the Commission launched in February 2020 the strategy "Shaping Europe's digital future", with the objective of making EU a global leader in the digital economy. Connectivity, and 5G in particular, is identified as one of the most fundamental building blocks.

The Communication on Europe's Digital strategy calls Europe to invest more in the strategic capacities that allow us to develop and use digital solutions at scale and to strive for interoperability in key digital infrastructures, such as extensive 5G (and future 6G) networks and deep tech.

In the Conclusions of the Special meeting of the European Council (1 and 2 October 2020), accelerating 5G deployment was identified as an area eligible for Recovery and Resilience Facility funding, (of which at least 20% will be made available for the digital transition). Furthermore, "to ensure the rapid deployment of 5G across the EU, the European Council also urges all Member States to submit their national plans on the roll-out of 5G to the Commission by the end of this year, as set out in the 5G Action Plan".

Despite the many anticipated benefits of 5G networks, there are a number of challenges and concerns pertaining to the area of public and internal security. In the context of a Europe that protects, the European Commission identified 5G networks as a strategic asset therefore requiring high cybersecurity standards[8] and preserving lawful investigation capabilities[9]. To attain these objectives, the needs of the law enforcement and other relevant authorities in the area of public and internal security should be taken on board though a coordinated approach in view of the ongoing 5G standardisation activities[10].

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

The Communication on ICT standardisation priorities as well as the 5G Action Plan identified 5G standards as key to competitiveness and the interoperability of global networks, with stakeholders from different standardisation cultures called upon to collaborate. It also details the actions required.

The three initial phases of 5G standardisation have now been completed, with the publication of 3GPP Release-15, Release-16 and Release-17 sets of specifications. This first phase focused on enhanced mobile broadband while also supporting ultra-reliability and low latency. Release-16 provided the basis for 3GPP's IMT-2020 submission for an initial full 3GPP 5G system. Release-17 provides stabilisation and enhancements of the concepts introduced in the two initial phases and introduces satellite access. The work on 3GPP Release-18 is ongoing.

Release-16 (R16) takes into account a number of functionalities needed for 5G deployment by vertical industry, as called for by the EU 5G strategy. This includes notably: Integrated access and backhaul (IAB), easing deployment where fibre is not accessible; NR in unlicensed spectrum, multi factories applications; Features related to Industrial Internet of Things (IIoT) and ultra-reliable low latency communication (URLLC); positioning; intelligent transportation systems (ITS) and vehicle-to-anything (V2X) communications with additional use cases taken into account. Release-16 delivered key standards for use-cases such as those related to industrial applications, and *transversal needs such as lawful interception* and lawful access to retained data. The availability of standards promoting open innovation and opportunities for start-ups is also key.

Release-17 (R17) is completed as of September 2022. It includes additional features making the standards more widely applicable and with even better performance characteristics. It covers satellite access to 5G as the main new capability as well as a number of improvements of the features introduced in the two initial phases of 5G, e.g. on services to the industry (the "verticals"), on the support of Internet of Things (IoT), on direct communications between mobiles, in particular in the context of autonomous driving (V2X), and in several specific aspects of access (radio) network and of the core network (slicing, edge computing, MIMO, Repeaters,...).

Release-18, completed in 2024, does not introduce any new key concepts but is a stabilisation and enhances functionalities introduced previously. Release 19 is aiming to advance 5G towards 6G, enhancing 5G network performance and strengthening the support for services like XR, indoor positioning, and non-terrestrial networks.

In support of EU industrial capabilities, the Commission launched a 5G public-private-partnership (5G PPP) in 2013 which entered its third phase in 2018. The 5G PPP was designed to deliver solutions, architectures, technologies and standards for the ubiquitous next generation communication infrastructures of the coming decade. It had successfully performed in depth piloting of 5G technology in critical industrial sectors, showing the usability of 5G for multiple use cases.

The European Commission had called on Member States and industry to commit to the following objectives:

- a standardisation approach that preserves future evolution capabilities and aims at availability of 5G global standards by end of 2019;
- a holistic standardisation approach encompassing both radio access and core networks as coordinated activities within global standardisation bodies, encompassing disruptive use-cases and promoting open innovation;
- establishment of cross-industry partnerships by 2017, at the latest, to support timely standard-setting, partly by leveraging international cooperation partnerships, in particular towards the digitisation of industry.

In October 2018 the European Commission hosted a 3GPP workshop in the context of the submission of the 3GPP 5G specifications to the ITU. The aim was to inform the ITU sanctioned Evaluation Groups, policy makers and interested experts on the progress of the 3GPP work to meet and exceed the performance requirements for IMT-2020 radio interface technologies. 3GPP's 5G standard has been submitted to the ITU evaluation process in July 2019, which was the target date to submit to ITU the candidate technologies to obtain acceptance as an IMT-2020 technology (the 5G label).

As part of the ITU process on the evaluation of candidate technologies (RIT/SRIT), the 5G PPP has provided the only European evaluation group that submitted its analysis and findings to ITU successfully in 2020.

The Commission took also steps, through the FPI Project on internationalisation of EU ICT standardisation, to support the organisation of more 3GPP meetings in Europe, in order to facilitate the active participation of a

broad range of European delegates, from key industrial players, but also SMEs, academia and research institutions. This project provided financial support for the organisation of 3GPP meetings in the EU, and echoes recurring requests from administration and smaller industrial stakeholders to have SDO meetings organised in Europe.

The Advanced 5G and later 6G networks are expected to be the basis for Europe's digital and green transition For Horizon Europe, the new Framework Programme started in 2021, the Commission and the European industry have launched the Smart Network and Services Joint Undertaking (SNS JU) with EUR 900 million EU funding, in order to lead the 6G technology research and to maintain sovereignty. In December 2023, 3GPP committed to develop 6G specifications.

- In addition, to ensure the ability of the law enforcement authorities to detect and investigate serious crime and terrorism, there is a need to provide for contingency on lawful interception and lawful disclosure of data in the course of judicial investigations. To this end, it is necessary to provide for adequate technical means for the judicial authorities to be able to request for legal interception also in the context of 5G networks, PIN (Personal IoT Network) and non-terrestrial networks (NTN).
- Six main challenges have been identified that would benefit from an appropriate standardisation activity, namely:
- Being able to perform Mobile Subscriber Identification and Localisation by authorized LEAs on the radio interface with the assistance of Mobile Network Operators aside new strong 5G security features to get permanent digital IDs and precise localisation. Outside the field of the judicial investigations, ensuring the identification and positioning capabilities are also necessary to perform efficiently the Search And Rescue (SAR) activities.
- Being able to benefit from a complete copy of intercepted communications with precise location information despite fragmentation, slicing and virtualization of 5G e.g. multi-access edge computing systems and international private networks.
- Being able to benefit from a clear copy of intercepted communications, notably if the target is a user of encrypted communication services, including end-to-end encrypted communication applications and Rich Communication Services (RCS), or if the target is an inbound roamer (encrypted S8HR and N9HR roaming agreement). This should be done without prejudice to strong encryption mechanisms and with full respect for privacy.
- Ensuring the network based confidentiality and integrity of lawful interception systems considering that they will become logical components in 5G networks, as well as in PIN, NTN and may move outside of European jurisdictions.
- Ensuring that data preservation and lawful access mechanisms can be used in a way that is compatible with the principles set out by the Court of Justice of the European Union(cf. judgement in Joined cases C-511/18 and C-512/18 and C-520/18, La Quadrature du Net; *judgement in the case C-140/20, Commissioner of An Garda Síochána*). This could notably include the ability to i) retain data for fixed operators, mobile operators and Internet Service Providers in a more targeted manner, e.g. based on geographical criteria, possibly combined with temporal criteria, ii) perform expedited retention (quick freeze) of traffic data.
- Ensuring a trusted access to electronic evidence by developing standardized electronic interfaces (e.g. from ETSI TC LI or 3GPP Sa3 LI working group) and supporting cross-border exchange of electronic evidence (e.g. the e-Evidence Digital Exchange System, eEDES) based on ETSI /3GPP standards.
- These functional capabilities should be maintained without causing exorbitant impediments to the core functions and benefit of the 5G networks as well as of PIN, NTN and also be in line with current obligations on electronic communications networks and services to provide for such services to the law enforcement authorities. 3GPP 6G specifications are expected to include the most secure features allowing the smooth standardisation of lawful interception features.

(A.3) REFERENCES

- Communication on " Shaping Europe's digital future"
- COM(2016) 176 final *ICT standardisation priorities for the digital single market*
- COM(2016) 588 final 5G for Europe: An Action Plan and accompanying Staff Working Document
- SWD(2016) 306on 5G Global Developments
- SWD(2016) 110final Communication on digitising European Industry Reaping the full benefits of a Digital Single Market
- Next Generation Mobile Networks Alliance 5G White Paper, https://www.ngmn.org/de/5g-white-paper.html

- White paper on vertical sectors published by the 5G Public Private Partnership together with the European Commission https://ec.europa.eu/digital-single-market/en/blog/5g-empowering-vertical-industries-0
- 5G PPP Infrastructure -Trials and Pilots Brochure (N°2): https://5g-ppp.eu/the-5g-ppp-infrastructure-trials-and-pilots-brochure-n2-is-out/
- https://www.3gpp.org/news-events/3gpp-news/partner-pr-6g.

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

The Communication on ICT standardisation priorities for the digital single market proposes priority actions on 5G, some of which are reflected in section C.2.

ACTION 1: Global industry standards. Foster the emergence of global industry standards under EU leadership for key 5G/6G technologies (radio access network, core network) and network architectures notably through the exploitation of 5G public-private partnership results in key EU and international standardisation bodies (3GPP, ITU, ETSI).

ACTION 2: Ensure that 5G/6G standards are compatible with innovative use-cases of vertical industries and ensure sufficient spectrum-sharing capabilities, notably through broader participation of industries and authorities with sector-specific needs and in close collaboration with other industry specific standards developing organisations, in 5G standardisation organisations. Several projects funded by the European Commission, as well as the 5G PPP are dealing with 5G standardisation.

ACTION 3: Lawful interception and lawful disclosure related standards. Foster the emergence of standards that ensure proper provisions for enabling lawful interception mechanisms in the context of 5G networks by encouraging and coordinating law enforcement involvement in 5G standardisation related committees (e.g. ETSI TC LI, ETSI NFV-SEC, 3GPP SA3-LI) and promoting a European approach based on its legal system.

ACTION 4: SDOs to work with the stakeholders in standardisation to deliver a report on the standardisation needs and specific requirements for the uptake of 5G in vertical sectors (e.g. transportation, healthcare, manufacturing, energy).

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

3GPP

Release 16 is a major release for the project, not least because it brings our IMT-2020 submission - for an initial full 3GPP 5G system - to its completion (see details below).

In addition to that formal process, work has progressed on around 25 Release 16 studies, on a variety of topics: Multimedia Priority Service, Vehicle-to-everything (V2X) application layer services, 5G satellite access, Local Area Network support in 5G, wireless and wireline convergence for 5G, terminal positioning and location, communications in vertical domains and network automation and novel radio techniques. Further items being studied include security, codecs and streaming services, Local Area Network interworking, network slicing and the IoT.

As with previous generations of mobile technology, 3GPP will follow Release 16 with a continuous programme of 5G standardisation, delivering performance enhancements and new features required by the market in a series of periodic releases.

5G-ACIA

5G-ACIA is an alliance formed to ensure that the needs of the automation industry are considered, fostering developing a 5G technology that addresses industrial requirements. 5G-ACIA aims at being the central global forum for shaping 5G in the industrial domain. See https://www.5g-acia.org/

CEN-CENELEC

CEN/CLC/JTC13 supports the ENISA work regarding 5G.

ETSI

TC LI: Particularly ETSI TS102 656, and ETSI TS 102 657

TC EE (Environmental Engineering): https://www.etsi.org/committee/ee

TC MSG/TFES: https://www.etsi.org/committee/MSG is responsible for identifying European regulatory requirements and creating harmonised standards to support the deployment of IMT family networks in Europe. ETSI TC MSG/TFES is developing harmonised standards for 5G base stations (including repeaters) and user equipment, updating the EN 301 908 series to include 5G support. ETSI TC MSG/TFES is continuously monitoring 3GPP activities to include the new relevant features and the major updates in the harmonised standards that ETSI TC MSG/TFES is maintaining. Once regulated in Europe, new spectrum (bands) are also added to the ETSI TC MSG/TFES Harmonised Standards. ETSI TC MSG/TFES will develop harmonised standards for IMT technologies beyond 5G once they are specified in ITU and 3GPP.

TC RRS: https://www.etsi.org/committee/RRS is the ETSI centre of expertise for Reconfigurable Radio Systems and software-controlled Spectrum Sharing and actively contributes to Expert Group Radio Equipment Directive (EG RED) meetings. TC RRS has developed a comprehensive secure framework on Software Reconfiguration of Radio Equipment which is specifically tailored to the needs of RED Articles 3(3)(i) and 4 and is expected to also support the implementation of the future Cyber Resilience Act. TC RRS is furthermore assessing spectrum sharing schemes in collaboration with global organizations with the objective to address any gaps for key use cases including Programme Making and Special Events (PMSE), eHealth, Industrial Internet of Things (IoT), etc.

SC SAGE (Security Algorithms Group of Experts):

ISG NFV (Network Functions Virtualisation): http://etsi.org/nfv/ . NFV is a key technology enabler for 5G. ETSI GR NFV-IFA 037 (report on further NFV support for 5G) provides recommendations for enhancements to the NFV architectural framework and its functionality aiming to provide further support to address 5G network use cases. ETSI GR NFV-IFA 046 profiles and extends NFV capabilities to enhance the support for vRAN use cases and deployments. Normative work updating NFV standards is ongoing in NFV Release 5.
ISG NFV has also analysed the impact of supporting LI in NFV architectures in ETSI GS NFV-SEC 004.

OSM (Open Source MANO) http://osm.etsi.org/ , developing an open source Management and Orchestration (MANO) software stack aligned with ETSI NFV.

TFS (Tera Flow SDN) https://tfs.etsi.org/, developing an open source cloud native SDN controller enabling smart connectivity services for future networks beyond 5G.

ISG MEC (Multi-Access Edge Computing): https://www.etsi.org/committee/mec offers application developers and content providers cloud-computing capabilities and an IT service environment at the edge of the network. https://www.etsi.org/technologies/multi-access-edge-computing. ISG MEC published a report on "MEC 5G Integration (ETSI GR MEC 031) describing key issues, solution proposals and recommendations for MEC integration into 3GPP 5G system. The study addressed topics such as MEC System interactions with the 5G System, including the correspondence of the current MEC procedures to procedures available in 3GPP 5G system specification, options for the functional split between MEC and 5G Common API framework, and the realisation of MEC as 5G Application Function(s). Moreover, ISG MEC has updated MEC specifications (e.g. ETSI GS MEC 011) to align with the related 3GPP 5G standards (e.g. 5G Common API Framework). In addition, ISG MEC provides an application developer-focused sandbox for API experimentation and exploration (try-mec.etsi.org) that includes 5G network deployment options.

ISG ENI (Experiential Networked Intelligence): https://www.etsi.org/committee/ENI is defining a Cognitive Network Management architecture and protocol (ETSI GS ENI 005 V3.1.1 (2023-06) and ETSI GS ENI 019 V3.1.1 (2023-06)), using Artificial Intelligence (AI) techniques and context-aware policies to adjust offered services based on changes in user needs, environmental conditions and business goals. It therefore fully benefits all networks, including 5G networks, by providing automated service provision, operation, and assurance, as well as optimized slice management and resource orchestration. ENI has also launched Proof of Concepts (PoCs) aiming to demonstrate how AI techniques can be used to assist network operations including 5G/6G. The use of Artificial Intelligence techniques in the network will solve future network deployment and operation problems.

ETSI ISG ETI (Encrypted Traffic Integration) has moved from its problem statement (ETSI GR ETI 001) to further develop mitigation in the form of a Zero Trust Architecture that is expected to be published in both an overview and a detailed specification in 2023.

ISG IPE (IPv6 Enhanced Innovation): https://www.etsi.org/committee/1424-ipe published a report on "5G Transport over IPv6 and SRv6" to provide guidelines on how to deploy IPv6-based technologies on 5G backhaul networks.

ISG NIN (non-IP Networking): https://www.etsi.org/committee/NIN

ISG F5G (Fixed 5G): https://www.etsi.org/committee/F5G studies and develops optical networks in multiple application environments such as residential, business and industry, supporting and complementing the mobile networks, either as a transport infrastructure as well as an extension of services in indoor scenarios where 5G coverage may be deficient. Similar to the mobile network, the ETSI ISG F5G is specifying the fixed network generations (ETSI GR F5G 021) F5G and F5G Advanced and releases (release 3 and 4 at the moment). The ISG F5G includes the specification of a variety of functions and performance requirements for the fixed network generation(s) with a focus on fibre-based networks.

ISG THz (Terahertz) https://www.etsi.org/committee/2124-thz concentrates on establishing the technical foundation for the development and standardization of THz communications (0.1 - 10 THz). In this pre-standardisation activity, systematic output on channel models, system parameters, and evaluation assumptions for the evaluation of THz communication and sensing systems are prepared, targeting 3GPP and other standardisation activities leading towards 6G. The first two Group Reports, focused on Frequency bands and Use Cases of interest for THz communications have been available since the end of 2023, followed by two Group Reports (on Channel measurements and modeling in THz bands and RF Hardware Modeling) in 2024.

ISG RIS (Reconfigurable Intelligent Surfaces) https://www.etsi.org/committee/1966-ris?jjj=1631218280300 identifies and describes RIS related use cases and deployment scenarios, specifies derived requirements and identifies technology challenges in several areas including fixed and mobile wireless access, fronthaul and backhaul, sensing and positioning, energy and EMF exposure limits, security and privacy. It also documents a networking e2e reference architecture including RIS elements, describes RIS based specific deployment practice / guidelines, provides a gap analysis for RIS microelectronics and enabling technologies and makes proofs of concepts.

ISG mWT (millimetre wave transmission): https://www.etsi.org/committee/mWT , is active across the entire wireless transmission industry to facilitate the use of microwave and millimetre-wave with particular focus at mobile backhauling promoting evolution of technology, standards and spectrum regulations to match the requirements coming with the deployment of 5G. Additional activities have been added in the research of Sub-TeraHz frequency bands as well as wireless backhaul architectures and planning criteria in order to meet the growing capacity and performance needs of 5.5 and 6G.

ISG ZSM (Zero Touch Management): https://www.etsi.org/committee/ZSM . Provides a framework which enables the management of the network and services without human involvement. The automation of operation will ensure that the complexity of next generation networks, 5G and beyond, will be manageable.

ETSI TC DECT has published the first release of the new DECT-2020 NR (New Radio) technology (in ETSI TS 103 636 parts 1 to 5). The standardization effort will continue in the coming years with further releases, additional functionality and Application Specific profiles addressing the needs of multiple vertical industries. The production of test specifications has also started and the basic Harmonised Standard (HEN) for access to radio spectrum has been generated.

DECT-2020 NR is a new radio interface supporting Ultra Reliable Low Latency Communications (URLLC) and massive Machine Type Communications (mMTC) as specified for IMT-2020 usage scenarios. The technology supports multiple operating bands and radio channel bandwidths The new DECT-2020 NR air interface co-exists with the existing DECT system. DECT-2020 NR has been approved by ITU-R as an IMT-2020 radio interface technology.

GSMA

The GSMA (Global System for Mobile Communications) represents the interests of mobile operators worldwide, uniting nearly 800 operators with more than 300 companies in the broader mobile ecosystem, including handset and device makers, and software companies. Mobile operators will play a key role in 5G, as they will provide the infrastructure and services to a wide spectrum of 5G applications, from consumer mobile telephony to vertical industrial applications such as agricultural monitoring.

For more details see https://www.gsma.com/futurenetworks/technology/understanding-5g/

IEEE

IEEE has many efforts underway to develop standards that can serve as components of 5G systems:

- IEEE 802.11ax is an extension of the current WLAN standards by improving aggregated throughput with high user density. IEEE 802.11ax targets Mid Band, sub 6GHz unlicensed spectrum. IEEE 802.11ax meets the requirements for Indoor Hotspot and Dense Urban Areas according to an evaluation of IEEE 802.11ax performance vis-à-vis IMT-2020 criteria, which was endorsed by the IEEE 802.11 Working Group.
- IEEE 802.11ay targets bonding 2GHz channels to achieve extremely high point to point throughput in excess of 20 Mb/s. IEEE 802.11ay is implemented in the unlicensed millimetre wave band (60GHz).
- IEEE 802.11bd is evolution of IEEE 802.11p for next generation V2X communication.
- IEEE 802.11be Extremely High Throughput (EHT) is the potential next amendment to the 802.11 IEEE standard, and will likely be designated as Wi-Fi 7. It will build upon 802.11ax, focusing on WLAN indoor and outdoor operation with stationary and pedestrian speeds in the 2.4 GHz, 5 GHz, and 6 GHz frequency bands.
- IEEE 802.11bf WLAN sensing - supports the 60 GHz band sensing by improving and modifying the directional multi-gigabit (DMG) implementation in IEEE 802.11ad-2012 and the enhanced DMG (EDMG) implementation in IEEE 802.11ay-2021, both of which use beamforming to provide higher data rates.
- Packet-based fronthaul transport networks in support of dense deployments of very small cells (IEEE 1914.1).
- Radio over Ethernet (IEEE 1914.3) in support of backhaul and fronthaul over Ethernet.
- Precision Timing Protocol (IEEE 1588) which enables phase synchronous wireless networks such as LTE TDD.
- IEEE 802 access network (IEEE P802.1CF) and time sensitive networking for fronthaul (IEEE P802.CM).
- Tactile networking: IEEE P1918.1 covering application scenarios, architecture and functions, IEEE P1918.1.1 specifies Haptic Codecs.
- Radio Regulatory Technical Advisory Group (IEEE 802.18) and Wireless Coexistence (IEEE 802.19).

For a list of these and other IEEE standardisation activities related to 5G and next generation communications technologies, please see: https://ieee-sa.imeetcentral.com/eurollingplan/ .

IEC

At the IEC/SC 65C level in WG 16 an IEC PAS project is in progress related to “5G communication systems for industrial process measurement and control applications”. After the PAS publication, the content of the PAS should be divided into individual parts as IS and consequently adopted at the Cenelec level.

ITU

In ITU, 5G technologies are discussed under the IMT-2020 banner and 6G technologies under IMT-2030, as defined in ITU-R Resolution 56[1]. ITU-T SG 13, SG 12, SG 11, SG 15 and SG 5, and ITU-R WP 5D are driving the 5G and 6G standardization in ITU.

ITU-R WP 5D is responsible for the overall radio system aspects of International Mobile Telecommunications (IMT) systems, comprising IMT-2000, IMT-Advanced, IMT-2020 and IMT-2030. It has developed several Recommendations and Reports on performance requirements, spectrum requirements, radio interfaces, frequency bands, spectrum sharing and compatibility, as well as IMT specifications and related technologies.

More info about the group: https://www.itu.int/en/ITU-R/study-groups/rsg5/rwp5d

More info about IMT technology: https://www.itu.int/en/ITU-R/study-groups/rsg5/rwp5d/Pages/IMT.aspx

ITU-R SG 5 has recently approved several publications related to IMT including IMT-2030 New Recommendation ITU-R M.2160 on the “Framework and overall objectives of the future development of IMT for 2030 and beyond”

IMT-2020, Revision of Recommendation ITU-R M.2150 on “Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-2020 (IMT-2020)”)”, adding a 4th Radio Interface Technology., IMT-Advanced Revision of Recommendation ITU-R M.2012 on “Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-Advanced (IMT-Advanced)”, IMT-2000 Revision of Recommendation ITU-R M.1457 on “Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-2000 (IMT 2000)”.

Other publications on IMT

- Recommendation ITU-R M.1036 providing the "Frequency arrangements for implementation of the terrestrial component of IMT in the bands identified for IMT in the Radio Regulations" was updated.
- New Report ITU-R M.2541 about the "Technical feasibility of IMT in bands above 100 GHz".
- New Report ITU-R M.2528 about the "Capabilities of the terrestrial component of IMT-2020 for multimedia communications".
- New Report ITU-R M.2516 on the "Future technology trends of terrestrial IMT systems towards 2030 and beyond".
- Report ITU-R M.2480 on "National approaches of some countries on the implementation of terrestrial IMT systems in bands identified for IMT".
- The "Handbook on International Mobile Telecommunications (IMT)" provides general guidance to ITU Members, network operators and other relevant parties on issues related to the deployment of IMT systems to facilitate decisions on the selection of options and strategies for the introduction of their IMT-2000, IMT-Advanced and IMT-2020 networks.

ITU-T SG13 on Future networks, with focus on IMT 2020, has approved over 90 standards on 5G, including IMT-2020-related terms and definitions, architecture, QoS functional requirements, slicing, orchestration, information-centric networking, FMC, machine learning in future networks including IMT-2020 etc. (e.g. ITU-T Y.3100, Y.3106, Y.3107, Y.3170, Y.3172, Y.3150), and 8 Supplements. It has ~50 work items under development. Among new perspectives are the fixed, mobile and satellite convergence aspects and the work on deterministic services and communication.

More info: ITU-T WP: 2017-2020: SG13

A flipbook "5G Basics" is a collection of available ITU-T standardization outcomes by the end of 2017 that led to IMT-2020 standards.

ITU-T SG13 through the JCA-IMT2020 maintains the online Roadmap for IMT-2020. It captures the ongoing IMT-2020 and beyond (network aspects) standardization efforts in different SDOs and ITU-T along with pointers to the actual specification/ Recommendation location. A snapshot of it was published in July 2024 as ITU-T Supplement 59 to Y.3100-series Recommendations "IMT-2020 standardization roadmap".

More info: SG13 - Future networks and emerging network technologies (itu.int)

SG13 organised a Workshop on "Future technology trends towards 2030 " on 24-25 July 2023 in Geneva. The relevant outcomes of this workshop are summarized in https://www.itu.int/en/ITU-T/Workshops-and-Seminars/2023/0724/Documents/Workshop_Outcomes_July_2023.pdf

ITU-T SG3 (tariff and accounting principles and international telecommunication/ICT economic and policy issues) adopted a new Technical Report ITU-T DSTR-STUDY_IMT2020MVNOs describing 5G-related policy considerations for Mobile Virtual Network Operators (MVNOs).

ITU-T SG12 (performance, QoS and QoE) adopted a new Technical Report ITU-T GSTR-5GQoE defining a scope for the analysis of QoE in 5G services and several use cases where this scope is applicable. The use cases are: Tele-operated Driving, Wireless Content Production, Mixed Reality Offloading, and First Responder Networks. Other 5G use cases related work includes Recommendations ITU-T G.1035 (QoE influencing factors for VR services), ITU-T G.1036 (QoE influencing factors for AR services), ITU-T P.1320 (QoE assessment of extended reality (XR) meetings). With learnings from the EU Horizon 2020 TRIANGLE project (5G Applications and Devices Benchmarking), ITU approved ITU-T G.1052 (Testbed framework for mobile application QoS and QoE evaluation).

More info: https://itu.int/go/tsg12

Under subcategories for ITU-T Recommendations dealing with signalling requirements and protocols for IMT-2020 (ITU-T Q.5000 – Q.5049) and testing specifications for IMT-2020 and IoT (ITU-T Q.4060 – Q.4099), ITU-T SG11 approved 25 new standards. Currently, there are 18 ongoing work items related to signalling requirements and protocols of IMT-2020 networks, including signalling for UAV, AI-based protocol for managing energy efficiency, signalling for digital twin networks, fixed, mobile and satellite convergence, streaming services lightweight core dedicated networks, ML in future networks to name but a few.

SG11 developed new Recommendation ITU-T Q.4073 "Framework for interconnection testing of Voice, Video over 5G" and advanced Q.VoiNR-test "VoNR/ViNR interconnection testing for interworking and roaming scenarios".

More info: https://itu.int/go/tsg11

The objectives of the ITU-T Focus Group on Testbeds Federations for IMT-2020 and beyond (FG-TBFxG), which was established by ITU-T SG11 in 2021, was to harmonize testbeds specifications across SDOs and Fora, develop the required application program interfaces (APIs) aligned with the testbeds federations reference model defined in Recommendation ITU-T Q.4068, as well as define a set of use cases for federated testbeds and associated APIs, such as "Testbed-as-a Service" (TaaS). The Focus Group was established following the results of the joint ITU/IEEE/ETSI Workshop, which was organized in 2021.

In April 2024, The FG-TBFxG concluded its work. It developed eight deliverables, which includes a set of 18 use cases for testbeds federations and associated requirements for different APIs. ITU-T SG11 started eight new work items based on FG-TBFxG deliverables.

More info: https://itu.int/go/fgtbf.

ITU-T SG15 on Transport, Access and Home is developing Recommendations ITU-T G.8300-series "Mobile network transport aspects". SG15 has approved the following 5G related Recommendations:

- ITU-T G.8300: Characteristics of transport networks to support IMT-2020/5G
- ITU-T G.8310: Functional architecture for metro transport network
- ITU-T G.8312: Interfaces for a metro transport network
- G.8312.20: Overview of fine grain MTN
- ITU-T G.8331: Metro transport network linear protection
- ITU-T G.8321: Characteristics of MTN equipment functional blocks
- ITU-T G.8350: Management and Control for metro transport network

SG15 also developed the following supplements:

- G Suppl.66: 5G wireless fronthaul requirements in a passive optical network context

- G Suppl. 67: Application of optical transport network Recommendations to 5G transport
- G Suppl.69: Migration of a pre-standard network to a metro transport network
- G Suppl.74: Network slicing in a passive optical network context
- G Suppl.75: 5G small cell backhaul/midhaul over TDM-PON

More info: https://itu.int/go/tsg15

ITU- T Focus Group on Machine Learning for 5G network (FG-ML5G) was active from January 2018 to July 2020 and worked towards the application of the machine learning techniques to the IMT-2020 operation. The outputs of the FG-ML5G include:

Output of ITU-T SG13, based on FG-ML5G specifications:

- "Architectural framework for machine learning in future networks including IMT-2020" (ITU-T Y.3172, June 2019)
- "Machine learning in future networks including IMT-2020: use cases" (Supplement 55 to Y.3170 Series, October 2019)
- "Framework for evaluating intelligence levels of future networks including IMT-2020: (ITU-T Y.3173, February 2020)
- "Framework for data handling to enable machine learning in future networks including IMT-2020: (ITU-T Y.3174, February 2020)
- Machine learning marketplace integration in future networks including IMT-2020" (ITU-T Y.3176, September 2020)
- Architectural framework for machine learning model serving in future networks including IMT-2020 (Y.3179: April, 2021)
- Y.3181 (draft): Architectural framework for Machine Learning Sandbox in future networks including IMT-2020
- Y.3182 (draft): Machine learning based end-to-end multi-domain network slice management and orchestration

Deliverables FG ML5G submitted to ITU-T SG13 for consideration:

- FG ML5G specification: "Requirements, architecture and design for machine learning function orchestrator"
- FG ML5G specification: "Vertical-assisted Network Slicing Based on a Cognitive Framework"

More information at: https://www.itu.int/en/ITU-T/focusgroups/ml5g

ITU-T SG5 is responsible for studying methodologies for evaluating the effects of ICTs on climate change and the circular economy. It has developed a series of 26 ITU-T Recommendations, Supplements and Technical Reports related to the environmental aspects of 5G, which cover aspects ranging from innovative energy storage (ITU-T L.1220) (ITU-T L.1221) (ITU-T L.1222), energy feeding (ITU-T L.1210), energy efficiency for future 5G systems (ITU-T L.Suppl.36),liquid cooling solutions (L.1326) energy efficiency metrics and measurement for base station sites (ITU-T L.1350)(ITU-T L.1351) , smart energy solutions (ITU-T L.1380, ITU-T L.1381, ITU-T L.1382), smart energy saving of 5G base stations (ITU-T L.Suppl.43), energy saving technologies for 5G RAN equipment (ITU-T L.1390), 5G technology and human exposure to RF-EMF (ITU-T K.Supplements 1, 4, 9, 14 and.16), electromagnetic compatibility – EMC (ITU-T K.76, ITU-T K.114, ITU-T K.116, ITU-T K.123, ITU-T K.152, ITU-T K.Suppl.10 and ITU-T K.Suppl.26), resistibility analysis of 5G systems (ITU-T K.Suppl.8), e-waste management (ITU-T L.1050) and assessing the use of ICT solutions impact GHG emissions of other sectors (ITU-T L.1480).

More info: https://www.itu.int/itu-t/workprog/wp_search.aspx?sg=5 and https://www.itu.int/en/ITU-T/climatechange/Pages/ictccenv.aspx

https://www.itu.int/en/ITU-T/studygroups/2017-2020/05

ITU-T SG20 approved Recommendation ITU-T Y.4421 "Functional architecture for unmanned aerial vehicles and unmanned aerial vehicle controllers using IMT-2020 network", which provides a functional architecture for UAVs and UAV controllers using IMT-2020 networks and functionalities defined in the application layer, service and application support layer, and security capabilities.

More info: https://itu.int/go/tsg20

(C.2) OTHER ACTIVITIES RELATED TO STANDARDISATION

EC

There are several projects funded by the European Commission, dealing with 5G standardisation. Also, the 5G PPP deals with some issues connected to 5G standardisation.

https://5g-ppp.eu/

(C.3) ADDITIONAL INFORMATION

Interactions between IETF and 5G developments fall into several categories:

New dependencies on existing IETF technology:
For instance, introducing a flexible authentication framework based on EAP (`RFC 3748, RFC 5448). This work is being addressed in the EAP Method Update (EMU) Working Group. This working group has been chartered to provide updates to some commonly used EAP methods. Specifically, the working group shall produce documents to:

- Provide guidance or updates to enable the use of TLS 1.3 in the context of EAP TLS (RFC 5216). Update the security considerations relating to EAP TLS, to document the implications of using new vs. old TLS versions, any recently gained new knowledge on vulnerabilities, and the possible implications of pervasive surveillance.
- Update the EAP-AKA' specification (RFC 5448) to ensure that its capability to provide a cryptographic binding to network context stays in sync with what updates may come to the referenced 3GPP specifications through the use of EAP in 5G.

- Dependencies on ongoing IETF work: The IETF Deterministic Networking (DETNET) Working Group defines mechanisms to guarantee deterministic delays for some flows across a network. As one of the 5G use cases is time-critical communication and low-latency applications, this is a component technology that is being looked at. Similarly, IETF routing-related work such as traffic engineering , service chaining and source routing are likely tools

for managing traffic flows in 5G networks, as they are for other large service provider networks. 5G-related topics are also discussed in the Distributed Mobility Management Working Group .

- There are many IETF tools already for dealing with virtualisation and separation of networks (see 3.1.2 Cloud computing, below), so the first order of business is mapping what can be done with those tools for the 5G use cases.
- https://wiki.ietf.org/en/group/iab/Multi-Stake-Holder-Platform#h-311-5g-and-beyond

[4] see: e.g. https://5g-ppp.eu/event-calendar/#

[5] https://ec.europa.eu/digital-single-market/en/news/have-your-say-coordinated-introduction-5g-networks-europe

[6] Industry Manifesto 7 July 2016: http://ec.europa.eu/newsroom/dae/document.cfm?action=display&doc_id=16579;

[7] Ministerial Declaration "Making 5G a success for Europe" signed during the informal meeting of competitiveness and telecommunications ministers on 18 July in Tallinn

[8] *Commission Recommendation of 26 March 2019 on Cybersecurity of 5G networks*

[9] *8268/19 11 April 2019, Position paper on 5G, Europol*

[10] *8983/19 6 May 2019, Law enforcement and judicial aspects related to 5G, EU counter Terrorism coordinator*

3.1.2 Cloud and edge computing

A Policy and legislation

(A.1) POLICY OBJECTIVES

Establishing a coherent framework and conditions for cloud computing was one of the key priorities of the digital agenda for Europe. The digital single market strategy confirmed the importance of cloud computing, which is driving a paradigm shift in the delivery of digital technologies, enhancing innovation, digital single market and access to content. The Communication "2030 Digital Compass: the European way for the Digital Decade" sets two relevant goals for 2030: 75% business cloud adoption, and the deployment of 10 000 climate-neutral and highly secure edge nodes.

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

By enabling data storage and processing, cloud and edge computing are key enabling technologies for the digital transformation.

In 2023, the European cloud computing market was worth over €110 billion and is forecast to reach €129 billion by 2024. The latest Eurostat data available (end of 2023) shows the current state of play in the European Union regarding the use of cloud computing by enterprises. The main findings are summarised below:

- 45.2 % of EU enterprises used cloud computing in 2023, mostly for e-mail, file storage, and office software.
- In 2023, among enterprises that purchased cloud computing services, 75.3 % were 'highly dependent' on cloud as purchasers of sophisticated cloud services.
- Compared with 2023, the use of cloud computing increased by 4.2 percentage points.

The development of the cloud computing market and the efficient delivery of cloud services particularly depend on the ability to build economies of scale. The establishment of a Digital Single Market will unlock the scale necessary for cloud computing to reach its full potential in Europe. EU-based cloud providers have

only a small share of the cloud market, which leaves the EU exposed to dependency risks and limits the investment potential for the European digital industry in the data processing market. Also, given the impact of data centers and cloud infrastructures on energy consumption, the EU is taking steps to lead they way towards making these infrastructures climate-neutral and energy efficient by 2030, while using their excess energy to help heating homes, businesses and common public spaces.

The proposed actions follow the direction as outlined in the EU Communication on ICT standardisation priorities which identified cloud as a key priority for Europe. The actions include a follow-up of cloud standards coordination started in 2012/2013 when the Commission asked ETSI to coordinate stakeholders to produce a detailed map of the necessary standards (e.g. for security, interoperability, data portability and reversibility).

The Cloud Select Industry Group (C-SIG) has been open to all organisations, groups and individuals having a professional interest in cloud computing matters and are active in the European cloud market. The Communication "Unleashing the Potential of Cloud Computing in Europe" (2012) identified key actions to be supported by Cloud Select industry Groups. See section C1 below. The Commission is also pursuing international cooperation in the field of cloud computing, and a number of policy and joint research initiatives have been put in place with Japan, Brazil and South Korea and are ongoing with USA.

Cybersecurity is an important concern for users of cloud and edge computing. Under the Cybersecurity Act, ENISA is currently working on a draft Cybersecurity Certification Scheme for Cloud Services, which is regularly discussed with Member State experts in the EU cybersecurity certification group (ECCG). Once Member States reach consensus, the scheme will go through the comitology procedure to be adopted as an implementing act. The work of ENISA follows relevant work done as part of the study *Certification Schemes for Cloud Computing* (SMART 2016/0029). In April 2018 the Commission launched two DSM (Digital Single Market) Cloud Stakeholder groups (https://ec.europa.eu/digital-single-market/en/news/cloud-stakeholder-work-ing-groups-start-their-work-cloud-switching-and-cloud-security). The DSM Working Group on Cloud Certification Scheme will begin exploring an EU certification scheme on cloud security. The Group consists of national cyber security authorities, cloud service provider, cloud service customer as well as auditing entities. The European Security Certification Framework (EU-SEC) strives to address the security, privacy and transparency challenges associated with the greater externalization of IT to Cloud services. EU-SEC will create a certification framework under which existing certification and assurance schemes can co-exist. EU-SEC is funded by Horizon 2020 and publishes its results at www.sec-cert.eu.

To enable customers to effectively switch between different cloud service providers, the Data Act removes vendor lock-in practices and sets minimum interoperability requirements. Article 30 paragraph 3 of the Data Act stipulates that when building open interfaces for their services, providers of Platform as a Service and Software as a Service must ensure compatibility with the standards and specifications published in a central Union standards repository for the interoperability of data processing services. Art. 35 paragraph 8 obliges the Commission to build this repository by means of implementing acts. To prepare this repository, the Commission will launch a study that will map the landscape of existing harmonised standards and open interoperability specifications that could qualify for recognition in the repository. The study will also seek to advice the Commission on possible gaps in the standardisation landscape, as the Data Act empowers the Commission to launch possible new requests for harmonised standards to European standardisation organisations. Previous work on interoperability and switching includes the CloudWatch2 project which (reported on the status of interoperability and security standards, developed a catalogue of cloud services and mapped EU cloud services and providers), a study on switching cloud providers (SMART 2016/0032), and SWIPO (self-regulatory codes of conduct to facilitate data portability and cloud switching in support of article 6 of the Regulation on the Free-Flow of Non-Personal Data, which ultimately did not gain the desired market traction https://swipo.eu/) These portability codes intend to support article 6 of the Regulation on the free-flow of non-personal data.

On 15 October 2020 all EU Member States signed a Declaration on building the next generation European cloud. A key role in building the European cloud plays the launch of the European Alliance for Industrial Data and Cloud . The objective of the Alliance is to establish a competitive European cloud supply and to foster cloud adoption in the EU private and public sectors, in order to build technological autonomy and data sovereignty in Europe. The Alliance will bring together the key EU industrial actors on the supply side and the demand side with Member States' authorities. Its aim will be to substantially increase the share of EU suppliers on the

European public cloud infrastructure market by 2030. More concretely the aim of the Alliance is to:

- Build the next generation cloud supply: the Commission is committed to co-invest in the interconnection and deployment across the EU.
- Deploy pan-European cloud marketplaces, which will offer users a single portal to cloud offerings meeting key EU standards and rules.
- Define common requirements for cloud services operating on the EU market. The future EU Cloud Rulebook will be developed by the Commission in close cooperation with Member States and in consultation with relevant stakeholders.

The JRC published a study on the relationship of open source software and standards setting at the end of 2019 (https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/relationship-between-open-source-software-and-standard-setting) . The objective of the study was to identify possible commonalities and barriers for interaction between standardisation and open source (OSS) processes and in particular the interplay between OSS and FRAND licensing in standardisation.

Open source continued to be a major driver of innovation in the area of Cloud services. Almost all Cloud services are largely based on open source technologies. The role of open source for Cloud interoperability and portability is of high importance.

(A.3) REFERENCES

- Regulation (EU) 2023/2854 of the European Parliament and of the Council of 13 December 2023 on harmonised rules on fair access to and use of data and amending Regulation (EU) 2017/2394 and Directive (EU) 2020/1828 (Data Act)
- Regulation (EU) 2018/1807 of the European Parliament and of the Council of 14 November 2018 on a framework for the free flow of non-personal data in the European Union
- COM(2016)176 "ICT Standardisation priorities for the digital single market"
- COM(2016)178 "European cloud initiative — building a competitive data and knowledge economy in Europe" (Along with SWD(2016)106 and SWD(2016)107)
- COM(2012)529 "Unleashing the potential of cloud computing in Europe"
- COM(2015)192 "A digital single market strategy for Europe"
- Directive (EU) 2016/1148 of the European Parliament and of the Council of 6 July 2016 concerning measures for a high common level of security of network and information systems across the EU (NIS Directive).
- COM(2021)118 "2030 Digital Compass: the European way for the Digital Decade"

The volume of data generated is greatly increasing. A growing proportion of data is expected to be processed at the edge, closer to the users and where data are generated. This shift will require the development and deployment of fundamentally new data processing technologies encompassing the edge, adding to those current and future developments concerning a centralised cloud-based infrastructure models

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

The Communication on ICT Standardisation Priorities for the digital single market proposed priority actions in the domain of Cloud. Some actions are still relevant and mentioned below. Others come from the need to respond to the challenges of the Digital Decade Communication

ACTION 1: Identify needs for ICT standards and open source technologies to further improve the interoperability, data protection and portability of cloud services and continue or start respective development activities. In particular, a set of ICT standards, practices, and rules are needed to ensure (1) fair access to and use of data, (2) a trusted, legally compliant data sharing across parties, including data intermediaries and altruism organizations and (3) that data processing services are interoperable, such that switching between providers of data processing services. This should also take into account available open source technologies and their role for interoperability, data sovereignty, data protection and management of multiple clouds

ACTION 2: Promote the use of the ICT standards needed to further improve the interoperability, data sovereignty, data protection and portability of cloud services as well as multi-cloud management.

ACTION 3: Further strengthen the interlock between standardisation and open source in the area of Cloud

and establish and support bilateral actions for close collaboration of open source and standardisation. Foster a level playing field that allows the use of Open Source procedures and deliverables where they make economic sense complementing or substituting standardisation.

ACTION 4: Promote international standards on service level agreements (SLAs) and usage of the cloud code of conduct (CoC).

ACTION 5: Promote the use of the ISO/IEC JTC 1 reference cloud architecture and define generic cloud architecture building blocks, taking into account available international standards. Map available standards to the generic cloud architecture building blocks. Define privacy, security and test standards for each building block. This will also help determine which standards can be used for open cloud platforms and architectures taking into account the key role of open source for cloud infrastructure design and implementations.

ACTION 6: Promote the development of adequate standards/open source developments to ensure a competitive playing field for cloud services provision in Europe and contribute to the green agenda.

ACTION 7: SDOs and open source communities to foster their collaboration, mutual exchange, integration of Open Source outcomes in SDO deliverables and identification of technologies, e.g. APIs, that have been developed in open source and could be standardised.

ACTION 8: SDOs should focus on addressing the edge/cloud X-continuum paradigm and standardisation challenges, taking into account available international standards. In particular, due to huge increase of connected devices and systems, several computing deployments are embracing the notion of computing continuum, where the right compute resources are placed at optimal processing points, i.e., cloud data centre, edge computing systems and end devices, This requires the support of: (1) continuum of technologies across sensors, connectivity, gateways, edge processing, robotics, platforms, applications, Al, and analytics, including underlying technologies like optical, wireless (cellular and non-cellular) and satellite communications, (2) continuum of intelligence and edge capabilities, (3) continuum of edge applications across vertical sectors and seamless integration.

ACTION 9: SDOs to contribute to the preparation of an overview of relevant harmonised standards and open interoperability specifications that respond to the legal requirements outlined in the Data Act and that could be recognised in the to-be-established common Union repository for the interoperability of data processing services.

Action 10: SDOs to Promote the development of a standard or a set of standards for processor sockets for cloud computing infrastructure.

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

CEN & CENELEC

When it comes to Cloud Security, CEN-CLC/JTC 13 'Cybersecurity and Data protection' mirrors the activities of ISO/IEC JTC 1 SC 38 'Cloud Computing and distributed platforms', and considers in this respect the potential adoption of International Standards as European Standards, where market relevant. CEN-CLC/JTC 13's scope covers the development of standards for cybersecurity and data protection covering all aspects of the evolving information society. This includes notably: Management systems, frameworks, methodologies; Data protection and privacy; Services and products evaluation standards suitable for security assessment for large companies and small and medium enterprises (SMEs); Competence requirements for cybersecurity and data protection; Security requirements, services, techniques and guidelines for ICT systems, services, networks and devices, including smart objects and distributed computing devices.

CEN-CLC/JTC 13 developed the following deliverables:

- CEN/TS 18026:2024 "Three-level approach for a set of cybersecurity requirements for cloud services"
- CEN/CLC/TS 18072:2024 "Requirements for Conformity Assessment Bodies certifying Cloud Services" (under publication)

CEN/CLC JTC 25 'Data management, Dataspaces, Cloud and Edge' was established in September 2024 to address standardization in cloud and edge computing areas including:

- Organizational frameworks and methodologies
- Smart technology, objects, distributed computing devices
- Cloud infrastructure and service management
- Edge computing architectures and deployments

The committee addresses cloud and edge computing through its Working Groups, particularly:

- WG 4: Cloud and Edge, focusing on standards for cloud service management, edge computing architectures, and the computing continuum.

CEN-CLC/JTC 25 aims to develop standards supporting the European cloud strategy implementation, particularly addressing the Data Act activities for cloud switching and interoperability. It took over the activities of the CEN/CLC Focus Group on Data, Dataspaces, Cloud and Edge, which was disbanded on December 31, 2024.

ETSI

ISG NFV (Network Functions Virtualisation): https://www.etsi.org/committee/NFV adapts standard IT virtualisation technologies, consolidating heterogeneous network infrastructures based on disparate, ad hoc equipment types onto industry standard servers, switches and storage. ISG NFV develops the NFV architectural framework to make more efficient the integration of edge computing and NFV.

GS NFV-EVE 011 documents the set of criteria to help characterize cloud-native VNFs.

GR NFV-REL 014 studies and evaluates reliability for cloud-native VNFs.

GS NFV-IFA 029 documents enhancements of the NFV architecture for providing "PaaS"-type capabilities and supporting virtualised network functions (VNFs) which follow "cloud-native" design principles.

Specifications and reports on container infrastructure management:

- GS NFV-IFA040 "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Requirements for service interfaces and object model for OS container management and orchestration specification"
- GS NFV-IFA036 " Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Specification of requirements for the management and orchestration of container cluster nodes"
- GR NFV-IFA038 "Network Functions Virtualisation (NFV) Release 4; Architectural Framework; Report on network connectivity for container based VNF"
- GS NFV-SEC023 " Network Functions Virtualisation (NFV) Release 4; Security; Container Security Specification"
- GS NFV-SOL 018 "Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; Profiling specification of protocol and data model solutions for OS Container management and orchestration"
- Specifications and reports on multi-site / multi-domain deployments
- GS NFV-IFA 032 " Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Interface and Information Model Specification for Multi-Site Connectivity Services"
- GS NFV-IFA 030 "Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Multiple Administrative Domain Aspect Interfaces Specification"
- GR NFV-SOL 017 "Network Functions Virtualisation (NFV) Release 3 Protocols and Data Models Report on protocol and data model solutions for Multi-site Connectivity Services"

ETSI ISG NFV started cooperation with several open source projects. Especially a gap analysis was performed to align NFV standards with open source, see GS NFV-IFA 051. NFV works in close cooperation with OpenStack. Interfaces of CNCF are profiled to create specifications on container infrastructure management. Cooperation has started with LFN Anuket, Nephio, Sylva.

ISG MEC (Multi-access Edge Computing): https://www.etsi.org/committee/MEC offers to application developers and content providers cloud-computing capabilities and an IT service environment at the edge of the network. ISG MEC is developing a set of standardized Application Programming Interfaces (APIs) to enable MEC services. To application developers and content providers, the access network offers a service environment with ultra-low latency and high bandwidth and direct access to real-time network information that can be used by applications and services to offer context-related services.
Relevant ISG MEC documents:

- The group led the publication of a White Paper on "MEC security: Status of standards support and future evolutions" written by several authors participating in ETSI ISG MEC, ETSI ISG NFV SEC and ETSI TC CYBER. The work identified aspects of security where the nature of edge computing leaves typical industry approaches to cloud security insufficient.
- Following the white paper, ISG MEC has completed a study on MEC Security (ETSI GR MEC041) and has commenced associated normative work, including API Gateway for Client Applications (ETSI GS MEC 060) with architectural impacts captured in the latest draft of the Framework and Reference Architecture specification (ETSI GS MEC 003).
- Also multi-MEC and MEC-Cloud environments can be relevant in this context. In the domain of Cloud Federation, ETSI ISG MEC published a study ETSI GR MEC 035.
- As a follow-up to the previous study (MEC 035), the group has completed the related normative work (ETSI GS MEC 040) to standardize MEC Federation Enablement APIs.
- A MEC specific testing methodology framework (ETSI GR MEC-DEC 025), which forms the basis for the creation of Conformance Test Specification for MEC APIs. These are captured in a multi-part deliverable comprising of Test Requirements and Implementation Conformance Statements (ETSI GS MEC-DEC 032-1); Test Purposes (ETSI GS MEC-DEC 032-2); and Abstract Test Suite in both TTCN-3 and the Robot Framework (ETSI GS MEC-DEC 032-3). Test Descriptions, with associated Interoperability Feature Statement templates, are also specified in support of MEC Interoperability testing (ETSI GS MEC-DEC 042).

ISG IPE (IPv6 Enhanced Innovation): https://www.etsi.org/committee/1424-ipe has published a report "IPv6 based Data Centers, Network and Cloud Integration".

ISG NIN (Non-IP Networking): is investigating communications and networking protocols to provide the scale, security, mobility and ease of deployment required for a connected society. It is developing a forwarding plane standard that, while still supporting traditional Internet protocols, will also natively support new forms of routing, with a clean interface between the forwarding plane and the control and management planes. Thus, when accessing a service that might be provided at the edge or centrally, a client no longer needs to discover an IP address which identifies an interface to the equipment that provides the service, but can identify the service, content, etc, directly.

ISG ETI (Encrypted Traffic Integration): is exploring means to ensure the smooth integration of encrypted traffic to the operation of networks. The concern is that with an over enthusiastic approach to encryption the data required to manage the network effectively is hidden from management points (e.g. routers, switches, control planes). The intent of the work of the ISG is captured in the published problem statement (ETSI GR ETI 001) and is being addressed in ongoing work that endorses the Zero Trust Architecture wherein network elements have to attest to their function in the network before managing it.

ISG ZSM (Zero Touch Management): https://www.etsi.org/committee/ZSM. Provides a framework which enables the management of the network and services without human

involvement. The automation of operation will ease the management of the edge-cloud continuum, and the enforcement of security and privacy policies.

ISG F5G (Fixed 5G): completed three releases for the F5G (ETSI GR F5G 001) and F5G Advanced (ETSI GR F5G 021) network generations. The F5G Advanced Use Cases (ETSI GR F5G 020) are driving the different F5G standards release requirements. Currently, release 3 is finalized and release 4 has been started. From the beginning of the ISG, the use of cloud services was a focus of F5G and the requirements for the fixed network have been specified for guaranteed and mission critical cloud services. Starting from the F5G Advanced generation, computing takes a prominent role within the F5G Advanced network, where the F5G Advanced architecture defines cross-plane computing to use computing for the optimization of networks and providing cloud-based services. Dedicated interfaces to cloud services and the interfaces between different cloud computing resources, which are located throughout the F5G Advanced network are defined in the F5G Advanced Architecture. The E2E F5G Advanced management provides specifications about how the F5G Advanced network should handle requests for Cloud based services to support them with the Optical Cloud Network (OCN) architecture.

OSM (Open Source MANO): http://osm.etsi.org/ developing an open source Management and Orchestration (MANO) software stack aligned with ETSI NFV.

ISG NIN (Non-IP Networking): is investigating communications and networking protocols to provide the scale, security, mobility and ease of deployment required for a connected society. It is developing a forwarding plane standard that, while still supporting traditional Internet protocols, will also natively support new forms of routing, with a clean interface between the forwarding plane and the control and management planes. Thus, when accessing a service that might be provided at the edge or centrally, a client no longer needs to discover an IP address which identifies an interface to the equipment that provides the service, but can identify the service, content, etc, directly.

ISO/IEC

ISO/IEC JTC 1/SC 27 Information security, cybersecurity and privacy protection

- ISO/IEC 27017 — Code of practice for information security controls based on ISO/IEC 27002 for cloud services
- ISO/IEC 27018 — Code of practice for personally identifiable information (PII) protection in public cloud acting as PII processors
- ISO/IEC 27036-4 — Information security for supplier relationships — Part 4: Guidelines for security of cloud services

ISO/IEC JTC 1/SC 38 Cloud computing and distributed platforms:

A full suite of standards is available and in progress in ISO/IEC JTC 1 SC 38 on cloud computing technologies including, most notably, the ISO Cloud Reference Architecture but also work on vocabulary, SLAs, etc. This is complemented by work in ISO/IEC JTC 1 SC27 on cybersecurity and on more specific work as on Virtualisation. Below is a non-exhaustive list of relevant ISO standards.

https://www.iso.org/committee/601355.html

- ISO/IEC 19086-1 — Cloud computing — service level agreement (SLA) framework — Part 1: Overview and concepts
- ISO/IEC 19086-2 — Cloud computing — Service level agreement (SLA) framework — Part 2: Metric model
- ISO/IEC 19086-3 — Cloud computing — Service level agreement (SLA) framework — Part 3: Core conformance requirements
- ISO/IEC 19086-4 — Cloud computing — Service level agreement (SLA) framework — Part 4: Components of security and of protection of PII
- ISO/IEC 19941 Cloud Computing — Interoperability and portability
- ISO/IEC TR 22678 — Cloud Computing — Guidance for Policy Development
- ISO/IEC TR 23186 — Cloud computing — Framework of trust for processing of multi-sourced data
- ISO/IEC TR 23187 — Cloud computing — Interacting with cloud service partners (CSNs)
- ISO/IEC TR 23613 — Cloud service metering and billing elements
- ISO/IEC 23751 — Cloud computing and distributed platforms — Data sharing agreement (DSA) framework
- ISO/IEC TR 23951 — Cloud computing — Best practices for cloud SLA metrics
- ISO/IEC 22624 — Cloud Computing — Taxonomy based data handling for cloud services
- ISO/IEC 22123-1 — Cloud computing — Part 1: Vocabulary
- ISO/IEC 22123-2 — Cloud computing — Part 2: Concepts
- ISO/IEC 22123-3 — Cloud computing — Part 3: Reference architecture
- ISO/IEC TS 23167 — Cloud Computing — Common Technologies and Techniques (work in progress)
- ISO/IEC TR 23188 — Cloud computing — Edge computing landscape (work in progress)
- ISO/IEC TR 3445 — Cloud computing — Audit of cloud services
- ISO/IEC 5140 — Cloud computing — Concepts for multi-cloud and other interoperation of multiple cloud services
- ISO/IEC TS 5928 Cloud computing and distributed platforms — Taxonomy for digital platforms
- ISO/IEC TS 7339 Cloud computing and distributed platforms — Cloud computing — Platform capabilities type and Platform as a Service (PaaS)
- ISO/IEC 19944-1 Cloud computing and distributed platforms — Data flow, data categories and data use — Part 1: Fundamentals
- ISO/IEC 19944-2 Cloud computing and distributed platforms — Data flow, data categories and data use — Part 2: Guidance on application and extensibility
- ISO/IEC DTR 10822 — Cloud computing — Multi-cloud management — Part 1: Overview and use cases
- ISO/IEC DTS 10866 — Cloud computing and distributed platforms — Framework and concepts for organizational autonomy and digital sovereignty
- ISO/IEC 20151 — Cloud computing and distributed platforms — Dataspace concepts and characteristics
- ISO/IEC 19274 — Cloud computing and distributed platforms — Networking in cloud computing and edge computing
- ISO/IEC 20996 — Cloud computing — Cloud service customer business continuity and resilience

ISO/IEC JTC 1/SC 7 Software and systems engineering

- ISO/IEC TS 25052-1:2022 Systems and software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE): cloud services — Part 1: Quality model

- ISO/IEC NP TS 25052-2 ISO/IEC Systems and software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE): cloud services — Part 2: Measurement of Cloud Service Quality

ITU

ITU-T SG13 leads ITU's work on standards for future networks and 5G and is the primary SG working on cloud computing and data handling. ITU-T SG13 produced Y.3500-series Recommendations and approved 42 Recommendations and 2 Supplements and has 23 ongoing work items covering different aspects of cloud computing (e.g. overview and functional requirements for data storage federation, cloud computing infrastructure requirements, functional requirements of knowledge as a service, principles of cloud native application development, functional requirements of computing resource abstraction, functional requirements of cloud resource optimisation, and cloud computing - functional requirements of function as a service).

In July 2022 SG13 set up an ad-hoc "*Future ICT Evolution for emerging Web Era*" to consider technology evolution in line with the future Web 3.0 era**.**

Y.Sup49 to ITU-T Y.3500-series (11/2018) - Cloud computing standardisation roadmap, including deliverables of various SDOs: https://www.itu.int/rec/T-REC-Y.Sup49/en .

Flipbook "Cloud computing: From paradigm to operation" with a collection of many ITU-T outputs on cloud computing: https://www.itu.int/en/publications/Documents/tsb/2020-Cloud-computing-From-paradigm-to-operation/index.html

In the domain of Big Data for Cloud, ITU-T related work is listed in the Big Data chapter of this Rolling Plan.

More info: SG13 - Future networks and emerging network technologies (itu.int)

ITU-T SG11 is developing standards on cloud and edge computing with regard to signalling, monitoring and interoperability testing. SG11 developed several Recommendations which cover monitoring of cloud computing, signalling requirements of intelligent edge computing for different applications (e.g. data management interfaces for intelligent edge computing-based smart agriculture service and data management interfaces for intelligent edge computing-based flowing-water smart aquaculture system), interoperability testing of cloud computing and testing requirements for virtual switches (ITU-T Q.3914, ITU-T Q.4040-Q.4059-series, ITU-T Q.5001, Q.5007, Q.5011, Q.5028, Q.5029, Q.5030). The ITU-T Q.Supplement 65 "Cloud computing interoperability activities", provides the summary information for cloud computing interoperability activities of existing standards development organisations (SDOs) and the groups, forums and open sources developing the specifications that have the potential to utilize cloud computing interoperability testing tools.

The ongoing work items of SG11 focus on: signalling requirements for orchestration supporting confidential computing in multi-access edge computing, protocol for supporting computing and network convergence in fixed, mobile and satellite convergence in IMT-2020 network and beyond, signalling requirements and interfaces of edge-aided energy management agent at intelligent edge computing, signalling architecture for microservices based intelligent edge computing, data management interfaces in educational robot system with intelligent edge computing, data management interfaces for public decision-making framework on Intelligent edge computing, data management interfaces for intelligent edge computing-based smart pest and disease management service.

SG11 developed several Recommendations which define signalling architecture and requirements for Computing Power Network (CPN) – ITU-T Q.4140-Q.4159 series.

More info: https://itu.int/go/tsg11

ITU-T SG20 develops standards on Internet of things (IoT), smart cities and communities. It also studies aspects related to edge computing for the Internet of things (IoT) which allows IoT deployments to be enhanced through data processing closer to the end device. ITU-T SG20 has approved the following Recommendations:

- Recommendation ITU-T Y.4122 "Requirements and capability framework of edge computing-enabled gateway in the IoT"
- Recommendation ITU-T Y.4208 "IoT requirements for support of edge computing"
- Recommendation ITU-T Y.4486 "Framework of cross edge decentralized service by using DLT and edge computing technologies for IoT devices"

Additionally, ITU-T SG20 is also progressing draft Recommendations and draft Supplements in this field, including:

- Draft Recommendation ITU-T Y.IoT-IIEC "Framework of the integrated intelligent IoT service based on multi edge computing"
- Draft Supplement ITU-T Y.Sup.EdgeIoT-usecases "Supplement to ITU-T Y.4208 - Use cases of edge computing based Internet of Things"

More info: https://itu.int/go/tsg20

ITU-T SG17 works on cloud computing security. It has approved four Recommendations:

- ITU-T X.1603 "Data security requirements for the monitoring service of cloud computing",
- ITU-T X.1604 "Security requirements of network as a service (NaaS) in cloud computing"
- ITU-T X.1605 "Security requirements of public infrastructure as a service (IaaS) in cloud computing"
- ITU-T X.1606 "Security requirements for communication as a service application environments". . SG17 is working on Security guidelines for container, distributed cloud, multi-cloud, edge cloud and Security requirements of cloud-based platform under low latency and high reliability application scenarios, network security situational awareness platform for cloud computing, etc.

More details here: https://www.itu.int/en/ITU-T/studygroups/2017-2020/17

IEEE

Cloud computing:

IEEE 2302, IEEE Standard for Intercloud Interoperability and Federation (SIIF), provides a model that allows a range of deployment topologies and governance, and can be applied to many application domains using different implementation approaches; IEEE P2303 Standard for Adaptive Management of Cloud Computing Environments.

Fog/Edge Computing:

Work is going on in IEEE P1934.1, "Nomenclature and Taxonomy for Distributing Computing, Communications and Networking along the Things-to-Cloud Continuum" and IEEE P1935 "Standard for Edge/Fog Manageability and Orchestration."

More recently IEEE SA initiated a new family of standards on cloud-edge collaborative framework through its work on IEEE P2805.1 on "Self-Management Protocols for Edge Computing Node," IEEE P2805.2 on "Data Acquisition, Filtering and Buffering Protocols for Edge Computing Node," IEEE P2805.3 on "Cloud-Edge Collaboration Protocols for Machine Learning," and IEEE P2961 on "Guide for an Architectural Framework and Application for Collaborative Edge Computing."

With increased usage of cloud computing, cybersecurity is a core consideration. IEEE SA has initiated a pre-standards Industry Connections program to focus on "Cybersecurity of Agile Cloud Computing."

For more information, see: https://ieee-sa.imeetcentral.com/eurollingplan/

IETF

The IETF has multiple groups working on standards for virtualization techniques, including techniques used in cloud computing and datacenters.

The Layer 2 Virtual Private Networks (L2VPN) Working Group produced specifications defining and specifying solutions for supporting provider-provisioned Layer-2 Virtual Private Networks (L2VPNs). They also addressed requirements driven by cloud computing services and data centers as they apply to Layer-2 VPN services. The L2VPN Service Model (L2SM) Working Group is tasked to created a data model that describes an L2VPN service.

The Layer 3 Virtual Private Networks (L3VPN) Working Group was responsible for defining, specifying and extending solutions for supporting provider-provisioned Layer-3 (routed) Virtual Private Networks (L3VPNs). These solutions provide IPv4, IPv6, and MPLS services including multicast.

The Layer Three Virtual Private Network Service Model (L3SM) Working Group was tasked to create a YANG data model that describes an L3VPN service (an L3VPN service model) that can be used for communication between customers and network operators, and to provide input to automated control and configuration applications.

The Network Virtualization Overlays (NVO3) Working Group develops a set of protocols and extensions that enable network virtualization within a datacenter environment that assumes an IP-based underlay. An NVO3 solution provides layer 2 and/or layer 3 services for virtual networks enabling multi-tenancy and workload mobility, addressing management and security issues.

The System for Cross-domain Identity Management (SCIM) Working Group worked on standardising methods for creating, reading, searching, modifying, and deleting user identities and identity-related objects across administrative domains, with the goal of simplifying common tasks related to user identity management in services and applications.

The Computing in the Network Research Group (coinrg) of the IRTF explores existing research and fosters investigation of "Compute In the Network" and resultant impacts to the data plane. The goal is to investigate how to harness and to benefit from this emerging disruption to the Internet architecture to improve network and application performance as well as user experience.

The Workload Identity in Multi System Environments (wimse) Working Group is chartered to address the challenges associated with implementing fine-grained, least privilege access control for workloads deployed across multiple service platforms, spanning both public and private clouds. The work will build on existing standards, open source projects, and community practices, focusing on combining them in a coherent manner to address multi-service workload identity use cases such as those identified in the Workload Identity Use Cases Internet Draft. The goal of the WIMSE working group is to identify, articulate, and bridge the gaps and ambiguities in workload identity problems and define solutions across a diverse set of platforms and deployments, building on various protocols used in workload environments. The WG will standardise solutions (as proposed standard) and document existing or best practices (as informational or BCP) per the Program of Work.

https://wiki.ietf.org/en/group/iab/Multi-Stake-Holder-Platform#h-312-cloud-and-edge-computing

FRAUNHOFFER INSTITUTE AND OFE

The Fraunhoffer Institute and Open Forum Europe (OFE) have been carrying out a study on behalf of the European Commission, entitled "The impact of Open Source Software and Hardware on technological independence, competitiveness and innovation in the EU economy". The study is in latest stages of being published (foreseen September 2021). The analysis estimates a cost-benefit ratio of above 1:4 and predicts that an increase of 10% of OSS contributions would annually generate an additional 0.4% to 0.6% GDP as well as more than 600 additional ICT start-ups in the EU. Case studies reveal that by procuring OSS instead of proprietary software, the public sector could reduce the total cost of ownership, avoid vendor lock-in and thus increase its digital autonomy. The study also contains policy recommendations including the promotion OSS in addition to standardisation as a further channel of knowledge and technology transfer, e.g., as an explicit dissemination channel for Horizon Europe projects.

OGF

Open Grid Forum (OGF) is a leading standards development organisation operating in the areas of grid, cloud and related forms of advanced distributed computing. The OGF community pursues these topics through an open process for development, creation and promotion of relevant specifications and use-cases.

http://www.ogf.org/

OMG

Object Management Group (OMG): the OMG's focus is always on modelling, and the first specific cloud-related specification efforts have only just begun, focusing on modelling deployment of applications & services on the clouds for portability, interoperability & reuse. http://www.omg.org/

Hosted by the OMG is the Cloud Standards Customer Council, which has produced a series of customer-oriented white papers on diverse topics related to cloud computing, all of which are publicly accessible at: http://www.cloud-council.org/resource-hub.htm

ONEM2M

The oneM2M architecture is based on distributed computing capabilities, data management and storage, and it supports interworking with non-oneM2M entities and integrates with communication infrastructures. The oneM2M system operates in the cloud when the data are centralized. At the same time, separate oneM2M based cloud services may be federated as an alternative to the direct integration of dedicated data bases. The oneM2M standards also address edge related technologies for Automotive and Industry 4.0 domains. In 2018 oneM2M started a dedicated work item on Edge and Fog Computing (WI-0080). Different solutions have been developed, such as Edge/Fog offloading, dynamic service management, common service description /service-awareness, loosely/tightly coupled Edge/Fog Computing. The study of those solutions resulted in related normative work that contains advanced features and enhancements for oneM2M specifications TS-0001, TS-0004 and TS-0026. Specific studies are available as Technical reports as well as all specifications being made publicly accessible at: <https://onem2m.org/technical/published-specifications>.

Related guidelines are also provided in ETSI TR 103 527 V1.1.1 (2018-07) SmartM2M; Virtualized IoT Architectures with Cloud Back-ends.

OASIS

The Topology and Orchestration Specification for Cloud Applications (TOSCA) TC works to enhance the interoperability and portability of cloud applications and services, throughout the lifecycle of users' needs, regardless of changes of cloud vendor or vendor interfaces. TOSCA enables the interoperable description of application and infrastructure cloud services, and changes to services (such as adding servers or storage), independent of the supplier creating the service, and any particular cloud provider or hosting technology. TOSCA is at the top of the list of "most used standards projects" in the Cloudwatch2 study. TOSCA's base specification v1.0 and object model was issued in 2013. The TC developed a YAML profile for simple representations and data exchange; the current version 1.3 was issued in 2020. The OASIS TOSCA TC and ETSI NFV ISG cooperate to align their Network Functions Virtualisation (NFV) service models and specifications.

The Cloud Application Management for Platforms (CAMP) TC advances an interoperable protocol that cloud implementers can use to package and deploy their applications. CAMP defines interfaces for self-service provisioning, monitoring, and control. Common CAMP use cases include: moving on-premise applications to the cloud (private or public) or redeploying applications across cloud platforms from multiple vendors.

The OASIS Open Data Protocol (Odata) TC works to simplify the querying and sharing of data across disparate applications and multiple stakeholders for re-use in the enterprise, Cloud, and mobile devices. A REST-based protocol, OData builds on HTTP and JSON using URIs to address and access data feed resources. OASIS OData standards have been approved as ISO/IEC 20802-1:2016 and ISO/IEC 20802-2:2016.

The goal of the OASIS Virtual I/O Device (VIRTIO) TC is to simplify virtual devices, making them more extensible and more recognizable. It ensures that virtual environments and guests have a straightforward, efficient, standard, and extensible mechanism for virtual devices. Guest can use similar standard PCI drivers and discovery mechanisms for PCI devices of the VIRTIO family as for physical PCI devices.

The OASIS Infrastructure Data-Plane Function (IDPF) committee defines interoperable multi-vendor interfaces for devices, on physical or virtualised systems, based on the PCI Express (Peripheral Component Interconnect Express) high-speed serial expansion bus standard used in both virtualised data centers and physical motherboards. Standardized composition and sharing of networked devices allows for live migration and decoupling of data center tenants as well as operator infrastructure, significantly improving the portability of data and data center installations.

OFE

Recently Open Forum Europe (OFE) carried out a study on behalf of the European Commission, entitled "Standards and Open Source: bringing them together". The aim of this study was to analyse and make practical progress on the collaboration models between SDOs and cloud open source software development initiatives, and to develop a roadmap of actions to improve the integration of open source communities in the standard setting process.

https://ec.europa.eu/digital-single-market/en/news/standards-and-open-source-bringing-them-together

W3C

The Web & Networks Interest Group explores solutions for web applications to leverage network capabilities in order to achieve better performance and resources allocation, both on the device and network. The group discusses requirements of a client, edge, and cloud coordination mechanism and its standardization in Client-Edge-Cloud coordination Use Cases and Requirements .

(C.2) OTHER ACTIVITIES RELATED TO STANDARDISATION

AIOTI

The Alliance for AI, IoT and Edge Continuum (AIOTI) has an active Working Group that focuses on standardisation, covering topics such as high-level architectures, landscape and gap analysis and semantic interoperability. In the area of cloud and edge computing, several reports were published on identifying high-priority standardisation gaps, standardisation contributions from EU-funded projects and various computing continuum scenarios. All deliverables can be found here: https://aioti.eu/resources-standardisation/

The AIOTI Focus Group on High-Level Architectures is working on guidance for IoT and Edge Computing Integration in Data Spaces. This report provides an analysis of the integration of IoT and edge computing in data spaces. It explains the context, provides a definition of data spaces, and enumerates the challenges of data spaces, as well as the positioning of data spaces in the AIOTI high-level architecture (HLA). It describes the relation to existing solutions: a construction approach relying on reference architecture standards and patterns; the use of reference architectures proposal from IDSA, oneM2M, ETSI MEC; the work carried out by several large-scale projects: PLATOON, INTERCONNECT, SmartBear, ASSIST-IoT. It provides recommendations for data space standards. The second report this group prepared is about Guidance for the Integration of Digital Twins in Data Spaces. This report focuses on the integration of digital twins in data spaces: it provides a context on data spaces, digital twins, IoT and edge computing

and standardisation: it provides an analysis of the integration of digital twins in data spaces taking an architecture approach; it describes a large number of digital twin use cases in domains such as agriculture, connected vehicles, smart cities, energy, smart manufacturing; The document can be used to provide insights and sources for future standardisation work related to the integration of digital twins in data spaces. This document also leverages the following reports: The EU Observatory for ICT Standardisation (EUOS) published in June 2022 a report prepared by the StandICT technical work group (TWG) entitled Landscape of Digital Twins and BDVA report published in February 2024 prepared by the task force on data spaces and task force on standards entitled Data Sharing Spaces and Interoperability.

BSI

Cloud Computing Compliance Controls Catalogue (C5)

The C5 defines a baseline for cloud security, divided into thematic sections (e.g. organisation of information security, physical security), using mostly recognised security standards. C5 outlines prerequisites for a conformity assessment using international standards (ISAE 3000, ISAE 3402), adding cloud specific requirements, especially for transparency.

C-SIGS

The cloud select industry groups as a contribution from Europe to the global cloud standardisation community.

- Cloud Select Industry Group on Code of Conduct: the European Commission has been working with industry to finalise a code of conduct for cloud computing providers. The code of conduct supports a uniform application of data protection rules by cloud service providers. The Code of Conduct for Protection of Personal Data in cloud services has been published in June 2016. Strong relationship with ISO/IEC 27018 standard.
- Cloud Select Industry Group on Service Level Agreements: the goal of this subgroup is to work towards the development of standardisation guidelines for SLAs for cloud services. Work was submitted to ISO/IEC SC38 committee as input to the work on the 19086 standards.
- Cloud Select Industry Group on Certification Schemes: the Digital Single Market Strategy 2015 (DSM) committed the European Commission to delivering a European Cloud Initiative, including certification.

GICTF

Global Inter-Cloud Technology Forum (GICTF) is promoting standardisation of network protocols and the interfaces through which cloud systems inter-work with each other, to promote international interworking of cloud systems, to enable global provision of highly reliable, secure and high-quality cloud services, and to contribute to the development Japan's ICT industry and to the strengthening of its international competitiveness.

http://www.gictf.jp/index_e.html .

GAIA-X

Gaia-X aims at developing common requirements for a European data infrastructure based on standards which ensure transparency and interoperability. GAIA-X addresses this requirement by aligning network and interconnection providers, Cloud Solution Providers (CSP), High Performance Computing (HPC) as well as sector specific clouds and edge systems. https://www.data-infrastructure.eu/ "

OCC

The Open Cloud Consortium (OCC) supports the development of standards for cloud computing and frameworks for interoperating between clouds; develops benchmarks for cloud computing; and supports reference implementations for cloud computing, preferably open source reference implementations. The OCC has a particular focus in large data clouds. It has developed the MalStone Benchmark for large data clouds and is working on a reference model for large data clouds.

https://www.occ-data.org/

TM FORUM

TM Forum: The primary objective of TM Forum's Cloud Services Initiative is to help the industry overcome these barriers and assist in the growth of a vibrant commercial marketplace for cloud-based services. The centrepiece of this initiative is an ecosystem of major buyers and sellers who will collaborate to define a range of common approaches, processes, metrics and other key service enablers.

https://www.tmforum.org/ioe/

SNIA

Storage Networking Industry Association (SNIA): The Cloud Work Group exists to create a common understanding among buyers and suppliers of how enterprises of all sizes and scales of operation can include cloud computing technology in a safe and secure way in their architectures to realise its significant cost, scalability and agility benefits. It includes some of the industry's leading cloud providers and end-user organisations, collaborating on standard models and frameworks aimed at eliminating vendor lock-in for enterprises looking to benefit from cloud products and services.

http://www.snia.org/cloud

(C.3) ADDITIONAL INFORMATION

Open source projects address particular aspects of cloud computing (e.g. OpenStack (IaaS), the Open Networking Foundation (ONF), Cloud Foundry (PaaS), Docker (Container technology) and kubernetes) and as such, open source communities should be encouraged to collaborate with standardisation and submit their APIs for standardisation.

3.1.3 Data interoperability

A Policy and legislation

(A.1) POLICY OBJECTIVES

In its communication **A European strategy for data (COM (2020) 66 final)**, the Commission describes the vision of a common European data space, a Single Market for data in which data could be used irrespective of its physical location of storage in the Union in compliance with applicable law. Various policy initiatives that have been undertaken since then, see section 3.0.1 Data Economy for an overview.

The EU data strategy communication specifically mentions the importance of data interoperability and data quality: *Data interoperability and quality, as well as their structure, authenticity and integrity are key for the exploitation of the data value, especially in the context of AI deployment. Data producers and users have identified significant interoperability issues which impede the combination of data from different sources within sectors, and even more so between sectors. The application of standard and shared compatible formats and protocols for gathering and processing data from different sources in a coherent and interoperable manner across sectors and vertical markets should be encouraged through the rolling plan for ICT standardisation and (as regards public services) a strengthened European Interoperability Framework.*

OPEN DATA

The **DIRECTIVE on open data and the re-use of public sector information ((EU) 2019/1024)** mentions the need for the use of formal open standards:

> *Article 5 Available formats:*
>
> *1. Without prejudice to Chapter V, public sector bodies and public undertakings shall make their documents available in any pre-existing format or language and, where possible and appropriate, by electronic means, in formats that are open, machine-readable, accessible, findable and re-usable, together with their metadata. Both the format and the metadata shall, where possible, comply with formal open standards.*

The **COMMISSION IMPLEMENTING REGULATION laying down a list of specific high-value datasets and the arrangements for their publication and re-use ((EU) 2023/138)** mentions interoperability in its opening statements:

> *(3) Harmonising the implementation of the re-use conditions of high-value datasets entails the technical specification for making the datasets available in a machine-readable format and via application programming interfaces (APIs). Making high-value datasets available under optimal conditions strengthens the open data policies in the Member States, building on the principles of findability, accessibility, interoperability and reusability (FAIR principles).*
>
> *(9) In addition to Directive (EU) 2019/1024, other Union legal acts, including Directive 2007/2/EC of the European Parliament and of the Council and Directive 2005/44/EC of the European Parliament and of the Council may be of relevance for the re-use of public sector information falling within the scope of this Implementing Regulation, notably where those Union acts lay down common requirements for data quality and interoperability.*

DATA SPACES

The need for interoperability is mentioned in several places in the **Data Governance Act (DGA)**, in particular in the article on the European Data Innovation Board - a new expert group introduced in the DGA:

> *Article 30, Tasks of on the European Data Innovation Board*
>
> *(f) to advise the Commission, in particular taking into account the input from standardisation organisations, on the prioritisation of cross-sector standards to be used and developed for data use and cross-sector data sharing between emerging common European data spaces, cross-sectoral comparison and exchange of best practices with regard to sectoral requirements for security and access procedures, taking into account sector-specific standardisation activities, in particular clarifying and distinguishing which standards and practices are cross-sectoral and which are sectoral;*
>
> *(g) to assist the Commission, in particular taking into account the input from standardisation organisations, in addressing fragmentation of the internal market and the data economy in the internal market by enhancing cross-border, cross-sector interoperability of data as well as data sharing services between different sectors and domains, building on existing European, international or national standards, inter alia with the aim of encouraging the creation of common European data spaces;*
>
> *(h) to propose guidelines for common European data spaces, namely purpose- or sector-specific or cross-sectoral interoperable frameworks of common standards and practices to share or jointly process data for, inter alia, the development of new products and services, scientific research or civil society initiatives, such common standards and practices taking into account existing standards, complying with the competition rules and ensuring non-discriminatory access to all participants, for the purpose of facilitating data sharing in the Union and reaping the potential of existing and future data spaces, addressing, inter alia:*
>
> *(i) cross-sectoral standards to be used and developed for data use and cross-sector data sharing, cross-sectoral comparison and exchange of best practices with regard to sectoral requirements for security and access procedures, taking into account sector-specific standardisation activities, in particular clarifying and distinguishing which standards and practices are cross-sectoral and which are sectoral;*

(ii) requirements to counter barriers to market entry and to avoid lock-in effects, for the purpose of ensuring fair competition and interoperability;

(iii) adequate protection for lawful data transfers to third countries, including safeguards against any transfers prohibited by Union law;

(iv) adequate and non-discriminatory representation of relevant stakeholders in the governance of common European data spaces;

(v) adherence to cybersecurity requirements in accordance with Union law;

Article 33 of the **Data Act** specifies the interoperability requirements for participants in data spaces:

1. Participants in data spaces that offer data or data services to other participants shall comply with the following essential requirements to facilitate the interoperability of data, of data sharing mechanisms and services, as well as of common European data spaces which are purpose- or sector-specific or cross-sectoral interoperable frameworks for common standards and practices to share or jointly process data for, inter alia, the development of new products and services, scientific research or civil society initiatives:

(a) the dataset content, use restrictions, licences, data collection methodology, data quality and uncertainty shall be sufficiently described, where applicable, in a machine-readable format, to allow the recipient to find, access and use the data;

(b) the data structures, data formats, vocabularies, classification schemes, taxonomies and code lists, where available, shall be described in a publicly available and consistent manner;

(c) the technical means to access the data, such as application programming interfaces, and their terms of use and quality of service shall be sufficiently described to enable automatic access and transmission of data between parties, including continuously, in bulk download or in real-time in a machine-readable format where that is technically feasible and does not hamper the good functioning of the connected product;

(d) where applicable, the means to enable the interoperability of tools for automating the execution of data sharing agreements, such as smart contracts shall be provided.

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

Overall, the application of standard and shared formats and protocols for gathering and processing data from different sources in a coherent and interoperable manner across sectors and vertical markets should be encouraged. This applies to the sharing of open data via data portals, as well as to the sharing of restricted data via data spaces.

Standardisation at different levels (such as metadata schemata, data representation formats, data usage policies and licensing conditions) is essential to enable broad data sharing findability, accessibility and reusability and interoperability with the overall goal of fostering innovation and generating value. This refers to all types of data, including both structured and unstructured data, and data from different domains as diverse as geospatial data, statistical data, weather data, industrial data, public sector information and research data, to name just a few.

Three main processes can be distinguished in the sharing of data, be it via data spaces or via open data portals:

- I. Data Discovery
- II. Data Sharing
- III. Data Usage

A fourth process covers the data management aspects that enable organisations to share high-quality data:

- IV. Data Governance

In each of the processes, data holders, data users and data intermediaries need to collaborate, requiring interoperability and standards. Various kinds of standards need to come into play to support the 3 processes. Below ~~some aspects are listed~~ a non-exhaustive selection of aspects is provided, clustered by layer of the European Interoperability Framework (EIF).

Legal aspects:

- Data protection and cybersecurity
- Intellectual property / trade secrets
- Identification of parties

Organisational aspects:

- Data quality (criteria and classification)
- Data provenance, lineage
- eArchiving
- Data sharing agreements (contracts, licences, service level agreements, terms of use)
- Types of data sharing , e.g. event streams, file transfer, large data sets, ...

Semantic aspects:

- Data catalogues (description & discovery)
- Data models and schemas, Ontologies, linked data
  - including specific cross-domain topics such as Data Privacy Vocabulary
- Documentation: metadata
- Semantic integration (i.e., a shared and formalized understanding on the meaning of the used terminology / concepts)
- Definition of upper and/or commonly agreed taxonomies, ontologies as well as controlled vocabularies

- Mapping rules and commonly agreed principles
- Persistent URIs of data models / ontologies
- Data constraints: distinguishing valid and not valid data

Technical aspects:

- Data formats and syntaxes
- Data sharing protocols (APIs, file transfer)
- Aggregation techniques
- Anonymisation and pseudonymisation techniques
- Obfuscation techniques

The **FAIR data principle**s (https://www.go-fair.org/fair-principles/) originating from the research community, should be used as a guide to identify the standardisation needs. FAIR data principles are not standards themselves, but rather provide a set of criteria against which standards can be evaluated to make data Findable, Accessible, Interoperable and Reusable (FAIR). A set of specifications for an object-oriented implementation of the FAIR principles, the so-called FAIR Digital Objects, has been released by the FDO Forum (fairdo.org) in 2022.

Open source developments also provide a lot of foundational technologies for data interoperability and data exchange. Open source may complement standardisation efforts, but may also provide additional standards for addressing the respective challenges. It will increasingly be important to establish collaboration mechanisms between standardisation and open source and to look at transposing open source technologies into standards and specifications in support of the EU data strategy.

PROGRESS

Looking at the data standards landscape, the challenge lies not so much in a lack of standards, but rather in the multitude of standards and involved standards development organisations. There is a need for convergence and clarity. The Annual Union work programme 2024 includes an action on a European Trusted data framework. The HLF workstream 14 report on Data Interoperability by the High-Level Forum for European standardisation provides a comprehensive set of recommendations on the way to accomplish this framework, which has served as the basis for a standardisation request.

I. DATA DISCOVERY

The DCAT standard (W3C) is a vocabulary designed to facilitate interoperability between data catalogues. The Application Profile for data portals in Europe (DCAT-AP) has been implemented for the referencing of open data in the European open data portals. The DCAT Application Profile has been developed as a common project under the former ISA2 programme, currently Interoperable Europe, the Publications Office (PO) and CNECT to describe public-sector data catalogues and datasets and to promote the specification to be used by data portals across Europe. The common application profile and promoting this among the Member States is substantially improving the interoperability among data catalogues and the data exchange between Member States.

The DCAT-AP related work, including its extensions to geospatial data (GeoDCAT-AP) and statistical data (StatDCAT-AP) also highlights the need for further work on the core standard. These are topics for the W3C smart descriptions & smarter vocabularies (SDSVoc) under the VRE4EIC Project.

The DCAT-AP standard can also be used to support Data Discovery in data spaces. It can act as a "common denominator" to help querying and searching data catalogues in various data spaces using the same "language". Currently its use (with possible extensions) is considered under the scope of the mobility data space (Metadata | NAPCORE), the health data space (by the TEHDAS project Joint Action Towards the European Health Data Space – TEHDAS - Tehdas), the Language Data Space (https://language-data-space.ec.europa.eu/index_en) and the data space for smart and sustainable cities and communities (https://eurocities.eu/projects/data-space-for-smart-and-sustainable-cities-and-communities-ds4sscc/). Another extension of DCAT-AP, i.e., BregDCAT-AP is being considered in the public procurement data space (https://single-market-economy.ec.europa.eu/single-market/public-procurement/digital-procurement/public-procurement-data-space-ppds_en). DCAT-AP variation for High Value Datasets aims to assist on the discoverability of datasets falling into the six categories (geospatial, Earth observation and environment, meteorological, statistics, companies and company ownership, and mobility) and can act as a "connector" to the related data spaces. The same holds for GeoDCAT-AP which acts as a "bridge" between geospatial open data residing into data.europa.eu portal and those falling into the scope of the INSPIRE directive (https://inspire-geoportal.ec.europa.eu/srv/eng/catalog.search#/home).

Following the recommendations in the HLF workstream 14 report, the draft standardisation request aims to establish a formal implementation framework.

II. DATA SHARING

For open data, the topics of data provenance and licensing (for example the potential of machine-readable licenses) need to be addressed, as encouraged in the current and proposed revision of the PSI Directive (see section B.1). The Open Data Directive encourages the use of standard licenses which must be available in digital format and be processed electronically (Article 8(2)). Furthermore, the Directive encourages the use of open licenses available online, which should eventually become common practice across the EU (Recital 44). In addition, to help Member States transpose the revised provisions, the Commission adopted guidelines which recommend the use of such standard open licenses for the reuse of PSI. Currently, Interoperable Europe vocabularies and solutions are used for the implementation of Single Digital Gateway Regulation (SDGR https://eur-lex.europa.eu/eli/reg/2018/1724/oj) in the design of common data models for evidences that are going to be exchanged between Member States. SDGR highlights the need to insure functional, technical and semantic interoperability in the exchange of evidences which can only be assured by using standard and shared data representation formats. The High Value Datasets Implementing Act put additional emphasis on the licensing part by stating that " *High-value datasets shall be made available for re-use under the conditions of the Creative Commons Public Domain Dedication (CC0) or, alternatively, the Creative Commons BY 4.0 licence, or any equivalent or less restrictive open licence, allowing for unrestricted re-use.* "

Restricted data, standards are needed to facilitate the secure and trusted sharing of data. Apart from commercial data, restricted data also includes personal data (based on consent) and sensitive data from public institutions. This means that a complex combination of requirements will need to be addressed, including:

- legal aspects, such as data protection, consent management
- commercial aspects, such as licences, contracts, prices, terms of use, and the handling of trade secrets
- technical aspects, such as establishing secure connections, transaction logging and data lineage.

Common cross-domain data sharing mechanisms are needed to manage this complexity. Following the recommendations in the HLF workstream 14 report, the draft standardisation request aims to establish a harmonised standard for trusted data transactions.

Pre-standardisation work is already ongoing in the CEN workshop Trusted Data Transaction.

III. DATA USAGE

Vocabularies, Data Models and Ontologies are a key enabler for Data Usage, since they enable to create a common semantic layer across disparate data sets. The RDF (resource Description Framework) is a well established standard methodology to describe domain and cross-domain concepts. Data integration tools enable to combine data sets for data analytics purposes, either by ingesting the data or by virtual integration techniques.

In the eGovernment domain, Core Vocabularies have been established (i.e., Core Person, Core Organization, Core Location, Core Public Event, Core Criterion and Core Evidence), Core Public Service Application Profile and Asset Description Metadata Schema (for describing reusable solutions), under the former ISA2 programme, currently Interoperable Europe. They were used in the TOOP-OOP (Once-Only Principle) project and are now used in the Once Only Principle (OOP) Technical System (established through the Implementing Act https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32022R1463 published in 2022) under the scope of the Single Digital Gateway Regulation EU 2018/1724.

The mapping of existing relevant ontology standards for other big data areas would be beneficial. Moreover, it will be beneficial to select or develop domain ontologies for the common European data spaces, supported by common best practices and tools (including those of OpenAPIs). The use of AI tools such as Large Language Models, Semantic Networks, or Machine Learning and Deep Learning Frameworks can prove to be useful.

Following the recommendations in the HLF workstream 14 report, the draft standardisation request aims to establish a formal implementation framework for the selection of trusted ontologies and data models.

IV. DATA GOVERNANCE

Data governance is relevant to individual participants, as well as to collaborative structures such as portals and data spaces. Standards that address data availability, data quality, data security and data retention fall under this process.

Following the recommendations in the HLF workstream 14 report, the draft standardisation request aims to establish a standard for the quality assessment of internal data governance processes.

DATA SPACES

Data spaces create the environments for the data sharing processes. Convergence of governance principles, architecture and enabling services will further help to enhance interoperability.

Following the recommendations in the HLF Workstream 14 'Data Interoperability' report, one of the deliverables in the standardisation request is a maturity model for Common European Data Spaces.

Ongoing pre-standardisation work includes the Data Spaces Blueprint and the Data Spaces Maturity Model.

(A.3) REFERENCES

- Regulation (EU) 2022/868 of the European Parliament and of the Council of 30 May 2022 on European data governance and amending Regulation (EU) 2018/1724 (Data Governance Act)
- Regulation (EU) 2022/1925 of the European Parliament and of the Council of 14 September 2022 on contestable and fair markets in the digital sector (Digital Markets Act)
- Regulation (EU) 2022/2065 of the European Parliament and of the Council of 19 October 2022 on a Single Market For Digital Services and amending Directive 2000/31/EC (Digital Services Act)
- Directive (EU) 2019/1024 of the European Parliament and of the Council of 20 June 2019 on open data and the re-use of public sector information (recast)
- Regulation (EU) 2018/1807 of the European Parliament and of the Council of 14 November 2018 on a framework for the free flow of non-personal data in the European Union
- Regulation (EU) 2023/2854 of the European Parliament and of the Council of 13 December 2023 on harmonised rules on fair access to and use of data and amending Regulation (EU) 2017/2394 and Directive (EU) 2020/1828 (Data Act)
- Regulation (EU) 2024/903 of the European Parliament and of the Council of 13 March 2024 laying down measures for a high level of public sector interoperability across the Union (Interoperable Europe Act)
- Regulation (EU) 2018/1724 of the European Parliament and of the Council of 2 October 2018 establishing a single digital gateway to provide access to information, to procedures and to assistance and problem-solving services (Single Digital Gateway Regulation)
- Commission Implementing Regulation (EU) 2022/1463 of 5 August 2022 setting out technical and operational specifications of the technical system for the cross-border automated exchange of evidence and application of the 'once-only' principle
- COM(2020) 66 final "A European strategy for data"
- COM(2018) 232 final "Towards a common European data space"
- COM(2014) 442 Towards a thriving data-driven economy
- COM(2016) 176 ICT Standardisation Priorities for the Digital Single Market
- COM(2017) 9 Building a European Data Economy: A Communication on Building a European Data Economy was adopted on 10 January 2017. This Communication explores the following issues: free flow of data; access and transfer in relation to machine generated data; liability and safety in the context of emerging technologies; and portability of non-personal data, interoperability and standards. Together with the Communication the Commission has launched a public consultation.
- Decision (EU) 2015/2240 on interoperability solutions and common frameworks for European public administrations, businesses and citizens (former ISA2 programme, currently Interoperable Europe, https://joinup.ec.europa.eu/collection/interoperable-europe/interoperable-europe) as a means for modernising the public sector
- The PSI Directive (2013/37/EU) on the re-use of public sector information (Public Sector Information Directive) was published in the Official Journal on 27 June 2013. The Directive requests to make available for reuse PSI by default, preferably in machine-readable formats. All Member States transposed it into national legislation.
- COM(2011) 882 on Open data
- COM(2011) 833 on the reuse of Commission documents
- C(2018) 2375 final "Recommendation on access to and preservation of scientific information"

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

ACTION 1: SDOs to support the work on a European trusted data framework

ACTION 2: SDOs to optimize the management of DCAT and DCAT-AP (data discovery)

- Related legal requirements: Open Data Directive, implementing act on High Value Data Sets, Data Act
- Help to establish a governance framework for DCAT profiles
- Develop rules for the management of new requirements, including criteria to decide whether to implement these in the base DCAT-AP standard or as extensions
- Consider the development of interface standards for DCAT-AP publication and querying
- Evaluate the suitability of DCAT for sharing of closed data, for example in a data spaces context

ACTION 3: SDOs to define a framework for the sharing of data from smart devices (data sharing, data usage, data retention, security of data in transit and data at rest)

- Related legal requirements: Data Governance Act, Data Act, GDPR, eIDAS

ACTION 4: SDOs to consider the existing standards and define a framework for the sharing of consent-based data based (data altruism by organisations or persons), including metadata standards to define the consent attributes (e.g. purpose) and mechanisms to manage withdrawal of consent (data sharing, data governance).

- Related legal requirements: Data Governance Act, GDPR
- Support the fair access to and use of data and as well trusted, legally compliant data sharing across parties, including data intermediaries and altruism organisations.
- Provide interoperability based on widely accepted European and international standards (included open source), in order to support cross-border data flows, between EU and other markets outside Europe.

ACTION 5: SDOs to optimize the management of domain ontologies:

- Related legal requirements: Open Data Directive, implementing act on High Value Data Sets, Data Act
- Help to establish a common governance framework for ontologies
- Address long-term sustainability aspects such as maintenance funding
- Develop standard criteria to evaluate quality of ontologies, e.g. avoiding bias, ensuring completeness, use of persistent URLs
- Develop standard methods for the automated testing of ontologies

ACTION 6: SDOs to identify standards for data integration, semantic mapping / tagging, data fabric. Also addressing the way this can help to leverage common domain ontologies (data usage)

ACTION 7: SDOs to define standards for data governance, addressing two levels:

- Data governance standards to support individual parties, for example certification of internal data governance processes and tools.
- Data governance standards to support collaborative data sharing, in particular open data portals and data spaces.
- Data governance standards to support collaboration with existing communities for the creation and evolution of each specification / standard.

ACTION 8: Support standardisation needs of the European open data infrastructure, especially the European Data Portal and the SEMIC ….

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

This chapter on Data Economy covers the high-level, horizontal aspects as outlined in part A above. The ongoing activities listed below are focused on that level, as well. There are many more ongoing activities and available standards relevant for data which are included in the other, sector-specific chapters.

CEN & CENELEC

CEN/CLC JTC 25 'Data management, Dataspaces, Cloud and Edge' was established in September 2024 to address standardization in data management and interoperability, including:

- - Data governance, data quality and data lifecycle management
- - Interoperability, portability and switch ability
- - Data model specifications and frameworks
- The committee addresses data interoperability through its Working Groups, particularly:
- - WG 2: Dataspaces, focusing on dataspace interoperability standards
- - WG 3: Data Management and Governance, addressing data quality and metadata standards

The JTC aims to develop standards that support the European data strategy implementation and, in particular, the Data Act standardization activities, such as the harmonized standard on interoperability. The committee's work directly supports the objectives outlined in Article 33 of the Data Act regarding interoperability requirements for data space participants and works in close connection with the CEN Workshop 'Trusted Data Transactions', that developed and published CEN/CWA 18125 :2024 'Trusted Data Transaction'.

CEN/TC 468 'Preservation of digital information' works on the functional and technical aspects of the preservation of digital information. In this field, the committee will develop a structured set of standards, specifications and reports, addressing business requirements, including compliance with the European legislative and regulatory framework (e.g. GDPR, eIDAS). This committee is developing a TR 'Mapping of existing standardisation deliverables on European digital archiving and preservation' and a TS 'Policy and functional requirements for the electronic archiving services'. The TC has established WG 1 'General concepts for preservation of digital information'.

ETSI

ETSI TC SmartM2M is developing a set of reference ontologies, mapped onto the oneM2M Base Ontology. This work has commenced with the SAREF ontology, for Smart Appliances, but is being extended to add semantic models for data associated with smart cities, industry and manufacturing, smart agriculture and the food chain, water, automotive, eHealth/aging well and wearables (https://saref.etsi.org/).

ETSI ISG CIM (cross-cutting Context Information Management) has developed the NGSI-LD API (GS CIM 009 v1.87.1) which builds upon the work done by OMA Specworks and FIWARE. NGSI-LD is an open framework for the exchange of contextual information for smart services, aligned with best practices in linked open data. The NGSI-LD API is based on the NGSI-LD Information Model (GS CIM 006 v1.32.1). It is now capable of attesting the provenance of information as well as supporting fine-grained encryption (GS CIM 019). Ongoing activities involve increased interoperability with oneM2M data sources. Applications and use cases are extended to Digital Twins, eHealth, analytics for government services, federated data spaces, and GDPR-compatible data sharing. Furthermore, ISG CIM will publish at the beginning of 2025 the GR CIM 048 report about handling DCAT data catalogues and data services with NGSI-LD.

ETSI's ISG MEC continues to expand upon developing its set of standardized Application Programming Interfaces (APIs) for Multi-Access Edge Computing (MEC). MEC technology offers IT service and Cloud computing capabilities at the edge of the network. Shifting processing power away from remote data centres and closer to the end user enables an environment that is characterized by proximity and ultra-low latency and provides exposure to real-time network and context information.

ETSI's TC ATTM committee has specified a set of KPIs for energy management for data centres (ETSI ES 205 200-2-1). These have been combined into a single global KPI for data centres, called DCEM, by ETSI's ISG on Operational energy Efficiency for Users (OEU), in ETSI GS OEU 001. TC ATTM took into account ETSI Position Paper GR OEU 036 on «Data interoperability format with applications for connected buildings» from ETSI ISG OEU. On this basis, TC ATTM started to work on Building Information Modelling (BIM) standardisation to support smart sustainable efficient communities.

SC USER: has produced a set of documents related to "User-Centric approach in the digital ecosystem".
Note: this body of work also applies to several other sections of the ICT rolling plan, such as, IoT, eHealth, Cyber security, e-privacy, accessibility, but are documented only once.

ETSI TR 103 438 User Group; User centric approach in Digital Ecosystem
ETSI EG 203 602 User Group; User Centric Approach: Guidance for users; Best practices to interact in the Digital Ecosystem
ETSI TR 103 603 User Group; User Centric Approach; Guidance for providers and standardisation makers
ETSI TR 103 604 User Group; User centric approach; Qualification of the interaction with the digital ecosystem
ETSI TR 103 437 Quality of ICT services; New QoS approach in a digital ecosystem

SC USER has initiated an action to finalise the project by defining and implementing a proof of Concept of a "Smart interface for digital ecosystem", which is a user interface that meets the needs and expectations of the user at his request, and is an "Intelligent", "highly contextualised" personalisation, agile and proactive interface with an integrated QoS. This project will be based on the Smart Identity concept.

GS1

Digital Link - GS1 Digital Link | GS1

Electronic Data Interchange - https://www.gs1.org/standards/edi

EPCIS 2.0 Standard https://ref.gs1.org/standards/epcis/"

ISO

ISO/TC 46/SC 4 Technical interoperability

- ISO 15836 Information and documentation — The Dublin Core metadata element set

ISO/IEC JTC1

In 2018 JTC 1/SC 42 Artificial Intelligence was formed, and contains a WG 2 which is responsible for the Big Data work program.

SC 42 has published the following published big data standards:

ISO/IEC 20546:2019 Information technology -- Big Data -- Overview and Vocabulary (https://www.iso.org/standard/68305.html?browse=tc)

ISO/IEC TR 20547-2:2018 Information technology -- Big data reference architecture -- Part 2: Use cases and derived requirements (https://www.iso.org/standard/71276.html?browse=tc)

ISO/IEC TR 20547-5:2018 Information technology -- Big data reference architecture -- Part 5: Standards roadmap (https://www.iso.org/standard/72826.html?browse=tc)

ISO/IEC 20547-1: Information technology -- Big Data reference architecture -- Part 1: Framework and application process

ISO/IEC 20547-3: Information technology -- Big Data reference architecture -- Part 3: Reference architecture

SC 42 is progressing the following current big data projects, which are expected to complete in the next year:

ISO/IEC 24688: Information technology -- Artificial Intelligence -- Process management framework for Big data analytics

See for further information: https://www.iso.org/committee/6794475.html

Built on its foundation standard that is ISO/IEC 38500 (Information technology - Governance of IT for the Organization), JTC 1/SC 40 IT service management and IT governance has developed or is developing the following standards on Governance of Data:

38505-1: Information technology - Governance of IT - Part 1: Application of ISO/IEC 38500 to the governance of data

38505-2: Information technology - Governance of IT - Part2: Implications of ISO/IEC38505-1 for Data Management

38505-3: Information technology - Governance of Data - Part3: Guidelines for Data Classification

See for further information https://www.iso.org/committee/5013818.html

ISO/IEC JTC1 SC32 on "Data management and interchange" work on standards for data management within and among local and distributed information systems environments. SC 32 provides enabling technologies to promote harmonization of data management facilities across sector-specific areas. https://www.iso.org/committee/45342.html

ISO/IEC 5207 Information technology — Data usage — Terminology and use cases

ISO/IEC 5212 Information technology — Data usage — Guidance for data usage

ISO/IEC 9075 Series Information technology — Database languages SQL

ISO/IEC 11179 Series Information technology — Metadata registries (MDR)

ISO/IEC 15944 Series Information technology — Business operational view

ISO/IEC 19583 Series Information technology — Concepts and usage of metadata

ISO/IEC 19763 Series Information technology — Metamodel framework for interoperability (MFI)

ISO/IEC 39075 Information technology — Database languages — GQL

ISO/IEC JTC 1/SC 7 Software and systems engineering

ISO/IEC 25024:2015 Systems and software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE) — Measurement of data quality

ISO/IEC CD 25040.2 Systems and software engineering – Systems and software Quality Requirements and Evaluation (SQuaRE) – Quality evaluation framework

ISO/IEC TS 27560:2023 Privacy technologies — Consent record information structure

ITU-T

ITU-T SG11 developed Q.Suppl.76 which defines common approaches and interfaces for data exchange between the central equipment identity register and the equipment identity register. It can be used to combat counterfeit and the use of stolen ICT devices as well as for other purposes. Also, based on the increasing demand for data-based smart agriculture services, ITU-T SG11 developed three new standards defining data management interfaces:

- 5028 "Data management interfaces for intelligent edge computing-based smart agriculture service";
- 5029 "Data management interfaces in digital twin smart aquaculture system with intelligent edge computing";
- 5030 "Data management interfaces for intelligent edge computing-based flowing-water smart aquaculture system".

Currently, SG11 continues developing data management interfaces for educational robot systems, public decision-making frameworks, smart pest and disease management services.

ITU-T SG13 Recommendation ITU-T Y.3600 "Big data - Cloud computing based requirements and capabilities" covers use-cases of cloud computing based big data to collect, store, analyse, visualize and manage varieties of large volume datasets: https://www.itu.int/rec/T-REC-Y.3600/en

Also, SG13 published Y.3600-series Supplement 40 "Big Data Standardisation Roadmap" which will be revised in 2022: https://www.itu.int/rec/T-REC-Y.Sup40/en

SG13 has 10 ongoing work items on big data, in particular, it is working on big data functional requirements for data integration (Y.bdi-reqts).

Recently approved ITU-T Recommendations on big data include Y.3605 (09/2020) with big data reference architecture and functional architecture of big data-driven networking Y.3653 (04/2021).

See a flipbook "Big Data - Concept and application for telecommunications": https://www.itu.int/en/publications/Documents/tsb/2019-Big-data/mobile/index.html.

The work programme of SG13 is available at: http://itu.int/itu-t/workprog/wp_search.aspx?sg=13

More info: https://www.itu.int/en/ITU-T/studygroups/2017-2020/13

ITU-T SG20 "Internet of things (IoT) and smart cities & communities (SC&C)" is studying big data aspects of IoT and SC&C. ITU-T Study Group 20 developed Recommendation ITU-T Y.4114 "Specific requirements and capabilities of the IoT for big data" which complements the developments on common requirements of the IoT described in Recommendation ITU-T Y.4100/Y.2066 and the functional framework and capabilities of the IoT described in Recommendation ITU-T Y.4401/ Y.2068 in

terms of the specific requirements and capabilities that the IoT is expected to support in order to address the challenges related to big data. This Recommendation also constitutes a basis for further standardization work such as functional entities, application programming interfaces (APIs) and protocols concerning big data in the IoT.

ITU-T SG20 also published Recommendation ITU-T Y.4461 "Framework of open data in smart cities" which clarifies the concept, analyses the benefits, identifies the key phases, roles and activities and describes the framework and general requirements of open data in smart cities, Recommendation ITU-T Y.4473 "SensorThings API - Sensing" that specifies the SensorThings application programming interface (API), Recommendation ITU-T Y.4472 "Open data application programming interface (APIs) for IoT data in smart cities and communities", and Supplement ITU-T Y.Suppl.61 "Features of application programming interface (APIs) for IoT data in smart cities and communities".

ITU-T SG20 has approved Recommendation ITU-T Y.4505 "Minimal Interoperability Mechanisms for Smart and Sustainable Cities and Communities".

Additionally, ITU-T SG20 is working on the following work items: draft Supplement ITU-T Y.Sup-datainterop-usecases "Use cases of data interoperability in Internet of things", draft Recommendation ITU-T Y.AIoT-dfs-arc "Reference architecture of data fusion service in artificial intelligence of things", draft Recommendation ITU-T Y.AIoT-dpsm "Requirements and framework of data processing for smart manufacturing with Artificial Intelligence of Things", draft Recommendation ITU-T Y.DSE-LISF "Reference architecture of data sharing and exchange based on lightweight intelligent software framework for Internet of things devices", draft Recommendation ITU-T Y.Interop-DPM "Integrated Interoperability framework for Data Processing and Management", draft Technical Report ITU-T YSTR.GenAI-Sem-Interop "Implications of Generative Artificial Intelligence on Semantic Interoperability for Data Use" and draft Recommendation ITU-T Y.Evaluation-dfp "Quality evaluation framework of data as a factor of production for smart sustainable cities".

The work programme of SG20 is available at: https://www.itu.int/ITU-T/workprog/wp_search.aspx?sg=20

More info: https://itu.int/go/tsg20

ITU-T Focus Group on metaverse (FGMV) published relevant technical specifications to support metaverse applications for Smart Cities & Communities: FGMV 28 "Requirements for the metaverse based on digital twins enabling integration of virtual and physical worlds", FGMV 29 "Reference model for the metaverse based on a digital twin enabling integration of virtual and physical worlds", and FGMV 31 "Technical Specification on Requirements, functional framework and capability of IoT for metaverse".

The ITU-T Focus Group on Data Processing and Management (FG-DPM) to support IoT and Smart Cities & Communities was set up in 2017. The Focus Group played a role in providing a platform to share views, develop a series of deliverables, and showcase initiatives, projects, and standards activities linked to data processing and management and establishment of IoT ecosystem solutions for data focused cities. This Focus Group concluded its work in July 2019 with the development of 10 Technical Specifications and 5 Technical reports. The complete list of deliverables is available here https://itu.int/en/ITU-T/focusgroups/dpmITU-T SG17 has approved six standards on big data and open data security:

ITU-T X.1147 "Security requirements and framework for big data analytics in mobile internet services"

ITU-T X.1376 "Security-related misbehaviour detection mechanism based on big data analysis for connected vehicles"

ITU-T X.1603 "Data security requirements for the monitoring service of cloud computing"

ITU-T X.1750 " Guidelines on security of big data as a service for Big Data Service Providers"

ITU-T X.1751 "Security guidelines on big data lifecycle management for telecom operators"

ITU-T X.1752 "Security guidelines for big data infrastructure and platform" (under approval as of Sept 2021).

More info: https://www.itu.int/en/ITU-T/studygroups/2017-2020/17

ITU-T Focus Group on Artificial Intelligence (FG-AI4H), established in partnership with ITU and WHO, is working towards establishing a standardized assessment framework for the evaluation of AI-based methods for health, diagnosis, triage or treatment decisions.

https://www.itu.int/en/ITU-T/focusgroups/ai4h/

IEEE

The IEEE "Big Data Governance and Metadata Management: Standards Roadmap" has been developed to guide IEEE standards and pre-standardization projects related to Big Data (mobile health, energy efficient processing, personal agency and privacy) and open data.

Relevant standards activities include:

- IEEE 1752 series of standards on mobile health data
- IEEE 3652.1, Guide for Architectural Framework and Application of Federated Machine Learning
- IEEE 7002, Standard for Data Privacy Process
- IEEE 7005, Standard for Transparent Employer Data Governance
- IEEE P3800, Data Trading System: Overview, Terminology, and Reference Model
- IEEE P7004, Standard for Child and Student Data Governance
- IEEE P7015 , Standard for Data and Artificial Intelligence (AI) Literacy, Skills, and Readiness.

There also are pre-standards programs, including:

- IC16-001 Open Data
- IC19-004 Technology and Data Harmonization for Enabling Clinical Decentralized Clinical Trials
- IC21-007 Ethical Assurance of Data-Driven Technologies for Mental Healthcare
- IC21-013 Synthetic Data

For more information, see: https://ieee-sa.imeetcentral.com/eurollingplan/ .

IETF

The A Semantic Definition Format for Data and Interactions of Things (asdf) Working Group is tasked with developing Semantic Definition Format (SDF) into a standards-track specification for thing interaction and data modelling. In the process of developing this specification, further functional requirements that emerge in the usage of SDF for model harmonization will be addressed.

https://wiki.ietf.org/en/group/iab/Multi-Stake-Holder-Platform#h-313-data-interoperability

OASIS

The OASIS Open Data Protocol (Odata) TC works to simplify the querying and sharing of data across disparate applications and multiple stakeholders for re-use in the enterprise, Cloud, and mobile devices. A REST-based protocol, OData builds on HTTP and JSON using URIs to address and access data feed resources. OASIS OData standards have been approved as ISO/IEC 20802-1:2016 and ISO/IEC 20802-2:2016.

The NIEMOpen OASIS project (formerly known as the "National Information Exchange Model") is a framework for exchanging information between public and private sector organizations, with particular focus on issued and vocabularies for e-government and public administration issues. The framework includes a reference data model for objects, properties, and relationships, allowing data elements to be shared, extended and harmonized across vertical topics and governmental functions, as well as a set of technical specifications for using and extending the data model in information exchanges.

The Code List Representation (genericode) v1.0 final standard is a semantic model of code lists and accompanying XML serialization that can encode a broad range of lists of information elements such as country codes, abbreviations and lookup tables. This serialization is designed to enable automatic interchange or distribution of machine-readable code list information between systems, and so more widely reuse existing categorizations.

The OASIS ebCore TC maintains the ebXML RegRep ('registry and repository') standard, also approved as ISO 15000-3:2023, that defines the service interfaces, protocols and information model for an integrated registry and repository. The repository stores digital content while the registry stores metadata that describes the content in the repository. RegRep was used in the EU TOOP project, which was concluded in 2021.

RegRep can be used in conjunction with ebXML Messaging including AS4 using a recently developed binding for the Registry Services of the OASIS ebXML RegRep Version 4.0 OASIS Standard. This binding is compatible with the AS4 profile of ebXML Messaging as used, for example, in the European Commission's eDelivery Building Block, and complements the existing protocol bindings specified in OASIS RegRep Version 4.0. This AS4 binding is also of relevance to the Once-Only Technical System for the Single Digital Gateway (see section 3.2.4, eGovernment).

OGC

The Open Geospatial Consortium (OGC) defines and maintains standards for location-based, spatio-temporal data and services. The work includes, for instance, schema allowing description of spatio-temporal sensor, image, simulation, and statistics data (such as "datacubes"), a modular suite of standards for Web services allowing ingestion, extraction, fusion, and (with the web coverage processing service (WCPS) component standard) analytics of massive spatio-temporal data like satellite and climate archives. OGC develops community standards, often based from standards from CEN and ISO. OGC also contributes to the INSPIRE project.

http://www.opengeospatial.org

ONEM2M

The oneM2M Partnership Project has specified the oneM2M Base Ontology (oneM2M TS-0012, ETSI TS 118 112) to enable syntactic and semantic interoperability for IoT data. The oneM2M standard defined a middleware layer, residing between a lower layer, comprising IoT devices and communications technologies, and an upper layer of IoT applications. Thus, it enables a wide range of interactions between applications and the underlying technologies needed to source data from connected devices and sensors as well as sharing of data from many sensors that are managed by different device owners and service providers. All oneM2M specifications are publicly accessible at at Specifications (onem2m.org).

W3C

DCAT Version 3 now contains also provisions on Application Profiles (DCAT-AP) The application profiles themselves are hosted by the stakeholders creating them. There is currently no registry for Application Profiles:

- Data Catalog Vocabulary (DCAT) - Version 3 https://www.w3.org/TR/vocab-dcat/
- SKOS https://www.w3.org/TR/skos-primer/

ODRL serves to express constraints with respect to data and metadata:

- ODRL Information Model 2.2 https://www.w3.org/TR/odrl-model/
- ODRL Vocabulary and Expression https://www.w3.org/TR/vocab-odrl/
- PROV-N: The Provenance Notation https://www.w3.org/TR/prov-n/

RDF 1.2 works toward interoperability between Linked data and the world of Property Graphs. This also includes work on the SPARQL query language and an entire suite of further technical specifications:

- RDF 1.2 https://www.w3.org/TR/rdf12-concepts/
- SPARQL 1.2 https://www.w3.org/TR/sparql12-update/
- JSON-LD 1.1 https://www.w3.org/TR/json-ld11/ but work started on updating it.
- SHACL Shapes Constraint Language https://www.w3.org/TR/shacl/

Work on Spatial Data in cooperation with OGC continues, improving best practices and working towards increased interoperability

- Spatial Data on the Web Best Practices https://www.w3.org/TR/sdw-bp/
- Spatial Data WG with further links https://www.w3.org/groups/wg/sdw/
- Time Ontology in OWL https://www.w3.org/TR/owl-time/

There are further Technical Specifications that can be found in :

- Data Ecosystem https://www.w3.org/ecosystems/data/
- Data Tag on W3C TR https://www.w3.org/TR/?filter-tr-name=&tags%5B%5D=data

(C.2) OTHER ACTIVITIES RELATED TO STANDARDISATION

ISA AND ISA2 PROGRAMME OF THE EUROPEAN

COMMISSION

The DCAT application profile (DCAT-AP) has been defined. DCAT-AP is a specification based on DCAT (a RDF vocabulary designed to facilitate interoperability between data catalogues published on the web) to enable interoperability between data portals, for example to allow metasearches in the European Data Portal that harvests data from national open data portals.

Extensions of the DCAT-AP to spatial (GeoDCAT-AP: https://semiceu.github.io/GeoDCAT-AP/drafts/latest/) and statistical information (StatDCAT-AP: https://joinup.ec.europa.eu/collection/semantic-interoperability-community-semic/solution/statdcat-application-profile-data-portals-europe) have also been developed.

https://joinup.ec.europa.eu/asset/dcat_application_profile/description

DCAT-AP | Joinup (europa.eu)

https://semiceu.github.io/DCAT-AP/releases/2.2.0-hvd/

Core Vocabularies can be used and extended in the following contexts:

- Development of new systems: the Core Vocabularies can be used as a default starting point for designing the conceptual and logical data models in newly developed information systems.
- Information exchange between systems: the Core Vocabularies can become the basis of a context-specific data model used to exchange data among existing information systems.
- Data integration: the Core Vocabularies can be used to integrate data that comes from disparate data sources and create a data mesh-up.
- Open data publishing: the Core Vocabularies can be used as the foundation of a common export format for data in base registries like cadastres, business registers and public service portals.

The Core Public Service Vocabulary Application Profile allows harmonised ways and common data models to represent life events, business events and public services across borders and across-sectors to facilitate access.

ADMS is a standardised vocabulary which aims at helping publishers of semantic assets to document what their assets are about (their name, their status, theme, version, etc) and where they can be found on the Web. ADMS descriptions can then be published on different websites while the asset itself remains on the website of its publisher.

More info can be found in the following links:

https://joinup.ec.europa.eu/collection/semantic-interoperability-community-semic/core-vocabularies

Core Vocabularies | Joinup (europa.eu)

https://ec.europa.eu/isa2/solutions/core-public-service-vocabulary-application-profile-cpsv-ap_en

https://joinup.ec.europa.eu/collection/semantic-interoperability-community-semic/adms

CEF

Under the framework of the Connecting Europe Facility programme support to the interoperability of metadata and data at national and EU level is being developed through dedicated calls for proposals. The CEF group is also promoting training and webinars for using the "context broker", in collaboration as appropriate with the NGSI-LD standards group ETSI ISG CIM.

AQUASMART

AquaSmart enables aquaculture companies to perform data mining at the local level and get actionable results.

The project contributes to standardisation of open data in aquaculture. Results are exploited through the Aquaknowhow business portal.

www.aquaknowhow.com

AUTOMAT

The main objective of the AutoMat project is to establish a novel and open ecosystem in the form of a cross-border Vehicle Big Data Marketplace that leverages currently unused information gathered from a large amount of vehicles from various brands.

This project has contributed to standardisation of brand-independent vehicle data.

www.automat-project.eu

BODYPASS

BodyPass aims to break barriers between **health sector** and **consumer goods** sector and eliminate the current data silos.

The main objective of BodyPass is to **foster exchange**, linking and re-use, as well as to integrate **3D data assets** from the two sectors. For this, BodyPass adapts and **creates tools** that allow a secure exchange of information between data owners, companies and subjects (patients and customers).

The project aims at standardizing 3D data

www.bodypass.eu

EU COMMISSION

A smart open data project by DG ENV led directly to the establishment of the Spatial Data on the Web Working group, a collaboration between W3C and the OGC.

G8 OPEN DATA CHARTER

In 2013, the EU endorsed the G8 Open Data Charter and, with other G8 members, committed to implementing a number of open data activities in the G8 members' collective action plan (publication of core and high-quality datasets held at EU level, publication of data on the EU open data portal and the sharing of experiences of open data work).

FUTURE INTERNET PUBLIC PRIVATE PARTNERSHIP PROGRAMME

Specifications developed under the Future Internet public-private-partnership programme (FP7):

FIWARE NGSI extends the OMA Specworks NGSI API for context information management that provides a lightweight and simple means to gather, publish, query and subscribe to context information. FIWARE NGSI can be used for real-time open data management. ETSI's ISG for cross-cutting Context Information Management (CIM) has developed the NGSI-LD API (GS CIM 004 and GS CIM 009) which builds upon the work done by OMA

Specworks and FIWARE. The latest FIWARE software implements the newest ETSI NGSI-LD specification.

FIWARE CKAN: Open Data publication Generic Enabler. FIWARE CKAN is an open source solution for the WG10 publication, management and consumption of open data, usually, but not only, through static datasets. FIWARE CKAN allows its users to catalogue, upload and manage open datasets and data sources. It supports searching, browsing, visualising and accessing open data

BIG DATA VALUE CPPP TF6 SG6 ON BIG DATA STANDARDISATION

In the big data value contractual public-private-partnership, a dedicated subgroup (SG6) of Task Force 6: Technical deals with big data standardisation.

FAIR PRINCIPLES AND THE GO FAIR INITIATIVES

FAIR Principles stands for **F** indability, **A** ccessibility, **I** nteroperability, and **R** euse of digital assets. The principles emphasise machine-actionability (i.e., the capacity of computational systems to find, access, interoperate, and reuse data with none or minimal human intervention) data as a result of the increase in volume, complexity, and creation speed of data. GO FAIR is a community that has been working towards implementations of the FAIR Guiding Principles.

ISDA STANDARDISATION ACTIVITIES

- The Dataspace Protocol 2024-1more information about the protocol: https://docs.internationaldataspaces.org/ids-knowledgebase/v/dataspace-protocol
- Making the Dataspace Protocol an international standard documents: https://internationaldataspaces.org/standardizing-the-dataspace-protocol/
- IDSA rulebook provides information to know more about interoperability in data spaces: https://docs.internationaldataspaces.org/ids-knowledgebase/v/idsa-rulebook/idsa-rulebook/3_interoperability
- IDSA mapping of data spaces related standards: https://internationaldataspaces.org/why/international-standards/

(C.3) ADDITIONAL INFORMATION

3.1.4 Internet of Things

A Policy and legislation

(A.1) POLICY OBJECTIVES

The Internet of Things (IoT) is a key priority area of the digital single market. The IoT is a cross domain technology that connects more objects to the internet — including industrial processing machines and the items industrially processed (cyber-physical systems), household equipment, wearable electronics, vehicles, and sensors. The number of connected devices are exceeding 20 billions and forecast steadily to grow to 50 billion of devices in use around the world by 2030, creating a massive web of interconnected devices spanning, is expected to generate 79.4 zettabytes (ZB) of data. Besides the innovation potential in many industrial sectors, the IoT also has the potential to help address many societal challenges including climate change, resource and energy efficiency and ageing.

A large number of proprietary or semi-closed solutions to address specific problems have emerged, leading to non-interoperable concepts, based on different architectures and protocols. Consequently, the deployment of truly IoT applications, i.e. where information of connectable “things” can be flexibly aggregated and scaled, has been limited to a set of “intranets of things — or goods”.

In the emerging IoT economy, voluntary global standards can accelerate adoption, drive competition, and enable cost -effective introduction of new technologies. Standardisation facilitates the interoperability, compatibility, reliability, security and efficiency of operations on a global scale among different technical solutions, stimulating industry innovation and providing greater clarity to technology evolution. Interoperability between IoT networks operated by different companies along the value chain opens up opportunities to address EU policy objectives, e.g. greater resource efficiency for a more circular economy, sustainable and responsible supply chains through transparency and traceability, and others.

Industry is in the best position to develop the technological standards and solutions to address global IoT ecosystem opportunities and challenges. There is a need for a secure solution that is interoperable and scales across a global IoT ecosystem. In this context, the European large-scale

pilots (LSP), which were the subject of a call for proposals in 2016, were supporting the deployment of IoT solutions, by enhancing and testing their acceptability and adoption by users and the public, and by fostering new market opportunities for suppliers to the EU.

Large-scale pilots are providing the opportunity to demonstrate actual IoT solutions in real-life settings and should make it possible for providers to test business opportunities. The concept has later been broadened and further extended to more vertical sectors in the context of the 'Digitising and transforming European industry and services' focus area for cross-programme integrated activities around major challenges. The final Horizon 2020 calls for proposals resulted in the launch of more large-scale projects and pilots to notably address the digital transformation of manufacturing, health and care, rural area, agriculture, and smart energy, paving the way toward the integration of European data spaces and associated platforms.

The first calls of Horizon Europe extended the interoperability framework and platforms to accommodate the most recent developments of the Cloud-Edge-continuum and decentralised processing and machine learning through the creation of a MetaOS for the Edge. This was followed by a cluster of projects focused on swarm intelligence of distributed Edge nodes. Moreover, all IoT recent developments have been continuously incorporated and aligned with the concept of the Common European data spaces (in areas such as mobility, energy, agriculture, etc.). The new paradigm of computing moving to the edge is also being piloted on a large scale in Horizon Europe for the energy domain. The European data spaces are currently being developed, piloted and deployed in the Digital Europe programme and Horizon Europe. Further commercial deployment of IoT platforms and solutions are being prepared under the Connecting Europe Facility Digital, with the actual works on the deployment scheduled for 2025.

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

The proposed actions on IoT in previous rolling plans followed the direction as outlined in the EU communication on ICT standardisation priorities which identified Internet of Things as a key priority for Europe.

One of the major achievements over the last years has been the gradual building of cooperation amongst all actors involved in IoT standardisation, the organisation of high-level events on strategic IoT standardisation issues and initiatives have been proven to be successful instruments and are now common practice in several sectors.

ETSI TC Smart M2M has developed a mapping of standards for IoT and gap analysis taking into account the most promising business models and use-cases, published in ETSI TS 103 375 and TS 103 376.

IoT standards are notably supporting the emergence of business models unleashing the commercial capabilities of systems and devices integrations. Beyond identifying standards, it is also important to identify reference models of implementation that businesses can share. This approach which was initially followed in the Future Internet PPP (FI-PPP), has now been adopted in other industrial organisations, such as the Alliance for AI, IoT and Edge Continuum (AIOTI), and PPPs such as the Big Data Value Association (BDVA) and Open & Agile Smart Cities (OASC), which are now cooperating on common standardisation subjects. AIOTI is also maintaining the High-Level Architecture reference model by incorporating new results from priority topics (e.g. semantic interoperability, security, privacy, AI, please see the R6 of the report here: https://aioti.eu/wp-content/uploads/AIOTI-HLA-Report-R6-Final.pdf).

There is need to correctly position IoT standardisation in relation to existing global initiatives such as ISO/IEC JTC 1/SC 41 '*Internet of Things and Digital Twin*', oneM2M, and the ITU Study Group 20. Agreement to cooperate on common topics and take up of European results in global action are very encouraging results.

Semantic interoperability, (Generative) AI and machine learning, edge and swarm computing, distributed intelligence and learning, digital twins, security, privacy, and 5G/IoT interactions are emerging as priority topics.

With the broadening of the vertical footprints of IoT the main challenge is to work in cooperation across partnerships (PPPs and other alliances), and to ensure dissemination and adoption of best practices across domains, by continuing and deepening the cooperation towards common objectives to ensure all standardisation efforts converge.

(A.3) REFERENCES

- COM(2022) 68: Data Act
- COM(2020) 66: A European strategy for data
- COM (2020) 767: Data Governance Act
- COM(216) 176: ICT standardisation priorities for the digital single market
- COM(2016) 180: Digitising European industry

reaping the full benefits of a digital single market

- SWD(2016) 110/2: Advancing the internet of things in Europe
- COM(2009)278: "Internet of Things — An action plan for Europe": Standardisation will play an important role in the uptake of IoT, by lowering entry barriers to newcomers and operating costs for users, by being a prerequisite for interoperability and economies of scale and by allowing industry to better compete at international level. IoT standardisation should aim at rationalising some existing standards or developing new ones where needed.
- BEREC BoR (16)39 , Report on enabling the Internet of Things

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

The Communication on ICT standardisation priorities for the digital single market proposes priority actions in the domain of internet of things. Actions mentioned below reflect some of them.

ACTION 1: SDOs to work on a landscape overview report and a gap analysis for IoT standardisation in the edge and swarm context including IoT decentralized, distributed approaches to swarm intelligence addressing collective behaviour of decentralized, self-organized IoT systems.

ACTION 2.1: SDOs to continue ongoing work in the area of semantic standards for better data interoperability. Special focus should be put on further extending the SAREF ontology both in number of extensions (e.g. SAREF for maritime, etc.) and the content of each extension and further evolve it towards the requirements of the common European Data Spaces. Define and provide guidance on a process to reuse, extend and maintain ontologies based on a common information model, taking into account the needs of the application domains (e.g. health, energy, ...).

ACTION 2.2 Define a process to define SAREF interoperability profiles that would extend current standards on behaviour and policy interoperability and contribute to ISO/IEC 21823-5 IoT Behaviour and Policy Interoperability.

ACTION 2.3 SAREF should also be adapted for new realities such as edge computing, (federated) machine learning and (Generative) AI, metaverse, digital twin, etc. SDOs should also continue ongoing work for existing standards (e.g. ISO 13584-1 or IEC 61360/ Common Data Dictionary) on semantics. Contributions on ISO/IEC 30152 (guidance on the integration of IoT and digital twin to data spaces) should be provided taking into account the support of SAREF.

ACTION 2.4 Provide guidance on how SAREF can be used to support digital twin interoperability. Concepts for digital twins require additional property types for operational use compared to the purely descriptive properties of an asset. These are states and parameters of the assets as well as their measured and actor values (dynamic data). Commands and entire functions (often called technical functions) must also be described using the same concepts. The concept of properties in today's standards is to extend such semantics in the data models to be able to represent dynamic values correctly. Models for functions/commands are to be developed or existing ones defined in standards.

ACTION 2.5 Stakeholders, who are not members of ETSI, can contribute to the SAREF ontology via ETSI labs. The draft of the EN 303760 for SAREF to be approved by the EU member states to enter into force in 2024/2025.

ACTION 3: SDOs to provide standards supporting compliance as well as standards enabling the integration of (Generative) AI, data processing capabilities and digital twin systems into IoT products, systems, applications and processes. The digital twin part should cover aspects such as identifiers, trust, security, privacy, APIs, provisioning, monitoring, vocabularies and ontologies, metadata, etc.

ACTION 4: Develop a European standard for cyber security compliance of products and systems that is aligned with the current compliance framework of organisations based on the ISO 27000 *Information Security Management* Standards series, new work on the evaluation of complex system (ISO/IEC 27115) and on the reuse of evaluation schemes (ISO/EC 27116) and the GDPR regulation and the future compliance framework of systems based on standards such as ISO/IEC 27100, ISO/IEC 27400, 27402, 27403, ISO 31700.. Preferably the standard could be used to facilitate the compliance with the requirements set out in the NIS 2 and DORA directives and the cybersecurity certification framework

ACTION 5: Promote the development and foster the adoption of novel Reference Architectures for IoT developed in ISO/IEC JTC 1/SC 41 (ISO/IEC 30141 Ed2 IoT reference architecture, ISO/IEC 30188 Digital twin reference architecture) and OneM2M. This architectures should interconnect highly heterogeneous and distributed edge nodes and (resource-constraint) devices and be compliant to the latest developments such as edge computing, distributed intelligence and learning, cognitive computing, mesh networking, swarm computing and digital twins.

ACTION 6: SDOs to assess further gaps and develop standards on the safety and cybersecurity of IoT consumer products under the European Cybersecurity Act or sectorial legislation.

ACTION 7: SDOs should consider further inclusion of and outreach to verticals.

ACTION 8: SDOs should get involved in the definition of the technical common ground of the Common European Data Spaces to be developed and deployed under the Digital Europe and Horizon Europe programmes and leverage the IoT interoperability standardisation assets for that purpose. This could include the management of data lifecycle, common interoperability and discovery language, common data models, data curation network, trustworthiness, governance models, decentralised architecture, scale-up methodologies, etc. Alignment of specifications should be undertaken between ISO/IEC 20151 (Dataspace concepts and characteristics), the DSSC blueprint and the CEEDS blueprint.

ACTION 9: SDOs should look in the standardisation needs of the new edge paradigm and investigate the impact on it of the specific use cases of the verticals (such as energy, mobility, agriculture, health and other). Specific concepts such as software containers, APIs and interfaces, etc. should be explored.

Action 10: Increased collaboration/synchronization between standardisation bodies (e.g., ETSI SAREF, W3C SOSA/SSN, IEEE 1872.2 Autonomous Robotics Ontology, ISO 21823- 3 IoT Semantic Interoperability, etc.).

Action 11: SDOs should consider addressing the standardisation of federated Learning and (Generative) AI for IoT edge related challenges. In particular, federated Learning brings AI models close to the edge to enhance data protection, improve inference reliability, and increase autonomy of end clusters (e.g., end IoT/IIoT devices, on-premises servers, etc.). The cloud plays a federation role for aggregating insights from different IoT edge distributed clusters to generate a federated model shared with each individual cluster. Such standardisation challenges are: (1) workflow standardisation, (2) interfaces edge/cloud, orchestration, (3) model contamination, and (4) pipes for handling distributed traffic.

Action 12: SDOs should get involved in the standardisation of IoT Swarm Systems. In particular, focus on concepts for IoT intelligence clustering to promote collaboration and share of resources and functions for performing specific tasks. These concepts impose standardisation challenges in the required architecture, such as interfaces, data models and ontologies and as well as security and privacy models.

Action 13: SDOs should focus on standardisation needs for IoT and edge computing coexistence/integration/interoperability and continuum across several sectors and platforms, based on the new PWI TR JTC1-SC41-22 (Internet of Things (IoT) – Architecture considerations for IoT, edge and cloud) resulting from EUCloudEdgeIoT.. In particular, the use of end-to-end capabilities of IoT technologies across the edge granularity and beyond impose continuum standardisation challenges, such as support of interoperability by the means of new interfaces, data models, security and privacy models and security and privacy models.

Action 14: SDOs should consider addressing standardisation challenges for service discovery and authentication in the context of distributed and federated edge computing systems and in particular, for scenarios where multiple mobile devices are used that require services simultaneously and uninterruptedly. There is a challenge of effectively managing billions of IoT devices, ensuring that they are suitably configured, running appropriate software, kept up-to-date with security updates and patches, and run only properly authenticated and authorised applications. Authentication of services and service providers, while accounting for resource usage, is also an essential part of the economics of the network of the future. There is a need of ensuring interoperability across platforms, devices, and locations, by enabling assets to be securely purchased and transferred between virtual and real-world locations, authenticated and validated, using various consensus methods that support the validation of identity, ownership, and usage rights of any asset subject to relevant rights.

Action 15: SDOs should investigate and elaborate

on system-level optimisation techniques combining lower power consumption and energy harvesting technologies, E2E energy methods and models for data compression and exchange in edge-cloud IoT platforms, benchmarking methods for energy-efficient and low CO2 footprint of edge IoT infrastructure and technical solutions, energy-efficient data aggregation mechanisms in intelligent edge IoT systems considering the associated processing and connectivity capabilities across the computing continuum. Specify (or modify existing) interfaces that help monitor and control of the energy usage in communication protocol layer stacks applied in IoT and edge computing solutions. Specify (or modify existing) IoT and edge computing related standards, interfaces, data models and ontologies to reduce the energy and carbon footprint.

Action 16: SDOs should investigate IoT system level and network function virtualisation and AI-based zero-touch operations automation including automated reconfiguration and setup.

Action 17: SDOs to work towards a faster standardisation cycle more adapted to the fast pace of IoT technology developments. Some examples already exist (e.g. for SAREF and FIWARE).

Action 18: European and international SDOs to increase collaboration, information exchange and contribution with relevant EU projects. Collaboration is already ongoing with ETSI SmartM2M and ISO/IEC JTC1 SC41. It should be deepened further and other SDOs should also follow.

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

CEN

CEN/TC 224 '*Personal identification and related personal devices*' addresses IoT privacy-related standardisation solutions (e.g. EN 419212-4:2018 on '*Application Interface for Secure Elements for Electronic Identification, Authentication and Trusted Service*').

https://standards.cen.eu/dyn/www/f?p=204:7:0::::FSP_ORG_ID:6205&cs=1FB1CC5B5F03F85F0ECCECA7598551CFC

CEN/TC 225 '*Automatic Identification and Data Capture (AIDC) technologies*' works in the field of automatic identification and data capture techniques such as 1D and 2D optical data carriers, RFID and RTLS. The Technical Committee develops application-oriented European standards with the aim to promote the use of open and interoperable ways to identify objects, locations and industrial items. These identifiers and data carriers centred standards will serve as a corner stone for the development of interoperable solutions for data sharing in the context of the IoT.

https://standards.cen.eu/dyn/www/f?p=204:7:0::::FSP_ORG_ID:6206&cs=1E12277AECC001196A7556B8DBCDF0A1C

Within CEN & CENELEC, vertical sectors further address sector-specific IoT solutions, for example: CEN/TC 251 '*Health Informatics*', CEN/TC 278 '*Intelligent Transport Systems*', CEN/TC 294 '*Communication systems for meters*', CEN/TC 442 '*Building Information Modelling (BIM)*'

CENELEC

CLC/TC 57 *'Power systems management and associated information exchange'* has notably developed European Standards for data models in power systems (EN IEC 61850-x), Application Program interfaces (EN IEC 61970-x) and Data and Communication security (EN IEC 62351-x).

CLC/TC 205 '*Home and Building Electronic Systems (HBES)*' developed a European Standard on IoT Semantic Ontology Model Description (EN 50090-6-2), which explains the HBES IoT Model structures, semantically expressing the current HBES Open System solutions, with the goal of improving the semantic information HBES IoT gateways or HBES IoT devices provide. This standard was published in December 2021 and will be revised in the course of 2023-2024.

CLC/TC205 also developed a European Standard EN50090-6-3 documenting a RESTful Interface to EN 50090 compliant installation to retrieve functional data, device data, data on location and also allowing http and web socket callback subscription. This standard was published in July 2023.

A further New Work Item Proposal was approved by CLC BT for CLC/TC205 which will specify CoAP based IPv6 communication for IP field bus devices: this should result in the publication of the EN50090-4-4 in the course of 2024.

ECMA

Ecma Technical Committee TC53 standardises JavaScript software APIs for embedded systems. The APIs provide a portable, secure, vendor neutral execution environment in a layer above the operating system. The scope of work includes low-level input/output, sensors, networking, storage, displays, and audio. Information about the committee may be found at https://www.ecma-international.org/technical-committees/tc53/ and the current "ECMAScript embedded systems API specification" may be found athttps://ecma-international.org/publications-and-standards/standards/ecma-419/.

ETSI

TC smartM2M: ETSI, with the support of the Commission, has developed the SAREF standard ETSI TS 103 264, a reference ontology for smart appliances, which is a first ontology standard in the IoT ecosystem and sets a template and base for development of similar standards for other industries, to unlock the full potential of IoT. SAREF is mapped onto the oneM2M Base Ontology. The SAREF model is being extended to add semantic models for data associated with smart cities, industry and manufacturing, smart agriculture and the food chain, water, automotive, eHealth/aging well and wearables. SAREF allows

appliances, of any type, make or manufacturer, to exchange energy related information, with any energy management system (at home or in the cloud) for energy management and keeping the user informed.

ISG CIM (cross-cutting Context Information Management): is developing specifications for applications to publish, discover, update and access context information, initially for a broad range of smart city applications and now for other areas such as Digital Twins. A particular focus is enabling exchange of linked data and context information, using a simple API, NGSI-LD (ETSI GS CIM 009 V1.8.1) based on JSON-LD, and a high-level data model (ETSI GS 006 V1.3.1) referencing existing (or new) taxonomies and ontologies (e.g. SAREF). The NGSI-LD API and data model can be used for implementing Digital Twins based on property graphs (ETSI GR CIM 017 V1.1.1).

ETSI TC DECT has published the updates to release of the DECT-2020 NR (New Radio) technology (ETSI TS 103 636 parts 1 to 5) in December 2021. The standardization effort will continue in next years with further releases, additional functionality and defining access profiles addressing the needs of multiple vertical industries. DECT-2020 NR radio interface is supporting Ultra Reliable Low Latency Communications (URLLC) and massive Machine Type Communications (mMTC) as specified for IMT-2020 usage scenarios. The standards support multiple operating bands (19) up to 6 GHz and can operate with 1,728, 3,456 or 6,912 MHz radio channel bandwidths. The new DECT-2020 NR can co-exist with the existing DECT system in 1880-1900 MHz sharing spectrum.
The Harmonised Standard (HEN) EN 301 406-2 for access to radio spectrum has been produced.
DECT-2020 NR is now part of IMT-2020 recommendation M.2150-1 maintained by ITU-R.. Several vertical applications have been considered for DECT-2020 NR, including home and building automation, industry automation and smart metering. https://www.etsi.org/technologies/dect

MSG TFES has developed Harmonized Standards for LTE-M and NB-IoT equipment (Base Stations and devices) to facilitate and accelerate Machine Type Communication deployments in E-UTRA and NR bands.

TC CYBER: ETSI Standard EN 303 645 for «Cyber Security for Consumer Internet of Things» can be used in a certification scheme to be developed under the Cybersecurity Act, and has already led to the development of an accompanying test specification (TS 103 701, published in August 2021) and implementation guide (TR 103 621, latest version published in September 2022) as well as cyber security requirements for residential Smart Door Locking Devices within TC CYBER (see Consumer IoT security roadmap).

ETSI SC USER: has developed a set of documents "User-Centric approach in digital ecosystem", focusing of the roles, expectations and potential solutions for users.

ETSI has a number of other activities related to radio systems for the IoT. These activities include Smart Body Area Networks developed in **TC SmartBAN,** and standards for ultra-narrowband radio technology in the **TC ERM LTN (Low Throughput Networking)** working group. These are used in existing commercial LPWAN networks.

ISG IPE (IPv6 Enhanced Innovation): is working on a report "IPv6 based enterprise networking and Industrial Internet", that provides guidelines on how to deploy IPv6-based networks in industrial Internet and enterprise networks using protocols like 6LowPAN, LPWAN, RPL, etc. defined by IETF.

ISG MEC (Multi-access Edge Computing): https://www.etsi.org/committee/. MEC offers to application developers and content providers cloud-computing capabilities and an IT service environment at the edge of the network. ISG MEC continues to expand upon its set of standardized Application Programming Interfaces (APIs) to enable MEC services. In support of IoT, MEC has published its IoT API (ETSI GS MEC 033) to assist the deployment and usage of IoT devices that require additional support in a MEC environment, e.g., due to security constraints, limited power, compute and communication capabilities.

TC ATTM cooperate with TC SmartM2M to extend SAREF model in the area of smart sustainable efficient communities.

IEC

IEC SyC Smart Energy has a Joint Working Group, JWG 3, with ISO/IEC JTC 1/SC 42

IEC has the following projects underway on IoT:

Due for publication in 2024, the International Standard, IEC/IEEE 60802 *'Time-sensitive networking profile for industrial automation*', is a joint project between standards committees IEC/TC 65/SC 65C *'Industrial Networks*' and IEEE 802 *'LAN/MAN Standards Committee*'. It will allow IoT wide connectivity without disturbing the Industrial Automation critical control traffic.

Due for publication in 2023, the International Standard, IEC 62872-2..., the International Standard, IEC 62872-2 "*Internet of Things (IoT) – Application framework for industrial facility demand response energy management*' is a project in IEC/TC 65/JWG 17, a joint working group between IEC/TC 65 and ISO/IEC JTC 1/SC 41, that promotes the development and fosters the adoption of the international Reference Architecture for IoT developed in ISO/IEC JTC 1/SC 41 (see also clause B. Action 5).

IEC SC23K *'Electrical Energy Efficient products' is* developing a series of IEC Standards (IEC63345 and 63402-x) for Smart Grid on Premises side. IEC63402-2-2 describes 5 data models. These 5 data models create an interoperability layer, which allows to connect every load /generator to the Customer Energy Manager (CEM).

IEEE

IEEE has a number of existing standards (current and under development), activities, and events that are directly related to creating the environment needed for a vibrant Internet of Things, recognising the value of IoT to industry and the benefits this technology innovation brings to the public. Some key standards activities are:

- Architectural framework:
  - The focus of IEEE 2413 provides an architectural framework for the IoT, which includes descriptions of various IoT domains, definitions of IoT domain abstractions, and identification of commonalities between different IoT domains. It promotes cross-domain interaction, aids system interoperability and functional compatibility.
  - The focus of IEEE P1931.1, the standard for an architectural framework for Real-time Onsite Operations Facilitation (ROOF) is to define how an end user is able to securely provision, commission and decommission devices.

- Harmonization and security of IoT: IEEE P1451.99 is focused on developing a standard for harmonization of IoT devices and systems. This standard defines a method for data sharing, interoperability, and security of messages over a network, where sensors, actuators and other devices can interoperate, regardless of underlying communication technology.
- Sensor Performance and Quality: Sensors are fundamental to IoT ecosystem with large volume of different sensors integrated into a complex framework. IEEE 2700 proposes a common framework for sensor performance specification terminology, units, conditions and limits is provided.

Smart Manufacturing and Smart Factories: New standardisation efforts: IEEE P2879, General Principles for Assessment of a Smart Factory; IEEE 2934, Standard for Logistics Operation Process in a Smart Factory; IEEE P2806, System Architecture of Digital Representation for Physical Objects in Factory Environments; and IEEE P2806.1, Standard for Connectivity Requirements of Digital Representation for Physical Objects in Factory Environments.

- Digital Transformation: IEEE P2023, Standard for Digital Transformation Architecture and Framework
- Impact on Society 5.0: IEEE 3079.3, Standard for a Framework for Evaluating the Quality of Digital Humans
- IEEE P3141 Standard for 3D Body Processing

IEEE, through its LAN/MAN Standards Committee, has initiated a collaborative activity with the IEC SC65C committee on the IEC/IEEE 60802 TSN Profile for Industrial Automation, which will define time-sensitive networking profiles for industrial automation.

IEEE also has focused initiatives on sensor interfaces to cyber-physical systems through its IEEE 2888 family of standards, including the specification of sensor interface for cyber and physical world, standard for actuator interface, orchestration of digital synchronization between cyber and physical world, and architecture for virtual reality disaster response training system with six degrees of freedom (6 DoF).

For more information, see: https://ieee-sa.imeetcentral.com/eurollingplan/.

IETF

The IETF has a number of Working Groups chartered to develop standards to support the Internet of Things.

The IPv6 Over Low Power WPAN (6LOWPAN) Working Group developed standards to ensure interoperability between smart object networks and defining the necessary security and management protocols and constructs for building such networks.

The IPv6 over Networks of Resource-constrained Nodes (6LO) Working Group develops IPv6 adaptation mechanisms to a wider range of radio technologies including "Bluetooth Low Energy" (RFC 7668), ITU-T G.9959 (as used in Z-Wave, RFC 7428), and the Digital Enhanced Cordless Telecommunications (DECT) Ultra Low Energy (ULE) cordless phone standard and the low-cost wired networking technology Master-Slave / Token-Passing (MS/TP) that is widely used over RS-485 in building automation.

The IPv6 Over Low Power Wide-Area Networks (lpwan) WG focused on enabling IPv6 connectivity over the following selection of Low-Power Wide-Area networking technologies: SIGFOX, LoRa?, WI-SUN and NB-IOT.

The Light-Weight Implementation Guidance (LWIG) Working Group focused on helping the implementors of the smallest devices. Standards developed by the group enable the building of minimal yet interoperable IP-capable devices for the most constrained environments.

The Routing over Low Power and Lossy Networks (ROLL) Working Group is developing standards to support the routing of communications within low-power and lossy networks.

The Constrained RESTful Environments (CORE) Working Group is specifying protocols that allow applications running in resource-constrained environments to interoperate with each other and the rest of the Internet. CORE is one of the most active IoT groups. Its main output centres around the "Constrained Application Protocol" (CoAP, RFC 7252), a radically simplified UDP-based analog to HTTP. Extensions to CoAP enable group communications (RFC 7390) and low-complexity server-push for the observation of resources (RFC 7641). This is complemented by a discovery and self-description mechanism based on a weblink format suitable for constrained devices (RFC 6690). Current WG activities focus on extensions that enable transfer of large resources, use of resource directories for coordinating discovery, reusable interface descriptions, and the transport of CoAP over TCP and TLS. CoRE is also looking at a data format to represent sensor measurements, which will benefit from the "Concise Binary Object Representation" (CBOR) (RFC 7049), a JSON analog optimised for binary data and low-resource implementations.

The A Semantic Definition Format for Data and Interaction of Things (asdf) Working Group is developing Semantic Definition Format (SDF) into a standards-track specification for thing interaction and data modelling. In the process of developing this specification, further functional requirements that emerge in the usage of SDF for model harmonization will be addressed.

The IOT Operations (iotops) Working Group is discussing and documenting operational issues related to IoT devices, in particular related to device onboarding and lifecycle management. This group is also tackling issues related to IoT operational security.

Security aspects of the IoT are being addressed in the following Working Groups:

The Trusted Execution Environment Provisioning (TEEP) WG is working on standardising protocols for provisioning applications into secure areas of computer processors.

The Software Updates for Internet of Things (SUIT) WG is working on mechanisms for securely updating the firmware in IoT devices.

The Authentication and Authorisation for Constrained Environments (ACE) WG is working on a standardised solution for authentication and authorisation to enable authorised access to resources on a device in constrained environments. In such environments, typical for the IoT, the network nodes are limited in CPU, memory and power. This work was supported by the COSE WG that built simplified CBOR analogs for the JSON object signing and encryption methods that were developed in the JOSE WG.

The DTLS In Constrained Environments (DICE) WG focused on supporting the use of DTLS Transport-Layer Security in these environments. Such constrained environments, including constrained devices (e.g. memory, algorithm choices) and constrained networks (e.g. PDU sizes, packet loss), are typical for the IoT, Smart grids, etc.

The Lightweight Authenticated Key Exchange (LAKE) WG is developing a 'lightweight' authenticated key exchange (LAKE) that enables forward security. 'Lightweight' refers to:

- resource consumption, measured by number of round-trips to complete, bytes on the wire, wall-clock time to complete, or power consumption
- the amount of new code required on end systems which already have an OSCORE stack

but the LAKE must still provide the security properties expected of IETF protocols, e.g., providing confidentiality protection, integrity protection, and authentication with strong work factor.

While the IoT-oriented IETF working groups have already produced the first wave of mature standards for IoT, new research questions are emerging based on the use of those standards. The IRTF Thing-to-Thing Research Group (T2TRG) was chartered in 2015 to investigate open research issues in IoT, focusing on issues that exhibit standardisation potential at the IETF.

https://wiki.ietf.org/en/group/iab/Multi-Stake-Holder-Platform#h-314-internet-of-things

ISO/IEC JTC 1

ISO/IEC JTC 1/SC 41 '*Internet of Things and Digital Twin*', has published 34 International Standards specific to IoT and continues to develop more. ISO/IEC JTC 1/SC 41 has developed ISO/IEC 30141 (IoT reference architecture) and ISO/IEC 20924 (IoT vocabulary), and ongoing work includes the following:

- IoT trustworthiness framework (ISO/IEC 30149)
- Methodology for trustworthiness of IoT system/device (ISO/IEC 30147)
- Data exchange platform requirements for IoT services (ISO/IEC 30161)
- Compatibility requirements and model for devices within industrial IOT systems (ISO/IEC 30162)
- Diverse use-cases covered by IoT
- Monitoring the ongoing regulatory, market, business and technology IoT requirements
- Development of IoT standards that build on the foundational standards in relevant ISO/IEC JTC 1 Sub-Committees

The list of ISO/IEC JTC 1/SC 41 projects can be found here:

https://www.iec.ch/dyn/www/f?p=103:23:3095716894820::::FSP_ORG_ID,FSP_LANG_ID:20486,25 and

ISO - ISO/IEC JTC 1/SC 41 - Internet of things and digital twin

ISO/IEC JTC 1/SC27 '*Information security, cybersecurity and privacy protection*', deals with a broad set of standards in the areas of security and data protection ("privacy"). Many of the existing standards can be applied to IoT systems, such as the ISO/IEC 27001 standard on information security management. Three standards are currently being developed, that are specifically related to IoT Cybersecurity (ISO/IEC 27400, ISO/IEC 27402 and ISO/IEC 27403)

ITU

ITU-R

A variety of radio technologies is used to implement the Internet of Things, extending from short range devices (SRDs) to wide area sensor networks (WASN) and global terrestrial IMT systems as well as satellite systems. The ITU-R Study Groups are developing technical and operational standards to facilitate the deployment of IoT on a global basis, including harmonized frequency spectrum and appropriate regulatory regimes.

Resolution ITU-R 66 invites ITU-R Study Groups to conduct studies on the technical and operational aspects of radio networks and systems and to develop ITU-R Recommendations, Reports and/or Handbooks, as appropriate.

In response to this Resolution, ITU-R Working Party 1A is the main responsible group to carry out studies on Power Line Telecommunication (PLT).

To satisfy the demand of Question ITU-R 221-2/1 that calls for studies of acceptable levels of radiation from telecommunication systems utilizing wired electrical power supply so as not to impair the performance of radiocommunication systems, Reports ITU-R SM.2158 and ITU-R SM.2212 on "Impact of PLT systems on radio systems operating below 80 MHz and in the VHF and UHF bands above 80 MHz" were approved. These Reports illustrate the potential for interference to various radiocommunication services in the presence of emissions/radiation from PLT systems and devices and discuss potential methods for mitigating the interference from PLT emissions.

Report ITU-R SM.2503 on "Evaluation of radiated electromagnetic disturbances of household appliances and their interferences over an IoT network in the 915 MHz frequency band" evaluates the levels of electromagnetic disturbances generated by household appliances and examines how these interferences may affect the functioning of a Wireless Sensor Network (WSN) operating in the 915 MHz band in some administrations, a system which is widely used within IoT due to its technical flexibility and low cost.

Resolution ITU-R 54 calls for studies to achieve harmonization for short-range devices (SRDs).

ITU-R WP 1B is responsible for the studies relating to spectrum management methodologies and economic strategies. Among its current studies, WP 1B deals with the harmonization of SRDs.

Report ITU-R SM.2153 on "Technical and operating parameters and spectrum use for short-range radiocommunication devices" provides SRD definitions and short descriptions of different applications using SRDs, e.g.: Telecommand, Telemetry, Voice and video, Detecting avalanche victims, RLANs, Railway applications, among others. This Report also indicates the typical technical characteristics and limitations such as the common frequency ranges or the antenna requirements, and it explains administrative requirements like the mutual agreements between countries and/or regions and the licences requirements.

ITU-R WP 1B has carried out studies with the aim to globally and regionally harmonize the frequency bands used by SRDs. Recommendation ITU-R SM.1896 on "Frequency ranges for global or regional harmonization of short-range devices" and Recommendation ITU-R SM.2103 on "Global harmonization of short-range devices categories" are the reference documents on this matter.

ITU-R WP1C has also revised Report ITU-R SM.2179 on "Short-range radiocommunication devices measurements". This Report intends to complete the set of ITU-R Recommendations and ITU-R Reports by documenting the measurement methods available for SRDs.

ITU-R WP 5A cover studies on Wide-area Sensor and Actuator Network (WASN) Systems that support machine-to-machine (M2M) communications to a large number of sensors and/or actuators.

ITU-T

ITU-T SG20 "Internet of things (IoT) and smart cities & communities" is responsible for IoT-related studies including smart cities and communities (SC&C).

Definition of IoT can be found in Recommendation ITU-T Y.4000/Y.2060 "Overview of the IoT" http://itu.int/itu-t/Y.4000

Some of the approved standards by ITU-T SG20 include: " " "Requirements of IoT-based electric power infrastructure monitoring system" (Recommendation ITU-T Y.4221), "Requirements and functional architecture of data services provided via IoT-based technologies for the safety of manufacturing-related working environments" (Recommendation ITU-T Y.4488), "Requirements of IoT-based electric power infrastructure monitoring system" (Recommendation ITU-T Y.4221), "Common requirements and capabilities of smart cities and communities from IoT and ICT perspectives" (Recommendation ITU-T Y.4223), "Framework of IoT services for safety protection of working environment" (Recommendation ITU-T Y.4488), "Metadata for camera sensing information of autonomous mobile IoT devices" (Recommendation ITU-T Y.4604), "IoT requirements and capabilities for support of blockchain" (Recommendation ITU-T Y.4227), "Requirements and framework of Industrial IoT (IIoT) infrastructure for smart manufacturing" (Recommendation ITU-T Y.4228), "Requirements and functional architecture of IoT sensing quality management service" (Recommendation ITU-T Y.4502), "Framework of common rule enablement for intelligent IoT services in heterogeneous IoT platform environments" (Recommendation ITU-T Y.4503), "Service framework of prediction for intelligent IoT" (Recommendation ITU-T Y.4504), and etc.

SG20 is currently working on draft Recommendation ITU-T Y.4229 (Y.IoT-SFFS) "Requirements and reference functional model of IoT-based smart forest firefighting system", draft Recommendation ITU-T Y.4231 (Y.IoT-Vreqs) " Requirements and capability framework of the internet of things for vision", draft Recommendation ITU-T Y.4232 (Y.IoT-RTPS) "Requirements, capabilities and use cases of Internet of Things infrastructures in roadside traffic perception system", draft Recommendation ITU-T Y.4508 (Y.DPM-alm-fra) "Functional requirements and architecture of blockchain-based activity logs management for IoT data processing and management", draft Recommendation ITU-T Y.4706 (Y.dem-IoT) "Data exchange model for IoT devices in power transmission and transformation equipment" and etc.

The complete list of Recommendations developed by ITU-T SG20 is available at: https://www.itu.int/ITU-T/recommendations/index_sg.aspx?sg=20.

The work items under study are available at: https://www.itu.int/ITU-T/workprog/wp_search.aspx?sg=20.

More info: https://itu.int/go/tsg20

ITU-T SG20 closely collaborates with oneM2M, LoRa Alliance and TM Forum. ITU-T SG20 also closely collaborates with ISO and IEC in the framework of the Joint IEC-ISO-ITU Smart Cities Task Force (J-SCTF).

The joint coordination activity on IoT and smart cities and Communities (JCA-IoT and SC&C) continues its role of promoting international coordination among SDOs in this area of IoT standardization. http://itu.int/en/ITU-T/jca/iot. JCA-IoT and SC&C maintains the global online IoT standards roadmap: http://itu.int/en/ITU-T/jca/iot/Documents/deliverables/Free-download-IoT-roadmap.doc. The IoT and SC&C Standards Roadmap is also available as Supplement ITU-T Y.Suppl.58 "Internet of Things and smart cities and communities standards roadmap".

ITU-T Focus Group on Artificial Intelligence (AI) and Internet of Things (IoT) for Digital Agriculture (FG-AI4A), established by ITU-T SG20, explored emerging technologies including AI and IoT in data acquisition and handling, modelling from a growing volume of agricultural and geospatial data, and providing communication for the optimization of agricultural production. The activities of FG-AI4A were conducted in close cooperation with FAO. FG-AI4A has concluded its work in June 2024.

More info: https://itu.int/go/fgai4a

ITU-T Focus Group on Data Processing and Management (FG-DPM) developed a series of deliverables on data processing and management to support IoT and Smart Cities & Communities: https://itu.int/en/ITU-T/focusgroups/dpm.

ITU-T SG11 continues its role in developing testing specifications of IoT, its applications and identification systems. SG11 approved several Recommendations which specify testing requirements for IoT. SG11 approved ITU-T Q.4069 "Testing requirements and procedures for Internet of Things based green data centres", ITU-T Q.4075 "Test specifications for remote testing of Internet of Things using the probes" and Q.4071 "The testing of 3D ultra high density IoT networks".

Also, SG11 approved a new Recommendation ITU-T Q.4068 "Open application program interfaces (APIs) for interoperable testbed federations" which describes a set of open APIs for interoperable testbed federation able to manage not only the interconnection and the interoperability of testbeds in a federation, but also to handle the resources advertisement, allocation and provision. It is designed for different domains including IoT and it contains a technical framework, which provides a common reference for developers to facilitate the implementation and promotion of interoperability of testbeds.
The ITU-T Focus Group on Testbeds Federations for IMT-2020 and beyond (FG-TBFxG), which was established by SG11, developed the requirements for application program interfaces (APIs) aligned with the Testbeds Federations Reference Model defined in ITU-T Q.4068. Based on FG-TBFxG deliverables SG11 started eight new work items.

Currently, SG11 is developing framework for testing and monitoring IoT devices and networks using technical Requirements from Manufacturer Usage Description (MUD) (Q.MUD_IOT).

More info: https://itu.int/go/tsg11.

ITU-T SG13 approved a new Recommendation ITU-T Y.2248 "Service model for entry-level smart farms" (01/2023) that covers reference architecture, service requirements and service scenarios for the entry-level smart farm and ITU-T 2249 "Service model for human-centric touring guide with augmented reality" (09/2023) that specifies a service model for a human-centric touring guide with augmented reality (AR), including the concept, reference architecture, service requirements, and specific application scenarios of the service model.

More info: https://www.itu.int/en/ITU-T/studygroups/2022-2024/13/

ITU-T SG17 approved Recommendations ITU-T X.1361 "Security framework for the Internet of things based on the gateway model", ITU-T X.1362 "Simple encryption procedure for Internet of things (IoT) environments", ITU-T X.1363 "Technical framework of personally identifiable information (PII) handling system in Internet

of things (IoT) environment", ITU-T X.1364 "Security requirements and framework for narrow band Internet of things ", ITU-T X.1365 "Security methodology for use of identity-based cryptography in support of Internet of Things (IoT) services over telecommunication networks", ITU-T X.1366 "Aggregate message authentication scheme for IoT environment", ITU-T X.1367 "Standard format for Internet of things (IoT) error logs for security incident operations", ITU-T X.1368 "Secure firmware/software update for Internet of things devices", Supplement to ITU-T X.660 - Guidelines for using object identifiers for IoT and is approving ITU-T X.1369 "Security requirements and framework for IoT service platform" (X.ssp-iot) and working on "Security requirements for IoT devices and gateway " (X.iotsec-4), "Security risk analysis framework for IoT devices" (X.ra-iot), "Security controls for Internet of Things (IoT) systems" (X.sc-iot), and "Security methodology for IoT service platform" (X.ssp-iot) and "Security methodology for zero-touch massive IoT deployment"(X.ztd-iot).

More info: https://www.itu.int/en/ITU-T/studygroups/2017-2020/17

ITU-T SG3 agreed on Technical Report ITU-T DSTR-IoTM2M-Roaming, "Roaming aspects of IoT and M2M including any related development and tariff principles", and Technical Report ITU-T DSTR-IoT-DLT-Accounting, "Accounting and billing aspects in Internet of Things (IoT) ecosystem and integrated approach using Distributed Ledger Technology (DLT)".

ITU-T SG3 is currently working on a draft Recommendation ITU-T D.IoT/M2M Roaming "Roaming aspects of IoT and M2M including any related development and tariff principles".

More info: https://www.itu.int/en/ITU-T/studygroups/2022-2024/03

OASIS

The OASIS Message Queuing Telemetry Transport (MQTT) TC has produced a standard M2M/IoT connectivity protocol designed to support messaging transport from remote locations/devices involving small code footprints (e.g. 8-bit, 256KB ram controllers), low power, low bandwidth, high-cost connections, high latency, variable availability, and negotiated delivery guarantees. MQTT also has been approved as ISO/IEC 20922:2016. A variant MQTT-SN protocol is being developed for very constrained devices often operating within unstructured sensor networks.

The OASIS Advanced Message Queuing Protocol (AMQP) TC provides a ubiquitous, secure, and reliable internet protocol for high-speed transactional messaging. AMQP also has been approved as ISO/IEC 19464:2014. A major cloud platform uses AMQP to connect to its cloud IoT hub.

The OASIS Open Building Information Exchange (oBIX) TC enables mechanical and electrical control systems in buildings to communicate with enterprise applications, and provides a platform for developing new classes of applications that integrate control systems with other enterprise functions.

3GPP

3GPP, since Release 13, offers three new Low Power Wide Area Network (LPWAN) radio access technologies for long-range, power efficient, massive machine-type communications:

- Extended Coverage GSM Internet of Things (EC-GSM-IoT),
- LTE for Machine-Type Communications (LTE-M) and
- Narrowband Internet of Things (NB-IoT).

Each has been standardized to ensure that increasingly diverse device and application types are supported by 3GPP networks, around the world. An overview is available here: http://www.3gpp.org/news-events/3gpp-news/1805-iot_r14 and more details here: http://www.3gpp.org/news-events/3gpp-news/1906-c_iot

3GPP has been adding IoT-centric features, including capabilities to avoid network congestion, use networks more effectively, enhance security and, crucially, enable IoT devices to manage power resources efficiently, to its specification set in Release 13 and Release 14.

Massive IoT support is one of the key objectives of future 5G systems. This will be a focus of future work in 3GPP, given the already extensive IoT support in 4G.

ONEM2M

oneM2M partnership project, launched by several SDOs and industry representatives in 2012 as a global initiative to ensure the most efficient deployment of Machine-to-Machine (M2M) communications systems and the Internet of Things (IoT)
The latest technical specifications can be found on Specifications (onem2m.org).

oneM2M opens up the IoT ecosystem by creating an abstraction layer that simplifies the exchange of cross-silo data. It offers a common IoT Service Layer which can be readily embedded within different hardware and software, connecting the numerous devices in the field with IoT application servers worldwide. To do this, oneM2M offers interworking with the most common technologies and protocols used in the IoT today. Additionally, oneM2M supports access control based discovery and communication across deployments (addressing problem statement above that said we have "Intranet of Things").

oneM2M has published Release 2A in March 2018 and its Release 3 in September 2018. oneM2M Release 4 will be finalized in Q3 2021, work on Release 5 commenced and is ongoing.

oneM2M includes specifications covering requirements, architecture, protocols, security, and management, abstraction and semantics. Release 2 added new functionality, particularly by expanding management, abstraction and semantics, security, and interworking with underlying technologies. oneM2M Release 3 adds seamless interworking with 3GPP network services for IoT, while Release 4 adds, for instance, time management, process management, semantic reasoning, software campaigning, enhanced and new interworking, security enhancements, discovery based operations as well as semantic ontology mapping. Some of the new features under discussion for Release 5 include the topics of AI for Internet of Things (IoT) systems, tools for data licensing and, controls to guarantee adherence to privacy regulation such as GDPR and PIPA (Korea).

OIC

OIC works on defining the connectivity requirements for devices including the definition of the specification, certification and branding to deliver reliable interoperability; IP protection; and providing an open source implementation of the standard.
https://openconnectivity.org/developer

UNECE

The United Nations Centre for Trade Facilitation and Electronic Business (UN/CEFACT) has developed a library of clearly defined

semantic data elements called the Core Component Library in order to enable clear understanding of electronic information between source and receiver of the information. UNECE would encourage consideration of the UN/CEFACT Core Component Library in trade-related applications of Internet of Things. See: http://www.unece.org/cefact/codesfortrade/unccl/ccl_index.html

UN/CEFACT has also developed standards and clear guidance related to Smart Containers. This includes a White Paper to explain the potential use cases and a Business Requirement Specification in order to clearly define the processes and information relevant to each potential use case. See: White Paper (available also in French and Russian): http://www.unece.org/fileadmin/DAM/cefact/GuidanceMaterials/WhitePapers/WP-SmartContainers_Eng.pdf and BRS: http://www.unece.org/uncefact/mainstandards.html

Further work is continuing on Trade Facilitation applications of Internet of Things. See: https://uncefact.unece.org/display/uncefactpublic/Internet+of+Things+for+Trade+Facilitation

W3C

W3C continues to push for the use of Linked data to help manage data streams in IoT and Smart City scenarios. The latest developments were discussed at the Second W3C Workshop on the Web of Things.

Currently, there are two active Groups:

The Web of Things Interest Group brings together stakeholders interested in the Web of Things to explore ideas prior to standardisation together with collaboration with external groups, e.g. standards development organizations and industry alliances.

The Web of Things Working Group has recently advanced two specifications to Candidate Recommendation and aims to advance them to W3C Recommendations. The Web of Things (WoT) Architecture describes the abstract architecture for the W3C Web of Things. The architecture can be mapped onto a variety of concrete deployment scenarios, several example patterns of which are given, including the RAMI reference architecture. The Web of Things (WoT) Thing Description describes a formal model and a common representation for a Web of Things (WoT) Thing Description. A Thing Description describes the metadata and interfaces of Things, where a Thing is an abstraction of a physical or virtual entity that provides interactions to and participates in the Web of Things. Because it is Linked data, things can thus be combined with other semantics, e.g. the GDPR vocabulary from the Data Privacy Community Group.

OGC

The Open Geospatial Consortium (OGC) defines and maintains standards for location-based, spatio-temporal data and services. Some of the work is related to IoT, e.g. a modular suite of standards for web services allowing ingestion, extraction, fusion, and (with the web coverage processing service (WCPS) component standard) analytics of massive spatio-temporal data like satellite and climate archives.

ISO/TC 211 '*Geographic information*' and OGC have a strong relation and cooperation in the development of standards for the geospatial domain, and particularly geospatial data. ISO/TC 211 activities are mirrored at European level by CEN/TC 287 '*Geographic Information*'.

http://www.opengeospatial.org

(C.2) OTHER ACTIVITIES RELATED TO STANDARDISATION

AIOTI

The Alliance for AI, IoT and Edge Continuum (AIOTI) was initiated in 2015 by the European Commission to promote interoperability and convergence between standards, facilitate policy debates and prepare a Commission's initiative for large-scale testing and experimentation planned in 2016. AIOTI has meanwhile been transformed and set up as a stand-alone organisation that serves now as the multi-stakeholder platform for stimulating IoT and Edge Computing Innovation in Europe, bringing together small and large companies, academia, policy makers and end-users and representatives of society in an end-to-end approach. AIOTI's contribution goes beyond technology and addresses horizontal elements across application domains, such as matchmaking and stimulating cooperation in IoT and Edge Computing ecosystems, creating joint research roadmaps, driving the convergence of standards and interoperability and defining policies.

AIOTI has an active Working Group that focuses on standardisation. All deliverables can be found here: https://aioti.eu/resources-standardisation/

EC

Several projects funded by the European Commission, integrated in the Internet of Things Research in Europe Cluster (IERC), deal with aspects of standardisation in IoT: CALIPSO, GAMBAS, IOT.EST, OPENIOT, UIOT6, SPRINT and PROBE-IT. In particular:

- OPENIOT deals with standardisation of open source solution for creating utility/cloud-based environments of internet-connected objects,
- SPRINT has an active contribution to W3C (web services), OMG (e.g. on exchange formats, APIs) and OASIS (data exchange formats),
- PROBE-IT validates standards or pre-standards at European and international level and performs pre-standardisation research work on standardisation requirements.

The Future Internet PPP (FI-PPP) also deals with some issues connected to standardisation for the IoT.

IVA

IVA is a subproject of ´ICT for Sweden´, with the objective of supporting the entire value chain, from business benefits to sensors.

http://www.iva.se/IVA-seminarier/Internet-of-Things-IoT---fran-af-farsnytta-till-sensorer/

UK

The KTN (Knowledge Transfer Network) has an IoT interest group

https://connect.innovateuk.org/web/internet-of-things

FINLAND

An IoT cluster supports investment in IoT

http://www.investinfinland.fi/industries/rd-and-innovation/internet-of-things-in-finland/124

LORA ALLIANCE

Specifications intended for wireless battery-operated things in regional, national or global networks. LoRaWAN targets key requirements of the IoT such as secure bi-directional communication, mobility and localisation services

IIC

Works on promoting the uptake of technologies around the industrial internet including:

- building confidence around new and innovative approaches to security;
- developing use-cases and test beds;
- influencing global standards development; and

facilitating open forums to share and exchange best practices.

DENMARK

The Nordic IoT center is supported by the Danish Agency for Science and Higher Education, enabling partnerships in the Nordic region, completing the value chain for IoT products and services and documenting compliance to international standards http://www.nordiciotcentre.com/

(C.3) ADDITIONAL INFORMATION

There are a number of global activities ongoing in the area of IoT standardisation. In particular there are: the oneM2M partnership project, to which ETSI contributes and of which ITU-T SG20 transposed the oneM2M specifications; relevant standardisation activities in IEC; a focus group in ISO/IEC JTC 1; the standards project on MQTT in OASIS; the IoT reference architecture; and the IoT Interoperability standards at ISO/IEC JTC 1/SC 41.

The IoT requirements of e.g. from retail manufacturing, the automotive, aeronautics, pharmaceutical, and medical equipment industries and the medical sector in general should be taken fully into consideration. Security, privacy, and management of control of the access to and ownership of data are essential for the development of IoT. Without acceptance by commercial users and consumers, the role of IoT would be limited to specific vertical markets. Wide acceptance is essential in commoditising IoT mechanisms and make them accessible e.g. to manufacturing and for manufactured products, or into m/e/Health applications.

IoT requires the interlinking of often disparate standards. These standards are often the product of different SDOs. There is a need to bring these bodies and their standards together to achieve the often small changes needed to allow products and services to interoperate.

Existing standards should be checked to take account of the protection of individuals with regard to personal data processing and the free movement of such data in the light of the proposal for a General Data Protection Regulation. Specific privacy by design standards should be identified and where necessary developed.

3.1.5 Electronic identification and trust services including e-signatures

A Policy and legislation

(A.1) POLICY OBJECTIVES

This relates to Regulation (EU) No 910/2014 of the European Parliament and of the Council of 23 July 2014 on electronic identification and trust services for electronic transactions in the internal market and repealing Directive 1999/93/EC, amended by Regulation (EU) 2024/1183 as regards establishing the European Digital Identity Framework.

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

The eIDAS Regulation (EU) 910/2014, was originally adopted on 23 July 2014, addressing in one comprehensive piece of legislation, electronic identification, electronic signatures, electronic seals, electronic time stamping, electronic registered delivery services, electronic documents and certificate services for website authentication as core instruments for electronic transactions in the European Union.

The Regulation (EU) 2024/1183 of 11 April 2024 amending Regulation (EU) No 910/2014 as regards establishing the European Digital Identity Framework was published on 30 April 2024 and entered into force on 20 May 2024. This amendment mandates that each Member State shall provide at least one European Digital Identity Wallet which offers to natural and legal persons secure and easy access to different e-services, provided by both the public and private sector supporting a wide range of different use cases. The wallet is required to support privacy by design, ensure strict data minimalisation, and give users full control over which personal data attributes are issued to and exchanged from the wallet, with issuers and verifiers practicing restraint in attribute handling. The European Digital Identity Wallet, trust services and end-user products must be accessible to persons with disabilities following the requirements of Regulation 2019/882.

The wallet must fulfil the requirements for Level of Assurance 'High' and the security and functionalities of the wallet must be certified. The data processing of the wallet must be demonstrated to be conformant to GDPR.

In addition, the revised eIDAS Regulation establishes new qualifiable trust services consisting of:

- the issuance and validation of Electronic attestation of attributes concerning information related to natural and legal person identity, such as addresses, age, gender, civil status, family composition, nationality, educational and professional qualifications and titles, licenses, other permits and payment data, that can be offered, shared and exchanged across borders, in full security, enforcing strong data protection and with legal effect across borders.
- the management of remote electronic qualified signature or seal creation device,
- the electronic archiving of electronic data and electronic documents, ensuring the receipt, storage, retrieval and deletion of electronic data and electronic documents ensuring their durability, legibility, integrity, confidentiality and proof of origin throughout the preservation period, and
- the recording of electronic data in electronic ledgers, a sequence of electronic data records, with ensured integrity and accuracy of the chronological ordering.

The revised eIDAS Regulation requires the Commission to issue many implementing acts that, in case of trust services, shall list reference standards and, when necessary, establish specifications and procedures for the requirements specified in the Regulation.

The Commission receives advice from Member States and engages with the private sector to establish technical and operational specifications, and reference standards for the requirements of the European Digital Identity framework. This occurs within the "European Digital Identity Cooperation Group" established by Commission Decision C(2024)6132 pursuant to Article 46e of the eIDAS regulation, which defines the rules of procedure concerning the involvement of the Member States and other stakeholders. The requirements include issuance and exchange of selected attestation of attributes, the functionality and security of the European Digital Identity Wallets, the assurance of the European Digital Identity framework including certification of the wallet, identity proofing and governance. Standardisation Bodies will be activated and existing international and European

standards and technical specifications should be re-used where appropriate to support the planned secondary legislation relying on standards to meet the regulatory requirements. Existing standards that meet the requirements of the proposed framework should therefore be identified and new standards and guidelines are needed to support the implementation of the new trust services of electronic archiving, attestation of attributes, the management of remote electronic signature and seal creation devices, and electronic ledgers.

For the European Digital Identity Framework and to support the remainder of the eIDAS regulation, further standardisation work will be needed, because the planned secondary legislation may refer to the availability of standards as possible means to meet the regulatory requirements. Existing standards that meet the requirements of the proposed framework should therefore be identified and new standards and guidelines are likely to have to be drafted to facilitate the implementation of the proposed new trust services of electronic archiving, attestation of attributes, the management of remote electronic signature and seal creation devices, and electronic ledgers.

The EC has decided to prepare a thorough Standardization strategy (hereinafter also - "strategy") related to the EUDI Wallet implementation as derived from the revised eIDAS Regulation.

Standardization Strategy

This strategy is a comprehensive plan aimed at guiding, promoting, and supporting the development and maintenance of standards and technical specifications within the digital identity domain. This strategy focuses on facilitating the adoption and creation of standards and technical specifications that ensure the digital identity solution is consistent, secure, GDPR compliant, interoperable, and user-friendly across all EU member states. It aligns with existing relevant standards and regulations to ensure coherence and compliance across the board.

The key components of the strategy are:

1. Assessment: Analyse current practices against the latest EU Digital Identity Wallet Architectural Reference Framework (ARF), to identify gaps in high-level requirements for implementing the eIDAS Regulation.
2. Planning: Identify the nature of the gaps and plan a course of action for each one. This involves determining whether gaps can be filled by existing standards, require the development of new standards, or need interim technical specifications.
3. Support for Implementing Acts: Assist in the preparation of the Implementing Acts by providing comprehensive analysis, gap identification, and recommendations for integrating standards and technical specifications.
4. Integration into Public Procurements: Facilitate the use of standardized solutions in public procurements by referencing approved standards.

An initial gap analysis has been carried out. The results are summarized in a few Gap Analysis Report documents ("fiche"), related to specific Implementing Acts. These "fiche" documents touch upon the different topics that are included in the ARF and point out the necessary work to be done to close the gaps, as far as can be foreseen at this stage, and as a basis for discussion and collaboration with SDO's and other stakeholders.

SDOs Involvement or engagement.

The engagement with the SDOs is needed so that both the EC and the SDO's will agree on a common gap analysis, the work needed to close the gap, including the association with each SDO.

More precisely, there is a need to agree on the following:

1. Confirm the common understanding of the technical gaps that were found regarding the ARF.
2. Agreement on the support of existing standards or technical specifications regarding the required functionalities from the technical requirements, sorted into the following categories: (1) fully supported; (2) partially supported; or – (3) not supported at all.
3. Detect and map the requirements into: (1) Existing standards published; (2) existing standards in draft or under development by SDOs recognised under Reg. 1025/2012; (3) existing technical specifications from non-recognised SDOs (e.g., OpenID4VP by OpenID or Verifiable Credentials by W3C); or – (4) needs not covered by any available standards or specifications.

The foreseen activities involving SDOs include an initial gap definition to commence discussion aiming to gather the following information:

1. Commenting on the initial gap analysis.
2. Collaborating with SDOs to influence the development or enhancement of standards by

contributing to working groups, providing technical input, and participating in the drafting process.

3. Monitoring the progress of these developments to ensure that the necessary updates or new standards are addressed in a timely manner.
4. Identifying major functionalities that require new or updated standards.
5. Assigning the responsibility for developing these standards to recognized European Standardization Organizations.
6. Securing funding for the process.
7. Ensuring that the developed standards meet the EUDIW requirements and are ready for integration into the Implementing Acts.

(A.3) REFERENCES

- Regulation (EU) No. 910/2014 of the European Parliament and of the Council of 23 July 2014 on electronic identification and trust services for electronic transactions in the internal market and repealing Directive 1999/93/EC (eIDAS Regulation). With entering into force of Regulation (EU) 2024/1183 on 2024-05-20 the eIDAS Regulation was amended and the consolidated text made available by the Publication Office
- Commission Implementing Regulation (EU) 2015/1501 of 8 September 2015 on the interoperability framework
- Commission Implementing Regulation (EU) 2015/1502 of 8 September 2015 on setting out minimum technical specifications and procedures for assurance levels for electronic identification means
- Commission Implementing Decision (EU) 2015/1984 of 3 November 2015 defining the circumstances, formats and procedures of notification
- Commission Implementing Regulation (EU) 2015/806 of May 2015 laying down specifications relating to the form of EU trust mark for qualified trust Services
- Commission Implementing Decision (EU) 2015/1506 of 8 September 2015 laying down specifications relating to formats of advanced electronic signatures and advanced seals to be recognised by public sector bodies
- Commission Implementing Decision (EU) 2015/1505 of 8 September 2015 laying down technical specifications and formats relating to trusted lists
- Commission Implementing Decision (EU) 2016/650 of 25 April 2016 laying down Standards for the security assessment of qualified signature on seal creation devices
- Commission Recommendation C(2021) 2021/3968 of 3rd June 2021 on a common Union Toolbox for a coordinated approach towards a European Digital Identity Framework
- Regulation (EU) 2024/1183 of the European Parliament and of the Council of 11 April 2024 amending Regulation (EU) No 910/2014 as regards establishing the European Digital Identity Framework. The consolidated text was made available by the Publication Office
- The European Digital Identity Wallet Architecture and Reference Framework (ARF) establishing high level requirements as reference to create uniform conditions for its implementation

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

Action 1. SDOs to take ongoing EU policy activities into account in standardisation, e.g. in ISO/IEC JTC 1/SC 27/WG 5 (identity management and privacy technologies) and other working groups of ISO/IEC JTC 1/SC 27. Also, the standards being developed by ISO/IEC JTC1 SC17 including on mobile driving licenses and identity management via mobile devices are particularly relevant to electronic identification. Furthermore, in order to promote the strengths of the European approach to electronic identification and trust services at global level and to foster mutual recognition of electronic identification and trust services with non-EU countries, ESOs should keep European and international standards aligned wherever possible. The promotion and maintenance of related European approaches, which especially take into account data protection considerations, in international standards should be supported.

ACTION 2: As required by the revised eIDAS Regulation prepare standards for:

a) Interfaces between the European Digital Identity Wallet and trust services as well as services for signing by means of electronic signatures and seals.

b) Interfaces between the European Digital Identity Wallet and relying parties and issuers of electronic

attestations of attributes.

c) Issuance and revocation of wallets.

d) Policy and security requirements on providers of electronic attestation of attribute services including issuance and revocation of electronic attestation of attribute.

e) Security evaluation and certification of the European Digital Identity Wallet.

f) Policy and security requirements on providers of trust services for electronic ledger.

g) Policy and security requirements on providers of trust services for electronic archiving.

h) Update to trusted lists to support new trust services.

i) Management of trust relating to the EU Digital Identity Wallet.

j) Supporting additional requirements for identity proofing and validation of attributes.

k) Adapting existing standards to take into account new provisions and requirements in the revised Regulation including accessibility for persons with disabilities and special needs, alignment with NIS2.

l) Ensuring that the requirements of privacy by design are met so that compliance with GDPR can be demonstrated.

m) Next generation of registered electronic mail and electronic delivery to take account of new services and components available under the revised regulation including EU digital identity wallets and electronic ledgers.

n) Use of electronic identities and electronic signatures with other trust services including electronic ledgers in support of smart contracts.

o) Support implementation and use of the Trusted Lists, including support for new trust services and other potential used of trust lists for managing the trust infrastructure of the EU Digital Identity Wallet.

p) Maintain and update the set of standards supporting creation and validation of electronic signatures, seals, certificates, attestations and timestamps and their preservation.

ACTION 3: SDOs to cooperate and work in the areas of identifiers, vocabularies, semantics, taxonomies, ontologies for electronic attestations, considering work from stakeholders that are already involved in these activities in their respective sectors.

ACTION 4: The impact of quantum computing technologies on the cryptographic algorithms, in particular public key cryptography, used for electronic identification and trust services including e-signatures needs to be analysed, and the potential impact on the relevant standards identified. This should lead to guidance on the migration to Quantum Safe Cryptography.

ACTION 5: SDOs to engage in a collaborative process to address the gaps between existing standards/ technical specifications and the requirements of the EUDI Wallet ecosystem. This involves reviewing the initial gap analysis and participating in discussions to agree on the necessary steps for addressing these gaps. Additionally, SDOs are to contribute to identifying key functionalities that need new or updated standards/ technical specifications and be involved in their development to support the successful implementation of the EUDI Wallet as outlined in the eIDAS 2 regulations.

ACTION 6: SDOs to develop technical interoperability mechanisms between wallets released in different regions of the world, such as EUDIW, LACnet. Technical interoperability could set the grounds for the future adoption of political and regulatory decisions that allow, in the long term, for mutual recognition of digital identities with legal effects that would support international trade and commerce and would providing a way to evaluate the trustworthiness of a wallet or an attestation in cross-regional contexts.

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

CEN & CENELEC

CEN/TC 224 '*Personal identification and related personal devices with secure element, systems, operations and privacy in a multi sectorial environment*' develops standards for strengthening the interoperability and security of personal identification and its related personal devices, systems, operations and privacy. CEN/ TC 224 addresses sectors such as Government/Citizen, Transport, Banking, e-Health, as well as Consumers and providers from the supply side such as card manufacturers, security technology, conformity assessment body and software manufacturers.

CEN/TC 224/WG 20 is dedicated to standardization of EUDI wallet.

On September 2024, CEN/TC 224 organized with ETSI/TC ESI the "ETSI & CEN Workshop on EU Digital Identity Framework Standards".

The presentations are available on https://www.etsi.org/events/2353-cen-etsi-workshop#pane-5/.

An important document has recently been finalised by the TC, CEN/TR 17982:2023 'European Digital Identity Wallets standards Gap Analysis'. This document identifies relevant existing standards and standards work in progress around European Digital Identity Wallets. It also **identifies missing work items and overlaps in standards** and is supposed to work as a roadmap for future standardization projects in the area.

CEN/CLC/JTC 19 '*Blockchain and Distributed Ledger Technologies*' focuses on European requirements for Distributed Ledger Technologies and proceeds with the identification and possible adoption of standards already available or under development in other SDOs (especially ISO TC 307), which could support the EU Digital Single Market and/or EC Directives/Regulations.

In the context of the eIDAS Regulation, CEN/CLC/JTC 19/WG 1 started developing the Technical Specification *"Policy and Security Requirements on Trust Services on Electronic Ledger"* in support of the new Electronic Ledger Trust Service, and the Technical Specification *"Functional and interoperability requirements on Decentralized Identifier (DID)"* in support of the EUDI Wallet and issuance of Electronic attestation of attributes.

CEN & CENELEC Sector Forum Energy Management & Energy Transition (SFEM) starting from April 2021 has a dedicated focus group for Blockchain and DLT which brings together stakeholders coming from the energy sector as well as from academic and research bodies. This focus group prepared an overview of blockchain/DLT related activities and applications in the electricity sector (incl. sector coupling) and elaborated a complete view of the current challenges (technical and non-technical) regulatory, RD&I, Pre-normative research (PNR), use cases, and standardization needs in the field of "DLT in energy". The final report of the group was prepared in November 2022 for the review of the Swiss Federal Office of Energy and was made available in 2023.

CEN/TC 468 'Preservation of digital information' is developing a Technical Specification "Policy and functional requirements of the electronic archive service" in support of the new Electronic archiving trust service.

CEN & CENELEC standards and their status can be searched here: https://standards.cencenelec.eu/dyn/www/f?p=205:105:0:

ETSI

ETSI TC ESI is progressing several work items in support of the amended eIDAS Regulation and the associated Architecture Reference Framework https://portal.etsi.org/tb.aspx?tbid=607&SubTB=607#/lt-50611-work-programme)

TC SET keeps on improving the UICC technology by adding the possibility to host and address several virtual Secure Elements embedded into the same hardware component. This allows multiple virtual Secure Elements to coexist logically separated and be addressed independently thought the same physical interface. This technology is the base for a new feature allowing to have multiple subscriptions to a mobile network active in a mobile phone using just one eUICC. This also offers the means to embed independent identity (e.g. eIDAS), payment or transport applications in the same physical secure element.

These additional features also imply working on the improvement of the interface between the device and the embedded SE. TC SET is working on the definition of a high speed, versatile interface based on MIPI I3C technology allowing easier integration in mobile devices for supporting multiple applications in addition to network authentication. This will benefit to digital identity wallet integration when high level of assurance is required.

ETSI ISG PDL (Permission Distributed Ledgers) provides the foundations for the operation of permissioned distributed ledgers, with the ultimate purpose of creating an open ecosystem of industrial solutions to be deployed by different sectors. . ISG PDL (Industry Specification Group on Permissioned distributed ledgers, and Distributed Ledger technology) has published Group Reports and Specifications (GRs & GSs) for smart contracts and a GS for DAOs (Distributed Autonomous Organisations) among other subjects' non-repudiation, redactability, digital identity, etc... these have many digital identity related matters, not least of which the following:

- ETSI GR PDL 014v1.1.1 Study on non-repudiation techniques.
- ETSI GR PDL 017v1.1.1 eIDAS2 (developed in cooperation with TC ESI).
- ETSI GS PDL 018v1.2.1 Redactable Distributed Ledgers.
- ETSI GR PDL 019v1.1.1 PDL Services for Identity and Trust Management
- ETSI GS PDL 023v1.1.1 DID - Decentralized identifiers Framework
- ETSI GR PDL 030v1.1.1 Trust in Telecom System (draft)
- ETSI GS PDL-023 – DID "Decentralized Identity" Framework (developed in cooperation with TC ESI and STF 655).

ETSI ISG ETI (Encrypted Traffic Integration) is developing a Zero Trust Architecture approach to networks that builds on the identity management platform being developed by TC CYBER in TS 103 486 and in the cited work in TC ESI in order to enable a semantic, or capability, assured path through networks.

GS1

Digital Signatures - WR21-307_GSCN_AI_ISO20248DataStructure_eBallot with Errata (gs1.org)

ISO

The ISO Technical Committee, **ISO/TC 154** *Processes, data elements and documents in commerce, industry and administration*, addresses standardisation and registration of business, and administration processes and supporting data used for information interchange between and within individual organizations and supports standardisation activities in the area of industrial data.

Ongoing work:

- Requirements and roles & responsibilities for fulfilling trusted e-communications in commerce, industry and administration
- Qualified trust services for long-term signature of kinds of electronic documents
- Validation of long-term signature
- Trusted (or qualified) electronic registered delivery services (or platform)
- Dematerialisation and proof of dematerialisation
- Requirements for providing trusted e-communications in the mobile environment
- Requirements for providing trusted e-communications in the cloud environment

Projects include the ISO 14533 series of standards for *Processes, data elements and documents in commerce, industry and administration -- Long term signature profiles.*

https://www.iso.org/committee/53186.html

The ISO Technical Committee **ISO/TC 321** *Transaction Assurance in e-Commerce*, addresses standardisation in the field of "transaction assurance in e- commerce related upstream/ downstream processes", including the following:

- Assurance of transaction process in e-commerce (including easier access to e-platforms and estores);
- Protection of online consumer rights including both prevention of online disputes and resolution process;
- Interoperability and admissibility of inspection result data on commodity quality in cross-border e-commerce;
- Assurance of e-commerce delivery to the final consumer.

https://www.iso.org/committee/7145156.html

ISO/TC307 (Blockchain and Distributed Ledger Technology) established with **ISO/IEC JTC1/SC27** the joint working group 4 (JWG 4) that developed:

- ISO/TR 23249:2022 Blockchain and distributed ledger technologies – Overview of existing DLT systems for identity management
- ISO/TR 23644:2023 Blockchain and distributed ledger technologies (DLTs) — Overview of trust anchors for DLT-based identity management.

https://www.iso.org/committee/6266604.html

ISO/IEC JTC 1

ISO/IEC JTC 1/SC 37, *Biometrics*, is responsible for the standardisation of generic biometric technologies pertaining to human beings to support interoperability and data interchange among applications and systems. Generic human biometric standards include: common file frameworks, biometric application programming interfaces, biometric data interchange formats, related biometric profiles and other standards in support of technical implementation of biometric systems, evaluation criteria to biometric technologies, methodologies for performance testing and reporting, cross-jurisdictional and societal aspects of biometric implementation. The complete list of standards published or under development, can be found in on the SC 37 homepage:

https://www.iso.org/committee/313770.html

Published standards and ongoing projects related to the topics include the series of biometric data interchange standards for different biometric modalities, biometric technical interfaces, related biometric profiles and other standards in support of technical implementation of biometric systems, and cross jurisdictional and societal aspects of biometric implementation. Representative projects include revisions to some of the ISO/ IEC 19794 series for *Biometric data interchange formats*, ISO/ IEC 29794 series for *Biometric sample quality* and ISO/IEC 39794 series for *Extensible biometric data interchange formats*. These projects include generic extensible data interchange formats for the representation of data, a tagged binary data format based on an extensible specification in ASN.1 and a textual data format based on an XML schema definition (both capable of holding the same information). The ISO/IEC 30107 series for *Biometric presentation attack detection* and ISO/IEC 24779 series for *Cross-Jurisdictional and societal aspects of implementation of biometric technologies - pictograms, icons and symbols for use with biometric systems* are multi-part standards of relevance.

ISO/IEC JTC 1/SC 27, *Information security, cybersecurity and privacy protection,* is responsible for international IT security. The most relevant standards to electronic identification and trust services are developed by SC 27/WG 5 *Identity Management and Privacy Technologies*. After completion of foundational frameworks, specifically, the ISO/IEC 24760 series *A framework for identity management* and ISO/IEC 29100 for *Privacy framework*, priorities for WG 5 are related standards and Standing Documents on supporting technologies, models, and methodologies. WG 5's Projects include:

- A framework for identity management – Part 1: Terminology and concepts (ISO/IEC 24760-1, 2nd edition:2019)
- A framework for identity management – Part 2: Reference framework and requirements (ISO/IEC 24760-2, 1st edition:2015)
- A framework for identity management – Part 3: Reference framework and requirements (ISO/IEC 24760-3, 1st edition:2016)
- Privacy framework (ISO/IEC 29100, 1st edition:2011; Amendment 1:2018)
- Privacy architecture framework (ISO/IEC 29101, 2nd edition:2018)
- A framework for access management (ISO/IEC 29146, 1st edition:2016)
- Requirements for partially anonymous, partially unlinkable authentication (ISO/IEC 29191, 1st edition:2012)
- Privacy enhancing data de-identification terminology and classification of techniques (ISO/IEC 20889, 1st edition:2018)
- Privacy impact assessment – methodology (ISO/IEC 29134, 1st edition:2017)
- Extension to ISO/IEC 27001 and ISO/IEC 27002 for privacy management – Requirements and guidelines (ISO/IEC 27701, 1st edition:2019)
- WG 5 Standing Document 2 – "Privacy references list"
- WG 5 Standing Document 4 – "Standards Privacy Assessment"

ISO/IEC JTC 1 SC 27 is working in close collaboration with CEN/ CLC/JTC 13 *'Cybersecurity and Data protection'* on eIDAS related standardisation activity.

ISO/JTC 1/SC 17 *Cards and security devices for personal identification* is responsible for standardisation and interface associated with their use in inter-industry applications and international interchange in the area of:

- Identification and related documents,
- Cards,
- Security devices and tokens

https://www.iso.org/committee/45144.html

ITU-T

ITU-T SG2 is responsible for studies related to numbering, naming, addressing and identification, and resource assignment. SG2 Approved new Recommendation ITU-T E.118.1 in March 2023, "ITU-T management of the allocation of globally assigned Issuer Identifier Numbers (IINs)", and is continuing work on: updates to Recommendation ITU-T E.118, "The international telecommunication charge card" to reflect current and future use of Issuer Identifier Numbers (IINs); a new Recommendation ITU-T E.IoT-NNAI, "Internet of Things Naming Numbering Addressing and Identifiers"; and a new Technical Report TR.OTTnum, "Current use of

E.164 numbers as identifiers for OTTs".
More info: http://itu.int/ITU-T/go/tsg2

ITU-T SG3 is responsible, *inter alia*, for studying international telecommunication/ICT policy and economic issues and tariff and accounting matters (including costing principles and methodologies). SG3 has approved Recommendation ITU-T D.1140/X.1261, "Policy framework including principles for digital identity infrastructure" and Recommendation ITU-T D.1141, "Policy framework and principles for data protection in the context of big data relating to telecommunication/ICT services" (under publication) .
More info: http://itu.int/ITU-T/go/tsg3

ITU-T SG11 is developing a new standard Q.TSCA "Procedure for issuing digital certificates for signalling security". This draft standard is a continuation of SG11 activities on implementation of security measures (Recommendations ITU-T Q.3057, Q.3062 and Q.3063) on signalling level in order to cope with different types of attacks on existing ICT infrastructure and services (e.g. OTP intercept, calls intercept, spoofing numbers, robocalls, etc.).

ITU-T SG13 studies the concepts and mechanisms to enable trusted ICT, including framework, requirements, capabilities, architectures and implementation scenarios of trusted network infrastructures and trusted cloud solutions in coordination with all study groups concerned. It has approved Recommendations ITU-T Y.3058 "Functional architecture for trust enabled service provisioning", Y.3059 "Trust Registry for Devices: requirements, architectural framework", Y.3060 "Autonomous networks - overview on trust" and agreed G.Suppl.84 "Standardization roadmap on Trustworthy Networking and Services".

ITU-T SG17 is responsible for the study and coordinate the work on ICT security and identity management. It has approved Recommendations ITU-T X.1058 "Information technology - Security techniques - Code of practice for Personally Identifiable Information protection", ITU-T X.1087 "Technical and operational countermeasures for telebiometric applications using mobile devices", ITU-T X.1148 "Framework of de-identification process for telecommunication service providers", ITU-T X.1171 "Threats and requirements for protection of personally identifiable information in applications using tag-based identification", ITU-T X.1212 "Design considerations for improved end-user perception of trustworthiness indicators", ITU-T X.1250 "Baseline capabilities for enhanced global identity management and interoperability", ITU-T X.1252 "Baseline identity management terms and definitions", ITU-T X.1275 "Guidelines on protection of personally identifiable information in the application of RFID technology", ITU-T X.1403 "Security considerations for using distributed ledger technology data in identity management", ITU-T X.1451 "Risk identification to optimize authentication", ITU-T X.1363 "Technical framework of personally identifiable information (PII) handling system in IoT environment", ITU-T X.1770 "Technical guidelines for secure multi-party computation" and is developing many more draft Recommendation in this domain: (X.5Gsec-t, X.guide-cdd, X.sec-QKDN-tn, X.smsrc, X.scpa, X.sgos, X.rdda, X.vide, etc).

More info: http://itu.int/ITU-T/go/tsg17

Under the Security, Infrastructure and Trust Working Group led by ITU under the Financial Inclusion Global Initiative (a joint programme of the ITU, World Bank and Bank for International Settlements and supported by the Gates Foundation), studies on strong authentication technologies applications for digital financial services are being undertaken. The use of identity verification and authentication system based on DLT are also being studied.

See Report: https://www.itu.int/en/ITU-T/extcoop/figisymposium/Documents/ITU_SIT_WG_Implementation%20of%20Secure%20Authentication%20Technologies%20for%20DFS.pdf

ITU-T SG20 is the lead study group for Internet of Things identification. The Study Group developed Recommendation ITU-T Y.4811 "Reference framework of converged service for identification and authentication for IoT devices in decentralized environment". ITU-T SG20 is working on draft Technical Report "Identification management service of IoT device" (YSTR.IoT-IMS) and draft Supplement to ITU-T Y.4811 - Implementation of converged service for identification and authentication for IoT devices in decentralized environment (Y.Supp-Imp-CSIADE).

More info: https://itu.int/go/tsg20

UNECE

The United Nations Economic Commission for Europe in its Recommendation 14 outlines base elements to take into account in the use of electronic authentication methods. It recommends that the authentication methods should be chosen in light of the nature of the electronic transaction and the relationship between the parties involved in the exchange. Not all electronic exchanges require the highest level of reliability.

See: (available also in French and Russian) http://www.unece.org/fileadmin/DAM/cefact/recommendations/rec14/ECE_TRADE_C_CEFACT_2014_6E_Rec14.pdf

Further work is being developed on this topic within UN/CEFACT. See: http://www.unece.org/fileadmin/DAM/cefact/cf_plenary/2018_plenary/ECE_TRADE_C_CEFACT_2018_7E.pdf

OASIS

The OASIS Security Services (SAML) TC maintains and extends the widely used Security Assertion Markup Language (SAML, also ITU-T Recommendation X.1141) standard. A profile of SAML is used for cross-border identification and authentication of citizens in the eIDAS nodes provided by the eID Building Block of the Connecting Europe Facility (CEF). SAML is also used at national level in Member States.

The PKCS#11 industry cryptographic method is commonly used in most commercial certificate authority (CA) software for proving identity, as well as cross-platform smart card software. The OASIS PKCS#11 committee recently released its Specification v3.1 and Profiles v3.1 in support of the "Cryptoki" (from "cryptographic token interface") API to use and access PKCS#11 certificates.

OASIS' Lightweight Verifiable Credential Schema and Process (LVCSP) committee (https://www.oasis-open.org/committees/lvcsp) defines methods for enabling individuals (credential subjects) to voluntarily share their verified identity attestations, such as know-your-customer (KYC) determinations across different platforms and services, using the W3C Verifiable Credential (VC) standard. These methods allow shared identity attestations consistent with GDPR traceability, the permission of data subjects, and decentralized exchanges.

The OASIS Trust Elevation TC defines a set of standardized protocols that service providers may use to elevate the trust in an electronic identity credential presented to them for authentication.

The OASIS DSS-X TC defines standard Digital Signature Service

Core Protocols, Elements, and Bindings. The latest version provides both JSON- and XML-based request/response protocols for signing and verifying, including updated timestamp formats, transport and security bindings and metadata discovery methods. This TC works in close liaison with the ETSI Electronic Signatures and Infrastructures (ESI) TC.

The OASIS ebXML Message TC maintains the OASIS ebMS3 (also ISO 15000-1) standard and the AS4 standard (also ISO 15000-2). AS4 is profiled as the message exchange protocol of the European Commission's eDelivery Building Block. Several dozens policy domains use eDelivery for cross-border secure and reliable exchange of documents and data. AS4 is also used in the EESSI system for digitalisation in social security coordination.

The OASIS Business Document Exchange TC provides complementary eDelivery specifications for service location and capability lookup.

The OASIS ebCore TC has delivered version 3 of the CPPA specification. CPPA3 provides standard data definitions, and formats for electronic, XML-based protocol profiles and business collaboration agreements, as well as algorithms for formation, matching, discovery and registration. Version 3 is an evolution of work done in the joint ebXML project with UN/CEFACT. It complements other ebXML standards for messaging including AS4.

OIDF

Set of standards and related certification profiles addressing identity transactions over the internet. Active working groups in this area include: the OpenID Connect WG, AccountChooser WG, Native Applications WG, Mobile operator Discovery, Registration and Authentication WG (MODRNA), Health Related Data Sharing WG (HEART), and Risk and Incident Sharing and Coordination WG (RISC)

http://openid.net/wg/

IETF

The following IETF Working Groups are active in this area:

The Web Authorization Protocol (OAUTH) WG developed a protocol suite that allows a user to grant a third-party Web site or application access to the user's protected resources, without necessarily revealing their long-term credentials, or even their identity. It also developed security schemes for presenting authorisation tokens to access a protected resource.

The ongoing standardisation effort within the OAUTH working group is focusing on enhancing interoperability of OAUTH deployments.

The Public Notary Transparency (TRANS) WG developed a standards-track specification of the Certificate Transparency protocol (RFC6962) that allows detection of the mis-issuance of certificates issued by CAs or via ad-hoc mapping by maintaining cryptographically verifiable audit logs.

The Automated Certificate Management Environment (ACME) WG specifies conventions for automated X.509 certificate management, including validation of control over an identifier, certificate issuance, certificate renewal, and certificate revocation. The initial focus of the ACME WG is on domain name certificates (as used by web servers), but other uses of certificates can be considered as work progresses.

The Supply Chain Integrity, Transparency, and Trust (SCITT) Working Group works to define a set of interoperable building blocks that will allow implementers to build integrity and accountability into software supply chain systems to help assure trustworthy operation. For example, a public computer interface system could report its software composition that can then be compared against known software compositions or certifications for such a device thereby giving confidence that the system is running the software expected and has not been modified, either by attack or accident, in the supply chain.

The Secure Patterns for Internet Credentials (spice) Working Group is chartered to analyze existing and emerging IETF technologies and address any remaining gaps to facilitate their application in digital credentials and presentations.

The SPICE WG will develop digital credential profiles that support various use cases. The profiles developed by the SPICE WG will enable digital credentials to leverage existing IETF technologies. Privacy by design, confidentiality, and consent will be considered, and implementation guidance will be given for each proposed standard in the program of work.

https://wiki.ietf.org/en/group/iab/Multi-Stake-Holder-Platform#h-315-electronic-identification-and-trust-services-including-e-signatures

W3C

Verifiable Credentials provide a mechanism to express credentials, e.g. driving licenses, on the Web in a way that is cryptographically secure, privacy respecting, and machine-verifiable. Currently, the following Specifications and Notes have already been issued:

- Verifiable Credentials Data Model 1.1 https://www.w3.org/TR/vc-data-model/
- Verifiable Credentials Implementation Guidelines 1.0 https://www.w3.org/TR/vc-imp-guide/
- Verifiable Credentials Use Cases https://www.w3.org/TR/vc-use-cases/

Decentralized Identifiers (DIDs) are a new type of identifier that enables verifiable, decentralized digital identity. A DID refers to any subject (e.g., a person, organization, thing, data model, abstract entity, etc.) as determined by the controller of the DID. In contrast to typical, federated identifiers, DIDs have been designed so that they may be decoupled from centralized registries, identity providers, and certificate authorities:

- Decentralized Identifiers (DIDs) v1.0 https://www.w3.org/TR/did-core/
- Use Cases and Requirements for Decentralized Identifiers https://www.w3.org/TR/did-use-cases/
- DID Implementation Guide v1.0 https://www.w3.org/TR/did-imp-guide/
- DID Specification Registries https://www.w3.org/TR/did-spec-registries/
- DID Method Rubric v1.0 https://www.w3.org/TR/did-rubric/

Web Authentication defines an API enabling the creation and use of strong, attested, scoped, public key-based credentials by web applications, for the purpose of strongly authenticating users. The current work is on Web Authentication: An API for accessing Public Key Credentials - Level 3 https://www.w3.org/TR/webauthn-3/

Web payments: An important goal of Secure Payment Confirmation (SPC) is to streamline strong customer authentication (SCA). One way to reduce friction is to allow many authentications

for a given registration. In other words, ideally the user registers once and can then authenticate "everywhere" (consistent with the policies of the relying party; they have to opt-in). The following Specifications are relevant:

- Secure Payment Confirmation https://www.w3.org/TR/secure-payment-confirmation/
- Payment Request API http://www.w3.org/TR/payment-request/
- Payment Method IDs http://www.w3.org/TR/payment-method-id/
- Payment Handler API https://www.w3.org/TR/payment-handler/
- Payment Method Manifest https://www.w3.org/TR/payment-method-manifest/

Work on Social Networking includes identity schemes that can play a role:

- ActivityPub https://www.w3.org/TR/activitypub/
- Social Web Protocols https://www.w3.org/TR/social-web-protocols/
- IndieAuth https://www.w3.org/TR/indieauth/

The Web Crypto API describes a JavaScript API for performing basic cryptographic operations in web applications, such as hashing, signature generation and verification, and encryption and decryption: https://www.w3.org/TR/WebCryptoAPI/ See also the note on use cases: http://www.w3.org/TR/webcrypto-usecases/ narrowing the scope of the Web Crypto API.

Identity for WebRTC 1.0 defines a set of ECMAScript APIs in WebIDL to allow and application using WebRTC to assert an identity, and to mark media streams as only viewable by another identity. This specification is being developed in conjunction with a protocol specification developed by the IETF RTCWEB group. https://www.w3.org/TR/webrtc-identity/

Accessibility of authentication methods in Web Accessibility Guidelines (WCAG 2.2). Especially relevant are success criteria 3.3.8 on Accessible Authentication (Minimum) and 3.3.9 on Accessible Authentication (enhanced). Such criteria will be integrated in the updated standard EN 301 549 on ICT Accessibility.

IEEE

IEEE has standards and pre-standards activities relevant to Electronic Identification and Trust Services, including dealing with blockchain technology, authentication, and biometric identification.

IEEE 1363.3, Standard for Identity-Based Cryptographic Techniques using Pairings
IEEE 2410, Standard for Biometric Open Protocol
IEEE 2790, Standard for Biometric Liveness Detection

IEEE 3801, IEEE Standard for Blockchain-based Electronic Contracts

IEEE P2049.3, Standard for Human Augmentation: Identity
IEEE P2799, Standard for Confirming and Conveying Identity Over the Internet
IEEE P2933, Standard for Clinical Internet of Things (IoT) Data and Device Interoperability with TIPPSS—Trust, Identity, Privacy, Protection, Safety, Security
IEEE P2989, Standard for Authentication in Multi-Server Environment
IEEE P3210, Standard for Blockchain-based Digital Identity System Framework

There are also several pre-standards activities looking at digital identity, including guidelines for the provision and use of digital identities for digital resilience.

For more information, see: https://ieee-sa.imeetcentral.com/eurollingplan/.

(C.2) OTHER ACTIVITIES RELATED TO STANDARDISATION

EUDI WALLET PILOT PROJECTS

- European Digital Identity Wallet Consortium (EWC). Focus: Testing the storage and display of digital travel credentials, facilitating instant payments, and enabling cross-border identification for businesses.
- POTENTIAL Consortium. Focus: User authentication for accessing government services, opening bank accounts, e-prescriptions, and digital driving licenses.
- NOBID Consortium. Focus: Authorizing payments for products and services using the EUDI Wallet.
- DC4EU Consortium. Focus: Deploying the wallet in educational contexts (e.g., professional credentials) and social security applications, utilizing the European Blockchain Services Infrastructure.

The pilots are exploring various use cases that include:

- Accessing digital public services (e.g., applying for passports or driving licenses).
- Opening bank accounts online without repeated identity verification.
- Facilitating travel through digital identity documents.
- Signing contracts electronically between businesses and consumers.

OTHER RELATED IMPORTANT PROJECTS ORDERED BY DATE

- 2023-08-23 OntoChain https://ontochain.ngi.eu
  OntoChain aims to enable trustworthy transactions of services and contents. The project defines innovative decentralised reputation models that reveal the hidden quality/types of services and credibility of data sources, keeping a balance between privacy and trust.
- 2022-10-31 eSSIF-Lab https://essif-lab.eu
  Self-sovereign identity (SSI) supports identity management in a safe and reliable internet allowing secure transactions and eliminating logins. SSI aims to empower EU organisations to make secure and innovate transactions with stakeholders saving billions of euro on administrative expenses.
- 2020-12-31 AMBER https://www.amber-biometrics.eu
  AMBER addresses issues facing biometric solutions on mobile devices and develop solutions and theory to ensure secure, ubiquitous and efficient
  authentication whilst protecting privacy of citizen.
- 2020-08-31 SMOWL https://smowl.net/en/
  SMOWL is a practical and reliable solution for online user identification and monitoring. It consists in a new cyber-security service covering the need for a continuous, automatic and scalable authentication of online user's identity and monitoring.

- 2020-03-31 Smart-Trust https://web.archive.org/web/20201230011033/https://smart-trust.eu/
  Smart-Trust introduces a new technological enabler for Mobile ID which drastically increases the reliability and trust levels of identity verification at European borders, thus increasing the security of member states.
- 2019-12-31 DECODE https://decodeproject.eu
  DECODE provides tools that put individuals in control of whether they keep their personal information private or share it for the public good.
- 2019-02-28 ARIES - A ReliAble euRopean Identity EcoSystem https://www.aries-project.eu/
  ARIES aims to set up a reliable identity ecosystem combining mature technologies for high level of assurance, such as biometrics or use of secure elements, with innovative credential derivation mechanisms.
- 2018-12-31 SAFEcrypto https://www.safecrypto.eu
  SAFEcrypto will provide a new generation of practical, robust and physically secure post quantum cryptographic solutions that ensure long-term security for future ICT systems, services and applications. Novel public-key cryptographic schemes (digital signatures, authentication, public-key encryption, identity-based encryption) will be developed using lattice problems as the source of computational hardness.
- 2018-09-30 CREDENTIAL - Secure Cloud Identity Wallet https://credential.eu
  The goal of CREDENTIAL is to develop, test and showcase innovative cloud based services for storing, managing, and sharing digital identity information and other critical personal data.
- 2018-04-30 ReCRED http://www.recred.eu
  ReCRED's ultimate goal is to promote the user's personal mobile device to the role of a unified authentication and authorization proxy towards the digital world.

3.1.6 e-Infrastructures for data and computing intensive science and the European Open Science Cloud

A Policy and legislation

(A.1) POLICY OBJECTIVES

RESEARCH DATA AND COMPUTING INFRASTRUCTURES FOSTERING A PARADIGM SHIFT IN SCIENCE (OPEN SCIENCE)

Data driven science today pervades all research fields blurring geographical and disciplinary boundaries. The technological and digital progress unfolding over the last few decades produced more effective scientific instruments, which generated a rapid increase in research data volumes and availability across a wide range of scientific disciplines. The European Commission in FP6, FP7, H2020 and Horizon Europe (HE) funded several projects to establish and consolidate a European e-infrastructures environment and to build the European Open Science Cloud, a federated and open multi-disciplinary environment where research data can be found and re-used, with tools and services for research, innovation and educational purposes. Underpinning the efforts of the research communities, e-infrastructures have fostered innovation and scientific progress across disciplines and between the private and public sector. A large number of data e-Infrastructures, mixing the capabilities of scientific communities and technology providers, have been launched in domains of astronomy, earth and ocean observation, climate, environment and biodiversity, etc. Moreover, pan European e-Infrastructures initiatives were launched across disciplinary domains providing a participatory network of open access repositories at European scale. These initiatives fill the gap between user-application and generic e-Infrastructure layers for high-volume storage, data interoperability, high-performance computing and connectivity layers. This framework of e-science services enabled the progress of Open

Science practices to improve the quality, efficiency and responsiveness of research.

Despite the greater possibilities of sharing and accessing research data and the Commission policies on open research data, promotion of "openness" is not sufficient to realise the full potential of communication and re-use of research data. The vast amounts of research generated data are still dispersed across thousands of venues. A March 2016 article in Nature proposed guiding principles for scientific data management and stewardship by introducing the FAIR acronym, which stands for Findable, Accessible, Interoperable and Re-usable. Soon after the publication, the FAIR Principles became one of the cornerstones of EU's Open Science policy and have been rapidly adopted by publishers, funders, and other stakeholders from across the research community.

Building on the existing EU-funded e-Infrastructures and to enable the development and uptake of Open Science in Europe the EC proposed and is promoting the creation of a European Open Science Cloud (EOSC), as presented in the Communication "European Cloud Initiative". EOSC essentially involves the federation of existing research data infrastructures and the realisation of a Web of FAIR Data and Related Services for Science, making research data interoperable and machine actionable. It fosters the definition, implementation and further development of advanced solutions for the effective provisioning and use of high quality scientific data, with metadata descriptors, ease of access, interoperability and reusability, fully implementing the FAIR principles. Therefore, the application of standards and recommendations is of utmost importance in order to allow for interoperability, avoid fragmentation and improve the efficiency and effectiveness of research.

The European Commission, with the European data strategy, aims to make the EU a leader in a data-driven society. Among other actions, the Strategy intends to foster the rollout of common European data spaces in crucial sectors such as industrial manufacturing, green deal, mobility or health: EOSC has been recognised as the European digital space for research. The work that has been conducted within EOSC to enable interoperability across research domains and data discovery to support multi-disciplinary reuse is critical to supporting collaboration with the European data spaces. Research infrastructures within the ESFRI roadmap already play a key role in EOSC. Engaging further with the research communities will be key to developing an EOSC for and by the researchers. Strong links with research domains will naturally foster opportunities for collaboration with the data spaces.

To complement the access to the wealth of European research data, with the new Regulation for the European High Performance Computing Joint Undertaking and the Coordinated Plan on Artificial Intelligence (AI) the European Commission is also ensuring the capacity to process large volumes of information with services closer to European researchers and innovators.

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

Research/science funders have a common problem when tackling the area of research data infrastructure. The landscape is geographically fragmented and different disciplines have different practices. It is difficult to build critical mass and provide common services to different scientific disciplines and to take advantage of economies of scale. Some scientific communities are pushing the envelope and adopting new technologies while others are lagging behind. Scientists are, at the end of the day, the generators and users of research data in their experiments, simulations, visualization of complex data arrays, etc. There is a need to bring together capabilities from different scientific fields and also the competences of technology and service providers to use the potential of ICT.

Interoperable data infrastructures will allow researchers and practitioners from different disciplines to access and process the data they need in a timely manner. The implementation of the FAIR principles as standard practice for research data will enable collaborations across different domains of science.

Today, EU-funded e-Infrastructures and EOSC resources play a fundamental role in the life of European researchers.

In the initial phase of development of EOSC from 2016 to 2020, the EC made a financial investment of approximately €350 million to begin building the foundations of EOSC through project calls in Work Programmes in Horizon 2020. This investment was targeted to develop a new pan-European access mechanism to public e-infrastructures, to coordinate related national activities, to connect European research infrastructures (RIs) to EOSC, to set up and begin the implementation of the FAIR guiding principles, and to start a FAIR-compliant certification scheme for research data infrastructures. These projects have involved the community of stakeholders of EOSC and have been steadily developing the broader EOSC ecosystem.

The initial development phase under Horizon 2020 supported more than 35 projects, laying the foundations of EOSC and showcasing its diversity and complexity. The EOSCpilot project engaged extensively with stakeholders and proposed a governance framework and policies, as well as developing interoperability pilots across scientific domains. EOSC-hub brought together service providers to create a single contact point to discover, access and use a wide range of resources for data-driven research. Five science cluster projects connected the European Strategy Forum on Research Infrastructures (ESFRI) projects and landmarks to the EOSC Portal in the domains of environmental sciences, life sciences, astronomy and particle physics, photon and neutron sciences, and social sciences and humanities. Five regional projects coordinated the efforts of national and thematic initiatives in contributing to EOSC through groupings of European countries.

The continuous funding of the INFRAEOSC destination further consolidated the EOSC landscape under the Horizon Europe Work Programme complemented by the support of the Co-Programmed Partnership Agreement with the EOSC Association. The Commission decided to run a public procurement action for the implementation and operation of the first reference node of the EOSC ecosystem (called the EOSC EU Node) in 2023. The evolving concept of the distributed and federated EOSC Nodes and the "system of systems" has replaced the preliminary central EOSC Portal approach by kickstarting the establishment of national, regional and thematic EOSC Nodes interconnected by the procured EOSC EU Node of the Commission.

Under the first implementation phase of EOSC projects have been actively working on recommendations for the adoption of practices models and standards. Relevant examples are:

- the work of OpenAIRE and EuroCRIS initiatives to expand the CERIF model to also include research outputs. CERIF was initially conceived to document and exchange research information (funding programmes and projects, researchers and research institutions, etc.) and has since been adopted by many Member States and institutions
- in the context of FAIR data, the project FAIRsFAIR is coordinating an analysis of the European Framework for audit and certification of digital repositories that comprise three certification instruments, with increasing degrees of complexity and depth:
  - CoreTrustSeal (CTS): this is based on Data Seal of Approval (DSA)and World Data System (WDS) van ICSU. All digital repositories that have one or more of these certifications are listed at https://www.coretrustseal.org/why-certification/certified-repositories/
  - Nestor Seal: verification according to DIN 31644
  - ISO 16363 certification) are contribution to harmonise and promote standards in metadata
- several EOSC related projects (notably the 5 ESFRI Cluster projects) are strongly contributing in promoting practices and standards in disciplinary metadata for description and re-use of research data
- the RDA FAIR Data Maturity Model Working Group has developed a common set of core assessment criteria for FAIRness and a generic and expandable self-assessment model for measuring the maturity level of a dataset.

Moreover, the EOSC Executive Board (an EC expert group called to prepare the ground for the second phase of the EOSC implementation) produced a set of documents and recommendations with relevance to establishing governance, principles, architecture and interoperability in the EOSC. Among these documents, the EOSC Interoperability Framework Report is the foundation of the work that the project EOSC Future is carrying out to establish a concrete EOSC Interoperability Framework (EOSC IF).

Under the current implementation phase in Horizon Europe, the focus shifted towards the establishment and enlargement of the EOSC Federation that is a distributed and federated ecosystem of EOSC Nodes individually onboarding their relevant scientific data and service providers and other research outcomes to EOSC. The interoperability between the EOSC Nodes therefore became a cornerstone of the developments and harmonisation efforts. The definition of the core federating capabilities of the EOSC EU Node, the corresponding architecture design, and the particular open-source software implementation choices are paving the way towards an EOSC Blueprint Architecture, common best practices and community standards. These efforts are exploiting synergies with the Simpl (Smart Middleware) development aiming to be adopted by all Common European Data Spaces, including EOSC itself.

(A.3) REFERENCES

- EOSC Strategic Research and Innovation Agenda - SRIA [version 1.0] (2021 https://op.europa.eu/s/vRXa), SRIA version 2.0 is under community consultation by the EOSC Association https://eosc.eu/sria-2-0-community-consultation/
- Memorandum of Understanding for the

Co-programmed European Partnership for the European Open Science Cloud (EOSC) https://ec.europa.eu/info/sites/default/files/research_and_innovation/funding/documents/c_2021_4113_f1_annex_en_v3_p1_1213802.pdf

- European Open Science Cloud (EOSC) main background documents (https://ec.europa.eu/info/sites/default/files/research_and_innovation/strategy_on_research_and_innovation/documents/ec_rtd_eosc-main-background-documents.pdf)
- EOSC strategic implementation plan (2019 https://publications.europa.eu/s/mIIi) and EOSC Work Plan 2019-2020 (2019 https://op.europa.eu/s/ngwM)
- Turning FAIR into reality. Final report and action plan from the European Commission (EC) Expert Group (EG) on FAIR data (2018)
- Prompting an EOSC in practice. Final report and recommendations of the Commission 2nd High Level EG on the EOSC (2018)
- Council conclusions on European Open Science Cloud (EOSC) (ST 9291 2018 INIT, ST 9291 2018 INIT (2018))
- Commission Recommendation (EU) 2018/790 of 25 April 2018 on access to and preservation of scientific information:
- Commission Staff Working Document (SWD) - Implementation Roadmap for the EOSC (SWD(2018) 83 final (2018))
- Realising the EOSC. First report and recommendations of the Commission highlevel EG on the EOSC (2016)
- COM(2016) 178 final European Cloud Initiative — Building a competitive data and knowledge economy in Europe.
- COM(2016) 180 Digitising European Industry - Reaping the full benefits of a Digital Single Market.
- COM(2016) 176 ICT Standardisation Priorities for the Digital Single Market.
- COM(2012) 401 final: Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions — Towards better access to scientific information: Boosting the benefits of public investments in research.
- COM(2012) 4890 final: Commission Recommendation on access to and preservation of scientific information.

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

ACTION 1: Supporting standardisation within Horizon Europe INFRAEOSC Destination. The attention on standardisation will be included in the Destination INFRAEOSC, part of the Horizon Europe Work programme for Research Infrastructures (Pillar 1 Excellent Science). Notably for topics related to building the federating core of EOSC, creating FAIR enabling services and supporting the implementation of the FAIR principles, the European Commission will strengthen the objective of contribution to the adoption of practices and standards applicable to the EOSC and that will potentially have a larger impact on other data initiatives such as the European common Data Spaces.

ACTION 2: Recognising RDA as a fundamental contributor to standards on data.The Research Data Alliance (RDA) is not primarily a standardisation body but is a mechanism to speed-up the adoption of standards for research data and computing infrastructures. The RDA, with its form of Multi-Stakeholder Platform, develops recommendations that have the potential of becoming ICT specifications. There is also an ongoing effort of promoting industrial participation within the RDA processes

ACTION 3: SDOs to work closely with EOSC and e-infrastructures service providers and RDA. Practices adopted by research digital infrastructures respond to needs that most likely will be valid for wider user communities and operators and will determine new standards on technologies that are emerging through the scientific use and soon will be widespread. Therefore identifying standards needs and developing them in the area of research data (notably in the context of the European Open Science Cloud) will accelerated the uptake of data intensive technologies

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

RESEARCH DATA ALLIANCE (RDA)

Supports the Commission's strategy to achieve global scientific data interoperability in a way that real actors (users and producers of data, service providers, network and computing infrastructures, researchers and their organisations) are in the driving seat.
It has memorandums of understanding (MoUs) with related standardisation activities/organisations: IETF, W3C, ICSU/CODATA. Synergies with other organisations/activities will need to be identified in the future.

OAI

The Open Archives Initiative develops and promotes interoperability standards that aim to facilitate the efficient dissemination of content. The Open Archives Initiative has its roots in an effort to enhance access to e-print archives as a means of increasing the availability of scholarly communication.

ITU-T

Regarding the global e-Infrastructure, the ITU is using the digital object architecture (DOA), on which the recommendation ITU-T X.1255 "Framework for discovery of identity management information" is based.

SG11 is addressing the growing problem of counterfeited telecommunication/ICT products and devices, which is adversely affecting all stakeholders in the ICT field (vendors, governments, operators and consumers). Within this activity, SG11 developed number of Recommendations which describe approaches on how to combat the circulation of counterfeit equipment. The Recommendation ITU-T Q.5050 "Framework for solution to combat counterfeit ICT Devices", which is the first one in the Q.5050-Q.5069-series "Combating counterfeiting and stolen ICT devices", describes a reference framework with high-level challenges and requirements that should be considered when deploying solutions to combat the circulation and use of counterfeit ICT devices. SG11 developed four Recommendations and six technical reports/supplements on this subject matter.

SG11 continues its studies related to Equipment Identity Registers (CEIR). SG11 approved Q.Suppl.76 which defines common approaches and interfaces for data exchange between the central equipment identity register and the equipment identity register. Afterwards, SG11 completed and consented draft Recommendation ITU-T Q.5055 "Technical requirement, interfaces and generic functions of CEIR". SG11 also determined draft Recommendation ITU-T Q.5054 "Consumer centric framework for combating counterfeit and stolen ICT mobile devices". The approval is planned at the next SG11 meeting (February 2025).

All details are available on dedicated web page at: https://itu.int/go/CS-ICT.

SG11 continues developing standards related to combating stolen ICT equipment. SG11 approved Recommendation ITU-T Q.5051 "Framework for combating the use of stolen mobile Devices".

SG11 approved Q.Supplement.75 "Use cases on the combat of counterfeit ICT and stolen mobile devices", Q.Supplement.74 "Roadmap for the ITU-T Q.5050-series - Combat of counterfeit ICT and stolen mobile devices" and Q.Supplement.73 "Guidelines for permissive versus restrictive system implementations to address counterfeit, stolen and illegal mobile devices". Currently, SG11 is revising Q.Suppl.75 using inputs received from developing countries.

SG11 is developing a technical report which lists use cases on the combat of multimedia content misappropriation.

More info: https://itu.int/go/tsg11.

ITU-T SG20 is currently working on draft Recommendation ITU-T Y.4499 Framework for urban infrastructure monitoring based on crowdsourcing (Y.UIM-cs-framework).

More info: https://itu.int/go/tsg20.

(C.2) OTHER ACTIVITIES RELATED TO STANDARDISATION

Related topics in H2020 WP on e-Infrastructures and EOSC (proposals selected within these calls may contribute to standardisation):

EINFRA-1-2014: Managing, preserving and computing with big research data
EINFRA-3-2014: Towards global data e-Infrastructures — research data alliance
EINFRA-8-2014: Research and education networking — GÉANT
INFRASUPP-7-2014: e-Infrastructure policy development and international cooperation
EINFRA-22-2016: User driven e-infrastructure innovation
EINFRA-21-2017: Platform-driven e-infrastructure innovation
EINFRA-12-2017: Data and Distributed Computing e-Infrastructure for Open Science
INFRASUPP-02-2017: Policy and International cooperation measures for research infrastructures (RDA)
INFRAEOSC-05-2018-2019 - Support to the EOSC Governance
INFRAEOSC-04-2018 - Connecting ESFRI infrastructures through Cluster projects
INFRAEOSC-02-2019 - Prototyping new innovative services
INFRAEOSC-01-2018 - Access to commercial services through the EOSC hub
INFRAEOSC-03-2020 - Integration and consolidation of the existing pan-European access mechanism to public research infrastructures and commercial services through the EOSC Portal
INFRAEOSC-07-2020 - Increasing the service offer of the EOSC Portal

Related topics in Horizon Europe on EOSC (proposals selected within these calls may contribute to standardisation):

HORIZON-INFRA-2021-EOSC-01-03 - Deploying EOSC-Core components for FAIR
HORIZON-INFRA-2021-EOSC-01-04 - Innovative and customizable services for EOSC
HORIZON-INFRA-2021-EOSC-01-05 - Enabling discovery and interoperability of federated research objects across scientific communities
HORIZON-INFRA-2021-EOSC-01-06 - FAIR and open data sharing in support of cancer research
HORIZON-INFRA-2022-EOSC-01-04 - Support for initiatives helping to generate global standards, specifications and recommendations for open sharing of FAIR research data, publications and software
HORIZON-INFRA-2022-EOSC-01-02 - Improving and coordinating technical infrastructure for institutional open access publishing across Europe
HORIZON-INFRA-2022-EOSC-01-03 - FAIR and open data sharing in support of healthy oceans, seas, coastal and inland waters

(C.3) ADDITIONAL INFORMATION

Interoperability across data and services will allow researchers to gather new insights and open up new territories for scientific discovery by combining data showing correlations which are as of today impossible to explore. Cross-disciplinary Open Science can be seen as the ultimate goal of the EOSC. Interoperability is also a key element to allow EOSC to interact with thematic European Data Spaces and other data lakes . This requires the use of formal standards, protocols and APIs to enable to combine datasets from different disciplines and to compose a pipeline of services for processing and analysing data.

Moreover, institutions and research groups should not be locked into certain tools. Use of open standards and APIs will allow data to be transferred from one tool to another.

As an example, the emerging EOSC interoperability framework will specify a series of profiles to help connect multiple approaches to AAI. The aim is to have interoperable AAIs, not a one-size fits all, since different research infrastructures and services use different profiles and users may have preferences over which account and sign-in method is used.

However, due to the fast technological development, interoperability is the most complex challenge within EOSC and any federated digital platform and it has to be considered as a continuous activity.

RDA will be a good support to turn the proposed framework for action for data infrastructures into practice. The global framework of RDA and the role of EOSC among the international initiatives of science clouds will help to consolidate Europe's role of a global partner and a global leader in research data infrastructures.

3.1.7 Broadband infrastructure mapping

A Policy and legislation

(A.1) POLICY OBJECTIVES

The *digital single market* must be built on reliable and trustworthy data. In this context, the European Commission has launched a project to map fixed and mobile quality of broadband services in Europe. The tool went live in May 2020. It consists of an interactive online mapping application that aggregates and visualizes various dimensions of quality of service (QoS) delivered by broadband networks (fixed and mobile) in the European Union. The project constitutes a crucial instrument to assess and monitor the achievement of the new connectivity goals as described in the Communication on Connectivity for a Competitive Digital Single Market – Towards a European Gigabit Society and the 5G action plan. However data-collection is on a voluntary basis and therefore the data set is not yet complete.

In 2017, in order to complement the deployment of the EU broadband mapping platform, the Commission has launched a new study on Fixed and Mobile Convergence in Europe (SMART 2016/0046). On the basis of the datasets collected in the EU broadband mapping platform, the study supports the EU policy-making process by assessing the technical/political/economic obstacles that prevent the definition of common (fixed and mobile) network performance measurements in the Union. In 2019 BEREC started work on the development of Guidelines on Geographic Surveys of the new CODE for Electronic Communication. In march 2020 the guidelines were adopted with a second phase on the identification of areas for investment due to be completed by end 2020. In parallel the European Commission has started the development of a mapping broadband coverage methodology based on the BEREC guidelines with a view to meet the mapping requirement of EU level needs on monitoring, programming of funds and state aid assessment. The mapping methodology is due to be tested and finalised in 2021.

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

Telecom manufacturers, operators and other stakeholders have an interest in assuring a minimum of interoperability of broadband infrastructure mapping to facilitate the deployment of next-generation networks, simplify their operation, reduce cost and finally open up a single market dimension.

In order to achieve the EU broadband objectives of the Digital Agenda Europe, it is fundamentally important that there is reliable and valid data on existing and planned broadband infrastructures, services offered; and demand and investment. A standardised mapping of broadband infrastructures and services as well as of other related data will help identify gaps of broadband coverage and quality of service level and identify suitable areas of investment. Increasing the reliability of coverage data (QS1) will be particularly useful to avoid duplication of financing as subsidies can be allocated to areas truly affected by market failure and regulatory needs linked to market regulation. Gathering reliable quality of service data (QS2 and QS3) based on common methodologies will feed into other regulatory aspect linked to net neutrality and consumer protection as well as assisting in the provision of reliable 5G services to vertical industries.

The Broadband mapping project has revealed that in the absence of a commonly agreed methodologies for all three aspects, Member States administrations have developed a variety of different methodologies to map coverage and quality of service resulting in multiple mapping initiatives using different data sets and attributes (which NRAs, Ministries, regional agencies are sometimes running in parallel). Mapping data is not comparable across the EU and often public authorities lack detailed and reliable data to set policies, to ensure that public funding is compliant with relevant regulation, to programme funds and successfully monitor the execution of these actions at regional, national and European level. This lack of reliable data risks resulting in policy paralysis, in regulatory uncertainty, and poor planning of broadband projects.

The EU mapping platform collects three data sets concerning fixed and wireless services including:

- QoS-1: Calculated availability of service, network performance of existing infrastructure (coverage);
- QoS-2: Measured provision of service, excluding end user's environment;
- QoS-3: Measured experience of service, including end user's environment

BEREC Guidelines on Geographic Surveys

- Article 22 of the new CODE calls on BEREC to develop guidelines on Geographic Surveys in full cooperation with the EC and relevant MS authorities with a view to collect mapping data to satisfy a number of policy and regulatory functions at EU and MS level.
- **Phase 1: January 2019- March 2020:** BEREC carried out task1 and 2 and delivered the Guidelines regarding verification of QoS1 information, including - the possibility to verify by QoS2 and QoS3 information and adopted and published the guidelines - in March 2020. The BEREC Guidelines foster also state aid compliance but it is not their main objective to ensure compliance with state aid rules. NRAs/OCAs can use information collected under Art 22 to assist the state aid process but may also need to collect complementary information in line with the State Aid guidelines rules.
- **Phase 2: March 2020-1st Quarter 2021:** In phase 2 BEREC is due to carry out task 3 in order to develop the Guidelines on the procedures to invite undertakings and public authorities to declare their intention to deploy VHCN over the duration of the relevant forecast period for (Art 22.3 and Art 22.4). Work is expected to be finalised in Q2 2021. Similarly to phase I also these Guidelines foster also state aid compliance but it is not their main objective to ensure compliance with state aid rules. NRAs/ OCAs can use information collected under Art 22 to assist the state aid process but may also need to collect complementary information in line with the State Aid guidelines rules.

Broadband Mapping Methodology

- In January 2020 the EC has launched a study aimed at the development of common methodology on broadband coverage for fixed and mobile infrastructures and services . The methodology aims at including key data, not foreseen within the BEREC Guidelines, in order to allow an easy application in the field of State Aid: The broadband mapping methodology developed by the three experts concerns the specific application of the BEREC guidelines within the context state aid with possible repercussions on the monitoring of the achievement of EU objectives and the negotiation of EU funds. The work is expected to feed the update of the forthcoming Guidelines on State Aid for Electronic Communication Networks to be finalised and adopted by Q1 2022.

(A.3) REFERENCES

- Directive 2002/22/EC of the European Parliament and of the Council on universal service user's rights relating to electronic communication networks and services (Amended by Directive 2009/136/EC)
- COM(2016) 590 final/2 European Electronic Communication Code
- Directive 2002/ 21/EC of the European Parliament and of the Council on a common regulatory framework for electronic communications networks and services (amended by Directive 2009/140/EC)
- Directive 2007/2/EC of the European Parliament and of the Council establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)
- BEREC Net neutrality measurement tool (October 2017)
- BEREC Common Position on monitoring of mobile network coverage (July 2018)
- RSPG and BEREC joint report on mobile connectivity in 'challenge areas' (December 2017)
- Study from the EC commissioned to IMIT - Fixed and Mobile Convergence in Europe: SMART 2016/0046
- BEREC Common Position on information to consumers on mobile coverage (December 2017)
- DIRECTIVE (EU) 2018/1972 establishing the European Electronic Communications Code: article 22.
- BoR (20) 42 BEREC Guidelines on Geographical surveys of network deployments
- C(2020) 6270 final on a common Union toolbox for reducing the cost of deploying very high capacity networks and ensuring timely and investment-friendly access to 5G radio spectrum, to foster connectivity in support of economic recovery from the COVID-19 crisis in the Union.

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

ACTION 1 SDOs to further develop a standardised methodology and guidelines to assess and map availability and quality of fixed and wireless/mobile

broadband services (including coverage, QoS and QoE, key quality indicators - KQI) also in view of the development of VHC (very high-capacity) and 5G services for a range of public and private users including the large industries such as vertical industrial sectors.

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

CEN & CENELEC

CLC/TC 209 has developed and maintains a complete set of European standards in the field of cable networks for television signals, sound signals and interactive services. This EN series, EN 60728, deals with cable networks, including equipment and associated methods of measurement for headend reception, processing and distribution of television and sound signals and for processing, interfacing and transmitting all kinds of data signals for interactive services using all applicable transmission media. These signals are typically transmitted in networks by frequency-multiplexing techniques.

These include:

A. regional and local broadband cable networks (i.e. based on optical fibre and coaxial cables)

B. extended satellite and terrestrial television distribution networks or systems

C. individual networks or systems that receive satellite and terrestrial television, and all kinds of equipment, systems and installations used in such cable networks, distribution and receiving systems.

The extent of this standardisation work is from the antennas and/or special signal source inputs to the headend or other interface points to the network up to the terminal input of the customer premises equipment.

The standardisation takes into account coexistence with users of the RF spectrum in wired and wireless transmission systems.

Typical data rates for internet access in these kind of networks range from 30 Mbit/s to 200 Mbit/s, with cable network operators now starting to introduce gigabit services to their customers.

https://www.cenelec.eu/dyn/www/f?p=104:7:327929463237701::::FSP_ORG_ID,FSP_LANG_ID:1258287,25

CLC/TC 215 have published, among others, EN 50173-4 on broadband cabling of private homes (both copper and optical fibre cabling) and EN 50700 on fibre optic access network cabling design. CLC/TC 46X 'Communication cables' have published and will maintain cable standards to support those different systems (e.g. EN 60966 series, EN 50117 series, EN 50288 series, EN 50441 series, EN 50407 series).

ETSI

ETSI has continually developed an extensive set of standards aimed at measurement, testing, quality assurance and quality of service in communications networks.

TC ATTM is working on broadband infrastructure mapping to support the deployment of multiservice in smart community area

TC STQ (Speech and Multimedia Transmission Quality) is responsible for standardisation relating to terminals and networks for speech and media quality, end-to-end single media and multimedia transmission performance, Quality of Service (QoS) parameters for networks and services and Quality of Experience (QoE) descriptors and methods. STQ have developed a series of standards dealing with quality of service as perceived by the user, performance metrics and measurement methods. STQ are developing a Technical Report on best practices for robust network QoS benchmark testing and ranking (TR 103 559). They have also developed TRs and ETSI Guides on throughput measurement guidelines.

TC INT (Core Network and Interoperability Testing) is responsible for the development of core network test specifications for interoperability, conformance, performance and security. TC INT is developing a TS for a methodology for end to end internet related customer experience measurements for fixed and mobile networks. It will describe the concept, the requirements, the parameters and the procedures which should be used for Internet speed quality measurements, and is being developed in cooperation with ITU-T SG.11.

TC CABLE is responsible for standardisation related to integrated broadband cable telecommunication network technologies. TC CABLE is developing a TS on measurement methods for the network performance of broadband data services. The focus is on measurement of QoS performance in the access network. While the TS is taking the cable access network into account, the methods are designed in a network agnostic way such that their applicability to other delivery networks of broadband data services is not precluded. TC CABLE is engaging with stakeholders on the European level to establish standardized methodology enabling consumers to compare the performance of different service providers.

TC BRAN is responsible for developing Harmonized Standards (HS) to meet the minimum essential requirements of the Radio Equipment Directive 2014/53/EU to enable fair sharing of spectrum in the 5 GHz and 6 GHz frequency ranges and other license-exempt bands. Technologies such as those developed from IEEE 802.11 and Bluetooth use this spectrum. Another role of TC BRAN is to minimise interference to other applications such as radar, road tolling, etc. As technologies evolve, advanced techniques are being developed to use the spectrum more efficiently. TC BRAN includes these advances in its HSs to ensure the Radio Equipment Directive is adhered to by all devices within their scope.

ISG F5G is addressing the evolution of the fixed broadband network generations with the functional and performance-oriented generations (F5G generation and F5G Advanced generation). The ETSI ISG F5G has finished the Release 3 of the F5G Advanced specification and has started working on the Release 4 of F5G Advanced specifications. Optical networks are the focus, covering applications that range from the services to domestic users to the enhancement of services to industrial production and business in general, by the extension of reach from fibre to the site to fibre

to the single desk or production chain, by extension of Fibre to the Home/Premises (FTTH/FTTP) to Fibre to the Room (FTTR). The ETSI ISG F5G has so far published several deliverables addressing different aspects of this evolution of fibre networks, that has been considering and benefitting of the work done in the other important standard organizations and industry groups in the same area, establishing channels of collaboration with the most relevant of them. Of particular importance to the mapping of broadband infrastructure refer the QoS and QoE related specifications of ETSI ISG F5G.

The (technical) deliverables list for consideration to the topic of broadband infrastructure mapping:

- The F5G Advanced Generation Definition providing different performance dimensions including user's bandwidth, latency, reliability, energy usage, and different functional dimensions including guaranteed reliable experience, optical sensing, industrial grade networking, fibre to everywhere. (ETSI GR F5G 021 V1.1.1 (2023-11))
- F5G Advanced Quality of Service (QoS) and Quality of Experience (QoE) of broadband services over fixed networks. The ISG F5G specifies for residential networks and service, the service and network Key Performance Indicators (KPI) and Key Quality Indicators (KQI) for a variety of residential services (ETSI GS F5G 015 V1.2.1 (2024-03)), the measurement specification (ETSI GS F5G 017 V1.1.1 (2024-04)) and the specification of the measurement system (ETSI GS F5G 026 V1.1.1 (2024-08)). Similar specifications for enterprise- and SME-oriented services QoS and QoE are currently under development.
- F5G Advanced Use Cases describe use cases for different market segment including home, enterprises, verticals and network infrastructure optimizations. (ETSI GR F5G 020 V1.1.1 (2024-06), Release 3). The Release 4 work item has been approve3d and future work will describe a variety of use cases for all different market segments.
- F5G Advanced Requirements, Gap Analyses and Technology Landscape document specifies the network requirements for the use cases, lists the standardization gaps and available technologies to implement those use cases. (Work Item 23, work in progress)
- F5G Advanced Architecture specifies the end-to-end fixed network from an architectural perspective. (Work Item 24, work in progress)
- Testing F5G Advanced functionality and performance work items specify the FTTR and 50G-PON test cases and test setup.
- The Autonomous Level definition work items specifies the classification of fixed networks regarding the level of autonomy.
- The computing collaboration work item specifies the interfaces and the requirements for collaboration of different compute resources and services located through out the F5G Advanced network including on-premises compute, access network compute, aggregation network compute, and core network compute functionality.
- The end-to-end management and control work items specify the management and control architecture for the F5G Advanced network.
- The PON-based industrial network work item specifies the industrial network architecture and requirements, where optical networking technology is applied to a full new set of scenarios in vertical industries environment.

ISG IPE: has developed guidelines for deploying IPv6 in 5G transport networks, data centres, cloud networks, etc.

ITU-R

ITU-R Working Party (WP) 5C is responsible for studies related to fixed wireless systems and HF systems in the fixed and land mobile services. It studies performance and availability objectives, interference criteria, RF channel/block arrangements, system characteristics and sharing feasibility. It should be noted that for fixed wireless access (FWA) systems, work related to public access systems for potentially large deployment coverage is carried out in ITU-R Working Party 5A.

Some of the deliverables regarding the fixed and mobile quality of broadband services include:

- Recommendation ITU-R M.1079 on "Performance and quality of service requirements for International Mobile Telecommunications-2000 (IMT-2000) access networks"
- Report ITU-R F.2058 on "Design techniques applicable to broadband fixed wireless access systems conveying Internet protocol packets or asynchronous transfer mode cells"
- Report ITU-R F.2086 on "Technical and operational characteristics and applications of broadband wireless access in the fixed service"
- Report ITU-R F.2393 on "Use of fixed service for transport of traffic, including backhaul, for IMT and other terrestrial mobile broadband systems"
- Report ITU-R M.2243 on "Assessment of the global mobile broadband deployments and forecasts for International Mobile Telecommunications"
- Report ITU-R M.2378 on "Operational guidelines for the deployment of broadband wireless access systems for local coverage operating below 6 GHz"

ITU-R SG6 studies and develops issues associated with what is termed the "presentation layer" for radio and television broadcasting including these programmers which are delivered by broadband systems. This includes signal formats for the making and exchange of television and radio programmes, and also ways to evaluate picture and sound quality that are a critical element in the choice of the parameters for the "presentation layer" end-to-end. One of the historical standards is Recommendation ITU-R BT.500 "Methodologies for the subjective assessment of the quality of television images".

More information : Working Party 6C (WP 6C) - Programme production and quality assessment (itu.int)

ITU-T

ITU-T Study Group 12, on Performance, Quality of Service (QoS) and Quality of Experience (QoE), continues studying performance of packet-based networks and other networking technologies.

The 2019 edition of Recommendation ITU-T Y.1540 *Internet protocol data communication service – IP packet transfer and availability performance parameters* recognizes many changes in the design of IP services and in the protocols employed by end-users.

ITU-T Y.1540 (2019) introduced new Annexes A and B that defines IP-layer Capacity parameters in ways that cater toward assessment, and provides requirements for reliable methods of measurement of IP-layer Capacity.

The updated international standard, available at https://itu.int/ITU-T/Y.1540 is aligned with related relevant work in ETSI TC STQ, BBF, IETF, among others. An open source implementation of the Y.1540 methodology for UDP-based IP capacity measurements is available. A Supplement accompanying Y.1540 provides guidance on the interpretation of IP-layer capacity measurements, examples of testing campaigns and a brief introduction to the open source implementation. It is available at https://www.itu.int/rec/T-REC-Y.Sup60/en.

Recommendation ITU-T E.806 (2019) (https://itu.int/ITU-T/E.806) provides guidance on measurement campaigns, monitoring systems and sampling methodologies to monitor the quality of service in mobile networks.

Recommendation ITU-T E.812 (2020) (https://itu.int/ITU-T/E.812) introduces the crowdsourcing approach for the assessment of end-to-end quality of service in fixed and mobile broadband networks. Use cases of the crowdsourcing approach include the assessment of mobile network coverage of mobile networks, as well as performance monitoring and benchmarking for fixed and mobile networks.

Recommendation ITU-T Y.1545.1 (2017) (https://itu.int/ITU-T/Y.1545.1) provides guidance on monitoring the QoS of Internet services to regulators, network service providers and subscribers.

Approved in 2024, a new Recommendation ITU-T E.813 (https://itu.int/ITU-T/E.813), focuses on mapping and visualization strategies for the assessment of connectivity and QoS.

ITU-T SG11 approved Recommendation ITU-T Q.3960 "Framework for Internet related performance measurements". It aims to enable the customers of telecom networks' to estimate their Internet performance access: http://www.itu.int/itu-t/q.3960. Also, testing procedures are described in Supplement 71 to ITU-T Q.3960 "Testing methodologies of Internet related performance measurements including e2e bit rate within the fixed and mobile operator's networks," https://itu.int/ITU-T/workprog/wp_item.aspx?isn=13819

ITU-T SG11 approved Recommendation ITU-T Q.3961 "Parameters for bottleneck evaluation of the web-browsing service" which defines parameters for bottleneck evaluation of the web-browsing service, including parameters in the network layer, in the transportation layer and in the application layer, and the characteristic parameters (https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=14417).

Currently, SG11 is developing new technical report TR.MPLRA "Requirements and architecture for monitoring packet loss caused by network congestion".

ITU-T SG13 created the ITU-T Focus Group on Technologies for Network 2030 (FG NET-2030) to look at the enhanced broadband, low latency and guaranteed type of communications to be available on the networks of far future around 2030 - 2035. This implies dealing with fixed, mobile, satellite and many networks operation. More about the area of expertise, study and objectives of the group is elaborated in the White Paper, "Network 2030 - A Blueprint of Technology, Applications and Market Drivers Towards the Year 2030 and Beyond" (05.2019): https://www.itu.int/en/ITU-T/focusgroups/net2030/Documents/White_Paper.pdf

https://www.itu.int/en/ITU-T/focusgroups/net2030

ITU-T SG15 is responsible in ITU-T for the development of standards for the optical transport network, access network, home network and power utility network infrastructures, systems, equipment, optical fibres and cables. This includes related installation, maintenance, management, test, instrumentation and measurement techniques, and control plane technologies to enable the evolution toward intelligent transport networks, including the support of smart-grid applications.

More info: https://itu.int/go/tsg15

IETF

The Large-Scale Measurement of Broadband Performance (LMAP) Working Group standardised the LMAP measurement system for performance measurements of broadband access devices such as home and enterprise edge routers, personal computers, mobile devices, and set top boxes, whether wired or wireless.

Measuring portions of the Internet on a large scale is essential for accurate characterisations of performance over time and geography, for network diagnostic investigations by providers and their users, and for collecting information to support public policy development. The goal is to have the measurements (made using the same metrics and mechanisms) for a large number of points on the Internet, and to have the results collected and stored in the same form.

https://wiki.ietf.org/en/group/iab/Multi-Stake-Holder-Platform#h-317-broadband-infrastructure-mapping

(C.2) OTHER ACTIVITIES RELATED TO STANDARDISATION

INSPIRE

Thematic working group utility and government services from European Commission Joint Research Centre set out on 2013 "Data Specification on Utility and Government Services — Technical Guidelines", a "non-paper" document.

SMART 2012/2022

A "Broadband and infrastructure mapping study" contracted by the European Commission.

http://www.broadbandmapping.eu.

SMART 2016/0046

"Study on Fixed and Mobile Convergence in Europe"

The project is expected to facilitate the identification of key elements to define a common European standard to measure network performance taking into account on-going international standardisation activities for network performance measurements with a view to align European and international efforts in this domain while ensuring the involved of relevant stakeholders.

https://ec.europa.eu/digital-single-market/en/news/study-fixed-and-mobile-convergence-europe-2017

VIRGO

In the context of standards-based infrastructure mapping, a European project VIRGO (Virtual Registry of the Ground

Infrastructure) began in 2014 with a focus on mapping cloud computing. It is coordinated by Infratel Italia which is active in broadband mapping in Italy.

ECC REPORT 195

The Electronic Communications Committee (ECC) drafted Report 195, ´Minimum Set of Quality of Service Parameters and Measurement Methods for Retail Internet Access Services´.

http://www.erodocdb.dk/Docs/doc98/official/pdf/ECCREP195.PDF

ECC recommendation (15)03, ´Provision of Comparable Information on Retail Internet Access Service Quality´.

http://www.erodocdb.dk/Docs/doc98/official/pdf/REC1503.PDF

ITU-T PROJECTS

The ITU-T reference guide G.1011: ITU-T has a suitable recommendation for the QoS of different types of most important services in its reference guide G.1011, Table 9-1.

https://www.itu.int/rec/T-REC-G.1011/en

ITU-T interactive transmission maps of backbone broadband connections worldwide. The scope of this ITU project is to research, process and create maps of core transmission networks (optical fibres, microwaves, submarine cables and satellite links) for the following ITU regions: Arab region, CIS region, the EUR region, the Asia-Pacific region, the North America region, Latin America and the Caribbean region, and the Africa region.

http://www.itu.int/en/ITU-D/Technology/Pages/InteractiveTransmissionMaps.aspx

3.1.8 Accessibility of ICT products and services

A Policy and legislation

(A.1) POLICY OBJECTIVES

Accessibility of ICT products and services includes telecommunications, audio-visual media services, **digital services and platforms**, the web and new emerging technologies. ICT accessibility is complemented by assistive technology**, therefore** interoperability of the two is required to ensure access by persons with disability to ICT and ICT based services on an equal basis with others. **Further, where technologies are interoperable, this interoperability must also be accessible**. **The European Union's digital agenda, as well as COVID-19 have led to the rapid digitalisation of all aspects of life. Therefore the accessibility of e-education, teleworking, e-governance, e-health and other digital aspects of private and public services is essential to allow persons with disabilities to participate in society at equal level with other citizens.**

In this specific policy area, the Directive on the accessibility of public sector bodies' websites and mobile applications **(the Web Accessibility Directive)** is covered by a harmonised standard based on globally agreed web accessibility guidelines. This **policy** area also relates to the Directive on accessibility of products and services **(**the European Accessibility Act**)**. In addition to the **upcoming adoption of new and revised harmonised standards, as requested in standardisation request M/587**, the European Accessibility Act allows for the adoption of technical specifications that would provide presumption of conformity with the accessibility requirements of the Directive. Relevant EU policies also include the European Electronic Communication Code (EECC), Audiovisual Media Services Directive, EU Digital Education Action Plan, as well as EU policies on Digital Services (DSA, DMA), Digital ID Regulation, and Artificial Intelligence (AI Regulation).

The above mentioned policies are in support of the EU implementation of the UN Convention on the Rights of Persons with Disabilities to which the EU

and Member States are a party. It is important to note that under the Convention state parties are obliged to remove accessibility barriers and to adopt and promote a design for all approach in the development of standards and guidelines **(Article 9 - accessibility).**

On 14 January 2020 the Commission adopted a Communication on a Strong Social Europe for Just Transitions, to prepare the way for an action plan to reinforce the implementation of the European Pillar of Social Rights. In the context of Pillar Principle 17 on the inclusion of persons with disabilities, the Communication recognises that people with disabilities continue to face difficulties in accessing education and training, employment, social protection systems and health care in the Member States.

In March 2021, the Commission adopted Strategy for the Rights of Persons with Disabilities 2021-2030, an aim of which is to support the implementation of the UN Convention within the EU.

The Strategy recognizes the "*limited accessibility of ICT tools necessary for teleconferencing, telework arrangements, distance learning, online shopping, and access to COVID-19 related information*" (p.5). To solve some of the accessibility gaps, the Strategy has proposed several measures for the coming years, including:

- the foundation of a European resource centre, which is called AccessibleEU and was launched on the 4th July 2023, to increase coherence in accessibility policies and facilitate access to relevant knowledge;
- providing guidance to Member States to support the implementation of the accessibility obligations under the public procurement Directives, and promote training for public procurers to buy accessible; the guidance document was published in 2021.
- ensuring accessibility and inclusiveness in the reinforced EU digital government strategy, focusing on human-centric and user-friendly digital public services across Europe that respond to the needs and preferences of European citizens, including the needs of persons with disabilities
- evaluating the Web Accessibility Directive and assess whether revision is necessary to address any gaps identified. The review of the Web Accessibility directive has now been published, along with its executive summary;
- The Commission's Action Plan 2022 - 2025 was published in 2022. It addresses web accessibility, to be shared and promoted in all EU institutions, bodies and agencies in view of ensuring compliance of EU websites, documents published on these websites and online platforms, with European accessibility standards.

The Strategy also highlights the importance and aims of ensuring accessible digital education, healthcare, art, culture, recreation, leisure, sport, and tourism; ensuring accessible EU policy-making for all citizens; and continuous removal and prevention of barriers by all services for staff and public with disabilities (e.g. accessible ICT equipment and tools for online meetings) of EU institutions.

Regulation 1025/2012 on European standardisation (2) states:

"(24) The European standardisation system should also fully take into account the United Nations Convention on the Rights of Persons with Disabilities. It is therefore important that organisations representing the interests of consumers sufficiently represent and include the interests of people with disabilities. In addition, the participation of people with disabilities in the standardisation process should be facilitated by all available means".

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

Standardisation needs arise, for instance from the UN Convention, Article 9 which requires, inter alia, the development of minimum, standards and guidelines for the accessibility of facilities and services, and from the general obligations to promote universal design when drafting standards. Work on this area needs to advance at European level, where possible in coordination with related work at international level, and to support harmonised market requirements within Europe.

In October 2016, Directive (EU) 2016/2102 on the accessibility of public sector bodies' websites and mobile application was published in the Official Journal. This directive, also referred to as the Web Accessibility Directive (WAD), includes a presumption of conformity with the accessibility requirements set out in Article 4 for content of websites and mobile applications which meet the relevant harmonised standards. At the time of publication, this presumption of conformity was provided by the relevant clauses of the European standard EN 301 549 v1.1.2 (2015-04). This standard was the result of the policy Mandate 376.

In April 2017, the European Commission issued standardisation request M/554 to the European standardisation organizations, CEN, CENELEC and ETSI. The purpose of this request was to develop an

appropriate harmonised European standard (hEN), based on the standard EN 301 549 V1.1.2 (2015-04), covering the essential requirements included in the WAD. This standardisation request was accepted in June 2017, with the creation of the CEN-CENELEC-ETSI Joint Technical Body on eAccessibility (including collaboration of the W3C). The working group revised EN 301 549 accordingly, leading to EN 301 549 V2.1.2 (2018-08) being adopted and published by the ESOs.

Subsequently, following the fitness checks required under the standardisation Regulation, and in line with its obligations under the WAD, the Commission published the references to this new European standard on December 20, 2018 in the Commission Implementing Decision (EU) 2018/2048. Standard EN 301 549 V2.1.2 (2018-08) on the "Accessibility requirements for ICT products and services" thus became a harmonised standard. (Note: it has been superseeded and is no longer a harmonised standard.)

The Directive also requires drafting of a methodology for monitoring the conformity of websites and mobile applications with the requirements, as well as a model accessibility statement to be used by public sector bodies to provide in a comprehensive and clear manner, details on the compliance of their websites and mobile applications with the Directive. This has been realised, respectively, through the Commission Implementing Decision (EU) 2018/1524 of 11 October 2018 establishing a monitoring methodology and the arrangements for reporting by Member States in accordance with the WAD and the Commission Implementing Decision (EU) 2018/1523 of 11 October 2018 establishing a model accessibility statement in accordance with Directive (EU) 2016/2102 .

In March 2021 a new version of the standard was published: EN 301 549 V3.2.1 (2021-03) and then submitted to the Commission for referencing in the Official Journal. According to Commission Implementing Decision (EU) 2021/1339 of 11 August 2021, amending Implementing Decision (EU) 2018/2048, this new harmonised standard replaces the previously harmonised version in conferring a presumption of conformity with the corresponding essential requirements of the Web Accessibility Directive (WAD), as specifically listed in Annex A of that standard.

In April 2019, Directive (EU) 2019/882 of the European Parliament and of the Council of 17 April 2019 on the accessibility requirements for products and services, also known as the European Accessibility Act (EAA) was adopted by the European Union. Member States had to transpose the act into national legislation by June 2022. A Standardisation Request, asking the ESOs to draft an updated revision of EN 301 549, was adopted in 2022. This standardisation request, Mandate 587, submitted by the European Commission to, and accepted by, the ESOs accordance with Article 10 of Regulation (EU) No 1025/2012, requests:

- the development of:

  - Harmonised standard(s) setting up requirements on the accessibility of non ICT information related to products
  - Harmonized standard for the accessibility of support services related to products and services (help desks, call centres, technical support, relay services and training services)
  - Harmonized standard for the accessibility of emergency communications and for the answering of emergency communications by the PSAPs (public safety answering points-including to the single European Emergency number 112)

- the revision of:

  - EN 301 549 Accessibility requirements for ICT products and services
  - EN 17161:2019 Design for All - Accessibility following a Design for All approach in products, goods and services - Extending the range of users
  - EN 17210 Accessibility and usability of the built environment - Functional requirements
  - CEN/CLC/ETSI TR 101551 Guidelines on the use of accessibility award criteria suitable for public procurement of ICT products and services in Europe
  - CEN/CLC/ETSI/TR 101 552 Guidance for the application of conformity assessment to accessibility requirements for public procurement of ICT products and services in Europe

(A.3) REFERENCES

- Directive (EU) 2016/2102 of the European Parliament and of the Council of 26 October 2016 on the accessibility of the websites and mobile applications of public sector bodies. The Web Accessibility Directive.
  - Commission Implementing Decision (EU) 2018/1524 of 11 October 2018 establishing a monitoring methodology and the arrangements for reporting by Member States. The monitoring and reporting requirements.
  - Commission Implementing Decision (EU) 2018/1523 of 11 October 2018 establishing

a model accessibility statement. The model Accessibility Statement.

- Commission Implementing Decision (EU) 2021/1339 of 11 August 2021 amending Implementing Decision (EU) 2018/2048 as regards the harmonised standard for websites and mobile applications

- Directive (EU) 2019/882 of the European Parliament and of the Council of 17 April 2019 on the accessibility requirements for products and services. - The European Accessibility Act.
- The UN Convention on the Rights of Persons with Disabilities (UN CRPD).
- General comment No. 2 (2014) Article 9: Accessibility.
- Directive (EU) 2018/1808 of the European Parliament and of the Council of 14 November 2018 amending Directive 2010/13/EU on the coordination of certain provisions laid down by law, regulation or administrative action in Member States concerning the provision of audiovisual media services (Audiovisual Media Services Directive) in view of changing market realities
- Directive (EU) 2018/1972 of the European Parliament and of the Council of 11 December 2018 establishing the European Electronic Communications Code (Recast), which builds on the Tallinn and Berlin Declarations and refers to the WAD and the EAA as references also for the implementation.
- Regulation (EU) 2022/612 of the European Parliament and of the Council of 6 April 2022 on roaming on public mobile communications networks within the Union (recast), which highlights supporting aim of Directive (EU)2018/1972 to ensure that access for end-users with disabilities to emergency services is available through emergency communications and is equivalent to that enjoyed by other end-users
- The Commission's eGovernment Action Plan 2016 - 2020, which also refers to accessibility. Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on public procurement (esp. Articles 42 and 62). that contains the obligation to "buy accessible".
- The Digital Education Action Plan (2021-2027) is a renewed European Union (EU) policy initiative to support the sustainable and effective adaptation of the education and training systems of EU Member States to the digital age. It highlights accessible and inclusive digital educations for all, including learners with disabilities.
- The Commission's Strategy for the Rights of Persons with Disabilities 2021-2030.
- The Commission's proposed Declaration on European Digital Rights and Principles

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

ACTION 1: SDOs to work on the development and revisions of the harmonised standards and technical reports, as requested by standardisation request Mandate 587.

ACTION 2: SDOs to produce a technical report describing requirements for ICT products and services to be designed to meet the needs of persons with cognitive and learning disabilities; the report should propose enhancements to relevant existing standards and identify needs for further standardisation such as the development of measurable requirements to address cognitive accessibility to be included in the standards implementing relevant legislation. The report should take into account the latest research in the field of cognitive disabilities and give guidance on which aspects of cognitive disabilities are sufficiently well understood so that support for people with such disabilities can be standardised (and tested) in a technically meaningful way.

ACTION 3: SDOs to produce a technical report on the possible accessibility requirements and standardisation needs of ICT products and services that are based on emerging technologies, such as natural language processing, wearables, virtual and augmented reality, AI, as well as biometrics and enhanced ICT security. These technologies must be designed to meet the needs of persons with disabilities, which includes cognitive and learning disabilities.

ACTION 4: SDOs to continue work on the implementation of the methodology developed under M/473, providing that new standardisation deliverables including the European standards comply with the methodology for mainstream accessibility in standardisation processes and the revision of existing standards in line with what it was agreed in the Mandate deliverable 3.1

(C.1) RELATED STANDARDISATION ACTIVITIES

CEN-CENELEC-ETSI

A further version of the EN was published by CEN, CENELEC and ETSI in March 2021 solving some errors detected in the previous edition and improving its usability. This new edition, EN 301 549 V3.2.1 (2021-03) (EN 301549:2021) was developed to meet the essential requirements included in the Directive on the accessibility of the websites and mobile application of public sector bodies. Currently, a new revision is being developed in response to the standardisation request to the European standardisation organizations as regards the accessibility requirements of products and services in support of Directive (EU) 2019/882 of the European Parliament and of the Council and to the Web Accessibility Directive.

CEN & CENELEC

CEN/CLC/TC11 has adopted the following deliverables in relation to this subject:

- EN 17210:2021 Accessibility and usability of the built environment - Functional requirements
- CEN/TR 17621:2021 Accessibility and usability of the built environment - Technical performance criteria and specifications
- CEN/TR 17622:2021 Accessibility and usability of the built environment - Conformity assessment"

ISO/IEC JTC1

The work ISO/IEC JTC1 SWG-A was doing (TR 29138-2) was passed to JTC1 SC35.

A framework for personalization and adaptation of user interfaces at runtime, based on the context of use (consisting of a user's needs and preferences, their envisioned tasks, their equipment, and environmental parameters of interaction). The framework is based on the well-known REST protocol, and JSON and XML formats. A registry-based approach is employed for the definition of terms describing a user's personal preferences and needs.

Published standards: ISO/IEC JTC 1 SC36

ISO/IEC 24571-1 Information Technology – Individualised adaptability and accessibility in e-learning, education and training – Part 1: Framework and reference model

ISO/IEC JTC 1 SC 35

ISO/IEC DIS 24752-8 Information technology -- User interfaces -- Universal remote console -- Part 8: User interface resource framework

CEN

CEN formed a Strategic Advisory Group on Accessibility (SAGA) to consider how to address accessibility throughout the standardisation process; this group includes representatives of national standards bodies, CENELEC and ETSI, and organisations representing persons with disabilities and older people.

http://www.cencenelec.eu/standards/Sectors/Accessibility/Pages/default.aspx

DIN

DIN is preparing a national standard DIN 13278 "Smart mobility for people with reduced mobility". The idea is that people with disabilities can communicate in public spaces, e.g. with public transport or traffic lights. It is planned to submit the finished document as a national project proposal at European level.

ETSI

ETSI continues to produce accessibility standards on specific ICT topics. The effort will focus on standardisation related to the EAA. Revisions of the EN 301 549 and a range of other relevant standards and reference documents will be central, along with a series of plugtests to ensure interoperability and quality of total conversation, exploring and defining the concept of reference terminal from EN 301 549; a guide to user-centred terminology for existing and upcoming devices and services is underway as well as work on recommendations for development of ICT to meet the needs of people with cognitive disabilities; initial early investigations are being made into transmission quality and its possible link to reported intelligibility problems for some hearing-impaired people; see also EG 202 952, a set of guidelines to identify "Design for All" aspects in ETSI deliverables.

ETSI is also focusing on the accessibility of emergency communications. The work produced by STF 642 (now closed) led to the development and publication of TS 103 919, which addresses the accessibility and interoperability of emergency communications, along with the handling of such communications by public safety answering points (PSAPs), including the single European Emergency number 112. Additionally, this STF delivered the mature draft EN 303 919, covering similar content and expected to evolve into a Harmonized Standard in a follow-up project.

ETSI has initiated a programme to develop methods for objective assessment of Listening effort, in particular for speech in the presence of background noise. The results are available in TS 103 558. STF 575 (closed) produced results of subjective tests and of objective model at the acoustical interface. STF 590 (closed) was dedicated to the electrical interface and provided results of subjective tests for different types of terminals and several network impairments. TS 103 558 has been completed with these results as a new annex and the objective model has been updated.This database, built with people without hearing disabilities, gives a reference to develop further studies dedicated to hearing impaired people. As there are a lot of different hearing impairments, it will be needed to define typical types of hearing impairments and reference signal amplifications (level and frequency enhancement) in order to compute loudness and listening effort, in association with subjective tests."

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http://www.etsi.org/technologies-clusters/technologies/human-factors/accessibility;
http://webapp.etsi.org/WorkProgram/Report_WorkItem.asp?WKI_ID=35174;
http://webapp.etsi.org/WorkProgram/Report_WorkItem.asp?WKI_

ID=37153;
http://webapp.etsi.org/WorkProgram/Report_WorkItem.asp?WKI_ID=35796
https://portal.etsi.org/webapp/WorkProgram/Report_WorkItem.asp?WKI_ID=58838

IEC

IEC TC 100/TA 16 is producing international publications addressing aspects of active assisted living (AAL), including issues related to accessibility, usability and specific user interfaces related to audio, video and multimedia systems and equipment within the scope of TC 100.

http://www.iec.ch/dyn/www/f?p=103:7:0::::FSP_ORG_ID,FSP_LANG_ID:11009,25

IEEE

IEEE has standards and pre-standards activities that support greater accessibility of ICT products and services, and for ethical and inclusion considerations [Digital Inclusion, Identity, Trust, and Agency (DIITA)]. The following is a list of related IEEE projects.

IEEE standards activities:

- IEEE 2998, Recommended Practice for Building Accessible Applications
- IEEE P2955, Recommended Practice for Creating Self Learning Tutorials and Side by Side Learning
- IEEE P3337, Standard for Requirements for Designing Accessible Intelligent Cyber-Physical Systems (AICS) for Well-Being
- IEEE PP3386, Standard for Defining and Inferring User Accessibility Needs for Applications including Augmented Reality and Artificial Intelligence Systems

IEEE pre-standards activities:

- IC19-004 Technology and Data Harmonization for Enabling Clinical Decentralized Clinical Trials
- IC20-018 Transforming the Telehealth Paradigm Sustainable Connectivity, Accessibility, Privacy, and Security for All

For more information, see: https://ieee-sa.imeetcentral.com/eurollingplan/.

IETF

Relevant work is in the ART area. For instance RFC 3551 identifies the requirements for SIP to support the hearing impaired and RFC4103 defines the RTP payload for text conversation.

RFCs 4103 and 5194 are being referenced in various accessibility regulations being proposed in the US (Section 255/508) and EU (e.g. M376).

https://wiki.ietf.org/en/group/iab/Multi-Stake-Holder-Platform#h-318-acccessibility-of-ict-products-and-services

ISO

ISO/IEC Guide 71, Guidelines for standards developers to address the needs of older persons and persons with disabilities was published in 2014 and adopted by CEN & CENELEC as CEN-CENELEC Guide 6:2014. ITU also adopted it as H-Series Supplement 17.

JTC1 SWG-A (special working group on accessibility) has been disbanded. Work has been transferred to ISO/IEC/JTC1 SC35 (User Interfaces). https://www.iso.org/standard/57385.html

ISO/TC 59/SC 16 has approved ISO 21542:2021, Building construction — Accessibility and usability of the built environment. This documents withdraws ISO 21542:2011, which was the main base for the drafting of EN 17210.

ISO/TC 59/SC 16 is working on ISO/NP 5727, Accessibility and usability of the built environment — Accessibility of immovable cultural heritage — General criteria and methodology for interventions.

ISO/TC 59/SC 16 is working on ISOFDIS 5727, Accessibility and usability of the built environment — Accessibility of immovable cultural heritage — General criteria and methodology for interventions. The project is at its last stages, and its publication is expected before the end of 2024.

ITU

ITU-T and ITU-R have produced relevant work on accessibility and human factors. Relevant information is found in the ITU Accessibility Portal:

https://itu.int/en/ITU-T/accessibility

Additionally, more details on the Radiocommunication Sector contribution to Bridging the Digital Disabilities Divide can be found at: https://www.itu.int/en/ITU-R/information/Pages/disabilities-divide.aspx

Within ITU-T SG16, related technical groups include Question 26/16 on accessibility and Question 24/16 on human factors, which include various experts with disabilities and cooperate with advocacy organizations (such as the G3ict, WFD and RNIB), in addition to other technical groups such as ITU-T, D, R Study Groups and ISO/IEC JTC1 SC35.

More info on Q26/16: https://itu.int/itu-t/workprog/wp_search.aspx?Q=26/16

More info on Q24/16: https://itu.int/itu-t/workprog/wp_search.aspx?Q=24/16

Recommendation ITU-T F.790 on accessibility guidelines for older persons and persons with disabilities is complemented by ITU H-series Supplement 17 (2014), which mirrors the new edition of ISO/IEC Guide 71 containing guidelines for standards developers to address the needs of older persons and persons with disabilities.

More info on ITU-T F.790: https://itu.int/rec/T-REC-F.790

More info on ITU H-series Supplement. https://itu.int/rec/T-REC-H.Sup17

ITU-T F.791 contains recommended terminology for accessibility for use in the international context and assists in defining context for procurement activities of accessible systems and services: https://itu.int/rec/T-REC-F.791

The checklist in ITU-T FSTP-TACL describes how to prepare ICT standards that include accessibility from their inception. Two other ITU-T technical papers describe arrangements for accessible meetings and for accessible remote participation in meetings (FSTP-AM — Guidelines for accessible meetings; and FSTP-ACC-RemPart — Guidelines for supporting remote participation in meetings for all) that aim at increasing the participation of persons with disabilities at real and virtual meetings. ITU-T technical papers on accessibility: https://itu.int/pub/T-TUT-FSTP

ITU-T F.921 (08/2018) "Audio-based network navigation system for persons with vision impairment" explains how to accommodate the users' experience of inclusive audio-based network navigation

systems and ensure their interoperability: https://itu.int/rec/T-REC-F.921.

ITU-T F.930 (03/2018) "Multimedia telecommunication relay services", which provides a functional description of four common types of relay services in use today: text relay, video relay, captioned telephone service relay and speech-to-speech relay. Telecommunications relay services enable persons who have hearing or speech disabilities and who otherwise would be unable to engage in voice telecommunications, to make voice telephone calls to other persons: https://www.itu.int/rec/T-REC-F.930

ITU-T H.871 (07/2019) "Safe listening guidelines for personal sound amplifiers (PSAs)" provides characteristics of PSAs and suggests ways of informing consumers about the potential unacceptable noise levels when using these devices for prolonged periods of time: https://www.itu.int/rec/T-REC-H.871

ITU and WHO global standard ITU-T F.780.2 (Rev. 2023) "Accessibility of telehealth services" defines accessibility requirements for technical features to be used and implemented by governments, healthcare providers and manufacturers of telehealth platforms to facilitate the access and use of telehealth services by persons with disabilities and specific needs: https://www.itu.int/rec/T-REC-F.780.2-202304-I

Recommendations developed in collaboration with ISO/IEC JTC1 SC35 "User Interfaces":
- ITU-T T.701.11 (09/2020) - Guidance on text alternatives for images (Twin text with ISO/IEC 20071-11:2019) (https://www.itu.int/rec/T-REC-T.701.11)
- ITU-T T.701.21 (03/2022) - Guidance on audio description (Twin text with the published ISO/IEC TS 20071-21:2015) (https://www.itu.int/rec/T-REC-T.701.21-202203-I)
- ITU-T T.701.25 (03/2022) - Guidance on the audio presentation of text in videos, including captions, subtitles and other on-screen text (Twin text with the published ISO/IEC TS 20071-25:2017) (https://www.itu.int/rec/T-REC-T.701.25-202203-I)

Technical Paper FSTP.ACC-WebVRI (2022) "Guideline on web-based remote sign language interpretation or video remote interpretation (VRI) system" (https://www.itu.int/pub/T-TUT-FSTP-2022-ACC.WEBVRI) describes a web-based VRI, based on Web real time communication (RTC), and describes how it can be used in a scenario where community sign language interpreters can participate, as well as ways in which other remote services, online medical treatment and distance education, can harmonize with the Web-based VRI system.

Technical Paper ITU-T FSTP-ACC-Rural (2023) "Use cases of accessibility to multimedia systems in rural and out-of-home environments" (https://www.itu.int/pub/publications.aspx?lang=en&parent=T-TUT-FSTP-2023-ACC.RURAL) describes the use cases of interactive mobile digital unit in rural and out of home environments, especially in developing countries.

ITU-T SG9 is studying accessibility to cable TV systems and services under its Question 11/9, which is progressing a draft new Recommendation on *"Common user profile format for audiovisual content distribution"* (J.acc-us-prof) and the group completed a new technical report TR.CUP (2023) "Concept of a common user profile format used to personalize audiovisual media" (https://www.itu.int/pub/T-TUT-FSTP-2023-1)

More info on Q11/9: https://www.itu.int/itu-t/workprog/wp_search.aspx?Q=11/9

ITU-T SG20 "Internet of things (IoT) and smart cities and communities (SC&C)" also developed Recommendation ITU-T Y.4204 "Accessibility requirements for IoT applications and services": https://www.itu.int/rec/T-REC-Y.4204-201902-I/en, Recommendation ITU-T Y.4211 "Accessibility requirements for smart public transportation services": https://www.itu.int/ITU-T/workprog/wp_item.aspx?isn=14646 and Recommendation ITU-T Y.4219 on "Accessibility requirements for user interface of smart applications supporting IoT": https://www.itu.int/ITU-T/workprog/wp_item.aspx?isn=17948. ITU-T SG20 is currently working on draft Recommendation on "Requirements and capabilities of accessible service management using user accessibility preference profile for IoT services" (Y.ACC-ASM), draft Recommendation on "Accessibility requirements for metaverse services supporting IoT" (Y.ACC-IoTMV), draft Recommendation on "Requirements and capabilities of a digital twin for pedestrian accessibility facilities for persons with disabilities" (Y.dt-PAF), draft Recommendation on "Functional architecture of IoT-enabled smart accessibility service in smart communities" (Y.IoT-SAS) and draft Technical Report on "Guidelines on developing ICT services for accessible smart cities" (YSTR.ACC-SCC).

More info: https://itu.int/go/tsg20

ITU, together with other UN agencies, developed a Toolkit on Digital Transformation for People-Oriented Cities and Communities. The resources contained in this Toolkit include international standards and guidance, the latest research and projections, and cutting-edge reports on a variety of timely topics relevant to the digital transformation of cities and communities. The toolkit contains a module on "Connectivity, Digital Divide and Digital Inclusion" and "Accessibility and Digital Inclusion".

More info: https://toolkit-dt4c.itu.int/

The Radiocommunication Assembly 2023 (RA-23) updated and approved Resolution ITU-R 67-2 on "Telecommunication/ICT accessibility for persons with disabilities and persons with specific needs". In response to this Resolution, ITU-R Study Groups continue to conduct studies and research to develop guidelines and recommendations related to telecommunication/ICT accessibility for persons with disabilities and persons with specific needs, in cooperation with ITU-T and ITU-D.

ITU-R SG 6 is responsible for Accessibility systems for broadcasting and the latest umbrella document is Report ITU-R BT.2207 on "Accessibility to broadcasting services for persons with disabilities. This Report describes methods of making programmes accessible for people with hearing disabilities, sight impairment and any other problems that an aging audience may experience.

During the 2019-2023 study period, ITU-R Study Group 6 updated the following publications:

Recommendation ITU-R BT.1702 on "Guidance for the reduction of photosensitive epileptic seizures caused by television". The guidance proposed in this Recommendation is for the protection of the vulnerable section of the viewing population who have photosensitive epilepsy, and who are therefore prone to seizures triggered by flashing lights, including certain types of flashing or flickering television images or rapidly changing images or certain types of regular patterns.

Report ITU-R BT.2447 on "Artificial intelligence systems for programme production and exchange". The media conversion technology is used for human-friendly (improved accessibility) broadcasting to assure that the produced programme content is

successfully available to all viewers including visually or hearing-impaired.

Handbook on "Digital Terrestrial Television Broadcasting networks and systems implementation". Chapter 14 of this Report deals with accessibility issues and how it can help those with disabilities.

ITU-R Study Group 6 continues to carry out studies in response to Question ITU-R 145/6 on "Systems for enabling access to broadcast and cooperative media for persons with disabilities".

There is a close collaboration and exchange between ITU-R SG 6 and ITU-D Study Group 1 Question 7/1 on "Telecommunication/ ICT accessibility to enable inclusive communication, especially for persons with disabilities". Healthy cooperation with relevant is ITU-T Study Groups on this subject is also maintained.

From its side, ITU-R Study Group 1 updated and approved Report ITU-R SM.2153 on "Technical and operating parameters and spectrum use for short-range radiocommunication devices". This Report sets out common technical and non-technical parameters for short-range radiocommunication devices (SRDs) among that including wireless applications in healthcare, such as hearing aid, guiding system for the blind and medical implant communications systems (MICS).

ITU-D SG1 Question 7 on "Access to telecommunication/ICT services by persons with disabilities and other persons with specific needs" also works on providing access to telecommunication/ ICT services by persons with disabilities and other persons with specific needs.

There are coordination mechanisms within ITU sectors as well as with organizations outside ITU in terms of accessibility activities:

- Intersector Rapporteur Group Audiovisual Media Accessibility (IRG-AVA) for joint work between ITU-T and ITU-R on audiovisual media accessibility: https://www.itu.int/en/irg/ava
- Joint Coordination Activity on Accessibility and Human Factors (JCA-AHF) for coordination and awareness raising on accessibility and human factors in standardization in ITU each sectors and groups outside ITU: https://www.itu.int/en/ITU-T/jca/ahf

W3C

- W3C Web Content Accessibility Guidelines (WCAG) - accessibility of content, including text, images, audio, video, coding and markup, forms, and other types of media https://www.w3.org/WAI/intro/wcag
- W3C Authoring Tool Accessibility Guidelines (ATAG) - accessibility of code editors, content management systems (CMS), and other software used to create web content https://www.w3.org/WAI/intro/atag
- W3C User Agent Accessibility Guidelines (UAAG) - accessibility of web browsers, media players, and some types of assistive technologies and mobile applications https://www.w3.org/WAI/intro/uaag
- W3C Accessible Rich Internet Applications (WAI-ARIA) - accessibility of dynamic content and applications https://www.w3.org/WAI/intro/aria

Both WCAG 2.0 and WCAG 2.1 continue to co-exist as operational W3C standards. To support harmonization and interoperability, WCAG can also be obtained as:

- ISO/IEC 40500:2012 - currently the same as WCAG 2.0 (update to WCAG 2.2 is being explored by W3C);
- EN 301 549 includes all WCAG 2.1 Success Criteria and Conformance Requirements (fully harmonized). It also applies WCAG 2.1 requirements to Non-Web Software (eg. mobile applications) and Non-Web Documents (e.g. electronic files).

W3C actively maintains WCAG 2 material. This is primarily focused on updating informative material contained within the Understanding and Techniques documents. Additionally, W3C is developing WCAG 3. See https://www.w3.org/WAI/standards-guidelines/wcag/wcag3-intro/ for more information. WCAG 3 will have similar fundamental and specific accessibility requirements as WCAG 2. There will be a different structure, improved conformance model, and broader coverage addressing the needs of people with disabilities. Specific focus continues to be on areas including mobile, cognitive, and low vision accessibility, personalisation, pronunciation, and conformance testing – see https://www.w3.org/WAI.

W3C also provides non-normative technical guidance, such as Techniques for WCAG 2 and Understanding WCAG 2, and WCAG Evaluation Methodology (WCAG-EM)

(C.2) OTHER ACTIVITIES RELATED TO STANDARDISATION

GREENSCENT

TransMedia Catalonia research group has developed the concept of green accessibility as part of the GreenScent project. The concept of green accessibility has been the focus of the GDA (Green Digital Accessibility) Conference, now in its third edition: https://webs.uab.cat/gda/

Relevant publications include an ITU deliverable on an accessible and sustainable metaverse by Sarah McDonagh (https://www.itu.int/en/ITU-T/focusgroups/mv/Documents/List%20of%20FG-MV%20deliverables/FGMV-16.pdf)

WAI-COOP

Completed. Supporting implementation of the EU web accessibility directive and international standards for digital accessibility, including the W3C Web Content Accessibility Guidelines (WCAG) and the EN 301 549. Project in January 2021.

https://www.w3.org/WAI/about/projects/wai-coop/

WAI-GUIDE

Completed. Develops open curricula on web accessibility to help organizations across EU Member States and internationally to develop their own courses, promotes accessibility of authoring tools with focus on specific industries, and develops accessibility use cases for emerging technologies.

https://www.w3.org/WAI/about/projects/wai-guide/

EASY READING

Completed. Researches user needs for cognitive and learning disabilities and develops tooling using personalization techniques in close cooperation with end-users, and exchanges research findings with W3C standardization on cognitive accessibility and personalization

EASY READING – Keeping the user at the digital original

WE4AUTHORS PROJECT

Completed. We4authors is the acronym of "Pilot on web accessibility for web authoring tools producers and communities", a European Pilot Project led by Funka.

It consists of a set of focused initiatives with the most relevant and used licensed and open source CMS in public sector in Europe, that fosters and facilitates the incorporation of accessibility features as the default option in authoring tools.

https://www.funka.com/en/projekt/we4authors/what-is-we4authors/

WAI-TOOLS

Completed. Develops W3C Accessibility Conformance Testing (ACT) Rules to facilitate harmonized accessibility testing across EU Member States and internationally, and develops demonstrator monitoring in Portugal and Norway as examples for other EU Member States https://www.w3.org/WAI/about/projects/wai-tools/

WAI ACT

Completed. A cooperation framework for guidance on advanced technologies, evaluation methodologies, and research agenda setting to support eAccessibility

http://www.w3.org/WAI/ACT/

WAI DEV

Completed. Developing strategies to support mainstream production of inclusive components and services and showcasing good practice in inclusive design

http://www.w3.org/WAI/DEV/

AALIANCE2

Completed. Next Generation European Ambient Assisted Living Innovation; FP7 repository of existing standards

http://www.aaliance.eu/node/2

EIII

Completed. European Inclusion Internet Initiative: partners among others including Dutch, Danish, Italian and Iceland governments. The initiative was completed in December 2015

SMART 2014 /0061

Completed. Monitoring methodologies for web accessibility in the European Union. The objective of the study is to collect information on the monitoring methodologies for verification of compliance with web accessibility requirements in the different Member States

PROSPERITY4ALL

Develops the infrastructure and ecosystem that will allow for a ubiquitous auto-personalisation of interfaces and materials, based on user needs and preferences, to grow; it builds on the infrastructure provided by Cloud4All in order to create more parts of the GPII

http://www.prosperity4all.eu

http://www.cloud4all.info/

http://gpii.net/

RAISING THE FLOOR CONSORTIUM

Mission is to make the web and mobile technologies accessible to everyone with disability, literacy and ageing-related barriers, regardless of their economic status

http://raisingthefloor.org

EDF

Plug and Pray? A disability perspective on artificial intelligence, automated decision-making and emerging technologies" report looks at the impact of emerging technologies on the lives of persons with disabilities. It also provides recommendations to industry, policy makers, organisations of persons with disabilities and academia on how to best ensure that the gains of emerging technologies are equally distributed and potential risks avoided/ minimised.

https://www.edf-feph.org/publications/plug-and-pray-2018/

NETEX

Important work on accessibility done in NeTEx, especially the new European Passenger Information Accessibility Profile (EPIAP) and all its national counterparts. See especially NeTEx Part 6 (European Passenger Information Accessibility Profile-EPIAP)

ACCESSIBLE EU CENTRE

The Accessible EU Centre has published and will continue to publish guides and support materials to support the implementation of accessibility in spaces, products and services and to facilitate access knowledge on legislation and standards (including ICT).

https://accessible-eu-centre.ec.europa.eu/index_en

(C.3) ADDITIONAL INFORMATION

Accessibility needs to be ensured in ICT and many other areas (such as emergency communication, digital cinema, e-health, ICT used in public transport, ICT used in tourism, and e-learning, Internet of Things, emerging technologies/artificial intelligence, e-identification and e-governance systems, e-call, e-procurement, e-invoicing, e-payments, smart cities, European electronic toll service, intelligent transport/ automated vehicles, advanced manufacturing, robotics, audiovisual media and telecommunications, etc.) both for users with disabilities in the general public and for staff/entrepreneurs with disabilities in industry or public administration.

For this purpose, accessibility priorities raised in this chapter (3.1.10 Accessibility of ICT products and services) should be mainstreamed in relevant chapters of the Rolling Plan 2024.

The following list has been compiled from views expressed by some Member States and experts in the field. The list is intended to trigger further discussion with all stakeholders on possible future actions***:**

- Investigating accessibility features in standards for e-voting.
- Investigating harmonisation of quality standard for access services in audiovisual media services (subtitles for the deaf and hard of hearing, spoken subtitles, audio description and sign language interpretation).
- Investigating how mobile devices are useful to people with dexterity problems and reduced mobility and other type of disability when interacting with other ICT products and services; widening the scope (i.e. beyond mobile devices) of guidelines related to diminished motor control e.g. people with advanced Parkinson or similar disorders who can hardly or no longer write is also needed
- Applying standardisation of broadcasters accessible interfaces to IP (and other) systems.
- Convergence and interoperability of video relay services.
- Accessible hybrid TV services.
- Specification of requests for translation among languages, image and text representations, particularly those overcoming accessibility issues, e.g voice to text like automation of relay services for telephony and capturing/ subtitling TV transmissions for hearing-impaired people.
- Automatically generated description for blind and partially sighted people,
- Text to sign language, like automatically generated sign language** for deaf and hard of hearing people.
- Identification of accessibility issues, requirements and associated standardisation needs related to:
  - non-literate and dyslexic users; these requirements may turn out to be equally applicable for foreign users unable to understand available user interface languages.
  - security and privacy features of ICT services and devices (see below and sections security and ePrivacy) .
- Explore synergies with the Accessible EU Resource Centre
- Promote knowledge of relevant accessibility standards in ICT education degrees

Users have to use increasingly complex security procedures to access the services that they rely on. Attempts to increase security frequently include mechanisms that many users, particularly those with physical, **sensory** and cognitive disabilities, are unable to successfully handle without adopting highly insecure strategies such as writing down complex usernames and passwords. There is a need to provide standards and guidance on accessible security mechanisms that are compatible with human abilities, and appropriate to the type of service being used. In this context, the benefit of using of new technologies like biometrics or RFID could be evaluated.

This accessibility component of privacy and security issues could be addressed in general development following standardisation requests or, preferably, be mainstreamed in general privacy and security work.

Standards could be evaluated to produce a guide to user-centred terminology for all potential users in several EU languages, focusing on the benefits for those with learning and cognitive disabilities. The preponderance of different names for the same ICT features and functions is confusing for all people, but this can be a significantly more important problem for older users or users with learning and cognitive disabilities. This has a negative impact on individual citizens and on the size of the ICT market. A guide would provide benefits for all potential users, particularly older users and users with learning and cognitive disabilities who are currently partly excluded from benefiting from the use of modern ICT.

*mentioned future actions should be done in close cooperation with users and organisations representing users relevant accessibility measures are aiming to address.

** So long as quality of automatically generated sign language interpretation remains lower than quality of trained human interpreters, these are not preferred measure of ensuring accessibility for deaf and other sign language users. https://2tdzpf2t7hxmggqhq3n-jno1y-wpengine.netdna-ssl.com/wp-content/uploads/2017/02/WFD-and-WASLI-Statement-on-Avatar-FINAL-14032018-Updated-14042018-1.pdf"

(1) http://ec.europa.eu/justice/discrimination/disabilities/disability-strategy/index_en.htm

(2) http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:316:0012:0033:EN:PDF

3.1.9 Artificial Intelligence

A Policy and legislation

(A.1) POLICY OBJECTIVES

We are using AI on a daily basis, e.g. to translate text, generate subtitles for videos or to block email spam. Beyond making our lives easier, AI is helping us to solve some of the world's biggest challenges: from treating chronic diseases or reducing traffic accident (and therefore the fatality rates) to fighting climate change or anticipating cybersecurity threats. Like the steam engine or electricity in the past, AI is transforming our world, our society and our industries.

Since 1950s, the research on AI included a large variety of computing techniques and spread over many different application areas. In recent years, AI has experienced a period of fast development, which is motivated by three main driving factors: the progress in algorithms and computing techniques, the huge amount of available data generated by the advancements in ICT and Internet of Things applications, and the affordability of high-performance processing power, even in low-cost personal devices. These factors have contributed towards the rapid evolution of AI technologies such as large language models, which potentially could have a strong impact on society.

The way of approaching AI will shape the digital future. In order to enable European citizens, companies, governments, etc. to reap the benefits of AI, we need a solid European strategy and framework.

The EU strategy on AI was published on 25th April 2018, in the Commission Communication on Artificial Intelligence for Europe. One of the main elements of the strategy is an ambitious proposal to achieve a major boost in investment in AI-related research and innovation and in facilitating and accelerating the adoption of AI across the economy.

In February 2020 the Commission issued a White Paper on AI. The overall EU strategy proposed in the White Paper on AI proposes an ecosystem of excellence and trust for AI. The concept of an ecosystem of excellence in Europe refers to measures which support research, foster collaboration between Member States and increase investment in AI development and deployment. The ecosystem of trust is based on EU values and fundamental rights, and foresees robust requirements that would give citizens the confidence to embrace AI-based solutions, while encouraging businesses to develop them. The European approach to AI 'aims to promote Europe's innovation capacity in the area of AI, while supporting the development and uptake of ethical and trustworthy AI across the EU economy. AI should work for people and be a force for good in society.

Following a public consultation, the objectives of the White Paper were translated into a key AI package adopted by the Commission on 21 April 2021. This package includes a proposal for the first ever legal framework on AI (the AI Act), which addresses the risks of AI and positions Europe to play a leading role globally and the 2021 review of the Coordinated Plan.

The proposal for a legal framework is aimed at laying down rules to ensure that AI systems used in the EU are safe and do not compromise fundamental rights.

The 2021 Review of the Coordinated Plan on AI puts forward a concrete set of joint actions for the European Commission and Member States on how to create EU global leadership on trustworthy AI. Standardisation activities are one of the action areas identified in the 2021 Coordinated Plan as an area for joint action between the European Commission and Member States.

In December 2023, the colegislators reached an agreement on the AI Act which entered into force on 1 August 2024.

The European Commission will now monitor the correct implementation of the legislation through the newly established AI Office. The AI Office aims at enabling the future development, deployment and use of AI in a way that fosters societal and economic benefits and innovation, while mitigating risks. The Office will play a key role in the implementation of the AI Act, especially in relation to general-purpose AI models. It will also work to foster research and innovation in trustworthy AI and position the EU as a leader in international discussions.

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

The big increase in interest and activities around AI in the latest years brings together a need for the development of a coherent set of AI standards. In response to this, international and European standardisation alike have created committees on AI, including CEN-CENELEC JTC 21, ETSI OCG AI and ISO/IEC JTC 1/SC 42.

In addition, the AI Act is set as a New Legislative Framework-type legislation. Hence, the role of harmonised standards will be key to providing detailed technical specifications through which economic operators can achieve compliance with the relevant legal requirements. Harmonised standards will thus be a key tool for the implementation of the legislation and contribute to the specific objective of ensuring that that AI systems are safe and trustworthy.

As a consequence of this, the European Commission intends to intensify the elaboration of standards in the area of AI to ensure that standards are available to operators on time ahead of the application date of the future AI framework. In this respect, the Commission issued a first standardisation request to CEN and CENELEC in accordance with Regulation (EU) 1025/2012 in May 2023. Harmonised standards developed in response to that request will help companies to comply with the legal requirements of the AI Act. In early 2025, the Commission plans to issue an amended standardisation request to take into account the wording of the AI legislation as adopted and published in the OJEU. Other standardisation requests on energy efficiency and general-purpose AI models are also in preparation for the second half of 2025.

(A.3) REFERENCES

- Regulation (EU) 2024/1689 of the European Parliament and of the Council of 13 June 2024 laying down harmonised rules on artificial intelligence (Artificial Intelligence Act)
- COM(2020) 65 final: White Paper On Artificial Intelligence - A European approach to excellence and trust
- COM(2018) 237:Artificial Intelligence for Europe
- EC High-Level Expert Group on Artificial Intelligence (AI HLEG): Ethics Guidelines for Trustworthy Artificial Intelligence (AI)
- Coordintated plan on artificial intelligence, 2021 review
- C(2023)3215 – Standardisation request M/593: AI Standardisation Request

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

ACTION 1: SDOs should establish coordinated linkages with, and adequately consider European requirements or expectations from initiatives, including policy initiatives, and organisations contributing to the discourse on AI standardisation. This in particular includes the contents of the AI Act, the standardisation request on AI issued by the European Commission in 2023, its amendment, as well as the orientations set in the 2021 review of the Coordinated Plan.

ACTION 2: SDOs should further increase their coordination efforts around AI standardisation both in Europe and internationally in order to avoid overlap or unnecessary duplication of efforts and aim to the highest quality to avoid the creation and use of discriminating algorithms and to ensure a trustworthy and safe deployment of this technology.

ACTION 3: ESOs should coordinate with the Commission and appropriately direct their activities to ensure that the objectives set in the standardisation request on AI issued in 2023 (and its amendment) are adequately and timely fulfilled. This includes ensuring active participation of representatives from SMEs and civil society organisations in their activities.

ACTION 4: SDOs to take into account the cross-sectorial aspects of the AI Act and the interactions between the AI Act and existing or future sectorial safety legislation.

ACTION 5: EC and ESOs should coordinate to promote mobilisation of stakeholders around AI standardisation activities.

ACTION 6: Taking into account the gap analysis by EC/JRC, EC/JRC to coordinate with SDOs and other initiatives on a follow-up and ways to address the identified gaps.

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

CEN & CENELEC

A CEN-CENELEC Focus Group on Artificial Intelligence (AI) was first established in December 2018. The Focus Group published two

documents: a response to the EC white paper on AI as well as the CEN-CENELEC Roadmap for AI standardisation. Subsequently, CEN-CENELEC created a Joint Technical Committee, namely CEN-CENELEC JTC 21, which started its activities on 1 June 2021.

JTC 21 is producing standardisation deliverables in the field of Artificial Intelligence (AI) and related use of data, as well as providing guidance to other technical committees concerned with Artificial Intelligence. JTC 21 plays a crucial role in developing European Standards for AI technologies, addressing the unique needs and requirements of the European market and societal context. By developing harmonised standards, JTC 21 aims to support the implementation of AI systems that are technologically advanced and align with European values and the AI Act.

CEN and CENELEC have accepted the standardisation request on Artificial Intelligence from the European Commission. In this context, CEN-CLC/JTC 21 is currently developing European standards which will be able to provide manufacturers the presumption of conformity with the newly adopted Artificial Intelligence Act (AIA).

Five working groups operate under CEN-CENELEC JTC 21:

WG 1: Strategic Advisory Group (SAG),
WG 2: Operational aspects,
WG 3: Engineering aspects,
WG 4: Foundational and societal aspects,
WG 5: Joint standardization on Cybersecurity for AI systems.

The committee is developing homegrown European standards in support of the AI Act, including:

- AI Trustworthiness Framework
- AI Risk Management
- AI Quality Management System
- AI Conformity Assessment

For an overview of the work program to see the status of the standards under development, see the CEN-CLC/JTC 21 technical work page.

Additionally, a Task Group led by the European Trade Union Confederation (ETUC), and working under the Strategic Advisory Group in JTC 21/WG 1, publishes the "AI Standardization Inclusiveness" Newsletter to inform about the latest developments and decisions in JTC 21 and in the European AI community. Previous editions can be found here.

ETSI

In addition to CEN and CENELEC, ETSI is also active in the use of AI in ICT and coordinates work across a dozen technical bodies using the OCG AI (Operational Coordination Group for AI). A summary of current work on AI can be found in a dedicated white paper. The OCG AI is also in continual discussion with CEN-CENELEC JTC21.

ETSI TC HF (Human Factors) is organising works on the topic of human oversight and transparency/explainability of AI solutions, including also accessibility of explanations to all segments of society (user-oriented explanations for persons with varying physical/mental capabilities). This work also includes requirements for (future) human-AI collaborative systems for example in manufacturing processes.

The ETSI ISG on Experiential Networked Intelligence (ENI) is defining a Cognitive Network Management architecture. This is using Artificial Intelligence (AI) techniques and context-aware policies to adjust offered services based on changes in user needs, environmental conditions and business goals. ISG ENI outputs centre around network optimization & Cognitive Network Management architecture highlighted in https://eniwiki.etsi.org/index.php?title=ISG_ENI_Activities. This is described further in the whitepaper (https://www.etsi.org/images/files/ETSIWhitePapers/etsi-wp44_ENI_Vision.pdf) and a whitepaper on cognitive management (https://www.etsi.org/images/files/ETSIWhitePapers/ETSI_WP51_Understanding_the_Operator_Experience_Using_Cognitive_Manage.pdf). ISG ENI has published many GRs and GSs in the Field of AI Cognitive Network Management for global availability.

The ETSI ISG on Securing Artificial Intelligence (ISG SAI), created in October 2019, focused on three key areas: using AI to enhance security, mitigating against attacks that leverage AI, and securing AI itself from attack. ISG SAI collaborated closely with ENISA. ISG SAI outputs have centered around several key topics and the following have been published or are in development to date in part in response to Action 5 above:

- Problem Statement
- Mitigation Strategy
- Data Supply Chain
- Threat Ontology for AI, to align terminology
- Security testing of AI
- Role of hardware in security of AI
- Explainability and transparency of AI processing
- Privacy and security aspects of AI/ML systems
- Traceability of AI models
- Automated Manipulation of Multimedia Identity Representations
- Collaborative Artificial Intelligence (also know as Generative AI)
- Proofs of Concepts Framework.

The ETSI SAI work programme can be found at: https://portal.etsi.org/Portal_WI/form1.asp?tbid=877&SubTB=877

In September 2023 the ETSI TC SAI was created. ISG SAI was turned into TC SAI and work continues now only at the level of the new TC.

ETSI has several other ISGs working in the domain of AL/ML (Machine Learning). They are all defining specifications of functionalities that will be used in technology.

- ISG ENI develops standards that use AI mechanisms to assist in the management and orchestration of the network.
- ISG ENI is defining AI/ML functionality that can be used/reused throughout the network, cloud and end devices.
- ISG ZSM is defining the AI/ML enablers in end-to-end service and network management.
- ISG F5G on Fixed 5G is going to define the application of AI in the evolution towards 'fibre to everything' of the fixed network.
- ISG NFV on network functions virtualisation studies the application of AI/ML techniques to improve automation capabilities in NFV management and orchestration. GS NFV-IFA 047 defines the use of Management Data Analytics (MDA) Function (MDAF), corresponding service interfaces produced by the MDAF, and related information elements.
  GR NFV-EVE 027 studies Model-as-a-Service (MaaS) for AI-based applications and identifies relevant use cases in NFV.
- ISG CIM has published specifications for a data interchange format (ETSI CIM GS 009 V1.7.1 NGSI-LD API) and a flexible

information model (ETSI CIM GS 006 V1.2.1) that support the exchange of information from e.g. knowledge graphs, including relationships between entities and signing of information to guarantee the origins. The work is applicable to exchange of data/metadata with AI solutions, including storage of historical results for later (human) oversight and governance in the context of the AI ACT. Additionally, it has published ETSI CIM GR 021, which describes property-graphs-based approaches to machine learning, able to leverage additional information coming from the graph's relationships, supported by NGSI-LD.

- The ETSI TC MTS provides technologies, tools, and guidelines on conformance and interoperability testing and certification of protocols and other systems, including AI systems, that are under standardisation at various ETSI groups and committees.

IEC

SEG 10 Ethics in Autonomous and Artificial intelligence Applications

https://www.iec.ch/dyn/www/f?p=103:186:0::::FSP_ORG_ID,FSP_LANG_ID:22827,25

ISO/IEC JTC 1

ISO/IEC JTC 1 SC 42 Artifical intelligence

SC 42 Artificial Intelligence is looking at the international standardisation of the entire AI ecosystem. With 33 published standards and 36 current projects under development and 6 working groups, the program of work has been growing rapidly and continues to grow in 2025.

The structure of SC 42 is composed of 10 Working Groups:

- WG1: Foundations standards
- WG2: Data
- WG3: Trustworthiness
- WG4: Use cases and applications
- WG5: Computational approaches and computational characteristics of AI systems
- JWG 2: Joint Working Group ISO/IEC JTC1/SC 42 - ISO/IEC JTC1/SC 7 : Testing of AI-based systems
- JWG 3: Joint Working Group ISO/IEC JTC1/SC42 - ISO/TC 215 WG : AI-enabled health informatics
- JWG 4: Joint Working Group ISO/IEC JTC1/SC42 - IEC TC65/SC65A: Functional safety and AI systems
- JWG 5: Joint Working Group ISO/IEC JTC1/SC42 - ISO/TC 37 WG: Natural language processing
- JWG 6: Joint Working Group ISO/IEC JTC1/SC42 - ISO/CASCO: Conformity assessment schemes for AI systems

The following AdHoc Groups have also been created:

- AHG 4: Liaison with SC 27
- AHG 7: JTC1 joint development review (to ensure coordination with CEN-CENELEC JTC 21 on projects under the Vienna agreement)

An advisory Group has also been created on the topic of AI & Sustainability:

- JAG: Joint Advisory Group on AI and Sustainability with ISO/IEC JTC 1/SC 39

The list of published standards and projects under development can be found in:

Published standards: https://www.iso.org/committee/6794475/x/catalogue/p/1/u/0/w/0/d/0

- Projects under development: https://www.iso.org/committee/6794475/x/catalogue/p/0/u/1/w/0/d/0

In addition to the above projects under development, a number of ad hoc groups in the SC 42 WGs are studying topics that cross multiple areas such as:

a) machine learning computing devices

b) ontologies, knowledge engineering, and representation

c) data quality governance framework

d) testing of AI systems

e) AI standards landscape and roadmap

f) coordination with JTC 1 SC 27 on AI security and privacy proposed standards

g) data quality visualization

In addition, SC 42 has developed over 30 active liaisons with ISO and IEC committees, SDOs and industry organizations to encourage collaboration and build out the industry ecosystem around AI and Big Data.

ISO/IEC JTC 1 SC 7 - Software and systems engineering

ISO/IEC 25012:2008 Software engineering — Software product Quality Requirements and Evaluation (SQuaRE) — Data quality model

ISO/IEC TR 29119-11:2020 Software and systems engineering — Software testing — Part 11: Guidelines on the testing of AI-based systems.

IEEE

IEEE has a significant amount of activity in the fields of Autonomous and Intelligent Systems (A/IS) and related vertical industry domains. IEEE standards and pre-standards address: ethical and societal implications of artificial intelligence; foundational concepts, architecture and ontology; governance and management; data; trustworthiness; etc.

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Ethical and Societal Implications:

IEEE's Global Initiative on Ethics of Autonomous and Intelligent Systems developed "Ethically Aligned Design (EAD): A Vision for Prioritizing Human Wellbeing with Autonomous and Intelligent Systems," which served as the foundation for many other organizations' AI principles and the IEEE 7000 Series. The Global Initiative 2.0 now inspires a new paradigm for AI governance that shifts from merely mitigating risks to proactively embedding a "Safety First Principle" and "Safety by Design" into AI's design and lifecycle assessment, including for generative AI.

- IEEE 7000 Model Process for Addressing Ethical Concerns During System Design
- IEEE 7001, Transparency of Autonomous Systems
- IEEE 7002, Data Privacy Process

- IEEE 7005 Transparent Employer Data Governance
- IEEE 7007, Ontological Standard for Ethically Driven Robotics and Automation Systems
- IEEE 7009, Fail-Safe Design of Autonomous and Semi-Autonomous Systems
- IEEE 7014, Ethical considerations in Emulated Empathy in Autonomous and Intelligent Systems
- IEEE P7003, Algorithmic Bias Considerations
- IEEE P7004, Child and Student Data Governance
- IEEE P7008, Ethically Driven Nudging for Robotic, Intelligent and Autonomous Systems
- IEEE P7011, Process of Identifying and Rating the Trustworthiness of News Sources
- IEEE P7012, Machine Readable Personal Privacy Terms
- IEEE P7015, Data and Artificial Intelligence (AI) Literacy, Skills, and Readiness

IEEE 7000 ethical and governance standards are made available here for free to support widespread AI literacy.

The IEEE CertifAIEd Program: Through certification guidance, assessment and independent verification, IEEE CertifAIEd offers the ability to scale responsible innovation implementations, thereby helping to increase the quality of AIS, the associated trust with key stakeholders, and realizing associated benefits.

Foundational Concepts, Architecture, Ontology

- IEEE 1872 Series for Robotics and Automation
- IEEE 2755 Series on Intelligent Process Automation
- IEEE 3079.3, Framework for Evaluating the Quality of Digital Humans
- IEEE 3652.1, Architectural Framework and Application of Federated Machine Learning
- IEEE 11073-10101, IEEE/ISO/IEC International Standard—Health informatics-Device interoperability-Part 10101: Point-of-care medical device communication-Nomenclature
- IEEE 2894, Architectural Framework for Explainable Artificial Intelligence

Governance and Management

- IEEE 1232 Series for Artificial Intelligence Exchange and Service Tie to All Test Environments (AI-ESTATE)
- IEEE 2089, Age Appropriate Digital Services Framework - Based on the 5Rights Principles for Children
- IEEE 2830, Technical Framework and Requirements of Shared Machine Learning
- IEEE 2841, Framework and Process for Deep Learning Evaluation
- IEEE 2941, Artificial Intelligence (AI) Model Representation, Compression, Distribution, and Management
- IEEE P2247.1, Classification of Adaptive Instructional Systems
- IEEE P2802, Performance and Safety Evaluation of Artificial Intelligence Based Medical Device: Terminology
- IEEE P2840, Responsible AI Licensing
- IEEE P2863, Recommended Practice for Organizational Governance of Artificial Intelligence
- IEEE P2937, Performance Benchmarking for AI Server Systems
- IEEE P3119, Procurement of Artificial Intelligence and Automated Decision Systems
- IEEE P3394, Large Language Model Agent Interface

Trustworthiness, namely security, quality, transparency, bias, and accuracy, include:

- IEEE 2801, Quality Management of Datasets for Medical Artificial Intelligence
- IEEE P2751, 3D Map Data Representation for Robotics and Automation
- IEEE P3156, Requirements of Privacy-preserving Computation Integrated Platforms
- IEEE P3157, Vulnerability Test for Machine Learning Models for Computer Vision Applications
- IEEE P3181, Trusted Environment Based Cryptographic Computing
- IEEE P3187, Framework for Trustworthy Federated Machine Learning
- IEEE P3198, Evaluation Method of Machine Learning Fairness

Other aspects of ML and other AI techniques:

- IEEE 1855, Fuzzy Markup Language
- IEEE 1873, Robot Map Data Representation for Navigation
- IEEE 3079.3.1, Service Application Programming Interfaces (APIs) for Digital Human Authoring and Visualization
- IEEE 3129, Standard for Robustness Testing and Evaluation of Artificial Intelligence (AI)-based Image Recognition Service
- IEEE 3333.1.3, Deep Learning-Based Assessment Of Visual Experience Based On Human Factors
- IEEE 12207.2, Systems and software engineering - Software life cycle processes—Part 2: Relation and mapping between ISO/IEC/IEEE 12207:2017 and ISO/IEC 12207:2008
- IEEE P2874, Spatial Web Protocol, Architecture and Governance
- IEEE P2975 Series on Industrial Artificial Intelligence
- IEEE P2976, XAI—eXplainable Artificial Intelligence—for Achieving Clarity and Interoperability of AI Systems Design
- IEEE P2986, Privacy and Security for Federated Machine Learning
- IEEE P2987, Principles for Design and Operation Addressing Technology-Facilitated Inter-personal Control
- IEEE P3109, Arithmetic Formats for Machine Learning
- IEEE P3110, Computer Vision (CV)—Algorithms, Application Programming Interfaces (API), and Technical Requirements for Deep Learning Framework
- IEEE P3123, AI and ML Terminology and Data Formats
- IEEE P3127, Architectural Framework for Blockchain-based Federated ML
- IEEE P3128, Evaluation of AI Dialogue System Capabilities

- IEEE P3142, Distributed Training and Inference for Large-scale Deep Learning Models
- IEEE P3152, Description of the Natural or Artificial Character of Intelligent Communicators
- IEEE P3168, Robustness Evaluation Test Methods for a NLP Service that uses ML
- Standards on Knowledge Graphs (IEEE 2807 Series, IEEE P3154)

For more information, visit https://ieee-sa.imeetcentral.com/eurollingplan/.

IETF

The IETF Autonomic Networking Integrated Model and Approach Working Group will develop a system of autonomic functions that carry out the intentions of the network operator without the need for detailed low- level management of individual devices. This will be done by providing a secure closed-loop interaction mechanism whereby network elements cooperate directly to satisfy management intent. The working group will develop a control paradigm where network processes coordinate their decisions and automatically translate them into local actions, based on various sources of information including operator-supplied configuration information or from the existing protocols, such as routing protocol, etc.

Autonomic networking refers to the self-managing characteristics (configuration, protection, healing, and optimization) of distributed network elements, adapting to unpredictable changes while hiding intrinsic complexity from operators and users. Autonomic Networking, which often involves closed-loop control, is applicable to the complete network (functions) lifecycle (e.g. installation, commissioning, operating, etc). An autonomic function that works in a distributed way across various network elements is a candidate for protocol design. Such functions should allow central guidance and reporting, and co-existence with non-autonomic methods of management. The general objective of this working group is to enable the progressive introduction of autonomic functions into operational networks, as well as reusable autonomic network infrastructure, in order to reduce operating expenses.

https://wiki.ietf.org/en/group/iab/Multi-Stake-Holder-Platform#h-319-artificial-intelligence

ITU

AI for Good is the leading **United Nations** platform for global and inclusive dialogue on AI. The Summit is hosted each year in Geneva by the ITU in partnership with 40 UN Sister agencies. More info: https://aiforgood.itu.int.

ITU-T SG11 is developing ITU-T Recommendations implementing AI in signalling exchange, protocols and testing. ITU-T SG11 approved Recommendation ITU-T Q.5023 "Protocol for managing intelligent network slicing with AI-assisted analysis in IMT-2020 network". Among ongoing work there are protocol for managing energy efficiency with AI-assisted analysis in IMT-2020 networks and beyond; signalling requirements and architecture to support AI based vertical services in future network, IMT2020 and beyond; methods and metrics for monitoring ML/AI in future networks including IMT-2020; data management interfaces for intelligent edge computing-based smart agriculture service.

ITU-T Study Group 13 approved various ITU-T Recommendations covering AI-based networks as well as machine learning in future networks and IMT-2020, including use cases, architectural frameworks, quality of service assurance, service provisioning, data handling, learning models, network automation for resource and fault management, marketplace integration, cloud computing, Quantum key distribution networks (e.g. Recommendations ITU T Y.3142, Y.3170, Y.3172; Y.3173, Y.3174, Y.3175, Y.3176, Y.3177, Y.3178, Y.3179, Y.3180-Y.3186, Y.3325, Y.3531, Y.3550, Y.3654, Sup 55 to Y.3170-series and Sup 70 to Y.3800-series. More info: https://www.itu.int/en/ITU-T/focusgroups/ml5g/Pages

SG13 continues development of Recommendations on the above topics as well as ML for big data driven networking, ML as a tool to better shape traffic, man-like networking. Also, in the framework of 5G, SG13 studies ML and AI to enhance QoS assurance, network slicing, operation management of cloud services, integrated cross-domain network architecture, network automation, framework of user-oriented network service provisioning. It also maintains the AI standards roadmap, Supplement 72 to Y.3000-series, which has a matrix of different document types per vertical versus the related technologies for supporting AI. For more info contact tsbsg13@itu.int.

ITU has been at the forefront to explore how to best apply AI/ML in future networks including 5G networks. To advance the use of AI/ML in the telco industry, ITU launched the AI/ML in 5G Challenge in March 2020. The Challenge rallies like-minded students and professionals from around the globe to study the practical application of AI/ML in emerging and future networks. It also enhances the community driving standardization work for AI/ML, creating new opportunities for industry and academia to influence international standardization. The Challenge solutions can be accessed in several repositories on the Challenge GitHub: https://github.com/ITU-AI-ML-in-5G-Challenge.

Since its inception in 2020, the Challenge has grown to encompass other areas relevant to accelerate the achievement of sustainable development goals. The Challenge therefore has the following areas:

- AI/ML in 5G Challenge: https://aiforgood.itu.int/about-ai-for-good/aiml-in-5g-challenge/
- GeoAI Challenge: https://aiforgood.itu.int/about-ai-for-good/geoai-challenge/
- TinyML Challenge: https://aiforgood.itu.int/about-ai-for-good/tinyml-challenge/

ITU-T Study Group 12 (performance, QoS and QoE) offers guidance for the development of machine learning based solutions for QoS/QoE prediction and network performance management in telecommunication scenarios (Recommendation ITU-T P.1402). ITU-T P.565 describes a framework for the creation and performance testing of machine learning based models for the assessment of transmission network impact on speech quality for mobile packet-switched voice services. ITU-T P.565.1 is the first standardized instantiation of the framework. ITU-T E.475 introduces a set of guidelines for intelligent network analytics and diagnostics. SG12 has developed and standardized several quality models leveraging machine learning techniques for the objective estimation of dimensions of QoS and QoE.

AI for Road Safety: The ITU, together with the UN Secretary-General's Special Envoy for Road Safety and the Envoy on Technology, launched the initiative on ***AI for Road Safety***, which is in line with the UN General Assembly Resolution (UN A/RES/74/299) on Improving global Road Safety, which highlights

the role of innovative automotive and digital technologies. AI for Road Safety aims to leverage the use of AI for enhancing the safe system approach to road safety.

The new initiative supports achieving the UN SDG target 3.6 to halve by 2030 the number of global deaths and injuries from road traffic accidents, and the SDG Goal 11.2 to provide access to safe, affordable, accessible and sustainable transport systems for all by 2030. See:

https://aiforgood.itu.int/event/ai-for-road-safety/

https://aiforgood.itu.int/about/ai-ml-pre-standardization/ai4roadsafety/

ITU-T SG20 approved Recommendation ITU-T Y.4470 "Reference architecture of artificial intelligence service exposure for smart sustainable cities" that introduces AI service exposure (AISE) for smart sustainable cities (SSC), and provides the common characteristics and high-level requirements, reference architecture and relevant common capabilities of AISE, Recommendation ITU-T Y.4494 "Reference architecture of collaborative decentralized machine learning for intelligent IoT services", and agreed Supplement ITU-T Y.Suppl.63 "Unlocking Internet of things with artificial intelligence" that examines how artificial intelligence could step in to bolster the intent of urban stakeholders to deploy IoT technologies and eventually transition to smart cities. ITU-T SG20 is currently working on draft Recommendation ITU-T Y.RA-FML "Requirements and reference architecture of IoT and smart city & community service based on federated machine learning", draft Recommendation ITU-T Y.SF-prediction "Service framework of prediction for intelligent IoT", draft Supplement to ITU-T Y.4223 - Use cases of smart cities and communities supported by AI, draft Recommendation ITU-T Y.AIoT-fr Framework of Artificial Intelligence of Things, draft Recommendation ITU-T Y.AIoT-FRA Functional requirements and architecture for Artificial Intelligence of Things, draft Recommendation ITU-T Y.AIoT-dfs-arc Reference architecture of data fusion service in artificial intelligence of things, draft Recommendation ITU-T Y.AIoT-dpsm Requirements and framework of data processing for smart manufacturing with Artificial Intelligence of Things, and draft Technical Report ITU-T YSTR.GenAI-Sem-Interop Implications of Generative Artificial Intelligence on Semantic Interoperability for Data Use.

More info: https://itu.int/go/tsg20

ITU also coordinates the United for Smart Sustainable Cities (U4SSC) Initiative, which is a UN initiative that develops action plans, technical specifications, case studies, guidelines and offer policy guidance for cities to become smarter and more sustainable. The U4SSC Initiative is currently working on a Thematic Group on "Artificial Intelligence in Cities". U4SSC deliverable on Guiding principles for artificial intelligence in cities along with 5 case studies were published in February 2024.

More info: https://u4ssc.itu.int/

ITU-T Study Group 5 develops international standards, guidelines, technical papers and assessment frameworks that support the sustainable use and deployment of ICTs and digital technologies, and evaluate the environmental performance, including biodiversity, of digital technologies such as, but not limited to, 5G, artificial intelligence (AI), smart manufacturing, automation, etc. ITU-T SG5 approved Recommendation ITU-T L.1305 "Data centre infrastructure management system based on big data and artificial intelligence technology". This standard contains technical specifications of a data centre infrastructure management (DCIM) system, covering: principles, management objects, management system schemes, data collection function requirements, operational function requirements, energy saving management, capacity management for information and communication technology (ICT) and facilities, other operational function requirements and intelligent controlling on systems to maximize green energy use. Other aspects such as maintenance function requirements, early alarm and protection based on big data analysis and intelligent controlling on systems to decrease the cost for maintenance are also considered. Additionally, it has produced the following supplements: L Suppl. 48: Data centre energy saving: Application of artificial intelligence technology in improving energy efficiency of telecommunication room and data centre infrastructure and L Suppl. 53: Guidelines on the implementation of environmental efficiency criteria for artificial intelligence and other emerging technologies

More info: https://itu.int/go/tsg5

The Focus Group on Environmental Efficiency for Artificial Intelligence and other emerging technologies (FG-AI4EE) concluded in December 2022 and identified the standardization needs to develop a sustainable approach to AI and other emerging technologies. The FG-AI4EE developed 21 technical reports and specifications on requirements, assessment and measurement and implementation guidelines of AI and other emerging technologies.

More info: https://itu.int/go/fgai4ee

The ITU-T Focus Group on AI for Autonomous and Assisted Driving (FG-AI4AD) aims to develop a definition of minimal performance threshold for AI systems that are responsible for the driving tasks in vehicles, so that an automated vehicle always operates safely on the road, at least as a competent and careful human driver. The Focus Group has completed the Technical Report on "Automated driving safety data protocol – Ethical and legal considerations of continual monitoring": https://www.itu.int/pub/T-FG-AI4AD-2021-02 and is in the process of finalizing three additional TRs on related protocol specification, practical demonstrators and benefits of continual monitoring.

More info: https://itu.int/go/fgai4ad

ITU-T Focus Group on Artificial Intelligence (FG-AI4H), established in partnership with ITU and WHO, is working towards to establishing a standardized assessment framework for the evaluation of AI-based methods for health, diagnosis, triage or treatment decisions.
https://www.itu.int/en/ITU-T/focusgroups/ai4h/

The Focus Group on Artificial Intelligence for Natural Disaster Management (FG-AI4NDM) aims to underscore best practices for leveraging AI for supporting data collection modelling across spatiotemporal scales, and providing effective communications in the advent of disasters of natural origin. The activities of this Focus Group are conducted in collaboration with the World Meteorological Organization (WMO) and United Nations Environment Programme (UNEP).

More info: https://itu.int/go/fgai4ndm

Established by ITU-T SG20, ITU-T Focus Group on Artificial Intelligence (AI) and Internet of Things (IoT) for Digital Agriculture (FG-AI4A) explores emerging technologies including AI and IoT in data acquisition and handling, modelling from a growing volume of agricultural and geospatial data, and providing communication for the optimization of agricultural production. The activities of

this Focus Group are being conducted in cooperation with Food and Agriculture Organization of the United Nations (FAO).

More info: https://itu.int/go/fgai4a

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More info: https://itu.int/go/fgai4ndm

https://www.itu.int/en/ITU-T/extcoop/ai4resilience/Pages/default.aspx

Established by ITU-T SG20, ITU-T Focus Group on Artificial Intelligence (AI) and Internet of Things (IoT) for Digital Agriculture (FG-AI4A) explores emerging technologies including AI and IoT in data acquisition and handling, modelling from a growing volume of agricultural and geospatial data, and providing communication for the optimization of agricultural production. The activities of this Focus Group were conducted in cooperation with Food and Agriculture Organization of the United Nations (FAO).

More info: https://itu.int/go/fgai4a

ITU-T Focus Group on Artificial Intelligence Native for Telecommunication Networks (FG-AINN) was established by ITU-T Study Group 13 to explore and define the fundamental changes needed in network architecture to fully harness the potential of AI. This focus group, launched in July 2024, seeks to identify the requirements, challenges, and opportunities that AI-native networks will bring to the global communications landscape.

More info: https://www.itu.int/en/ITU-T/focusgroups/ainn/Pages/default.aspx

ITU-R

AI in Radiocommunication Standards: ITU Radiocommunication (ITU-R) Study Groups and forthcoming reports examine the use of AI in radiocommunications:

- ITU-R Study Group 1 covers all aspects of spectrum management, including spectrum monitoring. Question 241/1 looks at "Methodologies for assessing or predicting spectrum availability".
- ITU-R Study Group 6, dedicated to broadcasting services, is also studying AI and ML applications:
  - Question ITU-R 144/6, "Use of AI for broadcasting", considers the impact of AI technologies and how can they be deployed to increase efficiency in programme production, quality evaluation, programme assembly and broadcast emission.
  - Recommendation ITU-R BS.1387: "Method for objective measurements of perceived audio quality". The first application of neural networks, which is now called AI (artificial intelligence), in the field of broadcasting.
  - Report ITU-R BT.2447, "AI systems for programme production and exchange", discusses current applications and near-term initiatives. This Report is being revised regularly to reflect the latest progresses on AI for the applications in broadcasting industry chains.

OASIS

The Coalition for Secure AI (CoSAI) is a project launched at OASIS in mid-2024 by AI stakeholders to collaborate on open tools to identify and mitigate potential vulnerabilities and threats in AI systems, and lead to the creation of systems that are secure-by-design. Its initial deliverables are expected to include: guidance on software supply chain security for AI systems, including the deployment and structure of adequate provenance data, training and risk mitigation processes, and risks associated with integrating or relying on third-party models; expanding cybersecurity vulnerability and threat management methods, detection, and training, to address AI contexts; and developing a risk and controls taxonomy and scorecard for AI risk governance. For more information, see https://github.com/cosai-oasis/oasis-open-project/blob/main/CHARTER.md.

ONEM2M

oneM2M provides a standardized IoT data source for AI/ML applications. Furthermore, the oneM2M work item on "System enhancements to support AI capabilities" (WI-0105) aims to enable oneM2M to utilize Artificial Intelligence models and data management for AI services.

All oneM2M specifications are publicly accessible at Specifications (onem2m.org). See also the section on IoT in the Rolling plan.

W3C

The Web Machine Learning Working Group develops the Web Neural Network API for enabling efficient machine learning inference in web browsers. The Ethical Principles for Web Machine Learning document discusses ethical issues associated with using machine learning and outlines considerations for web technologies that enable related use cases.

The GPU for the Web Working Group develops the WebGPU specification and its companion WebGPU Shading Language to give web applications access to computation capabilities offered by modern GPU cards, allowing them to run AI computations efficiently on the device.

The Web & Networks Interest Group explores solutions for web applications to leverage network capabilities in order to achieve better performance and resources allocation, both on the device and network. The group discusses machine learning acceleration scenarios and requirements in Client-Edge-Cloud coordination Use Cases and Requirements.

(C.2) OTHER ACTIVITIES RELATED TO STANDARDISATION

THE EUROPEAN AI ALLIANCE

https://ec.europa.eu/digital-single-market/en/european-ai-alliance

THE HIGH-LEVEL GROUP ON ARTIFICIAL INTELLIGENCE

https://ec.europa.eu/digital-single-market/high-level-group-artificial-intelligence

AI ON DEMAND PLATFORM

http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/ict-26-2018-2020.html

H2020

R&D&I projects funded within topics ICT-26 from the H2020-ICT-Work Programme 2018-20 can produce relevant input for standardisation.

http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/ict-26-2018-2020.html

STANDICT.EU

This EU funded project produced a standardisation landscape report for the technology area of AI.

This overview or landscape document is a static "snap shot" of a dynamically updated database compiled within StandICT.eu.

The database is inclusive (from many different SDOs and organizations), re-useable (available for liaison to other organisations), filterable (to choose a subset of documents and organisations appropriate to a particular use), and easily exportable (CSV, Word, ODT, Mind-map).

https://www.standict.eu/landscape-analysis-report/landscape-artificial-intelligence-standards

(C.3) ADDITIONAL INFORMATION

EUROPEAN AI ALLIANCE

European AI Alliance is a forum set up by the European Commission engaged in a broad and open discussion of all aspects of Artificial Intelligence development and its impacts. Given the scale of the challenge associated with AI, the full mobilisation of a diverse set of participants, including businesses, consumer organisations, trade unions, and other representatives of civil society bodies is essential. The European AI Alliance will form a broad multi-stakeholder platform, which will complement and support the work of the AI High-Level Group in particular in preparing draft AI ethics guidelines, and ensuring the competitiveness of the European Region in the burgeoning field of Artificial Intelligence. The Alliance is open to all stakeholders. It is managed by a secretariat, and it is already open for registration.

High-Level Expert Group on Artificial Intelligence (AI HLG)

The group has now concluded its work by publishing the following four deliverables:

Deliverable 1: Ethics Guidelines for Trustworthy AI
The document puts forward a human-centric approach on AI and lists 7 key requirements that AI systems should meet in order to be trustworthy.

Deliverable 2: Policy and Investment Recommendations for Trustworthy AI
Building on its first deliverable, the HLEG put forward 33 recommendations to guide trustworthy AI towards sustainability, growth, competitiveness, and inclusion. At the same time, the recommendations will empower, benefit, and protect European citizens.

Deliverable 3: Assessment List for Trustworthy AI (ALTAI)
A practical tool that translates the Ethics Guidelines into an accessible and dynamic self-assessment checklist. The checklist can be used by developers and deployers of AI who want to implement the key requirements. This list is available as a prototype web-based tool and in PDF format.

Deliverable 4: Sectoral Considerations on the Policy and Investment Recommendations
The document explores the possible implementation of the HLEG recommendations, previously published, in three specific areas of application: Public Sector, Healthcare and Manufacturing & Internet of Things.

CAI.

In September 2019, the Committee of Ministers of the Council of Europe set up an Ad Hoc Committee on Artificial Intelligence – CAHAI. The Committee examined the feasibility and potential elements on the basis of broad multi-stakeholder consultations, of a legal framework for the development, design and application of artificial intelligence, based on Council of Europe's standards on human rights, democracy and the rule of law. The committee, which brings together representatives from the Member States, had an exchange of views with leading experts on the impact of AI applications on individuals and society, the existing soft law instruments specifically dealing with AI and the existing legally binding international frameworks applicable to AI. CAHAI finalised its work at the end of 2021 by adopting the final deliverable titled "Possible elements of a legal framework on artificial intelligence, based on the Council of Europe's standards on human rights, democracy and the rule of law" https://rm.coe.int/cahai-2021-09rev-elements/1680a6d90dthat.

Based on results of CAHAI work, Council of Europe has established in 2022 a new Committee for AI – CAI.

CAI drafted and negotiated the text of the Framework Convention on Artificial Intelligence and Human Rights, Democracy and the Rule of Law that was opened for signature on 5 Septembre 2024. It is the first-ever international legally binding treaty for AI and aims to ensure that activities within the lifecycle of artificial intelligence systems are fully consistent with human rights, democracy and the rule of law, while being conducive to technological progress and innovation.

The Framework Convention covers the use of AI systems by public authorities – including private actors acting on their behalf – and private actors. The Framework convention requires states to comply with fundamental rights principles. It puts in place remedies, procedural rights and safeguards, as well as the obligation to carry out risk and impact assessments with the establishment of sufficient prevention and mitigation measures. The Council of Europe also developed a methodology for risk and impact assessments: "the HUDERIA". HUDERIA is a standalone, non-legally binding guidance document that parties to the Framework Convention have the flexibility to use or adapt, in whole or in part, to develop new approaches to risk assessment or to refine existing ones, in accordance with their applicable laws.

CAHAI: https://www.coe.int/en/web/artificial-intelligence/cahai

CAI: https://www.coe.int/en/web/artificial-intelligence/cai

Framework Convention: https://www.coe.int/en/web/artificial-intelligence/the-framework-convention-on-artificial-intelligence

HUDERIA: https://www.coe.int/en/web/artificial-intelligence/huderia-risk-and-impact-assessment-of-ai-systems

AI ON DEMAND PLATFORM

From 2014 to 2020, the European Commission funded a large €20 million project on Artificial Intelligence (AI) under the framework programme on R&D Horizon 2020. It aimed to mobilise the AI community in Europe in order to combine efforts, to develop synergies among all the existing initiatives and to optimise Europe's potential.

The Commission plans to increase its investment in AI further, mainly through two programmes: the research and innovation framework programme Horizon Europe, and the Digital Europe programme.

UNESCO International research centre on Artificial Intelligence (IRCAI)

UNESCO has approved the establishment of IRCAI, which will be seated in Ljublijana (Slovenia). IRCAI aims to provide an open and transparent environment for AI research and debates on AI, providing expert support to stakeholders around the globe in drafting guidelines and action plans for AI. It will bring together various stakeholders with a variety of know-how from around the world to address global challenges and support UNESCO in carrying out its studies and take part in major international AI projects. The centre will advise governments, organisations, legal persons and the public on systemic and strategic solutions in introducing AI in various fields.

AI STUDIES

In addition to the previous initiatives, the Commission is planning to conduct some technical studies about AI. Among them, there will be one specifically targeted to identify safety standardisation needs.

STANDARD SHARING WITH OTHER DOMAINS

AI is a vast scientific and technological domain that overlaps with other domains also discussed in this rolling plan, e.g. big data, e-health, robotics and autonomous systems and so forth. Many of the standardisation activities of these domains will be beneficial for AI and the other way around. For more details, please refer to section "C.1-Related standardisation Activities".

3.1.10 European Global Navigation Satellite System (EGNSS)

A Policy and legislation

(A.1) POLICY OBJECTIVES

The European Global Navigation Satellite System (EGNSS) encompasses the Global Satellite Navigation System established under the Galileo programme and the European Geostationary Overlay Service (EGNOS). Both are included, together with Copernicus and any other future Space-based service, under the EU Space Programme.

Galileo entered Initial Operational Capability (IOC) phase in 2016. Since then, anyone with a Galileo-enabled device, either for leisure or professional purposes, is able to use its signals for positioning, navigation and timing. Currently almost any model of smartphones and tablets on the market are Galileo-enabled, and form an installed base about 4 billion devices.

The Galileo system is currently providing four types of services:

- **Open Service (OS)**: Galileo open and free of charge service set up for positioning and timing services.
- **Public Regulated Service (PRS)**: Service restricted to government-authorized users, for sensitive applications that require a high level of service continuity and robustness.
- **Search and Rescue Service (SAR)**: Europe's contribution to COSPAS-SARSAT, the international satellite-based search and rescue distress alert detection system, boosting the rescue responses thanks to its unprecedented speed and accuracy, and delivering unique features like the Return Link (RLS).
- **High Accuracy Service (HAS)**, a service complementing the OS by providing an additional navigation signal and added-value services in a different frequency band. The HAS signal provides a precision down to 20 cm, globally on Earth.

The **Open Service Navigation Messages Authentication (OSNMA)** will be declared in a short future, and will help to reduce the risk of spoofing by allowing a GNSS receiver to verify to a certain extent the authenticity of the GNSS information and of the entity transmitting it, to ensure that it comes from a trusted source.- Although OSNMA improves the resilience against spoofing it does not completely prevent it because of the fact OSNMA is, as the name implies, based on the unencrypted Open Service (OS) signal of Galileo. Only Galileo PRS provides full and complete protection against spoofing.

EGNOS is Europe's regional satellite-based augmentation system (SBAS) that is used to improve the performance of global navigation satellite systems, such as GPS and soon Galileo. It has been deployed to provide safety of life navigation services to aviation, maritime and land-based users over most of Europe. EGNOS improves the accuracy and reliability of satellite navigation positioning information, while also providing a crucial integrity message regarding the continuity and availability of a signal.

Both Galileo and EGNOS services create extensive socio-economic benefits, and the range of their applications is wide, spanning across numerous market segments and generating value for both public and private sectors. The links between Galileo services and ICT are particularly strong, as satellite navigation services are considered one of the key enabling technologies for ICT, and are becoming increasingly important for the digital. Apart from Satellite navigation, also that GNSS time signals are crucial for navigation on land, at sea, and in the air. Therefore GNSS time signals are essential for the current digital infrastructure. This is the reason to offer a dedicated Timing Service as part of the Galileo Mission.

The objective of the EU is to ensure that Galileo and EGNOS are widely used, and standardisation plays an important role in this process, especially when it comes to downstream market of EGNSS services, which is growing every day. Standards are a powerful tool to support safety-related applications as well as to ensure the interoperability of Galileo services. Introducing or updating standards related to EGNSS downstream applications is therefore a priority.

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

The importance of standardisation in relation to space has been evoked during the public consultation on the Space Strategy for Europe, which ranked standardisation as most important for the market uptake of Galileo and EGNOS. In reaction to this, the European Commission's Space Strategy for Europe, adopted on 26 October 2016, states that "*in longer*

term, the Commission will encourage the uptake of space solutions through standardisation measures and roadmaps".

In 2017, a study on the overview of EGNSS downstream standardisation and assessment of gaps and future needs has been finalised. The study, after consultations with industry stakeholders, standard setting organisations, governments and civil society representatives, identified the most important areas for EGNSS downstream standardisation and outlined some 50 proposals for action. Based on that, DG GROW has identified three priority areas:

- **Intelligent transport (aviation, drones, road, maritime, rail),**
- **Intelligent interconnectivity (location-based services, IoT, 5G), and**
- **Intelligent infrastructures (timing and synchronisation of critical infrastructures, such as energy grids)**

On 3 October 2018, a workshop with Member States and standardisation organisations took place, in which the Commission services discussed the priorities for the EGNSS downstream standardisation. A Staff Working Document taking stock of the various activities in the field of EGNSS downstream standardisation was adopted in December 2019.

EGNSS downstream standardisation has also been highlighted in the EGNSS Work Programme for 2019 and 2020, as well as in the Management Plan 2021 of the Directorate-General for Defence Industry and Space.

(A.3) REFERENCES

- COM(2016) 705 final Space Strategy for Europe
- Staff Working Document "EGNSS downstream standards development" SWD(2019) 454 final
- Management Plan 2021 DG Defence Industry and Space, https://ec.europa.eu/info/system/files/management-plan-defis-2021_en.pdf
- GNSS Market Report, Issue 6
- Overview of EGNSS downstream standardisation and assessment of gaps and future needs to facilitate the integration of Galileo and EGNOS user applications , Valdani Vicari & Associati (VVA), GMV and Lexjus Sinacta (LS), November 2017,
- "Use Galileo" website with the latest information on the Galileo-ready devices in all market segments, https://www.usegalileo.eu/

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

ACTION 1: -5G- SDOs to include the support for signal authentication and position integrity (EGNSS differentiators) in 5G reference architecture, for example through updating of 3GPP Technical Specifications TS 23.501 or TS 22.071

ACTION 2: -IoT- SDOs to update standards related to the IoT reference architecture in order to include signal authentication and position integrity in information exchange and sensor description standards, for example OneM2M TS-001-V2.10.0

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

CEN

CWA 16874:2015 Verification of performance levels of EGNOS Enabled mass-market receivers:

https://standards.cen.eu/dyn/www/f?p=204:110:0::::FSP_PROJECT,FSP_ORG_ID:59362,1923139&cs=19FC4E69741D67095B636AF741017E2E7

CWA 16390:2018 Interface control document for provision of EGNOS/EDAS/multi-GNSS based services for tracking and tracing the transport of goods

https://standards.cen.eu/dyn/www/f?p=204:110:0::::FSP_PROJECT,FSP_ORG_ID:66264,2238989&cs=15C2D155C664EC72312D4BB69624DEBFB

Draft CWA xxxx Verification of performance levels of Galileo Enabled mass-market receivers (under development in CEN & CENELEC Workshop 17):

https://www.cen.eu/news/workshops/Pages/WS-2019-005.aspx

In preparation of the future Galileo Timing Service, a Standard for the Timing Receivers is being developed under CEN/CENELEC.

To this end, a dedicated Working Group was created under JTC5: WG9 "Galileo Timing Receivers".

The development process is close to finalization. Having passed the Enquiry phase with 100% positive votes, the Standard is expected to be published before end 2024.

This will be the first ever Standard for GNSS Timing Receivers in the world.

ETSI 3GPP

Working Group 4 under the Radio Access Network (RAN) Technical Specifications Group (TSG) - Radio performance and protocol

aspects (system) - RF parameters and BS conformance, deals with standards concerning GNSS.

IEEE

IEEE has a number of standards and projects related to the technology that supports and enables Geoscience Remote Sensing and Global Navigation Systems. These include the following:

- IEEE 211, Standard Definitions of Terms for Radio Wave Propagation
- IEEE 1937.1, Standard Interface Requirements and Performance Characteristics of Payload Devices in Drones
- IEEE 2402 Standard Design Criteria of Complex Virtual Instruments for Ocean Observation
- IEEE P1952 Standard for Resilient Positioning, Navigation and Timing (PNT) User Equipment
- IEEE 4003-2021 - IEEE Standard for Spaceborne Global Navigation Satellite System-Reflectometry (GNSS-R) Data and Metadata Content

Series of IEEE 1937.x projects, including:

- IEEE P1937.6, Unmanned Aerial Vehicle (UAV) Light Detection and Ranging (LiDAR) Remote Sensing Operation
- IEEE P1937.7, Unmanned Aerial Vehicle (UAV) Polarimetric Remote Sensing Method for Earth Observation Applications

For more information, see: https://ieee-sa.imeetcentral.com/eurollingplan/.

ITU

ITU-R Working Party (WP) 4C is the responsible group for systems and networks of the radionavigation-satellite service (RNSS), which covers Aeronautical and Maritime radionavigation services.

More info: https://www.itu.int/en/ITU-R/study-groups/rsg4/Pages/default.aspx

ITU-R WP 4C has been regularly revising the following:

- Recommendation ITU-R M.1318 on "Evaluation model for continuous interference from radio sources other than in the radionavigation-satellite service to the radionavigation-satellite service systems and networks operating in the 1 164-1 215 MHz, 1 215-1 300 MHz, 1 559 1 610 MHz and 5 010-5 030 MHz bands"
- Recommendation ITU-R M.1787 on "Description of systems and networks in the radionavigation-satellite service (space-to-Earth and space-to-space) and technical characteristics of transmitting space stations operating in the bands 1 164-1 215 MHz, 1 215-1 300 MHz and 1 559-1 610 MHz".
- Recommendation ITU-R M.1902 on "Characteristics and protection criteria for receiving earth stations in the radionavigation-satellite service (space-to-Earth) operating in the band 1 215-1 300 MHz".
- Recommendation ITU-R M.1903 on "Characteristics and protection criteria for receiving earth stations in the radionavigation-satellite service (space-to-Earth) and receivers in the aeronautical radionavigation service operating in the band 1 559-1 610 MHz"
- Recommendation ITU-R M.1904 on "Characteristics, performance requirements and protection criteria for receiving stations of the radionavigation-satellite service (space-to-space) operating in the frequency bands 1 164-1 215 MHz, 1 215-1 300 MHz and 1 559-1 610 MHz"
- Recommendation ITU-R M.1905 on "Characteristics and protection criteria for receiving earth stations in the radionavigation-satellite service (space-to-Earth) operating in the band 1 164-1 215 MHz"
- Recommendation ITU-R M.1906 on "Characteristics and protection criteria of receiving space stations and characteristics of transmitting earth stations in the radionavigation-satellite service (Earth-to-space) operating in the band 5 000-5 010 MHz"
- Recommendation ITU-R M.2030 on "Evaluation method for pulsed interference from relevant radio sources other than in the radionavigation-satellite service to the radionavigation-satellite service systems and networks operating in the 1 164-1 215 MHz, 1 215-1 300 MHz and 1 559-1 610 MHz frequency bands"
- Recommendation ITU-R M.2031 on "Characteristics and protection criteria of receiving earth stations and characteristics of transmitting space stations of the radionavigation-satellite service (space-to-Earth) operating in the band 5 010-5 030 MHz"
- Report ITU-R M.2220 on "Calculation method to determine aggregate interference parameters of pulsed RF systems operating in and near the bands 1 164-1 215 MHz and 1 215-1 300 MHz that may impact radionavigation-satellite service airborne and ground-based receivers operating in those frequency bands"
- Report ITU-R M.2458 on "Radionavigation-satellite service applications in the 1 164-1 215 MHz, 1 215-1 300 MHz and 1 559-1 610 MHz frequency bands"
- Report ITU-R M.2496 on "Use of RNSS receiver characteristics in assessment of interference from pulsed sources in the 1 164-1 215 MHz, 1 215-1 300 MHz and 1 559-1 610 MHz frequency bands" provides further information on RNSS receiver front end characteristics, including the appropriate usage of these parameters in interference evaluations
- Report ITU-R M.2513 on "Studies regarding the protection of the primary radionavigation-satellite service (space-to-Earth) by the secondary amateur and amateur-satellite services in the frequency band 1 240-1 300 MHz"

The World Radiocommunication Conference 2023 (WRC-23) approved a preliminary agenda item for WRC-31 "to consider possible allocations to the radionavigation-satellite service (space-to-Earth) in the frequency bands [5 030-5 150 MHz and 5 150-5 250 MHz] or parts thereof, in accordance with Resolution **684 (WRC-23)**".

More info: https://www.itu.int/en/ITU-R/study-groups/rsg5/rwp5b/Pages/default.aspx

ITU-T SG15 Question 13/15 is working on "Network synchronization and time distribution performance", which is an important technology for satellite networks. It is working on realizing robust and reliable network synchronization solutions (e.g. as related to GNSS back-up). Technical Report: "GSTR-GNSS - Considerations on the use of GNSS as a primary time reference in telecommunications" was published in July 2020.

More info: https://www.itu.int/net4/ITU-T/lists/q-text.aspx?Group=15&Period=17&QNo=13&Lang=en

https://itu.int/go/tsg15

ITU-T SG2 Question 3/2 is working on a technical report "identify call location for emergency service". GNSS data can help to implement handset based AML(Advanced Mobile Location) solution.

More info: https://itu.int/go/tsg2

ONEM2M AND AIOTI

oneM2M is one of the most relevant IoT architecture definition standards organisation and the EC can address it through its members, such as ETSI or AIOTI, to include the options to support EGNSS differentiators in the reference architectures.

The Alliance for AI, IoT and Edge Continuum Innovation (AIOTI - https://aioti.eu/) associates key industrial players, as well as well-known European research centres, universities, associations and public bodies, and promotes convergence and interoperability of AI, IoT and Edge Continuum, standards. Through its working groups, such as WG Standardisation (https://aioti.eu/standardisation/), AIOTI can support the EC to promote the use of authentication and integrity of EGNSS within AI, IoT and Edge Continuum reference architectures.

On the other hand, the EC may also choose to address ETSI, who is the founding partner of Technical Specification TS-0001, containing information on how to manage location. All oneM2M Technical Specifications and Technical Reports are publicly accessible at: Specifications (onem2m.org)

3.1.11 Quantum Technologies

A Policy and legislation

(A.1) POLICY OBJECTIVES

Quantum Technologies (QT) include a variety of novel concepts with the aim to make use of quantum phenomena as a resource. This includes quantum sensing, quantum imaging, quantum metrology, quantum simulation, quantum communication and quantum computing, as well as quantum enabling technologies. Quantum technologies allow engineering of novel devices and infrastructures with the promise of many new applications in a number of domains that can contribute to the solution of some of today's most pressing social and economic challenges. These technologies enable capabilities beyond any classical technique. Examples include achieving higher sensitivity, lower power consumption and automatic higher security, maintenance-free quantum-referenced operation for more reliable industrial facilities, etc. Furthermore, QT pave the way for novel methods as for instance for earth surveys in times of climate change, exploration of natural resources as well as information transmission and processing, and, specifically, with respect to the last item, novel methods for unprecedented security in communication. QT-based applications are approaching the market and will be a pivotal factor for success in a wide and diverse range of industries and businesses. These technologies are vital to European independence and safety, as the field of information processing, storage, transmission and security at large is affected by them.

In 2018, the European Commission has launched its large-scale and long-term Quantum Flagship research ten-year initiative to support and foster the creation and development of a competitive European quantum technologies industry, as well as the consolidation and expansion of leadership and excellence in European quantum technology research. Along with this initiative, it is important to highlight the EuroHPC Joint undertaking, where quantum computing plays a key role, as well as the EuroQCI initiative, aimed at deploying a Europe wide Quantum communication infrastructure.

Quantum technologies are moving towards technological maturity and wider adoption. From the market perspective, one of the measures to achieve

an accelerated development and uptake has been identified by the Quantum Flagship in its Strategic Research Agenda: the promotion of coordinated, dedicated standardisation and certification efforts. Currently, the industry is relatively fragmented with few to no standards in place. In order for the field to mature and to achieve interoperability between different systems, technologies, ecosystems, and companies, standardisation is a crucial basis. The importance of standardisation has been also echoed by the Strategic Industry Roadmap produced by the European Quantum Industry Consortium.

Standardisation is indeed of paramount importance to facilitate the growth of new technologies, and the development of efficient and effective supply chains. The harmonisation of technologies, methodologies, and interfaces enables interoperable products, innovation, and competition, all leading to structuring and hence growth of markets. As indicated in the review "Towards European Standards for Quantum Technologies" that presents insights from the perspective of the CEN and CENELEC focus group on Quantum Technology (FGQT), as quantum technologies are maturing, time has come to start thinking about further standardisation needs. The deliverables from the FGQT, the Standardization Roadmap on Quantum Technologies and Quantum Technologies Use Cases, have led to the establishment of the CEN-CENELEC Joint Technical Committee 22 (CEN/CLC/JTC 22) on quantum technologies. FGQT's European Standardisation Roadmap on Quantum Technologies is being widely cited, e.g. in ISO/IEC's own upcoming standardisation, related to the IEC-led ISO/IEC JTC 3 on quantum technologies, which mirrors the JTC 22 approach.

In the past, standardisation has often been perceived as standing in contradiction to innovation. On the contrary, standardisation is one of the most adequate and powerful tools to quickly capitalise and disseminate knowledge and have it implemented in the industry. That is to transfer research results to the market. In addition, the standardisation process, as such, is a knowledge sharing and knowledge production process because it serves as a common platform for actors with heterogeneous backgrounds, capacities and knowledge, i.e. research, industry, academia, public administration, and the wider society.

For the Quantum Technologies domain standardisation is not only about requirements setting a basis for certification, but can also address vocabularies, terminologies, quality benchmarks, models, exchange protocols, concerns the complete stack of the quantum devices, from low level hardware components to high level applications and others.

Standards bring along a number of benefits. They enable a reduction of costs and an improvement of efficiency, they define and defragment markets and harmonise supply chains, they ensure the quality, safety, and security of products and/or services, and support compliance with relevant legislation including EU regulations. Standards satisfy customer expectations and requirements, enable access to markets and to customers in other countries. Standards achieve compatibility and interoperability between products and components and increase knowledge about new technologies and innovations (see "Making Quantum Technology Ready for Industry"). Furthermore, proper standardisation and standardisation processes can be a game-changer for the development of the "Quantum" community. In quantum computing, for example, the interfaces dictate how different hardware components work with each other and how different software components interact with other software and hardware components. Without such interoperability there is no viable ecosystem as companies cannot fully specialize to offer their solution for the wider marketplace and they do not have full access to all relevant customers. Likewise, customers also lose as equipment purchased from different vendors follows different hardware or software standards, meaning that each new purchase means new work to integrate existing systems (a.k.a. "vendor lock-in").

As, for any new technology, standardisation will help to improve the quantum technologies by providing a common ground for the terminology, their key control characteristics, their performance, their measurement, their analysis and their comparison. Standardisation will also bring greatest benefits in the area of interoperability and enhanced cooperation. As interfaces are standardised, they become easier to access and companies can further specialize to produce certain parts of the overall stack. Standardisation is key to innovation, competitivity and adoption of quantum technologies. In spite of the many potential benefits that could derive from the standardisation of the various QT, the effort is mostly driven by scientists rather than by industry. This is mostly due to the fragmentation of the funding instruments, which often focus only on the academic sector. Indeed, one of the drives for standardisation in QT has been the dissemination of results from Academia. If the EU aims at fostering QT ecosystem, a standardisation strategy that supports the inclusion of Industry is needed.

Figure 1

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

The development of quantum technologies and infrastructures is a key objective of the 2030 Path to the Digital Decade policy programme. The Commission has set a specific target for quantum (by 2025, the EU should have its first computer with quantum acceleration, paving the way for being at the cutting edge of quantum capabilities by 2030), and has proposed to set up a number of multi-country projects together with the MS (using the new instrument European Digital Infrastructure Consortium – EDICs) to ensure that this target is met. Standardisation will be key, especially to develop quantum infrastructures with interoperable (certified) quantum technologies.

In order to achieve the ambitious targets set, and to ensure that the EU can make full use of the transformative potential of quantum, a broad and ambitious strategic implementation approach is being put in place. It is based on the development of a thriving European quantum ecosystem and includes several closely interconnected pillars of activity (see Figure 1), as follows:

- **Supporting research and innovation:** The EU's R&D plans in quantum technologies are funded under Horizon Europe and are based on the Strategic Research Agenda (SRA) prepared by the Strategic Advisory Board of the Quantum Flagship, after consultations with more than 2000 quantum experts across Europe. The SRA is structured in four main activity areas, i.e.: Communication, Computing, Simulation, and Sensing and Metrology.

The Flagship's ramp-up phase covered the period 2018-2020 and was funded under H2020 with EUR 150 million. This phase made it possible to finance 24 projects and has resulted in some impressive achievements, such as a proof-of-concept for building a scalable European quantum computer based on trapped ion technology, and the development of the next generation of atomic-based programmable quantum simulators (see also EuroHPC Joint Undertaking). Thanks to the progress made by the Flagship, today several EU-based start-up companies are now offering quantum computing and quantum simulation products commercially.

The second phase of the flagship, funded under Horizon Europe (HE), aims to continue the maturing of the quantum technologies platforms developed during the ramp-up phase and to achieve the transfer of research results from the labs to industry and real-life applications. The first projects under HE are expected to started before end 2022.

Moreover, several European quantum infrastructure development and deployment initiatives, which are described in more detail below, will provide numerous standardisation opportunities to further integrate and mature the R&D results of the Flagship, notably in the fields of quantum computing and quantum communication.

Regarding quantum sensing, the Flagship is kick-starting the industrialisation of next-generation quantum sensing devices in Europe, including establishing a pilot line for testing and sensing, developed and operated by a network of RTOs. The further maturation of the pilot lines and their integration with the standard semiconductor process is foreseen in the chips act initiative. This also leads to the creation of a single testing and experimentation facility throughout the

Union, bringing together the classical microelectronics with the quantum facilities.

- **Investing in a pan-European Quantum Communication Infrastructure (EuroQCI)**: EuroQCI is proposed to be part of the Secure Connectivity Programme. It is about developing an ultra-secure end-to-end quantum communication infrastructure combining the best of quantum and traditional cyber-security technologies in order to protect critical data and communications all over the EU, using both ground- and space-based technologies.
- **Investing in quantum computers and hybrid super- and quantum computers in EuroHPC:** The EuroHPC Joint Undertaking will support at least two generations of advanced quantum computers and simulators, interconnected with the EuroHPC supercomputing facilities, as part of a European federated computing infrastructure. The Joint Undertaking is already working on the integration of a European quantum simulator within its supercomputing infrastructure, and has launched a call for expressions of interest for bringing into service at least three quantum computers (funded with a total of up to EUR 80 million), based on as many different quantum technologies developed in the EU as possible.
- **Investing in quantum chips under the Chips Act:** Quantum is an integral part of our new and ambitious Chips Act Initiative, of which the goals include fostering technology and engineering capacity for quantum chips in the EU. The Chips Act Initiative will leverage pilot lines to scale up manufacturing and accelerate the integration of the design and manufacturing of quantum chips with the established microelectronics industry's mass-market fabrication processes. We will also take advantage of the 'Chips Fund', to invest in quantum start-ups.
- **Forging international cooperation:** this key area of the Flagship is reflected in its openness to collaboration with like-minded global partners, when there is reciprocity and a commitment to achieving mutual benefits. This collaboration is to take place in a spirit of fairness, without unjustified restrictions on the sharing of intellectual property and key technologies (e.g. recent calls with Canada for basic research in quantum, funded with a contribution from the EU side of EUR 4 million). Discussions for cooperation with Japan and the Republic of Korea have started, as part of the digital partnership agreements with these countries.
- **Education, training, skilling and reskilling initiatives** funded under DEP, such as a pan-European Master's courses at a number of universities, which will help to produce the next generation of quantum researchers, and programmes of shorter course which will enable existing members of the workforce to discover the potential of quantum. Interactions are also taking place with the USA.

In addition to the above activities, many EU MS (notably Austria, Denmark, France, Germany, Hungary, the Netherlands, and Spain) have launched national quantum programmes, and it is estimated that at least EUR 4 billion is due to be invested in quantum at national level in Europe in the first half of the current decade. In addition, a number of MS are also using their RRF plans to invest in quantum, where the overall level of planned investments between now and the end of 2026 is estimated to be of at least EUR 1 billion.

(A.3) REFERENCES

- COUNCIL REGULATION (EU) 2021/1173 on establishing the European High Performance Computing Joint Undertaking and repealing Regulation (EU) 2018/1488
- REGULATION (EU) 2021/695 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL establishing Horizon Europe – the Framework Programme for Research and Innovation, laying down its rules for participation and dissemination, and repealing Regulations (EU) No 1290/2013 and (EU) No 1291/2013
- REGULATION (EU) 2021/694 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL establishing the Digital Europe Programme and repealing Decision (EU) 2015/2240

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

ACTION 1: CEN & CENELEC to continue their standardisation work on the most recent topics for quantum technology that were suggested by the Focus Group on Quantum Technologies and their published standardisation roadmap.

ACTION 2: SDOs should develop standards for supply chains for modular quantum computers and communication architectures, and their enabling technologies. Initially the focus should be on QT research infrastructure, evolving towards QT commercial infrastructure

ACTION 3: The creation of an intelligent Dashboard to support SMEs, in which the existing standards as well the work relating to quantum technologies of the main standardisation bodies are presented. The dashboard will facilitate SMEs to identify relevant open-source projects in the field of Quantum Computing and Communications, e.g. providing tools for testing, benchmarking etc.

ACTION 4: SDOs to set up processes for eliciting industry standardisation needs, and industry alliances to coordinate their experts' efforts to contribute to standardisation.

ACTION 5: SDOs should further increase their coordination efforts in Europe and internationally around Quantum Technologies standardisation in order to to avoid overlap or unnecessary duplication of efforts.

ACTION 6: SDOs should appropriately consider the effect of quantum computing and Quantum communication technologies on cybersecurity and provide an overview and analyse whether new standards or updates of existing standards on safety, privacy and cybersecurity are required.

ACTION 7: SDOs should devote specific attention to the standardisation processes (public documents) and existing or future sectorial export control legislation.

ACTION 8: SDOs should cooperate with the EuroQCI and start forming the technical committees to create the necessary pre-standards/standards for the commercial quantum communication technology in synergy with the specific requirements that are being explored for a certification of the technology.

ACTION 9: SDOs should cooperate with the EuroHPC Joint Undertaking and start forming the technical committees to create the necessary pre-standards/ standards for quantum computing technology in synergy with the specific requirements that are being explored for a certification of the technology.

ACTION 10: SDOs should establish benchmarking frameworks for evaluating the performance and quality of algorithmic outputs from quantum computers, ensuring these benchmarks evolve with advancements in hardware and software and align with ongoing standardization efforts in testing, validation, and certification.

ACTION 11: SDOs should work towards developing standardized quantum computing programming frameworks. These standards should foster interoperability, reducing fragmentation across different platforms.

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

ETSI

ETSI ISG QKD:

(Quantum Key Distribution, https://www.etsi.org/committee/1430-qkd) was the first forum aiming to standardise quantum communication technologies. Founded in 2008 by members mostly from Europe, global representation has grown, including from the USA, Canada, South Korea and Japan, in addition to the main actors in QKD within Europe. Increasingly, application vendors and service providers are also represented. Its members are focused on standardisation to support the creation of products and services that include QKD or consume QKD keys.

Addressing the security of QKD systems from which networks can be constructed is a priority. It developed a framework within which QKD protocols can be constructed with an associated security proof in GS QKD 005 "Quantum Key Distribution (QKD); Security Proofs", (https://www.etsi.org/deliver/etsi_gs/qkd/001_099/005/01.01.01_60/gs_qkd005v010101p.pdf). Fundamental aspects of "Implementation Security of Quantum Cryptography" were addressed in ETSI White Paper No. 27. GS QKD 016 "Quantum Key Distribution (QKD); Common Criteria Protection Profile - Pair of Prepare and Measure Quantum Key Distribution Modules", (https://www.etsi.org/deliver/etsi_gs/QKD/001_099/016/01.01.01_60/gs_QKD016v010101p.pdf) is an initial Common Criteria (https://www.noraonline.nl/wiki/ISO/IEC_15408) Protection Profile under version 3.1 Rev 5 of the Common Criteria. A revision under CC:2022 Rev 1 and CEM:2022 Rev 1 is currently under evaluation by the German certification body BSI for certification. This is an important step within the security certification scheme, but further deliverables are envisaged to support QKD product certifications and acceptance as a high-security technology in a broad market. The important issue of authentication within QKD links is being analysed.

GR QKD 003 "Quantum Key Distribution (QKD); Components and Internal Interfaces", (https://www.etsi.org/deliver/etsi_gr/QKD/001_099/003/02.01.01_60/gr_qkd003v020101p.pdf) describes components and interfaces within QKD systems. GS QKD 011 "Quantum Key Distribution (QKD); Component characterization: characterizing optical components for QKD systems" (https://www.etsi.org/deliver/etsi_gs/qkd/001_099/011/01.01.01_60/gs_qkd011v010101p.pdf) specifies optical characterisation methods for important components. These are intended to help develop component supply chains and the characterisation of complete QKD modules are being addressed next, since such characterisations are important in security evaluations. Previously module security was addressed

in GS QKD 008 "Quantum Key Distribution (QKD); QKD Module Security Specification", (https://www.etsi.org/deliver/etsi_gs/qkd/001_099/008/01.01.01_60/gs_qkd008v010101p.pdf).

GS QKD 002 "Quantum Key Distribution; Use Cases" (https://www.etsi.org/deliver/etsi_gs/qkd/001_099/002/01.01.01_60/gs_qkd002v010101p.pdf) describes early use cases for QKD and GS QKD 012 "Quantum Key Distribution (QKD); Device and Communication Channel Parameters for QKD Deployment" (https://www.etsi.org/deliver/etsi_gs/QKD/001_099/012/01.01.01_60/gs_QKD012v010101p.pdf) important parameters for deployments. An analysis of existing approaches to network architecture is underway but ISG QKD has concentrated mainly on specifying fundamental interfaces for interoperability, such as delivery of keys (GS QKD 004 "Quantum Key Distribution (QKD); Application Interface", https://www.etsi.org/deliver/etsi_gs/QKD/001_099/004/02.01.01_60/gs_qkd004v020101p.pdf and GS QKD 014 "Quantum Key Distribution (QKD); Protocol and data format of REST-based key delivery API", https://www.etsi.org/deliver/etsi_gs/QKD/001_099/014/01.01.01_60/gs_qkd014v010101p.pdf), and control and orchestration in Software Defined Networks (GS QKD 015 "Quantum Key Distribution (QKD); Control Interface for Software Defined Networks", https://www.etsi.org/deliver/etsi_gs/QKD/001_099/015/02.01.01_60/gs_QKD015v020101p.pdf and GS QKD 018 "Quantum Key Distribution (QKD); Orchestration Interface for Software Defined Networks", https://www.etsi.org/deliver/etsi_gs/QKD/001_099/018/01.01.01_60/gs_QKD018v010101p.pdf). Specifications are also under development for a REST-based Interoperable Key Management System API (DGS/QKD-020_InteropKMS) and corresponding SDN orchestration (DGS/QKD-021_OrchInterKMS). Improving use of vocabulary is an ongoing effort, in part via GR QKD 007 "Quantum Key Distribution (QKD); Vocabulary" (https://www.etsi.org/deliver/etsi_gr/QKD/001_099/007/01.01.01_60/gr_qkd007v010101p.pdf).

TC CYBER WG QSC: *(Quantum-Safe Cryptography)* addresses security issues to protect cryptographic techniques from quantum threats. It develops recommendations and specifications for the transition to quantum-safe Information and Communication Technology (ICT).

WG QSC focus is on the practical implementation of quantum safe primitives, including performance considerations, implementation capabilities, protocols, benchmarking and practical architectural considerations for specific applications. WG QSC work does not include the development of cryptographic primitives.

WG QSC work supports Action 6. Work covers the migration towards a post-quantum world (TR 103 619) and the specification of Quantum-Safe Hybrid Key Exchanges. (TC CYBER WG QSC publications and TC CYBER WG QSC work programme).

ITU

ITU's work has been concentrated mainly in the area of quantum communication and more generally has been limited to implications of quantum technologies on communication and communication networks. The work on QKD networks and Quantum Enhanced Networking is led by ITU-T Study Group 13 ("Future networks and emerging network technologies", https://www.itu.int/en/ITU-T/about/groups/Pages/sg13.aspx) and ITU-T Study Group 17 ("Security",https://www.itu.int/en/ITU-T/about/groups/Pages/sg17.aspx). Some work on quantum random number generation has also been carried out in SG17. SG13 published 15 Recommendations and three Supplements on QKDN as follows:

- Recommendation ITU-T 3800 "Overview on networks supporting quantum key distribution";
- Recommendation ITU-T 3801 "Functional requirements for quantum key distribution networks";
- Recommendation ITU-T 3802 "Quantum key distribution networks – Functional architecture";
- Recommendation ITU-T 3803 "Quantum key distribution networks – Key management";
- Recommendation ITU-T 3804 "Quantum key distribution networks - Control and management";
- Recommendation ITU-T 3805 "Quantum Key Distribution Networks - Software Defined Networking Control";
- Recommendation ITU-T 3806 "Quantum key distribution networks - Requirements for quality of service assurance";
- Recommendation ITU-T 3807 "Quantum Key Distribution networks - QoS parameters";
- Recommendation ITU-T 3808 "Framework for integration of quantum key distribution network and secure storage network";
- Recommendation ITU-T 3809 "A role-based model in quantum key distribution networks deployment";
- Recommendation ITU-T 3810 "Quantum key distribution network interworking - Framework";
- Recommendation ITU-T 3811 "Quantum key distribution networks - Functional architecture for quality of service assurance";
- Recommendation ITU-T 3812 "Quantum key distribution networks - Requirements for machine learning based quality of service assurance";
- Recommendation ITU-T 3813 "Quantum key distribution networks interworking – functional requirements";
- Recommendation ITU-T 3814 "Quantum key distribution networks - functional requirements and architecture for machine learning enablement";
- Supplement ITU-T Sup70 to Y.3800-series "Quantum Key Distribution Networks - Applications of Machine Learning";
- Supplement ITU-T Sup74 to Y.3000-series "Standardization roadmap on Quantum Key Distribution Networks";
- Supplement ITU-T Sup75 to Y.3800-series "Quantum key distribution networks - Quantum-Enabled Future Networks".

ITU standards also provide a security framework for QKD networks (ITU X.1710 "Security framework for quantum key distribution networks", https://www.itu.int/itu-t/recommendations/rec.aspx?rec=14452), security requirements for key management for QKD networks (ITU-T X.1712), key combination methods (ITU X.1714 "Key combination and confidential key supply for quantum key distribution networks", https://www.itu.int/itu-t/recommendations/rec.aspx?rec=14453), and the architecture of a quantum noise random number generator (ITU X.1702 "Quantum noise random number generator architecture", https://www.itu.int/itu-t/recommendations/rec.aspx?rec=14095).

These ITU standards for QKD networks aim at enabling the integration of QKD technology into large-scale ICT networks and provision of the security of the latter.

The ITU-T Focus Group on Quantum Information Technology for Networks (FG-QIT4N, https://www.itu.int/en/ITU-T/focusgroups/qit4n/Pages/default.aspx) studied the evolution of quantum information technologies in view of their foreseen applications in ICT networks. The group was conducting exploratory 'pre-standardisation' studies to identify emerging standardisation demands and anticipate demands to arise in future.

The FG-QIT4N was established in September 2019 to provide a collaborative platform for interested stakeholders - such as researchers, engineers, practitioners, entrepreneurs and policy makers - to share knowledge, best practices and lessons learned to take full advantage of the ability and potential of QIT in networks.

The Focus Group had been organised as follows: two main research groups - one dedicated to Quantum Key Distribution Networks (QKDN), one dedicated to Quantum Information Networks (QIN) that are beyond QKDN - and a management group The term of the FGQIT4N expired in December 2021 and resulted in nine deliverables / reports, published in the ITU-T Focus Group Publications (https://www.itu.int/pub/T-FG).

Based on outcomes of FG-QIT4N, ITU-T SG11 is developing signalling requirements and protocols for QKDN, including protocol framework and specific interfaces (Ak, Kx, Kq-1, Ck). More info: https://itu.int/go/tsg11.

The Joint Coordination Activity on Quantum Key Distribution Network (JCA-QKDN) was established in late 2022 to actively engage relevant ITU-T study groups, external organizations and fora with active work related to QKDN standardization and maintains a standardization roadmap for QKDN that includes a database on related standards. More information: http://itu.int/en/ITU-T/jca/qkdn

ISO/IEC JTC 1 AND IEC/ISO JTC 3

ISO and IEC initiated all quantum technology standardization activities within the Joint Technical Committee JTC 1, specifically in ISO/IEC JTC 1/WG 14 on Quantum Information Technology, with the exception of security certification for QKD systems, which is handled by ISO/IEC JTC 1/SC 27/WG 3.

Following the establishment of the new Joint Technical Committee IEC/ISO JTC 3 on Quantum Technologies in 2024, the activities of JTC 1/WG 14 were transferred to JTC 3, and JTC 1/WG 14 was subsequently disbanded.

ISO/IEC 4879:2024 "Information Technology — Quantum Computing — Vocabulary" (https://www.iso.org/standard/80432.html) and ISO/IEC AWI TR 18157 "Information Technology — Introduction to Quantum Computing" (currently under development, https://www.iso.org/standard/85203.html) were assigned to JTC 3.

JTC 1/SC 27/WG 3 "Security Evaluation, Testing, and Specification" developed ISO/IEC 23837 "Information Security — Security Requirements, Test and Evaluation Methods for Quantum Key Distribution," a multipart standard based on ISO/IEC 15408 (Common Criteria). Part 1 "Requirements" (https://www.iso.org/standard/77097.html) and Part 2 "Evaluation and Testing Methods" (https://www.iso.org/standard/77309.html) were published in 2023.

The now-disbanded IEC SEG 14, an IEC/SMB Standardization Evaluation Group on quantum technologies, recommended the establishment of JTC 3.

IEEE

The U.S. Quantum Economic Development Consortium (QED-C) and international counterparts have expressed interest to IEEE in developing standards appropriate for the emerging quantum information market ("Quantum Initiative Support for Standards"). According to IEEE, quantum information standards are likely to evolve over time from informal efforts to formal specifications (IEEE "Developing standards"). A formal, international quantum standard starts when companies or individuals working in an area approach IEEE with a proposal called a Project Authorization Request (PAR). Active IEEE quantum standards projects include:

- IEEE P1913, Software-Defined Quantum Communication: This standard defines an application-layer protocol denoted as Software-Defined Quantum Communication (SDQC) that communicates over TCP/IP and enables configuration of quantum endpoints in a communication network to dynamically create, modify, or remove quantum protocols or applications.
- IEEE P3120, Standard for Quantum Computing Architecture, which adds the scopes of earlier P3120.1 and P3155 under one project.
- IEEE P7130, Quantum Technologies Definitions: This standard is related to specific terminology for quantum technologies, establishing definitions necessary to facilitate clarity and understanding to enable interoperability and compatibility.
- IEEE P7131, Quantum Computing Performance Metrics & Performance Benchmarking: This standard covers quantum computing performance metrics, with the objective to standardise performance benchmarking of quantum computing hardware and software. The considered metrics and performance tests enable the evaluation of quantum computers standalone or by comparison against quantum and classical computers.
- IEEE P1943, Post-Quantum Network Security
- IEEE P2995, Quantum Algorithm Design and Development
- IEEE P3172, Post-Quantum Cryptography Migration
- IEEE P3185, Hybrid Quantum-Classical Computing
- IEEE P3329, Quantum Computing Energy Efficiency

For more information, see https://ieee-sa.imeetcentral.com/eurollingplan/.

CEN & CENELEC HTTPS://WWW.CENCENELEC.EU/

A working group consisting of CEN & CENELEC, JRC, DIN and the Quantum Flagship Coordination Office was set up for this purpose and resulted in the formation of the CEN-CENELEC Focus Group on Quantum Technologies (FGQT). The aim of the group was to develop a European roadmap on standardisation of Quantum Technology.

The FGQT roadmap is intended to work as a guideline document in defining topics and a structure of QT fields, identifying separate steps and proposing a logical order in a larger development that might be followed at a later stage. Thus it provides a basis for informed decision processes (i.e. investments in research) and a timeline for strategy as a reference. In the beginning of 2023, the FGQT has published their standardisation roadmap and a document for quantum technology use cases.

Subsequently, the CEN/CENELEC Joint Technical Committee 22 (JTC 22) "Quantum Technologies" was founded in March 2023, which is supported by the secretariat management of DIN. The following four working groups operate under JTC 22:

- WG 1 "Strategic Advisory Group"
- WG 2 "Quantum Metrology, Sensing and Enhanced Imaging, and Quantum Enabling Technologies".
- WG 3 "Quantum Computing and Simulation
- WG 4 "Quantum Communication and Quantum Cryptography".

The following topics are currently in the work program. Additional projects are expected to be added in 2024/2025.

- Update of the FGQT Standardization Roadmap on Quantum Technologies
- CEN/CLC TR XXXX, Quantum network best practices
- CEN/CLC TR XXXX, QKD and PQC – An equitable analysis and comparison of both technologies
- CEN/CLC TR XXXX, Gap analysis of current quantum communication and quantum cryptography standards
- CEN/CLC/TR XXX, Layer model of Quantum Computing
- CEN/CLC/TR XXX, Performance benchmarks of quantum computing applications
- CEN/CLC/TR XXX, Hybridization of Quantum Computing
- CEN/CLC/TR XXX, Cryogenic Solid-State Quantum Computing – Part 1: Descriptions and functional requirements of modules
- EN XXX, Quantum technologies – Characterization of quantum technologies – Metrics and terminology
- EN XXX, Traveling-wave parametric amplifiers (TWPA) – Parameters and test methods

IETF

Some IETF protocols rely upon cryptographic mechanisms that are considered secure given today's "classical computers" but would be vulnerable to attacks by a Cryptographically Relevant Quantum Computer (CRQC). These mechanisms rely upon algorithms based on integer factorization or the discrete logarithm problem. Active work is underway to develop and validate Post-Quantum Cryptography (PQC) mechanisms that are expected to be resilient to the cryptanalysis capabilities of future CRQCs (e.g., CFRG, US NIST). Select IETF WGs (e.g., LAMPS, TLS, IPSECME, COSE) have already begun standardizing revised protocol behaviors. The focus of the Post-Quantum Use In Protocols Working Group is to support this growing body of work in the IETF to facilitate the evolution of IETF protocols and document associated operational guidance with respect to PQC.

The WG will provide a standing venue to discuss PQC (operational and engineering) transition issues and experiences to date relevant to work in the IETF. The WG will also provide a venue of last resort to discuss PQC-related issues in IETF protocols that have no associated maintenance WGs. This WG will not update existing protocols, specify new protocols, define new cryptographic mechanisms, or assess whether a given cryptographic mechanism is quantum-resistant.

(C.2) OTHER ACTIVITIES RELATED TO STANDARDISATION

IRTF: QUANTUM INTERNET RESEARCH GROUP

The Internet Research Task Force (IRTF) has hosted the Quantum Internet Research Group (QIRG) since the IETF 101 meeting in March 2018. The QIRG has no official membership and participation is open to everybody. The Research Group communicates primarily through its mailing list which can be freely subscribed and posted to. The entire mailing list archive is publicly available online. The QIRG also holds two or three meetings per year, virtually or in-person, usually at the IETF meetings. The scope of the QIRG's work is defined in its charter. A key goal of the QIRG is the development of an architectural framework delineating network node roles and definitions that will serve as the first step toward a quantum network architecture. However, it is important to note that the QIRG focuses on fully entanglement-based quantum networks. QKD and trusted repeater networks are also often discussed, but usually in the context of being a stepping stone towards such a full quantum internet. The QIRG, just like all the other IRTF Research Groups, does not work on standards. It is instead focused on developing research collaborations and teamwork in exploring research issues related to the Internet. Nevertheless, the Research Group does also work on producing technical documents on quantum networks. Currently, the research group is working on two documents:

- Architectural Principles for a Quantum Internet - now published as RFC9340.
- Application Scenarios for the Quantum Internet.

Since quantum networks are so different when compared to classical networking, the QIRG is also focused on educating the classical networking community on this new subject. In addition to discussions on the mailing list, the QIRG also hosts seminars with speakers from both industry and academia. So far three such seminars have taken place:

- "Practical Quantum Networking at Room Temperature" by Mehdi Namazi (Qunnect Inc.)
- "Genuine and Optimized Entanglement-Based Quantum Networks" by Wolfgang Dür (University of Innsbruck),
- "Building Quantum Networks at the Local-Area Scale" by Marc Kaplan (VeriQloud)

https://wiki.ietf.org/en/group/iab/Multi-Stake-Holder-Platform#h-3111-quantum-technologies

EUROPEAN QUANTUM INDUSTRY CONSORTIUM (QUIC)

The European Quantum Industry Consortium (QuIC, https://www.euroquic.org/) is a European not-for-profit business association aiming to build a strong, vibrant ecosystem between business actors and leading research and technology organisations in the Quantum Technology domain. QuIC believes that only a strong and unified quantum technology community in Europe will be able to succeed in the current global race to become the center of the next technological revolution. QuIC organises the work toward its objectives in Working Groups. As QUIC is the voice of quantum industry in Europe, the Standards Working Group (WG4) aims to become the unified voice of quantum industry in Europe on standardisation issues. It will provide a single point of contact to

voice the needs for standardisation from the industry to decision makers, politics, and standardisation bodies.

The Standards Working Group (WG4) intends to:

- foster communication between the QuIC members and the Standardisation bodies and facilitate the creation and interchange of information. Within this realm, WG4 will organise communication events with SDOs and other relevant Groups to build awareness and promote standardisation activities for Quantum technologies among the members of the QuIC;
- set up a methodology and the tools for eliciting the standardisation needs coming from the Industrial members of the QuIC and communicate these needs with the SDOs.
- develop a living document "State-of-the-art on standardisation activities in Quantum Technologies". The document will present among the others the updated information on the activities of SDOs and the upcoming standards;
- create twinning activities with the other Working Groups of QuIC
- Support QuIC in running projects such as QUCATS.

WG4 will not set up standards, since its role will be supportive of SDOs activities.

EURAMET EMN-Q: QUANTUM METROLOGY COORDINATION

A group of European National Metrology Institutes (NMIs) have recently created a European Metrology Network for Quantum Technologies (EMN-Q, www.euramet.org/quantum-technologies) under the auspices of EURAMET (https://www.euramet.org/) to tackle this technological paradigm shift. Large companies, as well as start-ups, have started to develop and engineer quantum devices or begun to integrate them into their products: the commercial success of QT, together with progress in research and development, relies on certification and reliability built upon internationally agreed standards and metrological traceability.

Therefore, the objective of the EMN-Q is to coordinate the activities of the European NMIs to ensure their efficient support for European competitiveness in quantum technologies. A special focus of the EMN-Q will be to develop new measurement capabilities and dedicated services to serve the rapidly-growing needs of industry and research institutions in this field.

Industry, governmental agencies, academic sectors or any other type of stakeholder are welcome to contact the EMN-Q and discuss their metrology needs. These can relate not only to quantum characteristics of quantum devices, but also to metrology of key enabling technologies, metrology that can improve the supply chain of industrial quantum devices or other industrial needs connected with quantum technologies.

The commitment of the EMN-Q is to become the unique contact point to stakeholders interested in metrology for quantum technologies by:

- contributing to standardisation & certification of quantum technologies;
- promoting the take-up of metrology in the development of these technologies;
- supporting industrial needs in synergy with the technological objectives of the EC Quantum Flagship and national quantum technology programs;
- promoting the use of quantum measurement techniques where advantageous for "classical" technical areas.

The EMN-Q is developing Roadmaps and a Strategic Research Agenda to identify priorities for research by Europe's national metrology institutes and designated institutes and to identify collaboration partners for such research.

The European Metrology Network (EMN) for Quantum Technologies will support the integration of measurement science with quantum technologies in three sections: Quantum Clocks and Atomic Sensors, Quantum Electronics and Quantum Photonics.

(C.3) ADDITIONAL INFORMATION

STANDICT.EU: EU FUNDING FOR ICT STANDARDISATION

The StandICT.eu 2023 project (https://standict.eu/about) is a Coordination and Support Action of the EU Horizon 2020 framework programme. It started in Sept. 2020 and has as its "(...) central goal to ensure a neutral, reputable, pragmatic and fair approach to support European and Associated states presence in the international ICT standardisation scene". To this goal, the project issues ten open calls with funding opportunities for European experts in several strategic fields, including the field of Quantum Technologies. Currently, the StandICT project supports an editor of the FGQT's Quantum Technologies Standardisation Roadmap.

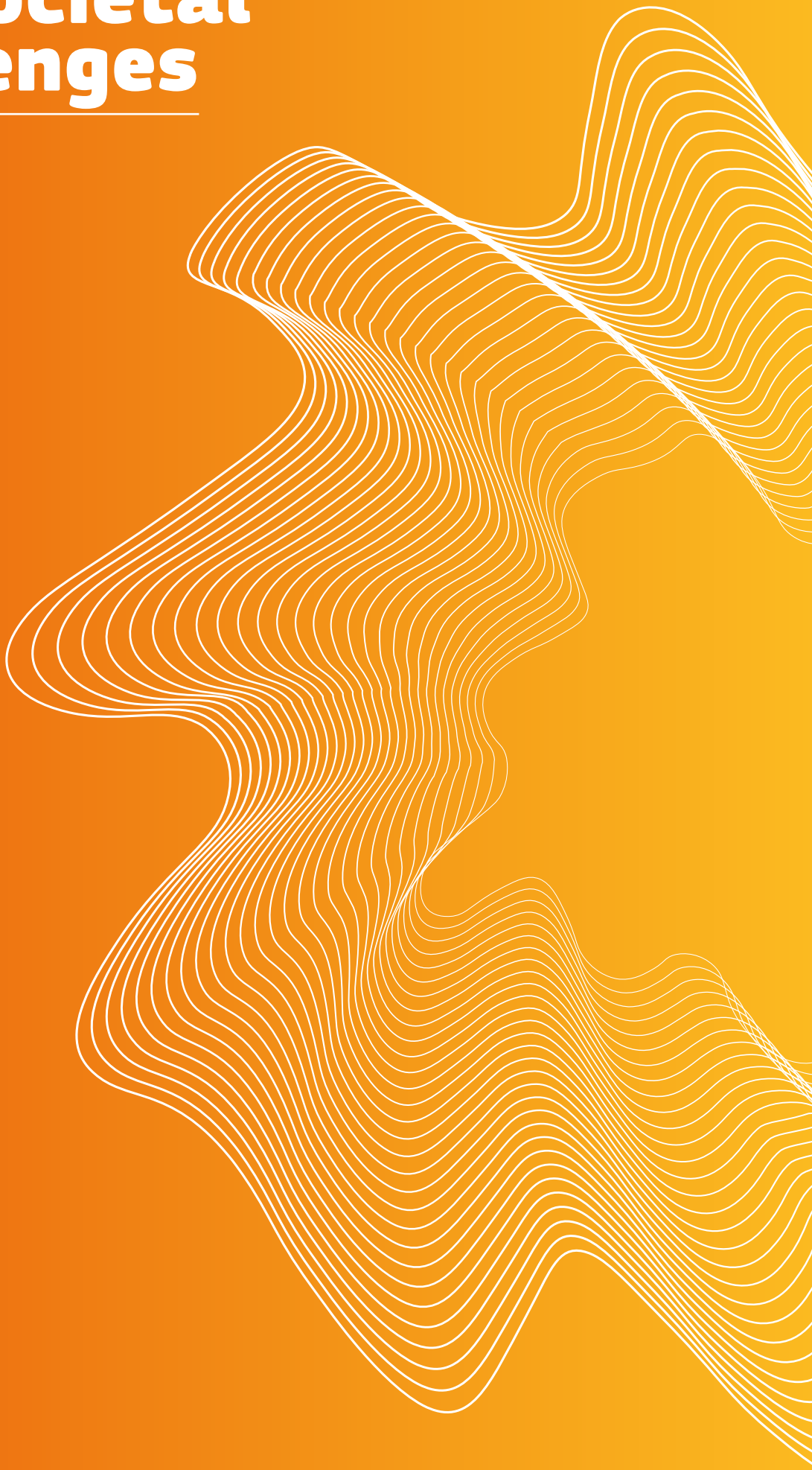
QUCATS

QUCATS is a Coordination and Support Action of the EU Horizon Europe framework programme. It started in May 2022 and it has a whole work-package dedicated to Standardisation

EUROQCI-CSA

Within 2022 a new CSA project will start coordinating the first deployment of national EuroQCI projects and start preparing the large-scale QKD testing and certification infrastructure.

3.2 Societal challenges



3.2.1 Digital health, healthy living and ageing

A Policy and legislation

(A.1) POLICY OBJECTIVES

The creation of the European Health Data Space (EHDS), which will enable secure and trustworthy access to health data across the EU, is one of the priority areas of the Commission. Negotiations on the **European Health Data Space** regulation concluded in Spring 2024, and the regulation is now undergoing the last stages of the legislative process, with the regulation entering into force in March 2025. The European Health Data Space is a key pillar of a strong European Health Union and the first sector-specific European data space emerging from the 2020 European Strategy for Data. The regulation will provide for rules, common standards and practices, infrastructures, and a governance framework for the primary and secondary use of electronic health data.

The political agreement on the EHDS-regulation aims to:

- ensure that individuals have access to and control over their health data in the context of healthcare (primary use);
- establish a genuine single market for digital health through the certification of Electronic Health Record systems (EHR systems) and the labelling of wellness applications;
- allow researchers, innovators, policymakers, and regulators to make the most of the available health data in the context of their activities for the benefit of society, while preserving trust and security (secondary use).

It builds on the priorities set in the Commission Communication (COM(2018) 233) on enabling the digital transformation of health and care in the Digital Single Market and the Commission Recommendation for a European Electronic Health Record exchange format (EEHRxF) of 2019 (C(2019)800). Both are part of the Commission Priority "A Europe fit for the digital age".

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

Recent, ongoing and future EU initiatives will contribute to foster the implementation of the European Health Data Space.

On the primary use of health data, the Commission aims to continue developing the **cross-border infrastructure MyHealth@EU** further and to promote the use of the **European electronic health record exchange format** (EEHRxF). There are currently 145 countries operational in MyHealth@EU, which allows the cross-border exchange of health data, and its translation to the language of the country of destination. The services currently available under MyHealth@EU are ePrescription and Patient Summary. The extension to new categories of health data (laboratory results, medical imaging studies and reports, and hospital discharge reports) is already ongoing. In February 2019, to facilitate the interoperability of health data in the EU, the Commission adopted a Recommendation for a European electronic health record exchange format (EEHRxF). The EEHRxF Recommendation outlines technical specifications for patient summaries, ePrescriptions and eDispensations, laboratory results, medical imaging studies and reports as well as hospital discharge reports. The eHealth Network has also adopted further guidelines on all the listed data categories, to facilitate their implementation in MyHealth@EU and in other contexts. The upcoming EHDS Regulation will ensure the implementation of the support for the EEHRxF in all EHR systems placed on the Union market. Citizens will have the right to receive and share their health data in this format.

The upcoming EHDS Regulation includes **harmonised rules for the interoperability and logging components of electronic health record systems** (EHR systems) and devices feeding data into EHR systems. It will also introduce a mandatory labelling scheme for wellness applications claiming interoperability with EHR systems. Joint Action Xt-EHR funded under the 2022 EU4Health work programme is conducting further work on technical specifications for the primary use of health data (for the provision of healthcare services) in the context of the upcoming European Health Data Space. This includes technical specifications on the interoperability of priority categories of electronic health data, extension of MyHealth@EU use cases to support remote provision of healthcare services, the use of electronic identification, and requirements for the certification of electronic health record systems and the labelling of mobile wellness applications.

To prepare such technical specifications, the Joint Action Xt-EHR will build upon previous initiatives, such as the **X-eHealth** project which ended in 2022. It is also in part supported by the XpanDH and xShare projects that conduct experimentation with the EEHRxF.

The **PaTHED** project, conducted in 2023-2024, has piloted patient access to translated health data in the context of MyHealth@EU infrastructure. This pilot project has developed a reference implementation of such solutions, in the form of components for a patient-facing mobile app. Patients' access to their health data is also targeted in the context of the **large scale pilots (LSPs)** supporting implementation of the EU Digital Identity Framework. These pilots are deploying the first set of EU Digital Identity Wallet functionalities for different use cases, including one on ePrescription ("**POTENTIAL**" project).

The "**POTENTIAL**" consortium selected by the EC is a Large Scale Pilot project with the eHealth use case, e-Prescription. This use case is based on an eHealth Network approved Vision document on how to integrate EUDI Wallet functions with the cross-border e-Prescription workflow supported by the MyHealth@EU (European Health Digital Service Infrastructure). In total 148 participants from 19 EU member states and Ukraine gather in the "POTENTIAL" Consortium to pilot new coming EU Digital Identity Wallet (EUDIW) prototypes in six Use Cases: e-Prescription alongside Electronic Government services, Account opening, SIM registration, Mobile Driving Licence, Remote Qualified Electronic Signature, and Electronic Prescription.

An action co-funded under the Digital Europe Programme is to be launched in 2025 for supporting patients' access to their health data in the context of healthcare services for citizens across the EU. The goal is to enable patients to access priority categories of data in the upcoming EHDS, building on the results of previous projects and rolling out the solution widely in healthcare settings.

Finally, the Horizon Europe project '**Label2Enable**' that started in June 2022 has promoted the CEN-ISO/TS 82304-2 health app assessment framework and label in Europe. The objective of Label2Enable is threefold: to achieve trust, use and adoption. In 2021, CEN-ISO/TS 82304-2- health and wellness apps - quality and reliability' was published.

Past, present and future projects focused on eHealth standardisation, harmonisation and interoperability include:

- Unicom, which has worked on the implementation of the ISO IDMP (IDentification of Medicinal Products) standards and on their piloting in national and cross-border digital health services, particularly in e-Prescription;
- **InteropEHRate**, which has complemented and integrated the current interoperability infrastructures with new technologies for health data exchange centred on the citizen;
- **Smart4Health,** enabling the citizen-centred EU-EHR exchange for personalised health;
- X-eHealth, which has developed draft technical specifications for the EEHRxF for laboratory results and reports, hospital discharge reports, and medical imaging studies and reports;
- Label2Enable, which has promoted a health app quality and reliability label based on CEN-ISO/TS 82304-2;
- XpanDH, which has experimented with the EEHRxF in multiple domains, including through networks of adopters, and has prepared bundles for technical specifications of the format;
- xShare, which is working on the definition of the xShare button for sharing data in alignment with the upcoming EHDS regulation, on building the EEHRxF standards and policy hub, and is developing methods for industry engagement;
- Xt-EHR, which is working on the formal specifications of the EEHRxF and on the certification requirements for the EHR systems, in preparation for the upcoming EHDS.

More specifically, InteropEHRate and **Smart4Health** provided interoperability protocols and technologies for health data exchange centred on the citizen.

On secondary use of health data, the Commission will be supporting the establishment of health data access bodies (HDABs) across Member States. The HDABs will be connected through **HealthData@EU, an infrastructure that enables multi-country data access.** The HealthData@EU infrastructure pilot project will be completed by end of 2024. Member States are supported in the establishment of health data access bodies through direct grants. In 2024, the Commission launched an action to support building capacity in Member States for secondary use of data with focus on training for HDABs staff on key topics. Additionally, in 2024, the Commission is running a call to strengthening the role and capabilities of HDABs in streamlining the testing and deployment pathways for healthcare AI solutions.

In 2022, the Joint Action "Towards a European Health Data Space" (TEHDAS) has contributed to the design and development of the EHDS. In 2024, a second Joint Action, TEHDAS2, was launched to prepare the ground for the harmonised implementation of the secondary use of health data in EHDS. Standardisation may be helpful in addressing the challenges of secondary use of health data. This could involve standardising health datasets metadata, health data minimisation (anonymisation, pseudonymisation, linkage and synthetic data), data quality and utility assessment (e.g., through a label), health data secure processing environments and data access request applications format and procedures. Furthermore, the QUANTUM project is working on developing a data quality and utility label in line with the provisions of the upcoming EHDS.

To ease the transition from primary use of health data to secondary use, the alignment of data standards for secondary use with the EEHRxF standards and terminologies, as employed in primary use of health data under the EHDS, should be explored.

(A.3) REFERENCES

- COM/2022/197 final Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the European Health Data Space; text adopted by the European Parliament following the negotiations by the co-legislators.
- COM/2018/233 final COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS on enabling the digital transformation of health and care in the Digital Single Market; empowering citizens and building a healthier society
- European Health Data Space (europa.eu)
- Commission Recommendation on a European Electronic Health Record exchange format (C(2019)800)
- ISO/TS 82304-2:2021 Health Software - part 2: health and wellness apps - quality and reliability
- eHealth Network Guidelines: Guidelines on the electronic exchange of health data under Cross-Border Directive 2011/24/EU - General Guidelines; Guidelines on ePrescription and eDispensation of Authorised Medicinal Products; Guidelines on Patient Summary; Guidelines on Laboratory results and reports; Guidelines on Medical imaging studies and reports; Guidelines on Hospital discharge reports – all published on the eHealth Network website.
- https://www.interopehrate.eu/
- https://unicom-project.eu/
- https://xpandh-project.iscte-iul.pt/
- https://xshare-project.eu/
- https://www.xt-ehr.eu/
- Joint Action Towards the European Health Data Space – TEHDAS - Tehdas
- https://ehds2pilot.eu/
- https://label2enable.eu/
- https://quantumproject.eu/

Note: The Rolling Plan 2025 also includes chapter 3.2.6 Pandemic Preparedness

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

ACTION 1: For the further development of the citizens' electronic health records, evaluate and address standardisation needs of high relevance regarding terminological and technological profiles for the cross-border digital single European market.

Identify and address possible standardisation needs to ensure smooth implementation of the EHDS, including patients' access to priority categories of health data, support to the development of the EEHRxF and its wide implementation and integration in EHR systems as well as support to the implementation of identification management and telemedicine services.

Areas of specific relevance and interest for EHDS implementation are:

- Technical specifications (datasets, data fields, data groups, coding systems and values, content representation and transmission, base standards and profiles, etc) to be implemented as part of the European electronic health record exchange format (EEHRxF) for the priority categories of health data (ePrescription, patient summary, medical test results and reports, medical imaging studies and reports, discharge reports);
- Functional and technical specifications applicable to all Electronic Health Record systems for the

registration, interoperability and security of health data;

- Technical specifications for the interoperable, cross-border identification and authentication mechanism for patients and health professionals;
- Technical specifications for cross-border identification and authentication mechanism for patients, health professionals, and healthcare provider organisations.

ACTION 2: Evaluate and report on the opportunities and needs for standardisation supporting active and healthy living and ageing with special emphasis on:

- Open service platforms APIs taking into account progress made under H2020 on the top smart homes and smart cities
- Service robotics for assisted working, and independent living including regulatory acceptance:
- Identify standardisation needs to support specific issues, e.g. occupational health and safety, memory deficiency, mental health issues.
- Ensuring interoperability of devices to enable plug-and-play connectivity of the different devices and services for personal management and delivery of the actual services for an active and healthy living and ageing.

Whereas:

- it is necessary to facilitate the involvement of societal stakeholders in the development of standards in the field of active and healthy ageing; ensure user participation from the beginning to avoid purely technical-driven innovation, e.g. by involving specific user groups in SDOs.
- given the challenge of the ageing population, the standardisation work must also take into account aspects of personal services dedicated to the autonomy including ICT solutions in order to promote secure and harmonised solutions at the European level;
- it is important to consider the synergies between standardisation and active and healthy ageing with similar standards in the areas of ambient assisted living and eHealth as proposed by the H2020 PROGRESSIVE project and referenced in the eStandards project and activities undertaken by the Task Force 'Ageing in community' in ISO/TC 215;
- all the standardisation work on active and healthy living and ageing should ensure a high-level of privacy protection, security and adhere to principles of good ethical practice.

ACTION 3: *'Data protection by design' (GDPR, Article 25) in eHealth products and services*

It is recommended to check whether a standardisation request might be needed pursuant to Regulation 1025/2012 for one or more European standardisation deliverable(s) concerning data protection by design for the development of eHealth products and services, particularly in the context of the EHDS and the measures regarding EHR systems, devices connecting to EHR systems and wellness applications.

ACTION 4: Evaluate the needs and options on standardisation of health datasets metadata, techniques for health data minimisation and confidentiality (anonymisation, pseudonymisation, linkage and synthetic data), data quality and utility assessment (e.g. through a label), health data secure processing environments, measures necessary to preserve the confidentiality of IP rights and trade secrets when processing health data for secondary uses, and data access request applications format and procedures, in the context of the upcoming European Health Data Space Regulation.

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

BSI

PAS 277:2015 Health and wellness apps — Quality criteria across the life cycle — Code of practice

CEN

CEN/TC 251 provides a focal point for the development of standards in the Health Informatics domain, in close collaboration with ISO/TC 215. CEN/TC 251 is taking forward the eHN guidelines, contributing to international standardisation solutions, while providing Europe with an International Patient Summary standard (EN ISO 27269) and a European implementation guide (TS 17288). The technical committee is also responsible for the development, publication and maintenance of the EN ISO IDMP series of standards (Health informatics - Identification of medicinal products), accompanying implementation guides and related standard requirements documents and logical data models. These will be used for the medication section of the patient summary and the ePrescription/eDispensation. For medical imaging and image reports, CEN/TC 251 publishes the "DICOM" standards (EN ISO 12052) and is in the process of adopting an ISO reference standards portfolio for clinical imaging (ISO 21860). CEN/TC 251 experts are actively participating in EU projects supporting the adoption and use of standards and specifications

in conjunction, contributing to maturing the European Electronic Health Record Exchange Format.

With respect to the adopted Artificial Intelligence Act and the related standardization request, CEN/TC 251 is actively participating in the preparatory work on the application of AI in healthcare.

CEN/TC 251 explores the needs for further alignment of semantic and technical interoperability specifications of personal health data to be made available for both primary and secondary use under the EHDS.

CENELEC

CENELEC has adopted as European Standards IEC 62304 (Medical device software -- Software life cycle processes) and IEC 82304-1 (Health software – Part 1: General requirements for product safety)

CEN & CENELEC

CEN-CLC/JTC 11 has just ended the works related to the standardisation of the built environment, which is a key issue regarding older people and people with disabilities:

- EN 17210:2021 Accessibility and usability of the built environment - Functional requirements
- CEN/TR 17621:2021 Accessibility and usability of the built environment - Technical performance criteria and specifications
- CEN/TR 17622:2021 Accessibility and usability of the built environment - Conformity assessment

CEN-CENELEC-ETSI

A further version of the EN was published by CEN, CENELEC and ETSI in March 2021 solving some errors detected in the previous edition and improving its usability. This new edition, EN 301 549 V3.2.1 (2021-03) (EN 301549:2021) was developed to meet the essential requirements included in the Directive on the accessibility of the websites and mobile application of public sector bodies. Currently, a new revision is being developed in response to the standardisation request to the European standardisation organizations as regards the accessibility requirements of products and services in support of Directive (EU) 2019/882 of the European Parliament and of the Council and to the Web Accessibility Directive.

ISO

The European Medicines Agency is part of a project to finalise the implementation guides to support the adoption of the ISO standards for the identification of medicinal products (IDMP).

A set of standards and implementation guides are being developed jointly by ISO/TC 215 and CEN/TC 251, where this work started originally.

There is a newly-formed ISO/TC 215 subcommittee in the area of Genomic Informatics (https://www.iso.org/committee/7546903.html). This is collaborating with other SDOs.

ISO/IEC JTC 1

A framework for personalization and adaptation of user interfaces at runtime, based on the context of use (consisting of a user's needs and preferences, their envisioned tasks, their equipment and environmental parameters of interaction). The framework is based on the well-known REST protocol, and JSON and XML formats. A registry-based approach is employed for the definition of terms describing a user's personal preferences and needs.

The following standards are published as part of this framework:

ISO/IEC CD 24571-1 Information Technology – Individualised adaptability and accessibility in e-learning, education and training – Part 1: Framework and reference model

ISO/IEC DIS 24752-8 Information technology -- User interfaces -- Universal remote console -- Part 8: User interface resource framework

ISO/IEC

The standard 62304 Health software - Software life cycle processes is being updated, by ISO and IEC. One of the issues to be addressed is about the improvement of the security aspects that relate to health software. This has also led to the onset of the development of a new standard ISO/IEC 80001-5-1 Safety, Security and Effectiveness in the implementation and use of connected medical devices or connected health software - Part 5: Security -Sub-Part 5-1: Activities in the Product Lifecycle in ISO/TC215/JWG 7

ETSI

ETSI TC eHealth: In addition to the activity jointly with CEN and CENELEC noted above ETSI through the efforts of the eHEALTH group, acting within ETSI as a "Hub for Health", have prepared a number of documents to bring the efforts across ETSI into focus for responding to the actions of the plan listed above. Of particular note with respect to Actions 1 and 2 the eHealth group has published a short series of white papers, a Special Report into the role of ICT on recovery from COVID, and is maintaining and extending its work programme developing use cases and data models. This is closely aligned to the work in ETSI CYBER on further development of the "secure by design", "privacy by default" paradigms (particularly with respect to IoT in EN 303 645), and with integration to the semantic identification frameworks developed in SmartM2M for SAREF. Thus, as a "hub for health" ETSI is actively promoting the implementation of the driver that "*Very little of ICT is eHealth specific, all of eHealth depends on ICT*" with a view to ensuring that all of ETSI's output is societally and eHealth relevant for enabling Health crisis management and recovery as well as for the core operation of all health operations. https://www.etsi.org/technologies/ehealth

Published (with links) and in further development:

- TR 103 477: eHEALTH; Standardization use cases for eHealth
- TR 103 817: eHEALTH; Presence preserving proximity function trigger (3PFT)
- ES 203 668: eHEALTH Data recording requirements for eHealth
- SR 003 809: eHEALTH; The role of ICT to enable Health crisis management and recovery; Responding to the 2019 SARS-CoV-2 Pandemic
- White paper 29: The argument in favour of eHealth standardization in ETSI
- White paper 33: The role of SDOs in developing standards for ICT to mitigate the impact of a pandemic

ETSI TC DECT: is developing digital enhanced cordless telecommunications (DECT) ultra-low energy (ULE), a low-power wireless technology providing optimal radio coverage in indoor

scenarios for reliable audio and data services suitable for many eHealth applications, e.g., health monitoring, emergency alarms for vulnerable people and remote medical monitoring.

ETSI TC smartBAN: is working on smart body area networks. Standards for a dedicated radio technology for these networks are being developed.

ETSI SC USER: In the series of documents "User-centric approach in digital ecosystem", SC USER has worked on use cases including e-health and is currently working on the "Smart Identity" (STF 626) as the first step of the project "Smart Interface" and focused on the use case "Health". ETSI is one of the SDOs listening the voice of users, their expectations, behaviors and requests through the User Group.

ETSI ISG F5G: The Use Cases identified as drivers for the F5G work include several aspects of digital health. The architecture defined (second Release under development) provides the essential characteristics required to support those use cases. Specific studies will in future allow a detailed discussion of the features of the network needed to serve healthcare specific applications.

ETSI TC smartM2M: The SAREF ontology, which makes use of oneM2M as communication framework (ETSI TS 103 264 (Reference Ontology and oneM2M Mapping), was enhanced with a specific extension i.e. SAREF4EHAW: extension for the eHealth/ Ageing-well domain.
Sources: https://saref.etsi.org/sources/saref4ehaw/. ETSI Technical Specification: ETSI TS 103 410-8 V1.1.1 (2020-07): "SmartM2M; Extension to SAREF; Part 8: eHealth/Ageing-well Domain"

IEC

IEC SC 62B is developing standard IEC 61910-1, which describes a high-level data exchange language between systems making medical imagery. IEC Systems Committee on Active Assisted Living (SyC AAL) fosters standardisation which enables usability, accessibility, and cross-vendor interoperability of AAL systems and services. The work has started with the collection use cases, definition of the terminology and the design of an architecture model for AAL systems.

IEEE

IEEE standards address technology components and applications, related to different aspects of the healthcare domain, including software, management, guidance, and recommended practices. Focus on addressing challenges utilizing devices and services in the form of remote patient monitoring and care, including addressing the portability, interoperability, verification, and validation for data to be utilized for clinical research, healthcare delivery and monitoring and precision medicine.

IEEE 1708, Standard for Wearable Cuffless Blood Pressure Measuring Devices.

IEEE 1752.1 Standard for Open Mobile Health Data—Representation of Metadata, Sleep, and Physical Activity, and Metabolic Measures .

IEEE P1752.2 – Standard for Open Mobile Health Data for Cardiovascular Activity

IEEE 2621 Standard for Wireless Diabetes Device Security Assurance

IEEE 2621.2/UL 2621-2 Information Security Requirements for Connected Diabetes Solutions.

IEEE 2791 Standard for Bioinformatics Computations and Analyses Generated by High-Throughput Sequencing (HTS) to Facilitate Communication.

IEEE 11073 Standards Series enables service-oriented (medical) device connectivity including semantic interoperability.

IEEE P2673 Standard for Patient Digital Biomedical Data Files with 3D Topological Mapping of Macroanatomy and Microanatomy for Use in Big Data and Augmented Intelligence Systems.

IEEE P2727 (two standards) covers medical devices with measurement functions, including cardiac defibrillators.

IEEE P2731 standard for a unified terminology for brain-computer interfaces, based on input from IEEE P2794 "Reporting Standards for in Vivo Neural Interface Research."

IEEE P2801 recommended practice for the quality management of datasets for medical AI for datasets.

IEEE P2802 Performance and safety evaluation of AI based medical devices including terminology.

IEEE 2933 -2024 Standard for clinical IoT data and device interoperability with TIPPSS (Trust, Identity, Privacy, Protection, Safety, Security).

IEEE P2968 Standards Series for Decentralized Clinical Trials, on Patient Safety, as well as Thread Modeling, Cybersecurity, and Data Privacy.

IEEE P3333 standards series defines criteria for 3D medical applications and printing.

IEEE P3350 Recommended Practice for Improving Generalizability of Artificial Intelligence for Medical Imaging

IEEE P3386 Standard for Defining and Inferring User Accessibility Needs for Applications including Augmented Reality and Artificial Intelligence Systems

IEEE P3493.1 Standard Framework for Secure, Compliant, Coordinated, and Inclusive Healthcare Data Recycling: Cancer Care

IEEE P4005 Standard Protocol and Scheme for Measuring Soil Spectroscopy

Pre-standards activities:

- Clinical Trial Technology Modernization Network (CTTMN)
- Transforming the Telehealth Paradigm: Connectivity, Accessibility, Privacy and Security for ALL
- Ethical Assurance of Data-Driven Technologies for Mental Healthcare
- Zero Trust Cybersecurity for Health Technology Tools, Services, and Devices
- Technology Standards for the Aging (AgeTech)
- Data Quality Standards of Electronic Health Records Workgroup
- WAMIII (Wearables & Medical IoT Interoperability & Intelligence) Program to incubate potential standards that will enable trust in the seamless, secure personal patient area network and bioinformatics highway for connected medical devices in, on or around the human body.

Conformity Assessment: Medical Devices Cybersecurity based on IEEE 2621 Standard

The IEEE Global Standardized Registry for Medical Mobile Health Apps will serve as a directory of apps that have attested and been assessed for satisfying the established set of guardrail criteria (technical, ethical and clinical) required to attain an IEEE standard identifier for inclusion in the registry.

For more information, see: https://ieee-sa.imeetcentral.com/eurollingplan/.

ITU

World Telecommunication Standardization Assembly (WTSA) Resolution 78 "Information and communication technology applications and standards for improved access to e-health services" drives ITU-T's work in this domain.

The ITU published the Continua Design Guidelines in the ITU-T H.810 series (2019), Interoperability design guidelines for personal health systems (which is complemented by 46 conformity testing specifications); ITU-T H.860 (4/2014), Multimedia e-health data exchange services; Y.4110/Y.2065, Service and capability requirements for e-health monitoring services; Y.4408/Y.2075, Capability framework for e-health monitoring services; technical papers HSTP-H810 (7/2014) and HSTP-H810-XCHF (2017) with an introduction to the H.810 series and data exchange within it. Updated editions of the ITU-T H.810 series architecture are produced regularly (annually or so).

More info: https://itu.int/en/ITU-T/e-Health

SG13 is developing a new Recommendation on "QoS requirements for smart healthcare supported by IMT-2020" (Y.IMT2020-qos-req-sh). In addition, SG13 published Supplement 66 to Y.3000-series "Network 2030 Services: Capabilities, performance and design of new communications services for the Network 2030 applications" that depicts the requirements for the telesurgery and robotics surgery for future around year 2020+. Supplement 67 to Y.3000-series of ITU-T Recommendations "Representative use cases and key network requirements for Network 2030" describes the use case with remote robotic surgery.

ITU-T SG16 (Multimedia) and ITU-T SG20 (IoT, smart cities and communities) are developing further standards addressing e-health services and systems.

Some of the standards approved under SG16 include:

- Framework for telemedicine systems using ultra-high definition imaging (Recommendation ITU-T F.780.1)
- Guidelines for safe listening devices/systems (Recommendation ITU-T H.870), a joint standard with WHO.

More standards on this topic within SG16 are developed under Q28/16 on "Accessibility to multimedia systems and services": https://itu.int/itu-t/workprog/wp_search.aspx?Q=28/16

The ITU Product Conformity Database contains information on health devices that passed conformance tests against the corresponding ITU-T Recommendations.

More info: https://itu.int/go/tcdb

ITU-T Focus Group on Artificial Intelligence (FG-AI4H), established in partnership with ITU and WHO, is working towards to establishing a standardized assessment framework for the evaluation of AI-based methods for health, diagnosis, triage or treatment decisions.
https://www.itu.int/en/ITU-T/focusgroups/ai4h/

More info: https://www.itu.int/go/fgai4h.

ITU-T SG20 approved Recommendation ITU-T Y.4908 on "Performance evaluation frameworks of e-health systems in the IoT" and Recommendation ITU-T Y.4484 on "Framework to support Web of Objects ontology based semantic data interoperability of eHealth services". ITU-T SG20 is also developing draft Recommendation ITU-T Y.4233 on "Framework for smart public health emergency management in smart and sustainable cities" (Y.FSPH), and draft Recommendation ITU-T Y.4496 on "Requirements and reference architecture of smart service for public health emergency" (Y.RA-PHE).

More info: https://itu.int/go/tsg20

ITU also coordinates the United for Smart Sustainable Cities (U4SSC) Initiative, which is a UN initiative that develops action plans, technical specifications, case studies, guidelines and offer policy guidance for cities to become smarter and more sustainable. U4SSC developed the U4SSC deliverable on "Smart public health emergency management and ICT implementations". U4SSC through its Thematic Group on Digital Wellbeing aims to research and benchmark existing digital wellbeing frameworks, approaches, and interventions. More info: https://u4ssc.itu.int/

The Report on "The role of digital technologies in aging and health" was developed by ITU and PAHO.

ITU-T SG5 approved Recommendation ITU-T L.1016 on Method for Evaluation of the Environmental, Health and Safety Performance of True Wireless Stereo Headphones.

JIC

Joint Initiative Council for Global Health Informatics Standardisation in which CEN/TC 251, ISO/TC 215, HL7 International, GS1, SNOMED International, CDISC, IHE, DICOM, and PCHA participate as members

OASIS

The OASIS Security TC and the OASIS Web Security Services TC developed and maintain foundational Web Services security standards such as SAML (also ITU-T Recommendation X.1141) and WS-Security, which are used in the Integrating the Healthcare Enterprise (IHE) technical framework used in the eHealth Digital Service Infrastructure, the initial deployment and operation of services for cross-border health data exchange under the Connecting Europe Facility (CEF).

The OASIS Emergency Management TC developed, in cooperation with ITU-T, the World Meterological Organisation, Health Level Seven (HL7) and emergency agencies, standards for data exchange across emergency-related systems. Emergency Data Exchange Language (EDXL) specifications include EDXL-HAVE, an XML messaging standard primarily for exchange of health facility availability information. EDXL-Situation Reporting (SitRep) supports data sharing of information on situations, incidents, events and responses. EDXL Tracking Emergency Patients (TEP) supports sharing of emergency patient and tracking information from the point of patient encounter through definitive care admission or field release.

ONEM2M

Data Structures like the Electronic Health Records EHR can by exchanged safely, reliable and securely over wide area data networks, between ICT components (oneM2M CSE's), on site (e.g. in Hospitals) and Data centers.

oneM2M standard based technology enables a multivendor interoperable data exchange framework between clinics, doctors, medicinal products and health care providers and hence enables an eHealth Interoperability Framework.

The SAREF ontology makes use of oneM2M as communication framework (ETSI TS 103 264 (Reference Ontology and oneM2M Mapping) and a specific extension of SAREF i.e. SAREF4EHAW: extension for the eHealth/Ageing-well domain is available. Sources: https://saref.etsi.org/sources/saref4ehaw/ . The related ETSI Technical Specification is : ETSI TS 103 410-8 V1.1.1 (2020-07): "SmartM2M; Extension to SAREF; Part 8: eHealth/Ageing-well Domain"

All oneM2M specifications are publicly available at: Specifications (onem2m.org)

(C.2) OTHER ACTIVITIES RELATED TO STANDARDISATION

ASSESS CT

Investigated the fitness of the clinical terminology SNOMED CT as a potential standard for EU-wide eHealth deployments, scrutinising clinical, technical, financial, and organisational aspects.

http://assess-ct.eu/

EESSI

Electronic exchange of social security information (EESSI). EESSI is an IT system that will help social security bodies across the EU to exchange information more rapidly and securely, as required by EU regulations on social security coordination.

http://ec.europa.eu/social/main.jsp?catId=869&langId=en

EU-US EHEALTH WORK

The collection of eHealth related competencies and the provision of educational material, (including eHealth standards) for the health care work force in the EU and USA

(C.3) ADDITIONAL INFORMATION

Guidelines, code of conduct

The following links provide additional information of ongoing work.

Guidelines on:

- On the electronic exchange of health data under the Cross-Border Healthcare Directive 2011/24/EU (general guidelines and guidelines for specific use cases): https://health.ec.europa.eu/ehealth-digital-health-and-care/eu-cooperation/ehealth-network_en
- On an Organisational Framework for eHealth National Contact Points (2015)

http://ec.europa.eu/health/ehealth/key_documents/index_en.htm

- Report of the Working Group on mHealth assessment guidelines

https://digital-strategy.ec.europa.eu/en/library/report-working-group-mhealth-assessment-guidelines

- Code of Conduct on privacy for mobile health apps,

https://digital-strategy.ec.europa.eu/en/library/code-conduct-privacy-mhealth-apps-has-been-finalised

- Consultation on safety of apps

https://digital-strategy.ec.europa.eu/en/library/summary-report-public-consultation-safety-apps-and-other-non-embedded-software

3.2.2 Digital skills

A Policy and legislation

(A.1) POLICY OBJECTIVES

The development of digital skills is currently a political priority for the European Commission and for Member States. In her political guidelines, President von der Leyen highlighted the need to unlock the potential of digital technologies for learning and teaching and to develop digital skills for all. Digital is one of the 6 Commission priorities for 2019-2024 with a dedicated digital strategy to empower people with a new generation of technologies, named "A Europe Fit for the Digital Age". The policy objectives are:

- to ensure that all citizens can develop their digital skills;
- to support the development of advanced and specialised digital skills;
- to support education and training in their digital transition.

As a result, the Commission organised a Structured Dialogue with Member States on digital education and skills. The objective of the dialogue was to increase the political visibility and commitments on digital education on skills. The dialogue brought together the different strands of policy into a strong integrated, coherent and more ambitious approach and make the most of the synergies between the different policy fields – education, digitalisation, labour, finances. The dialogue encompassed different branches and institutions of government, as well as the private sector, social partners and civil society. The results of this dialogue have been used by the Commission for two proposals for Council Recommendations (see hereunder).

The Digital Education Action Plan 2021-2027 sets out a vision for digital education and skills. In order to achieve this vision, the Action Plan covers two priority areas: 1) Fostering the development of a high-performing digital education ecosystem; 2) Enhancing digital skills and competences for the digital transformation. The Plan encompasses a series of actions that address the development of digital skills, from basic to advanced. As part of the implementation of the Action Plan and based also on the results of the Structured Dialogue with Member States, two Council Recommendations in the area of digital education and skills were adopted by the Education, Youth, Culture and Sport (EYCS) Council the Council in November 2023.

The two proposals correspond to the two strategic priorities of the Digital Education Action Plan. The Council Recommendation on the key enabling factors for successful digital education and training articulates the vision for universal access to inclusive and high-quality digital education and training, for everyone, in formal education and training, set out in the Digital Education Action Plan. The Council Recommendation on improving the provision of digital skills in education and training aims to support Member States in facing common challenges related to the level of digital skills of different segments of the population and the ability of their education and training systems to support its provision from a lifelong learning perspective. The Council Recommendation covers the full spectrum of digital skills, from basic to advanced, and provides specific recommendations to member states concerning the support to ICT professionals. As part of the implementation of this Council Recommendation, the Commission is working on the development of guidelines for teaching high-quality informatics at primary and secondary school levels for teachers, which will be drafted by the end of 2025 with the support of an expert group. The Commission intends to monitor progress towards the implementation of this Recommendation, taking into account Member States' strategies or strategic approaches, and including the specific outcomes and impacts on the provision of digital skills and competences. This should be done within the European Education Area and its Education and Training Monitor, and as part of the Member States' reporting through the Digital Decade. The progress made towards implementing this Recommendation should be assessed no later than five years after its adoption (i.e. before November 2028).

The Skills Agenda, adopted in July 2020, is a five-year plan to help individuals and businesses develop more and better skills for resilience, recovery and for a fair and just green and digital transition. The Skills Agenda supports the development of digital skills with specific initiatives such as "Skills to support the green and digital transitions" or "Increasing STEM graduates, fostering entrepreneurial and transversal skills", among others, Digital Crash Courses for SMEs and "digital volunteers" programme to upskill the current workforce in digital areas, and ICT-Jump-Start trainings to provide short-term intensive training to tackle ICT skills shortages, with a focus on gender-balanced participation.

The first of the flagship action of the Skills Agenda is the EU Pact for Skills, a shared engagement model for skills development in Europe addressing up- and re-skilling to support a fair and resilient recovery and deliver on the ambitions of the green and digital transit ions. Signatories of the Pact are strongly encouraged to translate their engagement into concrete commitments on upskilling and reskilling. Under this initiative, the Large-Scale Skills Partnership in the digital ecosystem counts close to 150 members working together for the up and reskilling of the workforce in the ecosystem.

The Skills Agenda contribute to achieving the objectives of the Digital Compass, which translates the EU's digital ambitions for the next decade into clear, concrete targets, setting out a European way for the digital decade. Specifically, the Digital Compass puts forward the target of reaching by 2030 20 million ICT specialists (with convergence between man and women) and the minimum of 80% of the population to have acquired digital skills.

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

Pan-European digital competences (e-competences) frameworks and tools, as well as efficient and interoperable digital-learning solutions are indispensable for reducing digital skills shortages, gaps and mismatches. Similar activities are under development in the United States, Russia, Japan, Australia, Canada, South Africa and Latin America, and other parts of the world. In the Council Conclusions of 23 November 2007, Member States supported the Commission's intention to continue to provide a platform for the exchange of best practices, and to promote a regular dialogue on digital skills (e-skills) and develop a European e-Competence Framework.

Progress has been made with the publication of European Standards that focus on ICT professionals, describing their competences, skills, knowledge.

EN 16234-1 "e-Competence Framework (e-CF) — A common European Framework for ICT professionals in all sectors" and EN 17748-1 "Foundational Body of Knowledge for the ICT Profession (ICT BoK)" are available. EN 16234-1 (e-CF) provides a common European description about the competences of the ICT professional workforce applied across 5 proficiency levels that are related to EQF learning levels 3-8, together with key knowledge and skills examples. Its latest review was completed in 2019 (EN 16234-1:2019). To complement this, EN 17748-1 "Foundational Body of Knowledge for the ICT Profession (ICT BoK)" became available in 2022, aligning e-competences in a structured way with knowledge units within the ICT profession. Both standards are governed by CEN/TC 428 "ICT Professionalism and Digital Competences". This committee has also developed a series of Technical Specifications and Reports (TS and TR) guiding on standards implementation, together with further specifications in support of the ICT profession. (see Section C.1 about standardisation Activities)

CEN/TC 428 webpage: https://standards.cencenelec.eu/dyn/www/f?p=205:7:0::::FSP_ORG_ID:1218399&cs=16D-21D7497970A5A38FB4CCE737358BFE

Launched in 2016, the Digital Skills and Jobs Coalition is bringing together Member States, companies, social partners, non-profit organisations and education providers, who take action to tackle the lack of digital skills in Europe. In 2013, the DigComp framework was presented in which the key components of digital competence are summarised in five areas.

(A.3) REFERENCES

- COM(2020) 624 Communication "*Digital Education Action Plan 2021-2027 — resetting education and training for the digital age*" outlining the European Commission's vision for high quality, inclusive and accessible digital education in Europe in a lifelong learning perspective. It is a call to action for stronger cooperation at EU level and foresees the development of digital skills as one of two strategic priorities, with 7 dedicated actions that contribute to enhancing the digital skills of all citizens.
- COM(2020) 274 Communication "*The European Skills Agenda — for sustainable competitiveness, social fairness and resilience*" which is a five-year plan to help individuals and businesses develop more and better skills, by strengthening sustainable competitiveness; ensuring social fairness; and building resilience to react to crises, based on the lessons learnt during the COVID-19 pandemic
- COM (2018) 22 On 17 January 2018 the Commission published the first "*Digital Education Action Plan*" to support technology-use and digital competence development in education (primary, secondary, higher education).
- Council Recommendation (2018/C 189/01) *on key competences for lifelong learning*
- COM(2016) 381 On 10 June 2016 the European Commission published *"A new skills agenda for Europe — Working together to strengthen human*

capital, employability and competitiveness". It presents a number of actions and initiatives aiming to tackle the digital skills deficit in Europe. One of these actions is the launch in December 2016 of the Digital Skills and Jobs Coalition to develop a large digital talent pool and ensure that individuals and the labour force in Europe are equipped with adequate digital skills. This new coalition builds on the work already done under the *Grand Coalition for Digital Jobs* and the EU e-skills strategy, and will bring together a broader set of stakeholders beyond ICT-sector, including ICT-using sectors, training organisations, academia, social partners and Member States.

- COM(2016) 180 On 18 April 2016 the European Commission published the Communication *Digitising European industry*, which introduced a set of coherent policy measures as part of a digital single market technologies and public service modernisation package. Part of the communication is devoted to digital skills. In particular, it calls for human capital ready for the digital transformation with the necessary skills.
- COM(2013)654 Communication *Open up education: innovative teaching and learning for all through new technologies and open educational resources*".
- IP/13/182 *Grand coalition for digital jobs*

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

General recommendation: Standardisation proposals must be based on clear and well-defined market needs and be developed in full coherence with multi-stakeholder initiatives and public policies in this area. These include relevant European Commission's Communications: "*e-Skills for the 21st Century" (2007)*; "*Digitising European Industry" (2016); "European Skills Agenda"* (2020) as well as the on-going *Digital Skills and Jobs Coalition and a Blueprint for Sectoral Cooperation on Skills; and "Digital Education Action Plan" (2020).* The aim is to reduce skills shortages, gaps and mismatches; foster ICT professionalism and digital competence; and further mature the ICT profession, building on the European e-competence framework for ICT professionals and the digital competency framework for citizens.

Relevant stakeholders from the ICT sector, the education sector and policy makers are encouraged to join and engage into standardisation activities to continue ensuring that the standards developed are aligned with the various needs and adhere as much as possible to the goals of these stakeholders.

The public and private sectors need to collaborate on the following topics :

ACTION 1: SDO to make further progress towards a comprehensive framework for ICT professionals integrating four building blocks: (1) European e-competence framework (e-CF) and related job profiles, (2) foundational body of knowledge, (3) qualifications and certifications, and (4) ethics and values. This must now be complemented by relevant methods and tools for the further development, efficient implementation and regular maintenance of this framework to facilitate continued adoption by all relevant stakeholders and to strengthen ICT professionalism in Europe and foster balanced international dialogue and cooperation on this subject

- Continued action is needed to support all stakeholders active within the ICT professional ecosystem (i.e. supply and demand organisations, businesses of all sizes in all sectors, multinationals and SMEs, Human Resources departments, ICT professionals and digital leaders, and education and training) providers on how to apply these standards for ICT professional workforce development in the short, mid and long term. Effective tools and precise guidelines need to be maintained, along with case studies to illustrate practical implementation.
- Taking into account that the digital sector is rapidly evolving, the CEN/TC428 provided standards need regular review and update in a consistent and integrated manner. In particular, the next update of EN 16234-1 (e-CF) which has significant impact on critical areas of the European ICT Professional eco-system and digital infra-structure across European economy and society is overdue and must not be delayed any further.
- Consideration must also be given to the competence areas identified in the Blueprint for Sectoral Cooperation on European Skills Agenda plans for specific ICT areas, in particular software, blockchain, cybersecurity, Artificial Intelligence (AI) and digital sustainability (twin transition). There are significant projects in these topics that shall form the basis of further standards development to underpin the results of these projects and to provide a sound return on investment in the work, assisting the

supply of urgently required skills, and attracting more entrants to the ICT profession across sector and technology domains.

ACTION 2: Organisational capability: take stock of ongoing assessments, initiatives and their impacts regarding the capability of organisations (such as the report on Digital organisational frameworks and IT professionalism) in the context of the digital skills/e-competence of the personnel. Match personnel competence with organisational processes and procedures to ensure best return on investment in ICT.

ACTION 3: International cooperation: European SDOs need to coordinate and establish a regular dialogue and cooperation with international level with relevant associations (IEEE, ACM etc.) and standardisation bodies (ISO, NIST, IEEE etc.) in the field of ICT professionalism and digital competence.

ACTION 4: The consolidation of ICT professional framework that includes the European e-Competence Framework (EN 16234-1:2019) has been advanced following the publication of the outputs of additional work items CEN/TR 17748-1 (Foundational Body of Knowledge for the ICT Profession (ICT BoK), CEN/TR 17802 (e-Competence performance indicators and common metrics), CEN/TS 17699 (Guidelines for developing ICT Professional Curricula as scoped by EN16234-1 (e-CF) and CEN/TS 17834 (European Professional Ethics Framework for the ICT Profession (EU ICT Ethics)).

This work should be the basis for a new coherence in the definition and promotion of digital user skills (non-professional). Definition of digital skills at all levels, via a common language, avoids confusion and facilitates a progression in skills development that is appropriate for citizens in all walks of life, and also for addressing the skill and competence needs of the ICT profession. A planned coordination of outputs, like the e-Competence Framework and DigComp can broaden the influence of both constituencies, and the resulting beneficial impact on the development of high level professional skills, and is therefore an essential part of this work. New standards work items in this regard will be particularly important to leverage this synergy.

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

CEN

CEN/TC 428 'ICT Professionalism and Digital Competences' is responsible for the standardisation of a common language of professional ICT and digital competences, skills and knowledge applied in all domains. A non-exhaustive list of areas where CEN/TC 428 can develop its activity follows:

EN 16234:2019 (e-CF) maintenance and evolution

Interaction with different Frameworks

Curricula guidance

Professional profiles

Provide guidance for the assessment against EN 16234 (e-CF)

Interaction with different related frameworks (e.g., DigComp, ISO)

CEN/TC 428 - ICT Professionalism and Digital Competences published standards:

EN 16234-1:2019 e-Competence Framework (e-CF) - A common European Framework for ICT Professionals in all sectors - Part 1: Framework

CEN/TR 16234-2:2021 e-Competence Framework (e-CF) - A common European Framework for ICT Professionals in all sectors - Part 2: User Guide

CEN/TR 16234-3:2021 e-Competence Framework (e-CF) - A common European Framework for ICT Professionals in all sectors - Part 3: Methodology

CEN/TR 16234-4:2021 e-Competence Framework (e-CF) - A common European Framework for ICT Professionals in all sectors - Part 4: Case Studies

EN 17748-1:2022 Foundational Body of Knowledge for the ICT Profession (ICT BoK) - Part 1: Body of Knowledge

CEN/TR 17748-2:2022 Foundational Body of Knowledge for the ICT Profession (ICT BoK) - Part 2: User Guide and Methodology

CEN/TR 17802:2022 e-Competence performance indicators and common metrics

CEN/TR 17884:2022 ICT accessibility competences - Guidelines for a more inclusive ICT development

CEN/TS 17699:2022 Guidelines for developing ICT Professional Curricula as scoped by EN 16234-1 (e-CF)

CEN/TS 17834:2022 European Professional Ethics Framework for the ICT Profession (EU ICT Ethics)

The CEN workshop on ICT Skills has been definitively replaced by the CEN/TC 428 since 2014.

IEEE

IEEE 1484.20.2, Recommended Practices for Defining Competencies

IEEE 3527.1, Standard for Digital Intelligence (DQ) - Framework for Digital Literacy, Skills, and Readiness

IEEE P1484.2, Interoperable Learner Records (ILR) Recommended Practices

IEEE P1484.20, Competency Data Standards

IEEE P1484.20.3, Standard for Reusable Competency Definitions

IEEE P2955, Recommended Practice for Creating Self Learning Tutorials and Side by Side Learning

IEEE P2997, Enterprise Learner Record

IEEE P3202, Standard for Capability Evaluation Requirements of Blockchain Practitioners

IEEE P7015, Standard for Data and AI Literacy

For more information, see: https://ieee-sa.imeetcentral.com/eurollingplan/.

ISO/IEC JTC1

SC 27 "Competence requirements for information security management systems professionals"

SC 7/WG 20 "Software and Systems Bodies of Knowledge and Professionalisation and related activities"

SC 36 "Information Technology for Learning Education and Training" has in particular the following published standards of relevance:

ISO/IEC 2382-36: Information Technology - Vocabulary - Part 36: Learning, Education and Training

ISO/IEC 19788 All parts: Information technology — Learning, education and training — Metadata for learning resources

ISO/IEC 20013: Information technology for learning, education and training — Reference framework of e-Portfolio information

ISO/IEC 22602: Information technology — Learning, education and training — Competency models expressed in MLR

ISO/IEC 23126: Information technology for learning, education and training — Ubiquitous learning resource organization and description framework

ISO/IEC 23127: Information technology — Learning, education, and training — Metadata for facilitators of online learning

ISO/IEC TR 20748: Information technology for learning, education and training — Learning analytics interoperability

ISO/IEC TR 20821: Information technology — Learning, education and training — Learning environment components for automated contents adaptation

ISO/IEC TR 23842: Information technology for learning, education and training — Human factor guidelines for virtual reality content

See https://www.iso.org/committee/45392/x/catalogue/p/1

ITU

ITU-T Study Group 20 approved Recommendation ITU-T Y.4485 "Requirements and Reference Architecture of Smart Education" and is currently working on draft Recommendation ITU-T Y.4234 (ex Y.RemoteEd) "Requirements, capabilities and deployment models for e-learning in remote classrooms", draft Recommendation ITU-T Y.IoT-smartschool "Requirements of IoT-based smart school management system", draft Recommendation ITU-T Y.Evaluation-SE "Evaluation of capabilities for IoT-enabled frameworks of smart education" and draft Supplement ITU-T Y.Sup.IoT-SEDR "Functional framework and capability for digital resources in smart education based on IoT".
More information can be found here: https://itu.int/go/tsg20.

(C.2) ADDITIONAL INFORMATION

This topic is suitable for standardisation for well-documented needs. Fostering ICT professionalism is a challenging task and is essential to ensure that the European economy has the supply of professional skills that it needs and that are currently not being delivered in sufficient numbers. Digital skills must also be provided, at appropriate levels, to the whole population, including those who usually find more barriers in accessing ICT, such as old people and people with disabilities. Efforts to facilitate this cohort of people could include accessible e-learning environments, such as accessible MOOCs. As new technologies and new areas of their application emerge rapidly, establishing standardised skill sets is a great challenge requiring timely and regular updates. Since the 1990s, this topic has primarily been addressed by public-private partnerships with the ICT industry. More recently, many countries around the world have launched standardisation efforts. There is a need to maintain a European platform for exchanging best practices, implementing a master plan and coordinating across Europe. The existing structure of the CEN TC 428 - ICT Professionalism and Digital Competences - constitutes a good place for such a piece of work — following the already successful development of the e-CF.

The **e-Skills Manifesto** also contains contributions from various stakeholders. See: http://ec.europa.eu/DocsRoom/documents/21341/attachments/1/translations/en/renditions/pdf

EN 16234-1 (e-CF) and the accompanying European ICT Professional Role Profiles (CWA 16458-1) has been successfully implemented by ENISA in providing the European Cybersecurity Skills Framework (ECSF) for cybersecurity professionals in 2022. The European Cybersecurity Skills Framework (ECSF) is a practical tool to support the identification and articulation of tasks, competences, skills and knowledge associated with the roles of European cybersecurity professionals. It is the EU reference point for defining and assessing relevant skills, as defined in the Cybersecurity Skills Academy, which was recently announced by the European Commission. The EN16234-1 (e-CF) is applied furthermore in several (ongoing) large European sectoral Blueprint projects, such as the European Software Skills Alliance (ESSA), Artificial Intelligence Skills Alliance (ARISA) and Digital4Sustainability.

Development of CWA's building on these projects' results supports their sustainability while at the same time generating valuable applications of the e-C, supporting ICT professionalism in areas of specialisation such as Software, AI and Sustainability.

3.2.3 Digital learning

A Policy and legislation

(A.1) POLICY OBJECTIVES

The development of digital education is currently a political priority for the European Commission and for Member States. In her political guidelines, President von der Leyen highlighted the need to unlock the potential of digital technologies for learning and teaching and to develop digital skills for all. Digital is one of the 6 Commission priorities for 2019-2024 with a dedicated digital strategy to empower people with a new generation of technologies, named "A Europe Fit for the Digital Age". The policy objective is to support education and training in their digital transition. President von der Leyen announced in her 2021 State of the Union address that digital education and skills "need leaders' attention and a structured dialogue at top-level". As a result, the Commission announced the kick-off of the Structured Dialogue with Member States on digital education and skills. The objective of the dialogue is to increase the political visibility and commitments on digital education on skills. The dialogue aims to bring together the different strands of policy into a strong integrated, coherent and more ambitious approach and make the most of the synergies between the different policy fields – education, digitalization, labour, finances. The dialogue encompasses different branches and institutions of government, as well as the private sector, social partners and civil society.

The Digital Education Action Plan (2021-2027) is a renewed European Union (EU) policy initiative adopted in September 2020 to support the sustainable and effective adaptation of the education and training systems of EU Member States to the digital age. It offers a long-term strategic vision for high-quality, inclusive and accessible European digital education and supports the development of digital skills for all in a lifelong learning perspective. The Action Plan seeks stronger cooperation at the EU level on digital education and underscores the importance of working together across sectors. The Digital Education Action Plan 2021-2027 sets out a vision for digital education and skills. In order to achieve this vision, the Action Plan covers two priority areas: 1) Fostering the development of a high-performing digital education ecosystem; 2) Enhancing digital skills and competences for the digital transformation. As part of the implementation of the

Action Plan, two Council Recommendations in the area of digital education and skills were adopted by by the Education, Youth, Culture and Sport (EYCS) Council the Council in November 2023. The two proposals correspond to the two strategic priorities of the Digital Education Action Plan. The Council Recommendation on the key enabling factors for successful digital education and training articulates the **vision for universal access to inclusive and high-quality digital education and training**, for everyone, in formal education and training, set out in the Digital Education Action Plan. The Council Recommendation on improving the provision of digital skills and competences in education and training aims to support Member States in facing common challenges related to the level of digital skills of different segments of the population and the ability of their education and training systems to support its provision from a lifelong learning perspective. T

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

Efficient, accessible, affordable and interoperable digital learning solutions are necessary to promote the development of a large digital learning and technology-enhanced learning market in Europe. It is vital to ensure everyone's right to access education and lifelong learning.

The forced closure of schools and campus buildings in spring 2020 due to the Covid-crisis has pushed educators and students into teaching and learning with digital technology at a scale never seen before. Experience from the Covid-Crisis resulted in lasting innovations in education, particularly in the acceptance of hybrid/blended forms of education.

The shift to remote teaching and learning resulted in a surprising continuity in education but also revealed flaws and weaknesses regarding digital skills and competences levels in the population, access to infrastructure and the availability and usability of quality digital resources and platforms. Many teachers lacked experience and training - technical and pedagogical – for teaching with digital technologies, including in remote settings. Students too faced new challenges learning at home, including being able to use digital tools and resources independently, efficiently and safely.

Lessons should be learned from this and digital learning should be made understandable, pedagogically sound, usable and accessible for all learners, including those with additional needs. Digital learning also provides an opportunity to foster skills regarding accessibility using a design for all approach.

Standardisation can also contribute to safer and more open, understandable and adaptable technological support for teachers. However, standardisation must not reduce the professional autonomy of teachers, as this undermines the pluriformity of the education system.

ICT standardisation can help to ensure that teachers understand technology and have the competences to apply and embed it appropriately in their teaching. This concerns specifically teachers' awareness of the opportunities and risks with data analytics and algorithms. Teachers must be able to understand how data are gathered and processed, and judge whether this contributes to more personalised and effective teaching and learning.

Exchange of best practices in the pedagogical, ethical, organisation, logistical and standardization aspects of education should not only take place between national governments and experts, but also between executive organisations and consultancies that implement digital education in the EU Member States. These are the organisations that can bring experiences of education institutions and professionals to practice. The governance for realizing the European Education Area linked to the EU Action Plan Digital Education should be fully exploited.

Within this frame of reference the European Edtech Alliance (EEA), a consortium of national trade associations and clusters working with founders and providers of education technology, aims to support the growth of the European Edtech sector, and to connect and strengthen the pan-European Edtech ecosystem: https://www.edtecheurope.org

(A.3) REFERENCES

COM(2020) 624 Communication "*Digital Education Action Plan 2021-2027 — resetting education and training for the digital age*" outlining the European Commission's vision for high quality, inclusive and accessible digital education in Europe. It is a call to action for stronger cooperation at EU level to learn from the COVID-19 crisis and make education and training systems fit for the digital age.

COM(2020) 274 Communication "*The European Skills Agenda — for sustainable competitiveness, social fairness and resilience*" which is a five-year plan to help individuals and businesses develop more and better skills, by strengthening sustainable competitiveness; ensuring social fairness; and building resilience to

react to crises, based on the lessons learnt during the COVID-19 pandemic

COM (2018) 22 On 17 January 2018 the Commission published the "*Digital Education Action Plan*" to support technology-use and digital competence development in education. A new Action Plan is foreseen for adoption in September 2020.

Council Recommendation (2018/C 189/01) *on key competences for lifelong learning*

COM(2016) 381 On 10 June 2016 the European Commission published *"A new skills agenda for Europe — Working together to strengthen human capital, employability and competitiveness"*. It presents a number of actions and initiatives aiming to tackle the digital skills deficit in Europe. One of these actions is the launch in December 2016 of the Digital Skills and Jobs Coalition to develop a large digital talent pool and ensure that individuals and the labour force in Europe are equipped with adequate digital skills. This new coalition builds on the work already done under the *Grand Coalition for Digital Jobs* and the EU e-skills strategy, and will bring together a broader set of stakeholders beyond ICT-sector, including ICT-using sectors, training organisations, academia, social partners and Member States.

COM(2016) 180 On 18 April 2016 the European Commission published the Communication *Digitising European industry*, which introduced a set of coherent policy measures as part of a digital single market technologies and public service modernisation package. Part of the communication is devoted to digital skills. In particular, it calls for human capital ready for the digital transformation with the necessary skills.

COM(2013)654 Communication *Open up education: innovative teaching and learning for all through new technologies and open educational resources*".

IP/13/182 *Grand coalition for digital jobs*

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

General recommendation: Standardisation proposals must be based on clear and well-defined market needs and be developed in full coherence with multi-stakeholder initiatives and public policies in this area. These include relevant European Commission's Communications: "*e-Skills for the 21st Century" (2007)*; "*Digitising European Industry*" *(2016);"European Skills Agenda"* (2020) as well as the on-going *Digital Skills and Jobs Coalition and a Blueprint for Sectoral Cooperation on Skills; and "Digital Education Action Plan" (2020).* The aim is to reduce skills shortages, gaps and mismatches; foster ICT professionalism and digital competence; and further mature the ICT profession, building on the European e-competence framework for ICT professionals and the digital competency framework for citizens.

Relevant stakeholders from the education sector, EdTech industry and policy makers are encouraged to join and engage into standardisation activities to ensure that the European EdTech standards developed support how schools would like to use technology to reach their educational and pedagogical goals. At the same time we need to ensure that requirements are implementable by the EdTech industry, where EdTech products developed, based on developed standards supports the goal of the Commission.

ACTION 1: European digital learning standards to facilitate large scale adoption of best practices and solutions on a voluntary basis. The focus should be on specifications and guidelines for digital learning opportunities designed for all kinds of users, learning outcomes, credit points, assessment**,** micro-credentials and e-portfolios.

ACTION 2: Standardisation potential around digital learning services and tools: SDO to investigate digital learning courses and resources, content repositories and exchange mechanisms with a focus on data privacy including metadata, learning design and structure, technical and semantic interoperability supported by agreed protocols, exchange formats and vocabularies and data governance. Interoperability should include context-aware, adaptable and mobile/ambient e-learning systems and cross-domain aspects. This may include the learning trajectory or learning route including, e.g. the didactic approach, aimed learning & learner's profiles and the availability of additional tools that support digital learning. End users (learners and educators) should be involved in the design, testing and development of digital learning solutions and digital pedagogical services to ensure adoption in the different educational practices. Recent developments regarding the use of AI in education (e.g. for assessment and personalised learning) and related regulatory and ethical requirements from the European AI Act should be taken into account.

ACTION 3: Standardisation potential around interoperability and transfer of learners' data: SDOs should investigate standardising the exchange of learning data across diverse learning environments,

aligned with EU initiatives on e-Identity, e-Wallets, and the European Student Card. This should include secure use of student identifiers following ePrivacy objectives.

ACTION 4: European guidelines on ensuring accessible and inclusive digital learning: These guidelines should be based on a design-for-all approach to facilitate learning for diverse range of users, including learners with disabilities ensuring everyone has equal access to equivalent digital learning tools and services.

ACTION 5: SDOs to review and update available standards like the eCompetence Framework in order to address a situation like confinement and to better equip citizens with needed digital skills and technologies for use cases like remote working, e-learning and distance learning including in particular online teaching of schools, universities, online exams, training - and in general use cases around the digital transformation including the topic of security and privacy. This action is also relevant to the 3.2.6. Pandemic Preparedness chapter.

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

CEN

CEN/TC 353 - "Information and Communication Technology for Learning, Education and Training" has the following published standards of relevance:

CEN/TC 353 is responsible for the development of standards in the field of information and communication technologies supporting all aspects of learning, education and training. The European Standards (EN),
Technical Specifications (TS) and Technical Reports (TR) developed will support European policies with regard to all levels, modes and types of learning. The goal of this committee is to develop, support and facilitate a more harmonized European EdTech ecosystem that gives value to all stakeholders, users and beneficiaries of all aspects of learning technologies.'

CEN/TC 353 has the following published standards of relevance:

- EN 15981: European Learner mobility - Achievement information (EuroLMAI)
- EN 16425: Simple Publishing Interface
- EN 15982: Metadata for Learning Opportunities (MLO) - Advertising
- EN 15943: Curriculum Exchange Format (CEF) – Datamodel

See CEN/TC 353 Published Standards.

Several new working groups have been created, and may be expected to produce new standards or adopt existing standards:

- CEN/TC 353/WG 3 - API and data model for personal and organizational related information
- CEN/TC 353/WG 4 - Common secure Identify and Access Management (IAM) system and Secure Single Sign On and attributes for users within educational institutions
- CEN/TC 353/WG 5 - Common methods and procedures for reporting data produced by learners using digital resources and governance of the same data (xAPI statements)
- CEN/TC 353/WG 6 - Secure cyber ecosystem of digital resources, tools and services
- CEN/TC 353/WG 7 - Blockchain-based academic certificates complying with GDPR

CEN/CT 353 wishes to create a clear picture of how news technology could be used. This approach will support the emerging of new ways of training and proposes a state of the art assessment not only related to the EdTech experience of European Universities and training institutions but studies the really training potential of modern ICT and emerging technology such as virtual and augmented reality, gamification, simulation, etc. as well.

IEEE

IEEE/LTSC - "Learning Technology Standards Committee"

IEEE P1484.2, Recommended Practices for Learning and Employment Record (LER) Ecosystems

IEEE P1484.20, Competency Data Standards

- IEEE 1484.20.2, Recommended Practices for Defining Competencies
- IEEE 1484.20.3, Standard for Reusable Competency Definitions

IEEE 1589, Standard for Augmented Reality Learning Experience Model

IEEE P2247.2, Standard for Interoperability for Adaptive Instructional Systems

IEEE P2247.4 , Recommended Practice for Ethically Aligned Design of Artificial Intelligence in Adaptive Instructional Systems

IEEE P2834, Standard for Secure and Trusted Learning Systems (co-standards committee)

IEEE P2881, Standard for Learning Metadata

IEEE P2955, Recommended Practice for Creating Self Learning Tutorials and Side by Side Learning

IEEE P2997, Enterprise Learner Record

IEEE P7004, Child and Student Data Governance (CSDG)

IEEE P7015, Standard for Data and AI Literacy (co-standards committee)

IEEE P9274, Experience API (xAPI)

- IEEE 9274.1.1, JavaScript Object Notation (JSON) Data Model Format and Representational Stat Transfer (RESTful) Web Service for Learner Experience Data Tracking and Access
- IEEE P9274.4.2, Recommended Practice for Cybersecurity in the Implementation of the Experience Application Programming Interface (xAPI)

- IEEE P9274.2.1, xAPI Standard for JavaScript Object Notation for Linked Data (JSON-LD) for Application Profiles of Learner Experience Data
- IEEE P9274.3.1, xAPI Standard for Packaging, Launch, and Run-time of Experience Application Programming Interface (xAPI) in Session-based Learning

There also are relevant IEEE pre-standards activities, including:

Industry Consortium on Learning Engineering (ICICLE)

Digital Resilience—Tools and Methods to Support Response and Recovery from Crises, and specifically its sub-committee on eResilience in Education Systems

For more information, see: https://ieee-sa.imeetcentral.com/eurollingplan/.

ISO/IEC JTC 1 SC 36

Subcommittee (SC) 36 on Information Technology for Learning, Education and Training (ITLET) has the following work programme underway:

http://www.iec.ch/dyn/www/f?p=103:22:0::::FSP_ORG_ID:3410

Standards to ensure interoperability between information technology systems used in ITLET;

The identification of generic LET requirements for information technology systems and services used in ITLET situations (example: types of digital content)

Standards projects being addressed:

The description of metadata for learning resources

- ITLET vocabularies
- the personalization of the IT-enabled educational environment (individualized accessibility)
- models for describing competency
- the creation of an ITLET quality framework
- the advancement of e-Assessments, e-textbooks and related learning services, virtual experiments

Future work planned

- learning analytics
- massive open online course (MOOC) standardisation
- how existing standards and specifications may work together to better the LET environment
- ISO TR 20514: EHR Definition scope and context

http://www.iso.org/iso/home/standards_development/list_of_iso_technical_committees/iso_technical_committee.htm?commid=45392

ITU-T

ITU-T SG16 on multimedia has produced a series of standards that enable remote collaboration, e.g. Recommendation ITU-T F.742 on service description and requirements for distance learning services.

http://itu.int/ITU-T/go/tsg16

ITU-T SG13 approved Recommendation ITU-T Y.2241 "Service framework to support web objects based ubiquitous self-directed learning", Y.2246 "Smart farming education service based on u-learning environment" and Y.2248 "Service model for entry-level smart farms".

ITU-T SG13 also developed Recommendation ITU-T Y.3117 "Quality of service assurance-related requirements and framework for smart education supported by IMT-2020 and beyond" and Y.3122 "Quality of service assurance requirements and framework for smart grid supported by IMT-2020 and beyond".

http://itu.int/ITU-T/go/tsg13

The ITU also published a technology watch report on technology-based learning.

http://itu.int/en/ITU-T/techwatch/Pages/learning-standards.aspx

ITU-T Study Group 20 approved Recommendation ITU-T Y.4485 "Requirements and Reference Architecture of Smart Education" and is currently working on draft Recommendation ITU-T Y.4234 (ex Y.RemoteEd) "Requirements, capabilities and deployment models for e-learning in remote classrooms", draft Recommendation ITU-T Y.IoT-smartschool "Requirements of IoT-based smart school management system", draft Recommendation ITU-T Y.Evaluation-SE "Evaluation of capabilities for IoT-enabled frameworks of smart education" and draft Supplement ITU-T Y.Sup.IoT-SEDR "Functional framework and capability for digital resources in smart education based on IoT".

More info: https://itu.int/go/tsg20

(C.2) ADDITIONAL INFORMATION

Many alliances and organisations, including NRENs, EMREX, and Géant, are collaborating under the European Digital Education Hub on a comprehensive framework for Higher Education interoperability, addressing not only data transfer but broader interoperability needs for cooperation and mobility among universities. The Europass initiative has provided valuable semantic standardisation with ELM; this should be aligned with existing standards used in student exchange (e.g., Erasmus+). The Higher Education Interoperability Framework, developed by DG EAC. C4 with European University alliances as testbeds, supports the interconnection of HEI ICT systems and joint provision of education, aligning with the European Interoperability Framework (EIF).

EUROPEAN AGENCY FOR SPECIAL NEEDS AND INCLUSIVE EDUCATION/DAISY CONSORTIUM/EUROPEAN SCHOOLNET/ GLOBAL INITIATIVE OF INCLUSIVE ICTS/ INTERNATIONAL ASSOCIATION OF UNIVERSITIES/UNESCO

The ICT4IAL project is a multi-disciplinary network of European and international partners that represent both learning and ICT communities. This network was co-funded by the European Commission under the Lifelong Learning Transversal Programme, Key Activity

3: Information and Communication Technologies. The project aims to:

1. Raise awareness and increase the visibility of the issue of accessible information provision and its relevance for equitable lifelong learning opportunities;

2. Support accessible information provision within organisations through the development, trialling and evaluation of guidelines that build upon already existing work in the field.

https://www.ict4ial.eu/project-aims

TRUST FRAMEWORK FOR EDTECH IN EDUCATION

The Collaborative Trust Framework for EdTech (https://trustframework.io) is a relevant European initiative to drive standardisation in EdTech. The Trust Framework is a set of trust components worked out into deployable principles. It's designed for EdTech Founders, that want to build a long-lasting, trustworthy business with a perpetual positive effect on (public) education.

GÉANT (WWW.GEANT.EU)

The cooperation between the national research and education networks, has a prominent role in effectuating standards for interinstitutional interoperability in the higher education sector. Notable is their role with regard to the AARC-framework (aarc-project.eu), which assures European/international cross-institutional interoperability for authentication and authorization.

1EDTECH (1EDTECH.ORG)

defining various educational 'industry' standards for interoperability of educational applications. The organization is US-based, with a European branch. Notable is their effort to convert the OpenBadges standard (used in microcredentials) towards compatibility with the w3c standards for verifiable credentials.

3.2.4 eGovernment

A Policy and legislation

(A.1) POLICY OBJECTIVES

In the digital single market strategy, interoperability appears as an important enabler for boosting competitiveness. Cross-border interoperability is also considered key for modernising public administrations. At the European level, the Once Only Principle has for the first time been mandated by the implementation, as established by the Single Digital Gateway Regulation, of a technical system that allows the cross-border exchange of evidence relevant for the procedures under such regulation. The **Once Only Principle** entails that public administrations do not request from citizens and businesses to provide data that are already held by any public competent authority -even foreign authorities-, but take actions to share these data always in respect of data protection regulations and other applicable legal requirement, so citizens and businesses are requested to provide data of each type at most only once.

In addition to the multilingual challenge, semantic interoperability is compromised by the lack of commonly agreed and widely used data models, divergent interpretations of the same data and the absence of common reference data (e.g. code-lists, identifiers, taxonomies, references to organisations, geospatial references, license collections, etc.).

The European Commission, in the context of the former ISA2 programme (Interoperability solutions for European Public Administrations, Businesses and Citizens) currently Interoperable Europe (https://joinup.ec.europa.eu/collection/interoperable-europe/interoperable-europe), undertook a number of initiatives to achieve semantic interoperability in Europe.

The former ISA2 programme contributed in this area through several streams of work, focusing on the development, promotion and management of common data specifications, further described in the relevant subsections: DCAT-AP as a data standard to describe open data catalogues and datasets; ADMS-AP 2.0 as metadata description of reusable solutions, such as legal templates, data specifications and standards, technical protocols and open source software; European Legislation Identifier (ELI) to facilitate the exchange of legislation data in Europe; and Core Vocabularies as generic, simplified and reference data models

of important master data types used across public administration information systems and applications, such as persons, businesses, locations, public organisations and public services. Work performed by the former ISA2 programme is continued through the Digital Europe Programme Regulation (Regulation (EU) 2021/694) by the current Interoperable Europe. In the Digital Europe Programme, the need for sematic interoperability is highlighted for the creation of the common European data spaces, a concept introduced by the European Strategy for Data as well as an enabler to seamless and secure cross-border electronic communication.

The Interoperable Europe Act (Regulation - EU - 2024/903 - EN - EUR-Lex (europa.eu)), which entered into force on 11 April, aims to help governments and public administrations to cooperate, share information and deliver public services seamlessly across borders, sectors and organizational boundaries.

The Act will be the implemented through a set of measures, which can be summarised by the following four pillars:

- The setup of a multi-level governance framework to define the interoperability agenda, including the needs for common interoperability solutions.
- The introduction of mandatory interoperability assessments for the interoperable-by-design public services, starting from January 2025. This obligation will help public sector bodies to explore and, where appropriate, address cross-border interoperability aspects at the policy design phase.
- Mainstreaming of the sharing and reusing of interoperability solutions among public administration, powered by the one-stop-shop for solutions 'Interoperable Europe Portal'.
- A strengthened innovation and policy support, including training, regulatory sandboxes for policy experimentation, GovTech and policy implementation support projects, to develop, test and scale up

The Act establishes *an interoperability governance structure for public administrations across the EU to agree on shared interoperability solutions, such as frameworks, open specifications, open standards, applications, or guidelines*. At the centre of this governance is the 'Interoperable Europe Board', consisting of representatives from Member States and the Commission. The Board's tasks include recommending Interoperable Europe Solutions, proposing measures to relevant standardisation organisations and bodies to contribute to European standardisation activities and collaborating with international bodies (including on open source solutions, open standards or specifications) that could contribute to the development of the cross-border interoperability.

The Interoperable Europe Community brings together a broad set of interested practitioners and experts, for instance, from GovTech companies, the Open Source community, regions and cities across the EU to help implement new solutions.

Furthermore, the Act strengthens the role of the European Interoperability Framework by mandating the Interoperable Europe Board to develop the EIF and ensure its future evolution, and ensuring that EIF is applied in its operational and policymaking practice, notably through the interoperability assessment implementation. The new EIF is expected focus on concrete implementation recommendations, including for EU data spaces, in close coordination with the European Data Innovation Board (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2022%3A710%3AFIN).

In all of these work streams, care is taken to ensure compatibility between the public sector and what the private sector can achieve, noting existing standards and specifications. There are accordingly some main technology areas that need to be addressed further and where standards are important for supporting the implementation of EU policy objectives:

- DCAT-AP — This is addressed in detail in the section on Public Sector Information (PSI), Open Data and Big Data including a number of proposed actions;
- Exchange of metadata on re-usable interoperability assets among national and international repositories: The Asset Description Metadata Schema (ADMS) is a metadata description of interoperability solutions;
- Core Vocabularies to facilitate the development of interoperable IT solutions by ensuring a minimum level of interoperability for public administration master data usually stored in base registries.
- The CPSVP-AP aims at describing public services in the same way across different Service Catalogues, to enable federation and search across such catalogues.

The European interoperability framework is a commonly agreed approach to the delivery of European public services in an interoperable manner that defines basic interoperability guidelines in the form of common principles, models and recommendations. It is expected that many recommendations can help also the private sector for B2B, B2G and B2C services. For example, the

European standard on electronic invoicing is based on the concept of semantic interoperability and supports B2B and B2G transactions.

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

In the Digital Single Market strategy, interoperability and reduction of administrative burden appear as important enablers for boosting competitiveness. Cross-border interoperability and data exchange are also considered key for modernising public administrations. At the European level, the Once Only Principle has for the first time been included in the eGovernment Action Plan 2016-2020, where it is one of the underlying principles. Subsequently, Member States have committed themselves to the Once Only Principle, such as in the Tallinn Declaration on eGovernment and the Berlin Declaration on Digital Society and Value-Based Digital Government. Furthermore, the Once Only Principle has been included in article 14 of the Single Digital Gateway Regulation adopted on 2 October 2018. Moreover, the recent Digital Decade Communication, sets that by 2030, everyone should benefit from "a best–in-class digital environment providing for easy-to-use, efficient and personalised services and tools with high security and privacy standards". The implementation of the Once Only Principle is key to reaching this goal.

DCAT-AP

DCAT-AP is a specification based on W3C's Data Catalogue vocabulary (DCAT) for describing public sector datasets in Europe. For more information, see chapter *3.1.3 Data Interoperability.*

EXCHANGE OF METADATA ON RE-USABLE INTEROPERABILITY ASSETS (EGOVERNMENT)

Public administrations, businesses, standardisation bodies and academia are already producing interoperability solutions that, if (re)used, can facilitate interoperability among public administrations' services. However, these are not always easy to find. ADMS-AP 2.0 is a common way to describe interoperability solutions making it possible for everyone to search and discover them once shared through the forthcoming federation of repositories containing solutions for promoting interoperability.

With the intention to facilitate the visibility and re-usability of interoperability solutions across-borders and sectors, the Commission has made available a large set of interoperability solutions described using ADMS-AP 2.0, through a federation of asset repositories of Member States, standardisation bodies and other relevant stakeholders. Through this federation, accessible through the Joinup platform, semantic interoperability solutions may be searched and are made available through a single point of access.

CORE VOCABULARIES TO FACILITATE THE DEVELOPMENT OF INTEROPERABLE IT SOLUTIONS

The Commission's former ISA programme and currently Interoperable Europe is reducing semantic interoperability conflicts in Europe.

Agreement on definitions for the fundamental concepts should come firstly. These concepts are simplified data models which capture the minimal, global characteristics/attributes of an entity in a generic, country- and domain-neutral manner. Using a different terminology, these specifications are data models for important master data types used by numerous information systems and applications. These specifications are called "Core Vocabularies" in the former ISA2 programme, currently Interoperable Europe.

Working together with relevant stakeholders from public administration, industry and academia, the Commission has made available a series of core vocabularies with high reusability potential: the core person, core business, the core location, the core public service, the core public organisation, the core criterion and core evidence, and the core public event vocabularies.

In 2015, the core public service vocabulary application profile (CPSV-AP) also became available. Activities on financial reporting are under consideration.

LEGISLATION INTEROPERABILITY

The European Legislation Identifier (ELI) to make legislation available online in a standardised format including technical specifications on:

- legislation URI - Uniform Resource Identifier
- legislative resource metadata
- information exchange format ontology

Akoma Ntoso for European Union (AKN4EU) is the future machine-readable structured format for the exchange of legal documents in the EU decision-making process.

(A.3) REFERENCES

- Decision (EU) 2015/2240 on interoperability solutions and common frameworks for European

public administrations, businesses and citizens (former ISA2 programme) as a means for modernising the public sector (ISA2)

- Communication 2017/134 on the European Interoperability Framework - Implementation Strategy
- Directive 2003/98/EC of the European Parliament and of the Council of 17 November 2003 on the re-use of public sector information (public service information directive)
- National eGovernment strategies are in place in many EU Member States and the EFTA countries. Please also see Annex I.
- eGovernment Action Plan 2016-2020
- Tallinn Declaration on eGovernment(06.10.2017)
- The Berlin Declaration on Digital Society and Value-based Digital Government
- Regulation (EU) 2018/1724 of the European Parliament and of the Council of 2 October 2018 establishing a single digital gateway to provide access to information, to procedures and to assistance and problem-solving services and amending Regulation (EU) No 1024/2012 (Text with EEA relevance.)
- Regulation (EU) 2021/694 of the European Parliament and of the Council of 29 April 2021 establishing the Digital Europe Programme and repealing Decision (EU) 2015/2240, establishing a new EU funding programme focused on bringing digital technology to businesses, citizens and public administrations.
- Proposal for Regulation on European data governance (Data Governance Act) (EU)2020/0340. The proposal is the first of a set of measures announced in the 2020 European strategy for data. The instrument aims to foster the availability of data for use by increasing trust in data intermediaries and by strengthening data-sharing mechanisms across the EU.
- Europe's Digital Decade: digital targets for 2030
- The European Interoperability Framework (EIF)
- The European Legislation Identifier (ELI)
- Regulation (EU) 2024/903 of the European Parliament and of the Council of 13 March 2024 laying down measures for a high level of public sector interoperability across the Union (Interoperable Europe Act)
- European Data Innovation Board: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2022%3A710%3AFIN

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

ACTION 1: Following the Covid-19 situation and the experience gained with the current level of digitalisation of government services, the European Commission and SDOs to cooperate on analysing the current level of digitalisation and identifying gaps and needs regarding standards to support and further accelerate digitalisation. This should also include best practices.

ACTION 2: European Commission together with SDOs to facilitate a broad exchange with stakeholders and public authorities on standardisation and interoperability for eGovernment services.

ACTION 3: SDOs to identify and inform about standards that are available or under way and that are of relevance in supporting the European Interoperability Framework.

ACTION 4: SDOs to consider with Interoperable Europe and Digital Europe programme the development of a set of standards around the EIF based on the specifications produced by the Interoperable Europe (former ISA2) and the Digital Europe programmes.

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

W3C

The Registered Organization Vocabulary which is based on the Business Core Vocabulary has been published as a W3C Note by the W3C Linked Government Data Working group. http://www.w3.org/TR/vocab-regorg/

The W3C Data Exchange Working Group is chartered to create DCAT Version 3. Latest Draft is always at https://www.w3.org/TR/vocab-dcat-3/ DCAT has known gaps in coverage, for example around time series and versions. DCAT has been successful and is in wide use, but these gaps must be addressed if usage is to continue to grow across different communities and the variety of metadata schemas is to reduce. Maximizing interoperability between services such as data catalogs, e-Infrastructures and virtual research environments requires not just the use of standard vocabularies but of *application profiles*, initially created

by DIGIT. This will also affect some of the Core Vocabularies produced by the Commission.

The Working Group is also tasked to deliver Content Negotiation by Application Profile and guidance on publishing application profiles of vocabularies, but those are not mature yet. More information can be found on the page of the Data Exchange WG: https://www.w3.org/2017/dxwg/wiki/Main_Page

ITU

ITU-T Focus Group on Data Processing and Management (FG-DPM) was created in March 2017. FG-DPM concluded its work with the development of several deliverables covering a variety of topics including the following:

- DPM Framework for Data-driven IoT and Smart Cities and Communities
- Technical enablers for open data platform
- Data interoperability
- Data quality management for trusted data

The complete list of deliverables is available here: https://www.itu.int/en/ITU-T/focusgroups/dpm

ITU-T SG20 is currently working on draft Recommendation ITU-T Y.MIMbased-arch "MIM-based Architectural framework for interoperability in support of data sharing ecosystems", draft Recommendation ITU-T Y.DT-SSC-CVP "Classification of visualization precision levels for digital twin systems in smart sustainable cities" and draft Supplement to ITU-T Y.4563 – Use cases of data interoperability in Internet of things. ITU-T SG20 approved Recommendation ITU-T Y.4505 "Minimal Interoperability Mechanisms for smart and sustainable cities and communities", Recommendation ITU-T Y.4473 "SensorThings API - Sensing", Recommendation ITU-T Y.4560 "Blockchain-based data exchange and sharing for supporting Internet of things and smart cities and communities", Recommendation ITU-T Y.4561 "Blockchain-based Data Management for supporting Internet of things and smart cities and communities", Recommendation ITU-T Y.4563 "Requirements and functional model to support data interoperability in IoT environments", Recommendation ITU-T Y.4484 "Framework to support Web of Objects ontology based semantic data interoperability of eHealth services", Recommendation ITU-T Y.4602 "Data processing and management framework for IoT and smart cities and communities", Recommendation ITU-T Y.4603 "Requirements and functional model to support data quality management in IoT", Recommendation ITU-T Y.4602 "Data processing and management framework for IoT and smart cities and communities" and agreed Supplement ITU-T Y.Suppl.69 "Web based data model for IoT and smart city systems and services", Supplement ITU-T Y.Suppl.62 "Overview of blockchain for supporting Internet of things and smart cities and communities in data processing and management aspects".

More info: https://itu.int/go/tsg20

OASIS

The NIEMOpen OASIS project (https://www.niemopen.org/) (formerly known as the "National Information Exchange Model") is an open source framework for exchanging information between public and private sector organizations, with particular focus on issued and vocabularies for e-government and public administration issues.

The framework includes a reference data model for objects, properties, and relationships, allowing data elements to be shared, extended and harmonized across vertical topics and governmental functions, as well as a set of technical specifications for using and extending the data model in information exchanges.

The OASIS Transformational Government TC Framework (TGF) advances an overall framework for using information technology to improve the delivery of public services.

The OASIS Legal Document XML (LegalDocML) TC advances worldwide best practices for the use of XML within parliaments, assemblies, or congresses, within courts and tribunals, and generally for legal documents including contracts. The work is based on the Akoma Ntoso UN project. OASIS Akomo Ntoso is the basis of the future machine-readable structured format for the exchange of legal documents in the EU decision-making process, Akoma Ntoso for European Union (AKN4EU).

The Code List Representation (genericode) final v1.0 standard is a semantic model of code lists and accompanying XML serialization that can encode a broad range of lists of information elements such as country codes, abbreviations and lookup tables. This serialization is designed to enable automatic interchange or distribution of machine-readable code list information between systems, and so more widely reuse existing categories and codes.

The Single Digital Gateway regulation includes a system for once-only electronic exchange of evidences for electronic cross-border procedures. The regulation references the European Commission's eDelivery Building Block, which uses the OASIS/ISO standards ebXML Messaging and AS4, the eID Building Block, which uses OASIS/ITU SAML.

IEEE

Relevant IEEE activities include:

The IEEE CertifAIEd Program: Through certification guidance, assessment and independent verification, IEEE CertifAIEd offers the ability to scale responsible innovation implementations, thereby helping to increase the quality of AIS, the associated trust with key stakeholders, and realizing associated benefits.

Standards activities include:

- IEEE P2089, Standard For Age Appropriate Digital Services Framework—Based On The 5 Rights Principles For Children
- IEEE P2141 series of standards on blockchain technology for enterprise information systems and anti-corruption applications for centralized organizations
- IEEE P2145, Standard for Framework and Definitions for Blockchain Governance
- IEEE P2418.11, Framework for Use of Distributed Ledger Technology in Security of Electronic Voting (e-Voting) Systems
- IEEE P2784, Guide for the Technology and Process Framework for Planning a Smart City
- IEEE P2863, Recommended Practice for Organizational Governance of Artificial Intelligence
- IEEE P2874, Spatial Web Protocol, Architecture And Governance Working Group
- IEEE P3119, Standard for the Procurement of Artificial Intelligence and Automated Decision Systems

- IEEE P3652.1, Guide for Architectural Framework and Application of Federated Machine Learning
- IEEE P7002, Data Privacy Process
- IEEE P7004, Standard On Child And Student Data Governance
- IEEE P7005, Standard On Employer Data Governance

Pre-standards activities include:

- IEEE SA Industry Connection Program on AI-Driven Innovation for Cities and People; this program is focused on providing cities a governance mechanism to support responsible artificial intelligence systems (AIS).
- IEEE SA Industry Connection Program on Alliance for Best Practices and Standards in Smart Cities; this program aims to develop close collaboration between the technology industry and city leaders and stakeholders towards smart city solutions across cities and regions.

For more information, see: https://ieee-sa.imeetcentral.com/eurollingplan/.

(C.2) ADDITIONAL INFORMATION

Exchange of metadata on re-usable interoperability assets (eGovernment):

Several Member States already use ADMS-AP 2.0 to export interoperability solutions from national catalogues (e.g. Germany).

The Open Geospatial Consortium (www.opengeospatial.org) has also standardisation work available relevant to e-Government.

Core Vocabularies to facilitate the development of interoperable IT solutions:

The DG DIGIT and the DG CONNECT have developed other vocabularies and technical specifications to provide interoperability solutions under the ISA2 Programme and the CEF Telecom Programme. The use of these vocabularies and technical specifications is being promoted by the European Commission through funding programmes so public and private organizations are developing pilot projects and solutions that use them. In this context, some common standardisation action will be required to allow the use of these vocabularies and technical specifications in compliance with the public procurement legislation. Currently, Core Vocabularies are used in the **Once Only Principle** technical infrastructure.

3.2.5 eCall

A Policy and legislation

(A.1) POLICY OBJECTIVES

The pan-European in-vehicle emergency feature, 'eCall', is an interoperable service to be available in all new M1 and N1 model types of vehicles in order to reduce the consequences of accidents, i.e. fatalities and severity of injuries. Since 1 April 2018, regulation is in force and all new M1 and N1 model types of vehicles shall be equipped with the eCall service. Since 1st October 2017, EU Members States shall deploy eCall Public Safety Answering Points (PSAPs) equipped to handle the eCalls. According to Commission Delegated Regulation (EU) 2024/1180 new vehicle types need to be equipped with an eCall system, which supports eCall in PS domain (4G/5G) from 1st January 2026 onwards. According to Commission Delegated Regulation (EU) 2024/1084 new PSAPs need to be equipped with a system, which supports eCall in PS domain (4G/5G) since 2nd May 2024. For already deployed PSAPs the Commission Delegated Regulation (EU) 2024/1084 applies from 1st January 2026 onwards. PSAPs also need to support eCalls using circuit-switched (CS) communication networks as long as there is at least one CS telecommunication network in operation in the Member State.

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

In the event of an accident, in-vehicle sensors automatically trigger an eCall. An audio connection is made with the European emergency number 112 and routed to the PSAP. At the same time, emergency data are sent, providing information (the minimum set of data, or MSD) including the time, location and driving direction and other data. The emergency call can also be triggered manually.

Further conformance, performance and periodic tests need to be developed and innovative solutions found for situations (such as low cost, low powered 2-wheel vehicles- P2WVs) where normal full eCall provisions are not practical.

The European eCall Implementation Platform is making recommendations to ensure the best operation of the service and to take full advantage of all its possibilities. eCall is regulated for the life of the vehicle, and further provisions may be required in respect of periodic

technical inspection (PTI) and test, and at end-of-life decommissioning.

Recognising that introducing the service via new vehicle models will mean taking considerable time to equip all cars, EU regulation has already encouraged automotive manufacturers to voluntarily introduce eCall in existing models. However, now that the public land mobile network (PLMN) and PSAP support networks are in place and operational, there is a considerable aftermarket opportunity to bring the benefits of eCall to the current stock of vehicles throughout Europe, and several equipment vendors (both from within Europe and abroad) have already shown interest to fill this market niche, in some cases directly for 112-eCall, and in others for third-party service-supported eCall. Other entrants are expected. However, as it will prove more difficult to control the performance and quality of such aftermarket devices, there is an urgent need to develop standards for the physical parameters, installation and operational performance of such aftermarket devices, to enable adequate certification and PTI provisions. This will be essential to avoid PSAPs to be potentially inundated with false messages from such devices, and to increase the reliable and safe operation of such devices.

Subsequently (voluntary) specifications have been developed to extend the benefits of eCall to all categories of vehicles, and to migrate from 2G/3G communications to any wireless IP Multimedia Subsystem (IMS) communications media, and in special circumstances, to be supported over satellite communications. As soon as the new IMS specifications are validated it is desirable to upgrade them to EN's as soon as possible, so that they may be referenced in extensions to the current regulations.

(A.3) REFERENCES

- Regulation (EU) 2015/758 of the European Parliament and of the Council of 29 April 2015 concerning type-approval requirements for the deployment of the eCall in-vehicle system based on the 112 service and amending Directive 2007/46/EC
- Commission delegated regulation (EU) of 26 November 2012 305/2013 supplementing Directive 2010/40/EU of the European Parliament and of the Council with regard to the harmonised provision for an interoperable EU-wide eCall
- Commission Delegated Regulation (EU) 2024/1084 of 6 February 2024 amending Delegated Regulation (EU) No 305/2013 supplementing Directive 2010/40/EU of the European Parliament and of the Council with regard to the harmonised provision for an interoperable EU-wide eCall
- Commission Implementing Regulation (EU) 2017/78 of 15 July 2016 establishing administrative provisions for the EC type-approval of motor vehicles with respect to their 112-based eCall in-vehicle systems and uniform conditions for the implementation of Regulation (EU) 2015/758 of the European Parliament and of the Council with regard to the privacy and data protection of users of such systems
- Commission Delegated Regulation (EU) 2017/79 of 12 September 2016 establishing detailed technical requirements and test procedures for the EC type-approval of motor vehicles with respect to their 112-based eCall in-vehicles systems, of 112-based eCall in-vehicle separate technical units and components and supplementing and amending Regulation (EU) 2015/758 of the European Parliament and of the Council with regard to the exemptions and applicable standards
- Commission Delegated Regulation (EU) 2024/1180 of 14 February 2024 amending Regulation (EU) 2015/758 of the European Parliament and of the Council as regards the standards relating to eCall
- COM 2011/750/EU: Commission Recommendation of 8 September 2011 on support for an EU-wide eCall service in electronic communication networks for the transmission of in-vehicle emergency calls based on 112 (eCalls)
- Directive 2010/40/EU of the European Parliament and of the Council of 7 July 2010 on the framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport
- COM(2009) 434 final: eCall: Time for Deployment
- Directive 2002/22/EC of the European Parliament and of the Council of 7 March 2002 on universal service and users' rights relating to electronic communications networks and services (Universal Service Directive).
- Decision 585/2014 of the European Parliament and of the Council of 15 May 2014 on the deployment of the interoperable EU-wide eCall service Text with EEA relevance

Note: As an eCall is an emergency call, all relevant regulations applicable to emergency communication apply as well. See emergency communications section.

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

ACTION 1: SDOs to develop technical specification and standards for the implementation of eCall in vehicles of categories other than M1 and N1 and for other user types, taking into account requirements included within type-approval regulation and ongoing activities in this area (pilots, the Connecting Europe Facility (CEF), etc).

ACTION 2: SDOs to lay down physical and operating requirements for aftermarket in-vehicle devices.

ACTION 3: SDOs to draft guidelines on certification of eCall Systems including aftermarket in-vehicle devices.

ACTION 4: SDOs to provide conformance and performance tests to the recently developed standards for packet-switched networks (HLAP E-UTRAN — LTE/4G and migration to further generations by use of an IMS sublayer)

ACTION 5: SDOs to develop conformance and performance tests for recently developed technical specifications / standards for the provision of the eCall service eCall via shared vehicle platforms (C-ITS).

ACTION 6: SDOs to produce detailed conformity test specifications in support of certification schemes and periodic testing on IVS equipment.

ACTION 7: SDOs to carry out plugtest interoperability events, taking into account the technological evolution of the system [1].

ACTION 8: SDOs to collect feedback about the early versions of the standards and their implementation with technical representatives from vendors and implementers.

ACTION 9: SDOs to collect feedback from the relevant stakeholders on the real operation of the eCall service and when needed improve the standards, including through the European eCall Implementation Platform.

ACTION 10: SDOs to consider any changes to eCall that may be relevant in a 5G paradigm.

ACTION 11: In view of technology and networks evolution , SDOs to consider the development of conformance and interoperability test specifications for eCall provided over 4G (using VoLTE) and 5G (and VoNR) networks. When developing these specifications, considered the work done in CEN TS 17240

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

CEN

CEN/TC 278 WG 15 has developed several technical specifications (TS), EN standards, and other deliverables to define the MSD structure and the application protocols to transfer it from the vehicles to the PSAP, and the E2E test suites for Category M1 and N1 vehicles.

CEN/TC 278 WG 15 has developed several technical specifications (TS), EN standards, and other deliverables to enable and support eCall for all other categories of vehicle.

CEN/TC 278 WG15 has developed several technical specifications (TS), EN standards, and other deliverables to enable eCall via IMS networks, eCallvia C-ITS equipped vehicles, and eCall via satellite networks.

CEN/TC 278 WG15 has developed several technical specifications (TS), EN standards, and other deliverables to provide optional additional data while retaining the privacy requirements of the eCall Regulation and GDPR in order to provide better useful information to assist PSAPs to manage the response to the incident.

CEN/TC 278 WG 15 is currently revising several technical specifications (TS), EN standards, and her deliverables to enable and support eCall in PS domain (e.g. TS 17184, TS 17240 and EN 16072).

CEN/TC 278 WG 15 submitted a LS and asked 3GPP and ETSI to align certain 3GPP/ETSI requirements with the latest requirements in CEN/TS 17184:2022.

- EN 15722:2020 Intelligent transport systems - ESafety - ECall minimum set of data
- EN 16062:2023 Intelligent transport systems - ESafety - eCall high level application requirements (HLAP) using GSM/UMTS circuit switched networks
- EN 16072:2022 Intelligent transport systems - ESafety - Pan-European eCall operating requirements
- EN 16454:2023 Intelligent transport systems - ESafety - ECall end to end conformance testing
- TS 16405:2017 Intelligent transport systems - Ecall - Additional data concept specification for heavy goods vehicles
- EN 16102:2011 Intelligent transport systems - eCall - Operating requirements for third party support
- EN 17905:2023 Intelligent transport systems – eSafety - eCall HLAP in hybrid circuit switched/packet switched network environments

- CEN/TS 17148 Intelligent Transport Systems - eSafety - ProForma eCall Agreement between TPSP and ERO
- CEN/TS 17182 Intelligent transport systems - eSafety - eCall via an ITS-station
- CEN/TS 17184:2022 Intelligent transport systems - eSafety - eCall High level application Protocols (HLAP) using IMS packet switched networks
- CEN/TS 17240 Intelligent transport systems - eSafety - eCall end to end conformance testing for IMS packet switched based systems
- CEN/TS 17312 Intelligent transport systems - eSafety - eCall via satellite telecommunications
- CEN/TS 17234 Intelligent transport systems - eSafety - eCall: Tests to enable PSAPs to demonstrate conformance and performance
- CEN/TR 17249-1 Intelligent transport systems - eSafety - extending eCall to other categories of vehicle
- CEN/TS 17249-2 Intelligent transport systems - eSafety:Part 2: eCall for HGVs and other commercial vehicles
- CEN/TS 17249-3 Intelligent transport systems - eSafety - Part 3:eCall for Coaches and busses
- CEN/TS 17249-4 Intelligent transport systems - eSafety - Part 4: eCall for UNECE Category T, R, S agricultural/forestry vehicles
- CEN/TS 17249-5 Intelligent transport systems - eSafety - Part 5: eCall for UNECE Category L1 and L3 powered two wheel vehicles (vehicle based)
- CEN/TS 17249-6 Intelligent transport systems - eSafety - Part 6: eCall for UNECE Category L2, L4, L5, L6 and L7 Tricycles and Quadricycles (vehicle based)

Currently in approval procedures:

Intelligent transport systems - eSafety - eCall OAD for multiple Optional Additional Datasets

Intelligent transport systems - eCall optional additional data - Linked mobile phone number data concept

Intelligent transport systems - ESafety - Interoperability and user choice in 112 eCall aftermarket and third party eCall services

http://www.itsstandards.eu/

ETSI

ETSI TC MSG has largely contributed to eCall specifications, contributing in the definition of the transport protocol to send MSD from the vehicle system to the PSAP via GSM or LTE. The STF 456 has looked at the issue of the migration of the Networks and has adopted and published ETSI TR 103 140.

ETSI TC MSG has published TS 103 683 "Next Generation eCall High Level Application Protocol (HLAP) Interoperability Testing". This document was drafted by STF 568. A further enhancement of this specification (v2.1.1) was drafted by TTF T017.

ETSI TC MSG has published TS 103 412 v1.3.1 "Pan-European eCall end to end and in-band modem conformance testing".

ETSI TC MSG has published TS 103 428 "eCall High Level Application Protocol (HLAP) Interoperability Testing".

ETSI has supported **and will support** the organization of several eCall Test Fests and Plugtest events:

- 6th eCall Plugtest (2017; Kranj, Slovenia)
- 1st NG eCall Plugtests (2020; Kranj, Slovenia)
- 2nd NG eCall Plugtests (2022; Kranj, Slovenia)
- 6th NG112 Emergency Communications with NG eCall Plugtests (30.9.-4.10.2024 Malaga, Spain)

PILOTS

CIP Pilots HeEROs (Harmonised eCall European Pilot) tested the standards in real conditions.

The iHeERO pilot under the 2014 CEF call for proposals is expected to produce relevant contributions for eCall standardisation.

ITU

Recommendation ITU-T P.1140 (2022): *Speech communication requirements for emergency calls originating from vehicles.* https://www.itu.int/rec/T-REC-P.1140/en

ITU-T SG2 is responsible for Recommendation ITU-T E.212 "The international identification plan for public networks and subscriptions". Under the latest version of E.212, mobile network codes may be assigned to other applicants (e.g. for GSM-R networks) and these assignments are to be made according to procedures and criteria set by the national numbering plan administrator. It also encourages applications to the ITU's shared mobile country and network codes if networks and services are provided in more than one country. Use of global numbering resources for In Car Emergency Communication is under discussion in ITU-T Study Group 2. A statement on "global numbers used for the European eCall service" was published in ITU Operational Bulletin No.1155 of 1.IX.2018; TSB Circular 249 (2020) provides detailed background on in-car emergency services, such as eCall, and alerts national administrations, regulators and network operators that the ranges 883 130, 882 39 and 882 37 are being used for this service.

https://www.itu.int/md/T17-TSB-CIR-0249/en

The issue of ITU ranges for eCall services was also the subject of an ITU news article at https://news.itu.int/why-itu-assigned-numbering-ranges-are-critical-to-road-safety/ and video interview at https://youtu.be/VhA2S2ScJrw

ITU-T SG20 developed Recommendation ITU-T Y.4119 "Requirements and capability framework for IoT-based automotive emergency response system, Recommendation ITU-T Y.4467 "Minimum set of data structure for automotive emergency response system" and Recommendation ITU-T Y.4468 "Minimum set of data transfer protocol for automotive emergency response system".

More info: https://itu.int/go/tsg20

ISO

ISO/TC 204: ITS. These cover standardisation of information, communication and control systems in the field of urban and rural surface transportation, including intermodal and multimodal aspects, traveller information, traffic management, public transport, commercial transport, emergency services and commercial services in the intelligent transport systems (ITS) field.

The project includes:

ISO/DIS 15638-10: ITS– Framework for cooperative Telematics Applications for Regulated commercial freight Vehicles (TARV) — Part 10: Emergency messaging system/eCall (EMS)

ISO/PWI 21344: ITS– Public transport — Emergency services eCall device for emergency on connected vehicles using ITS station

http://www.iso.org/iso/iso_technical_committee%3Fcommid%3D54706

IETF

The Emergency Context Resolution with Internet Technologies (ECRIT) Working Group has developed a general architecture for enabling IP applications to discover and connect to emergency services.

The Geographic Location/Privacy (GEOPRIV) Working Group has developed protocols that allow IP networks to inform end devices about their geolocation, a critical pre-requisite for emergency calling.

The application-specific working groups in the IETF (for example, the Session Initiation Protocol Core (SIPCORE) Working Group) have developed extensions to support emergency calling as required.

https://wiki.ietf.org/en/group/iab/Multi-Stake-Holder-Platform#h-325-ecall

(C.2) ADDITIONAL INFORMATION

In respect of commercial vehicles and public transport vehicles, new recently developed Technical Specifications provide the possibility to link relevant related information (such as passenger numbers, commercial cargo type and detail, etc.), but further work may be required to enable and provide and exchange such information in a consistent manner to and between PSAPS, and provide additional information from sensors etc. In respect of public transport, innovative technologies may provide better assessment of the number of passengers involved, and additional specifications/standards may be needed to collect and present this detail to PSAPs in consistent and usable form.

Considerations need to be made for the provision of eCall in CCAM vehicles, especially to segregate eCalls from unmanned vehicles travelling between assignments from those where passengers are being transported in the vehicle.

As part of HeERO, EUCARIS (the European car and driving licence information system) has developed a module with which vehicle information can be exchanged internationally.

On the basis of the vehicle identification number (VIN), this module enables a link between the national vehicle registration authorities of the participating countries. When a foreign vehicle is involved in an accident, this module enables an instant Europe-wide search via EUCARIS to support the respective national 112 emergency centre(s).

[1] such as the eCall Testfest interoperability event which was held in Ostrava, Czech Republic, in November 2015 http://www.etsi.org/news-events/events/1002-4th-ecall-tesfest-2015

3.2.6 Pandemic preparedness

A Policy and legislation

(A.1) POLICY OBJECTIVES

The corona virus shook Europe and the world to its core, testing our healthcare and welfare systems, our societies and economies and our way of living and working together. The European Commission coordinated a **common European response** to the coronavirus outbreak, aiming in particular at reinforcing our public health sectors, restoring free movement within EU member states, and mitigating the socio-economic impact in the European Union.

Digital technologies and data had a valuable role to play in combating the COVID-19 crisis. Those technologies and data offered an important tool for informing the public and helping relevant public authorities in their efforts to contain the spread of the virus or allowing healthcare organisations to exchange health data.

To raise the level of preparedness for possible future pandemic crisis, it is therefore necessary to choose a common approach to the use of digital technologies and data. That approach should be effective in supporting competent national authorities by providing them with sufficient and accurate data to understand the evolution and effects of pandemic diseases. Similarly, these technologies should empower citizens to take effective and more targeted social distancing measures where necessary. At the same time, the proposed approach should uphold the integrity of the single market and protect fundamental rights and freedoms, particularly the rights to privacy and protection of personal data.

Mobile devices and their applications supported health authorities at national and EU level in monitoring and containing the COVID-19 pandemic. They provided guidance to citizens and facilitated the organisation of the medical follow-up of patients. Warning and tracing applications played an important role in contact tracing, limiting the propagation of disease and interrupting transmission chains. The EU Digital COVID Certificates, interoperable digital proofs of vaccination, test and recovery allowed public authorities to waive restrictions to travel and allowed citizens to access public spaces, events or gatherings.

In accordance with the principle of data minimisation, public health authorities and research institutions should process personal data only where adequate, relevant and limited to what is necessary, and should apply appropriate safeguards such as pseudonymisation, aggregation, encryption and decentralization.

Effective cybersecurity and data security measures are essential to protect the availability, authenticity integrity and confidentiality of data.

At global level relevant actions include the ongoing negotiation of an international accord on pandemic prevention, preparedness and response to ensure equity in both access to healthcare and tools needed to prevent pandemics (including technologies like vaccines, personal protective equipment, information and expertise). Such international agreement could complement the International Health Regulations (2005) (the "IHR"), a key instrument established to prevent, protect against, control and provide a public health response to the international spread of disease. In June 2024 the Seventy-seventh World Health Assembly adopted a package of amendments to the IHR, which introduced the possibility to issue health documents for vaccination also in digital format. The European Commission and EU Member States support WHO in the development and update of technical guidance, specifications, standards related to the issuance and ascertainment of authenticity of such digital health documents via their collaboration to the Global Digital Health Certification Network (GDHCN), WHO's digital infrastructure for the verification of digital health documents. The GDHCN builds on the experience of the EU Digital COVID Certificate and related tools developed during the COVID pandemics, and will extend its use-cases beyond COVID to the International Certificate of Vaccination and Prophylaxis (ICVP) that can serve pandemic preparedness, as well as use cases for international healthcare, such as the International Patient Summary.

(A.2) EC PERSPECTIVE

During the COVID-19 pandemic crisis EU Members States with the support of the European Commission worked within the eHealth Network (eHN) to develop common approaches towards protection-effective app solutions and a common framework for the issuance of digital vaccination, test and recovery certificates, that minimised the processing of personal data, whilst providing for interoperability of the different solutions, including cross-border.

The eHN issued a common EU toolbox as well as interoperability guidelines, which include a first set of essential requirements for digital health solutions, namely that they shall be: - voluntary; - approved by public health authorities; - anchored in accepted epidemiological guidance; - compliant with GDPR/ ePrivacy regulations; - based on proximity technology (Bluetooth), not on geolocation technology (GPS); - based on anonymised data; - Interoperable [across the EU]; - [cyber] Secure & effective.

Requirements for accessibility for persons with disabilities are a priority and shall be in line with the transposition legislation of the Web Accessibility Directive, which includes reference to Harmonised European Standard EN 301 549 V2.1.2. The European approach should encourage the publication/sharing of source codes for the digital solutions, as an indicator of security, auditability and interoperability requirements, as a way to maximise re-use, and also to address the need to enhance both national authorities' but also citizens' trust in the proper functioning of the applications and solutions and to provide transparency. Independent testing, access to source code and a policy for vulnerability handling and disclosure are in this respect deemed necessary.

Other technologies, such as blockchain/DLT have also the potential to support effective solution to cope with pandemics and support de-escalation strategies, in particular regarding decentralised and secure access to data. Such solutions shall also comply with EU values and provide for interoperability.

Both EU relevant institutions and bodies (see A.2) and SDOs (see C.1) developed several works and initiatives. Among the formers, the eHN continues its work to provide guidelines and recommendations for different solutions that could help dealing with pandemics building on its experience with COVID-19. In particular the eHN is now working on materials feeding into the implementation of common standards and rules under the European Health Data Space (EHDS), which will enable secure and trustworthy access to health data across the EU. The EHDS-enabled health data flow will contribute to preparedness to future health threats and pandemics, in compliance with EU values.

The solutions developed for the COVID-19 pandemics are now archived. ECDC remains in charge of the archived European Federation Gateway Service (EFGS), including technical specifications of contact tracing apps. As concerns the EU Digital COVID-19 Certificates, after the termination of the EU DCC Regulation on 30 June 2023, all standards and technical specifications were taken up by WHO in its Global Digital Health

Certification Network (GDHCN), establishing a global system for the authentication of health documents, with COVID-19 certificates as its first use-case. A Council Recommendation encourages EU member states to connect to the GDHCN to ensure smooth international travel and continuity of care to EU citizens. The EC and eHN cooperate with and support WHO in developing other use-cases for the GDHCN.

With the adoption of amendments to the International Health Regulation in June 2024 by the Seventy-seventh World Health Assembly, WHO State Parties will be able issue health documents also in digital format, in particular certificates of vaccination of prophylaxis. WHO is responsible in consultation with State Parties to develop and update technical guidance, including specifications or standards related to the issuance and ascertainment of authenticity of such digital health documents. The GDHCN will be the core digital infrastructure and trust network used for the verification of digital health documents, and alongside the digital COVID certificates it will include new use cases such as the digital International Certificate of Vaccination and Prophylaxis (ICVP), that is under development.

The European Recovery Plan focuses on concrete lines of actions: - The European Green Deal as Europe's sustainable growth strategy; - A deeper and more digital single market, including a deeper digital recovery helping to stimulate competitive innovation and to provide users with greater choice. This includes actions to support strategic digital capacities and capabilities, common European data spaces in key sectors and areas (such as the European Health Data Space), a fairer and easier business environment in particular for online environment, digitisation of public procurement and justice systems and boosting the EU's overall cybersecurity; - A fair and inclusive recovery, including reinforcing digital skills for children, students, teachers, trainers and all of us to communicate and work. These lines of actions will require ICT standardisation activities to support their take up and implementation.

(A.3) REFERENCES

- Common EU response - overview
- Commission Recommendation (EU) 2020/518 of 8 April 2020 on a common Union toolbox for the use of technology and data to combat and exit from the COVID-19 crisis, in particular concerning mobile applications and the use of anonymised mobility data (https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32020H0518&from=EN); (https://ec.europa.eu/commission/presscorner/detail/en/IP_20_626)
- Commission Communication 2020/2523 of 16 April 2020 on Guidance on Apps supporting the fight against COVID-19 pandemic in relation to data protection (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020XC0417%2808%29)
- eHealth Network Guidelines to the EU Member States and the European Commission on interoperability specifications for cross-border transmission chains between approved apps (https://health.ec.europa.eu/system/files/2020-06/mobileapps_interoperabilityspecs_en_0.pdf#:~:text=Member%20States%20and%20the%20Commission,SARS%2DCoV%2D2%20virus; https://ec.europa.eu/commission/presscorner/detail/en/ip_20_1043)
- COM/2020/112: Coordinated economic response to the COVID-19 Outbreak (https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1455633998284&uri=CELEX:52020DC0112)
- COM/2020/143: Coronavirus Response Using every available euro in every way possible to protect lives and livelihoods (https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1455633998284&uri=CELEX:52020DC0143)
- Commission Communication on the Recovery Plan COM 2020/456: Europe's moment: Repair and Prepare for the Next Generation (https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1590732521013&uri=COM:2020:456:FIN)
- European Parliament resolution on EU coordinated action to combat the COVID-19 pandemic and its consequences. (2020/2616(RSP)) (https://www.europarl.europa.eu/doceo/document/RC-9-2020-0143_EN.html)
- European Data Portal: specific section dedicated to COVID-19 related open data and applications: https://www.europeandataportal.eu/en/covid-19/overview
- Open Data Portal: specific section is dedicated to COVID-19 related open data of the European Institutions and bodies. https://data.europa.eu/euodp/en/home
- ECDC TECHNICAL REPORT Guidelines for the use of non-pharmaceutical measures to delay and mitigate the impact of 2019-nCoV: https://www.ecdc.europa.eu/en/publications-data/guidelines-use-non-pharmaceutical-measures-delay-and-mitigate-impact-2019-ncov
- ECDC TECHNICAL REPORT Contact tracing: public

health management of persons, including healthcare workers, having had contact with COVID-19 cases in the European Union https://www.ecdc.europa.eu/en/covid-19-contact-tracing-public-health-management

- EDPB - Guidelines 04/2020 on the use of location data and contact tracing tools in the context of the COVID-19 outbreak https://edpb.europa.eu/our-work-tools/our-documents/usmernenia/guidelines-042020-use-location-data-and-contact-tracing_it
- eHealth network - Mobile applications to support contact tracing in the EU's fight against COVID-19 - Common EU Toolbox for Member States and inventory of mobile apps related to COVID-19, Interoperability guidelines for approved contact tracing mobile applications in the EU and other documents in relation to the European gateway for interoperability of tracing applications are available at https://health.ec.europa.eu/system/files/2020-04/covid-19_apps_en_0.pdf
- European gateway for interoperability of tracing applications (https://ec.europa.eu/commission/presscorner/detail/en/ip_20_1904)
- Commission Implementing Decision (EU) 2020/1023 of 15 July 2020 amending Implementing Decision (EU) 2019/1765 as regards the cross-border exchange of data between national contact tracing and warning mobile applications with regard to combatting the COVID-19 pandemic Implementing decision - 2020/1023 - EN - EUR-Lex (europa.eu)
- Regulation (EU) 2021/953 on a framework for the issuance, verification and acceptance of interoperable COVID-19 vaccination, test and recovery certificates (EU Digital COVID Certificate) to facilitate free movement during the COVID-19 pandemic ELI: http://data.europa.eu/eli/reg/2021/953/oj
- COM(2021) 649 final: First Report of the Commission on the EU Digital COVID Certificate Regulation & Annex
- COM(2022) 123 final: Second Report of the Commission on the EU Digital COVID Certificate Regulation & Annex
- COM(2022) 753 final: Third Report of the Commission on the EU Digital COVID Certificates Regulation & Annex
- Council Recommendation (EU) 2023/1339 on joining the global digital health certification network established by the World Health Organization: Council Recommendation 2023/1339 - EN - EUR-Lex (europa.eu)
- WHO - Global Digital Health Certification Network: https://www.who.int/initiatives/global-digital-health-certification-network

B Requested actions

(B.1) ACTIONS IN SUPPORT OF BEING BETTER PREPARED FOR FUTURE PANDEMICS

ACTION 1: SDOs to identify ICT standards available or needs for new ICT standards for improving the processes and management of supply chains for products and services that are critical in the situation of an epidemic or pandemic. This may include standards for supporting the functioning and logistics of the distribution of vaccines, tasks like supply and capacity planning of medical supplies, hospital supplies, but also capacity planning and supply chains for vaccines and other medical equipment. If required, start activities to revise the respective standards, close functional gaps, or to develop new or additional standards to improve logistics and processes. Innovative technologies like AI, telemedicine Blockchain/DLT may be considered in this context as well.

ACTION 2: SDOs and stakeholders to review ongoing work regarding standards for providing care and assistance (i.e. tele-assistance) to citizens in non-hospital premises. Consider extending available standards or work if required, or starting the development of new standards, in particular for interoperability, security and privacy. Stakeholders should also consider activities on promoting the respective technologies and their uptake for being better prepared in future emergency situations like a pandemic.

ACTION 3: Healthcare data availability and integration - SDOs to update and, if needed, develop standards addressing the collection, storage of, and access to sensitive personal data. Topics to be addressed should be seen in the context of the European Commission's data strategy for Europe, e.g. regarding interoperability, portability, APIs, ontology, and for European data spaces, in this case the European Health Data Space. The standards should be fully compliant with EU legislation, in particular GDPR, and give the individual full control regarding usage and access rights.

ACTION 4: SDOs and stakeholders to analyse standards for processes and technologies around additive manufacturing and for agile re-focusing

of production efforts in case of specific needs in an epidemic or pandemic. This may include development of a reference architecture or architecture and process guidelines.

ACTION 5: Specifications related to interoperability, where meta-data specifications need to be agreed to identify food suppliers and food supply value chains. As a consequence of the COVID-19 lockdowns, supply chains should be enabled for 'flexible rerouting', e.g if global food supply chains are to be replaced with shorter chains for more local suppliers. Retail platforms should be able to instantly discover alternative tracks and resources via 'metadata discovery'.

ACTION 6: Prepare a horizontal cross-domain IoT standard, with the specification of minimum requirements on all professional and general public IoT devices, to ensure that the devices themselves can be used according to their initial objectives (e.g. easy installation and configuration) and that the data they provide can easily be understood and acted upon by non-ICT users (e.g. medical teams and their patients in the medical sector, mechanics in the automotive sector, first responders in the emergency sector, etc.). As a basis existing standards like ISO 9241should be used.

ACTION 7: Analyse whether HL7 FHIR Implementation Guide: Electronic Case Reporting (eCR) may be used or may have to be updated to better support public health surveillance as well as the delivery of relevant public health information to clinical care. This may be important with the adoption and maturing of Electronic Health Records (EHRs) and with Electronic Case Reporting (eCR) providing more complete and timely case data, support disease / condition monitoring, and assist in outbreak management and control. (See http://hl7.org/fhir/us/ecr/index.html)

* Note: there are actions in other chapters that are closely related to this chapter, such as Action 5 in the 3.2.3 Digital learning chapter.

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

Standards Development Organisations have reacted to COVID-19. Special activities, including concrete technical standards development projects, were started to support any action to help combat the virus, protect people, prepare for coming challenges and support the recovery of the economy.

Many of the ongoing standards projects will naturally assist and support ICT related initiatives, e.g. by providing basic technologies that are used in ICT infrastructures and applications. This includes many of the activities listed in the EU Rolling Plan for ICT Standardisation in general, and in the Rolling Plan chapter on eHealth in particular. As standards are maintained, reviewed and standardisation activities are undertaken, all stakeholders are encouraged to look at possible changes or additions to the standards based on the experience of the current pandemic and requirements for technologies and solutions to assist reacting to the challenges of such an exceptional situation.

The list below provides an overview of Covid-19 focused initiatives that have been undertaken:

CEN & CENELEC

CEN and CENELEC Members issued a report from their COVID-19 Crisis Management Network (CMN) established during the pandemic in 2020, that highlights the critical role the European standardization system played in tackling the early challenges of the pandemic. Lessons learned will inform our future decision-making in order to further enhance our organisational resilience in the face of future challenges. The CMN network also provided a platform to exchange best practices swiftly and efficiently over different working areas affected by the crisis. https://www.cencenelec.eu/news-and-events/news/2021/briefnews/2021-02-04-lessons-learned-covid-19-pandemic/

CEN/TC 251 (linked with ISO/TC 215) in relation to DTS 82304-2 "Health Software — Part 2: Health and wellness apps — Quality and reliability" (the DTS that was born also taking as main inputs the Italian UNI/TR 11708 and BSI's PAS277). https://standards.cen.eu/dyn/www/f?p=204:7:0::::FSP_ORG_ID:6232&cs=18CA078392807EDD402B798AAEF1644E1

CEN/TC 251 "Health informatics -- Accelerating Safe, Effective and Secure Remote Connected Care and Mobile Health Through Standards-Based Interoperability Solutions Addressing Gaps Revealed by Pandemics". https://standards.cencenelec.eu/dyn/www/f?p=CEN:110:0::::FSP_PROJECT,FSP_ORG_ID:78650,6232&cs=1214A0370A133F76DDBC3F95D322E2D4F . Label2Enable is an European project that has further developed this standard.

DP-3T

Decentralized Privacy-Preserving Proximity Tracing (DP-3T) https://github.com/DP-3T

ECMA INTERNATIONAL

Ecma Technical Committee TC51 works on access systems and information exchange between systems and developed ECMA-417, which specifies the architecture for a distributed real-time access system taking into account many technologies. This includes the layer concept of the system, the functionalities of each layer and the interfaces. ECMA-417 3rd edition (also published as ISO/IEC 24643) introduces vaccine passports as additional examples of complicated authentication.

ETSI

ETSI standards with relevance to pandemic preparedness

https://www.etsi.org/standards#page=1&search=covid&title=1&etsiNumber=1&content=1&version=0&onApproval=1&published=1&withdrawn=1&historical=1&isCurrent=1&superseded=1&startDate=1988-01-15&endDate=2024-09-15&harmonized=0&keyword=&TB=&stdType=&frequency=&mandate=&collection=&sort=1

EP eHealth

EP eHealth acts as coordinating body for ETSI's wider response and management of standards for eHealth.
https://portal.etsi.org/tb.aspx?tbid=696&SubTB=696#/

EP eHealth White Paper: The role of SDOs in developing standards for ICT to mitigate the impact of a pandemic
https://www.etsi.org/media-library/white-papers

ETSI Report comparing worldwide COVID-19 contact-tracing systems
https://www.etsi.org/newsroom/press-releases/1879-2021-02-etsi-unveils-its-report-comparing-worldwide-covid-19-contact-tracing-systems-a-first-step-toward-interoperability

TC ATTM SDMC

Standards on the relationship between deployment of ICT systems and implementation of services including COVID-19 and other health related services for cities and communities.
https://portal.etsi.org/tb.aspx?tbid=851&SubTB=851#/

SC USER Group

Is involved in the analysis of the impact of the lockdown on the use of electronic and numeric tools and is working, in the project « User-centric approach in the digital ecosystem » on the Smart Identity which may be a significant improvement for the personal data and access to services. https://portal.etsi.org/STF/STFs/STF-Homepages/STF543

HL7:

Central websites set up informing about specific projects around COVID-19.

https://confluence.hl7.org/display/CR/COVID-19+Response+Home
https://confluence.hl7.org/display/CR/COVID-19+Related+Projects

ISO/HL7 10781:2015 Health Informatics — HL7 Electronic Health Records-System Functional Model, Release 2 (EHR FM); also EN ISO 10781:2015
Voting on release 2.1 currently in progress in HL7.
Further updating may be done to improve the functional requirements to support the needs of RWD(real-world-data)-based pandemic management.

https://www.hl7.org/implement/standards/product_brief.cfm?product_id=269
https://www.iso.org/standard/84722.html

IEEE:

Statement from the Global Initiative on Ethics of Autonomous and Intelligent Systems: https://standards.ieee.org/content/dam/ieee-standards/standards/web/documents/other/gieais-covid.pdf

11073 series (Health Informatics): IEEE/ISO 11073 is a family of Health Informatics/ Device Communication for data interoperability and architecture standards intended to support interoperable communications for health care and wellness devices to assist healthcare product manufacturers and integrators create devices and systems for disease management, health and fitness, and independent living. Some are adopted as EN under the EN ISO 11073 series.

Covid-19 opened the conversation and catalyzed a movement towards innovative forms of healthcare monitoring, therapeutics and clinical research in a remote environment while exposing the many unaddressed challenges of utilizing connected technologies. The current pre-standards programs feature multidisciplinary experts from around the globe supporting innovation through open and standardized means for the benefit of equitable, sustainable and protected right to care.

The IEEE SA WAMIII Program develops consensus for solutions to establish stakeholder trust in the use of connected wireless medical devices that have the potential to bring myriad benefits to pharmaceutical manufacturers, patients, and healthcare providers, especially with the pandemic.

Papers on contact tracing from the 2020 21st IEEE International Conference on Mobile Data Management (MDM) are in the proceedings https://ieeexplore.ieee.org/xpl/conhome/9153070/proceeding

The IEEE SA Transforming the Telehealth Paradigm: Sustainable Connectivity, Accessibility, Privacy, and Security for All pre-standards activity seeks to address the challenges impeding trust and accessibility of telemetry services and devices for non-urgent care to enable ALL individuals with right to care, protection and privacy of their health and their data.

The IEEE SA Technology and Data Harmonization for Enabling Decentralized Clinical Trials (DCT) pre-standards activity. The goal of the program is to prioritize the areas DCT using DHT (Digital Health Toolkits) standards can accelerate adoption, mitigate risks, and optimize efficiencies with sponsors, regulators, sites, technologists, service providers, patient advocacy organizations, and other relevant stakeholders.

IEEE SA Ethical Assurance of Data-Driven Technologies for Mental Healthcare pre-standards activity. Even prior to the global pandemic, the use of data-driven technologies in mental healthcare was increasing. The use of such technologies also poses a series of well-known ethical, social, and legal risks for matters such as data privacy, explainability of automated decisions, and respect for mental integrity that must be addressed.

IEEE Digital Resilience - Tools and Methods to Support Response and Recovery from Crises pre-standards activity proposes plans to develop a framework that enables communities, villages, cities, regions, and countries to deploy architectures and select standardized technologies so they may address immediate and urgent needs during a crisis without sacrificing the long-term wellbeing and rights of people. Current subcommittees focus on Logistics and Supply Chain, e-Health and Telemedicine, Building Human Digital Resilience, and e-Resilience in Education Systems, etc.

More information can be found here: https://ieeesa.io/eu-rolling-plan

IHE:

Contribution on European Commission recommendation "On a common Union toolbox for the use of technology and data to combat and exit from the COVID-19 crisis, in particular concerning

the application mobile applications and the use of anonymized mobility data"
https://www.ihe-europe.net/ihe-in-europe/EU-policies

ISO

Several drafts relevant for e-health are developing in ISO, and even if not focused on covid-19, because they started before, they are reported as "affected" by Covid-19.

JTC 1/SC38 NP 5195 Technical requirements of community service system based on cloud computing in major public health emergencies

JTC 1/WG11 NP 5153 Smart City — City Service Platform for Public Health Emergency

JTC 1/SC 41 AHG 23 Study report on IoT Personnel positioning management system (PPMS)

For system, software, data quality models see ISO/IEC 25000 series

ITU

Overview page on activities to address Covid19 challenges
https://www.itu.int/en/Pages/covid-19.aspx

Series of webinars providing insights on how the application of digital financial services can help governments and private sector, in emerging economies especially, to implement measures related to social distancing during a lockdown caused by pandemic, e.g. Covid19. The objective is to provide insights on the innovative applications of telecommunications services, digital payments and fintech in addressing COVID-19 triggered social distancing and lockdown as well as to share lessons learned from governments and DFS stakeholders on the measures that they are implementing.
https://www.itu.int/en/ITU-T/webinars/Pages/dfs.aspx.

The ITU/WHO Focus Group on Artificial Intelligence for Health (FG-AI4H) has established an Ad-hoc Group on Digital Technologies for COVID Health Emergency (AHG-DT4HE). The AHG-DT4H has published the FG AI4H DT4HE Output 1 – Guidance on AI and digital technologies for COVID health emergency.
https://itu.int/go/fgai4h

ITU-T Study Group 20 is currently working on draft Recommendation ITU-T Y.4233 (ex Y.FSPH) "Framework for smart public health emergency management in smart and sustainable cities".

The "United for Smart Sustainable Cities" (U4SSC) is a UN initiative coordinated by ITU, UNECE and UN-Habitat, and supported by other 16 UN bodies to achieve Sustainable Development Goals, including SDG11: "Make cities and human settlements inclusive, safe, resilient and sustainable". A thematic group on ***"Lessons Learned From Building Urban Economic Resilience at City Level During and After COVID-19"*** has been established to address the urban dimension of cities in response to the COVID-19 pandemic. More information: https://u4ssc.itu.int/economic-resilience/

With the objective of coordinating standardization work on digital COVID-19 certificates (DCCs), ITU established the Joint Coordination Activity on Digital COVID-19 Certificates (JCA-DCC) in late 2021. JCA-DCC actively engages relevant ITU-T study groups, external organizations and fora with active work related to DCC standardization to foster use of compatible data architectures for data sharing and promote interoperability, agility and safety for users of DCCs, and all relevant stakeholders involved. Since 2023 the WHO's GDHCN lead is co-chair of the JCA-DCC. The work of JCA-DCC will transition into the next Study Period, starting from 2025, as the Joint Coordination Activity on Verifiable Health Credentials (JCA-VHC). More information: http://itu.int/en/ITU-T/jca/dcc

OASIS

Special and regularly maintained and updated website informing about OASIS specifications that can help governments, businesses and projects in the fight against COVID-19.
https://www.oasis-open.org/covid

PEPP-PT

Pan-European Privacy-Preserving Proximity Tracing - enabling tracing of infection chains across national borders.
https://www.pepp-pt.org/

ROBERT

ROBust and privacy-presERving proximity Tracing protocol - protocol for robust and privacy-preserving proximity tracing
https://github.com/ROBERT-proximity-tracing/

COVID-19 CREDENTIALS INITIATIVE (CCI)

Hosted by Linux Foundation Public Health (LFPH). CCI has adopted an open-standard-based open-source development approach to public health. CCI is looking to deploy and/or help deploy privacy-preserving verifiable credential projects to mitigate the spread of COVID-19. The community builds on Verifiable Credentials (VCs), an open standard and emerging technology.

(C.2) ADDITIONAL INFORMATION

SMALL AND MEDIUM ENTERPRISES – SMES (SBS/EUROPEAN DIGITAL SME ALLIANCE)

Although European SMEs were hit the hardest during this crisis, they played a vital role in combating COVID-19 in different industries. Utilising ICT technologies and standards, many European Digital SMEs have offered their solutions to citizens and enterprises for free, reflecting on European Solidarity during the crisis. Digital SMEs should be supported during the post COVID-19 recovery plan in order to scale up their technologies and be better prepared for future crises. The use of and access to ICT standards enabled Digital SMEs to provide their services. It is important for SMEs to be part of the standardisation making process, i.e actively engaged in drafting of standards, and be perceived as standards makers. Since SMEs are under-represented in this process, SDOs should proactively seeks to engage SMEs and/or take their needs into account.

In the context of contact tracing apps and other technologies to combat COVID-19 or to offer solutions for the recovery phase, standards that define

security, privacy, access to and storage of data, and interoperability are important for SMEs. Although SMEs are aware of these solutions, they need to be made aware of ICT standards behind them. These solutions were possible because of ICT standards that supported the backbone for ICT services in smart working, E-learning, e-Health, E-Banking, logistic, smart cities, tourism, and other industries. Therefore, standards are key to access and use new technologies that are made available to SMEs in an open and interoperable way. In addition, there is a need to raise awareness among SMEs on the use of ICT Standards. For example ETSI has already started the ETSI Technology Awareness Roadshow for SMEs. ESOs should initiate standards raising awareness actions towards SMEs.

Not only SMEs need awareness actions, but they also need practical guides for the use of ICT standards. As most SMEs suffer from limited capacities, it is essential for them to have specific and adapted instructions. SMEs associations such as SBS and the European DIGITAL SME Alliance, are well placed to support the development of such SME guides as they did for instance in the ISO27001 Guide for SMEs or the current development of SME Guides on (1) Industrial IoT and (2) Information Security Controls.

https://www.digitalsme.eu/ict-standards-will-help-save-the-economy-from-covid-19/

CONSUMERS (BEUC/ANEC)

Although the effectiveness of deploying technologies, such as tracing applications, has generally not been evaluated, these could be helpful tools to keep pandemics under control and allow a progressive lift of the lockdown. Nevertheless, it then becomes more important than ever to protect the fundamental rights and freedoms of consumers.

Standards can play a fundamental role in not only ensuring the effectiveness of the technology, but in ensuring the entitlement of consumers to data privacy and protection, and in making the technology accessible to consumers of all ages and abilities.

ENVIRONMENT (ECOS)

Although the challenges posed by the pandemic are understood, environmental legislation and targets must not be compromised and de-prioritised. The climate emergency poses serious threats and therefore citizens' health should remain a priority even after the pandemic. This means that post-COVID recovery plans should be based on the Green Deal and help to make the economy become more resilient to such shocks. In fact, environmental laws, taking for example those under the ecodesign framework, not only help the planet but also achieve cost savings and create jobs through innovation, all necessary in the situation we currently find ourselves in.

WORKERS (ETUC)

ETUC policy at European level has been set out in a public letter from the General Secretary to the Presidents of the EU institutions, which states: "Our priority at the moment is to save the enterprises, making sure that they can survive the lockdown and come back to the markets when it will be finished. And to protect the jobs of our members, making sure that those who are suspended from work do not become unemployed, but can keep their job and receive decent income compensation."

ETUC has established a web resource, at https://www.etuc.org/en/trade-unions-and-coronavirus, with comprehensive links to briefing material at European and national levels.

DIGITAL EUROPE

Digital Europe's White Paper on "How to relaunch manufacturing in a post-COVID-19 world" inter alia addresses standardisation needs:
https://www.digitaleurope.org/wp/wp-content/uploads/2020/05/DIGITAL-EUROPE_How-to-relaunch-manufacturing-in-a-post-COVID-19-world.pdf

ECSO – EUROPEAN CYBER SECURITY ORGANISATION

ECSO Recommendations. Cybersecurity in light of the COVID-19 crisis
https://www.ecs-org.eu/documents/uploads/ecso-recommendations-in-light-of-covid-19.pdf

COVID-19 CYBERSECURITY RESPONSE PACKAGE - An ECSO Cyber Solidarity Campaign. Updates from the home page: https://www.ecs-org.eu/

OTHER INFORMATION

The European Data Portal, where Open data from Member States open data portals are referenced, has implemented a specific section dedicated to COVID-19 related open data and applications: https://www.europeandataportal.eu/en/covid-19/overview

Overview on role of open source and robotics in the context of COVID-19: https://opensource.com/article/20/5/robotics-covid19

The list below provides a examples of international activities that are relevant to Pandemic Preparedness that have been undertaken:

- xShare Home - xShare (xshare-project.eu)
- Xt-EHR (Joint Action 09)
- TEHDAS1 and TEHDAS2 Second Joint Action Towards the European Health Data Space – TEHDAS2 - Tehdas

3.2.7 Safety, transparency and due process online

A Policy and legislation

(A.1) POLICY OBJECTIVES

The initiative relates to the Commission's policy and regulatory intervention to ensure a safe, predictable and trustworthy online environment and the respect of fundamental rights online. This has become especially prominent due to the full entry into application of the Digital Services Act in February 2024 (Regulation 2022/2065). The Regulation recognises that the increased use of intermediary services has resulted in new risks and challenges for individual recipients of the relevant service, companies and society as a whole. This particularly concerns illegal content (i.e. any information that, in itself or in relation to an activity is not in compliance with Union law or the law of any Member State which is in compliance with Union law) and categories of systemic risk (such as any actual or foreseeable negative effects on civic discourse and electoral processes, and public security).

The Regulation notes the importance of harmonising the rules on intermediary services across the EU internal market, so as to provide businesses with access to new markets and opportunities to exploit the benefits of the internal market, while allowing consumers and other recipients of the services to have increased choice. The Regulation's targeted set of uniform, effective and proportionate mandatory rules at Union level is therefore meant to safeguard and improve the functioning of the internal market.

Article 44 of the DSA further contributes to this goal since it determines that the European Commission shall support and promote the development and implementation of voluntary standards in a range of areas. It lists a total of ten topics, which we divide in three categories below.

(A.1.A) THE PROTECTION OF MINORS ONLINE

A first important domain concerns the EU's long-standing commitment to support, protect, empower and respect children online. This is well reflected in the Digital Service Act (DSA) and in the

new Better Internet for Children Strategy (BIK+), which supports its implementation. The DSA provides a regulatory framework to bring about stronger safeguards to protect minors using online platforms. Relating in particular to standardisation, Article 44.1 DSA point j notes that the Commission shall support and promote at least "(j) standards for targeted measures to protect minors online." In addition, further legal measures for the protection of minors online are set down in the revised Audiovisual Media Services Directive (AVMSD) and in the General Data Protection Regulation (GDPR).

Complementary to the existing legal and regulatory framework, the BIK+ strategy supports a comprehensive, prevention-oriented and multi-stakeholder approach with 3 pillars: 1) a safe, age-appropriate digital environment, 2) digital empowerment 3) active participation of children.

Access to inappropriate content – tackled under Pillar 1 – is one of the main concerns identified by both children and parents when contacting Safer Internet Centres' helplines. As children become more active online, and from ever younger ages, the possibility they will encounter something age-inappropriate online is also increasing, e.g. material that is adult-only, for example pornographic material or gambling, information that might lead a child into unlawful or dangerous behaviour, violent or disturbing content, or other content that may have a negative effect on the physical or mental well-being of children. Robust age verification mechanisms are one of the key elements to protect children and young people from this risk.

(A.1.B.) OTHER STANDARDISATION TOPICS UNDER ARTICLE 44 DSA

Article 44.1 lays down a diverse range of other standardisation topics that can contribute to the effective and consistent application of the DSA's regulatory regime. It notes in particular that the Commission shall support and promote the development and implementation of voluntary standards set by relevant European and international standardisation bodies, at least in respect of the following:

(a) electronic submission of notices under Article 16 [DSA];

(b) templates, design and process standards for communicating with the recipients of the service in a user-friendly manner on restrictions resulting from terms and conditions and changes thereto;

(c) electronic submission of notices by trusted flaggers under Article 22 [DSA], including through application programming interfaces;

(d) specific interfaces, including application programming interfaces, to facilitate compliance with the obligations set out in Articles 39 and 40 [DSA];

(e) auditing of very large online platforms and of very large online search engines pursuant to Article 37 [DSA];

(i) choice interfaces and presentation of information on the main parameters of different types of recommender systems, in accordance with Articles 27 and 38 [DSA].

Adopting such standards could facilitate in particular the application of the obligations in the DSA that may require implementation through technological means, covering technical procedures. This can support providers of intermediary services in successfully complying with the DSA. Such standards could in particular be useful for relatively small providers of intermediary services.

(A.1.C.) ONLINE ADVERTISING

A final category within that overall framework is online advertising. Article 44.1 DSA suggests three focal points for standardisation related to advertising:

(f) interoperability of the advertisement repositories referred to in Article 39(2);

(g) transmission of data between advertising intermediaries in support of transparency obligations pursuant to Article 26(1), points (b), (c) and (d);

(h) technical measures to enable compliance with obligations relating to advertising contained in this Regulation, including the obligations regarding prominent markings for advertisements and commercial communications referred to in Article 26;

Online advertising plays an important role in the online ecosystem since the provision of services by online platforms is sometimes in whole or in part remunerated directly or indirectly through advertising revenues. Online advertising can contribute to significant risks, ranging from ads that are illegal content, to contributing to financial incentives for the publication or amplification of illegal or otherwise harmful content and activities online, or the discriminatory presentation of advertisements. The DSA therefore foresees transparency obligations relating to advertisements on online platforms (Article 26 DSA) and a specific obligation to have advertising repositories for certain intermediary services (Article 39 DSA).

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

The DSA became fully applicable on 17 February 2024, and is being enforced throughout the EU by national competent authorities as well as the European Commission. Under the Regulation, services that reach more than 45 million users in the EU can be designated as Very Large Online Platforms (VLOPs) and Very Large Online Search Engines (VLOSEs) (hereafter: VLOPSEs). These actors are required to identify and assess systemic risks stemming from the design or functioning of their service and its related systems, or from the use made of their services.

The harmonized regulatory framework aims to create a safe, predictable and trustworthy online environment, including by setting up standards on the three over-arching topics described above under heading A.1.

(A.2.A) THE PROTECTION OF MINORS ONLINE

The DSA includes obligations to reduce illegal content, provide a high level of privacy, safety and security for minors on online platforms and prohibit targeted advertising towards minors based on profiling, as well as make terms and conditions more understandable for minors. Furthermore, VLOPSEs are obliged to take targeted and effective measures to mitigate systemic risks regarding the protection of minors, the rights of the child and the physical and mental well-being of their users. In particular with regards to the protection of minors, such measures can include tools such as age verification, parental controls and means for minors to flag abuse or access support in a situation of need.

The updated European strategy for a Better Internet for Kids (BIK+) recognizes the importance of age verification mechanisms but also their current flaws. Despite existing EU law, age verification mechanisms are still in many cases ineffective, with users often only required to tick a box to confirm they are aged 18 or older. The EU-funded euCONSENT pilot project demonstrated an interoperable technical infrastructure, implementing child protection mechanisms (such as age verification) and parental consent mechanisms based on relevant EU legislation such as the AVMSD and GDPR. The project prepared a Common Standards Framework to ETSI drafting protocols which includes all of the technical infrastructure requirements, interoperability protocols and assessment and certification processes. This framework could gain standard status during the post-project implementation phase. Building on ongoing work such as the above pilot project and taking account of the new DSA rules for online platforms, the Commission will support methods that allow consumers to prove age in a privacy-preserving and secure manner, to be recognised EU-wide. The BIK+ strategy requires the Commission to work with Member States, relevant stakeholders and European standardisation organisations to strengthen effective age verification methods, as a priority. These methods will be further supported by the recently adopted regulation establishing a European Digital Identity framework (eID), and be interoperable with the resulting EU Digital Identity Wallet. Further, Member States, in line with national legislation can choose to issue electronic IDs to the under-18s in order to help protect children from age-inappropriate content. This work will encourage market solutions through a robust framework of certification and interoperability.

(A.2.B) OTHER STANDARDISATION TOPICS UNDER ARTICLE 44 DSA

It is important to note that standardisation can facilitate the effective and consistent application of the obligations in the DSA through voluntary standards covering certain technical procedures. This can ensure that the technical design of systems and processes is efficiently and effectively implemented across all platforms and regulatory compliance in particular for new market entrants is clearly translated into technical requirements.

(A.2.C) ONLINE ADVERTISING

As stated before, online advertising plays a vital role in the platform ecosystem since services are sometimes in whole or in part remunerated directly or indirectly through advertising revenues. Online advertising can be major contributor to the risks identified under the Digital Services Act, such as through ads that are illegal content, by contributing to financial incentives for the publication or amplification of illegal or otherwise harmful content and activities online, or by a discriminatory presentation of advertisements. The DSA therefore foresees transparency obligations relating to advertisements on online platforms (Article 26 DSA) and a specific obligation to have advertising repositories for certain intermediary services (Article 39 DSA).

(A.3) REFERENCES

- Regulation (EU) 2022/2065 of the European Parliament and of the Council of 19 October 2022 on a Single Market For Digital Services and amending Directive 2000/31/EC (Digital Services Act)
- Regulation (EU) 2024/1183 of the European Parliament and of the Council of 11 April 2024 amending Regulation (EU) No 910/2014 as regards

establishing the European Digital Identity Framework

- COM(2022) 212 final Digital Decade for children and youth: the new European strategy for a better internet for kids (BIK+)
- Revised Directive 2010/13/EU of the European Parliament and of the Council of 10 March 2010 on the coordination of certain provisions laid down by law, regulation or administrative action in Member States concerning the provision of audiovisual media services (Audiovisual Media Services Directive) (codified version)
- Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation)
- COM/2021/142 final EU strategy on the rights of the child
- euCONSENT pilot project

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

ACTION 1: SDOs to look into the development and implementation of voluntary standards pursuant to Article 44 Digital Services Act, in particular regarding the protection of minors (Article 44.1. point j).

ACTION 2: Develop a European standard for online age verification under the DSA and in the context of the regulation establishing a European Digital Identity framework (eID), where the technical standard is aligned with the EUDI technical framework to ensure any solutions meet the Digital Wallet's high standards in terms privacy, safety and security.

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

IEEE

In 2016 the IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems ("The IEEE Global Initiative") started a project called "Ethically Aligned Design: A Vision for Prioritizing Human Wellbeing with Autonomous and Intelligent Systems." The final/latest version of Ethically Aligned Design, released in 2019, can be found here. A similar work is underway for the Ethics of Extended Reality and has produced numerous reports.

IEEE has various standards and pre-standards activities that contribute to safety, transparency and due process online. The P7000 series has relevant activities, including IEEE 7000, IEEE Standard Model Process for Addressing Ethical Concerns during System Design, and IEEE 7001, Standard for Transparency of Autonomous Systems.

IEEE 2089 focuses on providing Age Appropriate Digital Services, and is based on the 5Rights Principles, which were developed with youth and children involved. A standard for Online Age Verification (IEEE 2089.1) was approved in 2024 and work on Standard for Terms and Conditions for Children's Online Engagement (P2089.2) has been initiated.

Other standards activities include:

- IEEE 7002, Standard For Data Privacy Process
- IEEE 7010, Wellbeing Metrics Standard For Ethical Artificial Intelligence And Autonomous Systems
- IEEE P1589, Standard For An Augmented Reality Learning Experience Model
- IEEE P2840, Standard for Responsible AI Licensing
- IEEE P2863, Recommended Practice for Organizational Governance of Artificial Intelligence
- IEEE P2874, Standard for Spatial Web Protocol, Architecture and Governance
- IEEE P2987, Recommended Practice for Principles for Design and Operation Addressing Technology-Facilitated Inter-personal Control
- IEEE P3333.1.3, Standard For The Deep Learning-Based Assessment Of Visual Experience Based On Human Factors
- IEEE P3462 Recommended Practice for Using Safety by Design in Generative Models to Prioritize Child Safety
- IEEE P7003, Algorithmic Bias Considerations
- IEEE P7004, Standard On Child And Student Data Governance
- IEEE P7005, Standard On Employer Data Governance
- IEEE P7007™ -Ontological Standard For Ethically Driven Robotics And Automation Systems
- IEEE P7008, Standard For Ethically Driven Nudging For Robotic, Intelligent And Autonomous Systems
- IEEE P7009, Standard For Fail-Safe Design Of Autonomous And Semi-Autonomous Systems
- IEEE P7011, Standard For The Process Of Identifying & Rating The Trust-Worthiness Of News Sources
- IEEE P7012, Standard For Machine Readable Personal Privacy Terms
- IEEE P7014, Standard For Emulated Empathy In Autonomous And Intelligent Systems
- IEEE P7015, Standard for Data and Artificial Intelligence (AI) Literacy, Skills, and Readiness

- IEEE P7030, Recommended Practice for Ethical Assessment of Extended Reality (XR) Technologies

The IEEE CertifAIEd Program: Through certification guidance, assessment and independent verification, IEEE CertifAIEd offers the ability to scale responsible innovation implementations, thereby helping to increase the quality of AIS, the associated trust with key stakeholders, and realising associated benefits.

For more information, see: https://ieee-sa.imeetcentral.com/eurollingplan/.

ISO

ISO has started work on ISO/IEC PWI 7732 Age Assurance Systems. This standard aims to develop a framework for the creation of age assurance systems, including age verification and age estimation within five standardised levels of confidence (self-asserted, basic, standard, enhanced and strict). The project seeks to develop the privacy and technological framework that will sit around Age Assurance. This work is being progressed by ISO/IEC/JTC1/SC27/WG5 - Privacy and Identity Management.

CEN-CENELEC

The CEN-CENELEC Workshop on Age Appropriate Digital Services Framework has been finalised, based on the IEEE standard of the same name (IEEE 2089-2021).

(C.2) ADDITIONAL INFORMATION

EUCONSENT

The euConsent pilot programme was initiated by the Commission to explore the needs for standardisation and interoperability for age verification and parental consent mechanisms across at least 3 member states. The programme included a workstream (WS 5) on standardisation, which has drafted standards for technical requirements for age verification and for parental consent as they would apply to eIDAS as it stands today. The programme also developed requirements for certification of age verification and parental consent providers. It is recognised that the programme needs to progress through preparatory action, not just to adopt the standards for today's interoperability through eIDAS, but also to prepare for eIDAS 2.0 as the standards framework for that develops over the next few years.

3.2.8 Emergency communications and public warning systems

A Policy and legislation

(A.1) POLICY OBJECTIVES

Emergency communications

Emergency communications are defined primarily as a means of communication through interpersonal communications services between an end-user and the PSAP with the goal to request and receive emergency relief from emergency services.

Emergency communications should ensure effective access to emergency services for all, including end-users living with disabilities and roaming customers. Caller location is the most important contextual data that should be made available to Public Safety answering Point and should be accurate enough to enable the effective intervention of emergency services.

Public warning systems

Article 110 of the European Electronic Communication Code (EECC - Directive (EU) 2018/1972) requires that by 21 June 2022, Member States shall ensure that, when public warning systems regarding imminent or developing major emergencies and disasters are in place, public warnings are transmitted by providers of mobile number-based interpersonal communications services to the end-users concerned.

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

The lack of commonly agreed standards in support of electronic communications networks for emergency communications in Europe is a barrier to implementing future proof solutions which meet the requirements of the European Accessibility Act (EAA - Directive (EU) 2019/882) and the requirements of Article 109 of the EECC.

Standards for real time text and total conversation access to emergency services are required to meet the special needs of end-users living with disabilities and

to ensure equivalence of access under the relevant provisions of the EECC and the EAA for emergency communication to the European emergency number '112'.

Under mandate 587 submitted by the Commission and accepted by the ESOs, a Harmonized standard for the accessibility of emergency communications and for the answering of emergency communications by the PSAPs (public safety answering points-including to the single European Emergency number 112) will be developed.

(A.3) REFERENCES

- Directive (EU) 2018/1972 of the European Parliament and of the Council of 11 December 2018 establishing the European Electronic Communications Code.
- COMMISSION DELEGATED REGULATION (EU) 2019/320 of 12 December 2018 supplementing of Directive 2014/53/EU of the European Parliament and of the Council with regard to the application of the essential requirements referred to in Article 3(3) (g) of that Directive in order to ensure caller location in emergency communications from mobile devices.
- Directive 2002/58/EC of the European Parliament and of the Council of 12 July 2002 concerning the processing of personal data and the protection of privacy in the electronic communications sector (Directive on privacy and electronic communications).
- Recommendation 2003/558/EC of the Commission of the European Communities of 25 July 2003 on the processing of caller location information in electronic communication networks for the purpose of location-enhanced emergency call Services.
- Directive (EU) 2019/882 of the European Parliament and of the Council of 17 April 2019 on the accessibility requirements for products and services
- SWD/2022/0430 final: COMMISSION STAFF WORKING DOCUMENT Accompanying the document COMMISSION DELEGATED REGULATION (EU) ../... supplementing Directive (EU) 2018/1972 of the European Parliament and of the Council with measures to ensure effective access to emergency services through emergency communications to the single European emergency number '112'
- COMMISSION DELEGATED REGULATION (EU) 2023/444 of 16 December 2022 supplementing Directive (EU) 2018/1972 **of the European Parliament and of the Council with measures to ensure effective access to emergency services through emergency communications to the single European emergency number '112'**

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

ACTION 1: SDOs to update the existing standards to reflect the conceptual framework of the Directive (EU) 2018/1972, in particular where the concept of 'emergency services' is not consistently used to reflect the 'public safety answering points' or 'emergency communications' (for example ETSI TS 103 479).

ACTION 2: SDOs to address data protection and privacy requirements (privacy by design) in ongoing standardisation activities concerning emergency communications and processing and transmission of caller location information.

ACTION 3: SDOs to identify the applicable specifications and standardisation needs for the transmission of handset derived caller location to the most appropriate PSAPs by mobile network operators in both, user plane and control plane modes.

ACTION 4: SDOs to identify interoperability issues for packet switched emergency communications (e.g: VoLTE) at network and handset level, in particular when using roaming services.

ACTION 5: SDOs to set requirements, functional architecture, protocol and procedures specification for a Pan European mobile emergency application. Identify standardisation needs for the deployment of emergency applications enhanced with caller location information and accessibility features for the widest range of users, including end-users living with disabilities.

ACTION 6: ESOs to elaborate standards on accessibility of emergency communications as arising under the European Accessibility Act.

ACTION 7: to support the standardization of emergency SMS, in particular to '112', to enable the correct routing while roaming services are used.

ACTION 8: SDOs to define dictionaries for public warning messages for emergency communication service**s** based on the input of various civil protection agencies.

ACTION 9: SDOs to identify standardisation needs for the establishment of a Union wide public warning system in line with recital 294 of Directive (EU) 2018/1972.

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

ETSI

TC EMTEL: has published TS 103 625 "Transporting Handset Location to PSAPs for Emergency Calls - Advanced Mobile Location" and its corresponding test purposes (TS 103 825).

TC EMTEL has completed the TR to prepare requirements for communications involving IoT devices in all types of emergency situations (e.g. communications of individuals with authorities/ organisations, between authorities/organisations, from authorities/ organisations to the individuals, amongst individuals). The next step is to include the requirements in the appropriate Technical Specifications.

TC EMTEL has also published TS 103 479 describing the architecture (currently named 'Next Generation Emergency Communication architecture'), the core elements and corresponding technical interfaces for network independent access to emergency services. This work is complemented by a group of technical specifications describing test cases and scenarios for related interoperability and conformance testing.

The work is now complete for requirements, the functional architecture, the protocol and the procedures for implementing the Pan-European Mobile Emergency Application.
There are presently hundreds of emergency calling applications in use across Europe, but their use is constrained to the boundaries of the Public Safety Answering Point (PSAP) with which they are integrated.

TC EMTEL has published TS 103 478, specifying a framework for Pan-European Mobile Emergency Applications (PEMEA) and published specifications with various PEMEA extensions (refer to action 5). The PEMEA Extensions are specified in:

- TS 103 756 - PEMEA Instant Message Extension
- TS 103 871 - PEMEA Real Time Text Extension
- TS 103 945 - PEMEA Audio Video Extension
- TS 104 014 - PEMEA File Exchange Extension

ITU-T

ITU-T Focus Group on "Disaster relief systems, network resilience and recovery" produced several technical specifications that were published (http://www.itu.int/pub/T-FG/e) and were refined in ITU-T SG2 and SG15:

Recommendation ITU-T L.392 "Disaster management for improving network resilience and recovery with movable and deployable ICT resource units' was approved by ITU-T SG15 in April 2016.

Supplement ITU-T Suppl.35 "Framework of disaster management for network resilience and recovery" was approved by ITU-T SG15 in June 2017.

Recommendation ITU-T E.108 "Requirements for a Disaster Relief Mobile Message Service" was approved by ITU-T SG2 in January 2016.

Recommendation ITU-T E.119 (ex. E.rdr-scbm) "Requirements for Safety Confirmation and Broadcast Message Service for Disaster Relief" was approved by ITU-T SG2 in April 2017.

Draft new Recommendations ITU-T E.102 (ex. E.TD-DR) "Terms and definitions for disaster relief systems, network resilience and recovery " was approved by ITU-T SG2 in December 2019.

E.Suppl.1 to ITU-T E.100 series (ex E.sup.fdr) "Framework of disaster management for disaster relief systems" was agreed by ITU-T SG2 in February 2019.

TR.CLE, "Identify call location for emergency service" was agreed by ITU-T SG2 in June 2020 and provides an overview of technical solutions available for this purpose.

ITU-T SG2 also produced an amendment to its E.123 standard for quickly identifying next-of kin (or other emergency contact) in a mobile handsets' directory, for use in case of emergency, and has established a framework for international emergency call priority (ITU-T E.106 and E.107).

ITU-T SG2 has also developed the following:

Recommendation ITU-T E.161.1 on "Guidelines to select Emergency Number for public telecommunications networks"

TR.CLE, "Identify call location for emergency service" was agreed by ITU-T SG2 in June 2020.

More information on SG2 is available at https://itu.int/go/tsg2

Focus Group on Artificial Intelligence for Natural Disaster Management (FG-AI4NDM), established by ITU-T SG2, explored the use of AI for assisting with data collection and handling, improving modelling across spatiotemporal scales. FG-AI4NDM has finalized the Technical Report on AI for communications: Towards natural disaster management, the Standardization Roadmap on Natural Disaster Management: Trends and Gaps in Standardization ", the Glossary - Artificial Intelligence for Natural Disaster Management ", the Technical Report on Innovative Approaches to Natural Disaster Management: Leveraging AI for Data-related processes" . The Global Initiative on Resilience to Natural Hazards through AI Solutions which is a collaborative effort led by ITU, WMO, UNEP, UN Framework Convention on Climate Change (UNFCCC) and Universal Postal Union (UPU), will further build on the work of this Focus Group.

The activities of the FG-AI4NDM were conducted in close collaboration with the World Meteorological Organization (WMO) and United Nations Environment Programme (UNEP). at: https://itu.int/go/fgai4ndm

More information on the Global Initiative: https://www.itu.int/en/ITU-T/extcoop/ai4resilience/Pages/default.aspx

ITU-T SG15 has also developed the following:

Recommendation ITU-T L.390 on "Disaster management for outside plant facilities" (approved in October 2012)

Recommendation ITU-T L.391 on "Monitoring systems for outside plant facilities" (approved in November 2009)

More information on SG15 is available at https://itu.int/go/tsg15

ITU-T SG17 has transposed the OASIS Common Alerting Protocol versions 1.1 and 1.2 into ITU-T X.1303 and X.1303bis.

ITU-T SG13 developed a number of Recommendations including ITU-T Y.2074, Y.2222, Y.2705, Y.1271, Y.2205 and Supplement 19 to the ITU-T Y.2200-series —covering different aspects of

emergency communication operation. Recommendation ITU-T Y.3539 "Cloud computing - Framework of risk management" addresses framework of risk management in cloud computing, including risk assessment, risk treatment etc.

ITU-T FG NET2030 White Paper "Network 2030 - A Blueprint of Technology, Applications and Market Drivers Towards the Year 2030 and Beyond" elaborates on the critical infrastructure enable people to survive in emergency situations.

https://www.itu.int/en/ITU-T/focusgroups/net2030/Documents/White_Paper.pdf

ITU-T SG11 approved ITU-T Q.3615 which describes the Open GeoSMS Standard, which was developed by the Open Geospatial Consortium (OGC); geo-localisation is a key part of rapid and effective emergency responses. SG11 also drafted a number of Supplements to the Q-series Recommendations (e.g. Supplements 47, 53, 57, 61, 62, 63, 68, 69, 70 and 72) to support emergency telecommunications. SG11 developed the following Recommendations on emergency telecommunications:

- ITU-T Q.3060 "Signalling architecture of fast deployment emergency telecommunication networks to be used in a natural disaster" which defines a general framework for fast deployment emergency telecommunication networks (fdETNs) to be used in a natural disaster;
- ITU-T Q.3647 "Signalling requirements for emergency service in IMS roaming environment" which specifies the signalling architecture, interfaces and functional description, signalling requirements, signalling procedures and security consideration for emergency services in the home routing architecture of IMS roaming over long-term evolution (LTE) and LTE advanced;

Currently, ITU-T SG11 is developing the following new standards:

- Req_Frame_RRDN "Requirements and framework for rapid response to sudden natural disasters in network" which reduces rescue time and increases rescue effectiveness and success.
- IEM_arch_req "Reference architecture and signalling requirements for interactive emergency messaging through mobile network" which defines the reference architecture and signalling protocols required for providing interactive emergency messaging through mobile network by addressing the limitation in existing technologies.

ITU-T SG12 developed Recommendation ITU-T P.1140 (ex P.emergency) "Speech Quality Requirements for Emergency Calls" in March 2017. SG12 is updating this Recommendation.

ITU- T SG16 developed Recommendation ITU-T H.785.1 (ex H.DS-PISR) "Digital signage: Service requirements and a reference model on information services in public places via an interoperable service platform". This technology can be used for early warning to lessen damages, reporting up-to-the-minute situations and announcing traffic status/evacuation sites.

ITU-T SG20 developed the following:

- Recommendation ITU-T Y.4119 "Requirements and capability framework for IoT-based automotive emergency response system",
- Recommendation ITU-T Y.4467 "Minimum set of data structure for automotive emergency response system"
- Recommendation ITU-T Y.4468 "Minimum set of data transfer protocol for automotive emergency response system"
- Recommendation ITU-T Y.4220 "Requirements and capability framework of abnormal event detection system for smart home".

ITU-T SG20 is also developing the following:

- Draft Recommendation ITU-T Y.4226 (ex Y.isms) "Functional framework and requirements for disaster monitoring system"
- Draft Recommendation ITU-T Y.4705 (ex Y.nmm-isms) "Metadata model of sensing capability for disaster monitoring system"
- Draft Recommendation ITU-T Y.4222 (ex Y.smart-evacuation) "Framework of smart evacuation in a disaster or emergency in smart cities and communities "
- Draft Recommendation ITU-T Y.Fram-ssdp "Requirements and framework of metaverse simulation service for disaster prevention in electric power facilities"
- Draft Recommendation ITU-T Y.4496 (ex Y.RA-PHE) "Requirements and reference architecture of smart service for public health emergency"
- Draft Recommendation ITU-T Y.4233 (ex Y.FSPH) "Framework for smart public health emergency management in smart and sustainable cities"
- Draft Recommendation ITU-T Y.4229 (ex Y.IoT-SFFS) "Requirements and Reference functional model of IoT-based smart forest firefighting system"

ITU-T supports ITU/WMO/UNESCO IOC Joint Task Force on SMART submarine cable collaborating with WMO and UNESCO IOC. This task force is tasked with developing a strategy and roadmap that could lead to enabling the availability of submarine repeaters equipped with scientific sensors for ocean and climate monitoring and disaster risk reduction (tsunamis). Submarine cables with repeaters with scientific sensors (e.g., for water pressure, temperature and acceleration) are called SMART submarine cables. Data from SMART submarine cables can be used for tsunami early warning as well as climate change monitoring.

ITU-T SG15 approved following Recommendations related to SMART submarine cables and dedicated submarine cables for measurement:

- 9730.1: Dedicated scientific sensing submarine cable system
- 9730.2: Scientific monitoring and reliable telecommunications submarine cable systems

ITU-T SG5 is working on Recommendation ITU-T L.smart "Impact assessment framework for evaluating how ICT-based subsea infrastructure could support climate, environmental and biodiversity monitoring in the oceans".

Portugal is progressing the deployment of SMART submarine cables as CAM2 project.

ITU-R

The ITU's Radiocommunication Sector (ITU-R) also carries out studies on emergency communications. The Radiocommunication Assembly 2023 (RA-23) updated and approved Resolution ITU-R 55. This Resolution resolves that ITU-R Study Groups undertake studies related to the management of radiocommunications in disaster prediction, detection, alerting, mitigation and relief and continue studies on new emerging technologies that could support disaster prediction, alerting, detection, mitigation and relief. A list

of related ITU-R publications on this subject is provided in the Annex to this Resolution.

The information is regularly updated on the ITU-R webpage of Emergency Radiocommunications: https://www.itu.int/en/ITU-R/information/Pages/emergency.aspx

ITU-R Working Party 6A is revising Recommendation ITU-R BT.1774-2 on "Use of satellite and terrestrial broadcast infrastructures for public warning, disaster mitigation and relief", anticipated for completion in early 2025.

Given the importance of this subject, ITU-R also organizes capacity building activities. For instance, in March 2023 a joint ITU-R SG 6 – EBU Workshop "Broadcasting in times of crisis" was held aiming at reminding about the role of broadcasting in times of crisis, through real-life examples; informing about available emergency warning technologies in broadcasting and their synergy with other radiocommunication systems, and identifying high-level requirements to improve the role of broadcasting in this context.

In addition, joint ITU/WMO training activities for the period leading up to WRC-27 are being organised. There will be a series of three ITU/WMO Regional Workshops and Seminars for "Earth observations for Sustainable Development Goals: technologies, spectrum, applications, impacts" in 2024, 2025, 2026.

ITU-D

ITU-D SG2 Question 5/2 has developed a report on Utilization of telecommunications/ICTs for disaster preparedness, mitigation and response: https://www.itu.int/pub/D-STG-SG02.05.1-2017

W3C

WebRTC, the web's real-time communication service is currently being developed and specified jointly between the IETF and W3C. The IETF is working on the protocol level. The group heading this effort is called RTCweb.

W3C specifies the necessary API to connect the service to the web — application framework created by, among others, by HTML5. The group working on this part is called WebRTC. A good overview of the technology developed can be found in the STREWS project's security report on WebRTC.

IETF

The Emergency Context Resolution with Internet Technologies (ECRIT) Working Group has developed a general architecture for enabling IP applications to discover and connect to emergency services.

The Geographic Location/Privacy (GEOPRIV) Working Group developed protocols that allow IP networks to inform end devices about their geolocation, a critical pre-requisite for emergency calling.

The application-specific working groups in the IETF (for example, the Session Initiation Protocol Core (SIPCORE) Working Group) have developed extensions to support emergency calling as required.

The Secure Telephone Identity Revisited (STIR) WG is developing Internet-based mechanisms that allow verification of the calling party's authorisation to use a particular telephone number for an incoming call. The main focus is on the SIP as one of the main VoIP technologies used by parties that want to misrepresent their origin, in this context the telephone number of origin. See, for example, RFC7375 "Secure telephone identity threat model".

https://wiki.ietf.org/en/group/iab/Multi-Stake-Holder-Platform#h-328-emergency-communications-and-public-warning-systems

ISO

ISO/TC 204: intelligent transport systems (ITS). This covers standardisation of information, communication and control systems in the field of urban and rural surface transportation, including intermodal and multimodal aspects thereof, traveller information, traffic management, public transport, commercial transport, emergency services and commercial services in the intelligent transport systems (ITS) field.

Projects include:

ISO/AWI 19083-2: ITS — Public transport — Emergency evacuation and disaster response and recovery — Part 2: Data flow

ISO/PRF TR 19083-1: ITS — Public transport — Emergency evacuation and disaster response and recovery Part 1: Framework

ISO/NP 20530: ITS — Information for emergency service support via personal ITS station — General requirements and technical definition

ISO/PWI 21344: ITS– Public transport — Emergency services E-Call device for emergency on connected vehicles using ITS station

ISO 22951:2009 (Ed. 1): Data dictionary and message sets for pre-emption and prioritisation signal systems for emergency and public transport vehicles (PRESTO)

ISO 24978:2009 (Ed. 1): ITS Safety and emergency messages using any available wireless media — Data registry procedures

ISO/DTR 18317: ITS — Pre-emption of ITS communication networks for disaster relief and emergency communications

http://www.iso.org/iso.iso_technical_committee%3Fcommid%3D54706

ONEM2M

Some examples of features of oneM2M to enable communication in emergency situations are access controls, message prioritization, network congestion alleviation, group communication, subscription/ Notification and location tracking.

For more details see the oneM2M Technical Report in "TR-0046-Study_on_Public_Warning_Service_Enabler" and the oneM2M Technical Specification "TS-0037-IoT_Public_Warning_Service_Enablement".

All oneM2M specifications and reports are publicly available at: Specifications (onem2m.org)

OASIS

The OASIS Emergency Management TC created the Common Alerting Protocol (CAP), used by crisis responders, weather prediction agencies and emergency management stakeholders for broadcasting data about crisis conditions and locations, over various media including SMS, police radio and weather radio. CAP also is approved as ITU-T Rec X-1303. A suite of related Emergency Data Exchange Language (EDXL) resource and crisis management XML standards have also been developed, supporting exchange of health facility availability information (HAVE), data sharing of information on situations, incidents, events

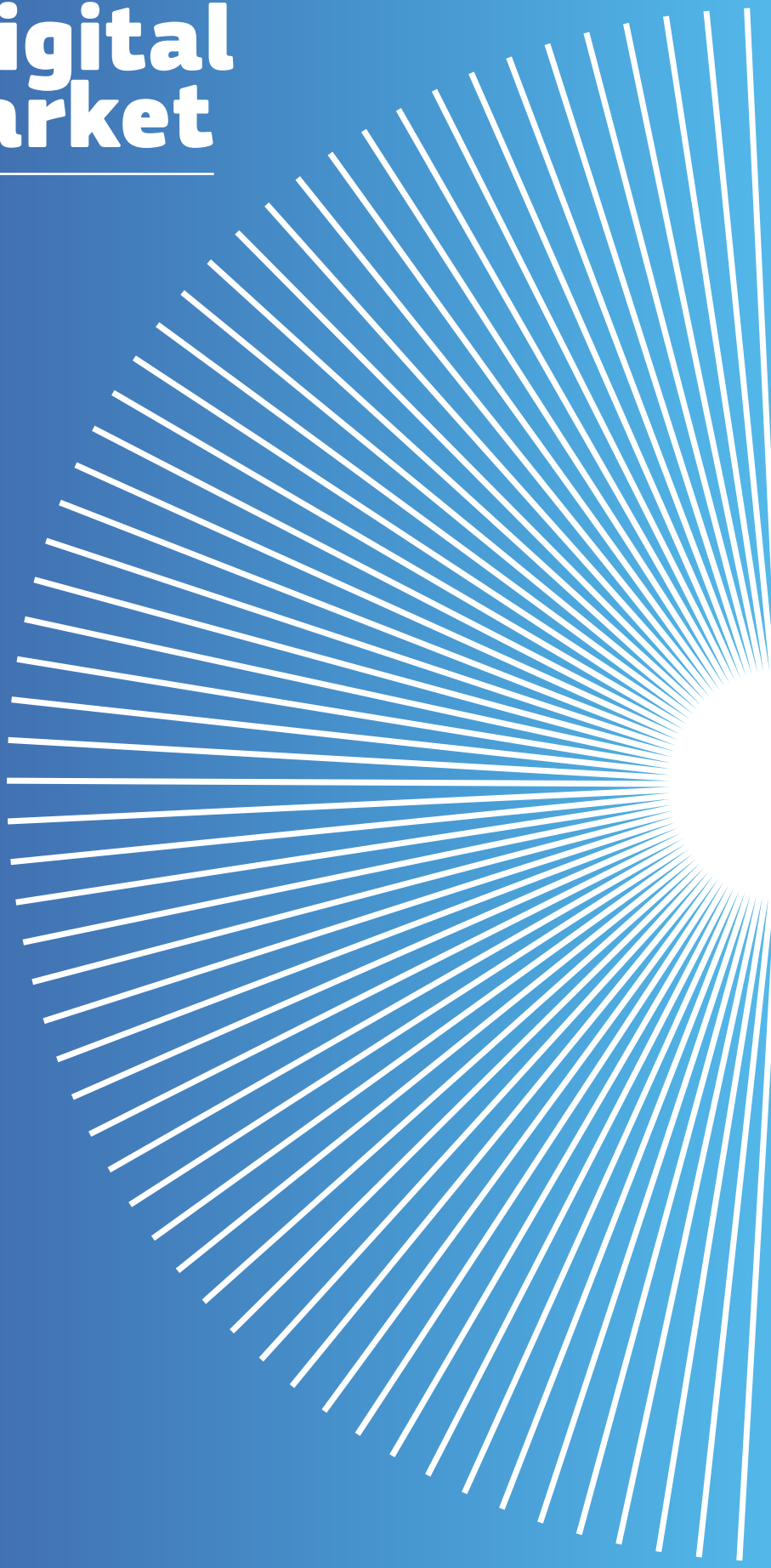
and responses (SitREP) and sharing of emergency patient and tracking information (TEP).

The Mobile Alerting Practices v1.0 note published in 2023 by OASIS' Emergency Management committee describes public network experience and best practices needed to issue large-scale distributions in a specific geographic area without crashing the control channel, and to reach geographic roamers, whose devices may retain their default behavior from their home network, when appropriate within the geographic remit of a warning.

EENA

The European Emergency Number Association (EENA) has published several documents regarding the accessibility of emergency communications. The latest ones are the existing obligations to Member States in this field (https://eena.org/knowledge-hub/documents/emergency-services-accessibility-forpersons-with-disabilities-2021-update/) and the state of implementation of Real Time Text and Total Conversation in Europe (https://eena.org/knowledge-hub/documents/rtt-and-tc-implementation-in-europe/).

3.3 Innovations for the Digital Single Market



3.3.1 e-Procurement: pre- and post-award

A Policy and legislation

(A.1) POLICY OBJECTIVES

Public procurement must ensure best value for money, while being transparent and simple as well as meeting environmental, innovative and social objectives. The digitalisation of Procurement processes, known as *eProcurement* is a key tool to achieve these goals.

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

The 2014 Public Procurement Directives mandates the use of eProcurement as the main method for carrying out public procurement procedures. Since April 2016, electronic notification and electronic access to tender documents have been mandatory; eSubmission of tenders became mandatory for all buyers in October 2018.

The procurement Directives also require the Commission to adopt implementing regulations on procurement standard forms and on the European Single Procurement Document. Furthermore, the Commission is empowered to mandate the use of technical standards in other areas of eProcurement as long as these are "thoroughly tested and proved their usefulness in practice" (See Directive 2014/24/EU Art. 22, last paragraph).

eProcurement in the EU is driven by a thriving ecosystem of private and public eProcurement solution providers. Being able to choose between multiple systems can bring better services and lower prices. However, it can also bring challenges such as lock-in with particular eTendering providers and having to learn to work with multiple eTendering systems to access documents, submit bids, etc.

Standards can offer solutions to these problems, as they can improve data portability, reduce the costs of understanding new systems and enable communication across systems. This has been recognised on various occasions, for example in 2013 by the Commission's Expert Group on eTendering (eTEG) and in 2016 by the Commission's Multi-Stakeholder Expert Group on eProcurement (EXEP). Such benefits will be available not only to public entities acting in the role as buyers, but also for private sector entities and service providers.

However, the practical development and use of standards for eProcurement is not without its difficulties. Products of CEN (a main driver of eProcurement standardisation activities within the CEN-BII workshop and CEN/TC 440) have faced several practical challenges in their implementation into software, relating to their availability and copyright licensing requirements. In this context, also, CEN/TC 440 is working on the possibility to integrate Free and Open Source solutions into eProcurement standards. As a result, CEN has initiated a pilot to permit 'derivative use,' ensuring that end-users can use the standard free of charge.

The standards will benefit both European businesses involved in public procurement and ICT service providers developing e-procurement services.

These benefits, among others, will:

- reduce the barriers for SMEs to participate in the eProcurement processes;
- enable the fulfilment of public policy objectives, such as sustainable public procurement, by allowing for tracking of information related to labels and certificates along with the item information, as well as information on sustainable services such as CO2 compensation;
- ensure open and free cross-border markets.

On behalf of CEN/TC 440, CEN successfully submitted a proposal to an EISMEA call (SMP-STAND-2023-ESOS-01-IBA) *Standardisation of pre-award phases of public procurement*.

The EISMEA Grant started in January 2024 and ensured the initiation of the standardisation projects in the Pre-Award phase.

Development of the standard is expected to continue until 2025-2026.

Meanwhile the Publications Office has developed an e-Procurement Ontology, which provides a common machine readable vocabulary for the concepts used in Public Procurement processes. The eProcurement Ontology ensures that all stakeholders in Public Procurement use the same terms and have the same understanding of key concepts. CEN/TC 440 uses this eProcurement Ontology in its standardisation efforts and liaises with the EC Publications Office to feed requirements from the standardisation work back into the Ontology.

(A.3) REFERENCES

- Commission Implementing Regulation (EU) 2019/1780 of 23 September 2019 establishing standard forms for the publication of notices in the field of public procurement and repealing Implementing Regulation (EU) 2015/1986 (eForms) (Text with EEA relevance)
- COM(2012) 179 final — Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on a strategy for eProcurement
- COM(2013) 453 final on end-to-end eProcurement to modernise public administration
- Directives 2014/23/EU (concessions), 2014/24/EU (general) and 2014/25/EU (sectoral) on public procurement
- Directive 2014/55/EU of the European Parliament and of the Council on electronic invoicing in public procurement (especially the part on contract management which is linked to eProcurement; please note there is a separate chapter on eInvoicing).
- Commission Implementing Regulation 2016/7 establishing the standard form for the European Single Procurement Document
- Commission Implementing Regulation 2015/1986 establishing standard forms for the publication of notices in the field of public procurement
- EISMEA call for support to Standardisation activities performed by CEN, CENELEC and ETSI

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

ACTION 1: Support CEN/TC 440 in the standardisation of eProcurement.

ACTION 2: Continue the development of the eProcurement ontology. The action owner for the ontology is the Publications Office of the EU together with stakeholders from Member States.

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

CEN

CEN/TC 440 — "Electronic public procurement" — was established in 2015 with the ambition to cover the full end-to-end eProcurement process, with the exception of eInvoicing, which is covered by CEN/TC 434. It succeeded the CEN workshop WS/BII3, which was closed on the 9 March 2016.

- CEN/TC 440 Website (including business plan).

To ensure that standards developed by CEN/TC 440 add value and meet the needs of the private and public actors along the supply chain (SC), **CEN/TC 440 develops standards for interoperability in data exchange and data sharing in e-Procurement for the business processes related to sourcing, tendering and operative processes like ordering and fulfilment (called pre- and post-award processes in the public sector).** CEN/TC 440 standards aim to support EU policies and legislation.

CEN/TC 440 standardises data exchange for the following business processes for e-Procurement:

- **pre-award processes**, which include electronic access to calls for tender (eAccess), electronic submission of tenders to procurement procedures (eSubmission), electronic signing of contracts and contract amendments (eContract), and electronic requests for quotation within framework agreements (eQuoting).
- **eContract**: the pre-award process of electronically signing a contract between a contract authority and a winning tenderer, as well as electronically signing contract amendments.
- **eCatalogue**: the post-award process whereby the seller shares a catalogue of goods or services with the buyer. The seller can subsequently update the catalogue and the buyer can accept or reject the catalogue and updates. The so-called punch-out process is also included, where a buyer can order goods or services directly from a seller's webshop.
- **eOrdering**: the post-award process of ordering goods or services from a seller. Both the buyer and seller can subsequently change, accept the reject the (changed) order.
- **eFulfilment**: the post-award process of notifying how ordered items will be delivered, and whether this requires special handling on the receiver side. The receiver can confirm (partial) receipt of the goods.

For each of these processes, the standards specifies:

- **Choreographies**: the message flows between the parties involved.
- **Transactions**: the semantics of the messages exchanged and the semantic model of the exchanged data.
- **Syntax bindings:** the syntax of the messages in specific languages such as ISO/IEC 19845:2015 (UBL) and UN/CEFACT CII.

In addition, CEN/TC 440 also specifies an architecture for eProcurement and identifies emerging technologies that can drive innovation. The CEN/TC 440 Business Plan provides detailed information on the scope, timing and deliverables of the activities.

The CEN/TC 440 standards are based on a common vocabulary of business terms, aligned with the CEN/TC 434 standards and the eProcurement Ontology (ePO) developed by the Publication Office and it is engaged in a collaboration with the Publication Office eProcurement working group to ensure that specific post-award semantic requirements in standards are met by the eProcurement ontology.

The following CEN/TC 440 standards are available:

- CEN/TR 17011-2-1 Model of innovative developments
- CEN/TR 17011-2-2 Requirements for innovative developments
- CEN/TR 17011-2-3 Legislative and regulatory landscape and adaptations for innovative developments
- CEN/TS 17011-4 Electronic Public Procurement – Architecture – Technical architecture
- CEN/TS 17011-5 Electronic Public Procurement – Architecture – Semantic architecture
- EN 17014-1 Electronic Public Procurement – Pre-Award – Part 1: Choreographies
- EN 17014-2 Electronic Public Procurement - Pre-Award – Part 2: Transactions
- CEN/TS 17014-3-1 Electronic Public Procurement - Pre-Award – Part 3-1: Syntax Binding, UBL

CEN/TC 461 — 'Integrity and accountability in public procurement' — established to define requirements/recommendations for how organisations ensure integrity and accountability in public procurement activities and processes. The committee started drafting EN 17687:2022 'Public procurement - Integrity and accountability - Requirements and guidance' in July 2020 and published the standard in August 2022. Having completed its task and with no further items to include in its work programme, the committee was made dormant in November 2022.

OASIS

The OASIS Universal Business Language (UBL) TC defines a common XML library of business document types supporting digitization of commercial and logistical processes for domestic and international supply chains. UBL includes document schemas that support eProcurement (eTendering) processes. UBL version 2.4 was published as OASIS standard in June 2024, and has been submitted to ISO/IEC to be published as ISO/IEC standard. UBL versions 2.4, 2.3, 2.2 and 2.1 are backwards compatible. OASIS currently works on UBL version 2.5. UBL version 2.1 is used in OpenPEPPOL (see section C.2) and various member states, and is also published as ISO/IEC 19845:2015.

The OASIS UBL TC also launched a Commodities subcommittee in 2024 to respond to demand for embedded sustainability and circularity data. See Circular economy and sustainability (Section C.1).

The eForms software development kit used for publishing eProcurement notices on TED (Tenders Electronic daily) is based on UBL v2.3.

The OASIS ebCore TC maintains the ebXML RegRep standard that defines the service interfaces, protocols and information model for an integrated registry and repository. The repository stores digital content while the registry stores metadata that describes the content in the repository. RegRep is used in OpenPeppol, in pre-award eTendering BIS profiles

- BIS P006 – Search Notices (ebXML RegRep as container for query definition in search notices to public repositories such as Notification Platforms)
- BIS P008 – Publish Notice (ebXML RegRep as container for publishing notices)

UNECE

The United Nations Economic Commission (UNECE) Recommendation 43 on Sustainable Procurement underlines that cost shouldn't be the only driver in Procurement processes. Environmental sustainability and social return are equally important factors to take into account. UNECE Recommendation 43 therefore describes a code of conduct for suppliers and vendors, and provides a checklist to evaluate to what degree they act accordingly. These UNECE recommendations should also be taken into account in e-Procurement standardisation.

See: (available also in French and Russian) http://www.unece.org/fileadmin/DAM/cefact/cf_plenary/2019_plenary/ECE_TRADE_C_CEFACT_2019_07E.pdf

IEEE

Some activities, for public procurement to meet innovative and social objectives with a focus on AI, include:

- IEEE P2863, Recommended Practice for Organizational Governance of Artificial Intelligence
- IEEE P3119, Standard for the Procurement of Artificial Intelligence and Automated Decision Systems is a new IEEE standards activity

For more information, see: https://ieee-sa.imeetcentral.com/eurollingplan/.

(C.2) OTHER ACTIVITIES RELATED TO STANDARDISATION

INTEROPERABLE EUROPE (SUCCEEDS ISA2)

The Interoperable Europe programme is an initiative of the European Commission succeeding the ISA2 programme. Its goal is to reinforce European interoperability policy beyond ISA2. Interoperable Europe provides resources for ICT interoperability on European level, some of which are of direct relevance for eProcurement:

- The European Single Procurement Document (ESPD) data model and the reference information tool eCertis, which were both developed under the ISA2 program. Based on the ESPD data model, a Digital Service Infrastructure (DSI) for e-Procurement was developed by ISA2 with funds from the Connected Europe Facility (CEF). Currently, almost all EU countries have at least one ESPD service in place and many are connected through eCertis. Interoperable Europe provides the test bed initially developed under ISA2 which supports validation of UBL based ESPD documents, as well compliance of electronic invoices with the European Norm for electronic Invoicing 16931-1:2017.

- The Semantic Interoperability Community (SEMIC), previously supported by the ISA2 program developed the Core Criterion and Core Evidence Vocabulary (CCCEV) which makes the ESPD data model domain independent like other Core Vocabularies.
- The eProcurement ontology (ePO) published by the Publications Office of the European Commission also has origins in ISA2. The ePO provides a common vocabulary for eProcurement terms and concepts across processes and standards, which is key to interoperability in eProcurement data exchange.

OPENPEPPOL

OpenPeppol is an open non-profit organisation that provides standards, practices and implementations for exchanging e-Procurement documents. It builds on the specifications that were created by the European Large Scale Pilot (LSP) Peppol, which ran from 2008 until 2012. OpenPeppol is not only a standardisation organisation, it also governs the Peppol network and implementations. Service Providers that are members of OpenPeppol provide standards-based networking services, which are overseen by National Peppol Authorities.

OpenPeppol aligns with the CEN standards for e-Procurement and e-Invoicing wherever possible. This results in a Peppol network which is largely compatible with CEN standards. The Peppol Business Interoperability Standards (BIS) for eInvoicing is a Core Invoice Usage Specification (CIUS) of the European Standard EN 16931-1 for eInvoicing published by CEN/TC 434.

Peppol is now supported by hundreds of service providers throughout Europe, servicing thousands of public and private organisations.

In 2023, Peppol logistics and transport messages were defined by the Peppol Logistics Incubation project. The six developed messages were published in November 2023 for use. In 2024, Peppol logistics sub-domain was established under the Peppol Post-Award Domain. Compliance with eFTI (EU's electronic Freight Transport Information) regulation was considered in the development of Peppol logistics messages so that these Peppol messages could act as the source of eFTI reporting. With this development procurement and logistics become integrated.

Several EU-funded projects provided proofs of concept of the Peppol concept, such as the Electronic Simple European Networked Services' (e-SENS) large scale pilot (LSP) which completed in 2017.

EXEP

The multi-stakeholder expert group on eProcurement (EXEP) assists and advises the Member States and the Commission on implementing the provisions of the new public procurement Directives relating to electronic procurement. It contributes to monitoring the uptake of eProcurement across the EU, sharing best practices, following new developments in the field, and addressing interoperability issues. The EXEP liaised closely with the now closed European multi-stakeholder forum on eInvoicing (EMSFEI) and with national forums to further promote the uptake of end-to-end eProcurement across the EU, including in the post-award phase. The group is responsible for ensuring the coherence between the recommendations arose from the EMSFEI and broader policies on end-to-end eProcurement. In addition, EXEP provides governance and support for initiatives like CEF and governs the standardisation process in the area of eProcurement.

TOOP

The Once-Only Principle Project (TOOP) was launched by the European Commission in January 2017 as an initiative of more than 50 organisations and closed on 31 March 2021.

The main objective of TOOP was to explore and demonstrate the once-only principle across borders, focusing on data from businesses. Doing this, TOOP enabled better exchange of business related data or documents with and between public administrations and reduced administrative burden for both businesses and public administrations.

The TOOP project ended in March 2021. Its outcome was used as a basis for the technical implementation of the Single Digital Gateway Regulation i.e., the Once Only Technical System. The Regulation came into force in 12/12/2023.

https://www.toop.eu/

3.3.2 e-Invoicing

A Policy and legislation

(A.1) POLICY OBJECTIVES

Electronic invoicing (eInvoicing), as defined in Directive 2014/55/EU, is the process through which an invoice is issued, sent and received in a structured electronic format which allows for its automatic and electronic processing; it brings numerous benefits to all users (senders, and recipients, service providers, tax authorities, etc). By automating the relevant business processes, eInvoicing leads to cost savings, increased efficiency, faster payments, and a reduced environmental impact especially if other business documents like order and dispatch advice are also available in electronic format. Its deployment is a strong tool in support of enterprise and financial policies as it makes enterprises more efficient and generates potentially significant savings for Member States' governments. Electronic invoicing can improve tax compliance and is an effective tool to reduce tax frauds, in fact its adoption also in the private sector transactions (B2B) is increasing worldwide, often by legal obligation and with proprietary formats.

eInvoicing is evolving rapidly and innovative applications of eInvoicing and uses are developing, based on Blockchain, AI, RPA, etc. and this evolution will shape policy developments in the coming years. The main objectives for the coming period are to achieve broad take-up of eInvoicing in Europe, extension of the use of the European Standard and the EU-model for eInvoicing to B2B, B2C and at an international level, and making the European standard fit for use according to all upcoming Commission e-Invoicing related policies, such as VAT reporting.

For electronic invoices related to ICT services addressing end users, attention will be paid to Human Factors such as universal accessibility, consistency and use of understandable language. Aspects such as clarity and ability to perceive of information structures and content, use of unambiguous, harmonised terminologies and standardised formats and information attributes and details must be considered for current and upcoming ICT services. ETSI has already addressed certain aspects related to the usability and accessibility of the basic elements (e.g. in Smart City environments) and on the general level; the ESOs, international standards bodies and consortia should coordinate and initiate work to develop recommendations addressing the requirements and user experience of e-Invoicing in digitised environments (covering applicable usability and accessibility aspects related to those attributes and context of use).

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

By specifying the semantic data model of the core elements of an electronic invoice, the published European standard EN 16931-1 and its list of syntaxes in Annex is intended to tackle the fragmentation that is a side effect of the vast number of eInvoicing standards, data formats, and usage requirements that exists across the EU and globally. The standard model preserves the necessary flexibility through Core Invoice Usage Specifications (CIUS) and extensions. It is important to promote the standards in order to facilitate interoperability while respecting different sector needs and practices. On the same basis, it should also be possible, by new standardisation activities, to support the adoption of e-Invoicing for B2B and B2C (e-receipts) and at an international level while ensuring the use of eInvoicing and the European Standard for VAT reporting obligations, as foreseen in the upcoming Commission legislation on this topic.

The Commission has addressed the issues around eInvoicing also on the political and legal level:

- Directive 2014/55/EU obliges public authorities and bodies of the Member States, in public procurement above EU thresholds, to accept electronic invoices compliant with the European Standard.
- On 8 December 2022, the European Commission published a legislative package composed of several pieces of legislation, around the "Proposal for a Council Directive amending Directive 2006/112/EC as regards VAT rules in the Digital Age". This Commission proposal makes eInvoicing by default the rule in the EU starting 2028 and contains provisions on VAT reporting based on electronic invoicing for intra-community transactions and below - on decision by each Member State.
- In 2023, the European Commission has evaluated the effects of Directive 2014/55/EU on the internal market and uptake of e-Invoicing in public procurement. As foreseen in article 12 of Directive 2014/55/EU, the report was submitted to the European Parliament and to the European Council.

(A.3) REFERENCES

- Directive 2014/55/EU of the European Parliament and of the Council on electronic invoicing in public procurement. Since April 2020, this Directive obliges public authorities and bodies of the Member States of the European Union to accept electronic invoices in public procurement, contracts above EU thresholds. These electronic invoices must comply with the European standard on electronic invoicing (EN 16931-1), and with any of the syntaxes on a limited list specified in CEN/TS 16931-2.
- Proposal for a Council Directive amending Directive 2006/112/EC as regards VAT rules in the Digital Age.
- Council Directive 2010/45/EU amending Directive 2006/112/EC on the common system of value added tax as regards the rules on invoicing.
- SWD(2013) 223 — Impact Assessment accompanying the document `Proposal for a Directive of the European Parliament and of the Council on electronic invoicing in public procurement´.
- COM(2013) 453 final on end-to-end e-Procurement to modernise public administration
- Explanatory Notes on VAT-invoicing rules (Council Directive 2010/45/EU)
- Council Directive 2006/112/EC on the common system of value added tax.
- COM(2010)712 "Reaping the benefits of electronic invoicing for Europe" describes a number of actions in different areas, including standardisation, needed to facilitate the deployment of e-Invoicing in Europe.
- COM(2012)179 "A strategy for e-procurement" states that the ultimate goal is "straight through e-procurement" with all phases of the procedure from notification (e-notification) to payment (e-payment) being conducted electronically.
- Commission Implementing Decision (EU) 2017/1870 of 16 October 2017 on the publication of the reference of the European standard on electronic invoicing and the list of its syntaxes pursuant to Directive 2014/55/EU
- Commission work programme 2022, Annex II, includes the "VAT in the digital age" initiative, which aims to modernise the current VAT rules, taking into account the opportunities offered by digital technologies. The initiative covers 1) VAT reporting obligations and e-Invoicing 2) VAT treatment of the platform economy and 3) single EU VAT registration.

Several European countries already introduced rules whereby public authorities only accept electronic invoices from suppliers, and all these initiatives will need to align with the standardisation activities carried out by CEN/TC 434 according to the Annex of the Standardisation Mandate M/528.

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

The deliverables defined in Standardisation Mandate M/528 have been published. The European Standard EN16931-1 and its complementary technical specifications and reports are available. CEN/TC 434 should pursue work on ensuring that the European Standard is aligned with the most recent Commission policies, as the 2022 legislative proposals on VAT digital Reporting and discuss further follow up activities leading to wider adoption and implementation of eInvoicing / automated processes.

ACTION 1: Continue the work in CEN/TC 434, which includes the following aspects and standardisation deliverables:

- ensure the EU standard is "fit for purpose" to serve a coherent eInvoicing policy in the EU, especially in line with the new requirements coming from the EU legislation for tax reporting based on eInvoicing
- maintenance activities
- preparation of the Amendment to the European Standard
- development of standardisation documents and tools that support and encourage the uptake of the European Standard and its ancillary deliverables
- communication activities (Capacity building) also addressing third countries at global level
- development of a standard supporting e-receipts, based on the European Standard on electronic invoicing.
- following the market and technological evolution in eInvoicing, ensure an active link with the work on Blockchain, in liaison with CEN/CENELEC/JTC 19 on Blockchain and Distributed Ledger Technologies.

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

CEN

CEN/TC 434 — "Electronic Invoicing" — was established to provide standardisation for e-Invoicing and to undertake the standardisation activities required by the Directive 2014/55/EU.

CEN/TC 440 — "Electronic public procurement" — was established in order to provide standardisation in the field of e-Procurement including post-award processes.

CEN/TC 445 — This CEN Technical Committee on Financial Services has published CEN/TS17901:2023, a standard for the electronic invoicing of insurance premiums, based on the European Norm16931-1. CEN/TC445 is also working on a standard for the digital portability of personal data in the insurance industry. This covers general data (e.g. name, birthdate, address, telephone, email, bank account, occupation) and business-specific data (e.g. those relevant to motor insurance, such as vehicle make/model, plate number, VIN, registration date etc.)."

"Digital information Interchange in the Insurance Industry" — has finalized the development of a new standard for the electronic invoice of the insurance premium, based on the standard invoice of EN16931-1. This standard FprCEN/TS 17901:2023 - Electronic Premium Invoice - Mapping to Electronic Invoice EN 16931-1 will be published at the beginning of 2024.

OASIS

The OASIS Universal Business Language (UBL) TC defines a common XML library of business document types supporting digitization of commercial and logistical processes for domestic and international supply chains. UBL includes document schemata that support eInvoicing. This also includes service location (BDXL 1.0) and capability lookup (SMP 2.0) that can be used together with a message protocol like AS4 (as used in the European Commission's eDelivery Building Block and in OpenPeppol) and an Exchange Header Envelope schema (XHE 1.0).

UBL version 2.4 was published as OASIS standard in June 2024, and has been submitted to ISO/IEC JTC1 to be published as ISO/IEC standard. UBL versions 2.4, 2.3, 2.2 and 2.1 are backwards compatible. OASIS currently works on UBL version 2.5. UBL version 2.1 is used in OpenPEPPOL (see section C.2) and various member states, and is also published as ISO/IEC 19845:2015.

The Code List Representation (genericode) final v1.0 standard is a semantic model of code lists and accompanying XML serialization that can encode a broad range of lists of information elements such as country codes, abbreviations and lookup tables. This serialization, originally designed for e-invoicing message assembly and used (among other things) by UBL tools, enables automatic interchange or distribution of machine-readable code list information between systems, and so wider re-use of existing normalised categories and code tables.

The OASIS UBL TC also launched a Commodities subcommittee in 2024 to respond to demand for embedded sustainability and circularity data. See 3.4.13 Circular economy and sustainability (Section C.1).

UNECE

The United Nations Centre for Trade Facilitation and Electronic Business (UN/CEFACT) Cross Industry Invoice version 16A is a maximum data set invoice model which aims to cover all potential needs of any industry and any transaction. Each implementation is therefore a subset of the overall standard, but extensions should not be necessary as every aspect is intended to be covered by the standard. This standard is re-released twice a year, but always backwards compatible with the official 16A version.

This standard is based on an overall Reference Data Model which brings direct links to electronic messages for all other supply chain operations.

ETSI

The ETSI Industry Specification Group on permissioned Distributed Ledgers and Distributed Ledger technology (SG PDL) has published Group Reports (GR) and Group Specifications (GS) for Smart Contracts and a Group Specification for Distributed Autonomous Organisations (DAO), among other subjects such as non-repudiation, redactability, digitial identity, etc... These address security and integrity related matters and may become relevant for e-invoicing, although this has not been specified yet. One of the publications potentially relevant for e-Invoicing is DGS/PDL-0026 'PDL in Settlement of Usage-Based Services'.

IEEE

IEEE Std 2142.1 - Recommended Practice for E-Invoice Business Using Blockchain Technology.

ITU

In 2022, ITU-T SG16 published Recommendation F.751.4 which provides a framework for electronic invoices based on distributed ledger technology (DLT).

(C.2) OTHER ACTIVITIES RELATED TO STANDARDISATION

OPENPEPPOL

OpenPeppol is an open non-profit organisation that provides specifications, practices and implementations for exchanging e-Invoicing documents. It builds on the specifications that were created by the European Large Scale Pilot (LSP) Peppol, which ran from 2008 until 2012. OpenPeppol does not only provide specifications, it also governs the Peppol network and implementations. Service Providers that are members of OpenPeppol provide standards-based networking services, which are overseen by National Peppol Authorities.

OpenPeppol aligns with the CEN standards for e-Invoicing wherever possible. This results in a Peppol network which is largely compatible with CEN standards. The Peppol Business Interoperability Standards (BIS) for eInvoicing is a Core Invoice Usage Specification (CIUS) of the European Norm 16931 for eInvoicing published by CEN/TC434.

Peppol is now supported by hundreds of service providers throughout Europe, servicing thousands of public and private organisations.

3.3.3 Retail Payments

A Policy and legislation

(A.1) POLICY OBJECTIVES

The speed at which technological change in payments is happening requires targeted policy measures. The European Union aims to be a highly competitive payments market, allowing all players to compete on fair and equal terms to offer innovative digital payment solutions.

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

Directive 2015/2366/EU (PSD2) set the foundation for safer and more innovative European payments. It aims at better protecting consumers when they pay online, promoting the development and use of innovative online and mobile payments, and making cross-border European payment services safer. On 8 April 2024, the Regulation (EU) 2024/886 (Instant Payments Regulation) entered into force and is expected to gradually remove a number of key obstacles to the widespread provision and use of instant credit transfers in euro (euro instant payments) in the EU. In synergy with PSD2, the European Digital Identity Wallets (EUDIWs) as established under Regulation (EU) 2024/1183 amending Regulation (EU) No 910/2014 as regards establishing the European Digital Identity Framework further enhances these goals by providing a secure and convenient platform for accessing digital services and authorizing payments, thereby strengthening the overall digital payment infrastructure in the European Union.

Payments have become strategic for the EU's economic and financial autonomy. Digitalisation and innovation are quickly changing the way payments are made Electronic (cashless) payments are becoming increasingly popular and the Covid-19 pandemic has further reinforced their importance, in particular with regard to contactless payments.

Today, the EU's electronic payments market is dominated by a few large global players providing nearly all cross-border payments in the European market, in particular when the payments at the point of sale (such as in shops) are concerned. Payment solutions provided by European payment service providers and fintechs are often very successful but only at national level. One of the reasons why these solutions have been so far failing to expand across the European Union and beyond is that they are not interoperable with one another. An increasing number of these payment solutions rely on technologies such as QR-codes, Bluetooth (BLE) or Near Field Communication (NFC). The absence of common technical standards is one of the obstacles to achieving the interoperability of these solutions.

Compounding these challenges is the lack of a standardized approach to Strong Customer Authentication (SCA). While SCA, mandated by PSD2, aims to enhance security for online transactions through multi-factor authentication, its inconsistent implementation across different financial institutions and service providers creates confusion and frustration for consumers. This fragmentation can undermine trust in digital payments and complicate the development and integration of new payment solutions. To fully realize the benefits of SCA, a harmonized standard is essential for seamless, secure, and user-friendly authentication processes across the European Union. The European Digital Identity Wallets (EUDIWs) could play a crucial role in addressing this issue by providing a standardized and secure platform for performing SCA, thereby enhancing the consistency and reliability of authentication processes across the EU.

Several initiatives led by the European Retail Payments Board (ERPB) and the European Payments Council (EPC) have been launched, aimed at adopting common European schemes and rules. This standardisation and harmonisation work aims to ensure the interoperability of instant payment solutions in shops and e-commerce. In particular, the ERPB Working Group on instant payments at the point of interaction (physical point of sale and e-commerce) has recognised the need for a standardised QR-code for both merchant-presented and consumer-presented use cases. A dedicated, multi-stakeholder group under the auspices of the EPC developed technical specifications for QR-codes for mobile-initiated credit transfers in various contexts (P2P, C2B, B2B and B2B) (EPC024-22). Based on these technical specifications, a specific document was derived for submission to the European Committee for Standardization (CEN) for their further standardisation as a European Standard. For this purpose, the EPC relies on its status of CEN liaison organisation, obtained in March 2024 through a ballot in CEN TC 225 – Automatic Identification and Data Capture (AIDC) Technologies. Along with this document, the EPC has subsequently prepared, according to the CEN procedures, a so-called New Work Item (NWI) proposal

and a rationale document for a 2-month balloting in CEN. According to the current schedule, the standard is forecast to be published in 2025.

Provided that the market factors are duly taken into account, resolving the issue of missing standards will make it easier for payment services providers and merchants alike to reach critical mass by making use of the digital single market and committing to make the necessary investments.

(A.3) REFERENCES

- Regulation (EU) 2024/1183 of the European Parliament and of the Council of 11 April 2024 amending Regulation (EU) No 910/2014 as regards establishing the European Digital Identity Framework.
- Regulation (EU) 2024/886 the European Parliament and of the Council of 13 March 2024 amending Regulations (EU) No 260/2012 and (EU) 2021/1230 and Directives 98/26/EC and (EU) 2015/2366 as regards instant credit transfers in euro.
- Directive 2015/2366/EU of the European Parliament and of the Council of 25 November 2015 on payment services in the internal market: https://eur-lex.europa.eu/eli/dir/2015/2366/oj
- Interim report of the ERPB Working Group on a Framework for interoperability of instant payments at the point of interaction (IPs at the POI): https://www.ecb.europa.eu/paym/groups/erpb/shared/pdf/13th-ERPB-meeting/Item_4.4_-_Interim_report_of_the_WG_on_a_framework_for_instant_at_POI.pdf

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

ACTION 1: CEN to work with the EPC on a single, open and secure European technical standard for QR-codes to support the uptake and interoperability of instant payments.

ACTION 2: ESOs to assess which existing standards are relevant for Strong Customer Authentication (SCA) with the European Digital Identity Wallets (EUDIWs) for private retail payments and future digital euro payments and determine whether new standards are needed.

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

CEN

CEN/TC 224 'Personal identification and related personal devices with secure element, systems, operations and privacy in a multi sectorial environment' develops standards for strengthening the interoperability, security and privacy of personal identification and its related personal devices. CEN/TC 224 addresses providers from the supply side such as card manufacturers, security technology, conformity assessment body and software manufacturers.

CEN/TC 225 'AIDC Technologies' works in the field of automatic identification and data capture techniques such as 1D and 2D optical data carriers, RFID and RTLS. The Technical Committee develops application-oriented European standards with the aim to promote the use of open and interoperable ways to identify objects, locations and industrial items. These identifiers and data carriers centred standards will serve as a corner stone for the development of interoperable solutions for data sharing in the context of the retail payments. CEN/TC 225 established a liaison with European Payment Council in order to create a European technical standard for QR codes to support the uptake and interoperability of instant payments based on the EPC specifications

https://standards.cen.eu/dyn/www/f?p=204:7:0::::FSP_ORG_ID:6205&cs=1FB1CC5B5F03F85F0ECCECA7598551CFC

EMVCO

EMV® QR Code Specification for Payment Systems: Merchant-Presented Mode and EMV® QR Code Specification for Payment Systems: Consumer Presented Mode are ISO 18004 compliant. The current versions of these specifications are available from: https://www.emvco.com/emv-technologies/qrcodes/

ETSI

ETSI's Secure Element Technologies committee (TC SET) develops and maintains specifications for the Secure Element (SE), e.g. the UICC or the SSP and its interfaces with the outside world for use in telecommunication systems including the Internet of Things (IoT) and other industry sectors.

The technical realisation of the SSP consists of a multi-part specification. Our first deliverable addresses generic portions of the SSP, regardless of its form factor and the physical interfaces it supports. Three following parts address specific classes of the SSP – the SSP integrated on a System on Chip (SoC) and two specific classes for embedded Secure Elements. All four documents have been published. In addition, new protocols (SPI and I3C) for the Secure Element have been published. This will then provide a future oriented technology to replace existing UICC technology. ETSI has also developed the respective test documents for the SSP specifications to facilitate conformance and interoperability of the products.

TC SET keeps on improving the UICC technology by adding the possibility to host and address several virtual Secure Elements

embedded into the same hardware component. This allows multiple virtual Secure Elements to coexist logically separated and be addressed independently thought the same physical interface. This technology is the base for a new feature defined in GSMA RSP which allows to have multiple subscriptions to a mobile network active in a mobile phone using just one eSIM. This offers the means to embed independent identity (e.g. eIDAS), payment or transport applications in the same physical secure element as the eSIM.

ISO

ISO/TC 68 /SC 9 ISO 12812 has been published. This includes five parts:

ISO 12812-1: General Framework

ISO 12812-2: Security and data protection for Mobile Financial Services

ISO 12812-3: Financial Application Management

ISO 12812-4: Mobile Payments to Persons

ISO 12812-5: Mobile Payments to Businesses

ISO/IEC JTC1/SC31 Automatic identification and data capture techniques - ISO/IEC JTC1/SC31:

ISO/IEC 18004:2015 Automatic identification and data capture - QR code bar code symbology specification

ITU-T

ITU-T SG3 continues work in the area of economic and policy issues pertaining to international telecommunication/ICT services and networks that enable Mobile Financial Services (MFS) through Question 12/3, including Direct Carrier Billing, Guidelines for Mobile Financial Service Agents, Interoperability for Competition in Mobile Financial Services, Cooperation frameworks between Authorities, Users and Providers for the development of the National Payments System, and Development of e-commerce in developing countries through mobile money (and vice versa).

ITU-T Focus Group Digital Financial Services (FG DFS) has published 85 recommendations for policymakers and DFS stakeholders and deliverables addressing the DFS ecosystem challenges and provide best practices for consumer protection regulators, key performance indicators for quality of service for DFS and merchant acceptance for DFS. There are also deliverables related to DFS in the areas of - interoperability, security, privacy, role of postal networks, competition, and enhancing digital credit. https://itu.int/en/ITU-T/focusgroups/dfs/Pages/deliverables.aspx

The Financial Inclusion Global Initiative (FIGI) was set up jointly by ITU, the World Bank, the Bank for International Settlements (BIS) and the Bill & Melinda Gates Foundation in 2017. The Financial Inclusion Global Initiative (FIGI) completed its work in September 2021. The main objective of FIGI was to implement the recommendations of the FG DFS, the high-level principles of the Payment Aspects of Financial Inclusion (PAFI) report of the World Bank and the BIS at a country level over the next three years (see https://figi.itu.int). ITU established a Digital Financial Services (DFS) Security Lab under FIGI to conduct security audit of mobile payment applications operating under USSD, STK and Android environments (see https://figi.itu.int/figi-resources/dfs-security-lab/). The DFS Security Lab methodology for testing of Android mobile payment applications is based on the OWASP Mobile Top 10 Security risks method and it is planned to develop it as a digital public good since it is based mainly on Open Source Software tools. The FIGI Security, Infrastructure and Trust Working Group which was led by ITU published a number of reports on security for digital financial services on topics such as strong authentication methodologies, addressing SS7 vulnerabilities, eKYC use cases for DFS, security assurance framework for DFS, security tests for USSD and STK applications, security audit of Android DFS applications, technical guidelines for securing mobile payment applications, DLT Security aspects and DFS Consumer Competency Framework amongst others. More details about the reports are available here : https://figi.itu.int/figi-resources/working-groups/.

As part of the activities of the DFS Security Lab in 2022, the security recommendations for mobile payments and addressing the vulnerabilities of telecommunications infrastructure and digital payment applications are being implemented at level of developing countries. Countries interested in setting up the Security Lab so they can conduct the security audits of the mobile payment applications can also contact the ITU for this and so far some four countries in Africa and Latin America have expressed such an interest.

ITU-T SG11 finalised and consented the baseline text of ITU-T Q.3057 (ex. Q.SR-Trust) “Signalling requirements and architecture for interconnection between trustable network entities”.

ITU-T SG11 started a draft technical report on low resource requirement, quantum resistant, encryption of USSD messages for use in financial services, which purpose is to examine new technologies for encryption of USSD in End-to-End manner and estimate its applicability to be integrated into existing USSD technology, suggesting new recommendation and signalling requirements for the integration of such technology into the existing reference architecture.

Relevant ITU work around digital currency is found in the Rolling Plan chapter on Blockchain.

ITU-T SG13 has approved two Recommendations on secure mobile payments and mobile banking solutions.

- ITU-T Y.2740 elaborates on approaches to develop system security for mobile commerce and mobile banking.
- ITU-T Y.2741 specifies the general architecture of a security solution for mobile commerce and mobile banking in modern telecommunication networks.

ITU-T SG12 is studying QoS and QoE aspects of digital financial services, including a methodology to test QoE. Two new ITU-T Recommendations were approved in ITU-T SG12 on digital financial services:

- New Recommendation ITU-T G.1033 highlights important aspects related to quality of service (QoS) and quality of experience (QoE) that require consideration in the context of digital financial services.
- New Recommendation ITU-T P.1502 introduces a methodology for testing the quality of experience (QoE) of digital financial services.

The Recommendations are based on the results of the ITU-T Focus Group on Digital Financial Services and the FIGI Security, Infrastructure and Trust Working Group. A new question (Q.13) was created in ITU-T SG12 on Perceptual and field assessment principles for quality of service (QoS) and quality of experience (QoE) of digital financial services (DFS) – all DFS QoS

recommendations including the interoperability and cross border QoS testing will be standardized in this question.

W3C

The open web platform offers tremendous potential as the driver behind the transformation of the web Payments industry. The platform forms the foundation of how online and in-store payments can be made easy on the web in the future. See https://www.w3.org/Payments/

The web payments working group , chartered to make payments easier and more secure on the web, through the development of new web standard protocols and APIs related to the initiation, confirmation, and completion of a payment. This serves to increase interoperability between payer and payee systems. The group is chartered to standardise programming interfaces, not user interfaces and not a new digital payment scheme. See https://www.w3.org/Payments/WG/

The web payments interest group, chartered to provide a forum for web payments technical discussions to identify use-cases and requirements for existing and/or new specifications to ease payments on the web for users (payers) and merchants (payees). It is also chartered to establish a common ground for payment service providers on the web platform. See https://www.w3.org/Payments/IG/

Other chartered groups (doing standards) are of course coordinated closely with web payments, such as security, crypto, privacy or authentication (also accessibility and internationalisation) and a number of other community-driven groups at W3C are doing work related to payments, or that will improve the web overall including payments. These include:

- the Interledger payments community group, which seeks to connect the many payment networks (ledgers) around the world via the web,
- the financial industry business ontology (FIBO) community group, which is developing extensions to schema.org related to financial industries,
- the Blockchain Community Group, which is studying and evaluating technologies related to blockchain, and use-cases such as interbank communications.

NEXO AND EPCNEXO

NEXO and EPCNEXO and the European Payment Council (EPC) currently focus on the protocols for card payment protocols in the Eurozone and aim to replace the current mess of proprietary protocols. The EPC is also involved in SEPA and sees iteself as the decision-making and coordination body for the European banking industry in relation to payments

(C.2) ADDITIONAL INFORMATION

In general regarding card, internet and mobile payments, some stakeholders believe that the following issues should in particular be addressed: security, access and accessibility, management and portability of customer data, and transparency.

Card, internet and mobile payments are already standardised by a large number of organisations. This creates a diversity which may prevent the use of common infrastructures and common security standards. A common series of standards would be beneficial to all players in the market. A global view on standards in these areas is important as the payment market is global as are most existing standards.

The Web Payment Security Interest Group was launched on 17 April 2019 to enable W3C, EMVCo, and the FIDO Alliance to collaborate on a vision for Web payment security and interoperability. They are especially discussing how the Payment Services Directive 2 (PSD2) regulations in Europe, that took effect in September 2019 will affect Web payments and what will be the role of EMVCo, W3C, and FIDO technologies.

3.3.4 Preservation of digital cinema

A Policy and legislation

(A.1) POLICY OBJECTIVES

The 2005 European Parliament and Council Recommendation on film heritage recommended Member States to ensure preservation of cinematographic works. The fourth application report on this Recommendation, published on 3 October 2014, shows that very few Member States are implementing digital workflows to preserve digital or digitised cinema. Those that have done it have used diverging standards.

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

The film heritage sector would benefit from European standards that describe the most efficient digital workflows and data formats for preservation of digital films. The resulting standards for digital preservation of films could also be of interest for digital preservation of other type of documents in public administrations. Some Member States, as Germany and France, are planning to adopt national standards.

(A.3) REFERENCES

- Recommendation of the European Parliament and of the Council of 16 November 2005 on film heritage and the competitiveness of related industrial activities, OJ L 323 of 9.12.2005, p.57. http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32005H0865:EN:NOT
- Council conclusions on "European film heritage, including the challenges of the digital era", adopted in November 2010 http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/educ/117799.pdf
- Council conclusions on "European Audio-visual Policy in the Digital Era" adopted on 25 November 2014 http://www.consilium.europa.eu/homepage/highlights/council-addresses-european-audiovisual-policy-in-the-digital-era?lang=en
- 4th Application report of the Film Heritage Recommendation, from 2.10.2014 https://ec.europa.eu/digital-agenda/en/news/european-commissions-report-film-heritage
- Archival Policy of the Swedish Film Institute http://www.sfi.se/Global/Filmarkivet/Policy%20of%20the%20Archival%20Film%20Collections%20of%20the%20Swedish%20Film%20Institute%20(2012).pdf
- British Film Institute Strategy "2012-2017" Film forever http://www.bfi.org.uk/about-bfi/policy-strategy/film-forever
- Results of the EU-funded research project EDCine ftp://ftp.cordis.europa.eu/pub/ist/docs/ka4/au_concertation_1006_edcine_en.pdf http://ec.europa.eu/avpolicy/docs/reg/cinema/june09/edcine.pdf
- Recommendations from the International Federation of Film Archives (FIAF):
  - FIAF Technical Commission Recommendation on the deposit and acquisition of D-Cinema elements for long-term preservation and access http://www.fiafnet.org/commissions/TC%20docs/D-Cinema%20deposit%20specifications%20v1%200%202010-09-02%20final%201.pdf
  - FIAF Technical Commission Recommendation on the Principles of Digital Archiving http://www.fiafnet.org/commissions/TC%20docs/Digital%20Preservation%20Principles%20v1%201.pdf

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

ACTION 1: SDOs to promote awareness and implementation of the European standard among relevant stakeholders (e.g. European film heritage institutions).

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

CEN

CEN/TC 457 was set dormant after publication of the following results:

- EN 17650:2022, A framework for digital preservation of cinematographic works - The Cinema Preservation Package
- CEN/TR 17862:2022, Guideline for the implementation of the Cinema Preservation Package (CPP) in EN 17650

In addition, they prepared a reference software that is publicly available

ISO - OAIS

OAIS (Open Archive Information System) — ISO 14721:2012

http://www.iso.org/iso/iso_catalogue/catalogue_ics/catalogue_detail_ics.htm?csnumber=57284

DIN

DIN is evaluating a revision of DIN SPEC 15587:2019 Guidelines for digitization of cinematographic film due to the latest developments in the digitization of film in Germany. The document gives guidelines for the digitalization to make a digital preservation possible.

The publication of EN 17650 and CEN/TR 17862 will be taken into account for the decision as well.

CST/FRAUNHOFER

CST/Fraunhofer started a new "Society of Motion Picture and Television Engineers" (SMPTE) activity for a mezzanine file format of digitised movies based on the interoperable master format (IMF) which can be extended to a preservation format of digital films

ITU

ITU-T Study Group 16 on multimedia services and applications. Developed with ISO/IEC JTC 1/SC29/WG1 Recommendation T.802 (Motion JPEG-2000) that is used for digital cinema. Additionally, SG16 is developing studies on cultural heritage under its Question 21/16 "Multimedia framework, applications and services".

Resolution ITU-R 60 (Reduction of energy consumption for environmental protection and mitigating climate change by use of ICT/radiocommunication technologies and systems) resolves "that ITU-R Study Groups should develop Recommendations, Reports or Handbooks on best practices in place to reduce energy consumption within ICT systems, equipment or applications operating in a radiocommunication service" and "possible development and use of radio systems or applications which can support reduction of energy consumption in non-radiocommunication sectors". ITU-R Study Groups have produced several outputs on climate change, but there is not much literature within ITU-R Study Groups regarding the environmental impact of ICT itself.

ITU-R Study Group 6 had approved Report ITU-R BT.2385 on "Reducing the environmental impact of terrestrial broadcasting systems". Like all industries, the broadcasting sector has a responsibility to improve its environmental performance. The main environmental impacts of the broadcasting industry are greenhouse gas (GHG) emissions, energy use, raw material consumption and electronic waste. This Report presents analyses of several case studies.

In addition, Question ITU-R 147/6 on "Energy Aware Broadcasting Systems" was approved by ITU-R SG6 in May 2022.

Other ITU-R publications include:

- Question ITU-R 143-2/6 on "Advanced Immersive Sensory Media Systems for Programme Production, Exchange and Presentation for Broadcasting"
- Recommendation ITU-R BT.2137 on "Technologies applicable to Internet Protocol (IP) interfaces for programme production"
- Report ITU-R BT.2386 on "Digital terrestrial broadcasting: Design and implementation of single frequency networks (SFN)"
- Report ITU-R BT.2446 provides methods for conversion of high dynamic range content to standard dynamic range content and vice-versa

ECMA

Ecma Technical Committee TC31 works on information and optical storage and developed the ECMA-421 Standard, which specifies a quality discrimination method for optical disks and operating method of storage systems for long-term data preservation. This Standard enables manufacturers to build data storage systems that use recordable and/or read-only optical disks for long-term data preservation and archival. ECMA-421 (also published as ISO/IEC 18630) allows for the preservation of digital cinematographic work and has the advantage of offering a low power consumption solution." https://ecma-international.org/publications-and-standards/standards/ecma-421/

3.3.5 Fintech and Regtech Standardisation

A Policy and legislation

(A.1) POLICY OBJECTIVES

Innovative IT solutions play an ever increasing and important role in the financial services sector. On the one hand, new financial technologies ('Fintech') are redefining the way individuals and companies save, borrow, invest, spend and protect their money by not only bringing new financial products and services to the market, but also facilitating access to these by enterprises and investors. On the other hand, by introducing state-of-the-art software and technology, they help financial services providers run their business in processing data, simplifying their market analyses, internal management, and KYC efforts. In this way, Fintech solutions, are revolutionising traditional financial sector business practices.

Other types of modern IT solutions, known as 'Regtech', can help enterprises meet their various regulatory obligations, in particular the reporting of data to public authorities for the purposes of financial supervision. Current reporting obligations are frequently excessively burdensome and costly due to the sheer number of these requirements, some of which are potentially duplicative and overlapping, and due to insufficient harmonisation/standardisation and occasionally a lack of clarity on what needs to be reported. Regtech solutions aim to facilitate the interpretation of requirements and subsequently help to gather the required data and transform it into the appropriate format. Apart from reporting, Regtech solutions are also available and are already used by financial institutions in the field of AML/CFT, ICT security, fraud prevention and creditworthiness assessment (CWA).Supervisory authorities use yet another group of IT tools and solutions ('Suptech') to simplify the verification, validation, processing, and analysis of the reported data.

In all these different ways, Fintech, including Regtech and Suptech tools, improves the quality, diversity, efficiency, and resilience of the financial system, and fosters a more competitive and innovative European financial sector. Business operations benefit from the use of standardised and innovative IT tools and solutions as they foster seamless information exchange among financial service providers, underpins trust of consumers, boosts innovation and enables compliance with financial legislation in a cost-effective way. Access to standardised data enables public authorities to perform supervision of financial institutions, monitoring of systemic risk, and market oversight more effectively and efficiently, thereby ensuring orderly markets, financial stability, investor protection and fair competition.

One of the fundamental elements necessary for the functioning of the financial system is data. Data is gathered by the providers of financial services and products for the purposes of KYC and as part of their day-to-day business operations. Data is gathered by supervisory and statistical authorities for the monitoring of the financial system. More and more often, data on market actors and investors is exchanged between financial services providers, and efforts are now being undertaken to allow for the sharing of data amongst public authorities – not least to reduce the burden on enterprises and financial services providers of having to report or provide this data. Over the last few decades, the amount and complexity of financial sector data has increased exponentially. Efforts are now being undertaken to improve and simplify the way financial data is exchanged across enterprises and authorities worldwide and reported to public authorities for the purpose of supervision. One of the solutions is to make such exchanges more automated and less dependent on human intervention However, automation requires the harmonisation/standardisation of content, meaning, terminology, tools and processes.

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

To address these challenges, the existing EU legislative framework is regularly revised to reflect the latest developments. The EU has also undertaken a number of specific initiatives which aim to promote digital finance, Fintech, and standardisation in the financial sector.

- In terms of technical standards, in May 2019 the EU adopted an RTS on the **European Single Electronic Format (ESEF)** for the digital format (xHTML) and structure (inline eXtensible Business Reporting Language-iXBRL) of annual financial reports. It enables both human and machine readable financial reports as required by the Transparency Directive. The extensible Business Reporting Language (XBRL) was identified by the Commission for referencing in public procurement according to the provisions of Regulation (EU) 1025/2012 on European standardisation. Further to the entry

into force of the Corporate Sustainability Reporting Directive (CSRD) as part of the Sustainable finance package, companies will publish in the coming years corporate sustainability reports which will have to be machine readable, by applying the ESEF. For this, the Commission adopted the European Sustainability Reporting Standards in July 2023, and plans to amend the ESEF so as to establish the appropriate technical standards and taxonomy applicable for this new reporting. In addition, the Commission adopted in November 2024 a Regulation to the effect of requiring **reports on income tax information** by very large multinational enterprises on the basis of inline XBRL.

- In addition, following the recommendations of the new Action Plan on the Capital Market Union (September 2020), the European Single Access Point (ESAP) Regulation entered into force in January 2024 as part of the CMU package. Starting from 2027, ESAP will provide EU-wide access to company data in digital formats aiming to reduce information search costs for cross-border investors and widen the investor base for companies. ESAP will make available in particular as from January 2028 the much demanded sustainability-related data published by companies pursuant to the CSRD.
- In September 2020, the European Commission adopted a **digital finance package**, including a digital finance strategy and legislative proposals on markets in crypto-assets and digital operational resilience, for the purpose of establishing a competitive EU financial sector that gives consumers access to innovative financial products while ensuring consumer protection and financial stability. The digital finance strategy sets out four main priorities: removing fragmentation in the Digital Single Market, adapting the EU regulatory framework to facilitate digital innovation, promoting a data-driven finance and addressing the challenges and risks with digital transformation, including enhancing the digital operational resilience of the financial system.
  - The main policy initiative to promote data-driven finance is a legislative proposal on the **open finance framework** currently scheduled for early 2023, with the main objective to facilitate data sharing in the financial sector. In May 2022, the European Commission launched a consultation on this topic.
  - Regulation (EU) 2022/858 of the European Parliament and of the Council of 30 May 2022 on a pilot regime for market infrastructures based on distributed ledger technology creates a regime in which market infrastructures can obtain exemptions from applicable financial regulations in order to be able to use distributed ledger technology (DLT) for the trading and settlement of securities transactions, thereby promoting the development of DLT in the financial sector while guaranteeing a high level of investor protection and transparency as well as preserving market integrity and financial stability.
  - In addition, the implementation of the **Digital Operational Resilience (DORA) proposal**, which is part of the digital finance strategy, will require some degree of data standardisation processing in the context of establishing a potential central database/hub/ or registry connecting other national registries in accordance with the mandate set out by Article 19 DORA for the ESAs to produce a joint report assessing the feasibility of further centralisation of incident reporting through the establishment of a single EU Hub for major ICT-related incident reporting by financial entities. An analysis of any data standardisation needs in the context of a possible single EU HUB for incident reporting could be thus part of the ESAs' overall assessment on prerequisites for the establishment of such a single EU Hub.
- November 2021 saw the adoption of the **Strategy on supervisory data in EU financial services**, which aims to modernise and improve the EU supervisory reporting system and is constructed around four building blocks. Those where standardisation will play a key role are: ensuring consistent and standardised data (centered around a Common Data Dictionary); facilitating the sharing and reuse of supervisory data amongst public authorities in the EU; and improving the design of supervisory reporting requirements (including greater use of international standards and identifiers). The Implementation of these building blocks will enable a more effective and efficient use of modern technologies, including Regtech and Suptech tools, for the purpose of supervisory reporting. The Commission services also explored the possibility of using Machine Readable and Executable (MRER) reporting requirements. A pilot project to write reporting instructions as machine-readable code has been completed in 2022 and will be followed-up by implementation initiatives.

(A.3) REFERENCES

- COM(2018) 109 final of 8 March 2018: FinTech Action plan: For a more competitive and innovative European financial sector.
- Commission Delegated Regulation (EU) 2018/815 of 17 December 2018 supplementing Directive 2004/109/EC of the European Parliament and of the Council with regard to regulatory technical standards on the specification of a single electronic reporting format.
- COM/2020/590 final of 24 September 2020: A Capital Markets Union for people and businesses – new action plan.
- COM/2020/591 final of 24 September 2020: Digital Finance Strategy for the EU.
- Directive (EU) 2022/2464 of the European Parliament and of the Council of 14 December 2022 amending Regulation (EU) No 537/2014, Directive 2004/109/EC, Directive 2006/43/EC and Directive 2013/34/EU, as regards corporate sustainability reporting.
- Regulation (EU) 2023/2859 establishing a European single access point.
- COM(2021) 798 final of 15 December 2021: Strategy on supervisory data in EU financial services.
- Ministerial Declaration on eGovernment - the Tallinn Declaration.
- The Parliament has written a report on the influence of technology on the future of the financial sector.
- Commission Implementing Regulation (EU) 2024/2952.

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

ACTION 1: The EC to start a coordination activity on FinTech standardisation, with CEN & CENELEC, European Supervisory Authorities, Fora Consortia, Industry, and with Standards Setting Organisations (such as ISO). Also ensure proper coordination with Open Source Projects (e.g. working on Blockchain).

ACTION 2: Develop a common data dictionary which describes the content and format of all data collected under various reporting frameworks in a structured, comprehensive, consistent, and unambiguous manner, using terms anchored in legislation to establish a clear link between collected data items and the relevant legislative requirements. The dictionary represents the 'define once' principle and could include machine executable reporting instructions. It would contribute to the objectives of the European Financial Data Space, Interoperable Europe Act and Digital Europe Programme by reducing the reporting burden for the industry, removing semantical interoperability obstacles and facilitating the exchange of data between supervisory authorities at EU and national level.

ACTION 3: Extend the governance structure to develop and maintain the data dictionary in banking to other sectors of the EU financial services, including a subject matter experts network on supervisory reporting.

ACTION 4: ESMA shall continue extending the XBRL-based reporting (actually inline XBRL) of listed companies under the Transparency Directive and addressing additional (i.e. yet uncovered) parts of the annual financial report and other regulated information under future legal acts.

ACTION 5: Develop European standards for the support of Union legislation and policies in the field of open finance, notably as regards the digital portability of personal data in the financial sector.

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

ISO AND IEC

ISO/TC 68 "Financial Services" develop standards in the field of banking, securities and other financial services, relevant to FinTech, with the following sub-committees:

- Financial services, security
- Securities and related financial instruments
- Core banking
- Reference data for financial services
- Information exchange for financial services

ISO/TC 68 is responsible for the development and maintenance of the ISO 20022 "Financial services - Universal financial industry message scheme" series, the ISO 17442 "Financial services — Legal entity identifier (LEI)" series and ISO 23897 "Financial services — Unique transaction identifier (UTI)".

Furthermore, ISO/IEC JTC 1/SC 27 "IT Security techniques" develops standardisation solutions relevant to FinTech, including

generic methods, techniques and guidelines to address both security and privacy aspects.

EUROFILING

Eurofiling is a collaborative environment created in 2005, bringing together the public and private sector: Regulators, Supervisors, financial institutions, providers, academic and private individuals. The common theme is European and National regulatory reporting versus the financial ecosystem. Eurofiling's objective is to improve collaboration and awareness to leverage interoperability. The Eurofiling community gathers in "Workshops" dedicated to interoperability in dictionaries, data point modelling, reporting standards, taxonomies, related know-how, academic research, interchange of experiences, future changes, best practices and materials for supervisory reporting frameworks.

Eurofiling is governed by the Board of Eurofiling Foundation p.f.

Standardisation resources on Supervisory Reporting: http://www.eurofiling.info .

CEN

CEN/WS XBRL: CEN workshop on improving transparency in financial and business reporting, including CWA 16744-3:2014 (European DPM-based XBRL taxonomy architecture), CWA 16746-1:2014 (standard regulatory roll-out package for better adoption: XBRL supervisory roll-out guide) and CWA 16746-2:2014 (standard regulatory roll-out package for better adoption: handbook for declarers). CWA 16744-1:2014 European Data Point Methodology for Supervisory Reporting, CWA 16744-2:2014 Guidelines for Data Point Modelling and CWA 16744-5:2014 Mapping between Data Point Model and Multidimensional Data Model, were promoted in August 2021 to the ISO standards ISO 5116-1:2021 , ISO 5116-2:2021 and ISO 5116-3:2021 respectively. The Data Point Model is widely used in Banking and Insurance reporting in Europe, and this promoting would contribute to widespread its use in other regions. European Authorities as EBA, EIOPA, ECB are currently developing the project "Data Point Model refit" to update it

The CEN XFS Workshop maintains multi-vendor device access specifications with a technical commitment to the Win 32 API. The related specifications are available here: https://www.cencenelec.eu/areas-of-work/xfs_cwa16926_340_release/

A CEN technical committee in financial services (CEN/TC 445) is working on a European Standard for the digital portability of personal data in the insurance industry. This covers general data (e.g. name, birthdate, address, telephone, email, bank account, occupation) and business-specific data (e.g. those relevant to motor insurance, such as vehicle make/model, plate number, VIN, registration date etc.).

IEEE

IEEE Standards Association has ongoing standardisation activities in the areas of FinTech, e-Invoices and Cryptocurrency.

The "Blockchain in Supply Chain Finance" Working Group runs IEEE 2418.7 to develop a Standard for the Use of Blockchain in Supply Chain Finance. It defines a baseline architectural framework and functional roles for blockchain-driven supply chain finance (SCF) implementations, e.g., core enterprise, suppliers, buyers, banks, blockchain platform providers and so on. In addition, this standard outlines uses cases and business flows for SCF based on blockchain, and specifies the functional and security requirements.

The "Knowledge Graph" Working Group is developing a Guide for Application of Knowledge Graphs for Financial Services (IEEE P2807.2).

There are also focused standardisation activities around E-Invoice. The "E-Invoice Business Using Blockchain Technology" Working Group of the IEEE Consumer Technology Society "Blockchain" Standards Committee develops a Recommended Practice for E-Invoice Business Using Blockchain Technology (IEEE 2142.1).

The "Cryptocurrency Exchange" Working Group of the IEEE Consumer Technology Society "Blockchain" Standards Committee develops the 2140.x family of standards addressing general requirements, user identification, anti-money laundering, a DLT exchange framework, and a custodian framework.

The IEEE Computer Society Blockchain and Distributed Ledgers Standards Committee has several active projects focused on cryptocurrency and performance metrics for cryptocurrency payments.

There is the IEEE Trusted Data and Artificial Intelligence Systems (AIS) Playbook for Financial Services.

The IEEE Computer Society Blockchain and Distributed Ledgers Standards Committee has several active projects focused on digital assets, electronics contracts and e-commerce through its work on:

- IEEE 3207, Standard for Blockchain-based Digital Asset Identification
- IEEE 3801, Blockchain-based Electronic Contracts
- IEEE 3802, Application Technical Specification of Blockchain-based E-Commerce Transaction Evidence Collecting
- IEEE P3206, Blockchain-based Digital Asset Classification
- IEEE P3208, Blockchain-based Digital Asset Exchange Model
- IEEE P3209, Blockchain Identity Key Management

The Consumer Technology Blockchain Standards Committee focused on several cryptocurrency standards, which include:

- IEEE 2140.1, General Requirements for Cryptocurrency Exchanges
- IEEE 2140.2, Security Management for Customer Cryptographic Assets on IEEE Cryptocurrency Exchanges
- IEEE 2140.5, Custodian Framework of Cryptocurrency
- IEEE 2143.1, General Process of Cryptocurrency Payment
- IEEE P2140.3, User Identification and Anti-Money Laundering on Cryptocurrency Exchanges
- IEEE P2143.2, Cryptocurrency Payment Performance Metrics
- IEEE P2143.3, Risk Control Requirements for Cryptocurrency Payment
- IEEE P2418.9, Cryptocurrency Based Security Tokens

There are also focused standardisation activities around E-Invoice. The "E-Invoice Business Using Blockchain Technology" Working Group of the IEEE Consumer Technology is developing IEEE 2142.1, Recommended Practice for E-Invoice Business Using Blockchain Technology

More information is available at https://ieee-sa.imeetcentral.com/eurollingplan/.

ITU-T

The ITU-T Focus Group on Digital Financial Services (FG DFS) for Financial Inclusion (FG-DFS) closed in December 2016 with 85 policy recommendations and 28 supporting thematic reports. The main recommendations can be accessed here: https://www.itu.int/en/ITU-T/focusgroups/dfs/Documents/201703/ITU_FGDFS_Main-Recommendations.pdf

The ITU-T Focus Group Digital Currency, including Digital Fiat Currency (FG DFC) closed in June 2019. It considered the regulatory issues for Central Bank Digital Currency and developed two main reports addressing the legal and regulatory issues:

- Digital Currency Implementation Checklist for Central Banks;
- Regulatory Challenges and Risks for Central Bank Digital Currency.

The Digital Currency Global Initiative (a collaboration between ITU and Stanford University) was set up in July 2020 to continue the dialogue and research initiated by the ITU-T FG DFC. It aims to compile case studies on implementations of central bank digital currency, stablecoins, emoney and cryptocurrencies in all aspects. Its activities are focused on three main pillars: engagement, innovative use and standardization. Three working groups have been set up under the Standardization pillar:

- Architecture, Interoperability Requirements and Use Cases (AIRU)
- Policy and Governance (PG)
- Security and Assurance (SA)

ITU-T Focus Group on Application of Distributed Ledger Technology (FG-DLT) concluded in August 2019. Its deliverables include a discussion of regulatory aspects of DLT, and a description of DLT use cases in the regulatory technologies space. See for more details chapter 3.3.6 on Blockchain and DLT. All FG-DLT deliverables are available here: https://itu.int/en/ITU-T/focusgroups/dlt

ITU-T SG17 approved ITU-T X.1149 "Security framework of open platform for FinTech services" and is working on more standards including "Security threats and requirements for digital payment services based on distributed ledger technology" (X.str-dlt), "Security assurance framework for digital financial services"(X.saf-dfs).

XBRL INTERNATIONAL

Base specifications and related resources: http://www.xbrl.org/

XBRL International is currently developing a syntax-independent version of XBRL: the open information model. This will facilitate the exchange of information between different systems, without loss of the agreed semantics.

XBRL EUROPE

XBRL Europe is a non-profit organization and has been set up to foster European XBRL efforts and to implement and share common XBRL projects between its members and to liaise with European authorities and organizations. XBRL Europe has existing working groups on:

- supervisory reporting (Corep/Finrep)
- SBR (tax, annual reports, statistics)

http://xbrleurope.org

IFRS

International Financial Reporting Standards taxonomies and related resources:

https://www.ifrs.org/issued-standards/ifrs-taxonomy/

IASB

International Financial Reporting Standards taxonomies and related resources:

https://www.ifrs.org/issued-standards/ifrs-taxonomy/

(C.2) ADDITIONAL INFORMATION

XBRL allows governments, regulators, institutions, private sector, etc. to build vocabularies and rules (called taxonomies) to report on different subjects, like the financial position, performance and economic viability of businesses, sustainability, gov-to-gov reporting, mortgage reporting and so on. XBRL permits the publication of structured digital financial reports, specifically matching predefined taxonomies. These may then be processed and retrieved by market participants, including analysts, supervisors, enterprise regulators, tax offices, clients, suppliers, creditors and investors.

The Netherlands standard business reporting (SBR) program, using XBRL taxonomies for business-to-government (tax-filings, annual accounts, statistics), business-to-business (especially Banks) and government-to-business interactions: see http://www.sbr-nl.nl/english/.

3.3.6 Blockchain and Distributed Digital Ledger Technologies

A Policy and legislation

(A.1) POLICY OBJECTIVES

Blockchain has great potential in providing an infrastructure for trusted, decentralised and disintermediated services beyond the financial sector.

While the FinTech industry has been an early adopter because of its early use case of Bitcoin, blockchain is benefiting and has the potential to transform many other industries. It is considered a foundational technology that some compare to the rise of the Internet in the early 90s. More than a technology, it could lead to a major institutional innovation by redefining the way we operate transactions, store and access information and share data (e.g. empowering patients to securely share e-health records and decide who to grant access to their data).

Many possible applications are being envisaged to deliver efficiency, immutability and transparency to the financial services industry, Fintech/Suptech actors, trust funds (e.g., for development or humanitarian programmes), eHealth, education, eGovernment, public registries, security certification of Internet of Things, Trusted Artificial Intelligence, food safety, managing intellectual property rights, extending eIDAS framework for eID management, etc.

It has also great potential for the private sector, in trading, contracting, supply chain management, traceability along industrial supply chains (e.g. on social & environmental conditions of work, on material composition or on the maintenance history of the item) and much more. It may also transform the governance of private organisations and of companies (concept of Decentralised Autonomous Organisation - DAO). Furthermore, from a regulatory and supervisory point of view, it could provide regulators with the same view into the data as the companies they are regulating, thereby reducing fraud and compliance costs and facilitating auditing. However, this process is hindered by a lack of coherent harmonisation and interoperability that constitute obstacles to cross-border and cross-sector transactions. European citizens, SMEs, Industry, Public sector and other relevant stakeholders need to support innovation within a safe and future-proof technological and regulatory environment, ensuring appropriate interoperability, transparency, accessibility, monitoring and governance. Provisions should be taken at all stages to be in line with General Data Protection Regulation (GDPR), electronic IDentification, Authentication, and Trust Services Regulation (eIDAS), the ePrivacy Directive, Anti-Money Laundering Directive (AMLD) and other relevant legal requirements.

In the context of the European Digital Single Market where the amount of online transactions and data is exploding, setting the right conditions for the advent of an open, trustworthy, transparent, compliant and authenticated transaction system is a real challenge for the EU. Existing decentralised environments lack trust, accountability, interoperability, regulatory certainty and mature governance models to interact among themselves and also with centralised systems.

The Regulation (EU) 2023/1114 of Markets in Crypto-assets (MiCA) entered into force in June 2023 and started to be implemented. The initiative aims to establish a comprehensive legal framework governing crypto assets service providers, including issuers of crypto-assets that were not previously subject to EU financial services regulations such as MiFiD 2, Directive (EU) 2014/65), as well as providers of related services. It is specifically applicable to the issuance and trading of tokens within non-MiFID DLT-based markets. The Regulation(EU) 2022/858 introduces a pilot regime for market infrastructures based on distributed ledger technology. Additionally, Regulation (EU) 2022/2554 on digital operational resilience for the financial sector (Digital Operational Resilience Act, or DORA) was adopted in June 2022, and shall apply from 17 January 2025.

The Regulation (EU) 2024/1183 "amending Regulation (EU) No 910/2014 establishing a framework for a European Digital Identity" (eIDAS2) was adopted on 30 April 2024 and entered into on 20 May 2024. It introduces a new trust service for electronic ledgers, and the European Digital Identity (EUDI) Wallet, identification means for European physical and legal persons based on Self Sovereign Identity principles.

The Data Act Regulation (EU) 2023/2854 entered into force on 11 January 2024 and aims to harmonise rules on fair access to and use of data, which, among other provisions, includes essential requirements regarding smart-contracts for data sharing.

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

In order to engage in and contribute to the development of the needed standards, the Commission follows up on the standardisation activities related to Blockchain and Distributed Ledger Technologies carried out by the different SDOs, such as ISO, ITU-T, ETSI or CEN & CENELEC. This includes the organisation of workshops bring together standards development organisations, fora and consortia active in international Blockchain/DLT standardisation, as well as key stakeholders, and representatives of PPPs like INATBA and deployment initiatives like the EBP (see A.3).

Moreover the EC support R&I projects through Horizon 2020 and Horizon Europe that contribute as well as to standardisation activities in ISO, CEN & CENELEC, ETSI, ITU-T, IEEE, W3C and IETF, considering also methods and tools for environmental and innovation management of DLTs. Two projects, Blockstand and Seeblocks, funded by the Digital Europe Programme support the participation of EU experts in those activities.

Horizon Europe and InvestEU programmes by the European Commission support collaborative research and innovation projects, as well as some funding being allocated to standardisation via projects such as Stand-ICT.eu and Standardisation Booster. The Digital Europe Programme supports the European Blockchain Services Infrastructure (EBSI), the EU blockchain regulatory sandbox and respective projects mentioned in C.2 below.

(A.3) REFERENCES

- Regulation (EU) 2024/1183 amending Regulation (EU) No 910/2014 as regards establishing a framework for a European Digital Identity
- COM(2017) 228 final Mid-Term Review on the implementation of the Digital Single Market Strategy
- EU Blockchain Observatory and Forum
- European Blockchain Partnership
- International Seminar on Joining Forces on Blockchain Standardisation 2020 and the 2021 iteration.
- The European Commission's Digital finance package, 24 September 2020: Digital finance package
- Regulation (EU) 2023/1114 on Markets in Crypto-assets (MiCA)
- Regulation 2022/858 on a pilot regime for market infrastructures based on distributed ledger technology
- COM/2020/595 final Proposal for a Regulation of the European Parliament and of the Council on digital operational resilience for the financial sector and amending Regulations (EC) No 1060/2009, (EU) No 648/2012, (EU) No 600/2014 and (EU) No 909/2014
- Proposal for a Directive of the European Parliament and of the Council amending Directives 2006/43/EC, 2009/65/EC, 2009/138/EU, 2011/61/EU, EU/2013/36, 2014/65/EU, (EU) 2015/2366 and EU/2016/2341 {SEC(2020) 309 final} - {SWD(2020) 203 final} - {SWD(2020) 204 final}
- Data act: Regulation (EU) 2023/2854 on harmonised rules on fair access to and use of data.

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

ACTION 1: The standardisation community should continue analysing possible standardisation gaps and identify solutions to fill them, taking into account also other chapters in the Rolling Plan including actions and references to Blockchain and DLT and their applications. Activities may focus on governance and interoperability, electronic ledgers, organisational frameworks and methodologies, processes and products evaluation schemes, Blockchain and distributed ledger guidelines, smart technologies, objects, distributed computing devices and data services.

ACTION 2: Continue identifying use cases which are relevant for EU (including EU regulatory requirements like from GDPR, AI Act, Data Act, ePrivacy, eIDAS, AMLD, TOOP, CSRD, etc.) also leveraging on the yearly event "Joining Forces for Blockchain Standardisation" co-organised by the European Commission and INATBA (see section C.2) with special focus on Smart Contracts, Digital Identity, Governance, Interoperability, CBDC/Crypto Assets; submit them to standardisation bodies, including CEN & CENELEC and ETSI, and also ISO, ITU.

ACTION 3: Continue identification of actual blockchain/DLT implementations in the EU and assess the need for standardisation, harmonisation and workforce training or adaptation.

ACTION 4: Standardisation of the operation and reference implementation of permissioned and

permissionless distributed ledgers and distributed applications, with the purpose of creating an open ecosystem of industrial interoperable solutions.

ACTION 5: Standards Development Organisations active in blockchain/DLT standardisation to liaise and coordinate to take advantage of synergies and maximise resources, including with relevant public and private partnerships

ACTION 6: ESOs to develop standards in line with the Data Act Regulation, in particular regarding essential requirements for smart-contracts. In addition, it would be recommended to explore a general framework for Governance of the European networks based on DLT to allow the flow of smart contracts between different networks.

ACTION 7: ESOs when relevant to develop the standards needed for the introduction of Digital Euro (CBDC), if the European Central Bank (ECB) decides to its issuance, and for digital assets (MiCA Regulation), in particular to ensure interoperability with smart-contracts, legacy systems, etc, linked with either CBDCs or private money. As per Art. 24 of the draft digital euro Regulation proposed by the Commission in June 2023, to ensure conditional payments on digital euro, the ECB may adopt detailed measures, rules and standards that PSPs can use to ensure interoperable conditional digital euro payment transactions. ESOs to liaise with ECB and in particular with the Digital euro scheme rulebook development group to ensure coordination between the standards for conditional payments involving digital euro and other existing or future standards.

ACTION 8: SDOs to develop standards and technical guidance, methods and tools for environmental and innovation management of DLTs to support the industry competitiveness and sustainable growth and ensure sustainability and safety for consumers. In particular In the context of the standardisation described in Action 7, SDOs to develop standards towards assessing environmental and sustainability impact including, in particular, CO2 footprint and energy consumption of different blockchains/DLTs, MiCA, EU Sustainable Finance taxonomy.

ACTION 9: Standardisation efforts to analyze and if needed, enhance the interoperability and international compatibility of the current and pending EBSI topics and capabilities previously mentioned.

ACTION 10: ESOs to develop standards in line with the eIDAS2 regulation, in particular regarding essential requirements for electronic ledgers.

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

ISO

ISO/TC 307: Blockchain and distributed ledger technologies has wide global outreach and involves majority of the EU Member States works with vocabulary, reference architecture, taxonomy and ontology (WG1), smart contracts (WG3), security, privacy and identity (JWG4 with ISO/IEC JTC1/SC27), governance (WG5), use cases (WG6), interoperability (WG7) and NFT (WG8).

For more information please see: https://www.iso.org/committee/6266604/x/catalogue/

ISO/TC 154: Processes, data elements and documents in commerce, industry and administration works with data interchange processes of blockchain based negotiable maritime bill of lading related to e-Commerce platform (ISO/WD 5909) and Processes, data elements and documents in commerce, industry and administration —Trusted communication platforms for electronic documents — Part 3: Blockchain-based implementation guideline (ISO/AWI TR 19626-3)

ISO/IEC JTC 1/SC 29 Coding of audio, picture, multimedia and hypermedia information has a work item on Smart contracts for media (FDIS 21000-23).

IEC

SyC Smart Energy has a working group Decentralized energy trading infrastructure which has links with blockchain/DLT.

IEEE

The IEEE Computer Society Blockchain and Distributed Ledgers (BDL) Standards Committee focuses on developing standards for blockchain-based digital asset management, digital asset classification, a digital asset exchange model, blockchain identity key management and on a digital identity system framework. In addition, the "Blockchain" Working Group develops a family of horizontal and vertical blockchain standards, address interoperability of blockchains, naming, cross-chain transaction consistency as well as data authentication and communication. IEEE also runs a pre-standardisation project on digital inclusion and agency, which leverages blockchain technology.

The IEEE Consumer Technology Society Blockchain Standards Committee (CTS/BSC) is focused on "Standardizing the decentralized world" from a consumer perspective. The scope of the Standards Committee is to develop and maintain standards, recommended practices and guides for blockchain technologies and applications, especially from the consumers' perspective, using an open and accredited process, and to advocate them on a global basis.

For more information, see: https://ieee-sa.imeetcentral.com/eurollingplan/.

ITU-T

The ITU-T Focus Group on Application of Distributed Ledger Technology (FG-DLT) concluded its work on 1 August 2019 and

produced a number of deliverables, which were transferred to ITU-T Study Groups 16 (Multimedia) and 17 (Security).

More information at: https://www.itu.int/en/ITU-T/focusgroups/dlt/Pages/default.aspx

In addition, some blockchain retaliated activities are taking place in SG5, SG11, SG13 and SG20.

ITU-T SG5 has approved Recommendation L.1317 "Guidelines on energy efficient blockchain systems" which focuses on blockchain energy demands and how these can be optimized. This Recommendation aims to explain the energy demand of blockchain, to define the blockchain energy model and to describe the energy efficiency parameters that can be calibrated in order to enhance the corresponding energy efficiency.

ITU-T SG11 developed Recommendation ITU-T Q.5026 "Signalling Requirements and Protocol for Providing Network-oriented Data Integrity Verification Service based on Blockchain in IMT-2020 network" and Q.4046 "Interoperability testing requirements of blockchain as a service". Currently, SG11 is developing new draft standard Q.BaaS-iopt-ts "Test suite for interoperability testing of blockchain as a service".

ITU-T SG13 has approved Recommendation ITU-T Y.2247 "Framework and Requirements of Network-oriented Data Integrity Verification Service based on Blockchain in Future Network" and Y.3081 "Self-Controlled Identity based on Blockchain: Requirements and Framework".

ITU-T SG20 has approved Recommendation ITU-T Y.4560 " Blockchain-based data exchange and sharing for supporting Internet of things and smart cities and communities ", Recommendation ITU-T Y.4561 "Blockchain-based Data Management for supporting Internet of things and smart cities and communities", Recommendation ITU-T Y.4907 "Reference architecture of blockchain-based unified KPI data management for smart sustainable cities", Recommendation ITU-T Y.4476 "OID-based resolution framework for transaction of distributed ledger assigned to IoT resources", Recommendation ITU-T Y.4486 "Framework of cross edge decentralized service by using DLT and edge computing technologies for IoT devices", Recommendation ITU-T Y.4491 "Framework of blockchain-based self-organization networking in IoT environments", Recommendation ITU-T Y.4492 "Decentralized IoT communication architecture based on information centric networking and blockchain" and "IoT requirements and capabilities for support of blockchain" (Y.4227). ITU-T SG20 is currently working on "Capability and functional architecture of blockchain of things peers" (Y.IoT-BoT-peer), "Functional requirements and architecture of blockchain-based activity logs management for IoT data processing and management" (Y.4508 (ex Y.DPM-alm-fra)) and "Requirements and functional architecture for blockchain-based sustainable and cooperative digital-twin creation system" (Y.DT-CS).

More info: https://itu.int/go/tsg20

ITU-T SG3 agreed on Technical Report ITU-T DSTR-IoT-DLT-Accounting, "Accounting and billing aspects in Internet of Things (IoT) ecosystem and integrated approach using Distributed Ledger Technology (DLT)", and Technical Report ITU-T DSTR_DLTUSF, "The Potential of Distributed Ledger Technology to Improve Management of Universal Service Funds" (under publication). ITU-T SG3 is currently working on a draft new Technical Report ITU-T TR_DLT "Usage of Distributed Ledger Technology (DLT) to handle accounting, policy, regulatory and economic issues in the international telecommunications/ICT domain".

W3C

W3C has formed a Blockchain Community Group, which is studying and evaluating technologies related to blockchain and use-cases such as interbank communications. Its work is complemented by a group on Blockchain and Decentralized Apps and one on Digital Assets.

W3C created the Decentralized Identifier Working Group (DID WG) https://www.w3.org/2019/did-wg/ URL-based identifiers (URIs) in use on the Web today (2019) require that the identifier be leased from an authority such as a Domain Name Registrar. A Decentralized Identifier (DID) is an identifier that does not need to be leased; its creation and use is possible without a central authority to manage it.

In addition to the "Blockchain Community Group" W3C has also a "Credential Community Group" (https://www.w3.org/community/credentials/) which has developed key standards for SSI (Self-Sovereign Identity) including Decentralized Identifiers (DID) Data model and Syntax and Verifiable Claims Use Cases and Data Model.

IETF

IETF IRTF

The Decentralized Internet Infrastructure Research Group (DINRG) investigates open research issues in decentralizing infrastructure services such as trust management, identity management, name resolution, resource/asset ownership management, and resource discovery. The focus of DINRG is on infrastructure services that can benefit from decentralization or that are difficult to realize in local, potentially connectivity-constrained networks. Other topics of interest are the investigation of economic drivers and incentives and the development and operation of experimental platforms. DINRG will operate in a technology- and solution-neutral manner, i.e., while the RG has an interest in distributed ledger technologies, it is not limited to specific technologies or implementation aspects.

https://wiki.ietf.org/en/group/iab/Multi-Stake-Holder-Platform#h-336-blockchain-and-distributed-digital-ledger-technologies

IETF SATP WG

The Secure Asset Transfer Protocol (SATP) aims to standardize an interoperability protocol for distributed networks, enabling the transfer of data and assets between different networks. While the primary focus has been on distributed ledger technologies (DLTs) due to extensive research in this area, the working group also considers other types of systems and networks. This makes SATP applicable to scenarios such as interoperability between centralized systems and distributed networks.

CEN & CENELEC

CEN & CENELEC established CEN/CLC/JTC19 on Blockchain and Distributed Ledger Technologies for specific European standardisation needs (for example in the context of EU regulations such as GDPR and eIDAS) not included in the ISO/TC 307 work program and, when necessary, for the adoption of international standards already available.

CEN-CLC/JTC 19 has 3 Working Groups:

- WG 1 "Decentralised Identity Management"

- WG 2 "Environmental Sustainability"
- WG 3 "Personal identifiable information (PII) in Blockchain and DLT"

More information on CEN/CLC/JTC 19 is available here.

CEN & CENELEC Sector Forum Energy Management & Energy Transition (SFEM) starting from April 2021 has a dedicated focus group for Blockchain and DLT which brings together stakeholders coming from the energy sector as well as from academic and research bodies. This focus group prepared an overview of blockchain/DLT related activities and applications in the electricity sector (incl. sector coupling) and elaborated a complete view of the current challenges (technical and non-technical) regulatory, RD&I, Pre-normative research (PNR), use cases, and standardization needs in the field of "DLT in energy". The final report of the group was prepared in November 2022 for the review of the Swiss Federal Office of Energy and was made available in 2023.

ETSI

Permissioned distributed ledgers are the kind of DLT best qualified to address most of the use cases of interest to the industry and governmental institutions.

ETSI ISG PDL is committed to analyse and provide the foundations for the operation of permissioned distributed ledgers, with the ultimate purpose of creating an open ecosystem of industrial solutions to be deployed by different sectors, fostering the application of these technologies, and therefore contributing to consolidating the trust and dependability on information technologies supported by global, open telecommunications networks. The ISG PDL incorporates research and new development results in the field as they become available, especially in aspects related to smart contracts, interoperability among ledgers, data management, and trust and reputation support. The group is actively working to facilitate the coordination and cooperation between relevant standardization bodies and open source projects. ETSI via ISG PDL has published Specifications on the Distributed Blockchain "Smart contracts" and "reference architecture". It is now working on the Specification of Redactable Block, Block Hashing, Reputation, etc. and collaborating with TC ESI on eIDAS and in support of smart contracts in the context of the Data Act Regulation.

ISG IPE (IPv6 Enhanced Innovation) studies how IPv6 could be applied to blockchain technology. The GR "IPv6-based Blockchain" outlines how the properties of IPv6, can be leveraged to achieve new direct payment mechanisms for users of the blockchain. IPE is working on GR "IPv6 and Cloud using Data Block Matrix for Food Supply Chain Tracking and Tracing" which introduces blockchain technology in the Food Supply Chain for food tracking and tracing.

TC ESI plans to work on policy and security requirements for use of ledgers as a trust service in support of smart contracts as well as on the use of EU Digital Identity Wallets and advanced and qualified electronic signatures / seals for identification with smart contracts. Such standards will support both the proposed Data Act and the proposed eIDAS2 regulation which establishes a framework for trust services in regards to the creation and maintenance of (qualified) electronic ledgers.

OASIS

The EEA Community Projects, formerly known as the Ethereum OASIS Open Project, is the hub for open source-based standards development in the Ethereum industry. It aims to facilitate Ethereum's longevity, interoperability, and ease of integration and intends to develop documentation and shared test suites that facilitate new features and enhancements to the Ethereum protocol. The projects seek to address interoperability of implementations. EEA projects include Ethereum projects like the Baseline Protocol and JSON-RPC API documentation under its stewardship.

The Baseline Protocol OASIS Open Project combines advances in cryptography, messaging, and blockchain to deliver secure and private business processes at low cost via the public Ethereum Mainnet.

UNECE

The United Nations Centre for Trade Facilitation and Electronic Business (UN/CEFACT) has developed two White Papers on Blockchain and a Sectoral Use Case paper. The first White Paper provides an overview of the base principles of Distributed Ledger Technology; the second explores the needs for standardisation in this area and concludes a strong needs for semantic data standards in order to ensure clear understanding between the issuer of information on a Blockchain and all users of that data. The UN/CEFACT Core Component Library can cover the data needs in trade transactions. The final UN/CEFACT Blockchain paper explores the specific needs of each sector (Maritime Transport, Suppy Chain, Agriculture, etc.) and provides a number of use cases.

See: White Paper 1: https://www.unece.org/fileadmin/DAM/cefact/GuidanceMaterials/WhitePaperBlockchain.pdf

White Paper 2: https://www.unece.org/fileadmin/DAM/cefact/GuidanceMaterials/WhitePaperBlockchain_TechApplication.pdf

Use Case paper: https://www.unece.org/fileadmin/DAM/cefact/cf_plenary/2019_plenary/CEFACT_2019_INF03.pdf

UN/CEFACT CCL: https://www.unece.org/cefact/codesfortrade/unccl/ccl_index.html

UN/CEFACT continues work on interoperability of ledgers. See: https://uncefact.unece.org/display/uncefactpublic/Cross+border+Inter-ledger+exchange+for+Preferential+CoO+using+Blockchain

(C.2) OTHER ACTIVITIES RELATED TO STANDARDISATION

INATBA

INATBA, the International Association of Trusted Blockchain Applications, has been launched with the support of the European Commission on 3 April 2019. It brings together representatives of the stakeholders across the value chain: industry, startups and SMEs, policy makers, international organisations, regulators, civil society and standard-setting bodies to support blockchain and Distributed Ledger Technology (DLT) to be mainstreamed and scaled-up across multiple sectors. It offers developers and users of DLT a global forum to interact with regulators and policy makers and bring blockchain technology to the next stage.

INATBA together with the European Commission from 2022 co-organises yearly the International Seminar on Joining Forces on Blockchain Standardisation (see section A.3 for the 2020 and 2021 iterations).

On 11-13 November 2019 INATBA together with EU Blockchain Observatory and forum, Alastria and the European Commission co-organised the Global blockchain congress CONVERGENCE, of which the next iteration is being anticipated in 2023.

INATBA has a Working Group on standardisation to support the development and adoption of interoperability guidelines, specifications and global standards, to enhance trusted, traceable, user-centric digital services, liaise with standards development organisations and to develop contributions to standardisation, such as use cases and requirements. Relevant for standardisation are also the interoperability and governance working groups.

https://inatba.org/

EBSI

The European Blockchain Partnership (EBP) has been set up on 10 April 2018 following the agreement of 28 European countries which signed a joint declaration to cooperate in the establishment of a European blockchain services infrastructure (EBSI) that will support the delivery of cross-border public services, through interoperability and open interfaces and with the highest standards of security. Today the EBP includes all EU Member States, Norway and Liechtenstein. The EBSI initiative has advanced in the following topics:

- EBSI created a generic profile for the full life-cycle of **Verifiable Credentials** and **Verifiable Presentations** for all use cases that involve the request, storage and presentation of personal data. This profile was based on the W3c specification of Verifiable Credential 1.0 data model (currently updated version v 1.1 has been released), the GDPR and other relevant EU Regulations.
- Natural person and legal entities are identified in EBSI by **decentralized identifiers**, a pseudonym which is resolvable using **DID Documents**. This data structure is based on the DID Document data model. and it contains information associated with a DID, such as verification method and services to interact with the subject of the DID.
- EBSI has designed and implemented two **DID methods,** which are the mechanism by which a particular type of DID and its associated DID document are managed.
- EBSI has also designed and implemented **verification services for digital information,** which will enable to check the status of verifiable credentials and other information data. These services can verify information related to the authenticity of products, digital documents of natural persons or data related to legal entities.
- All the information that supports the EBSI Trust Framework is stored in the **EBSI trusted registries.** This repository of data does not contain personal information and is stored in EBSI ledgers. EBSI has worked in the definition of these registries, and the accreditation objects that enable entities to play a role in this trust framework. Trusted registries are managed via authoritative channels.

In the short-term EBSI will address pending capabilities such as **selective disclosure** of information contained in a verifiable credential by using techniques such as **BBS+ signatures** represented in a **JSON-LD** structure. Other topic that will be faced in EBSI is the implementation of **JAdES signatures** to permit the verification of verifiable credentials and presentations in a more interoperable way.

BLOCKSTAND

BlockStand was launched in May 2023, funded under the European Union's Digital Europe Programme grant agreement no. 101102757. It supports the participation of European experts in blockchain standardisation activities at both European and international levels through and Experts' Selection Process. Other important outputs include a Standardisation Gaps & Recommendations Atlas, a proposal for a European Blockchain Standardisation Roadmap, and a European Blockchain Leadership Outlook. An Executive Management Board, comprised of high-level experts in the blockchain field, also provides strategic steering. https://blockstand.eu/

SEEBLOCKS

SEEBLOCKS.eu, launched in May 2023, is a 24-month Digital Europe Programme project that aims at delivering a targeted, democratic, industry-driven initiative to support European interests in standardisation within the Blockchain/DLT domain, bringing together EU researchers and open standards specialists, along with industry and policy experts with the primary goal to provide a tangible contribution to the presence of European players in International Blockchain/DLT standardisation, through 4 recurring Selecting and Engaging Procedures (SEPs). https://seeblocks.eu/

(C.3) ADDITIONAL INFORMATION

One direction of blockchain technology innovation in recent years was towards a highly promising area of secure, tamper-proof public data, eliminating the need for initial trust among involved stakeholders.

The clarification and mutual definition of several aspects of blockchain technology (such as blockchain interoperability, governance, trust, security of blockchain and of the underlying cryptographic mechanisms, blockchain compliance to legislation, the impact of blockchain on different sectors, etc) are crucial prerequisites to introducing the technology to society.

Global blockchain congress CONVERGENCE: https://blockchainconvergence.com/

3.3.7 Web 4.0 and virtual worlds

A Policy and legislation

(A.1) POLICY OBJECTIVES

In 2023, the Commission adopted a new strategy on Web 4.0 and virtual worlds to steer the next technological transition. The Communication (COM(2023) 442 final) *An EU initiative on Web 4.0 and virtual worlds: a head start in the next technological transition* outlines the vision, high-level objectives and actions. The Commission aims for a Web 4.0 and virtual worlds that reflect EU values and principles and fundamental rights, where people can be safe, confident and empowered, where people's rights as users, consumers, workers or creators are respected, and where European businesses can develop world-leading applications, scale up and grow. Furthermore, the Commission aims for a Web 4.0 and virtual worlds that are powered by open and highly distributed technologies and standards that enable interoperability between platforms and networks and freedom of choice for users, and where sustainability, inclusion and accessibility are at the core of technological developments.

The Communication describes virtual worlds as *"persistent, immersive environments, based on technologies including 3D and extended reality (XR), which make it possible to blend physical and digital worlds in real-time, for a variety of purposes such as designing, making simulations, collaborating, learning, socialising, carrying out transactions or providing entertainment"* and Web 4.0 as "*the expected fourth generation of the World Wide Web. Using advanced artificial and ambient intelligence, the internet of things, trusted blockchain transactions, virtual worlds and XR capabilities, digital and real objects and environments are fully integrated and communicate with each other, enabling truly intuitive, immersive experiences, seamlessly blending the physical and digital worlds."*

The Staff Working Document (SWD(2023) 250 final) accompanying the communication provides further information and insights on stakeholders' views, technology, market trends and relevant existing legislation impacting Web 4.0 and virtual worlds. The second part of the Staff Working Document (SWD(2023) 250 final Part 2/2) provides the final 23 recommendations put forward by the citizens from the work of the citizens' panel on virtual worlds. Additional scientific evidence is available in the study "Next Generation Virtual Worlds: Societal, Technological, Economic and Policy Challenges for the EU" carried out by the Joint Research Centre (JRC) in 2023.

The **Communication** presents a range of actions to build the foundation for the long-term transition towards Web 4.0 and the development of virtual worlds. The actions are structured around the objectives of the Digital Decade policy programme:

- People & skills
- Business: supporting a European Web 4.0 industrial ecosystem
- Government: supporting societal progress and improving public services
- Governance

The business and governance strands address aspects that are of particular relevance from an ICT standardisation perspective:

In section *3.2.3 Fostering a supportive business environment*, the communication states: "*Open standards are key to ensuring that the future Web 4.0 ecosystem will not be dominated by a select few, setting de facto standards and creating market entry barriers. The Commission, in cooperation with Member States and stakeholders, will engage with key organisations active in the development of standards for open and interoperable virtual worlds and Web 4.0. These efforts will feed into the EU Strategy on Standardisation and will draw on the work of the High-Level Forum on European Standardisation."* This objective is directly linked to Action 6 of the communication *"Support the development of standards for open and interoperable virtual worlds [Q4 2023]*".

In section *3.4.1 Governance at the EU and global level,* the communication addresses the further evolution of the internet "*To ensure that Web 4.0, starting with virtual worlds, is shaped as an open, secure space, respectful of EU values and rules, international engagement is needed on a broad scope of topics, from technological issues (such as standards for interoperability, identity management or connectivity) to content and practice (such as content access and creation versus disinformation, censorship versus freedom of speech, and surveillance versus privacy)."* This objective is associated to Action 9 in the communication *"Engage with existing multi-stakeholder internet governance institutions to design open and interoperable virtual worlds [from Q4 2023]; and support*

the creation of a technical multi-stakeholder forum to address certain aspects of virtual worlds and Web 4.0 beyond the remit of existing internet governance bodies [from Q1 2024].”

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

As explained in the SWD and the JRC report, reaching the full potential of Web 4.0 and virtual worlds will require a coordinated integration of digital technologies such as low latency and high throughput networks (e.g. 5G/6G, WIFI 6/7), flexible and high performant computing and storage systems (e.g. HPC or cloud-edge), VR/AR, data & AI, blockchain/NFT and cybersecurity.

The communication also states the importance of influencing developments in Web4.0 and virtual worlds now, while they are shaping up and major players are positioning themselves.

INTERNET GOVERNANCE

Virtual world developments are expected to have a large influence on the future internet. The corresponding standards emerging from competent multi-stakeholder organizations will bring about Internet governance discussions to be lead in existing Internet governance institutions or, on issues beyond their current remit such as the management of interoperability of virtual worlds based on public values such as privacy, security and safety, in a new technical multi-stakeholder forum on virtual worlds governance.

TECHNOLOGIES

In the topic of interoperability and standardisation, the **Communication** mentions that “*Large distribution platforms (in both the business-to-business and business-to-consumer segments) are among the early movers in virtual worlds. These large market players have a heavy global presence, including in the EU. This market dynamic leads to two major concerns. First, large entities can contribute to a closed ecosystem by setting de facto standards. Second, they may become future gatekeepers of virtual worlds by exploiting network effects, thus creating new market entry barriers for SMEs and start-ups in the EU.”*

Standardisation will be key to enable interoperability between different platforms and networks, enabling the seamless use of identities, avatars, data, virtual assets, experiences or environments and the associated rights across platforms and networks.

The table below shows the main building blocks listed in the forementioned Staff Working Document (SWD(2023) 250 final), where important technological developments are taking place with respect to virtual worlds. Each chapter number listed in the table refers to those outlined in the SWD. Promoting open standards in these technology areas will ultimately help to address the risk of lock-in effects.

The top three rows of the table depict the areas that need particular attention, since they are not or only partly addressed in other Chapters of the ICT rolling plan. This is particularly the case for Non-Fungible Tokens (NFTs) and Human-Computer Interfaces (HCIs), both of which have already found their space in the gaming world and represent large commercial potential. The rows in grey are already addressed in other Chapters but may require additional focus on Virtual Worlds.

*Chapter numbers in the table refer to text in SWD(2023) 250 final

KEY AREAS

Human interfaces and VR/AR devices

Human-computer interactions are traditionally screen, sound and keyboard oriented. With mobile, other kinds of interactions have become mainstream, in particular voice and motion.

Spatial computing is the most important newly emerging Human-Computer interface. Originating from the gaming world, applications are starting to find their way to other areas.

Extended reality (XR) technologies, such as virtual reality (VR), mixed reality (MR) and augmented reality (AR), enable users to interact with digital environments and objects in a more natural and intuitive way. Moreover, truly immersive virtual worlds would benefit from being experienced through VR or AR glasses or visors rather than traditional smartphones, tablets and PCs.

Furthermore, photonics technologies combined with microelectronics are steadily evolving AR/VR technology to be smaller, lighter, and less power-hungry, as well as more immersive and intuitive for end users. Innovative photonic technologies enabled projectors, displays, waveguides and cameras and have continuously improved the performance and power consumption of AR/VR headsets.

Interoperability aspects: Human-Computer interfaces are closely linked to device capabilities. Some degree of immersive experience can be accomplished through general purpose devices such as personal computers, mobile phones and tablets. Full immersion

will require dedicated extended reality (XR) devices (used in combination with general purpose devices). VR/AR devices are currently still very diverse and vendor-specific, with closed vendors-platforms and vendor-specific techniques to optimise performance. In the gaming world, the device-lock-in has been an important strategy. It will be in the interest of European players to create more openness around VR/AR devices…

Virtual experiences

The virtual experiences area comprises tools and technologies used to create models and experiences for users. The creative aspect is key here, designing full applications such as games and simulations but also designing virtual components such as avatars, buildings or clothes.

Computer aided design of physical objects 'still to be built' and creation of fully virtual objects also fit in this area.

Three-dimensional (3D) technology helps to create a sense of immersion, allowing users to experience a virtual environment that feels real and responsive. 3D models are used to create virtual objects, buildings, landscapes and characters.

Digital twins are positioned in this area as well, since these highly accurate digital simulations of real objects can be used in the development of virtual worlds and the deployment of Web 4.0.

Interoperability aspects: Storage formats for models and scenes, media standards for 3D video, 3D imaging and 3D sound, IP protection, …

Virtual economy & society

The virtual economy & society area comprises the new kinds of presence and interaction that will emerge in virtual worlds. Digital presence of people, business and government is likely to increase, creating a greater need for interoperability and trust across virtual worlds.

Interoperability aspects: Cross-world identity, portability of virtual assets, … See also Rolling Plan chapters 3.0.3 ePrivacy, 3.3.6 Blockchain and Distributed Digital Ledger Technologies

OTHER AREAS

Infrastructure

Advancements in computing power and network bandwidth and latency will enable even more immersive experiences.

Interoperability aspects: See Rolling Plan chapters 3.1.1 5G And Beyond, 3.1.7 Broadband infrastructure mapping, 3.1.11 Quantum Technologies. An important foundational driver is Cybersecurity, see Rolling Plan chapter 3.0.2.

Data

Data is raw material for virtual worlds and Web 4.0 applications. The conditions under which data is used and shared, raise questions on data protection, privacy, security, market power, and intellectual property.

Interoperability aspects: As a result of the EU strategy for data, new mechanisms for data sharing have been introduced. The European Common Dataspaces and Open Data from EU public sector bodies (high-value data sets) closely align with EU virtual worlds priorities. See Rolling Plan chapters 3.0.1 Data Economy, 3.0.3 ePrivacy, 3.1.3 Data Interoperability

Artificial intelligence

Artificial intelligence is becoming a commodity. While AI models are developed using powerful computers, the resulting algorithms can be deployed in many places (Cloud – Edge paradigm), helping to capture reality, generating avatars, …

The European AI strategy addresses the key challenges.

Interoperability aspects: Standardisation needs are addressed in chapter 3.1.9 Artificial Intelligence of the Rolling Plan.

Reality capturing

Virtual worlds may include aspects from the real world, creating augmented or mixed reality experiences.

The Internet of Things is an important enabler for the capture of events and state changes from the real world.

Traditional Automatic Identification and Data Capture (AIDC) techniques such as barcodes are of importance as well, enabling to efficiently capture data about disconnected objects such as products and packages.

Positioning systems, outdoors as well as indoors, are another building block.

Interoperability aspects: The technologies in this area tend to be quite generic and open, due to the wide range of applications. Main objective is to preserve this level of openness while the technologies evolve, with more computing power and intelligence moving to the 'edge'. See Rolling Plan chapters 3.1.4 Internet of Things, 3.1.10 European Global Navigation Satellite System.

(A.3) REFERENCES

- COM(2023) 442 final: An EU initiative on Web 4.0 and virtual worlds: a head start in the next technological transition
- SWD(2023) 250 final: Commission Staff Working Document accompanying the document An EU initiative on Web 4.0 and virtual worlds: a head start in the next technological transition
- COM(2014) 72 final: Internet Policy and Governance Europe's role in shaping the future of Internet Governance
- COM(2022) 548 final: Commission work programme 2023. A Union standing firm and united
- Regulation (EU) 2022/2065 of the European Parliament and of the Council of 19 October 2022 on a Single Market for Digital Services and amending Directive 2000/31/EC (Digital Services Act)
- Regulation (EU) 2022/1925 of the European Parliament and of the Council of 14 September 2022 on contestable and fair markets in the digital sector and amending Directives (EU) 2019/1937 and (EU) 2020/1828 (Digital Markets Act)
- COM/2022/68 final: Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on harmonised rules on fair access to and use of data (Data Act)
- Proposal for a Regulation amending Regulation (EU) No 910/2014 as regards establishing a framework for a European Digital Identity
- COM/2020/593 final: Proposal for a Regulation of the European Parliament and of the Council on Markets in Crypto-assets, and amending Directive (EU) 2019/1937
- Regulation 2022/858 on a pilot regime for market infrastructures based on distributed ledger technology

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

ACTION 1: SDOs to provide a mapping of ongoing or planned standardisation activities of relevance in supporting the development of interoperable virtual worlds and related technologies such as AR/VR or digital twins. This mapping should be done in relation to the areas provided in section A.2 above which also outline the policy needs and objectives.

ACTION 2: SDOs to identify and inform about virtual worlds related standardisation activities in vertical sectors such as design & manufacturing, health, cultural heritage or education.

ACTION 3: SDOs to identify the need for standardisation activities that ensure the privacy and security of users in the metaverse.

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

ETSI

ISG ARF (Augmented Reality Framework) defines a framework for the interoperability of Augmented Reality (AR) components, systems and services that specifies relevant components and interfaces required for AR and XR solutions as the basis for Metaverse applications. The design as a modular architecture allows components from different providers to interoperate through defined interfaces. Transparent and reliable interworking between different AR components fosters the successful roll-out and wide adoption of AR/XR applications and services.

Collection of use cases:

- GR ARF 002 "Augmented Reality Framework (ARF) Industrial use cases for AR applications and services"

Specification of the framework:

- GS ARF 003 "Augmented Reality Framework (ARF) AR framework architecture"

Specifications for interoperability requirements:

- GS ARF004-1 "Augmented Reality Framework (ARF); Interoperability Requirements for AR components, systems and services; Part 1: Overview"
- GS ARF004-2 "Augmented Reality Framework (ARF) Interoperability Requirements for AR components, systems and services Part 2: World Storage and AR Authoring functions"
- GS ARF004-3 "Augmented Reality Framework (ARF); Interoperability Requirements for AR components, systems and services; Part 3: World Capture, World Analysis and Scene Management"
- GS ARF 004-4 "Augmented Reality Framework (ARF); Interoperability Requirements for AR components, systems and services; Part 4: World Analysis, World Storage and Scene Management functions"
- GS ARF004-5 "Augmented Reality Framework (ARF); Interoperability Requirements for AR components, systems and services; Part 5: External Communications"

OpenAPI specification:

- GS ARF 005 "Augmented Reality Framework (ARF); Open APIs for the Creation and Management of the World Representation"

ISG CIM (cross-cutting Context Information Management) has consistently demonstrated a strong interest in Digital Twins, which is evidenced by the implementation of the document 'Feasibility of NGSI-LD for Digital Twins' (GR CIM 017 v1.1.1). The group is investing time and resources to identify how to align the NGSI-LD API (GS CIM 009 v1.8.1) for use in VR/AR applications (ETSI ISG CIM GR 0052 "VR and AR for Smart Learning: Guidelines for using NGSI-LD to train personnel in Smart Industries").

IEEE

IEEE has established the IEEE Metaverse Congress series and the IEEE Metaverse Community. IEEE has standardisation and pre-standardisation activities relating to the metaverse, including:

- IEEE P2048, Standard for Metaverse: Terminology, Definitions, and Taxonomy
- IEEE P3322, Guide for Comfort Requirements for Extended Reality (XR) Devices
- IEEE P3812.2, Standard for General Requirements for Identity Framework for Metaverse
- IEEE P7016, Standard for Ethically Aligned Design and Operation of Metaverse Systems
- IEEE P7030, Recommended Practice for Ethical Assessment of Extended Reality (XR) Technologies

A list of additional IEEE standards related to the metaverse is found here.

Pre-standards activities include The IEEE Global Initiative on Ethics of Extended Reality. This group developed a series of papers that can be found on its website, and of particular note is "Metaverse and its Governance." Other papers include:

- XR Ethics in the Classroom Webinar
- XR Report: Extended Reality (XR) Ethics in Medicine
- XR Report: Social and Multi-User Spaces in VR: Trolling, Harassment, and Online Safety (PDF)
- XR Report: Extended Reality (XR) Ethics in Education (PDF)
- XR Report: Extended Reality (XR) and the Erosion of Anonymity and Privacy (PDF)
- XR Report: Who Owns our Second Lives: Virtual Clones and the Right to Your Identity (PDF)
- XR Report: Extended Reality (XR) Business, Finance, and Economics (PDF)
- XR Report: Extended Reality (XR) Ethics and Diversity, Inclusion, and Accessibility (PDF)
- XR Report: Metaverse and Its Governance (PDF)

The IEEE Standards Association published a joint report (2024) with the Council of Europe on the Metaverse and its impact on human rights, the rule of law and democracy, identifying potential issues that the metaverse could bring, along with related governance considerations, including the role of standards."

For more information, see: https://ieee-sa.imeetcentral.com/eurollingplan/.

IEC

IEC/TC 100

TC 100 develops international standards in the field of audio, video and multimedia systems and equipment. Since its establishment, TC 100 has developed international standards regarding colour measurement and management, digital system interfaces and protocols, wearable electronic devices and technologies and applications for end-user networks.

Recently, it has established a WG 12 on metaverse (WG 12 Multimedia systems and equipment for metaverse), to define and analyze metaverse for future multimedia systems and equipment from a technical and standardization perspective. WG 12 has the following preliminary work item in its program of work:

- Title: Concept of metaverse for multimedia equipment and standardization areas in the TC 100
- Purpose: To identify standardization gaps in TC100, find potential new work items
- Scope: 1) Definition of the metaverse. 2) Impact of the metaverse on multimedia systems and equipment (i.e., interoperability between devices, user interfaces, interaction methods, implementation aspects, etc.). 3) Standardization gaps and potential new work items for TC 100, 4) Development of a document based on the above study.

The following relevant standards are **published** by TC 100:

- IEC TR 63344:2021 Conceptual model of standardization for haptic multimedia systems
- IEC TR 63308:2021 Virtual reality equipment and systems - Market, technology and standards requirements
- IEC TR 63289:2020 Conceptual model for TC 100 standardization on multimedia cyber technology

The following standards are **under development** in TC 100:

- PWI TR 100-42 ED1 Remote control and remote assist system in home and local area (TA 18)
- PWI TR 100-43 ED1 Haptic stimuli descriptors (Further discussion on standardization related to IEC TR 63344 - Haptics-conceptual model of standardization) (TA 18)
- PWI 100-45 ED1 AR Technology (TA 1)
- PWI TR 100-49 Multimedia Systems and Equipment for Metaverse - Part 1: General
- PWI 100-58 Multimedia Systems and Equipment for Metaverse - Part 2: Classification
- PWI TR 100-59 Multimedia Systems and Equipment for Metaverse - Part 3: Gap Analysis

ISO/IEC

ISO/IEC JSEG 15 Metaverse

The ISO/IEC JSEG 15, Metaverse, has been created to explore the needs for standardization and opportunities in Metaverse and related technologies. JSEG 15 is a 2-year "study group" to review: what Metaverse means, the current standard landscape, and produce recommendations for the following work to IEC/SMB and ISO/TMB. Established in October 2022 with representatives from IEC, ISO (including JTC1) and external organizations, it expects to deliver its final report by Q1 2025.

The work is separated out into 5 workstreams: (1) Terms & Definitions, (2) Market & Applications, (3) Technology & Architecture, (4) Standards landscape and (5) Regulatory & legal.

ISO/IEC JTC 1

ISO/IEC JTC 1/SC 29

SC 29 (*Coding of audio, picture, multimedia and hypermedia information*) contains the well-known JPEG and MPEG standardization groups. Most of its work is related to interoperability standardization for efficiently coded media, and thus falls into two basic areas:

- **Efficient coding of media**, including images, moving pictures, audio, graphics, fonts, haptic signals, point clouds, visual volumetric content, and other digital data
- **Digital information support**, including synchronization, presentation, storage and transport of single or combinations of media and related security and privacy management

These technologies are fundamental to metaverse/VR/AR development. Efficient coded representations for storage and communication of audio, video, haptics, etc., is fundamentally necessary for such applications. Moreover, the systems protocols control and use of such media are also required for operation of such a system. In addition to the traditional projects for which JPEG and MPEG standards are especially widely known, some recent areas of work in SC 29 that relate to metaverse applications are highlighted as follows:

- Point cloud coding for representation of spatial information
- Visual volumetric content coding using either video-based or graphics-based representations.
- 3D audio with support for audio objects that interact with audio scenes, such as exhibiting appropriate behaviour in response to spatial navigation, including echoes, occlusion, spatial orientation and distance effects.
- Haptic signal coding for interaction with virtual worlds.
- Coding of visual content for use by machine analysis systems as well as for display to human observers

The following relevant standards are published by SC 29:

- ISO/IEC 23005-1:2020 Specifies the architecture of MPEG-V (media context and control) and its three types of associated use cases: information adaptation from virtual world to real world; information adaptation from real world to virtual world; information exchange between virtual worlds
- ISO/IEC 23005-2:2018 Information technology - Media context and control, Part 2: Control information
- ISO/IEC 23005-3:2019 Information technology - Media context and control. Part 3: Sensory information
- ISO/IEC 23005-4:2018 Information technology - Media context and control. Part 4: Virtual world object characteristics
- ISO/IEC 23005-5:2019 Information technology - Media context and control, Part 5: Data formats for interaction devices
- ISO/IEC 23005-6:2019 Information technology - Media context and control, Part 6: Common types and tools
- ISO/IEC 23005-7:2019 Information technology - Media context and control. Part 7: Conformance and reference SW

More information available here: https://www.iso.org/committee/45316.html

ISO/IEC JTC 1/SC 24

To provide metaverse services for human life, the following fundamental standard technologies are needed in addition to knowledge information processing for each industry sector that integrates into a 3D virtual world:

- 3D virtual world representation, visualization, and information processing
- 3D avatar representation, visualization, and information processing
- VR/AR/MR-based information processing with 3D virtual worlds and avatars

SC 24 has **published** the following standards relevant to these three areas:

- 3D virtual world representation
  - ISO/IEC 14772 VRML series (Virtual Reality Modeling Language)
  - ISO/IEC 19775 X3D series (Extensible 3D)
  - ISO/IEC 19776 X3D encoding series (Extensible 3D encoding)
  - ISO/IEC 19777 X3D language bindings series (Extensible 3D language bindings)
  - ISO/IEC 18023 SEDRIS series (Synthetic Environment Data Representation and Interchange Specification)
  - ISO/IEC 18024 SEDRIS language bindings series
  - ISO/IEC 18025 EDCS (Environmental Data Coding Specification)
  - ISO/IEC 18026 SRM (Spatial Reference Model)
- 3D avatar representation
  - ISO/IEC 19774 Humanoid Animation (HAnim) series
- VR/AR/MR-based information processing with 3D virtual worlds and avatars
  - ISO/IEC 18038 Sensor representation in mixed and augmented reality
  - ISO/IEC 18039 Mixed and augmented reality (MAR) reference model
  - ISO/IEC 18040 Live actor and entity representation in mixed and augmented reality
  - ISO/IEC 18520 Benchmarking of vision-based registration and tracking methods for mixed and augmented reality
  - ISO/IEC 23884 Material property and parameter representation for model-based haptic simulation of objects in virtual, mixed and augmented reality (VR/MAR)
  - ISO/IEC 23488 Object/environmental representation for image-based rendering in virtual/mixed and augmented reality (VR/MAR)

The following standards are **under development** in SC 24:

- ISO/IEC 3721-1 Information model for MAR contents
- ISO/IEC 5927 Augmented and virtual reality safety – guidance on safe immersion, setup and usage
- ISO/IEC 19774-3 HAnim facial animation
- ISO/IEC 9234 Information modeling for VR/AR/MR based education and training systems

The following are **potential new work items** under discussion in SC24:

- Metaverse concepts, terminology, and definitions

- Sensor information modeling in MAR
- Benchmarking of indoor localization and tracking systems
- Use case classification for VR/AR/MR based education systems
- VR/AR/MR based education and training systems – Part 1: Terminology and Concepts

More information available here: https://www.iso.org/committee/45252.html

ITU-T

The ITU-T Focus Group on metaverse (FG-MV) has been established in December 2022 and concluded its work in June 2024. The FG-MV laid the groundwork for international standards for the metaverse. The group analyzed the technical requirements of the metaverse to identify fundamental enabling technologies in areas from multimedia and network optimization to digital currencies, Internet of Things, digital twins, and environmental sustainability.

During its tenure, the FG-MV has successfully completed its mandate and approved 52 Technical Specifications and Reports. See the FG-MV workplan, complete structure and list of deliverables at: https://www.itu.int/en/ITU-T/focusgroups/mv/Pages/FG-MV-structure-and-workplan.aspx.

Following the conclusion of the FG-MV, a new Global Initiative on Virtual Worlds - Discovering the CitiVerse has been launched to continue exploring and advancing study and development on metaverse and virtual worlds. More information is available at: https://www.itu.int/metaverse/virtual-worlds/.

Following a Contribution submitted to the FG-MV, an annual UN Virtual Worlds Day is being organized. The first edition was held by ITU, together with other 17 UN entities on 14 June 2024, in Geneve. The first UN Executive Briefing on Unlocking the potential of virtual worlds and the metaverse for the SDGs was launched during the first UN Virtual Worlds Day. More information, including recording, event highlights and the executive briefing, is available at: https://www.itu.int/metaverse/un-virtual-worlds-day/programme/.

ITU-T started metaverse specific studies within various Study Groups, namely SG16, SG17 and SG20. Many ITU-T Recommendations (standards) have been published that can be seen as building blocks for future metaverse applications and systems (including the field of Immersive Live Environments, Distributed Ledger Technologies and Digital Humans), some of which are:

- H.430.1: Requirements for immersive live experience (ILE) services
- H.430.2: Architectural framework for immersive live experience (ILE) services
- H.430.3: Service scenario of immersive live experience (ILE)
- H.430.4: Service configuration, media transport protocols, signalling information of MMT for Immersive Live Experience (ILE) systems
- H.430.5: Reference models for immersive live experience (ILE) presentation environment
- F.748.14: Requirements and evaluation methods of non-interactive 2D real-person digital human application systems
- F.748.15: Framework and metrics for digital human application systems
- Y.3090: Digital twin network - Requirements and architecture
- Y.4600: Requirements and capabilities of a digital twin system for smart cities
- F.751.0: Requirements for distributed ledger systems
- F.751.1: Assessment criteria for distributed ledger technology (DLT) platforms
- F.751.2: Reference framework for distributed ledger technologies
- HSTP.DLT-RF: Distributed ledger technology: Regulatory framework
- HSTP.DLT-UC: Distributed ledger technologies: Use cases
- F.747.10: Requirements of distributed ledger systems for secure human factor services

There are also several ITU-T Recommendations (standards) under study:

- H.IIS-FA: Functional architecture of interactive immersive services (IIS) system
- H.IIS-reqts: Requirements of interactive immersive services
- H.ILE-Haptic: Media transport protocols, signalling information of haptic transmission for immersive live experience (ILE) systems
- H.430.3 (V2): Service scenario of immersive live experience (ILE)
- F.DHAI: Framework and Requirements of Digital Human Access Interface
- F.DH-PE: Requirements and evaluation methods of digital human platform
- F.DHSMD: Technical requirements and evaluation methods of 3D digital human system based on smart mobile device
- F.3DIDH-reqts: Framework and requirements for the construction of 3D intelligent driven digital human application system based on multimedia services
- F.CEMP-DHS: Requirements and architectures of cloud-edge based multimedia platform for digital human services
- F.CSDH: Requirements of communication services for digital human
- F.CSDH: Requirements of communication services for digital human
- Y.dtmv-reqts: Requirements of integrating virtual and physical worlds through digital twins for the metaverse
- Y.dtmv-ref: Reference model of integrating virtual and physical worlds through digital twins for the metaverse
- Y.dtmv-if: Interface model and its requirements of integrating virtual and physical worlds through digital twins for the metaverse
- Y.ACC-IoTMV: Accessibility requirements for metaverse services supporting IoT
- Y.Fram-ssdp: Requirements and framework of metaverse simulation service for disaster prevention in electric power facilities

- Y.CIP: Requirements of metaverse-based emergency response in chemical industrial parks

W3C

The Immersive Web Working Group develops APIs to interact with Virtual Reality (VR) and Augmented Reality (AR) (collectively known as XR) devices and sensors in browsers. Main specification is the WebXR Device API, but the group also publishes WebXR modules, e.g., to better support AR scenarios or provide hand tracking capabilities to web applications.

The GPU for the Web Working Group develops the WebGPU specification and its companion WebGPU Shading Language to allow web applications to leverage 3D graphics and computation capabilities offered by GPU cards, allowing the rendering of complex and immersive 3D scenes.

The Accessible Platform Architectures Working Group ensures W3C specifications provide support for accessibility to people with disabilities, through review of W3C specifications, development of technical support materials, collaboration with other Working Groups, and coordination of harmonized accessibility strategies within W3C. The group developed the XR Accessibility User Requirements document, which lists user needs and requirements for people with disabilities when using virtual reality or immersive environments, augmented or mixed reality and other related technologies (XR).

(C.2) OTHER ACTIVITIES RELATED TO STANDARDISATION

METAVERSE STANDARDS FORUM (MSF)

Facilitates cooperation and coordination between international standards organizations. The Forum will not create standards itself but will coordinate requirements and resources to foster the creation and evolution of standards within standards organizations working in relevant domains.

Link: https://metaverse-standards.org/

(C.3) ADDITIONAL INFORMATION

[1] President von der Leyen's State of the Union 2022. Letter of intent

[2] Commissioner Breton blog People, technologies & infrastructure – Europe's plan to thrive in the metaverse

3.3.8 Media

A Policy and legislation

(A.1) POLICY OBJECTIVES

The European Media Freedom Act was adopted in April 2024 and entered into force the following month. The Act puts in place a new set of rules to protect media pluralism and independence in the EU, in addition to enhancing free movement of services. It introduces, among other things, a new right to customise the media offering on devices and interfaces. This means that users will be able to change the relevant configuration, including default settings, and adapt them to their own preferences.

More specifically, Article 20(1) of the Act provides that: '[u]sers shall have a right to easily change the configuration, including default settings, of any device or user interface controlling or managing access to and the use of media services providing programmes in order to customise the media offering in accordance with their interests or preferences in compliance with Union law'.

The objective of the provision is to enable recipients of media services providing programmes to effectively choose the content they want to watch or listen to according to their preferences without being constrained by certain commercial practices in the media sector. It contributes to ensuring a level playing field in the provision of diverse media services providing programmes in the face of technological developments in the internal market and fair access to media services in all their diversity.

Article 20(5) of the Act lays down an action for the newly created European Board for Media Services – composed of representatives of national regulatory authorities or bodies - to foster cooperation between media service providers, standardisation bodies or any other relevant stakeholders to promote the development of harmonised standards in this field. The activity of fostering cooperation also covers digital signals carried by devices which control or manage access to and the use of media services providing programmes.

The activity is motivated by the fact that the development of standards would help to avoid diverging technical standards creating barriers and additional

costs for the industry and consumers. The activity could facilitate access to European media services on connected devices and user interfaces and it would also encourage the development of solutions to implement obligations concerning media services laid down in the European Media Freedom Act. Even though the rules in Article 20 will only apply from May 2027, it is important to initiate early exchanges to provide sufficient legal certainty to relevant stakeholders, including manufacturers, developers and importers of the devices and user interfaces concerned.

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

In view of the policy objectives outlined above, the intention is to foster cooperation with relevant players regarding the development of the aforementioned standards.

(A.3) REFERENCES

- Regulation (EU) 2021/1083 European Media Freedom Act

B Requested actions

ACTION 1: Increased cooperation between media service providers, standardisation bodies and other relevant stakeholders to identify best practices, standardisation priorities and the development of harmonised standards related to the design of devices or user interfaces within the meaning of Article 20(1) of the European Media Freedom Act.

ACTION 2: Increased cooperation between media service providers, standardisation bodies and other relevant stakeholders to identify best practices, standardisation priorities and the development of harmonised standards related to the digital signals carried by devices referred to in Article 20(1) of the European Media Freedom Act.

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

ISO/IEC JTC1

ISO/IEC JTC 1/SC35 has developed and approved standards related to media accessibility, namely on:

- Audio description: ISO/IEC TS 20071:21:2015.
- Audio subtitling: ISO/IEC TS 200071-25:2017.
- Subtitling/captioning: ISO/IEC 20071:23:2018
- Easy-to-understand language: ISO/IEC 23859:2023

It is currently working on a standard on sign language: ISO/IEC AWI 20071-24

ITU-R

ITU-R Study Group (SG) 6 conducts studies and develops ITU-R Recommendations and Reports related to the radiocommunication broadcasting service, including vision, sound, multimedia and data services principally intended for delivery to the general public and for the international exchange of programmes.

During the 2019-2023 study period, ITU-R SG 6 updated and approved the following relevant publications (non-exhaustive):

- Recommendation ITU-R BS.1352 on "File format for the exchange of audio programme materials with metadata on information technology media"
- Recommendation ITU-R BS.1770 on "Algorithms to measure audio programme loudness and true-peak audio level"
- Recommendation ITU-R BS.1864 on "Operational practices for loudness in the international exchange of digital television programmes"
- Recommendation ITU-R BS.2051 on "Advanced sound system for programme production"
- Recommendation ITU-R BS.2125 on "A serial representation of the Audio Definition Model"
- Recommendation ITU-R BS.2143 on "Transport method for non-Pulse-Code Modulation audio signals and data over digital audio interfaces for programme production and exchange"
- Recommendation ITU-R BT.500 on "Methodologies for the subjective assessment of the quality of television images"
- Recommendation ITU-R BT.1203 on "User requirements for generic video bit-rate reduction coding of digital TV signals for an end-to-end television system"
- Recommendation ITU-R BT.1775 on "File format with editing capability, for the exchange of metadata, audio, video, data essence and ancillary data for use in broadcasting"
- Recommendation ITU-R 2073 on "Use of the high efficiency video coding for UHDTV and HDTV broadcasting applications"
- Recommendation ITU-R 2075 on "Integrated broadcast-broadband system"

- Recommendation ITU-R 2077 on "Real-time serial digital interfaces for UHDTV signals"
- Recommendation ITU-R BT.2137 on "Technologies applicable to Internet Protocol interfaces for programme production"
- Recommendation ITU-R BT.2144 on "Guidance for the introduction of new DTTB systems, technologies and applications in the broadcasting service"
- Recommendation ITU-R BT.2153 on "The use of componentized workflows for the exchange of non-live television programmes"
- Recommendation ITU-R BT.2154 on "High-level system architecture for immersive video for presentation on various types of display devices"
- Recommendation ITU-R BT.1833 on "Broadcasting of multimedia and data applications for mobile reception by handheld receivers".
- Recommendation ITU-R BT.2016 on "Error-correction, data framing, modulation and emission methods for terrestrial multimedia broadcasting for mobile reception using handheld receivers in VHF/UHF bands"

In 2023, ITU-R SG 5 also developed Report ITU-R M.2528 on "Capabilities of the terrestrial component of IMT-2020 for multimedia communications". This Report addresses the capabilities of IMT-2020 to distribute multimedia content such as video, audio, text and graphics, including support for real-time multimedia interactive applications. This Report also addresses the capabilities of IMT-2020 user devices and base stations to support such multimedia communications with low latency and wide transmission bandwidth. This new Report complements Report ITU-R M.2373 on "Audio-visual capabilities and applications supported by terrestrial IMT systems", which addresses the capabilities of IMT systems for delivering audio-visual services to the consumers and also covers some aspects of production of audio-visual content.

ITU-T

ITU has worked on media accessibility within the ITU-T SG16, Q26/16, and especially within te IRG-AVA Intersector Rapporteur Group Audiovisual Media Accessibilty: https://www.itu.int/en/irg/ava/Pages/default.aspx

More information: https://www.itu.int/en/ITU-T/accessibility/Pages/default.aspx

W3C

Real-time communications

- WebRTC: Real-Time Communication in Browsers (Recommendation)
  WebRTC defines a set of ECMAScript APIs in WebIDL to allow media to be sent to and received from another browser or device implementing the appropriate set of real-time protocols. This specification is being developed in conjunction with a protocol specification developed by the IETF RTCWEB group and an API specification to get access to local media devices.
  https://www.w3.org/TR/webrtc/
- Media Capture and Streams (Candidate Recommendation)
  Media Capture and Streams defines a set of APIs that allow local media, including audio and video, to be requested from a platform, media to be sent over the network to another browser or device implementing the appropriate set of real-time protocols, and media received from another browser or device to be processed and displayed locally.
  https://www.w3.org/TR/mediacapture-streams/

Integration with system capabilities

- Media Capabilities (Working Draft)
  Media Capabilities intends to provide APIs to allow websites to make an optimal decision when picking media content for the user. The APIs will expose information about the decoding and encoding capabilities for a given format but also output capabilities to find the best match based on the device's display.
  https://www.w3.org/TR/media-capabilities/
- Media Session (Working Draft)
  Media Session enables web developers to show customized media metadata on platform UI, customize available platform media controls, and access platform media keys such as hardware keys found on keyboards, headsets, remote controls, and software keys found in notification areas and on lock screens of mobile devices.
  https://www.w3.org/TR/mediasession/
- Picture-in-Picture (Working Draft)
  Picture-in-Picture intends to provide APIs to allow websites to create a floating video window always on top of other windows so that users may continue consuming media while they interact with other content sites, or applications on their device.
  https://www.w3.org/TR/picture-in-picture/

(C.2) OTHER ACTIVITIES RELATED TO STANDARDISATION

ITU-R

Resolution ITU-R 60 (Reduction of energy consumption for environmental protection and mitigating climate change by use of ICT/radiocommunication technologies and systems) resolves "that ITU-R Study Groups should develop Recommendations, Reports or Handbooks on best practices in place to reduce energy consumption within ICT systems, equipment or applications operating in a radiocommunication service" and "possible development and use of radio systems or applications which can support reduction of energy consumption in non-radiocommunication sectors".

Question ITU-R 147/6 on "Energy Aware Broadcasting Systems" was approved by ITU-R SG 6 in May 2022. ITU-R SG 6 has published several related documents:

- Report ITU-R BT.2385 on "Reducing the environmental impact of terrestrial broadcasting systems"
- Report ITU-R BT.2521 on "Practical examples of actions to realize energy aware broadcasting"
- Report ITU-R BT.2540 on "Display energy reduction through image signal processing"

(C.3) ADDITIONAL INFORMATION

In 2023, ITU-R SG 6 had the honour to win the Engineering, Science and Technology Emmy Award for

the development of a radiocommunication standard for High Dynamic Range Television (HDR-TV). This award exemplifies successful public-private sector collaboration to enhance the quality and accessibility of digital technologies.

3.4 Sustainable Growth

3.4.1 Smart grids and smart metering

A Policy and legislation

(A.1) POLICY OBJECTIVES

The energy system is undergoing considerable changes, mainly driven by decarbonisation, decentralisation and digitalisation, calling for smarter, flexible, responsive networks and markets that empower consumers and place them at the heart of it all.

Important policy milestones for this green and digital transformation are the EU's energy and climate targets for 2030 which also underpin Europe's leading role in the fight against climate change. The Fit for 55 Delivering the European Green Deal strategy set a 55% reduction target in net EU greenhouse gas emissions compared to 1990, and increased the EU-level target for the share of renewable energy consumed in the EU to at least 40% with a clause for a possible upwards revision by 2023. The revised Renewable Energy Directive (EU) 2023/2413, that entered into force on 20 November 2023, raises the EU's binding renewable target for 2030 to a minimum of 42.5%, up from the previous 32% target, with the aspiration to reach 45%. It means almost doubling the existing share of renewable energy in the EU. In this context, the electricity networks have a central role to play. In 2022, renewable energy sources made up a share of 41.2% of gross electricity consumption in the EU, 3.4 percentage points more than 2021(reference: Eurostat).

Moreover, the European Commission proposed a Path to the Digital Decade, a concrete plan to achieve the digital transformation of our society and economy by 2030. This will pave the way for the twin digital and green transformation of the energy sector to benefit from state-of-the-art digital solutions with lower environmental footprint and higher energy and material efficiency, leading to a more resilient, efficient and greener energy system.

The consumer position in the energy value chain is also very different now compared to what it used to be. The consumer is not the passive end ring in this chain anymore, paying without question the bills of incumbent's utilities. Instead, the consumer has the opportunity to choose between many energy suppliers and service providers to obtain the best deal and benefits or even get actively involved in the energy market. The Clean energy for all Europeans package adopted in 2019 reflects that. It contains a comprehensive framework for the electricity market addressing also issues on consumer protection, information and empowerment in the EU electricity sector. In the wake of the difficulties in the EU energy market seen in 2022, and following a Commission proposal in March 2023, the co-legislators adopted in May 2024 structural measures reinforcing this framework, under the reform of the EU electricity market design with the dual objective of securing European energy sovereignty and achieving climate neutrality. The reform consolidates the electricity market consumer-centric approach, providing consumers amongst others with greater contract choice and direct access to renewable energy and therefore supporting their stronger protection and empowerment to be active in a digital smart energy environment.

In the light of the challenges and opportunities that this new energy landscape presents for consumers and relevant stakeholders, standardisation in the energy domain should consider the physical limitations of the grid, the data privacy, cybersecurity, the market aspects and the resilience of the energy sector.

In this digital transformation of the energy sector, the sector and cross-sector sharing of data, in a customer-centric, secure and trustworthy manner, as well as the deployment of technologies facilitating that, are key. This makes the need more relevant than ever to set out the interoperability requirements and non-discriminatory and transparent procedures for access to data at the energy sector level, and beyond. To this respect, the Commission has recently adopted a new implementing Regulation ((EU) 2023/1162) to improve access to electricity metering and consumption data and facilitate the interoperability of energy services across the EU. This implementing act sets out a reference model of roles and responsibilities, information exchanges and procedures, building upon available standards and relevant European initiatives. Big Data and the Internet of Things, as well as Cloud-Edge continuum, edge intelligence, digital twins, 5G and artificial intelligence (including generative AI), smart grids and smart meters, smart homes, smart storage and smart charging data sharing platforms, distributed ledger technologies (DLT) will be key drivers for a successful digitalisation of energy. To succeed, we will need to build on achievements in the three pillars of the Digital Single Market – better access to digital goods and services, an environment where digital networks and services can prosper, and digital as a driver for growth. Energy and digital will come together most

closely if we enable European companies to deliver energy intelligent products and services across Europe without undue restrictions and if the energy sector actively contributes to horizontal Digital Single Market policies. The single energy market and the digital single market must go hand-in-hand, as in reality they feed each other.

Smart grids are a clear example of digital meeting energy, as they are about information exchange and making necessary data available to interested parties. Smart grids will enable improved energy efficiency and the integration of vast amounts of Renewable Energy Sources (RES) from an increasingly decentralised generation and new loads such as electric vehicles and energy storage; provide an opportunity to boost the retail market competitiveness and worldwide technological leadership of EU technology providers, and a platform for traditional energy companies or new market entrants such as ICT companies, including SMEs, to develop new, innovative energy services. That dynamic should enhance competition in the retail market, incentivise reductions in greenhouse gas emissions and provide an opportunity for economic growth.

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

Standards are needed to cover the communication requirements of grid management, balancing and interfacing with the millions of new renewable energy sources, as well as for the complex interactions of the new distributed energy market, which is also enriched with demand-side response services.

Communication standards will also be crucial for the deployment of electric vehicles and the establishment of smart cities. Harmonised communication protocols will provide standard components and interfaces giving 'plug-and-play' capability for any new entrant to the network, such as renewables or electric vehicles, or the use of open architectures based on global communication standards. Testing and profiling should also be considered in addition to standardisation, to further promote interoperability.

A major challenge is engaging the right stakeholders to cooperate and undertake the standardisation work, while taking into account the different requirements for smart grid management (of relevance to energy producers, the utility network operators, etc.) and smart consumption (involving the end consumer).

The EC has been working towards interoperability of the solutions and standardisation for several years now. The main coordination reference for smart grids at European level is the Smart Grids Task Force, which was given the mission to advise the European Commission on policy and regulatory directions at European level and to coordinate the first steps towards the implementation of Smart Grids in accordance with the energy legislation. It has issued key reports on standards, cybersecurity and flexibility markets. These are largely agreed by industry, European standards organisations, public authorities and consumer organisations. A number of DGs are currently participating there: ENER and CNECT (co-chair), GROW, JUSTICE, and JRC, along with more than thirty associations representing all relevant stakeholders, from both sectors – energy and telecommunications, and experts from national regulatory agencies and industrial market actors, as well as consumer associations and other relevant stakeholders.

To support and accelerate the rollout of smart energy grid solutions, the Commission issued to the European Standardisation Organisations the M/441mandate for smart meters and the M/490 for smart grids (M/490), in 2009 and 2011 respectively. These mandates were closely followed by the Smart Grids Task Force and its Expert Group 1 that focused on standards and interoperability. The mandates were successfully completed by the experts of the relevant Coordination Groups (SM-CG and SG-CG) who delivered a number of pertinent deliverables and standards. These Groups continue, also following their merging as of January 2021 into the CEN-CENELEC-ETSI Coordination Group on Smart Grids (CG-SG), to provide input to the development and maintenance of new and existing relevant standards. They also receive inputs from and provide input to the European Commission's activities related to standardisation and remain actively engaged in the work of the Smart Grids Task Force. The new CG-SG aims to promote the deployment of open and interoperable data architectures, based on European and international standards. The scope also includes any standards needed to design, operate and maintain electrical grids securely and efficiently. In the specific area of metering, its scope includes electricity, water, gas and heat/cooling metering devices and systems, and associated architectures.

CG-SG has been contributing over the past years to the Smart Grids Task Force work that aims with its expert knowledge at advising the Commission on several issues including designing and setting up interoperability requirements as well as transparent and non-discriminatory procedures for access to and exchange of electricity (and gas) data in the EU. This particular line of work, among others, inspires the

Commission's drafting of Implementing Acts on data interoperability, as provided for in Article 24 of the Electricity Directive (EU) 2019/944, starting with the first implementing Regulation (EU) 2023/1162 on metering and consumption data adopted in June 2023. CG-SG remains actively engaged in this initiative, now under the stakeholders' panel on data interoperability operated by the Joint Working Group of ENTSO-E/ EU DSO entity that is assisting the Commission in developing future implementing data acts in accordance with Implementing Regulation (EU) 2023/1162.

Specifically on , the Smart Grids Task Force experts developed a comprehensive sector-specific strategy on how to reinforce the implementation of the NIS directive at energy sector level (see their respective report published in September 2019). This activity fell under the overall effort to increase cybersecurity awareness and preparedness in the energy sector, as also illustrated by the latest Commission recommendation in this field and also fosters synergies between the Energy Union and the Digital Single Market agendas. Over the last period (December 2022 to 2024) the work focused on investigating and accordingly providing advice to the Commission regarding requirements and procedures that need to be in place to ensure cybersecurity in the energy infrastructure. Findings and recommendations fed into the development by the Commission of legislation on these topics in line with the Electricity Directive and Electricity Regulation, in particular the network code on sector-specific rules for cybersecurity aspects of cross-border electricity flows.

Moreover, benefiting from valuable contributions from our stakeholders, the EC fostered the creation of a common interoperability language called SAREF (Smart Appliances REFerence ontology), which became a standard of ETSI and OneM2M (the Global initiative for Internet of Things standardisation) in 2015. This was a first step and then we moved forward in order to fully enable, on a technical interoperability level, the smart grid and its demand-response mechanism. This work was supported via an EC funded study, which delivered a live demo in the autumn of 2017 and final results and recommendations in July 2018. The results of the study were fed in the standards along the full demand-side flexibility chain and were piloted on a European scale (multiple sites in 7 member states) in the large scale IoT pilot project Interconnect on smart grids and homes, which successfully ended in March 2024. The project has developed an architecture and adapters/connectors that can be used to SAREFise the full energy system and allow for an abundance of innovative interoperable services. In parallel work has been completed on extending SAREF to other verticals (e.g. automotive, water, health, etc.) allowing thus the creation of a cross-sector interoperable ecosystem. Cooperation with CEN & CENELEC is foreseen to further align SAREF with the data models developed at ISO and IEC. Work is under way to create an EN standard that would cover the principles of SAREF thus avoiding the need for annual update. The draft EN standard is currently being circulated among the member states for approval.

Within the general framework of the Internet of Things and 5G, the EC is looking at all other communication aspects and needs of smart energy and including the necessary conditions in the development of said communication domains as well as aligning with the other domains such as automotive, health, smart cities, etc.

Last but not least, in line with the Communication on Energy System Integration, the Commission proposed a Digitalisation of Energy Action Plan which aims to ensure the shift towards renewables, connected mobility, smart buildings, and a more integrated, responsive energy system with smart energy grids as its backbone and consumers at its core. The plan will also support the implementation of REPowerEU , the joint action for affordable, secure and sustainable energy. To address the targets spearheaded by DoEAP (as well as the European Strategy for Data), the EC is supporting innovation preparatory actions within its Horizon Europe programme for establishing the grounds for a Common European Energy Data Space. The results have been taken up by a deployment action under the DIGITAL Europe programme to support the commercial deployment and lay the ground for its long-term sustainability. Further on within the commitment to support the deployment of digital infrastructures within the DoEAP, the EC is proposing the development, piloting and deployment of an European digital spine for the energy system based on state-of-the-art digital cloud-edge continuum powered by (Generative) AI, which interconnects not only the traditional components of the energy system (e.g. the grid) but also other relevant assets and domains such as EV-charging and buildings.

See also the work of the International Agency on Energy, particularly its recommendations in terms of interoperability.

(A.3) REFERENCES

- Directive (EU) 2024/1711 on improving the Union's electricity market design
- Directive (EU) 2023/2413 on the promotion of energy from renewable sources

- Commission Implementing Regulation (EU) 2023/1162 on interoperability requirements and non-discriminatory and transparent procedures for access to metering and consumption data
- Directive (EU) 2022/2555 on measures for a high common level of cybersecurity across the Union (NIS 2 Directive)
- COM(2022) 552 final Digitalising the energy system – EU action plan
- COM(2020) 299 final Powering a climate-neutral economy: An EU Strategy for Energy System Integration
- COM(2020) 66 final A European strategy for data
- COM(2019) 640 final The European Green Deal
- Regulation (EU) 2019/941 on risk –preparedness in the electricity sector
- Regulation (EU) 2019/943 on the internal market for electricity
- Directive (EU) 2019/944 on common rules for the internal market for electricity
- Commission Recommendation C(2019)240 final on cybersecurity in the energy sector, and supporting Staff Working Document SWD(2019)1240 final
- COM(2017) 228 final: Mid-Term Review on the implementation of the Digital Single Market Strategy - A Connected Digital Single Market for All
- Directive 2014/94/EU on the deployment of alternative fuels infrastructure
- Recommendation 2014/724/EU on the data protection impact assessment template for smart grid and smart metering systems
- COM(2014) 356 Benchmarking smart metering deployment in the EU-27 with a focus on electricity; and accompanying SWD(2014) 188 and SWD(2014) 189
- C (2013) 7243 Delivering the internal electricity market and making the most of public intervention; and accompanying SWD (2013) 442 Incorporating demand side flexibility, in particular demand response, in electricity markets
- Recommendation COM 2012/148/EU on preparations for the roll-out of smart metering systems
- COM(2012) 663 Making the internal energy market work
- COM(2011) 202 Smart Grids: from innovation to deployment
- COM(2010) 245 "A Digital Agenda for Europe": actions 71 & 73 address respectively minimum functionalities to promote smart grid interoperability and a common set of functionalities for smart meters and are directly related to the standardisation activities at CEN & CENELEC and ETSI.
- Directives 2009/72/EC and 2009/73/EC: Internal market in electricity and natural gas;
- Directive 2009/29/EC amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community;
- Directive 2009/28/EC of the European Parliament and of the Council on the Use of Energy from renewable sources.
- Directive 2003/87/EC of the European Parliament and of the Council establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC
- COM(2015) 192: A Digital Single Market Strategy for Europe
- COM(2015) 339: Delivering a new deal for energy consumers
- Regulation (EU) 2016/679 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation)
- Regulation (EU) 2013/347 on guidelines for trans-European energy infrastructure
- Directive 2012/27/EU on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC
- COM(2016)176: ICT Standardisation Priorities for the Digital Single Market
- COM(2022) 108 final: REPowerEU

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

ACTION 1: Active involvement and participation of CEN & CENELEC CG-SG experts in the ongoing work of the Smart Grids Task Force, including regarding the activity on interoperability for access to data in a smart grid environment currently performed under the Joint Working Group of ENTSO-E/EU DSO entity, building upon available standards. This is to prepare the ground for implementing acts on interoperability requirements and transparent and non-discriminatory procedures for access and exchange of data. The respective reports from this latest strand of work, as well as earlier deliverables from other activities of the Task Force are available on the smart grids task force dedicated webpage (CIRCA BC), which is a collaborative platform that gives access to all task-force documents, via the platform library".

ACTION 2: ETSI, CEN & CENELEC and the other relevant SDOs and related organisations (such as DLMS, KNX and others) should combine their efforts to further enrich and extend the SAREF4ENER extension as well as the main SAREF ontology (including interoperability profiles and associated justifications (interoperability cases) from large-scale projects or initiatives like the EU code of conduct on energy management related interoperability of Energy Smart Appliances). The ETSI SAREF portal and the ETSI labs, which was launched recently, could be the tools to be leveraged for this purpose. Security aspects should be investigated. All new additions to the SAREF specifications should be transposed into the OneM2M specifications. A number of European projects could contribute to a larger scale deployment of SAREF-based solutions such as the Operational Digital Platforms under CEF Digital and the deployment of a common European data space in the DIGITAL programme, which is being prepared in Horizon Europe. An EN describing the principles of SAREF, thus avoiding annual updates, which is in under approval by the EU members States, should be completed. The updates needed to make SAREF fit for digital twins, edge-cloud IoT continuum, AI as well as other recent technological developments should be investigated and developed.

ACTION 3: CEN & CENELEC, IEEE and OASIS to foster their cooperation to ensure complementary parallel standardisation efforts, to avoid serious conflicts between their respective standardisation deliverables. This action should notably be undertaken in the context of H2-type standards (the interface used for smart grid communication), distributed energy resources and the smart grids architecture model as developed under M/490.

ACTION 4: ETSI, CEN & CENELEC should include the outcomes and recommendations from the H2020 IoT Large Scale Pilot on Smart Grids and Smart Homes INTERCONNECT into the SAREF4ENER and SAREF4BLDG standards. All new additions to the SAREF specifications should be transposed into the OneM2M specifications. The principles of SAREFisation should also be included.

ACTION 5: ETSI, CEN & CENELEC should collaborate with (or participate in) the Horizon Europe projects, which will establish the foundations for a Common European Energy Dataspace, and help identify, develop and standardise a set of common technical specifications for it, as well as the deployment action for the energy data space within the DIGITAL Europe programme. They should also collaborate with an upcoming Horizon Europe project on establishing an interoperable ecosystem in the energy area through creating a set of Minimum Interoperability Mechanisms for the energy sector.

ACTION 6: SDOs and related stakeholders and initiatives should work towards cross-sector interoperability, in particular for data exchange between grid, building and mobility domains.

ACTION 7: SDOs, in particular their grid-oriented, mobility-oriented, DER-oriented and storage-oriented technical committees, should cooperate to develop standards enabling the electric vehicles (with their – on-board or off-board – chargers) to play an active role through demand-response up to offering grid services.

ACTION 8: SDOs should collaborate with the project(s) ODEON and HEDGE-IoT resulting from call HORIZON-CL5-2023-D3-01-15 "Supporting the green and digital transformation of the energy ecosystem and enhancing its resilience through the development and piloting of AI-IoT Edge-cloud and platform solutions" to modify existing standards or adopt new ones based on the standardisation work and deliverables of the project(s).

ACTION 9: SDOs should collaborate with the European Commission and its initiatives to develop and standardise a (Generative)-AI-based "digital spine" of the European Energy System, which is incorporating all functionalities of the digital layer of the energy system, enables multiple innovative energy services, has the needed distributed cloud-edge architecture to support the evolving energy system and which is highly resilient, flexible and automated.

List of included standards groups:

CEN-CENELEC-ETSI Coordination Group on Smart Grids (CG-SG) that merges as of January 2021 the following two groups on Smart Grids and Smart Meters:

- Smart Grids
  - Final reports of the CG-SEG under M/490 and its iteration;
  - "Set of Standards" and "Privacy and Security" CG-SEG reports
  - The Interoperability Tool (IOP-Tool) of the CG-SEG, which is an extremely useful tool for finding the standards used;
  - Smart grid security certification in Europe - Challenges and recommendations, December 2014
  - CEN-CENELEC-ETSI Coordination Group on Smart Energy Grids (CG-SEG)
  - Building energy management system
  - Building automation and control systems (ISO)
- Smart Meters
  - Final reports of the CG-SG under M/411
  - CG-SG "Privacy and Security approach" reports
  - CG-SG 2017 Work Programme
  - Interoperability, Standards and Functionalities applied in the large scale roll out of smart metering - European Smart Grids Task Force Expert Group 1 – Standards and Interoperability, October 2015
  - Interoperability of interfaces for the large scale roll out of smart metering systems in EU Member States - European Smart Grids Task Force Expert Group 1 – Standards and Interoperability, August 2016
  - CEN-CENELEC-ETSI Coordination Group on Smart Grids (CG-SG)
  - European Commission Office for Infrastructure and Logistics – Manual Of Standard Building Specifications

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

On the level of technical standardisation and coordination of work, CEN & CENELEC (notably through the CEN-CENELEC-ETSI Coordination Group on Smart Energy Grids), IEEE and OASIS will foster their collaboration including identifying whether there are serious conflicts between their respective standardisation deliverables which may have a negative impact on interoperability and the market adoption of smart grid solutions. This especially concerns the relation between H2-type standards (notably EN 50491-12-1), the EN IEC 61850 series (Distributed Energy Resources), EN IEC 62746, EN IEC 61689-5, EN IEC 62325 with IEEE Std 2030.5 and OASIS OpenADR.

Standards development

CEN-CENELEC-ETSI

The mandate M/490 given to CEN-CENELEC-ETSI by the Commission in March 2011 has been completed.

The three ESOs have agreed to continue their collaboration in relation to smart grids following the completion of the work under the standardisation request, under the CEN-CLC-ETSI Coordination Group on Smart Energy Grids (CG-SEG). This group will focus on security and interoperability, follow up new developments in the field of smart grids and actively promote the results of its work at European and international levels.

In this context, two reports have been prepared by the CG-SEG to maintain transverse consistency and promote continuous innovation in the field of Smart Grids:

The Smart Grid Set of Standards report is the new release of the original "First set of standards" and proposes an updated framework of standards which can support Smart Grids deployment in Europe. It provides a selection guide setting out, for the most common Smart Grid systems the relevant set of existing and upcoming standards to be considered, from CEN & CENELEC, ETSI and further from IEC, ISO, ITU or even coming from other bodies when needed. It also explains how these are able to be used, where, and for which purpose. Standardisation gaps have been identified and the related standardisation work program has been defined. The results of these activities will be included in future releases of this report.

Cyber Security and Privacy report**:** In this report, security standardisation specific to Smart Energy Grid and security standardisation targeting generic standards are further monitored and analysed with the focus on two specific use cases: decentralized energy resource (DER) and substation automation. It shows the applicability and interrelationship between these two groups of standards. Furthermore, the Smart Grid Information Security approach has been followed to show the applicability of different standards on the selected, specific use cases for Smart Energy Grid deployments.

Regarding electromobility, a work programme and a list of relevant standards for the charging of electric vehicles was last updated in November 2014. Regarding charging points for electric vehicles of interest to the eMobility coordination group, and in support of the implementation of the alternative fuels infrastructure Directive 2014/94/EU, a new standardisation request was issued to the ESOs in March 2015. ETSI and the oneM2M Partnership project are active in the area of machine-to-machine (M2M) with some relation to smart grids. ETSI is also developing radio technologies for wireless interconnection in home automation networks with applications such as smart metering and energy control in the scope of the technology.

CENELEC

CLC/TC 57 *'Power systems management and associated information exchange'* develops European standards, in collaboration with the IEC, for power systems control equipment and systems including EMS (Energy Management Systems), SCADA (Supervisory Control And Data Acquisition). CLC/TC 57 is providing amendments to the ENs on 'Communication networks and systems for power utility automation' (EN 61850 series). CLC/TC 57 will also publish European Standards related to the Application integration at electric utilities (prEN 61968 series), energy management system application program interface (EMS-API) (prEN 61970 series) and on Power systems management and associated information exchange (EN 62351 series).

CLC/TC 205 *'Home and Building Electronic Systems (HBES)'* is responsible for the development of the EN 50090 series (Home & Building Electronic Systems protocol suite) and the EN 50491 series '*General requirements for Home and Building Electronic Systems (HBES) and Building Automation and Control Systems (BACS)*', and notably:

- EN 50491-11:2015 'General requirements for Home and Building Electronic Systems (HBES) and Building Automation and Control Systems (BACS) - Part 11: Smart Metering - Application Specifications - Simple External Consumer Display';
- EN 50491-12-1:2018 'General requirements for Home and Building Electronic Systems (HBES) and Building Automation and Control Systems (BACS) - Smart grid - Application specification - Interface and framework for customer - Part 12-1: Interface between the CEM and Home/Building Resource manager - General Requirements and Architecture'
- prEN 50491-12-2:2022'General requirements for Home and Building Electronic Systems (HBES) and Building Automation and Control Systems (BACS) - Part 12-2: Smart grid – Application specification - Interface and framework for customer - Interface between the Home / Building CEM'

CLC/TC205 also completed work on the following additional work items:

- EN 50090-6-2 'Home and Building Electronic Systems (HBES)-Part 6-2 IoT Semantic Ontology_Model_Description'

CLC/TC 205 further activities:

- Further work on the EN50090-x series, including
- standardization of an HBES open communication system API for 3rd Parties (future EN50090-6-3)
- standardization of an extension to the HBES communication system allowing communication across IPv6 networks (future EN50090-4-4)
- Possible extension of the EN 50491-11:2015 'General requirements for Home and Building Electronic Systems (HBES) and Building Automation and Control Systems (BACS) - Part 11: Smart Metering - Application Specifications - Simple External Consumer Display' to extend the standard with legally relevant data to be sent over the H1 interface
- Further work on the EN50491-12-x series in close cooperation with IEC SC23K
- Under the banner of CLC/TC 205, WG19 has been created, open, to relevant experts from other TCs e.g:
  - CLC/TC 82 'Solar photovoltaic energy systems';
  - CLC/TC 69X 'Electrical systems for electric road vehicles';
  - CLC/SR 120 'Electrical Energy Storage (EES) Systems';
  - CLC/TC 57 'Power systems management and associated information exchange';
  - CLC/TC 13 'Electrical energy measurement and control'
  - CEN/TC294'Communication systems for meters'
  - ETSI

Focusing on the S2 link (within a building, between customer energy management and energy resources including PV, storage, E-vehicle, white goods,...) these experts will work on producing a common ontology, defining the potential data at the interface with these energy resources, based on already known use cases, but in a "technology agnostic manner". For non-overlapping topics, WG19 hopes to also endorse the extensions of the SAREF4ENER that are the result of the Interconnect EU project.
This work will also feed the current activities of CLC/TC 205/WG 18 on Smart Grid/Smart Home Data Modelling.

- Under the banner of CLC/TC 205, WG20 has been created, which has set as goals to develop a technical specification guideline for cyber security for HBES/BACS, the future EN TS 50491-7

https://standards.cencenelec.eu/dyn/www/f?p=305:7:0:25:::FSP_ORG_ID,FSP_LANG_ID:1258281

CLC/TC 8X 'System aspects of electrical energy supply', develops standards to facilitate the functioning of electricity supply systems in open markets. In 2023, they will publish the revision of EN 50160 'Voltage characteristics of electricity supplied by public electricity networks'. In addition, the group will pursue the development of EN 50549 Part 1 and Part 2 that set requirements for generating plants to be connected in parallel with Low Voltage and Medium Voltage distribution networks, respectively.

CLC/TC 82 *'Solar photovoltaic energy systems'*, **CLC/ 88** *'Wind turbines'* and **CLC/SR 117** *'Solar thermal electric plants'* will continue to develop European Standards on Electric Generation, in close collaboration with the IEC.

CLC/TC 38 Instrument transformers are devices providing a secondary signal whose instantaneous value is substantially proportional to the instantaneous value of the primary voltage or current with a defined accuracy and intended to feed protective, metering or control equipment: their have therefore a crucial role both for the protection of the grid and for measurements in HV of voltage, current, power, energy, power quality, synchrophasors...

CLC/TC 38 'Instrument transformers' will continue to maintain the EN 61689 series on Instrument transformers in close collaboration with IEC TC 38 'Instrument transformers'", to integrate the relevant equipment in the digital framework.

In particular, in the past years the following Standards have been published in parallel with IEC TC 38:

- EN IEC 61869-9:2019 "Instrument transformers - Part 9: Digital interface for instrument transformers", which defines the requirements for the Digital interface for instrument transformers with reference to the EN 61850 Series.
- EN IEC 61869-13:2021 "Instrument transformers - Part 13: Stand-alone merging unit (SAMU)", which defines the requirements for the equipment to be used to retrofit instrument transformers with analogue output, to make them suitable for the digital environment.

Work is in progress to publish in a short time the following standards, which will cover also instrument transformers directly provided with a digital interface:

- EN IEC 61869-7 "Instrument transformers - Part 7: Specific requirements for low-power voltage transformers"
- EN IEC 61869-8 "Instrument transformers - Part 8: Specific requirements for low-power current transformers"
- EN IEC 61869-15 "Instrument transformers - Part 15: Additional requirements for voltage transformers for DC applications"
- EN IEC 61869-14 "Instrument transformers - Part 14: Additional requirements for current transformers for DC applications".

CLC/TC 17AC *'High-voltage switchgear and controlgear'* is responsible for the maintenance of the EN 62271 series on High-voltage switchgear and control gear.

CLC/TC 13 *'Electrical energy measurement and control'* Communications protocol standards continue to be expanded to cover developments in technology, including LoRa, WiSUN, CoAP and 5G as well as further enhancements to power line carrier based communications.
New metering standards to cater for DC networks has been developed and published in 2023. It could be used for EV charging, micro generation and other emerging low carbon energy applications, required for changes to the MID as specified in M541. It is EN 50470-4:2023, which has been offered for citation in OJEU under MID.

- the drive to allow a remote meter display that can be legally relevant to allow more innovation in smart metering. This will require cooperation between TC13 and TC205 WG16 to revise EN 50491-11 (interface to simple displays) to ensure data integrity across the H1 interface.
- the recent establishment of TC13 WG3 to address the need for secure and authenticated metering data can be accessed from EV chargers.

CENELEC Technical Bodies - CLC/TC 13 (cencenelec.eu)

CLC/TC 59X *'Performance of household and similar electrical appliances'* is responsible for EN 50631-x:2023 'Household appliances network and grid connectivity'. Meanwhile, TC 59X has replaced the first edition of 2017 by a new series of 2023.

This series was successfully offered to IEC and has since been published as an international standard series IEC 63510-x*, i.e. a globally accepted standard is achieved.

In a next step, the revision of this new IEC series is planned in IEC TC 59 WG 15 in close cooperation with CLC TC 59X in order to incorporate input, suggestions for improvement and further interoperability improvements with other protocol landscapes (e.g. MATTER, Home Connectivity Alliance).

* announced for 2024-10-30

CEN

CEN/TC 92 '*Water meters*', **CEN/TC 176** '*Thermal energy meters*' and **CEN/TC 237** '*Gas meters*' develop standards in response to the standardisation Request (M/541) in the frame of Directive on Measuring Instruments (2014/32/EU), relevant to Smart Grid standardisation.

CEN/TC 176 focuses on the standardization of thermal energy meters, covering requirements for accuracy, construction, and testing, including recommendations for installation, commissioning, and operation of all types, sizes, and working principles of thermal energy meters.

The **EN 1434-series of standards**, with its latest edition published in November 2022, provides comprehensive guidelines for thermal energy meters. This series is divided into several parts, each addressing different aspects, including:

- General requirements.
- Constructional requirements.
- Data exchange and interfaces.
- Pattern approval tests.
- Initial verification tests.
- Installation, commissioning, operational monitoring, and maintenance.

These standards ensure the reliability, accuracy, and repeatability of thermal energy meters, which are crucial for billing and optimization purposes. Furthermore, verification tests for each produced thermal energy meter or sub-assembly ensure that every meter consistently meets the required accuracy and performance standards. Accurate thermal energy measurement is key to optimizing energy use in heating and cooling systems, contributing to energy conservation and cost savings.

To ensure that these standards are kept up-to date with technological and regulatory requirements, work on amendments us underway to update these standards with requirements and guidance on:

- Durability of flow sensors for more than 10 years
- Sensitive measuring of the thermophysical parameters of heat conveying liquids
- Influence of flow profiles in water or water-glycol solution network
- Conductive pastes for pockets
- Fast response metering, defining test for thermal energy meters and calculators
- Product life extension, including durability of electronics and environmental design

Additionally, the technical committee is preparing the publication of a new edition of **CEN/TR 13582** on *guidelines for the selection, installation and operation of thermal energy meters*

CEN/TC 294 deals with standardization of communications interfaces for metering and submetering systems for Water, Fuel Gases, Heat and similar energies and fluids where the

protocols are applied to the meters, sensors and actuators and systems used to provide metering services. Security features like Confidentiality, Authenticity and Integrity are provided at the application and lower layers. Cooperation with CENELEC and ETSI, in relation to consistent protocol and use of spectrum, is an essential condition for achieving interoperability between entities in systems. Excluded from this scope are areas, which are under the responsibility of CLC/TC 205 and CEN/TC 247.

DLMS (DEVICE LANGUAGE MESSAGE SERVICE)

DLMS/COSEM (EN IEC 62056 series), the most widely deployed smart meter protocol is not listed as the state of the art protocol for smart metering and demand side control applications. In the forthcoming roadmap due for release next year, gaps in standards will be identified that will need to be addressed in order to support Demand-Size Flexibility. These will include adhoc profiles for smart meters as well as Industrial/Residential/Commercial Appliances, Residential EV Charging Stations and Energy and Water Health & Usage Monitoring Systems. This will allow standards based solutions to be developed delivering to market security, interoperability and compatible devices that can be controlled from an energy consumption view point to address the most important challenge of managing the consumption demand.

DLMS/COSEM specifies the data model, the messaging protocol and media-specific communication profiles. Since 2002, DLMS/COSEM has been internationally standardised as part of the IEC 62056 series *Electricity metering data exchange - The DLMS/COSEM suite* and the EN 13757 standards suites. DLMS/COSEM is under constant development to ensure it remains compatible with all current and emerging communications technologies and the latest demand side management applications.

ETSI

ETSI TC DECT has published updates of the DECT-2020 NR (New Radio) technology (ETSI TS 103 636 parts 1 to 5) during 2022. DECT-2020 NR supports Ultra Reliable Low Latency Communications (URLLC) and massive Machine Type Communications (mMTC).

TC DECT has produced DECT-2020 New Radio (NR) access profile for smart metering including smart electricity meters. Future work on access profiles will include new device types for other smart grid applications.

ETSI TC ATTM is collaborating with TC SmartM2M for the development of sustainable and efficient smart grids and smart metering within smart(community area.

IEC

IEC has a number of technical committees dealing with smart grids and smart metering:

- IEC SyC Smart Energy: Smart Energy
- IEC/TC 8: Systems Aspects for Electrical Energy Supply
- IEC/TC 8/SC 8A: Grid Integration of Large-capacity Renewable Energy (RE) Generation
- IEC/TC 8/SC 8B: Decentralized electrical energy systems
- IEC/TC 13: Electrical Energy Measurement and Control (including Smart Metering and demand side management)
- IEC/TC 17: High-voltage switchgear and controlgear
- IEC/TC 23: Electrical Accessories
- IEC/TC 23/WG12: Home and Building Electronic Systems (HBES)
- IEC/TC 23/SC23 K: Electrical Energy Efficiency products
- IEC/TC 38: Instrument transformers
- IEC/TC 57: Power Systems Management and Associated Information Exchange
- IEC/TC 64: Electrical installations and protection against electric shock
- IEC/TC 65: Industrial-process measurement, control and automation
- IEC/TC 69: Electric road vehicles and electric industrial trucks
- IEC/TC 82: Solar photovoltaic energy systems
- IEC/TC 85: Measuring equipment for electrical and electromagnetic quantities
- IEC/TC 88: Wind energy generation systems
- IEC/TC 95: Measuring relays and protection equipment
- IEC/TC 120: Electrical Energy Storage (EES) Systems
- IEC/TC 121: Switchgear and controlgear and their assemblies for low voltage
- ISO/IEC JTC 1: Information technology
- IEC/TC23/SC23K /WG3: Customer Energy Management Systems is progressing work items on:
  - IEC 63345 ED1: Energy Efficiency Systems – Simple External Consumer Display
- IEC 63402 ED1: Energy Efficiency Systems - Smart Grid - Customer Energy Management Systems - General Requirements and Architecture

The IEC SyC Smart Energy published a new version of the Smart Grid roadmap as IEC TR 63097:2017 *'Smart grid standardisation roadmap'*.

Systems committee on smart energy (SyC Smart Energy) provides systems level standardisation and coordination in the areas of smart grids and smart energy, including interactions in the fields of heat and gas. http://www.iec.ch/dyn/www/f?p=103:186:0::::FSP_ORG_ID,FSP_LANG_ID:11825

The IEC smart grid mapping tool provides a graphical and interactive overview of all smart grid related standards: https://mapping.iec.ch/#/maps/1

IEC TC57 WG15 addresses security requirements for the power system automation architecture and protocols defined within IEC TC57. With this, the focus lies on protocols like IEC 61850, IEC 60870-5-x, IEEE 1815 (DNP3) and the associated data models.

ISO/IEC JTC 1

ISO/IEC JTC 1/SC 27 has started the review of ISO/IEC TR 27019:2013 'Information technology - Security techniques-- Information security management guidelines based on ISO/IEC 27002 for process control systems specific to the energy utility industry'. ISO/IEC TR 27019:2013 provides guiding principles based on ISO/IEC 27002 for information security management applied to process control systems as used in the energy utility industry.

IEEE

The standardisation work of IEEE not only covers ICT, but also aspects of electrical power generation and distribution, including demand response, renewable energy sources, security, reliability and systems engineering. ICT standards work in Smart Grid includes:

- Smart Grid Interoperability: The IEEE 2030 series is based on an interoperability reference model that defines data flows for reliable, secure, bi-directional flow of electric power and identifies the necessary communication infrastructure, incl. for electric vehicles.

- Networking and Communications: The IEEE 1901 series of standards addresses broadband/narrowband over powerline; the 802 family of standards addresses many other aspects of networking.

- Cyber Security for Smart Grid: Multiple standards addressing cybersecurity for Intelligent Electronic Devices (IEEE 1686), Substation Automation (IEEE C37.240, IEEE 1711 series).

- Smart Metering and Demand Response: Multiple standards including IEEE 170X series and IEEE 1377 for communication protocols, 2030.5 for smart energy profiles, and IEEE 1901 series for smart metering functionality.

- Substation Automation: Standards include time protocol, synchronization work, and electric power system communication, such as IEEE 1815 (DNP3), IEC/IEEE 61850-9-3, IEEE C37.238, IEEE C37.118 series, etc.

- Electric Vehicle Charging: Standards include IEEE 2030.1.1, which specifies the design interface of electric vehicles as well as direct current and bi-directional chargers that utilize battery electric vehicles as power storage devices

For a list of these and other IEEE standardisation activities on Smart Grid, please see: https://ieee-sa.imeetcentral.com/eurollingplan/

ITU-T

ITU-R

ITU-R Working Party 1A on "Spectrum engineering techniques" deals with spectrum engineering techniques, including unwanted emissions, frequency tolerance, technical aspects of sharing, computer programs, technical definitions, Earth-station coordination areas and technical spectrum efficiency. Among the current study topics, ITU-R Working Party 1A deals with the impact on radiocommunication systems from wireless and wired data transmission technologies used for the support of power grid management systems.

In June 2021, a revision to Report ITU-R SM.2351 on "Smart grid utility management systems" was published. This document provides an overview of Smart Grid systems and details of the wide array of technologies that are available for the monitoring and control of Smart Grid networks and Smart Meter networks. These technologies include wired, e.g., power line telecommunications (PLT), and wireless communications, e.g. 6.25 / 12.5 / 25 kHz narrow band technologies up to multiple-MHz broadband technologies. This Report focuses principally on the electricity industry where the changes are most rapid and extensive, but similar developments are taking place in gas and water infrastructure (including clean water, wastewater and sewerage, and hot water). The main text includes an overview of the spectrum available in various countries for Smart Grids and Smart Meter systems.

ITU-T

ITU-T work on Smart Grid. ITU-T SG15 developed standards on power line communication (PLC, Recommendation ITU-T G.990x-series), which is one of the most important technologies for smart grid. ITU-T SG15 approved the following technical paper in September 2020: Use of G.hn technology for smart grid.

Detailed information is described in the document "smart grid standardisation overview and work plan" developed by ITU-T SG15 and available at: http://www.itu.int/en/ITU-T/studygroups/Pages/sg15-sg.aspx .

More information is available at https://itu.int/go/tsg15 (SG15) and https://www.itu.int/net4/ITU-T/lists/q-text.aspx?Group=15&Period=17&QNo=3&Lang=en (Q3/15).

ITU-T SG13 developed Recommendation ITU-T Y.2070 "Requirements and architecture of the home energy management system and home network services", ITU-T Y.2071 "Framework of micro energy grid" as well as ITU-T Y.2072 "Framework for an energy-sharing and trading platform". In addition, SG13 is working on QoS requirements for smart grid supported by IMT-2020 (Y.IMT2020-qos-req-sg), the distributed and virtualized energy storage systems (Y.dv-ess) and framework of trusted electricity brokerage for distributed energy resources (Y.energy-brokerage):

https://www.itu.int/itu-t/workprog/wp_item.aspx?isn=13977

https://www.itu.int/itu-t/workprog/wp_item.aspx?isn=15063

ITU-T SG17 approved Recommendations ITU-T X.1331 " Security guidelines for home area network (HAN) devices in smart grid system" and ITU-T X.1332"Security guidelines for smart metering services in smart grid".

ITU-T SG20 approved Recommendation ITU-T Y.4209 "Requirements for interoperation of the smart port with the smart city", Recommendation ITU-T Y.4419 "Requirements and Capability Framework of Smart Utility Metering (SUM)" and is working on the development of a series of Recommendations on "Energy data model for city-level energy management platform" (Y.CL-EDM), "Framework of city-level energy data sharing and analytics among buildings" (Y.energy-data), "Requirements of IoT-based power grid communication network" (Y.PGComNet-Reqts), "Data exchange model for IoT devices in power transmission and transformation equipment" (Y.dem-IoT) and "Key health indicators and evaluation model for power equipment in Smart Sustainable Cities" (Y.KHI-PE).

More info: https://itu.int/go/tsg20

OASIS

The OASIS Energy Interoperation TC defines interaction between Smart Grids and their end nodes, including Smart Buildings, Enterprises, Industry, Homes, and Vehicles. The TC developed data and communication models that enable the interoperable and standard exchange of signals for dynamic pricing, reliability, and emergencies.

The OASIS Energy Market Information Exchange (eMIX) supports exchanging price information and product definitions in energy markets and to those following markets. Energy Interoperation relies on the EMIX Specification for communication of price and product defintion. EMIX defines the information for use in messages that convey this actionable information.

The OASIS Web Services Calendar (WS-Calendar) defines a cross-domain standard for services to enable machine-based scheduling of human-centric activities. An essential distinction between energy and other markets is that price is strongly influenced by time of delivery. EMIX conveys time and interval by incorporating WS-Calendar into tenders, contracts, and performance calls.

IETF

RFC6272 identifies the key infrastructure protocols of the Internet Protocol Suite for use in the Smart Grid. The target audience is those people seeking guidance on how to construct an appropriate Internet Protocol Suite profile for the Smart Grid. In practice, such a profile would consist of selecting what is needed for Smart Grid deployment from the picture presented here.

The Energy Management (EMAN) WG has produced several specifications for an energy management framework, for power/energy monitoring and configuration. See http://datatracker.ietf.org/wg/eman/documents/ for the details. The framework focuses on energy management for IP-based network equipment (routers, switches, PCs, IP cameras, phones and the like).

Many of the IETF Working Groups listed under section 3.1.4 Internet of Things above are developing standards for embedded devices that may also be applicable to Smart grids.

https://wiki.ietf.org/en/group/iab/Multi-Stake-Holder-Platform#h-341-smart-grids-and-smart-metering

ONEM2M

oneM2M has published Release 2A in March 2018 and its Release 3 in September 2018. Work is ongoing on Release 4.

The oneM2M includes specifications covering requirements, architecture, protocols, security, and management, abstraction and semantics. Release 2 added new functionality, particularly by expanding management, abstraction and semantics, security and privacy, and interworking with underlying technologies. oneM2M Release 3 adds seamless interworking with 3GPP network services for IoT.

(C.2) OTHER ACTIVITIES RELATED TO STANDARDISATION

EEBUS

The EEBUS Initiative is a non-profit organisation, based in Germany, with international members from the automotive, heating, ventilation, air conditioning, white goods, PV, energy storage as well as energy management sector. On behalf of the industry EEBUS, describes the communication interface (= application, data model, transport protocol) to enable the connection between energy management relevant devices as well as corresponding control systems.

To achieve a standardised communication interface EEBUS is active in several national, European and international standardisation bodies. In particular, EEBUS was and is significantly involved in the creation of the ontology SAREF4ENER, driven by the European Commission, with its toolbox SPINE as a data model for energy management relevant applications. SPINE is used today within EN 50631 (Household appliances network and grid connectivity) for White Goods as well as HVAC devices. Furthermore, SPINE is the relevant data model for the national application rule concerning the grid connection in Germany and has been introduced into IEC PT63380 in the context of electromobility.

OPEN CHARGE ALLIANCE

The Open Charge Alliance is an industry alliance, based in the Netherlands, of EV charging hardware and software vendors, and charging network operators and service providers. OCA's mission is to foster global development, adoption, and compliance of the Open Charge Point Protocol (OCPP) and related standards through collaboration, education and testing. The Open Charge Alliance has promoted the benefits of the Open Charge Point Protocol (OCPP) in order to make Electric Vehicle (EV) networks open and accessible.

NIST

The US government sponsored a Smart Grid Interoperability Panel from 2009-2012 to spur cooperative industry and public agency development of open data standards for smart grid functionality: http://www.nist.gov/smartgrid/priority-actions.cfm. In 2013, the management of this project was turned over to industry stakeholders as a continuing standards cooperation project: http://sgip.org/

JISC

Japanese Industrial Standards Committee (JISC) created a roadmap for international standardisation for smart grid.

SGCC

Unrelated to the CEN-CENELEC Smart Grid Coordination Group (SGCC) the State Grid Corporation of China (SGCC) Framework is in place under the same acronym. A lot of further national activities and roadmaps could be mentioned as well, such as those of Austria, Spain, the United Kingdom, the Netherlands, France, South Korea and others.

KNX

KNX Association is a non-profit-oriented organization with headquarters in Brussels. Members are manufacturers developing devices for several applications for home and building control based on KNX like lighting control, shutter control, heating, ventilation, air conditioning, energy management, metering, monitoring, alarm/intrusion systems, household appliances, audio/video and more. Next to manufacturers, also service providers (utilities, telecom, etc.) can become a member of the KNX Association.

KNX is approved as an International Standard (ISO/IEC 14543-3-1 to 7 as well as ISO 22510) as well as a European Standard (CENELEC EN 50090 and CEN EN 13321-1) and Chinese Standard (GB/T 20965) for Home and Building Control.

(C.3) ADDITIONAL INFORMATION

Security, privacy and management of control of the access to and ownership of data are essential for the development of smart grids. Without wide acceptance

by commercial users and consumers, the role of smart grids would be limited to specific vertical markets only.

Mechanisms that allow users and providers to negotiate optimised usage, including planning and scheduling of availability and use of energy resources are addressed by CG-SEG and covered by CLC TC205, CLC TC13 and CLC/TC 57. IEC TC57 and IEC TC13 have a joint working group (JWG16) to ensure the CIM and COSEM models are compatible thereby ensure interoperability of protocols across grid control and metering systems.

- The part of the grid inside the home domain is also an element that has a significant impact on energy efficiency. Several elements are needed: local protocols for home automation networks; a multidisciplinary standardised approach covering all aspects of the problem, from application semantics to indoor interconnection wired or wireless technologies. An extensive semantic-level for building (and possibly applicable for home) already exists and is provided by CENELEC TC 205 within the EN 50491 series which is also compatible with EN IEC 62056 (DLMS/COSEM).

Applications include lighting and energy control, appliances control, power monitoring, smart metering and buildings energy management; provision of elements for a global solution on smart appliances and home energy control, such as suitable radio protocols for indoor coverage.

3.4.2 Smart and sustainable cities and communities

A Policy and legislation

(A.1) POLICY OBJECTIVES

Smart urban technologies can make a significant contribution to the sustainable development of European cities. 75% of the EU population lives in urban areas, a proportion that is growing as the urbanisation trend continues, both in Europe and worldwide.

A smart city is an entity that uses ICT effectively, to integrate the requirements of its urban community, in terms of energy and other utilities (production, distribution and use), environmental protection, mobility and transport, services for citizens (healthcare, education, emergency services etc.) and with proper regard for security, both of individuals and their personal data, and use it as a driver for economic and social improvements. This would also increase the deployment of smart technologies and solutions in rural communities, contributing to the development of businesses and creating conditions for making smart communities attractive to the population.

In standardisation terms, there are some over-arching requirements concerning standards for common terminologies, for citizens' interface with their local authority, etc. But mainly, smart city standards topics relate to the need to ensure commonalities —as far as these are appropriate and cost-effective— between the approaches taken by the different application areas, to enable the city to derive the best horizontal advantage from its overall approach and above all benefit from interoperability. The standards requirements as such for these application areas are specified in the Rolling Plan elsewhere at the appropriate points.

The core components in such a complex system are the frameworks that assist companies, cities and other actors to provide appropriate solutions that prioritise economic, social and environmental outcomes. Solutions should address the whole lifecycle, optimising environmental, social and economic outcomes through the seamless transfer of information.

Beyond engagement in European standardisation activities, ensuring a strong, common European voice in international standardisation fora is also very important.

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

Local Digital Twins for Smart Communities

Local digital twins (LDTs) are a virtual representation of the physical assets, processes and/or people within a geographically located community, which reflect and derive from cross-sectorial, historical and (near) real-time data.

LDTs can be at various levels of complexity and value and present a varied set of capabilities that need to be fulfilled e.g strategy, security, IoT, legal, etc.

The DUET Digital Twin Maturity Model relies on four classification criteria: Level 1 – Awareness of Twins, Level 2 – Experimental Twins, Level 3 – Predictive Twins, Level 4 – Intelligent Twins

The development of a EU Local Digital Twin toolbox (LDT Toolbox) composed of open-source components and based on mature, interoperable technical specifications and **reference logical architecture** can significantly enhance urban management and innovation. By fostering collaboration, leveraging existing technologies, and focusing on interoperability, cities can create robust digital platforms that harness the full potential of AI, big data as well as AR/XR/VR leading to smarter, more efficient, and sustainable urban environments. This is an on-going project undertaken by DG CONECT.

The EU Local Digital Twins (LDT) Toolbox project aimed at achieving several key objectives:

- Support the development, deployment, and integration of AI technologies within smart cities and communities.
- Enhance interoperability and standardization across various smart city initiatives.
- Facilitate the effective implementation of innovative solutions tailored to the unique needs of each city.
- Foster strategic partnerships with industry partners, academic institutions, and smart city networks.
- Engage in co-creation processes with a wide range of stakeholders to overcome barriers to technology adoption.
- Drive the adoption of AI technologies to foster innovation and interoperability in the development of smart cities.
- Enhance understanding of how advanced technologies, particularly AI, can support the planning, design, and implementation of key policies, strategies, and goals within a city, as well as the development and planning of improved management and service delivery systems.
- Standards for (combinations of / federated) Local Digital Twins should be aligned and interact with those for data spaces and data interoperability, to prevent that Digital Twin applications are a hard break in data life cycle management / governance, while their inputs come from and outputs flow to those data spaces, as they require a transparent data life cycle to function.

There is a need to create an innovative ecosystem of AI-based solutions that harness the full potential of urban data platforms, built on a robust set of technical specifications. These specifications will enable the development of a Local Digital Twin (LDT) toolbox using open-source components, facilitating interoperability, scalability, and innovation across cities.

The European Digital Infrastructure Consortium will implement the EU's "Local Digital Twins & CitiVERSE" initiative, connecting digital twins in member cities. This will use digital infrastructure across the EU, fostering technical interoperability and common standards, and reducing digital fragmentation. Local digital twin components developed in one member state can be used across the single market, benefiting digital SMEs and businesses beyond national borders. Cities and regions can choose the best value for money and co-develop joint initiatives and tenders, achieving economies of scale and positioning EU technology globally. The EU LDT Toolbox will be maintained and enhanced by the EDIC in the future, becoming the first common infrastructure at EU level underpinning smart cities. The LDT Toolbox will be certified and compliant to MIMs.

Minimal Interoperability Mechanisms (MIMs)

MIMs provide a minimal but sufficient set of capabilities and functional requirements that a city needs to achieve a certain objective described by each individual MIM, along with guidance to help provide a useful level of interoperability between different technical solutions that may be used to achieve that set of requirements. MIMs address in fact the interoperability of technical solutions between buyers, suppliers and regulators across the various governance levels.

MIMs are now evolving under the umbrella of the Technical Subgroup of the Living-in EU movement and Go Li.EU project. There are now 10 MIMs, including

Personal Data Management and Fair AI (championed by the cities of Helsinki and Amsterdam, respectively).

MIMs are also undergoing a normalisation process to harmonise the way each of them is described according to a new template. The upgraded version of MIMs will become part of the backbone of the Digital Twin toolbox to support cities and smart communities to develop and roll-out Local Digital Twins. Finally, a recommendation for the standardisation of the MIMs structure with the temporary designation of Y.MIM has recently been approved by ITU-T Study Group 20 dealing with Internet of Things, smart cities and communities, and will be published under the formal title: "Y.4505: Minimal Interoperability Mechanisms for smart and sustainable cities and communities". This will position MIMs as a global standard that every community can benefit from.

Within it, the Living-in EU technical group has been working for few years on the technical common ground of specifications. It is referred to as MIMs Plus and it consolidated in one place the above-described achievement plus the work of relevant standard initiatives. A new version will be released in 2024 with a high level of maturity to some individual MIMs and described according to the harmonised template defined by Y.4505 spec.

CitiVerse

New services such as **virtual worlds** will have a profound impact on the way people will interact. One example is the so-called **CitiVerse** that will be built on top of urban plataforms and local digital twins, through a series of interconnected and distributed hybrid and virtual worlds representing, and synchronized with, their physical counterparts. It will offer new administrative, economic, social, policy-making, and cultural virtual services and capabilities to city and community actors such as citizens, and urban planners.

A **CitiVerse** [1] is a series of interconnected and distributed hybrid and virtual worlds representing, and synchronized with, their physical counterparts. It offers new (administrative, economic, social, policy-making, and cultural) virtual goods/services/capabilities to city and community actors such as citizens, represented as digital avatars.

(A.3) REFERENCES

- Regulation (EU) 2024/903 of the European Parliament and of the Council of 13 March 2024 laying down measures for a high level of public sector interoperability across the Union
- Commission Implementing Decision (EU) 2024/459 on setting up the European Digital Infrastructure Consortium for Networked Local Digital Twins towards the CitiVERSE (LDT CitiVERSE EDIC)
- Strategic Implementation Plan of the EIP-SCC
- COM(2021) 205 final: Fostering a European approach to Artificial Intelligence
- COM(2012) 4701: Smart Cities and Communities — European Innovation Partnership
- COM(2017) 228 final: Mid-Term Review on the implementation of the Digital Single Market Strategy - A Connected Digital Single Market for All
- COM(2016) 176: ICT Standardisation Priorities for the Digital Single Market
- COM(2015) 192: A Digital Single Market Strategy for Europe

The "United for smart sustainable cities" (U4SSC) initiative coordinated by ITU, UNECE and UN-Habitat and supported by 13 other UN agencies and programmes to advocate for public policy to emphasize the importance of ICT in enabling the transition to smart sustainable cities (see the ITU section below for more details).

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

ACTION 1: A Toolbox for Local Digital Twins is being developed with a set of advanced AI-based tools for urban Digital Twin. Concerning Local Digital Twins, the following should be undertaken:

- ESOs to develop an European standard for a Local Digital Twin reference architecture depicting components and specifications, based on on-going works supported by the EC and EDIC on CitiVerse.

ACTION 2: Recommendation for the standardisation of the MIMs framework (Y.4505) has been approved by ITU-T Study Group 20 dealing with Internet of Things, smart cities and communities, to position MIMs as a global standard that every community can benefit from. There is a need to have a EU standard for the individual technical MIMs:

- ESOs to develop European standards of MIM key specifications (MIMs 1, 2, and 7) based on on-going works in Living-in.EU technical subgroup and standardisation efforts of the MIM framework at ITU-T (Y.4505).

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

CEN

CEN/TC 465 'Sustainable and Smart Cities and Communities,' established in October 2019, aligns with ISO/TC 268 to address European needs in sustainable development. It standardizes frameworks, tools, and guidance to support decision-making and implementation for sustainable urban and rural development, following ISO 37101 principles. The TC embraces innovative solutions, including digital, nature-based, and socially innovative approaches, while considering varied terminology like smart, intelligent, and agent-based processes. It serves as a European coordination platform, inviting stakeholders, including citizens and local governments, to actively participate in standards development.

CEN/TC 465 maintains the following working groups (WG):

WG 1: Sustainable Cities and Communities - Nature-Based Solutions (NBSs): Delivers a standard on NBS terminology, proposing classifications to support a nature-positive economy. Incorporates the EU agenda for NBS and targets goals like sustainable urbanization, ecosystem restoration, climate adaptation/mitigation, and resilience. Addresses gaps such as a lack of NBS definitions, monitoring methods, and measurable impacts, while simplifying communication for non-technical audiences.

WG 2: Framework for Standardization of Citizen Services: Produces a Technical Report (TR) to document best practices in designing and delivering smart and sustainable services by local governments, covering both direct and outsourced services. The framework aligns with ETSI TR 103455, ISO TC176 (quality management), and ISO TC312 (service excellence), focusing on impacts on individual citizens.

WG 3: Territorial Resilience Development: Develops a Technical Report on resilience concepts, methods, and tools for cities and communities, including defining urban resilience. Identifies local authority gaps and proposes a roadmap for integrating resilience. Builds on the CEN Workshop Agreements on City Resilience (CWA 17300–17302).

CEN/TC 465 explores industrial symbiosis as a method for achieving resource efficiency, carbon neutrality (especially Scope 3 reductions), and green growth. This initiative focuses on integrating industrial symbiosis into circular economy strategies across various city departments, emphasizing the leadership role of local governments as enablers, regulators, or facilitators. The WI will demonstrate how cities can leverage industrial symbiosis to advance the circular economy, fostering environmental, economic, and social benefits essential for net-zero targets.

The work builds on the 2018 CEN Workshop Agreement (CWA) 17354, which promoted best practices for industrial symbiosis by harmonizing diverse interpretations and advancing implementation. The WI will adapt the CWA to support sustainable cities and enable policymakers to apply industrial symbiosis consistently across sectors, aligning with EN ISO 37101 and enhancing city-industry collaboration

In September 2024, CEN/TC465/AHG "Climate-neutral and Smart Cities" was launched following a joint proposal by DIN and DS. The group will outline a work programme for CEN/TC 465 on climate-neutral and smart cities, foster collaboration among members and stakeholders, integrate related EU and national initiatives, and conceptualize interoperability for digital solutions. Recommendations will be submitted by March 2025

CEN/TC 465 maintains liaisons with ISO/TC 268 Sustainable Cities and Communities, CEN/TC 476 "Climate change", European Lift Association (ELA), RescueME, and NetworkNature. Pending liaison requests include NetZeroCities, PROBONO, ClimateView, and Symsites.

ETSI

ETSI is providing specifications relevant to city needs and service scenarios for their citizens and infrastructure, including concrete examples that reflect the importance of environmental factors and sustainability objectives.

ETSI's Human Factors committee (TC HF) has published a technical report (TR 103 455) to assess the needs of consumers and citizens that must be addressed by smart city standardisation, including accessibility, usability, personalization, interoperability and personal data protection.

ETSI's Access, Terminals, Transmission and Multiplexing committee (TC ATTM) is developing standards for sustainable digital multi-service cities to support the deployment and roll-out of smart city infrastructures. This work includes a TS detailing measures to ease the deployment of smart new services and their multiservice street furniture within the IP network of a single city or cluster of cities.

From digitizing industrial processes to creating smart services for citizens, it is essential to accurately record data together with its context information, the so-called metadata, and to transfer these without misinterpretation to other systems. Single-purpose solutions work well within a known context but are not suitable for multi-system interoperability.

ETSI's ISG on cross-cutting Context Information Management (ISG CIM) has published Group Specifications (GSs) for applications to publish, discover, update and access context information (ETSI ISG CIM GS009 V1.8.1), initially for a broad range of smart city applications and later for other areas, facilitated by a high-level information model for capturing the structure of physical environments as a graph which can be efficiently serialized as linked data (ETSI ISG CIM GS 006 V1.3.1). New specifications related to aligning and 'using geo-information' (ETSI ISG CIM GR CIM 049 and GS CIM-050), including consideration of CityGML and IFC as well as ETSI ISG CIM GR 051, which is about using NGSI-LD in the context of Building Information Management (BIM), are going to be published at the beginning of 2025 .

ETSI's ISG F5G looks at the advances that may be needed in optical technologies to provide fast, reliable and secure connections for smart-city applications. Some use cases address these applications.

In 2021 ETSI expects to complete a number of specifications on security and privacy issues, and on interworking with important IoT frameworks such as oneM2M.

ETSI published an extension to the SAREF ontology for Smart Cities in July 2019.

ETSI's ISG on Operational energy Efficiency for Users (ISG OEU) is working with ICT users' support, industry and communities included, on suitable solutions for sustainable digital multiservice in communities. OEU describes digital multiservice solutions leading to total interoperability which is a factor of sovereignty and digital sobriety for communities.

ETSI SC USER has worked, within the project "User-Centric approach in digital ecosystem". Also see section 3.1.3 on use cases for Smart cities. The next step is the Smart Interface based on the Smart Identity. This approach aims to improve the access and use of all the services provided by Smart Cities.

ETSI TC DECT has published updates of the DECT-2020 NR (New Radio) technology (ETSI TS 103 636 parts 1 to 5) during 2022. DECT-2020 NR supports Ultra Reliable Low Latency Communications (URLLC) and massive Machine Type Communications (mMTC).

TC DECT has produced DECT-2020 New Radio (NR) access profile for smart metering including smart electricity meters. Future work on access profiles will include other device types for smart building and smart city applications.

ETSI has recently created a Task force STF268 on Digital Twins, to identify different functionalities, use cases and the support needed for digital twins standardisation.

OneM2M

The oneM2M standard defines a middleware layer, providing common services for connecting IoT devices and IoT applications. With its data sharing capabilities, interworking capabilities (e.g. OGC), semantic interoperability, security and privacy functionalities oneM2M enables a wide variety of smart city use cases. Public authorities in Korea and India reference the oneM2M standard in their smart city projects. Interoperability and compliance testing as well as a Certification Program (onem2m.org) complement the standardisation activities. To focus on the sustainability aspects of IoT and Smart Cities, oneM2M established a Sustainability committee in 2021.
All oneM2M specifications are publicly accessible at https://www.onem2m.org/technical.

ISO

ISO TC 268 "Sustainable development in communities" is directly working on smart city-relevant issues, including terminology, management systems and indicators https://www.iso.org/committee/656906.html

- ISO/37122:2019Sustainable cities and communities - Indicators for smart cities Published
- ISO/ 37104: 2019Sustainable cities and communities -Guidance for practical implementation in cities Published
- ISO/37105:2019Sustainable cities and communities - Descriptive framework for cities and communities (Published)
- ISO 37106:2021 Sustainable cities and communities — Guidance on establishing smart city operating models for sustainable communities (Published)
- ISO/TS 37107:2019 Sustainable cities and communities — Maturity model for smart sustainable communities (Published)

IEC

IEC Smart Cities Systems Committee

IEC has a Systems Committee for Smart Cities whose role is to foster the development of standards in the field of electrotechnology to help with the integration, interoperability and effectiveness of city systems.
It does this:

- by promoting the collaboration and systems thinking between IEC/TCs, the SyC and other SDOs in relation to City systems standards,
- by undertaking systems analysis to understand the needs for standards and assess new work item proposals (NWIPs) related to city systems,
- by developing systems standards where needed and by providing recommendations to existing SyCs, TCs/SCs and other SDOs

Current projects:

- IEC 63152:2020 Smart cities - City service continuity against disasters - The role of the electrical supply
- IEC SRD 63152-2:2022 Smart cities - City service continuity – Implementation guideline and city service cases
- IEC SRD 63188:2022 Smart Cities Reference Architecture Methodology
- IEC SRD 63233-1:2022 Smart city standards inventory and mapping - Part 1: Methodology
- IEC SRD 63233-2:2023 Smart city standards inventory and mapping - Part 2 : Standards inventory
- IEC SRD 63233-4:2024 Smart city standards inventory and mapping - Part 4: Guidance on standards for public health emergencies
- IEC SRD 63235:2021 Smart city system - Methodology for concepts building
- IEC SRD 63273-1:2023 Smart city use case collection and analysis - City information modelling - Part 1: High-level analysis
- IEC SRD 63273-2:2024 Smart city use case collection and analysis - City information modelling - Part 2: Use case analysis
- IEC SRD 63320-1:2023 Smart city use case collection and analysis - Smart urban planning for smart cities - Part 1: High-level analysis
- IEC SRD 63476-1:2024 Smart city system ontology - Part 1: Gap analysis
- IEC Technology Report City information modelling:2021 City information modelling and urban digital twins
- IEC Technology Report Ontology standards in smart cities:2023 Ontology standards in smart cities

IEC Smart Cities Systems Committee has established two Joint Working Groups:

JWG 14 (with ISO TC 268) on Smart Cities Reference Architecture

JWG 16 (with ISO/IEC JTC1) on City Information Modelling and Urban Digital Twins

ISO, IEC

ISO-IEC/JTC 1 WG11 "Smart cities"

JTC1 has established a Working Group on Smart Cities which serves as the focus of and proponent for JTC 1's Smart Cities standardisation program, focusing in particular on standardisation from the IT perspective around the strategic topics on Semantic Interoperability of City Data, Software Platform for Open City Data, date use in smart cities, city digital twin and city knowledge trustworthiness.

Current projects:

ISO/IEC 30146:2019, Information technology — Smart city ICT indicators (Published)

ISO/IEC 21972:2020, Information technology — Upper level ontology for smart city indicators (Published)

ISO/IEC 30145-1: 2021, Information technology — Smart City ICT reference framework — Part 1: Smart city business process framework(Published)

ISO/IEC 30145-2:2020, Information technology — Smart City ICT reference framework — Part 2: Smart city knowledge management framework (Published)

ISO/IEC 30145-3:2020, Information technology — Smart City ICT reference framework — Part 3: Smart city engineering framework (Published)

ISO/IEC 24039:2022, Information technology — Smart city digital platform reference architecture — Data and service (Published)

ISO/IEC 5087-1: 2023, Information technology — City data model — Part 1: Foundation level concepts (Published)

ISO/IEC 5087-2, Information technology — City data model — Part 2: City level concepts (DIS)

ISO/IEC 5087-3, Information technology — City data model — Part 3: Service level concepts -Transportation planning ((*Note: On Dec 2022, ISO/IEC 5087-3 was transferred to the JWG between ISO/TC 204 and ISO/IEC JTC 1*)

ISO/IEC 5153-1, Information Technology — City service platform for public health emergencies — Part 1: Overview and general requirements (DIS)

ISO/IEC AWI TR 20169, Information technology — Overview of smart city standardization

ISO/IEC PWI 5217, Information technology — Guidance on smart city ICT infrastructure design — Overview(PWI)

ISO/IEC PWI 10311-2, Information technology — City service platform for public health emergencies —Part 2: Response resource management

ISO/IEC PWI 10235-4, Information technology — City data model — Part 4: Service level concepts for public health emergencies

ISO/IEC PWI 20822, Information technology — Domain knowledge trustworthiness evaluation for smart cities

ISO/IEC PWI 10267-1, Information technology—Data use in smart cities — Part 1: Framework

ISO/IEC PWI 10267-2, Information technology — Data use in smart cities — Part 2: Use case analysis and derived requirements

ISO/IEC PWI TS 10267-3, Information technology—Data use in smart cities — Part 3: Measurement, evaluation and reporting

JTC 1-ISO/TC 204 Joint Working Group:

To develop ISO/IEC 5087-3 (Information technology – City data model – part 3: Service level concepts – Transportation planning) using the framework defined for the ISO/IEC 5087 series on city data models where service city data standards are defined in terms of the foundation classes (ISO/IEC 5087-1) and city level classes (ISO/IEC 5087-2).

ISO, IEC, ITU

The IEC-ISO-ITU Joint Smart Cities Task Force was set up by all three SDOs with the key objectives:

- To build synergies and to promote minimization of overlap as applicable on ongoing works in ITU-T, IEC and ISO related to smart cities and communities;
- To maximize efforts in order to identify new areas of cooperation related to smart cities and communities;
- To develop a holistic view on smart cities and communities taking into consideration the scope, areas of work and expertise of ITU-T, IEC and ISO to support smart cities and communities' development.

IEEE

IEEE standards for Smart Cities address the many applications found within this domain, including smart energy/grid, intelligent transportation, water management, waste management, smart streetlights, smart parking, environment monitoring, smart community, smart campus, smart buildings, eHealth, eLearning, eGovernment, etc. Many standards in all these different domains are also relevant in a Smart City. Featured projects include:

- IEEE P1950.1, Communications Architectural Functional Framework for Smart Cities

This standard specifies the architectural and functional framework for smart cities aiming to enable communications within and across smart city ecosystems.

- IEEE P1951.1, Smart City Component Systems Discovery and Semantic Exchange of Objectives

This standard is focused on solving the discovery of the systems deployed in a smart city and enabling the sharing of objectives between these smart city systems to make them work towards a common goal.

- IEEE P2413.1, Reference Architecture for Smart City (RASC)

This standard provides an architectural blueprint for Smart City implementation leveraging cross-domain interaction and semantic interoperability among various domains and components of a Smart City.

- IEEE P2784, Technology and Process Framework for Planning a Smart City

This guide provides a framework that outlines technologies and the processes for planning the evolution of a smart city.

- IEEE P2850, Architectural Framework for Intelligent Cities Operation System

This standard defines an architecture framework for a computational operation system, which is designed to enable intelligent cities.

- IEEE P2872, Interoperable and Secure Wireless Local Area Network (WLAN) Infrastructure and Architecture

This standard describes a protocol that enables interoperable, semantically compatible connections between connected hardware (e.g., autonomous drones, sensors, smart devices, robots) and software (e.g., services, platforms, applications, AIS).

This standard describes a protocol that enables interoperable, semantically compatible connections between connected hardware (e.g., autonomous drones, sensors, smart devices, robots) and software (e.g., services, platforms, applications, AIS).

- IEEE P7803, Recommended Practice for Inclusive Sustainable Smart Cities

This recommended practice develops a number of key indicators to facilitate progress tracking that act as a practical means of measuring progress and pinpointing areas that pave the way for the establishment of Inclusive Sustainable Smart Cities, raising the standard of living to a level where individuals are thriving in their communities.

- IEEE P2874, IEEE Draft Standard for Spatial Web Protocol, Architecture and Governance

This standard supports access, access control, security, permissioning, governance, and rights management for the Internet of Things (IoT) and, more generally, objects that are addressable via any information and communications technology.

For more information please visit: https://standards.ieee.org/practices/foundational/smart-cities-standards/# and https://ieee-sa.imeetcentral.com/eurollingplan/.

ITU-R

Recent developments in the Internet of Things (IoT), Artificial Intelligence (AI) and smart grids and meters are driving and supporting the development of smart sustainable cities throughout the world. Several ITU-R Working Parties contribute to the development of ITU-R Reports and ITU-R Recommendations that contribute to the improvement of smart sustainable cities.

Among the current study topics, ITU-R Working Party (WP) 1A studies the impact on radiocommunication systems from wireless and wired data transmission technologies used for the support of power grid management systems.

Electronic devices and their networks, including those not used for telecommunications, can produce significative electromagnetic disturbances that may affect the functionalities of current and future telecommunications systems such as IoT (Internet of Things) and their applications. Report ITU-R SM.2503 on "Evaluation of radiated electromagnetic disturbances of household appliances and their interferences over an IoT network in the 915 MHz frequency band" evaluates the levels of electromagnetic disturbances generated by household appliances and how these interferences may affect the functioning of a Wireless Sensor Network (WSN) operating in the 915 MHz band in some administrations, a system which is widely used within IoT due to its technical flexibility and low cost.

ITU-R WP 1A has developed new Question ITU-R 243/1 on "Impact of unintentional radio frequency energy generated by electrical or electronic apparatus to the radiocommunication services".

ITU-R WP 1A has also developed Recommendation ITU-R SM.2152 on "Complementing current radio frequency delivery mechanisms using optical wireless communication" and Report ITU-R SM.2422 on "Visible light for broadband communications" and is continuing its studies on this subject in response to Question ITU-R 238/1.

Resolution ITU-R 54 calls for studies to achieve harmonization for short-range devices (SRDs).

ITU-R WP 1B is responsible for the studies relating to spectrum management methodologies and economic strategies. Among its current studies, WP 1B deals with the harmonization of SRDs.

Report ITU-R SM.2153 on "Technical and operating parameters and spectrum use for short-range radiocommunication devices" provides SRD definitions and short descriptions of different applications using SRDs, e.g.: Telecommand, Telemetry, Voice and video, Detecting avalanche victims, RLANs, Railway applications, among others. This Report also indicates the typical technical characteristics and limitations such as the common frequency ranges or the antenna requirements, and it explains administrative requirements like the mutual agreements between countries and/or regions and the licences requirements. Finally, it also provides useful information on national and regional rules including technical and operational parameters and spectrum use.

ITU-R WP 1B has carried out studies with the aim to globally and regionally harmonize the frequency bands used by SRDs. Recommendation ITU-R SM.1896 on "Frequency ranges for global or regional harmonization of short-range devices" details the frequency ranges appropriate for global and regional harmonization. On the other hand, Recommendation ITU-R SM.2103 on "Global harmonization of short-range devices categories" contains guidelines for the categories recommended for SRDs requiring operation on a globally harmonized basis.

International Mobile Telecommunications (IMT) are the on-going enabler of new trends in communication devices – from the connected car and intelligent transport systems to augmented reality, holography, and wearable devices, and a key enabler to meet social needs in the areas of mobile education, connected health and emergency telecommunications.

In this context, ITU-R WP 5D is responsible for carrying studies related to the development and enhancement of International Mobile Telecommunications (IMT).

In December 2023, the second revision of Recommendation ITU-R M.2150 containing the "Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-2020 (IMT-2020)" was approved. Similar to previous mobile generation technologies, this work is the basis for the development of 5G systems that provides great improvements and benefits to several ICT applications, including e-health, e-agriculture, e-manufacturing, intelligent transport systems, smart cities and traffic control, etc., to facilitate the development of the digital economy.

Recommendation ITU-R M.2160 on "Framework and overall objectives of the future development of IMT for 2030 and beyond" was approved in November 2023. IMT is expected to continue to better serve the needs of the networked society, for both developed and developing countries in the future. In this Recommendation, the framework of the development of IMT-2030, including a broad variety of capabilities associated with envisaged usage scenarios, is described. Furthermore, this Recommendation addresses the objectives for the development of

IMT-2030, which includes further enhancement and evolution of existing IMT. Aspects of interworking with other networks are also addressed.

ITU-T

ITU-T SG20 "IoT and smart cities and communities (SC&C)" is developing a series of standards that coordinate the development of IoT technologies in cities, including machine-to-machine communications and ubiquitous sensor networks. Some of these standards include sensor control networks in NGN environment (ITU-T Y.4250), platform interoperability for smart cities (ITU-T Y.4200), reference model of IoT-related crowdsourced systems (ITU-T Y.4205), Reference architecture of artificial intelligence service exposure for smart sustainable cities (ITU-T Y.4470), Requirements and capability framework of smart environmental monitoring (ITU-T Y.4207), self-organization network in IoT environments (ITU-T Y.4417), Open data application programming interface (APIs) for IoT data in smart cities and communities" (ITU-T Y.4472), Requirements of IoT-based civil engineering infrastructure health monitoring system (ITU-T Y.4214), Data processing and management framework for IoT and smart cities and communities (ITU-T Y.4602).
More info: https://www.itu.int/ITU-T/recommendations/index_sg.aspx?sg=20

ITU-T SG20 "IoT and smart cities and communities" developed various standards on SC&C including Recommendation ITU-T Y.4466 on Framework of smart greenhouse service, Recommendation ITU-T Y.4910 on Maturity model of digital supply chain for smart sustainable cities, Recommendation ITU-T Y.4607 on Requirements for the interworking of autonomous urban delivery robots, Recommendation ITU-T Y.4225 on Requirements and capability framework of digital twin for intelligent transport system, Recommendation Y.4498 on Framework for city-level energy data sharing and analytics among buildings and more.
More info: https://itu.int/go/tsg20

U4SSC is a United Nations initiative coordinated by ITU, UNECE and UN-Habitat and supported by 16 other UN agencies and programmes, to help cities and communities become smarter and more sustainable. U4SSC is currently working on several thematic groups including (but not limited to) city platforms, Lessons Learned From Building Urban Economic Resilience at City Level During and After COVID-19, artificial intelligence in cities, Enabling People-Centred Cities through Digital Transformation, digital wellbeing and etc, accelerate digital transformation in cities and achieve the Sustainable Development Goals (SDGs).
More info: https://u4ssc.itu.int/

Several U4SSC deliverables have been launched (since September 2020) including City Science Application Framework (containing 8 Case Studies), Guide to Circular Cities (containing 8 Case studies), Accelerating city transformation using frontier technologies, Blockchain for smart sustainable cities, Simple ways to be smart, Guidelines on tools and mechanisms to finance smart sustainable cities projects, Digital solutions for integrated city management and use cases, Compendium of survey results on integrated digital solutions for city platforms around the world, Smart public health emergency management and ICT implementations, Redefining smart city platforms: Setting the stage for Minimal Interoperability Mechanisms, Smart tourism: A path to more secure and resilient destinations, Compendium of practices on innovative financing for smart sustainable cities projects, Procurement guidelines for smart sustainable cities, Reference framework for integrated management of an SSC, Guiding principles for artificial intelligence in cities.

See the U4SSC deliverables available at: https://u4ssc.itu.int/publications/

To complement the work of the U4SSC, the first U4SSC Country Hub has been set up in Vienna, Austria, which is hosted by the Austrian Economic Centre. The first U4SSC Country Hub in Africa has also been set up in Kyebi, Ghana. The U4SSC Hubs provide a unique platform to accelerate cooperation between public and private sector and helps facilitate the digital transformation in cities and communities, while enabling technology and knowledge transfer.

ITU-T Recommendations (ITU-T Y.4900, ITU-T Y.4901, ITU-T Y.4902, ITU-T Y.4903) have become the foundation of the United for Smart Sustainable Cities (U4SSC) initiative's Key Performance Indicators (KPIs) for Smart Sustainable Cities project. Over 200 cities worldwide have already partnered with the U4SSC to pilot the indicators contained in Recommendation ITU-T Y.4903 "Key performance indicators for smart sustainable cities to assess the achievement of sustainable development goals" and implement Recommendation ITU-T Y.4904 "Smart sustainable cities maturity model".

More info: https://u4ssc.itu.int/u4ssc-kpi/
https://www.itu.int/en/publications/Documents/tsb/2017-U4SSC-Collection-Methodology/index.html

Four case studies (Daegu, Dubai, Singapore and Moscow) related to the implementation of the KPIs for SSC have been published.

In addition, City Snapshots and City Verification Reports have been developed on U4SSC KPIs. Six City Factsheets have been also published.

Find the published City Snapshots, Verification Reports, Factsheets and Case Studies available at: https://u4ssc.itu.int/u4ssc-kpis-report/

A Joint IEC-ISO-ITU Smart Cities Task Force (J-SCTF) has been created to develop an holistic view on smart cities and communities taking into consideration the scope, areas of work and expertise of ITU-T, IEC and ISO to support smart cities and communities development and share the ongoing development of the work items produced by the three organizations.

ITU, together with other UN agencies, developed a Toolkit on Digital Transformation for People-Oriented Cities and Communities. The resources contained in this Toolkit include international standards and guidance, the latest research and projections, and cutting-edge reports on a variety of timely topics relevant to the digital transformation of cities and communities.

More info: https://toolkit-dt4c.itu.int/

ITU, together with other organizations and UN agencies, is organizing the Digital Transformation Dialogues, including webinars, fireside chats and ask the experts sessions. These events discuss topics related to cross-sectoral digital transformation and related standardization activities.

Mote info: https://www.itu.int/cities/digitaltransformationdialogues/

ITU-T Study Group 5 develops standards on ICTs related to the environment, energy efficiency, clean energy and sustainable digitalization for climate actions. Q13/5 is dedicated to work on Building circular and sustainable cities and communities. ITU-T SG5 approved Recommendations ITU-T L.1604 "Development

framework for bioeconomy in cities and communities", ITU-T L.1610 on City science application framework, ITU-T L.1620 "Guide to circular cities", ITU-T L.1630 "Framework of a building infrastructure management system for sustainable cities". Additionally, SG5 developed Recommendation ITU-T L.1440 "Methodology for environmental impact assessment of information and communication technologies at city level". ITU-T SG17 is working on "Security measures for location enabled smart office services" (X.sles), "Security measure for digital twin system of smart cities" (X.smdtsc) and "Security measure for smart residential community" (X.smsrc).
https://itu.int/go/tsg17

In 2023, ITU-T set-up a focus group on metaverse (FG-MV) to work on pre-standardisation matters. The group analysed the technical requirements of the metaverse to identify fundamental enabling technologies in areas from multimedia and network optimization to digital currencies, Internet of Things, digital twins, and environmental sustainability.

The work of this group is relevant for smart and sustainable communities. It offers new (administrative, economic, social, policy-making, and cultural) virtual goods/services/capabilities to city and community actors such as citizens, represented as digital avatars).

IETF

The Energy Management (EMAN) WG has produced several specifications for an energy management framework, for power/energy monitoring and configuration. See http://datatracker.ietf.org/wg/eman/documents/ for the details. The framework focuses on energy management for IP-based network equipment (routers, switches, PCs, IP cameras, phones and the like).

A recently published standards track specification (RFC7603) presents the applicability of the EMAN information model in a variety of scenarios with cases and target devices. These use cases are useful for identifying requirements for the framework and MIBs. Further, it describes the relationship of the EMAN framework to other relevant energy monitoring standards and architectures.

Many of the IETF Working Groups listed under section 3.1.4 Internet of Things above are developing standards for embedded devices that may also be applicable to this section.

https://wiki.ietf.org/en/group/iab/Multi-Stake-Holder-Platform#h-342-smart-and-sustainable-cities-and-communities

OASIS

The OASIS Transformational Government TC Framework (TGF) advances an overall framework for using information technology to improve the delivery of public services. It is used in BSI's PAS 181:2014 as mentioned above.

AENOR

Over 20 Spanish standards at AENOR's CTN 178 on e.g. platforms interoperability, open data in smart cities, smart ports, rural communities and smart tourist destinations, basis for ITU-T SG20 recommendations on these topics

http://www.aenor.es/descargasweb/normas/aenor-Spanish-standardisation-on-Smart-Cities-CTN-178.pdf

BSI

BSI's PAS 181:2014 Description: British Smart City Framework. A good practices framework for city leaders to develop, agree and deliver smart city strategies. Uses OASIS TGF (below).

http://www.bsigroup.com/en-GB/smart-cities/Smart-Cities-Standards-and-Publication/PAS-181-smart-cities-framework/

BSI has adopted and published the deliverables of the Demand-side group on Urban Platforms initiative of the European Innovation Partnership on Smart Cities and Communities:

- Leadership Guide: a 'train read' document for city leaders (this now published under BSI logo)
- Management Framework: helping integrate across the functional silos (published under BSI logo)

BSI, FUTURE CITIES

Cities Standards Institute (CSI) was a joint activity to develop a strong network of cities, companies and SMEs that develop the next stage of the BSI's Smart City Catapult Framework. This was completed in 2017, the whole series include DIN SPEC 91347 (humble lampposts), 91357 (OUP), 91367 (mobile urban data), 91387.

DIN/DKE/VDE

The German Standardisation Roadmap Smart City

https://www.dke.de/resource/blob/778248/d2afdaf62551586a54b3270ef78d2632/the-german-standardisation-roadmap-smart-city-version-1-0-data.pdf

The DIN PAS Reference Architecture adopted from the Reference Architecture deliverable of the Urban platform initiative of the European Innovation Partnership on Smart Cities and Communities and the ESPRESSO project is anticipated to be complete in summer 2017.

ECMA

The ongoing work of TC53 can be extended into areas of "Smart and Sustainable Cities and Communities".

Ecma Technical Committee TC53 standardises JavaScript software APIs for embedded systems. The APIs provide a portable, secure, vendor neutral execution environment in a layer above the operating system. The scope of work includes low-level input/output, sensors, networking, storage, displays, and audio. Information about the committee may be found at https://www.ecma-international.org/technical-committees/tc53/ and the current "ECMAScript embedded systems API specification" may be found athttps://ecma-international.org/publications-and-standards/standards/ecma-419/.

(C.2) OTHER ACTIVITIES RELATED TO STANDARDISATION

ADAPT4EE/READY4SMARTCITIES

Activity related to eeSemantics: group was running a series of vocabulary camps addressing specific sub-areas.

HORIZON 2020 CALL SCC-03-2015 ESPRESSO

Development of system standards for smart cities and communities solutions.

The process for developing, maintaining and promoting smart cities and communities standards to ensure the interoperability of solutions, i.e. the adaptability of solutions to new user requirements and technological change and the avoidance of entry barriers or vendor lock-in through promoting common metadata structures and interoperability using /open standards as opposed to proprietary ones, together with open and consistent data. It should make relevant data and information as widely available as possible —including to third parties for the purpose of applications development— while using common, transparent measurement and data collection standards to ensure meaningfulness and comparability of performance/outcome measurements. The project together with the EIP SCC urban platform initiative is promoting the use of DIN SPEC 91357, freely available for the DIN website, by bringing it to the attention of European cities as well as promoting it worldwide. It is helping to bring DIN SPEC 91357 to CEN/CELELEC and ISO for international consideration. It also contributed to other standards such as the DIN smart "humble" lamppost standard.

INDUSTRY MEMORANDUM OF UNDERSTANDING ON URBAN PLATFORMS

93 organisations from industry and research have signed a Memorandum of Understanding on interoperable urban platforms. The group is led by SAP and developed a set of principles and a joint reference architecture framework to enable interoperability, scalability and open interfaces to integrate different solutions and to develop a joint data and service ontology to be used by individual Smart cities. In addition, they are working to accelerate the adoption of the developed framework by standardisation bodies and other stakeholders. The deliverables of the group (and most notably the reference architecture) have been standardised by DIN in DIN91357. The group is promoting the use of DIN SPEC 91357, freely available for the DIN website, by bringing it to the attention of European cities as well as promoting it worldwide. It is helping to bring DIN SPEC 91357 to CEN/CELELEC and ISO for international consideration.

https://ec.europa.eu/digital-single-market/en/news/memorandum-understanding-towards-open-urban-platforms-smart-cities-and-communities

DEMAND-SIDE GROUP (CITY-LED) ON URBAN PLATFORMS (WITHIN THE SMART CITIES MARKETPLACE)

A total of 110 cities — individual cities and two city networks — have already agreed to cooperate more strongly in the area of urban platform by signing a Letter of Intent. The group is working within the urban platforms initiative of the Smart Cities Marketplace. This group is led by London and has already produced a requirements document for smart city interoperability (urban platform), which is currently being tested. The requirements document is being used by the industry group of the MoU on urban platforms within the Smart Cities Marketplace to create a reference architecture framework and standards landscape. The members of the group are committed to implement commonly agreed open standard urban platforms and foster the deployment of smart city solutions. Two other deliverables of the demand-side group are:

- Leadership Guide: a 'train read' document for city leaders
- Management Framework: helping integrate across the functional silos

BSI has adopted and published the latter two deliverables under the BSI logo.

https://europa.eu/!ugqhnB

OPEN & AGILE SMART CITIES & COMMUNITIES (OASC)

City-led initiative to create a market which addresses the complex needs of smart cities and communities, especially interoperability, portability, replaceability and comparability, in order to avoid vendor lock-in and to support local digital entrepreneurship. OASC maintains a set of technical Minimal Interoperability Mechanisms (MIMs) which are open and free. Launched in March 2015, a current total of more than150 cities in 30 countries, representing 100 million citizens and a combined GDP of 3.5t€, mainly in Europe, have already committed to adopting the OASC principles. OASC promotes standards-based innovation and procurement across application domains, and the MIMs are directly linked to the existing standardisation processes on national, European and international level, including CEN TC465, ISO TC268/JTC1 IEC SyC Smart Cities and ITU-T SG20. OASC also maintains the consolidated Open Standards Library, the Connected Smart Cities (CSCC) Catalogue of standards-based services and suppliers, the SynchroniCity Guide and the OrganiCity Experimentation-as-a-Service model, and operates the OASC Academy for training.

www.oascities.org

SYNCHRONICITY

European IoT Large-Scale Pilot on Smart Cities (part of the 104m€ H2020 IoT-LSP Programme) with 8 core European cities (some are also EIP-SCC-01 Lighthouse Cities), 38 partners in total, a budget of 20m€ (15m€ EC contribution) and a running period of 36 months (2017-19). SynchroniCity aims to establish an open market for IoT-enabled urban services based on the Open & Agile Smart Cities (OASC) Minimal Interoperability Mechanisms (MIMs). The project validates the MIMs as well as other existing and emerging standards through around 20 pilots involving at least two cities, including an open call for new cities and companies to join. SynchroniCity actively builds upon and contributes to initiatives such as EIP-SCC, FIWARE and oneM2M, and both the validation results and new specifications are contributed to the relevant European and global SDOs, such as ETSI and ITU-T. Specifically, SynchroniCity partners are leading and contributing to the ETSI ISG CIM and to the ITU-T SG20 Open API work item and FG-DPM-IOTSCC.

www.synchronicity-iot.eu

LIVING-IN.EU

A bottom-up initiative of major stakeholders such as OASC, Eurocities, ENoLL and EIP SCC supported by the European Commission and the Committee of the Regions to support the roll out of urban platforms and digital services and solutions based on the data provided by the platforms and a European communities data space. The technical group within the initiative, which consists not only of signatory cities but also of stakeholders from major standards developing organisations, industry and others, has developed a consolidated report of standards and specifications for vendor-agnostic interoperable roll out of digital infrastructure

and services for smart communities unifying outcomes from the EIP SCC urban platform initiative, the SynchroniCity/OASC MIMs and specifications from standardisation initiatives and bodies such as OneM2M, TM Forum, OGC, etc. The report will be used as technical common ground by the European communities and within the Digital Europe Programme.

https://living-in.eu/

FUTURE INTERNET PUBLIC PRIVATE PARTNERSHIP

Specifications and technologies developed under the Future Internet Public Private Partnership programme (FP7) that can be used within the context of smart cities:

FIWARE has developed an open source implementation of the ETSI ISG CIM GS 009 V.1.8.1 NGSI-LD API that provides a lightweight and simple means to gather, publish, query and subscribe to context information. This is an API for context information management. Such information can be indeed open data and/or linked data and consumed through the query and subscription API. It is possible to publish real-time or dynamic data and offer it as open data for the reuse by applications.

FIWARE CKAN: Open data publication generic enabler. FIWARE CKAN is an open source solution for the publication, management and consumption of open data, usually, but not only, through static datasets. FIWARE CKAN allows to catalogue, upload and manage open datasets and data sources, while supports searching, browsing, visualising or accessing open data. FIWARE CKAN is an Open Data publication platform that is used by many cities, public authorities and organisations.

www.fiware.org/

EUROCITIES AND GREEN DIGITAL CHARTER (GDC)

A strategic, city-led initiative aiming to improve cities and citizens' quality of life through the use of open and inclusive digital solutions. GDC is a EUROCITIES initiative launched in 2009 and currently signed by 52 major European cities. It works at the highest level with CEN & CENELEC SF-SSCC, ETSI SDMC, the MoU on urban platforms and OASC.

Apart from GDC, EUROCITIES works with its member-cities for "Data" and "Standards & Interoperability" through the two respective working groups of its Knowledge Society Forum, a networking and collaboration mechanism for more than 70 European cities. http://www.greendigitalcharter.eu

H2020 CITYKEYS

Following the SCC-02-2014 call of H2020, nine partners, among which five cities, developed the first public European framework for the performance measurement of smart cities and smart city projects. A set of around 100 key performance indicators (KPIs) and a framework of open-architecture, interfaces and standards help cities design, select, monitor, evaluate and promote smart city solutions. The smart city KPIs of CITYkeys were used by ETSI SDMC for the creation of TS 103 463, "Key Performance Indicators for Sustainable Digital Multiservice Cities". http://www.citykeys-project.eu/

H2020 SMART CITIES LIGHTHOUSE PROJECTS

Following the directions of the Strategic Implementation Plan of the European Innovation Partnership on Smart Cities and Communities (EIP-SCC), a yearly Horizon2020 Smart Cities call for lighthouse innovation projects has been in place since 2014. The yearly budget is fluctuating, but it is in the ballpark figure of 100 M€/year and the funding of the individual calls is around 25 million per project. There are now 18 lighthouse projects at the moment (see also https://europa.eu/!u6YbvV). Within each project there are two to three leading cities implementing smart city solutions in the areas of energy and transport with the help of digital solutions, and a number of follower and observer cities that replicate the solutions developed for the leading cities. The projects are implementing among other things ICT urban platforms and are working together with their sister project ESPRESSO and the urban platform group within the Smart Cities Marketplace to implement open-standards based interoperable platforms.

https://europa.eu/!ugqhnB

FED4IOT

The Fed4IoT project faces the interoperability issue, focusing on large-scale environments and addressing the problem at different and synergic levels: device, platform and information. The goal of the project is to federate IoT and Cloud infrastructures to provide scalable and interoperable Smart Cities Applications by introducing novel IoT virtualization technologies. https://fed4iot.org/

AIOTI

The Alliance for AI, IoT and Edge Continuum Innovation (AIOTI) is a member driven alliance which objectives include: fostering experimentation, replication and deployment of IoT, supporting convergence and interoperability of IoT standards, gathering evidence on market obstacles for IoT deployment and mapping and bridging global, EU, and member states' IoT innovation activities. AIOTI welcomes membership input on any and all issues – from internal governance to future work streams.

WG Standardisation

This Working Group (https://aioti.eu/standardisation/) identifies and, where appropriate, makes recommendations to address existing AI, IoT and Edge Continuum standards, analyses gaps in standardisation, and develops strategies and use cases aiming for (1) consolidation of architectural frameworks, reference architectures, and architectural styles in the AI, IoT and Edge Continuum space, (2) (semantic) interoperability and (3) personal data & personal data protection to the various categories of stakeholders in the AI, IoT and Edge Continuum space.

STANDICT.EU

The StandICT.eu produced a standardisation landscape for the technology areas applicable to Smart Cities. The document is a static "snapshot" of a dynamically updated database compiled within StandICT.eu. The database is inclusive (from many different SDOs and organizations), re-useable (available for a liaison to other organisations), filterable (to choose a subset of documents and organisations appropriate to a particular use), and easily exportable (CSV, Word, ODT, Mind-map). https://www.standict.eu/landscape-analysis-report/landscape-smart-cities-standards

StandICT.eu landscape report on digital twins: https://www.standict.eu/landscape-analysis-report/landscape-digital-twins

StandICT.eu Standardisation Landscape for CitiVerse: https://www.standict.eu/news/landscape-citiverse-standards

DS4SSCC-DEP

The 'European Data Space for Smart Communities' action (launched in October 2023) is a 33m€ project running for 36 months (2023-2026) and a pivotal deployment following the preparatory action for a Data Space for Sustainable and Smart Cities and Communities (DS4SSCC). Emphasising sustainability aspects and diversity in communities, DS4SSCC developed a multi-stakeholder data governance scheme, created a catalogue of building blocks and a high-level reference architecture, delivered priority datasets, developed a roadmap towards implementing a mature data space on various governance levels.

DS4SSCC-DEP's vision revolves around creating a well-governed data space available for communities, developers and other supporting actors, aligning with the prospects outlined in Europe's Digital Decade objectives. DS4SSCC-DEP aims to build a territorial, place-based cross-sectoral data space for smart communities. This cross-sectoral approach distinguishes itself from sectoral data spaces by encompassing diverse domains, underpinning governance across all levels of society.

https://inventory.ds4sscc.eu/roadmap/recommended-action-for-standardisation

Alliance for IoT and Edge Computing Innovation (AIOTI)

AIOTI WG ICT for CO2 reduction methodologies published the report IoT and Edge Computing Carbon Footprint Measurement Methodology R3 at the end of June 2024. This Report addresses the users of IoT and Edge Computing technologies and services to help them understand and make informed choices on how to assess the carbon footprint of solutions and services they use and to also measure how these methodologies support carbon footprint reduction of their use. Release 3 of the report includes a use case that applies the Network Carbon Index (NCI), specified in ITU-T L.1333, updated the equations including the impact of higher-order effects including rebound effects, included a "simplified avoided carbon emissions equation", introduced in ITU-T (rev)L.1480, included example uses cases that apply the AIOTI equations defined in this report, included example use cases that apply the "simplified avoided emissions calculation". The report also has recommendations for practical use.

(C.3) ADDITIONAL INFORMATION

There are already many activities going on around smart cities in various standards development organisations around the globe. Industry, therefore, welcomes that the Commission does not see a need to trigger further standards development at this point in time but relies on the industry initiatives which have started in organisations around the globe.

Broad coordination, including stakeholders, Member States, and the Commission, is important for making consistent progress in this area which covers a large field of sub-domains. The Commission supports and encourages the efforts of the International and European SDOs to move towards common standards in the area of Smart Cities within as short timeframes as producing viable results allows.

The Spanish Secretary of State has identified the need to establish certain requirements for city platforms to allow interoperability. This is an opportunity for specific European standardisation work which could be developed by CEN & CENELEC and ETSI.

Spanish national plan on smart cities, with a governance model including an innovative advisory board on smart cities http://www.agendadigital.gob.es/planes-actuaciones/Paginas/plan-nacional-ciudades-inteligentes.aspx

ITU and UNECE "United for smart sustainable cities" (U4SSC) initiative to advocate for public policy to emphasize the importance of ICT in enabling the transition to smart sustainable cities.

[1] Definition is inspired on ISO/IEC 23005 and IEEE 2888 standards.

(1) ftp://ftp.cencenelec.eu/EN/EuropeanStandardisation/Fields/SmartLiving/City/SSCC-CG_Short_Version_Report_Jan_2015.pdf

3.4.3 ICT Environmental impact

A Policy and legislation

(A.1) POLICY OBJECTIVES

ICT is currently one of the fastest growing greenhouse gas-emitting and energy management sectors, however Digital transformation and Green transition have both synergies and conflicts:

- among the most important synergies:
  - Digital transformation for climate neutrality. It can reduce 15-20% of total GHG emissions;
  - Green transition for sustainable financing and new jobs in green digital transformation;
- among the most important conflicts:
  - ICT footprint: 2.1% to 3.9% of total emissions; eWaste- fastest growing waste category;
  - Green transition may block certain digitalisation patterns (built in obsolescence, blockchain mining, single use electronics, etc).

More in general, ICT can support the achievement of several targets established under the United Nations' Sustainable Development Goals (UN SDG) of the UN's 2030 Agenda for Sustainable Development 'Responsible consumption and production.

At the level of ICT, multiple methodologies are available to assess the environmental impact of ICT itself, but they do not provide a consistent methodological framework for this assessment. A solution to this is the work developed in various European and International standardisation bodies such as ETSI, ITU-T, IEC, ISO and others, around methodologies to assess this environmental impact, currently focused on energy management including energy consumption and greenhouse gas (GHG) emissions, with the achievement of good consensus. This work is performed in collaboration with industry, standardisation bodies and public authorities. The criteria for measuring the impact of ICT on the environment will be extended to other environmental sectors, like water and raw materials.

A key challenge is achieving transparency around claims relating to the environmental performance of ICT products and services, and setting an effective basis to drive competition.

One of the key initiatives for measuring the impact of digital solutions on the climate is the European Green Digital Coalition (EGDC). The ECDG is an initiative of companies, supported by the European Commission and the European Parliament, based on the request of the EU Council, which aims to harness the enabling emission-reducing potential of digital solutions to all other sectors. The ECDG has recently released science-based methodologies and guidance to measure the impact of digital solutions in reducing and avoiding greenhouse gas emissions across different sectors. The methodologies look at both the positive contribution and the direct carbon footprint of different digital solutions, and can be used by companies, local authorities and financial institutions to deploy and finance innovative digital solutions that have a net positive impact on the climate and bring with them economic benefits. The publications consist of 3 documents:

- Net Carbon Impact Assessment Methodology for ICT Solutions, building upon existing standards (predominantly ITU-T L.1480) and including sector specific methodologies
- Real Life Case Studies
- Deployment Guidelines

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

As laid down in the Communication of 9 March 2021 entitled '2030 Digital Compass: the European way for the Digital Decade' (COM(2021) 118 final), the electricity demand of data centres is expected to reach 3,2 % of the EU total by 2030, a 28 % increase from 2018. The Communication of 19 February 2020 on 'Shaping Europe's digital future' lays down the Union's commitment to reach climate-neutral, highly energy-efficient and sustainable data centres by 2030. Measurable and transparent indicators for the sustainability of digital infrastructures play an important role in this context. The recast Energy Efficiency Directive (Directive 2023/1791) obliges Member States to require owners and operators of data centres to make publicly available information on the sustainability performance of data centres above a certain size. As a first step to facilitate the reporting, and towards eventually establishing a common Union rating scheme for data centres, Delegated Regulation (EU) 2024/1364 identifies the relevant indicators for

reporting and outlines the methodology to calculate them.

Additional and related initiatives where the Commission is looking at the environmental impact of ICT from various fronts include:

- To analyse further the current situation of the ICT-sector and to consider possible options for future action, the Commission, DG CNECT, commissioned a study on the practical application of the new framework methodology for measuring the environmental impact of ICT (including a cost/benefit analysis for companies) and has organised, among other things, a workshop on policy measures, metrics, and methodologies in the context of environmentally-sound data centres.
- With CNECT playing the chief editor role under ITU-T the "ICT in Cities" methodology to assess the environmental impact of ICT at the city level is now finished (http://www.itu.int/rec/T-REC-L.1440-201510-P)
- With a life cycle approach (or cradle to grave), it provides:
  - a basis to help cities take the right decisions as regards their ICT infrastructure and the relevant energy costs/environmental effects;
  - a level playing field for industry to compete and innovate in providing the most sustainable solutions to cities.
- DG ENV launched conducted a pilot on product environmental footprint on category rules. It is looking at various ICT products such as IT equipment, uninterruptible power sources (UPS) and batteries. https://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR_en.htm
- DG GROW is working on the review (https://eco-servers-review.eu/of) the Ecodesign Regulation 2019/424 on servers and data storage products (products that can be normally found in data centres or in server rooms). Standards mandated under the standardisation request M/573 are under preparation.

(A.3) REFERENCES

- Commission Delegated Regulation (EU) 2024/1364 on the first phase of the establishment of a common Union rating scheme for data centres
- Directive (EU) 2023/1791 on energy efficiency and amending Regulation (EU) 2023/955
- COM(2021) 118 final 2030 Digital Compass: the European way for the Digital Decade
- COM(2019) 64 The European Green New Deal
- COM/2020/80 Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL establishing the framework for achieving climate neutrality and amending Regulation (European Climate Law)
- First Circular Economy Action Plan
- Regulation (EU) 2019/424 laying down ecodesign requirements for servers and data storage products pursuant to Directive 2009/125/EC of the European Parliament and of the Council and amending Commission Regulation (EU) No 617/2013
- COM(2015) 614: Closing the loop – An EU Action Plan for the Circular Economy
- COM(2010) 245: A Digital Agenda for Europe, Key Action 12:
  - (a) Assess whether the ICT sector has developed common measurement methodologies
    (b) Propose legal measures if appropriate
- Directive 2005/32/EC on eco-design of products
- Recommendation 2013/105/EC: Mobilising Information and Communications Technologies to facilitate the transition to an energy-efficient, low-carbon economy
- Directive 2012/27/EU on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC
- Directive 2010/31/EU of the European Parliament and of the Council on Energy Performance of Buildings
- Directive 2010/30/EU on Labelling and Information
- Regulation (EU) No. 347/2013 on guidelines for trans-European energy infrastructure
- COM(2009) 7604: Recommendation (9.10.2009) on mobilising Information and Communication Technologies to facilitate the transition to an energy-efficient, low-carbon economy
- COM(2009) 519 final: Investing in the Development of Low Carbon Technologies (SET Plan)
- COM(2008) 30 final: 20 20 by 2020, Europe's climate change opportunity
- COM(2008) 241: Addressing the challenge of energy efficiency through Information and Communication

Technologies

- Directive 2003/96/EC of the Council on Energy Taxation
- Directive 2009/125/EC (Ecodesign) plus its Implementing Regulations and Standardisation Requests. Proposal for a Regulation of the European Parliament and of the Council establishing a framework for setting ecodesign requirements for sustainable products and repealing Directive 2009/125/EC
- Regulation (EU) 2017/1369 (Energy Consumption)
- M/543 Standardisation Request with regard to ecodesign requirements on material efficiency aspects for energy-related products

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

ACTION 1: Definition of Global KPIs for Energy Management of Fixed and Mobile access, and Core networks.

ACTION 2: Guidelines for the use of Global KPIs for Data Centres.

ACTION 3: Definition of Global KPIs for Data Services.

ACTION 4: Guidelines for the definition of Green Data Services.

ACTION 5: Definition and guidelines of KPIs for ICT networks.

ACTION 6: SDOs to identify needs and develop standards to support UN SDGs, in particular KPI for both synergies and conflicts in Digital transformation and Green transition projects.

ACTION 7: ETSI, in collaboration with the EGDC, to consider possible paths for ITU L.1480 and L.1333 to be made available for European standardisation to meet EU policy objectives.

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

ESOS

Standardisation request M/462 on efficient energy use within broadband deployment was accepted by the ESOs to provide standards for measurement and monitoring, including the definition of energy-efficient KPIs. This standardisation request was not only limited to networks, but extended as well to data centres and other ICT nodes associated with broadband deployment.

Energy and more general resource management in data centres are addressed by a cross-ESO coordination group (Coordination Group Green Data Centres – CG-GDC). This group monitors European and international standardisation for data centre resource management (including energy) and maintains a live executive summary of that activity.

ftp://ftp.cencenelec.eu/EN/EuropeanStandardisation/HotTopics/ICT/GreenDataCentres/GDC_report_summary.pdf

The CEN-CLC-ETSI CG-GDC encourages and coordinates standardisation activities to support Commission objectives.. Further to a recommendation of the CG-GDC, CENELEC continues to maintain CLC/TR 50600-99-1, which links the DG JRC Best Practice Guidelines for the Code of Conduct for Energy Efficient Data Centres into the EN 50600 series.

CENELEC

CLC/TC 215 is responsible for a holistic series of ENs for the design, operation and resource efficiency of data centres (including KPIs) from a system point of view. This work was undertaken in response to EC Mandate M/462. Several CENELEC Technical Committees are responsible for energy efficient products deployed in data centres.

CLC/TC 111X 'Environment'.

CEN/CLC/JTC 10 'Material efficiency aspects for products in scope of Ecodesign legislation' covers material efficiency aspects for products in scope of the Ecodesign Directive 2009/125/EC and its future revisions. Producing generic and horizontal CEN-CENELEC publications covering aspects such as assessment methods, design rules, dematerialization, digitalization and transfer of information on a variety of material efficiency topics, in particular (but not limited to):

- Extending product lifetime.
- Ability to reuse components or recycle materials from products at End-of-Life.
- Use of reused components and/or recycled materials in products.

The reuse of components and/or recycled materials includes coverage of the European Commission defined list of Critical Raw Materials (CRM).

ETSI

ETSI's technical committees for Access, Terminals, Transmission and Multiplexing (TC ATTM), Cable (TC CABLE) and Environmental Engineering (TC EE), collaborated to develop standards in response to EC Mandate M/462 on enabling efficient energy management (efficient use of energy) in fixed and mobile information and communication networks and sites. The resulting standards cover global KPIs for energy management covering ICT sites (e.g. data centres, transmission nodes), mobile broadband access networks, fixed broadband access networks and cable access networks. These global KPIs are to support the deployment of eco-efficient networks and sites and to monitor the energy management of deployed broadband. These new KPIs, which will be used to define green sites and networks for all industrial and commercial users, are outlined in a series of ENs (EN 305 200 Series) based on ETSI's existing KPIs and TSs for energy efficiency in broadband deployment. The KPIs will provide ICT users with tools to monitor the energy management of networks and sites in full compliance with the Kyoto Protocol on climate change and the reduction of greenhouse gas emissions. EN 305 174 Series defines the most efficient engineering of ICT networks and sites in order to support the efficient deployment of these networks and sites.

Recent work includes new ENs on evaluating energy efficiency of future 5G networks, and work on multiservice street furniture, outlining processes to improve energy efficiency and to ease the deployment of smart new services in digital multiservice cities. EN 305 174-8 on broadband deployment and lifecycle resource management for the end of life of ICT equipment (efficient waste management) was also finalized. This EN will support future standards on field implementation of ICT waste management.

Furthermore, TC-EE is developing standards for the energy and material efficiency of ICT network equipment and this includes the standard for the implementing Regulations of the eco-design directive 2009/125/EC. In this contest, ETSI has already published series of standards for measurement methods for energy efficiency of fixed and mobile networks equipment. Recent work includes new standards for energy efficiency Key Performance Indicators (KPIs) for servers EN 303 470, for Radio Access Network equipment (ES 202 706-1), Routers and switches(ES 203 136), transport equipment and NFV (EN 303 471 in field assessment and ES 203 539 laboratory assessment) and broadband network Equipment (EN 303 215).

TC-EE published also the standard EN 303 423 "Environmental Engineering (EE); Electrical and electronic household and office equipment; Measurement of networked standby power consumption of Interconnecting equipment; Harmonised Standard covering the measurement method for EC Regulation 1275/2008 amended by EU Regulation 801/2013".

Based on the response to EC Mandate M/462, TC CABLE is extending the EN 305 200 series with a set of ENs standardizing an approach to energy efficiency in communication networks based on the assessment of network design and architecture. Taking into account current practices of the stakeholders represented in TC CABLE, this enables efficient design and operation of communications infrastructures end-to-end from the core network to the end user.

Furthermore, the Industry Specification Group on NFV (ISG NFV) has published a report (GR NFV-EVE 021) on "green NFV" within the framework of NFV Release 5. The report aims at providing design and runtime operation guidelines for optimizing energy consumption and at identifying standards enhancements to enable NFV management and orchestration to operate according to power saving policies. The normative work in NFV Release 5 includes also enhancements to specifications on interfaces and information model, and exposed KPIs and metrics to enable resources orchestration and application life cycle management to operate power saving policies. Also the metrics for energy consumption associated to virtualised compute resources and containerized workloads in NFV are defined.

ETSI's ISG CIM and ISG F5G also have work ongoing that contributes to the objective of energy efficiency.

ITU AND ETSI

Starting at the level of `good, networks and services´, they have approved methodologies for environmental impact assessment. These will make it possible to assess in a transparent, qualitative, accurate and consistent way the footprint and other aspects of various products and services that are part of everyday digital life, such as email, telephone services, laptops, broadband access. In addition, companies, public bodies and other organisations will be able to assess and report their ICT footprint based on ITU's "ICT in Organisation".

ITU and ETSI have also agreed a new standard to measure the energy efficiency of mobile radio access networks (RANs), the wireless networks that connect end-user equipment to the core network.

The standard (Recommendation ITU-T L.1330 and ETSI ES 203 228) is the first to define energy-efficiency metrics and measurement methods for live RANs, providing a common reference to evaluate their performance. Its application will build uniformity in the methodologies employed by such evaluations, in parallel establishing a common basis for the interpretation of the results.

ITU and ETSI has a close collaboration in the developing technically aligned deliverables on standards related to Energy Efficiency, Data Centres, circular economy and assessment methodologies of ICTs and CO2 trajectories.

Some of the international standards developed are listed on this site:
https://www.itu.int/net/ITU-T/lists/standards.aspx?Group=5&Domain=28

ITU

ITU-T SG5 is also developing a series of standards aimed at reducing electronic waste and transitioning to a circular economy including the supply chain (ITU-T L.1015, ITU-T L.1020, ITU-T L.1021, ITU-T L.1030, ITU-T L.1031, ITU-T L.1032, ITU-T L.1033, ITU-T L.1034, ITU-T L.1035, ITU-T L.1036, ITU-T L.1040, ITU-T L.1060, ITU-T L.1100, ITU-T L.1101, ITU-T L.1102, , ITU-T L.1022, ITU-T L.1023, ITU-T L.1024, ITU-T L.Suppl.4, ITU-TL.Suppl.5, ITU-T L.Suppl.20, ITU-T L.Suppl.27, ITU-T L.Suppl.28 (equivalent to ETSI TR103 476). Moreover, it is working to set the environmental requirements for 5G. There are four key aspects: Electromagnetic compatibility (EMC); Electromagnetic fields (EMF); Energy feeding and efficiency; and Resistibility. A series of standards on this topic have already been developed (ITU-T L.1220,(equivalent to ETSI TS 103 553-1), ITU-T L.1221 (equivalent to ETSI TS 103 553-2), ITU-T L.1222 (equivalent to ETSI TS 103 553-3), ITU-T K. Suppl.4, ITU-T K. Suppl.8, ITU-T K. Suppl.9, ITU-T K. Suppl.10, ITU-T K.Suppl.14, ITU-T K.Suppl.16, ITU-T K.Suppl.36).

ITU-T SG5 has also developed a series of standards on Universal Charger for mobile phones, stationary ICT devices and portable ICT devices (ITU-T L.1000, ITU-T L.1001, ITU-T L.1002, ITU-T L.1005, ITU-T L.1006, ITU-T L.1007).

In addition, ITU-T SG5 also develops standards that aim to assess the sustainability impacts of ICTs and adapt ICT infrastructure to the effects of climate change within the framework of the Sustainable Development Goals (SDGs), including, Recommendation ITU-T L.1400 "Overview and general principles of methodologies for assessing the environmental impact of information and communication technologies", ITU-T L.1410 (equivalent to ETSI ES 203 199) "Methodology for environmental life cycle assessments of information and communication technology goods, networks and services", ITU-T L.1420 "Methodology for energy consumption and greenhouse gas emissions impact assessment of information and communication technologies in organizations", ITU-T L.1430 "Methodology for assessment of the environmental impact of information and communication technology greenhouse gas and energy projects", ITU-T L.1440 - Methodology for environmental impact assessment of information and communication technologies at city level in which the European Commission through CNECTH5 acted as chief editor, ITU-T L.1450 "Methodologies for the assessment of the environmental impact of the information and communication technology sector"

A series of Green Efficiency KPIs has been developed by ITU-T SG5 including Recommendations, ITU-T L.1331 (equivalent to ETSI ES 203 228) "Assessment of mobile network energy efficiency", ITU-T L.1332 "Total network infrastructure energy efficiency metrics", ITU-T L.1333 "Carbon data intensity for network energy performance monitoring", ITU-T L.1350 "Energy efficiency metrics of a base station site", ITU-T L.1351 "Energy efficiency measurement methodology for base station sites", ITU-T L.1360 "Energy control for the software-defined networking architecture", ITU-T L.1361 (equivalent to ETSI ES 203 539): Measurement method for energy efficiency of network functions virtualization, ITU-T L.1362 (equivalent to ETSI ES 203 539): Interface for power management in network function virtualization environments – Green abstraction Layer version 2.

ITU-T has developed Recommendations ITU-T L.1371 "A methodology for assessing and scoring the sustainability performance of office buildings, ITU-T L.1470 "Greenhouse gas emissions trajectories for the information and communication technology sector compatible with the UNFCCC Paris Agreement", ITU-T L.1471 "Guidance and criteria for information and communication technology organisations on setting Net Zero targets and strategies", ITU-T L.1480. "Enabling the Net Zero transition: Assessing how the use of ICT solutions impacts GHG emissions of other sectors" and ITU-T L.1481 "Guidance on how to address Connect2030 targets on net abatement".

Some of the international standards developed by ITU are listed on this site: https://www.itu.int/net/ITU-T/lists/standards.aspx?Group=5&Domain=28

For more standards developed by SG5 on related topics, see: https://www.itu.int/ITU-T/recommendations/index_sg.aspx?sg=5

More info: https://itu.int/go/tsg5

ITU developed two reports, entitled "Turning digital technology innovation into climate action" and "Frontier technologies to protect the environment & tackle climate change", to highlight the emerging role of ICTs and digital technologies in accelerating climate actions.

ITU-T Focus Group "Environmental efficiency for artificial intelligence and frontier technologies" (FG-AI4EE) was created in May 2019 to identify the standardization gaps related to the environmental performance of AI and other emerging technologies including automation, augmented reality, virtual reality, extended reality, smart manufacturing, industry 5.0, cloud/edge computing, nanotechnology, 5G, among others. The Focus Group develops technical reports and specifications to address the environmental efficiency, as well as the water and energy consumption of emerging technologies. The focus group has already produced twelve deliverables available for download on FG-AI4EE homepage: https://itu.int/go/fgai4ee.

IEC

IEC TC 111 'Environmental standardisation for electrical and electronic products and systems'

IEC TC23 WG9. This WG is responsible for a holistic view of energy efficiency within the scope of TC23.

ISO/IEC JTC 1

ISO/IEC JTC 1 SC 39 'Sustainability, IT & Data Centres:

- has published International Standard ISO/IEC 21836 for Server Energy Effectiveness Metric (SEEM);
- has published International Standard ISO/IEC 23544 on Application Platform Energy Effectiveness (APEE);
- ISO/IEC 30134-8 on Carbon Usage Effectiveness (CUE) and ISO/IEC 30134-9 on Water Usage Effectiveness (WUE) are published;
- is working on a Technical Specification on Digital Services Ecodesign ISO/IEC TS 20125.

http://www.iso.org/iso/standards_development/technical_committees/list_of_iso_technical_committees/iso_technical_committee.htm?commid=654019

IEEE

Information about work being done by IEEE in areas of sustainability can be found under Sustainable Development on the IEEE website.

IEEE has created Planet Positive 2030, an output of the Sustainable Infrastructures and Community Development program (IEEE SICDP), that brings together a global, open community of experts to chart a path for all people to achieve a flourishing future for 2030 and beyond. Planet Positive 2030's current compendium document, Strong Sustainability by Design (available to the general public as a Request for Input document in 2023), features multiple chapters on the circular economy.

The program has also inspired a number of standards ideas, including the Standards Working Group:

P7800 Recommended Practice for Addressing Sustainability, Environmental Stewardship and Climate Change Challenges in Professional Practice.

Many IEEE standardisation activities directly contribute to assessing and reducing the environmental impact of ICT, such as IEEE 802.3 Energy Efficient Ethernet, the IEEE 1920 and IEEE 1680 family of standards on environmental impact assessment,

P7100 on measurement Measurement of Environmental Impacts of Artificial Intelligence Systems and P3469 on Environmental Liability Process Model for Accounting in Systems Engineering.

For more information, see: https://ieee-sa.imeetcentral.com/eurollingplan/.

IETF

The Energy Management (EMAN) Working Group has produced several specifications for an energy management framework, for power/energy monitoring and configuration. See http://datatracker.ietf.org/wg/eman/documents/ for the details. The framework focuses on energy management for IP-based network equipment (routers, switches, PCs, IP cameras, phones and the like).

A recently published standards track specification (RFC7603) presents the applicability of the EMAN information model in a variety of scenarios with cases and target devices. These use cases are useful for identifying requirements for the framework and MIBs. Further, it describes the relationship of the EMAN framework to other relevant energy monitoring standards and architectures.

The Internet Architecture Board has recently established the Environmental Impacts of Internet Technology (E-Impact) program as a venue for discussing environmental impacts and sustainability of Internet technology. Within this scope, the program looks at trends, issues, improvement opportunities, ideas, best practices, and subsequent direction of work related to Internet technology, architecture, and operations, including visibility and efficiency on energy and other environmentally-impacting attributes. In particular, the group focuses on Internet architecture's role in these topics.

See https://wiki.ietf.org/en/group/iab/Multi-Stake-Holder-Platform#h-343-ict-environmental-impact.

ECMA INTERNATIONAL

"ECMA-328 on determination of Chemical Emission Rates from Electronic Equipment and has been adopted by JTC 1 (ISO/IEC 28360). Ecma Technical Committee TC38 identifies and describes the environmental attributes related to ICT and CE (Consumer Electronics) products. TC38-TG1 specifically covers chemical emissions.

ECMA-74, the primary acoustic standard developed by Ecma Technical Committee TC26, defines ITTE and ICT product categories for noise measurements and specifies operating and mounting conditions for each product category. ECMA-109 prescribes how to declare noise emissions measured according to ECMA-74. The methods and transition guidelines for the EU Regulation 617/2013 implementing the Energy Related Products (ErP) Directive 2009/125/EC include ECMA-74 and ECMA-109 for acoustic noise and ECMA-383 (EN Journal C110/113 11.04.2014, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:JOC_2014_110_R_0005&from=FR)."

UNI (ITALY)

UNI published a pre-standardization document UNI/PdR 147:2023 on "Digital sustainability - Requirements and indicators for innovation processes" defining the requirements and key performance indicators (KPIs) that digital transformation projects shall have in order to be considered consistent with the Sustainable Development Goals (SDGs) of Agenda 2030.

The document addresses Action 6 in this chapter and is available for download (in Italian): https://store.uni.com/en/uni-pdr-147-2023.

Energy saving measures

CENELEC

Other ongoing work includes EN50523:2009 Household appliances interworking.

ISO

Energy model terminology is specified in:

- ISO/IEC CD 13273 (Energy efficiency and renewable energy sources)
- ISO/DTR 16344 (Common terms, definitions and symbols for the overall energy performance rating and certification of buildings)
- ISO/CD 16346 (Assessment of overall energy performance of buildings)
- ISO/DIS 12655 (Presentation of real energy use of buildings)
- ISO/CD 16343 (Methods for expressing energy performance and for energy certification of buildings)
- ISO 50001:2011 (Energy management systems — Requirements with guidance for use).
- ISO/TC 257 General technical rules for determination of energy savings in renovation projects, industrial enterprises and regions` is currently working on a standard on "energy efficiency and savings calculation for countries, regions and cities" (ISO/CD 17742)

ITU-T

Report "Intelligent sustainable buildings for smart sustainable cities", which provides technical guidance on environmentally-conscious design, maintenance, repair and operating principles and best practices from construction through to lifetime use and decommissioning http://www.itu.int/en/ITU-T/focusgroups/ssc/Documents/website/web-fg-ssc-0136-r6-smart-buildings.docx and other reports from the FG-SSC: http://www.itu.int/en/ITU-T/focusgroups/ssc/Pages/default.aspx

DATA CENTERS

CEN-CENELEC-ETSI

Coordination Group *Green Data Centres*

CENELEC

CLC/TC 215 'Electrotechnical aspects of telecommunication equipment' continues to revise the EN 50600 series of standards 'Information technology - Data centre facilities and infrastructures'. The 2nd editions of EN 50600-2-1 (on building construction) and EN 50600-2-5 (on security systems) were published in 2021. Furthermore, new KPI standards EN 50600-4-6 (Energy Reuse Factor, ERF) and EN 50600-4-7 (Cooling Efficiency Ratio, CER) have been published. Currently, the first edition for the „Data Centre Maturity Model for energy management and environmental sustainability" is under formal vote as CLC/TS 50600-5-1. This document uses the recommended practices of

CLC/TR 50600-99-1 for energy management (based on JRC's Best Practices document) and CLC/TR 50600-99-2 on environmental sustainability as a means to achieve defined maturity levels. CLC/TC 215 intends to publish additional KPIs standards for water usage effectiveness and carbon usage effectiveness by the end of 2022.

ETSI

TC ATTM has developed Global KPIs for Energy Management of Data Centres.

ETSI's industrial specification group (ISG) operational energy efficiency for users (OEU) gathers ICT users from the whole industry (all sectors, e.g. aircraft factories, banks, insurances, energy providers) and communities (e.g. European metropolises) and issues position papers and referential specifications on global KPIs and implementation sustainable standardisation. These position papers are issued to support the development of needed standards by standardisation technical committees.

ISO/IEC JTC 1

ISO/IEC JTC 1/SC 39 'Sustainability, IT & Data Centres' Working Group 1 deals with resource-efficient data centres, including the following tasks:

- Development of a data centre resource efficiency taxonomy, vocabulary and maturity model
- Development of a holistic suite of metrics and key performance indicators (KPI) for data centres
- Development of guidance for resource efficient data centres
- Development of an energy management system standard specifically tailored for data centres

ISO/IEC JTC 1/SC 39 Working Group 3 deals with the design and operation of sustainable data centre facilities and infrastructures.

https://www.iso.org/committee/654019.html

The ongoing standardisation activities by CEN & CENELEC and ETSI on data centres and other ICT nodes may be referenced in possible future legislation.

(C.2) OTHER ACTIVITIES RELATED TO STANDARDISATION

EUROPEAN COMMISSION

With the support of ICT companies, concluding the piloting of various methodologies for goods, networks, services & organisations. Elements such as compatibility and the workability of different standards have been assessed with a positive outcome regarding these two elements. The results can serve as an example, for ITU & ETSI in their common work to further align their methodologies for "goods, networks and services".

The EC has funded two studies that analyse the issue of growing energy consumption due to the expansion of cloud services in Europe, and put forward measures towards achieving the Digital Strategy goal of "climate neutral and highly energy efficient data centres and electronic communication networks and services by 2030" respectively.

- Energy-efficient Cloud Computing Technologies and Policies for an Eco-friendly Cloud Market
- Study on Greening Cloud Computing and Electronic Communications Services and Networks: Towards Climate Neutrality by 2050

The guidebook "*Stimulating industrial innovation in the construction sector through the smart use of ICT: connecting SMEs in digital value chains*" (2012)

- provides a market analysis of the construction industry in terms of the current and foresight integration of ICT and eBusiness solutions and systems;
- develops a framework for digital value networks in the construction sector.

https://ec.europa.eu/growth/sectors/digital-economy/ebsn_en

CLUSTER COLLABORATION FP7-SMARTCITIES-2013

Objective ICT-2013.6.2.

Data Centres in an energy-efficient and environmentally friendly Internet define common KPIs and ratios (metrics) and methodology for measuring them, to characterize the energy & environmental & economic behaviour of data centres. They disseminate the results and create a proper bidirectional communication channel between the Commission, the standardisation bodies and the cluster, to facilitate information sharing and to push a relevant shortlist of KPIs.

H2020 CITYKEYS

H2020 support action which coordinates projects in several cities piloting the L.Cities methodology (Recommendation ITU-T L.1440). Results of these pilots may provide feedback to improve the standard. The project piloted the L.Cities methodology (Recommendation ITU-T L.1440) in Tampere and Rotterdam. Results of these pilots can provide feedback to improve the standard.

http://www.citykeys-project.eu/

H2020 COREALIS

COREALIS proposes a strategic, innovative framework, supported by disruptive technologies, including Internet of Things (IoT), data analytics, next generation traffic management and emerging 5G networks, for cargo ports to handle upcoming and future capacity, traffic, efficiency and environmental challenges. The proposed beyond state of the art innovations, target to increase efficiency and optimize land use, while being financially viable, respecting circular economy principles and being of service to the urban environment. The innovations will be implemented and tested in real operating conditions in **5 Living Labs**, namely Piraeus port, Valencia port, Antwerp port, Livorno port and Haminakotka port.

https://www.corealis.eu/

SEMANCO

For the first time developing a Semantic Energy Information Framework (SEIF) to model the energy-related knowledge planners and decision makers need.

EESEMANTICS

Stakeholder group on Energy Efficient Buildings Data Models. Building on the standards promoted by Building Smart Alliance.

WORKING GROUP ON ENERGY CONSUMPTION

In the area of smart appliances (white goods, HVAC systems, lighting, etc.) a working group has been established bringing together energy consuming and producing products (EupP) manufacturers and stakeholders with the objective of creating a roadmap towards agreed solutions for interoperability. The focus is on communication with smart appliances at the information level in smart homes. The long-term perspective is M2M solutions in the context of IoT.

JRC

JRC - Best Environmental Management Practice

In Spetember 2020 a document on Best Environmental Management Practice (BEMPs) for the Telecommunications and ICT services sector was published, with references to various standards. https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/best-environmental-management-practice-telecommunications-and-ict-services-sector

EURECA

EURECA project

The "Data Center EURECA project" provides valuable information on "resource efficient procurement" of data centers.

https://www.dceureca.eu/

EUROPEAN GREEN DIGITAL COALITION (EGDC)

The European Green Digital Coalition (EGDC) is an initiative of companies, supported by the European Commission and the European Parliament, based on the request of the EU Council, which aims to harness the enabling emission-reducing potential of digital solutions to all other sectors. The EGDC is developing science-based methodologies to estimate the net environmental impact of real-life digital solutions, i.e. the positive impact as well as the solutions' own footprint. Link: https://www.greendigitalcoalition.eu

The impact will strongly depend on the uptake of these methodologies and associated regulation, if defined. Once this point is clarified the progress could be measured in, for instance, the number of companies reporting their footprint calculated using these methodologies.

3.4.4. European Electronic Toll Service (EETS)

A Policy and legislation

(A.1) POLICY OBJECTIVES

The European electronic toll service (EETS), as required by Directive (EU) 2019/520 (recast), repealing Directive 2004/52/EC and Commission Decision 2009/750/EC , is aimed at achieving interoperability of the electronic road toll systems in the EU. EETS involves two main stakeholders:

- Toll chargers, which operate either on behalf of a Member State or in the framework of a concession contract with a Public Authority of a Member State, levy the tolls for the circulation of vehicles on the road network in which they operate.
- EETS providers, supplying drivers or vehicle owners with the necessary equipment and services to access tolled infrastructures in the EU and ensuring the payment to the toll chargers of the fees due for use of their network.

The Directive (EU) 2019/520 of the European Parliament and of the Council of 19 March 2019 on the interoperability of electronic road toll systems and facilitating cross-border exchange of information on the failure to pay road fees in the Union (recast) started to apply on 19 October 2021. The Commission adopted on 28 November 2019 a Delegated and an Implementing Act which started to apply on the same date as the Directive.

Directive 2004/52/EC and Decision 2009/750/EC were repealed on 20 October 2021.

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

It is necessary to further develop standards, and to revise and update existing standards, to define communication between Toll Chargers and EETS providers, to define profiled requirements for interoperable electronic fee collection (EFC), and support the effective assessment of conformity to specifications, certification and suitability for use of EETS-related standards (underpinned by test standards).

(A.3) REFERENCES

- Directive (EU) 2019/520 of the European Parliament and of the Council of 19 March 2019 on the interoperability of electronic road toll systems and facilitating cross-border exchange of information on the failure to pay road fees in the Union on the interoperability of electronic road toll systems and facilitating cross-border exchange of information on the failure to pay road fees in the Union (recast).
- Commission Implementing Regulation (EU) 2020/204of 28 November 2019 on detailed obligations of European Electronic Toll Service providers, minimum content of the European Electronic Toll Service domain statement, electronic interfaces, requirements for interoperability constituents and repealing Decision 2009/750/EC
- Commission Delegated Regulation (EU) 2020/203of 28 November 2019 on classification of vehicles, obligations of European Electronic Toll Service users, requirements for interoperability constituents and minimum eligibility criteria for notified bodies
- Directive 2004/52/EC of the European Parliament and of the Council on the interoperability of electronic road toll systems in the Community;
- Commission Decision 2009/750/EC on the definition of the EETS and its technical elements;
- COM(2012)474 Implementation of the EETS.

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

ACTION 1: Technical support to keep the EETS legislation fit for purpose and, notably, advice on relevant new editions or standards that the legislator ought to consider when updating the Commission Implementing and Delegated Regulations.

ACTION 2: Periodic review and update, when necessary, of technical standards that support the EETS[1]. That includes improvement of technical standards based on feedback from actual implementation in tolling systems and maintaining consistency between these standards.

ACTION 3: Support the EC with advice and expertise in technical standards-related activities in the field of the EETS. Support the Notified Bodies Coordination Group in its activities defined in Article 20 of Directive (EU) 2019/520, related to Recommendations for Use (incl. listing of applicable standards). Support the Electronic Toll Committee and the ITS-CG in matters related to technical standards for electronic tolling and the EETS.

ACTION 4: Monitor and support relevant activities and update, when necessary, relevant technical standards to ensure long-term availability of DSRC tolling technology and improve its robustness against other radio technologies. This action also includes relevant support activities in interference and mitigation technique studies to enable sharing between EFC using DSRC and avoid interferences on EFC using DSRC by ITS-G5 and 5 GHz Radio Local Area Network devices, and other services operating in the 5GHz band.

ACTION 5: In accordance with Article 3(2) of Directive (EU) 2019/520, the Commission has requested CEN to revise the existing European standards to include information related to the automatic number plate recognition (ANPR) technology.

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

CEN

CEN/TC 278 — standardisation of Intelligent Transport Systems in Europe. CEN/TC 278/WG 1 standardises EFC. An overview of EFC standards and links to the standardised data structures and test suites may be consulted at https://www.itsstandards.eu/25-2/wp-1/

The following CEN EFC standard deliverables are referenced in the Directive (EU) 2019/520 and the associated European Commission Draft Implementing and Delegated Acts:

Dedicated Short-Range Communication (DSRC) charging transactions: EN 15509:2014 and EN 15876-1:2016

Real-time compliance checking transactions: EN ISO 12813:2019 and EN ISO 13143-1:2016

Localisation augmentation: EN ISO 13141:2015 and EN ISO 13140-1:2016

The electronic interfaces for DSRC- and GNSS-based schemes between the toll charger and the EETS provider: CEN/TS 16986:2016/AC:2017

Vehicle classification parameters: EN ISO 14906:2018

The standards mentioned above are periodically maintained, as all standards. The following are newly revised standards of documents, whose previous versions are cited in the recast of the EETS legislation; EN ISO 13143-1:2020 and EN ISO 14906:2018/Amd 1:2020

The following are ongoing or shortly upcoming revisions of relevant standards:

Review of EN 15509:2014 is ongoing

CEN/TS 16986 is being updated and converted into an EN. The CEN Enquiry is expected to be launched early 2022. The corresponding test standard CEN/TS 17154- parts 1 and 2 will be revised once prEN 16986 has been launched for CEN Enquiry.

A CEN new work item has been proposed entitled *EFC - Pre-study on the use vehicle license plate information and automatic number plate recognition (ANPR) technology*, in response to Directive (EU) 2019/520. It should notably lead to recommendations for extensions or new standards to close identified gaps in this proposed pre-study.

ETSI

ETSI TC ITS standardisation of Intelligent Transport System communication protocols in Europe

http://www.etsi.org/technologies-clusters/technologies/intelligent-transport

ISO

ISO TC 204 standardisation of Intelligent Transport Systems globally. ISO/TC204/WG5 standardises Electronic Fee Collection in close co-operation with CEN/TC278/WG1.

Systematic Review of ISO 12855:2015 – Information exchange between service provision and toll charging.

Revision of ISO 12813:2015 - Compliance check communication for autonomous systems.

(C.2) ADDITIONAL INFORMATION

It is required to further develop standards to support (i) maintenance of existing EFC standards, (ii) assessment and monitoring of key performance indicators for EETS (iii) conformity assessment of implementations to standards, EETS suitability for use and product certification (supported by test standards). It is also necessary to provide support for EFC standardisation activities in form of (iv) targeted technical standards as support for EETS-related activities.

[1] http://ec.europa.eu/growth/tools-databases/mandates/index.cfm?fuseaction=search.detail&id=216

3.4.5 Intelligent Transport Systems - Cooperative, Connected and Automated Mobility (ITS-CCAM) and Electromobility

A Policy and legislation

(A.1) POLICY OBJECTIVES

Intelligent transport systems apply ICT to the mobility sector. ITS services and applications help to significantly improve road safety, traffic efficiency and comfort, by helping transport users to take the right decisions and adapt to the traffic situation. They also help to increase the number of multimodality options and improve travel and traffic management. contributing to the EU's single market, competitiveness and the Green Deal objectives.

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

To take full advantage of the benefits that ICT-based systems and applications can bring to the mobility sector it is necessary to ensure interoperability and continuity of the services among the different systems throughout Europe. The existence of common European standards and technical specifications is paramount to ensure the interoperability of ITS services and applications and to accelerate their introduction and impact. International cooperation aiming at global harmonisation should be pursued.

(A.3) REFERENCES

- Regulation (EU) 2023/1804 of the European Parliament and of the Council of 13 September 2023 on the deployment of alternative fuels infrastructure.
- Directive (EU) 2019/1161 of the European Parliament and of the Council of 20 June 2019 amending Directive 2009/33/EC on the promotion of clean and energy-efficient road transport vehicles.
- Commission Implementing Regulation (EU) 2018-732 on a common methodology for alternative fuels unit price comparison in accordance with

Directive 2014/94/EU of the European Parliament and of the Council.Commission Delegated Regulation (EU) 2019/1745 supplementing and amending Directive 2014/94/EU as regards recharging points for L-category motor vehicles, shore-electricity supply for inland waterway vessels.

- COM(2018)283 final: On the road to automated mobility: An EU strategy for mobility of the future
- COM (2016) 766 A European strategy on Cooperative Intelligent Transport Systems, a milestone towards cooperative, connected and automated mobility.
- Directive 2010/40/EU of the European Parliament and of the Council on the framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport
- Directive (EU) 2023/2661 of the European Parliament and of the Council of 22 November 2023 amending Directive 2010/40/EU on the framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport.
- Commission Implementing Decision of 12 November 2024 establishing a working programme for Directive 2010/40/EU for the period 2024-2028
- COM(2019) 464 final Report to the European Parliament and the Council on the implementation of Directive 2010/40/EU.
- Commission Delegated Regulation (EU) No 305/2013 supplementing Directive 2010/40/EU of the European Parliament and of the Council with regard to the harmonised provision for an interoperable EU-wide eCall
- Commission Delegated Regulation (EU) 2024/1084 of 6 February 2024 amending Delegated Regulation (EU) No 305/2013 supplementing Directive 2010/40/EU of the European Parliament and of the Council with regard to the harmonised provision for an interoperable EU-wide eCall
- Commission Delegated Regulation (EU) No 885/2013 supplementing ITS Directive 2010/40/EU of the European Parliament and of the Council with regard to the provision of information services for safe and secure parking places for trucks and commercial vehicles
- Commission Delegated Regulation (EU) No 886/2013 supplementing Directive 2010/40/EU of the European Parliament and of the Council with regard to data and procedures for the provision, where possible, of road safety-related minimum universal traffic information free of charge to users
- Commission Delegated Regulation (EU) 2022/670 supplementing Directive 2010/40/EU of the European Parliament and of the Council with regard to the provision of EU-wide real-time traffic information services
- Commission Delegated Regulation (EU) 2017/1926 of 31 May 2017 supplementing Directive 2010/40/EU of the European Parliament and of the Council with regard to the provision of EU-wide multimodal travel information services
- Commission Delegated Regulation (EU) 2024/490 of 29 November 2023 amending Delegated Regulation (EU) 2017/1926 supplementing Directive 2010/40/EU of the European Parliament and of the Council with regard to the provision of EU-wide multimodal travel information services.
- Directive (EU) 2019/1024 on open data and the re-use of public sector information
- Commission Implementing Decision (EU) 2023/138 of 21 December 2022 laying down a list of specific high-value datasets and the arrangements for their publication and re-use
- Commission Decision 2008/8455/EC final on the conclusion of an Implementing Arrangement between the European Commission and the Department of Transportation of the United States of America in the field of research on Intelligent Transport Systems and Information and Communication Technologies applications to road transport
- COM(2008)886 final: Commission Communication Action Plan for the deployment of intelligent transport systems in Europe
- Commission Implementing Decision (EU) 2020/1426 of 7 October 2020 on the harmonised use of radio spectrum in the 5 875-5 935 MHz frequency band for safety-related applications of intelligent transport systems (ITS) and repealing Decision 2008/671/EC (notified under document C(2020) 6773)
- Recommendation C/2006/7125: Safe and efficient in-vehicle information and communication systems: update of the European statement of principles on human machine interface (EsoP).
- COM(2016)787 final: Reporting on the monitoring and assessment of advanced vehicle safety features, their cost effectiveness and feasibility for the review

of the regulations on general vehicle safety and on the protection of pedestrians and other vulnerable road users

- RSCOM17-26 rev.3 : Standardisation Request to CEPT to study the extension of the Intelligent Transport Systems (ITS) safety-related band at 5.9 GHz
- Standardisation request M/581 – Commission Implementing Decision of 24/032022 on a standardisation request to the European standardisation organisations as regards communication exchange, electricity and hydrogen supply for road, maritime transport and inland navigation.
- Directive (EU) 2018/1972 establishing the European Electronic Communications Code (Recast)Text with EEA relevance – the code regulates General Authorisations and gives guidance on the concept of 'technology neutrality' and how to implement it
- COM (2016) 588 5G for Europe: An Action Plan – the action plan sets out how 5G is to be deployed along Europe's roads and co-exists with existing technologies and according SWD (2016) 306Directive (EU) 2019/520 the interoperability of electronic road toll systems and facilitating cross-border exchange of information on the failure to pay road fees in the Union – this directive sets the 5.8 GHz microwave technologies as road tolling technology and Commission Delegated Regulation (EU) 2020/203 sets CEN DSRC as tolling standard
- Regulation (EU) No165/2014 on tachographs in road transport – obliges truck manufacturers to integrate remote enforcement interfaces in to trucks in the EU Commission Implementing Regulation (EU) 2016/799 making a CEN DSRC interface mandatory for smart tachographs in new vehicles from March 2022 onwards.
- Directive (EU) 2015/719 laying down maximum authorised dimensions and the maximum authorised weights makes CEN DSRC the remote enforcement interface for trucks in Europe and Commission Implementing Regulation (EU) 2019/1213 elaborates further on the technical implementation of on-board weighing equipment stipulating the use of CEN DSRC as enforcement interface and the use of C-ITS for the truck-trailer communication

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

B.1 GENERAL ACTIONS

ACTION 1.1: Work to organise and lay down governance principles to enable the development of a coherent set of domain ontologies (to enable re-use and extension, instead of replication, or even worse: different models) for datasets within scope of the delegated regulation and directly adjoining ones based on the linked data principles.

ACTION 1.2: Building on the work of the DATEX II PSA and the ongoing work within NAPCORE, undertake actions to revise DATEX II standards to support a wider range and approaches to publishing data.

ACTION 1.3: Building on the work of the DATA4PT CEF Programme Support Action, NAPCORE project and foreseen work of CoRoM undertake actions to revise Transmodel-based standards (NeTEx, SIRI, OJP, OpRa) to support a wider range and approaches to publishing multimodal data.

(B.2) COOPERATIVE, CONNECTED AND AUTOMATED MOBILITY (CCAM)

ITS to support the development of cooperative, connected and automated mobility. ITS services in general, and C-ITS (cooperative ITS) services in particular, along with the introduction of driving automation functionalities in vehicles are generally seen as converging paths: vehicles being connected to the mobility ecosystem in their immediate vicinity (other vehicles, infrastructure) and to the wider mobility ecosystem (central traffic management systems, other modes of transport, etc.), and to the internet.

As stated in the GEAR 2030 report1, vehicle-to-everything (V2X) connectivity should act as an additional enabler for the operation of highly and fully automated vehicles that will hit EU roads by 2030. Connectivity and cooperation can add collective intelligence and action to automation, thus improving the overall efficiency of transport flows, including in an intermodal perspective. For some functionalities and operations, it will even be essential.

Standards need to adhere to EU legislation and to maintain existing radio services in adjacent spectrum

bands, e.g. electronic road charging, the smart tachograph and weights and dimensions enforcement.

ACTION 2.1: To complete the minimum set of standards required for the interoperable deployment of CCAM services based on V2X communication, connecting all road users and infrastructure, including vulnerable road users (VRU), and ensuring the overarching principles set out in the ITS Directive, in particular by:

- achieving the Release 2 of ETSI TC ITS (TR 101 607) and CEN & CENELEC C-ITS standards;
- maintaining the Release 1 of the ETSI TC ITS and CEN & CENELEC C-ITS standards taking into account the feedback from pilots and early deployments:
- building on IEEE 802.11bd-2022 which is final and provides for Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 5: Enhancements for Next Generation V2X

ACTION 2.2: Plugtest activities for conformity and interoperability testing, including guidelines with methods for assessing the conformity of the identified minimum set of standards.

ACTION 3: SDOs are invited to develop and perform an in-depth scrutiny of CCAM services from the standardisation standpoint, taking into account existing architectures, current standards and technical specifications. The analysis should identify missing complementary standards and identify possibly conflicting standards with the overarching objective of delivering full application and service interoperability. The analysis should be based on currently implemented technologies (notably those recognised by the 17 Member States and other countries within the C-Roads platform, and subject to automotive deployment in line with COM (2016) 766) while also considering newly emerging technologies (in line with the 5G Action Plan) and build upon the principles and results of the RSCOM Mandate to CEPT (RSCOM17-26 rev.3) with the aim at achieving interoperability between various services.

Such a study has been undertaken by CEN TC278/WG17 jointly with ISO TC204/WG19. The result was published April 2022 is documented here: https://isotc.iso.org/livelink/livelink/Open/22166135

A further study in the CCAM community should be done to verify these findings, and prioritize actionable recommendations.

ACTION 4: SDOs should continue to support the implementation of a pan-European usable trust policy and processes to support multi-stakeholder business cases. In particular SDO should address misbehaviour detection and revocation of trust for C-ITS stations

ACTION 5: SDOs should continue international cooperation in the field of ITS and CCAM standardisation. See also Harmonization Task Group efforts in annex (C.1) Related standardisation activities.

OPEN IN-VEHICLE PLATFORM ARCHITECTURE AND HMI

The development, operation and user acceptance of vehicle-based intelligent transport systems and services will benefit from an agreed open in-vehicle platform architecture enabling a 'single platform —multiple services' approach and ensuring interoperability/ interconnection with legacy in-vehicle communication networks (e.g. CAN-bus) and (generic) infrastructure systems and facilities.

The issue so far has been addressed in a fragmented way, providing building blocks (e.g. the research projects CVIS, GST, OVERSEE, the eSafety working group on SOA and the recommendations of the EeIP Task Force OPEN, and the ITS study) but an overall logical and cost-effective synthesis seems to be lacking. C-ITS standards should also be taken into account. A study launched under the ITS Action plan (action 4.1) focused on synergies among legal provisions and obligations for heavy goods vehicles (HGV).

Currently, significant efforts are to be made on the messages and information within different platforms and how it will be displayed in the vehicle.

Working group 6 ("Access to in-vehicle data and resources") of the C-ITS Platform identified 3 possible technical solutions (on-board application platform, in-vehicle interface, data server platform) for accessing and sharing in-vehicle data. The following related standardisation needs have been identified:

ACTION 6: SDOs to continue developing standards for an advanced physical/electrical/logical interface including the necessary minimum level of security (i.e. integrity, authentication and availability) and the minimum data sets and standardised data protocols which enable ITS services, taking also into account the existing ISO standards including ISO 21177, ISO 21184, and ISO 21185 for access to in-vehicle data, and, if appropriate, ISO 20077-1:2016. This would include aspects on information via HMI or any other device regarding traffic related safety information.

ISO 21177:2023 is a new standard from ISO TC204 ITS that leverages C-ITS cybersecurity by applying the

ITS certificates (ETSI and IEEE p1609.2) and the related support infrastructure (PKI). This standard applies the service specific permissions to regulate access rights over Internet and can be directly used for vehicle data access control. A full European profile can be based on the CEN-ISO suite of 21184, 21185 and 21185 together with ISO 21177.

ELECTRIC VEHICLES (EVS) AND THEIR CHARGING INFRASTRUCTURE

Following the development of the electric vehicle market, new standardisation elements must be developed to underpin the deployment of charging infrastructure, particularly to facilitate the communication aspects between the charging infrastructure and EVs. The charging infrastructure must be fully integrated into the electricity system, allowing for new features such as 'Plug & Charge' or smart charging and bidirectional V2G services within a smart electricity system. The new standardisation elements identified must ensure that all actors, including e-mobility service providers (EMSPs) and e-roaming platforms have access to a fair market, based on sound interoperability requirements.

To support the development of standards for alternative fuels, DG MOVE has also adopted in 2022 a new standardisation mandate (M/581 COMMISSION IMPLEMENTING DECISION C(2022)1710 of 24.3.2022) which includes the development of European standards considering the following communication domains:

- In the EV Charging ecosystem:
  - EV-CP
  - CP-CPO
  - back-end (management system)
  - CPO-e-Roaming platform-EMSP

On that baisis, further action is needed to fill in the standardisation gap regarding the future EU Public Key Infrastructure (PKI) ecosystem for e-mobility. In particular, a standard is needed to cover the EU PKI technical requirements for a Certificate Trust List (CTL) working in combination with the standard ISO 15118 on vehicle-to-grid communication. This standard is key to ensure the interoperable and secure development of the e-mobility market, including the implementation of plug & charge solutions for automatic identificaiton and authorization of charging processes.

ACTION 7: Adaptation of "ETSI TS 102 941" to create a new standard defining the relevant technical specifications for the EU Public Key Infrastructure (PKI) for e-mobility based on a Certificate Trust List (CTL). The new standard shall be developed considering a full integration with ISO 15118, which is the main standard for communication (i.e., exchange of digital certificates) between electric vehicles and the charging infrastructure.

ACTION 8: Update of DATEX II Energy infrastructure data model to include new data types on electric recharging and hydrogen refuelling infrastructure. Need to consider the recommendations from the Sustainable Transport Forum (STF) expert group.

DIGITAL MAPS & LOCATION FEATURES:

It may be relevant to many services and applications to make use of a high precision location reference beyond current global navigation satellite systems aiming at enabling more effective and advanced services. To achieve this, all functional and technical methods need to be used (e.g. crowd sourcing, high precision objects and radio communications).

ACTION 9: SDOs to standardise data and communication aspects to ensure interoperable implementation and data sharing system for increased location referencing quality. Part of this task is available from CEN TC278/WG17 in the CEN/TS 17297 series on Location Referencing Harmonisation for Urban-ITS. Part 1: Transformation methods and Part 2: State of the art and guidelines. Further parts are needed to adapt these existing methods towards the new generation of digital map representations.

DIGITAL MAPS:

ACTION 10: SDOs to develop standards / specifications to steer and manage the exchange of accurate (public) road data in navigation-oriented maps, and of the timely integration of such updates in ITS digital maps for navigation and more advanced in-vehicle applications, including ITS applications for CCAM services and automated driving support, and for non-vehicle ITS applications. As far as possible, it will be significant to address the largest alignment with the technical framework for infrastructure for spatial information in the European community (INSPIRE).

Acknowledging that much of the standardisation work that is on-going is undertaken within ISO committees, but result in European Standards, the SDOs need to work closely with industry partners from the digital maps navigation sector plus representative highway authorities to develop a baseline standard for the coding of road network data for publication from highway authorities. This standard will be an evolution of the GDF EN ISO 20524 standards family. This is intended to link to, but not define, commercially delivered

map-based services to support, amongst other services, on-road navigation. This evolution shall be cognisant of the technical framework for infrastructure for spatial information in the European community (INSPIRE). It also needs to be consistent with the needs implies by the application of Directive (EU) 2019/1024 on open data and its implementing regulation which lists among the high-value datasets the mobility theme as defined in Annex I to Directive 207/2/EC.

DIGITAL LOCAL DYNAMIC MAPS:

ACTION 11: SDOs to extend the local dynamic map standards to integrate mechanisms supporting the use of high precision positioning, related objects and other collected data, in particular for some relevant safety related applications. This may require additional specific object definition standardisation.

(URBAN) ITS – MULTIMODAL SERVICES

Following the conclusion of the Standardisation request on urban ITS M/546, a pre-study on Urban ITS was carried out by CEN/TC 2782 to identify further standardisation needs. The report can be downloaded from: https://www.cen.eu/news/brochures/brochures/Urban_Intelligent_Transport_CEN-TC-278.pdf . It identified several actions, which were used as input to the EC Standardisation request M546:

ACTION 12: As possible further activities in relation to standardisation work on Urban ITS, the Commission will also discuss the following aspects with the ESOs and stakeholders:

The requested European standards and European standard deliverables should reuse, harmonise or interface as far as possible with existing standards, specifications (incl. priority actions A and B within the ITS Directive) and projects (CIVITAS, POSSE and smart cities projects etc.). In the domain of public transport, and particularly with respect to multimodal information and smart ticketing, the need for consistency will affect a broad set of standards and technical specifications, namely:

- Transmodel the European Public Transport Reference Data Model (EN 12896);
- SIRI (System Interface for Real-time Information EN 15531 1-4 & CEN TS 15531-5), largely based on Transmodel: defines standard exchanges of real- time public transport information and being extended to include new mobility services (sharing, pooling, rental and taxis);
- NeTEx (Network and Timetable Exchange, CEN TS 16614 1-6), based on Transmodel parts 1,2,3 and 5: defines a physical data model and standard exchanges of planned public transport information and being extended to include new mobility services (sharing, pooling, rental and taxis);
- OJP (Open Journey Planner, CEN TS 17118) defines an open API for distributed journey planning allowing systems to exchange information in order to provide cross-border or intermodal journey planning, or new and innovative information services.
- Standards supporting the emerging interoperable fare management (IFM) systems: Public Transport interoperability (IOPTA) standard ISO EN 15320 defines the functional system architecture and the application scenarios; the EN 1545 standard describes the data elements and the ISO EN 24014-1 standard, currently under revision, defines a reference functional architecture for IFMSs and establishes the requirements that are relevant for ensuring interoperability between several actors in the context of the use of electronic tickets.
- OpRa (Operating Raw data and statistics exchange): supports the identification of Public Transport raw data to be exchanged, gathered and stored in order to support the study and control phase of Public Transport Service and to enable Quality of Service evaluation. The work is compliant with Transmodel.

Necessary actions, in particular to fully satisfy the requirements of the Delegated Regulation EU 2017/1926 (priority action A): Public Transport:

ACTION 12 A: continue defining data exchange formats and publication services related to OpRa in compliance with Transmodel and NeTEx.

ACTION 12 B: continue developing NeTEx and SIRI European minimum profiles in order to support the requirements of the priority action A alongside an EU fare profile.

ACTION 12 C: continue developing data models for alternative fuels infrastructure, including the emerging needs concerning the communication of recharging stations with the grid. Concretely, new data models should cover the exchange of information regarding price, demand response, load control, metering and capacity forecast The work shall be in coherence with existing standards, Transmodel/ NeTEx/SIRI/ DATEX II – CEN/prTS 16157-10 and -12

Link Road Transport / Public transport

ACTION 12 D: to develop European standards for

the entire pedestrian network (with accessibility features), for the cycling network (including attributes such as surface quality and side-by-side cycling), for cycle counting data (e.g. location of counters, infrastructure type, modes counted, direction, and number of passages), for cyclist behaviour data (e.g. immediate turn choices, route choices, travel speed, and waiting times), and for cycle parking, ensuring alignment with relevant frameworks for data exchange and transport modelling. The work shall take into account the existing results of INSPIRE. It shall also consider the achievements of the GDF standard and possibility of Open Street Map and shall be linked to Transmodel/NeTEx (in particular to trip/route representation) and Datex II (in particular for parking).

ACTION 12 E: to develop clear interoperability between key data modelling concepts for the parking domain, bringing alignment between existing standards (Transmodel/NeTEx, DATEX II and ISO/prTS 5206-1).

ACTION 12 F: to develop the data model/data exchange format of the overall typology of Points of Interest to support the requirements of priority Action A.

ACTION 12 G: to develop clear interoperability between Transmodel/NeTEx service network and the INSPIRE infrastructure network in order to respond properly to the provisions of priority Action A.

ACTION 12 H: continue developing a glossary of terms with their definitions in the context of ITS, based as far as possible on the Public Transport Reference Data Model (Transmodel)

ACTION 12 I: Development of European standards for application programming interfaces (APIs) for the distribution of transport tickets, barcodes to enable interoperable ticketing.

ACTION 12 J: On the basis of the work done within NAPCORE and depending on further consultations between the Commission and Member State experts, to develop standards for unique EU identifiers (IDs) for multimodal access nodes (for scheduled modes and transport on demand where relevant).

ACTION 13: SDOs, to consider, in cooperation with the Commission and relevant stakeholders, possible further actions addressing the following aspects of Mobility Integration:

- To provide European Interoperable Standards for the content and applicability of traffic regulations and to provide standardised means to exchange Traffic Regulations robustly and securely between interested parties. The standards to be based on the ISO 24315 METR series. It is also necessary to provide mechanisms to support verification of content for Electronic Traffic Regulations and management/ governance policies for METR.
- To provide standards to manage operations and enforcement in controlled traffic zones (UVAR).
- Continue work on standards to manage services that impact or part of urban transport, e.g. management of road gritters, road maintenance operations, buses, waste collection, social service visits, etc. ITS technologies can be used to assist administrations to manage such services. This work has progressed to a large extent with SIRI-SX (Part 5). Any further work in that direction should be consistent and properly aligned with the existing SIRI work.

ACTION 14: SDOs to develop standards supporting the emerging IFM, taking into account the findings from the smart ticketing alliance and standard ISO TS 24192 (standard for communication between contactless readers and fare media with a focus on interoperability). This should include the development of:

- technical specifications and test procedures for the quality assurance of the interoperable fare medium;
- technical specifications and standards for profiles of information exchange between the operational entities in IFM; and
- a technical report for a security architecture framework.

ACTION 14 A: Develop a sales and reservation API using Transmodel data structures for sales and booking of simple (mono-modal) and combined (multi-modal) trip options, aligning as far as possible with the OSDM API.

DATA EXCHANGE AND REUSE

ACTION 15: Further development of the DATEX II standard taking into account input from road operators. The Programme Support Action (PSA) for Intelligent Transport Services for Road (ITS) in the framework of the Connecting Europe Facility (CEF) focused on the maintenance and further development of DATEX II for the provision of interoperable intelligent transport systems and services for road transport, in compliance with European specifications developed under the ITS Directive. Additional developments include the Systematic Reviews and revisions of Parts 8 and 9 of CEN 16157, adaptation and extensions to support additional datasets and provisioning of support for

Linked (open) Data. Due to the fact that DATEX II data are shared across service domain, developments should include realising interoperability at the data level in the DATEX II standards through the use of ASN.1 specifications for all data objects, thereby ensuring interoperability among services making use of such data and the various ASN.1 encoding schemes.

ACTION 15 A: Revision of the DATEX II foundational methodology standard (EN 16157-1) to better support multiple ICT technologies and to enable use of modern ICT developments.

ACTION 15 B: Revision of the DATEX II standards (CEN 16157 series) for representing traffic situation information, to enhance, streamline, and rationalise across multiple overlapping viewpoints including traffic situation publications, digital traffic regulations, VMS publications, traffic management plan publications, and dynamic lane control, and to take advantage of modern ICT developments.

ACTION 15 C: Revisions of the DATEX II common building block standards EN 16157-2 and EN 16157-7 to enhance, streamline, and take advantage of modern ICT developments

ACTION 15 D: Revision of the DATEX II standard EN 16157-5 for representing traffic data, to enhance, streamline, and take advantage of modern ICT developments.

ACTION 15 E: Revision of the DATEX II-based specification CEN TS 17241 for device status and faults, to better support device management data interchanges and improve interoperability with and reuse of the CEN 16157 series.

ACTION 15 F: Expansion of the DATEX II set of specifications to specify a mapping from DATEX II data models to JSON Schemas, to allow standardised JSON-based exchanges as desired by a significant user community.

ACTION 15 G: Merging of the TN-ITS (CEN TS 17268) and DATEX II specifications (primarily CEN TS 16157-11 on traffic regulations, but also foundational specifications) so that a data publisher does not need to consider implementing two different overlapping specifications for one use case.

ACTION 15 H: Extensive rewriting of the DATEX II specification CEN TS 16157-9 for data publications from traffic signal systems, to support new use cases and to remove usability problems and limitations of the existing specification.

ACTION 15 I: Expansion of the treatment of cyber-security in the exchange standards used with CEN DATEX II 16157 series (ISO TS 19468 and ISO 14827).

ACTION 15 J: Revision of relevant DATEX II data standards to improve coverage of the cycling mode – this will improve the CEN 16157 series parts 2, 10, 11 and 12.

ACTION 15 K: Development of a standard to extend the DATEX II Variable Message Signs (VMS) publication (EN 16157-4) to better enable translations from DATEX II publications to C-ITS messages, by including zones and traces for VMS including virtual VMS.

ACTION 16: European standardisation deliverables on reference data models, common data dictionaries and metadata structure across the three domains and specific European standards:

- Multimodal information services: new mobility services, alternative fuels infrastructure;
- Traffic management: static/dynamic road data, traffic and traffic control data, weather data and traffic prioritisation and access regulations; and
- Urban logistics: intelligent parking for light vehicles/ commercial vehicles/trucks and loading bays information and reservation services for special freight vehicles and logistic sectors

ACTION 17: Another issue is related to on board weighing systems for trucks, where different providers may equip the tractor and the trailers that it will tow. ETSI will deliver an interface standard and related security standards to ensure that the on board weighing computer in the tractor will be able to receive the weights per axle of any trailer, store them, secure them, and then calculate the total weight of the vehicle. The work will be based on cooperative intelligent transport systems (C-ITS).

ACTION 18: SDOs to consider standardisation activities in support of EU-wide data privacy policies (e.g. GDPR) in the area of ITS and CCAM, in compliance with European regulation and recommendations.

ACTION 19: Building on the collaboration between the DATEX PSA and the Alliance for Parking Data Standards, and the continued collaboration within the scope of NAPCORE, finalise the revision of the DATEX II on parking data publication standard (CEN/TS 16157-6) and ensure the necessary harmonisation with Transmodel/NeTEx.

ACTION 20: SDOs should continue to specify global common standards for the exchange of traffic

management and road-related data, noting the collaboration between NAPCORE, CEN/TC278/WG8 and ISO/TC204/WG9. This includes developments to support API specification.

ACTION 21: Provisioning of messaging structures and content complementary to the DATEX II standard (CEN 16157 series) to provide information about energy related infrastructure together with dynamic information on its availability (for example of electric charging station slots) is essential for vehicle drivers to determine their optimal routes and stops. This work will also take into account new forms of vehicles

ACTION 22: Further refine specifications for the electronic definition of traffic regulations (potentially revising CEN TS 16157-11 and collaborating in METR CEN/ISO developments). This work will need to be based on the outputs and recommendations of the NAPCORE project activities, in particular regarding possible overlap with TN-ITS (CEN/TS 17268) and the METR standards ISO 24315 series:

- Improve specifications for traffic technology device status and fault management (potentially replacing CEN TS 17241 with a more standardised part of the CEN 16157 series)
- Improve specifications for electronic definition and realisation of traffic management plans, strategies, measures and actions (potentially revising CEN TS 16157-8 and 16157-9)
- Improve traffic data exchange base standards to take into account evolving ICT trends, technologies and preferences, to keep them fit for purpose in the current decade (potentially revising EN 16157-1 and other dependent parts, and potentially creating new protocol and encoding specifications).

Based on the outputs and recommendations of the NAPCORE project activities, concerning further actions to harmonise parking data standards with possible revisions to CEN TS 16157-6 and ISO TS 5206-1, in alignment with parking data specifications from public transport standards in the TransModel, Siri and NeTEx CEN families.

PUBLIC-ARE MOBILE ROBOTS (PMR)

All of our cars are already slowly becoming 'connected vehicles'. But, of all the automated vehicle scenarios that our cities are most likely to face in the foreseeable future, the one that is likely to come soonest and to have the most unanticipated impacts, is the introduction of small robotic vehicles on the sidewalk.

Delivery robots are essentially containers on wheels that can ply sidewalks, intersections and roads over modest distances — without a human attendant — to carry food, packages, and documents. These PMRs will not just engage in package and food delivery, but also provide servant vehicles for pathway sweeping, snow removal, surveillance, equipment servicing, measurement, monitoring, repositioning dockless scooters to where they can be re-charged, shopping assistants, automated wheelchairs and potentially many other tasks.

Dozens of companies are already building and piloting small, electric sidewalk delivery robots with the goal of reducing the costs of delivering packages, parcels and food and parcels over their last mile. The reasons for this are quite easy to explain. The rapid developments in ICT and AI have enabled the 'dream' of automated servant vehicles to be realisable in respect of their mechanical instantiation, At the same time, cities are interested in reducing congestion and emissions from the use of trucks, vans, and other motor vehicles for deliveries — which have more than tripled in the past decade.

While the focus of attention of research, standardisation and regulation in respect of automated mobility has been directed towards connected and automated cars and LGVs, those vehicles will operate in a well organised domain encompassed by a century of regulations, and well established procedures and road management practices. There are no such established procedures and management practices for automated mobility devices on public pathways, bicycle lanes and other locations where interaction with vulnerable road users may occur.

ACTION 23: SDOs and research organisations, in cooperation with the Commission and relevant stakeholders, to develop deliverables addressing the following aspects:

Standards are needed to define the PMR paradigm, standardise the data that will need to be exchanged and its presentation, safety and reliability, journey data recorders, communications and cybersecurity, privacy, loading and unloading at the kerb, infrastructure support requirements, weather worthiness, mapping procedures, post-crash procedures, personal support and assistance, conformance requirements, etc.

Further research is needed into the societal consequences of automated mobility devices on public pathways and their interactions with people, in particular vulnerable road users or (e-)scooters, and other automated mobility devices.

Work has recently started in ISO TC204/WG19 under the ISO $448 series, and close cooperation from Europe is urgently needed to adapt to European urban needs.

SECURITY IN THE CONTEXT OF C-ITS

ACTION 24: SDOs to investigate security aspects of cooperative, connected and Automated Mobility (CCAM) and intelligent transportation systems. SDOs are invited to analyse the evolution of C-ITS 'Day1' standards from a security angle to support automated vehicles design and deployment. In particular, SDOs are invited to expand standards based on the already defined C-ITS security mechanisms to achieve appropriate levels of authenticity and integrity of messages being exchanged between fixed and mobile C-ITS stations for higher levels of automation use cases. Standards shall provide suitable mechanisms to support C-ITS services going beyond information services, building upon the C-ITS certificate & security policy published on the European C-ITS Point of Contact4 for the implementation of the EU C-ITS security credential management system according to COM (2016) 766 and COM(2018)283.

This work has started in ISO, CEN and ETSI. This is partly based on a request from the EC C-ITS Security WG updating the C-ITS Security Policy with a European profile for ISO 21177. There may be a need to extend this work to other ITS services and applications such as METR and other data publications needing regulative certainty.

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

CEN, ISO, ETSI

CEN & CENELEC and ETSI have been working together on a basic set of standards for Cooperative Intelligence Transport Systems (C-ITS) since 2014 on the so-called 'Release 1 specifications'. Work is currently underway in both CEN & CENELEC and ETSI to develop the next package of standards (Release 2).

CEN/TC 278 www.itsstandards.eu with ISO TC 204 and ETSI TC ITS [3]. Cooperation is also ensured through the ITS Standardisation Coordination Group (ITS-CG)

Release 1 has been finalised — see ETSI TC ITS technical report TR 101 067 with the Release 1 standards and the development of ISO TR 17465-3 with the CEN/ISO Release 1 list. A joint document listing Release 1 standards also includes relevant standards from other SDOs such as SAE and IEEE. Development of Release 2 is well advanced with all of the key documents in revision.

3GPP 4G LTE and 5G NR are also relevant, noting the commercial deployment of Release 15 5G networks, given that this access technology may also serve C-ITS purposes. The co-existence of technologies from 3GPP with those from ITS is being actively addressed in collaboration between ETSI and 3GPP SA6 in the context of the ETSI TVRA revision and updates in all of the ETSI TC ITS WG5 security documents. In particular with respect to Action 6 ETSI has addressed ISO 21177 and ISO 20077 in the developing update to TS 102 942 to ensure that on vehicle data and processes are protected from misuse by actors outside the vehicle.

ISO

ISO TC22 & ISO TC204 (CEN/TC278 WG16 & TC 301), SAE: In-vehicle Platform.

HLC & JWG between TC204 and TC22 discussing how to continue activities.

SAE looks at electrical connections related activities.

ETSI, CEN, ISO, SAE, IEEE Evaluation of the application of existing standards is an ongoing activity.

Harmonisation task groups (HTGs) are looking into harmonisation needs between the standards developed by the different organisations.

CEN, ETSI

CEN and ETSI are working, in consultation with main stakeholders (such as ASECAP, **5GAA** and C2C CC), to find an appropriate solution to ensure non-detrimental interference from ITS-G5 and 3GPP-based direct communication systems onto CEN DSRC technology at 5.8 GHz.

See also CEN/TR 16690 on Electronic fee collection — Guidelines for EFC applications based on in-vehicle ITS stations

CEN

CEN/TC 278 develop standards in the field of telematics to be applied to road traffic and transport, including those elements that need technical harmonization for intermodal operation in the case of other means of transport. It shall support: vehicle, container, swap body and goods wagon identification; communication between vehicles and road infrastructure; communication between vehicles; vehicle man machine interfacing as far as telematics is concerned; traffic and parking management; user fee collection; public transport management; user information.

CEN/TC278/WG3 develops Transmodel-based standards related to multimodal ecosystem. It includes TS 13149 series about Public Transport Vehicle Data, NeTEx series for planned data, SIRI series for real-time data, OJP API for journey planner, standards supporting interoperable fare management (IFM) systems and OpRa for observed data.

CEN/TC 278/WG 7: in charge of several work items including the TN-ITS specifications and a proposal to standardise the dictionary of the vehicle-generated data for map updates (Sensoris). WG 7 also works with ISO/TC 204/WG 3 jointly on several work items like e.g. GDF.

CEN/TC278/WG8: DATEX data exchange standards. DATEX II is a standardised e-language for traffic and travel data exchange between traffic control centres, traffic information centres and service providers. Further standardisation activities address new domains like energy infrastructure and traffic regulations, in particular for Urban Vehicle Access Regulations.

CEN/TC 278 WG17 was created specifically to address standardisation requirements for Urban ITS, initially focussing on the priority areas identified in M/546 but not limited only to these aspects. WG17 is not only a standards development group, but provides a cross cutting workspace to liaise with other SDOs.

ETSI, 3GPP

Cellular 4G LTE networks according to ETSI/3GPP TS 136 300 Rel. 14 and 5G NR networks according to ETSI/3GPP TS 138 300 Rel. 15 are commercially deployed, supporting all means of Internet Protocol (IP) based communication, including V2X.

ETSI TC ITS have acknowledged the importance of separating access layers (potentially with examples ITS-G5, LTE-V2X PC5 etc.) and upper layer protocols

Considering the continuing improvements of access technologies, e.g. LTE-V2X PC5, NR-V2X PC5, IEEE 802.110p and IEEE 802.11bd, it is important that the separation between access layers and upper layers is maintained in future standardisation.

Since edge computing is a key priority area for V2X services, ETSI ISG MEC (Multi-access Edge Computing) has established a collaboration with 5GAA (5G Automotive Association). Recently 5GAA also joined ETSI ISG MEC membership.

In addition with respect to Action 1 ETSI has developed a framework for device ontologies under the SAREF initiative and specifically supports a number of ITS related domains include SAREF4AUTO and SAREF4CITY (for integration to traffic management and planning), SAREF4ENER (to address EV charging), SAREF4ENVI (to address environmental aspects of transport). Full details can be found in https://saref.etsi.org

With respect to Action 2 ETSI continues to develop test specifications and to host interoperability events. This has recently been extended to ensure that tests are available for ITS Release 2.

In addressing Action 4 ETSI has developed a suite of standards for misbehaviour reporting including testing and interoperability plugtests. This work is ongoing and is being closely managed to ensure global interoperability.

As has been noted above ETSI is making inroads to assuring secure access to vehicle data as identified in Action 6 and has specifically addressed ISO 21177 and ISO 20077 in the developing update to TS 102 942 to ensure that on vehicle data and processes are protected from misuse by actors outside the vehicle.

The security standardisation work done in ETSI fully supports Action 25. This work has included addressing the threat of quantum computing with co-operative work across ETSI with TC CYBER and resulting in the recently published report on ITS Migration to a quantum safe cryptographic model (ETSI TR 103 949). ETSI works in close collaboration with the EC C-ITS policy group to ensure that the policy requirements for ITS deployment are fully supported by the ETSI standardisation programme.

Further work related to the Harmonized Standard for ITS is being performed in ERM TG37 while coexistence work with urban rail take place in TC RT/JTFIR (Joint Task Force TC ITS TC RT).

ETSI, IEEE

ETSI, in close collaboration with IEEE (for 1609.2 and 1609.2.1), maintain development of protocols for ITS Security. In 2021 the primary developments for C-ITS Release-2 Security have been completed and extensions to address misbehaviour reporting (TS 103 759), as well as developing a wider understanding of the risk environment are at the forefront of the security workplan. This includes extension of risk analysis to address the roles and risks from RSUs, Central ITS authorities, data on vehicles and remote access to that data, and to more fully address any security requirements arising from integration of multiple radio connectivity options.

ISO/IEC JTC1

SC 37 is responsible for the standardisation of generic biometric technologies pertaining to human beings to support interoperability and data interchange among applications and systems. Generic human biometric standards include: common file frameworks, biometric application programming interfaces, biometric data interchange formats, related biometric profiles and other standards in support of technical implementation of biometric systems, evaluation criteria to biometric technologies, methodologies for performance testing and reporting, cross jurisdictional and societal aspects of biometric implementation. SC 37 Biometrics home page: http://www.iso.org/iso/home/standards_development/list_of_iso_technical_committees/jtc1_home/jtc1_sc37_home.htm . The complete list of standards published or under development can be found in ISO Standards Catalogue of ISO/IEC JTC 1/SC 37 — Biometrics.

Published standards and ongoing projects related to the topics include the series of biometric data interchange standards for different biometric modalities, biometric technical interfaces, related biometric profiles and other standards in support of technical implementation of biometric systems, and cross jurisdictional and societal aspects of biometric implementation. Representative projects: amendments of ISO/IEC 19794-x: 2011/Amd. 2:2015 data format standards specifying XML encoding, extensible biometric data interchange formats ISO/IEC 39794-x (e.g. generic extensible data interchange formats for the representation of data: a tagged binary data format based on an extensible specification in ASN.1 and a textual data format based on an XML schema definition (both capable of holding the same information), ISO/IEC 30107-x Biometric presentation attack detection multi-part standard and ISO/IEC 24779-x — Cross-Jurisdictional and societal aspects of implementation of biometric technologies — Pictograms, Icons and Symbols for use with Biometric Systems multi-part standard.

Standards developed and in development in support of e-mobility include:

- ISO 15118 Road vehicles - Vehicle to grid communication interface
- IEC 62840 Electric vehicle battery swap system
- IEC 61851 Electrical systems for electric road vehicles and electric industrial trucks
- IEC 62196 Plugs, socket-outlets, vehicle connectors and vehicle inlets - Conductive charging of electric vehicle
- IEC 63110 Protocol for the management of EVs charging and discharging infrastructures
- IEC 63119 Information exchange for electric vehicle charging roaming service
- IEC 61850 Exchange of information with distributed energy resources

WGs/technical committees relating to the above e-mobility standards include:

- IEC TC 69 (Electrical power/energy transfer systems for electrically propelled road vehicles and industrial trucks)
- IEC TC18
- IEC TC 23 and SC 23H

ITU

ITU has various standardization activities in the area of ITS communications.

ITU-R:

- TU-R Working Party (WP) 5A is responsible for ITS studies in the Radiocommunication Sector and contributed to the World Radiocommunication Conference (WRC-19) on WRC-19 agenda item 1.12 "to consider possible global or regional harmonized frequency bands"(Resolution **237 (WRC-15)**). See WRC-19 final acts: https://www.itu.int/en/ITU-R/conferences/wrc/2019/Pages/default.aspx
- Approved various Recommendations including "Harmonization of frequency bands for Intelligent Transport Systems in the mobile service" (ITU-R M.2121); "Radio interface standards of vehicle-to-vehicle and vehicle-to-infrastructure two-way communications for ITS applications" (ITU-R M.2084); "Systems characteristics of automotive radars operating in the frequency band 76-81 GHz for ITS applications"(ITU-R M.2057); "Operational radiocommunication objectives and requirements for advanced ITS" (ITU-R M.1890); "ITS - Dedicated short range communications at 5.8 GHz"(ITU-R M.1453); "Millimetre wave vehicular collision avoidance radars and radiocommunication systems for ITS applications" (ITU-R M.1452)
- Also approved several Reports including "Advanced ITS Radiocommunications" (ITU-R M.2228), "Intelligent transport systems (ITS) usage" (ITU-R M.2445), "Examples of arrangements for ITS deployments under the mobile service" (ITU-R M.2444), "Coexistence between high-speed railway radiocommunication system between train and trackside operating in the frequency bands 92-94 GHz, 94.1-100 GHz and 102-109.5 GHz, and radio astronomy service and Earth exploration-satellite service (EESS) (active) and EESS (passive) services" (ITU-R M.2500).
- Question ITU-R 261/5 requests studies related to "Radiocommunication requirements for connected automated vehicles (CAV)". In response to this Question, ITU-R WP 5A developed Report ITU-R M.2534 on "Connected Automated Vehicles". Question ITU-R 263/5 on "Studies related to the further development of RSTT" was also approved.
- Volume 4 of the Land Mobile Handbook – Intelligent Transport Systems was published in November 2020.
- Further work and studies on ITS and CAV are being carried out by ITU-R WP 5A.
- ITU-R WP 5D is in charge of the studies related to the International Mobile Telecommunication (IMT) systems. IMT-2020 systems provide various specific applications to facilitate development of the digital economy, e.g., e-manufacturing, e-agriculture, e-health, intelligent transport systems, smart city and traffic control, etc., which could bring requirements beyond current capabilities of IMT systems. In this respect, ITU-R WP 5D has also carried out several studies that are of relevance for the improvement of Intelligent Transport Systems. This includes the revision of Recommendation ITU-R M.1036 on "Frequency arrangements for implementation of the terrestrial component of International Mobile Telecommunications (IMT) in the bands identified for IMT in the Radio Regulations" and also of Recommendation ITU-R M.2150 "Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-2020 (IMT-2020)". Recommendation ITU-R M.2160 on "Framework and overall objectives of the future development of IMT for 2030 and beyond" could also contribute to the development of intelligent transport systems given that sensing would support various innovative applications such as high precision positioning and localization of devices and objects, high resolution and real-time 3D-mapping for automated and safe driving/transport.
- ITU-R WP 1A revised Report ITU-R SM.2451 on "Assessment of impact on radiocommunication services from wireless power transmission for electric vehicle operating below 30 MHz"

ITU-T:

See ITU activities on Intelligent Transport Systems (ITS) and Smart Mobility at:

https://itu.int/en/ITU-T/ITS

See more information on ITU-T Standardization on ITS and Smart Mobility at:

https://itu.int/en/ITU-T/ITS/Standardization/

ITU-T SG16 approved Recommendations ITU-T F.749.2 "Service requirements for vehicle gateway platforms", ITU-T H.550 "Architecture and functional entities of Vehicle Gateway Platforms", ITU-T F.749.3 "Use cases and requirements for the vehicular multimedia networks", ITU-T H.551 "Architecture of Vehicle Multimedia Systems", ITU-T H.560 "Communications interface between external applications and a Vehicle Gateway Platform", ITU-T F.749.4 "Use cases and requirements for multimedia communication enabled vehicle systems using artificial intelligence", ITU-T F.749.5 "Vehicle domain service: General information and use case definitions", and the technical report FSTP.SS-OTA "Standardization survey for over-the-air updating in vehicle". Studies on gap analysis of vehicle gateways (HSTP-VG-Gap), Distributed vehicular multimedia services framework for V2X based edge computing (F.DVMSF-Edge), Vehicle information requirements of vehicle gateway platform to support automated driving (F.VG-AD-Reqs), Requirements for remote driving service based on vehicle gateway platform (F.VGP-RDSreqs), Requirements for intelligent traffic sensing devices in roadside (H.Sup.ITS-SD), In-vehicle multimedia applets: Framework and capability requirements (H.VMMA-FCR), and requirements for vehicle recognition application in visual surveillance system (F.VRVS) are continuing.
https://www.itu.int/itu-t/workprog/wp_search.aspx?sg=16

The Focus Group on Vehicular Multimedia (FG-VM) completed its mandate and published the three Technical Reports:

- "Use cases and requirements for the vehicular multimedia networks"
- "Architecture of Vehicle Multimedia Systems"
- "Implementation Aspects of Vehicular Multimedia"

The above deliverables are endorsed as ITU-T Recommendations (e.g. ITU-T H.551 and F.749.3 and ITU-T F.749.8) respectively.

The ITU-T Focus Group on AI for Autonomous and Assisted Driving (FG-AI4AD) studied a definition of minimal performance threshold for AI systems that are responsible for the driving tasks in vehicles, so that an automated vehicle always operates safely on the road, at least as a competent and careful human driver. FG-AI4AD completed the following Technical Reports, which have been submitted to ITU-T SG16 to further the studies in this area:

- "Automated driving safety data protocol – Specification" [under study by ITU-T SG16 as Recommendation ITU-T H.ADSDP-spec]
- "Automated driving safety data protocol – Practical demonstrators"
- "Automated driving safety data protocol – Public safety benefits of continual monitoring"

https://www.itu.int/en/ITU-T/ITS/standardization/Pages/sg16.aspx

The ITU is also actively involved in **"AI for road safety"**, in collaboration with the UN Secretary-General's Special Envoy for Road Safety and the UN Envoy on Technology, as well as other UN sister agencies **"AI for Road Safety"** harness the value of AI in enhancing the safe system approach to road safety, especially in low- and middle- income countries, where most of the road fatalities and injuries occur. It explores the role of AI in the following areas: road safety data and regulatory frameworks; safer vehicles; road infrastructure; and post-crash response

- See new initiative on "AI for Road Safety": https://itu.int/en/ITU-T/ITS/AIRoadSafety

ITU-T SG13 approved Recommendation ITU-T Y.4407/Y.2281 "Framework of networked vehicle services and applications using NGN" and is working on QoS requirements for train communication network supported by IMT-2020 (Y.IMT2020-qos-req-tcn) as well as on deployment of data platform for ITS in developing countries (Supp-Y.TDP-Gen).
https://www.itu.int/itu-t/workprog/wp_search.aspx?sg=13

ITU-T SG5 is working on effects of ICT enabled autonomy on vehicles longevity and waste creation (L.AUVE).
https://www.itu.int/itu-t/workprog/wp_search.aspx?sg=05

ITU-T SG20 approved Recommendation ITU-T Y.4211 "Accessibility requirements for smart public transportation services", Recommendation ITU-T Y.4809 "Unified IoT Identifiers for intelligent transport systems", Recommendation ITU-T Y.4225 "Requirements and capability framework of digital twin for intelligent transport system" and Recommendation ITU-T Y.4487 "A functional architecture of roadside multi-sensor data fusion systems for autonomous vehicles". ITU-T SG20 is working on draft Recommendation ITU-T Y.4230 (ex Y.EV-charging) "Requirements and capability framework of public smart charging service for electric vehicles, draft Recommendation ITU-T Y.IoT-CMP-VR "Functional framework and capabilities of coordination management platform for IoT based vehicle-road" and draft Recommendation ITU-T Y.bsis-sec "Security requirements and capabilities of base station inspection services using unmanned aerial vehicles"

More info: https://www.itu.int/en/ITU-T/ITS/standardization/Pages/sg20.aspx

ITU-T SG17 works on ITS security. It has approved Recommendations ITU-T X.1371 "Security threats to connected vehicles", ITU-T X.1372 "Security guidelines for Vehicle-to-Everything (V2X) communication", ITU-T X.1373 "Secure software update capability for intelligent transportation system communication devices", ITU-T X.1374 "Security requirements for external interfaces and devices with vehicle access capability", ITU-T X.1375 "Guidelines for intrusion detection system for in-vehicle networks", ITU-T X.1376 "Security-related misbehaviour detection mechanism using big data for connected vehicles" and is developing many more standards in this domain: (X.edrsec, X.eivnsec, X.evtol-sec, X.fstiscv, X.idse, X.ipscv, X.itssec-5, X.rsu-sec, X.srcd, etc).
More info: https://www.itu.int/en/ITU-T/ITS/standardization/Pages/sg17.aspx

The Collaboration on ITS Communication Standards provides a globally recognized forum for the coordination of an internationally accepted, globally harmonized set of Intelligent Transportation Systems (ITS) communication standards of the highest quality in the most expeditious manner possible to enable the rapid deployment of fully interoperable ITS communication-related products and services in the global marketplace.

The Collaboration meetings are typically held twice a year (March and September), and are usually organized back-to-back with other ITS events, including the Symposia on the Future Networked Car. During the CITS meetings, the representatives of relevant SDOs are invited to submit to the Collaboration meetings status reports on ITS standardization ongoing in their respective organizations. Based on the pertinent inputs and presentations, CITS maintains the global ITS Communication Standards Database. In 2023, CITS established the Expert Group on Communications Technology for Automated Driving, which aims to enhance the deployment of ADS products while ensuring their safety, particularly by tackling the challenge of ADS-equipped vehicles merging into congested lanes. To further the work within this new Expert Group, two Working Groups were established:

- WG1 – Vehicular communications for merging automatically into congested lanes
- WG2 – Vehicular communications for advanced emergency braking, including to protect VRUs

More information: https://www.itu.int/en/ITU-T/extcoop/cits/egcomad/Pages/default.aspx

IEEE

IEEE has standards activities in support of the digital transformation of transportation addressing e.g. communication, sensors, safety, and electric charging of EVs.

IEEE 802 LAN/MAN Standards Committee:
• Intra-vehicle communication: WGs 802.3/802.1 evolve Ethernet standards to support high bitrates and Time Sensitive Networking (TSN) in a vehicle.
• V2X-wireless communication: WG: 802.11 (WLAN): the physical layer for mission critical communication and ad-hoc V2X networking has been optimized in the dedicated 5.9 GHz spectrum (IEEE 802.11p). IEEE 802.11bd-2022: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 5: Enhancements for Next Generation V2X has been published. It supports many more use cases. ETSI ITS G5 relies on IEEE 802.11p and 802.11bd.

The Dedicated Short Range Communication Working Group develops the IEEE WAVE family of standards (Wireless Access in Vehicular Environments). WAVE adds a whole protocol stack on top of IEEE 802.11p/bd. In particular, IEEE 1609.2 standardises a PKI based security architecture and security functions for V2X.
ETSI ITS-G5 and IEEE WAVE coordinate to harmonize security features for V2X.

The Automotive Image Quality Working Group (in particular IEEE P2020) standardises a suite of objective and subjective test methods for measuring automotive camera image quality attributes, and tools and test methods to facilitate decision

making among OEM and Tier 1 system integrators and component vendors regarding automotive ADAS image quality.

The Lidar Working Group develops a Standard for the Performance of Lidar Used in Traffic Speed Measurements (P2452) and a Standard for Test Methods of Automotive Lidar Performance (P2936)

The Automated Vehicles Standards Committee develops a Standard for Automotive Radar Performance Metrics and Testing Methods for Advanced Driver Assistance Systems (ADAS) and Automated Driving System (ADS) Applications (IEEE P3116)

The Smart Transportation enabling Terminal Working Group (STTWG) of the Smart Devices Standards Committee SDSC develops a Standard for Edge Intelligent Terminal for Expressway Cooperative Transportation (IEEE P2979)

The AV Decision Making WG of the VT/ITS Standards Committee published the IEEE 2846 Standard for Assumptions in Safety-Related Models for Automated Driving System and a Literature Review on Kinematic Properties of Road Users for use on Safety-Related Models for Automated driving Systems). An Amendment (P2846a) covers additional scenarios and road users. P3321 is a Recommended Practice for the Application of Assumptions on Reasonably Foreseeable Behavior of Other Road Users.

The WG 'Exchange/Interoperability format for functional safety analysis and safety verification of IP, SoC and mixed signal ICs' (in particular P2851) defines a data format with which results of safety analyses (such as FMEA, FMEDA, FMECA, FTA) and related safety verification activities - such as fault injection - executed for IPs, SoCs and mixed signal ICs can be exchanged and made available to system integrators. The goal of the standard is to provide a common ground for EDA, SoC and IP vendors in needs of developing tools, SoC and IP for safety critical applications. P2851 has published a Whitepaper "A Landscape for the Development of Dependable Machines'.The Standard 2851-2023 for Functional Safety Data Format for Interoperability within the Dependability Lifecycle has been published. A Standard for the Enablement of Functional Safety Interoperability with Reliability is in the drafting stage (P2851.1)

The Distributed Ledger Technology in Connected and Autonomous Vehicles WG (in particular P2418.4) provides a common framework for distributed ledger technology (DLT) usage, implementation, and interaction in connected and autonomous vehicles (CAVs).

The Motor Vehicle Event Data Recorder Brake and Electronic Control Working Group published IEEE 1616.1 'Data Storage System for Automated Driving (EDR/DSSAD). The new standard builds on IEEE 1616-2021 'Standard for Motor Vehicle Event Data Recorder (MVEDR)' and takes the requirements for Event Data Recorder (EDR) / Data Storage System for Automated Driving Vehicles (DSSAD) into account as discussed in UNECE WP.29 GRVA.

The DFAD - Data Framework for Autonomous Driving WG has started drafting a Standard for Data Framework for Autonomous Driving (P3184).

The Software & Systems Engineering Standards Committee (C/S2ESC) has several WGs to develop a family of standards (P70xx series) for ethical considerations in a broad range of artificial intelligence/autonomous system uses, including vehicular contexts.

The 'Smart Grid Powerline Communication' WG develops IEEE 1901 to provide broadband over powerline communications to be used e.g. when charging electric vehicles (EVs).

The Working Group 'Creating technical specifications of quick charger for electric Vehicles' develops IEEE 2030.1.1 for a DC quick and bi-directional Charger for Use with Electric Vehicles.

Other standardization projects cover: Security Requirements and Testing Methods of Operating Systems in Connected Vehicles (P3130), Scenario Description Language for Autonomous Driving (3344), Standard for In-Cabin Vehicle Sensing & Communication Networks (P3377), and Assumptions on Reasonably Foreseeable Behavior of Other Road Users (P3321).

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For a list of these and other IEEE standardization activities on transportation, please visit: https://ieeesa.io/eu-rolling-plan

IETF

The IP Wireless Access in Vehicular Environments (ipwave) WG worked on Vehicle-2-Vehicle (V2V) and Vehicle-2-Internet (V2I) use-cases where IP is well-suited as a networking technology and will develop an IPv6 based solution to establish direct and secure connectivity between a vehicle and other vehicles or stationary systems. These vehicular networks are characterized by dynamically changing network topologies and connectivity.

V2V and V2I communications may involve various kinds of link layers: 802.11-OCB (Outside the Context of a Basic Service Set), 802.15.4 with 6lowpan, 802.11ad, VLC (Visible Light Communications), IrDA, LTE-D, LP-WAN. One of the most used link layers for vehicular networks is IEEE 802.11-OCB, as a basis for Dedicated short-range communications (DSRC). Several of these link-layers already provide support for IPv6. However, IPv6 on 802.11-OCB is yet to be fully defined. Some aspects of the IPv6 over 802.11-OCB work have been already defined at IEEE 1609 and the specification produced by this working group is expected be compatible with these aspects.

This group's primary deliverable is RFC8691, a standard to specify the mechanisms for transmission of IPv6 datagrams over IEEE 802.11-OCB mode.

https://wiki.ietf.org/en/group/iab/Multi-Stake-Holder-Platform#h-345-intelligent-transport-systems-its-cooperative-connected-and-automated-mobility-its-ccam-and-electromobility

OASIS

OASIS hosts the Open Mobility Foundation (OMF) OASIS Open Project, an open source project launched by a coalition of cities and mobility and software vendors to provide an end-to-end set of standardized data specifications and open source software for managing traffic, availability and route planning for micromobility devices (such as dockless e-scooters). Various standards and code modules for vehicle ID, monitoring, traffic, parking control, consumer/passenger privacy, and policy issues are under development.

ONEM2M

A distinguishing feature of oneM2M is its Basic Ontology specification, which enables semantic and syntactic interoperability across the IoT. This will become increasingly important as greater quantities of data are generated and shared across the IoT.

oneM2M has been designed for interworking: so it naturally lends itself to be used as a factory hub aggregating modern equipment (e.g. OPC-UA based), legacy controllers and the plethora of sensors that are being added to equipment to provide input for innovative applications and whose characteristics and usage do not match well with many of the controllers that are commonly used.
It is used, e.g., in BaSys 4.0, the Industrie 4.0 open-source middleware that has been funded by the German Federal Ministry of Education and Research (BMBF) since 2016, whose implementation is available as Eclipse Project BaSyx.

Furthermore, the interconnection capabilities that facilitate interoperability among smart cities also enable oneM2M to be used to support the operations of distributed, coupled supply chains.

These characteristics have been outlined in a recent study by ETSI (ETSI TR 103 536 - Strategic / technical approach on how to achieve interoperability/interworking of existing standardized IoT Platforms)

International cooperation for the development of harmonised global standards is particularly important in these areas. The Commission has concluded agreements with the US Department of Transport and with the Japanese Ministry for Land Transport and Industry. Cross-regional harmonisation task groups (HTGs) have been established in this area.

ETSI has cooperation and liaison agreements with relevant standards organisations such as IEEE, SAE, ISO, IETF, and standardisation supporting industry groups like TISA. Additionally ETSI have liaisons and contacts with regional and national standards organisations such as ARIB (Japan), CCSA (China) and TTA (Korea) and the Asian Pacific Telecommunication organisation (APT).

ITU has launched the Collaboration on ITS Communication Standards (CITS) aims at providing a globally recognized forum for the creation of an internationally accepted, globally harmonised set of ITS communication standards of the highest quality in the most expeditious manner possible to enable the rapid deployment of fully interoperable ITS communication-related products and services in the global marketplace. See http://itu.int/en/ITU-T/extcoop/cits

ICT for traffic management *and* **infrastructure to infrastructure (I2I)** *related information exchange and architectures beyond short range communications.*

CEN

CEN/TC278/WG8: DATEX data exchange standards. DATEX II is a standardised e-language for traffic and travel data exchange between traffic control centres, traffic information centres and service providers.

ISO

Standardisation activities are taken up in this area by ISO TC 204, with strong cooperation with CEN/TC 278, but also by ISO TC 22. ISO/TS 15638-19:2013 ITS — Framework for collaborative telematics applications for regulated commercial freight vehicles (TARV Part 19). It is at an early stage of development but not mature enough to serve as standard for reservation at that stage.

IEEE

IEEE has standards on charging communication: IEEE 1901 provides broadband over powerline communications to be used in charging, and IEEE 2030.1.1 on DC quick charging.

For a list of these and other IEEE standardisation activities on transportation, please see: https://ieeesa.io/eu-rolling-plan

ITU

Study groups 12 and 16 both have work items to transform the deliverables of ITU-T focus group on driver distraction (2011-13) into proper ITU-T Recommendations. The mandate of ITU-T study group 17 includes the study of security aspects of ITS communications.

W3C

W3C has several ongoing activities related to automotive/ITS.

The mission of the automotive working group (https://www.w3.org/auto/wg/) is to develop open web platform specifications for HTML5/JavaScript application developers enabling web connectivity through in-vehicle infotainment systems and vehicle data access protocols. The API is agnostic with regard to the connection used.

The mission of the automotive and web platform business group (http://www.w3.org/community/autowebplatform/) is to influence the open web platform on the unique needs of the automotive industry, and to help stakeholders within the automotive industry to build a good and practical understanding on the standardisation processes within the W3C. The initial scope of this business group will be to determine what vehicle data should be exposed through a web API(s).

Several community groups (pre-standardisation open fora) were also started to look at specific ITS issues, e.g. the traffic event ontology community group (https://www.w3.org/community/traffic/), and automotive ontology (https://www.w3.org/community/gao/).

(C.2.) OTHER ACTIVITIES RELATED TO STANDARDISATION

C-ITS PLATFORM (2014-2017)

Commission expert group (E03188) brought together representatives of all C-ITS stakeholders to cooperate on legal, organisational, administrative and governing aspects, but also on more technical issues such as standardisation, or security and certification of the system, in view to ensure the interoperability of systems across the Member States.

CCAM PLATFORM (2019-NOW)

Commission expert group (E03657) to provide advice and support to the Commission in the field of testing and pre-deployment activities for Cooperative, Connected, Automated and Autonomous Mobility (CCAM).

CAR-2-CAR COMMUNICATION CONSORTIUM (C2C-CC)

The industry organisation represents car manufacturers and actively participates and chairs ETSI TC ITS. It also contributes to CEN working groups.

C-ROADS

The C-Roads Platform is a joint initiative of 16 European Member States, 7 associated states and road operators for testing and implementing C-ITS services in light of cross-border harmonisation and interoperability https://www.c-roads.eu/platform.html

5G AUTOMOTIVE ASSOCIATION (5GAA)

A global, cross-industry organisation of companies from the automotive, technology, and telecommunications industries (ICT), working together to develop end-to-end solutions for future mobility and transportation services. 5GAA membership features key players with a global footprint in the automotive, technology and telecommunications industries. This includes automotive manufacturers, tier-1 suppliers, chipset/communication system providers, mobile operators and infrastructure vendors.

ERTICO — ITS EUROPE, GSM-A

Stakeholder organisations providing input to ETSI and CEN

"AMSTERDAM GROUP" (AG)

This is an umbrella organisation bringing together the C2C-CC, ASECAP, CEDR and POLIS for smooth alignment of deployment of Cooperative-ITS functionalities and technologies European wide. A strong support for standardisation activities, regulation and harmonisation is provided to the European community directly by the individual AG members as agreed within the AG.

UN/ECE WP29

The UNECE transport division provides secretariat services to the intergovernmental body World Forum for Harmonization of Vehicle Regulations (WP.29). The World Forum has set one of its priorities related to the establishment of a global applicable regulatory framework for automated/autonomous and connected vehicles.

http://www.unece.org/WP29.html

GENIVI

GENIVI® is a non-profit industry alliance committed to driving the broad adoption of specified, open source, in-vehicle infotainment (IVI) software.

The alliance develops an open standard for aligning automotive and consumer infotainment cycles.

http://www.genivi.org/

MIRRORLINK INITIATIVE

The MirrorLink initiative turns the car into a terminal; it has little computing power itself and relies instead on the phone as its processor. The mirror link standards have been published as by ETSI as TS 103 554-x as a 29 part multi-part standard under the Publicly Available Standards initiative.

http://www.mirrorlink.com/

EU AND NATIONAL FUNDED RTD PROJECTS AND PILOTS

The standardisation activities are supported by RTD projects, pilots and field operational tests in the area of CAM, in particular contributing to fine-tuning the standards, among others, DriveC2X, FOTSIS, PRESERVE, ITSSv6, ComeSafety2, COMPASS4D, iMobilitySupport, SIM-TD, SCORE@F, eCoMove, EasyWay, SPITS

WCO DATAMODEL

The WCO datamodel (world customs organisation data model) is an important standard for providing alignment for announcements to and from government about transport and trade. It makes communication throughout Europe between governmental parties and between government and commercial parties easier and cheaper.

EU FUNDED RTD PROJECTS AND PILOTS

Projects such as Mobinet, Mobincity, eCo-FEV; E-DASH, eDAS, SmartV2G, ODIN, COSIVU, SafeAdapt, Smart-LIC, VRUITS and the pilots ICT4EVEU, MOBI.Europe, MOLECULES, SmartCEM, CODECS, ENSEMBLE and green e-motion and the support action smart EV-VC will have outcomes possibly relevant for standardisation. Pilots from both IoT Large Scale Pilots and 5G Corridors initiatives also have potential to provide outcomes relevant to CAM/ITS standardisation.

ICT for traffic management *and* **infrastructure to infrastructure (I2I)** *related information exchange and architectures beyond short range communications.*

TN-ITS (TRANSPORT NETWORK ITS SPATIAL DATA DEPLOYMENT PLATFORM)

Based on the outcome of ROSATTE project (FP7), the TN-ITS association promotes the integration of accurate (public) road data in navigation-oriented maps, and their timely updating, including possible alignment with the technical framework for the INSPIRE project, including the identification of standardisation needs.

https://tn-its.eu/

A CEF-funded project (TN-ITS GO) was finalised end of 2021 to implement the exchange of data between 15 Member States and digital map providers. Further activities continue within the NAPCORE project.

https://tn-its.eu/tn-its-go

EU FUNDED PROJECTS (HORIZON 2020 WG 3.5 CALL)

Projects supporting local dynamic maps standardisation (e.g. HIGHTS)

SMART TICKETING ALLIANCE

The Smart Ticketing Alliance (STA) represents a platform for cooperation and a coordinated approach for establishing ticketing interoperability for the Public Transport sector. www.smart-ticketing.org

The ITxPT (Information Technology for Public Transport) Initiative aims to further cooperate on the implementation of standards for plug-and-play IT-systems applied to public transport. An integrated testbench offers services to specify, test, qualify and showcase IT solutions. www.itxpt.org

(C.3) ADDITIONAL INFORMATION

3.4.6 Digitisation of European Industry

A Policy and legislation

(A.1) POLICY OBJECTIVES

Industry is central to Europe's economy. It contributes to Europeans' prosperity through business in global and local value chains and provides jobs to 36 million people – one out of five jobs in Europe. In particular, the manufacturing sector is hugely important because of its major role in driving productivity and innovation. An hour of work in manufacturing generates nearly EUR 32 of added value. With a share of approximately 16% of the total value added, manufacturing is responsible for 64% of private sector R&D expenditure and 49% of innovation expenditure. Every new job in manufacturing creates between 0.5 and 2 jobs in other sectors. More than 80% of EU exports are generated by industry. Recent years have seen impressive growth rates in labour productivity, namely 2.7% per year growth on average since 2009.

Advanced manufacturing addresses the evolution of the manufacturing industry towards a new level of digitalisation, including intelligent production, process handling, and integration. This progression is driven by the application of ICT in manufacturing and includes any optimisation solution improving productivity, quality, and flexibility in the entire manufacturing lifecycle. To enhance sustainability, the manufacturing lifecycle must prolong the life of durable industrial products in compliance with circular economy objectives. To lower waste and pollution, and use energy in smarter ways, it should take into account operations such as testing and diagnosis, disassembly/repair/upgrade, and recycling.

Nowadays, work pieces and semi-finished products involved in the manufacturing lifecycle often possess information on themselves and suitable means of communication, i.e. they have cyber-physical characteristics. These products can control not only their logistical path, but rather the entire lifecycle workflow from operating to maintenance, dismantling and recycling. Decentralisation of the digitally stored information could logically be followed by decentralisation of control systems.

The European policy on advanced manufacturing focuses on fostering the development and speeding up of the uptake of innovative technologies by the European industry. This ambition unfolds in three objectives: accelerate the dissemination and commercialisation of advanced manufacturing technologies, boost the demand for advanced manufacturing technologies, and reduce skills shortages and competence deficits.

This follows the overall Digitising European Industry (DEI) objectives: to reinforce the EU's competitiveness in digital technologies and to ensure that every industry in Europe, in whichever sector, wherever situated, and no matter of what size can fully benefit from digital innovations. The DEI initiative does not focus on certain digital technologies, nor is it limited to one or a few industrial sectors. However, several DEI actions are specifically targeted at the manufacturing sector.

European manufacturers would benefit from more automated flexibility and data intelligence in supply chains. Agile manufacturing (e.g. reacting to changes in demand, in labour or in material resources available) would enable smarter logistics and lower production costs. Industrialising and digitising the complete manufacturing lifecycle including circular economy operations would enable a smarter use of energy and resources, while maintaining competitiveness in costs and quality. Simulations or rapid prototyping methods like 3D printing would enhance the design process. Big data analytics, turning the data stored in clouds to intelligence, would provide insights on achieving cost and carbon emission reductions. Eventually, an internet of manufacturing things (better known as the Industrial Internet of Things) would provide for smooth communication between the various machines of an intelligent supply chain, building on the increased presence of sensors and actuators.

There are a number of initiatives around advanced manufacturing in Europe, in the Member States and also outside Europe (see C.2). The objective at the European level is to strengthen the coordination among the various initiatives and to facilitate the deployment of advanced manufacturing at a pan-European level, thus improving the competitiveness of the European manufacturing industry both in the Single Market and on a global scale, and creating the conditions for the European technology providers to flourish.

At present, Machinery Directive 2006/42/EC applies to machinery, including those for advanced manufacturing. Following the initiative to make the legislation future-proof, the new Machinery Regulation (EU) 2023/1230 was adopted by the co-legislator. It will

apply as from 20 January 2027 and cover, in particular, new and emerging risks stemming from technological developments in the area of connectivity and artificial intelligence. However, just like its predecessor, the legislation is designed to be technology neutral . This ensures that innovative and advanced solutions can continue to be deployed, supported by state of the art harmonised standards as appropriate

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

Open Technologies can play a key role in accelerating the effectiveness of supply chains in manufacturing systems. In some cases, standardisation can also play a stabilising role of research activities on which real market opportunities may then be built on.
The opportunity is to ensure Europe's technological leadership through the massive integration of ICT into advanced manufacturing technologies, systems and processes.

The amount of communication between machines, sensors and actuators is increasing and will continue so. Machines will become increasingly self-organised as well as their supply chains, from design to warehousing until delivery of a product. IoT technologies will play a major role to support this. Securing high-speed communications infrastructures (e.g. broadband infrastructures) is vital. The specific industrial needs and requirements concerning, for example, availability, security and functional safety have to be taken into account in order to make these technologies suitable for advanced manufacturing. Moreover, the supply chains increasingly need flexibility in design to answer to individual customer requirements (mass customisation). Easier and cost-effective product differentiation is a key for growth. Additive manufacturing (3D printing) may push differentiation to a further stage of individualisation, generating a market of cloud-based production and retailing.

There is a need to promote the development of interoperability standards and European reference architectures, as well as open digital manufacturing platforms, including experimentation, validation, interoperability testing facilities and trusted labels and certification schemes.

The take-up of advanced manufacturing solutions will dramatically accelerate if they are compatible with the installed manufacturing base, and the related standards and technical specifications are coherent with the existing ones, e.g. on machinery, tools, digitalisation. In this respect, standardisation is of central importance since the success of advanced manufacturing demands an unprecedented degree of system integration across domain borders, hierarchy borders, and life-cycle phases. Consensus-based standards and technical specifications, and the close cooperation among researchers, industry and SDOs are the pre-requisites to ensure fruitful results especially in this domain.

Several research-oriented activities were launched under H2020:

I4MS (Innovation for Manufacturing SMEs) is an EU initiative dedicated to the manufacturing sector and in particular to its high-tech SMEs. I4MS is part of the public-private partnership "Factories of the Future" (PPP H2020 FoF).

Funded projects on flexibility and adaptability in the production chain (CloudFlow, INTEFIX, APPOLO), simulation (Fortissimo, CloudSME), robotics (EUROC) and data intelligence (LASHARE).

The EFFRA (European Factories of the Future Research Association) developed a roadmap for the development of Factories of the Future by 2020 in the framework of H2020.

SPIRE (Sustainable Process Industry through Resource and Energy efficiency) is a public-private partnership that represents more than 90 industrial and research process industry stakeholders from over a dozen countries across Europe.

OPEN DEI addresses **the Large-Scale Pilots (LSPs) and platform projects** under the Digitising European Industries (DEI) Focus Area, which work in different strategic sectors: one of them is the **healthcare** domain.

Robocoast EDIH (Finnish non profit international center of excellence for cybersecurity, AI and robotics focusing on Industry 4.0)

The DMP (Digital Manufacturing Platform)

STAND4EU (Boosting the Exploitation of Standardization Inputs from European Projects)

In addition lighthouse pilot projects in the framework of the Joint Undertaking on Electronic Components and Systems for European Leadership (ECSEL) will provide for validation of standards for future markets, including large-scale experimental test-beds.

(A.3) REFERENCES

Final Report of the MSP/DEI WG

COM(2016) 180 final. *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Digitising European Industry Reaping the full benefits of a Digital Single Market*

COM(2016)176 "ICT Standardisation priorities for the digital single market"

COM(2012)341 *A European strategy for key enabling technologies — A bridge to growth and jobs*

COM(2012) 582 final *A stronger European Industry for Growth and Economic Recovery*

SWD(2014) 120 *Advancing Manufacturing — Advancing Europe, Report of the Task Force on Advanced manufacturing for Clean Production*

COM(2009)512 *Preparing for our future: Developing a common strategy for key enabling technologies in the EU*

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

ACTION 1: Common communications standards and a reference architecture for connections between machines (M2M) and with sensors and actuators in a supply chain environment are a basic need and a priority. Specific industrial needs must be included, like standards which support communications on broadband infrastructures and data formats in order to allow for the quick transfer of large volumes of data over networked industries. This could ease the ability to switch between platforms. Analysis is required as to how to provide industries with a solution enabling wireless communications without interfering with other wireless networks. In particular, a check should be run on M2M standards against requirements like real-time capability and close to hardware runtime codes.

ACTION 2: As part of the new skills agenda for Europe, ESOs could check whether the e-skills standards sufficiently account for the manufacturing skills of IPCEIs and others such as micro-credentials could be used to address labour shortages for skilled workers, including future manufacturers, M2M, rapid prototyping and others.

ACTION 3: SDOs to continue to improve interoperability and reduce overlap, redundancy and fragmentation. Standards bodies should continue and further strengthen their coordinated approach regarding different reference architectures and measures should be taken to reduce overlap, redundancy and fragmentation and integrate existing protocols as well as open source technologies. One example is to develop further parts of the standards series IEC 63278 and ISO 23247 series on the asset administration shell in close collaboration with IEC/TC 65, ISO/TC 184/SC 4 and ISO/IEC JTC 1/SC 41 regarding the further properties of digital twins for industrial applications to improve interoperability. Besides others, this includes concepts for security, interaction, and discovery. The 'CEN-CENELEC-ETSI Coordination Group on Smart Manufacturing (SMa-CG) Task Group Industrial Data' has produced a 'SMART Manufacturing' Recommendation Paper.

ACTION 4: Interoperable and integrated security - SDOs should work on interoperability standards for security and for linking communication protocols in order to provide end-to-end security for complex manufacturing systems including the span of virtual actors (from devices and sensors to enterprise systems). This is also named OT-security. Standards should take into account risk management approaches as well as European regulation and regulatory requirements. The European Cyber resilience act looks at establishing common cyber security standards for connected devices.

ACTION 5: Create a hierarchical catalogue of technical and social measures for assuring privacy protection and task all SDOs impacting the DEI domain in general and the advanced manufacturing domain in particular to comment on and prioritize the elements in the catalogue. Digitising industry implies processing of data which may include personal data within the definition of the GDPR. That means, in addition to technical measures to ensure the security of the data, additional technical and social measures are needed to protect the privacy of personal data. Such social or non-technical measures will include, e.g. Codes of Conduct, Charters and Certifications, best practice guidelines, collection of evidence of privacy protection assurance, etc. Relevant work should be undertaken through established committees such as CEN-CLC JTC 13 and ISO/IEC JTC 1/SC 27 and in line with European values as for example CWA 17525:2020.

ACTION 6: Start the discussion about the possible development of harmonised standards in the area of additive manufacturing. Currently, CEN/TC 438 is developing together with ISO/TC 261 and ASTM its first harmonised standard under Machinery Directive: prEN ISO/ASTM 52938-1 Additive manufacturing of metals -- Environment, health and safety -- Part 1: Safety

requirements for PBF-LB machines. The availability of these standards could facilitate the manufacturer conformity assessment process. The European Commission should discuss together with SDOs and AM equipment manufacturers the possible need for harmonised standards in this area.

ACTION 7: To identify and analyse opportunities for revisions of existing standards or, incorporating new standards, on the methodology of risk assessment of (and test framework for) cyber-physical (machinery) products with a particular view on a functional safety levels of digital manufacturing processes and products exploiting real-time data flows, artificial intelligence, and different combinations of cloud-, edge-, and soft-computing. Current work should be considered such as EN ISO TR 22100-4:2020, ISO/IEC FDIS TR 5469, ISO/IEC AWI TS 29119-11, EN ISO FDIS 13849-1.

ACTION 8: To identify and promote open source technologies and relevant communities that complement standardisation work. Communities should be invited to present relevant work in the context of DEI to the MSP and the DEI/MSP working group. SDOs and open source communities should collaborate and consider establishing liaisons.

ACTION 9: Activities for the standardisation of sub-models of the asset administration shell are to be initiated through European involvement in committees such as IEC TC 65/WG 24. A sub-model must be standardized in its basic features, which means that there must be both basic/obligatory properties and basic/obligatory functions that can be supplemented by an industrial partner along the value chain with individual properties and functions. This means that, for example for energy considerations, the same obligatory property and functions must be available for different assets, so that, for example, all components of a system or systems of a plant can be easily consolidated or controlled in the same way. Specific amendments remain possible. Characteristics and properties of conceptual assets should be included in standardized dictionaries such as IEC and ISO Common Data dictionary (CDD).

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

DIN/DKE/SCI4.0:

DIN and DKE founded the standardisation Council Industrie 4.0 (SCI 4.0) in conjunction with the industry associations BITKOM, VDMA and ZVEI.

SCI 4.0 is responsible for orchestrating standardisation activities and, in this role, acts as a point of contact for all matters relating to standardisation in the context of Industrie 4.0 nationally and on international scale.

In collaboration with the Plattform Industrie 4.0, SCI 4.0 brings together the interested parties in Germany and represents their interests in international bodies and consortia. SCI 4.0 also supports the concept of practical testing in test centres by initiating and implementing new informal standardisation projects tailored to meet specific needs.

http://www.sci40.com

CEN

CEN/TC 438 'Additive Manufacturing' has been working since 2015 to standardize the process of AM, their process chains (hard and software), test procedures, environmental issues, quality parameters, supply agreements, fundamentals and vocabularies. CEN/TC 438 works closely with ISO/TC 261 in cooperation with ASTM F42. CEN/TC 438 will develop new projects that relate to aeronautic, medical, 3D manufacturing and data protection.

CEN/TC 310 "Advanced Automation Technologies and their applications" has been working since 1990 to ensure the availability of the standards the European industry needs for integrating and operating the various physical, electronic, software and human resources required for automated manufacturing. It works closely with ISO/TC 184 and other committees to achieve international standards wherever possible in order to meet the needs and opportunities of the global market, as well as establishing common European strategies wherever possible. A key tactic is to use the Vienna agreement process to initiate work in Europe to exploit the results of R&D projects and promote them to the ISO level at the earliest opportunity.

CENELEC

CENELEC/TC 65X "Industrial-process measurement, control and automation" works out methods for safe and secure communication protocols for wired and wireless industrial automation applications some of which are included in the 2,4 GHz industrial, scientific and medical radio band (ISM).

The EN IEC 61406 series 'Identification Link' specifies minimum requirements for a globally unique identification of physical objects which also constitutes a link to its related digital information:

EN IEC 61406-1: 2022-12 Part 1: General requirements

EN IEC 61406-2:2024-07 Part 2: Types/models; lots/batches, items and characteristics

The EN 62264 series 'Enterprise-control system integration' relate to the overall design architecture in the context of Industry 4.0. The series provide requirements for information flow in a manufacturing environment, and address IoT and Cybersecurity. '

EN 62264-3:2017 'Enterprise-control system integration - Part 3: Activity models of manufacturing operations management'

EN 62264-4:2016 'Enterprise-control system integration - Part 4: Object model attributes for manufacturing operations management integration'

EN 62264-5:2016 'Enterprise-control system integration - Part 5: Business to manufacturing transactions'

ETSI

ETSI ERM TG 11 is currently working on methods to improve the politeness of existing adaptive and non-adaptive mechanisms and to consider the inclusion of alternative mechanisms taking into account the needs of the wireless industrial applications operating in the 2,4 GHz ISM band.

ETSI ERM TG 41 is currently working on harmonised standards for wireless industrial applications in the frequency range 5725 MHz to 5875 MHz.

ETSI DECT is developing DECT-2020 NR further, a 5G radio interface able to operate on license exempt and licensed spectrum that will support Ultra Reliable and Low Latency use cases required by Industry Automation scenarios. https://www.etsi.org/technologies/dect

ETSI TC DECT has published updates to release of the new DECT-2020 NR (New Radio) technology (ETSI TS 103 636 parts 1 to 5). The standardization effort will continue in next years with further releases, additional functionality and DECT-2020 New Radio (NR) Access Profiles addressing the needs of multiple vertical industries. Industry Automation and monitoring is considered a fundamental vertical scenario for DECT-2020 NR and has been taken into account in the requirements of the technology to enable industry operational autonomy.

DECT-2020 NR is a new radio interface supporting Ultra Reliable Low Latency Communications (URLLC) and massive Machine Type Communications (mMTC) as specified by ITU-R IMT-2020 and required by many Industry Automation scenarios. The technology supports multiple operating bands (19) below 6 GHz and radio channel bandwidths (1.728, 3.456 or 6.912 MHz). DECT-2020 NR is part of ITU-R IMT-2020 technology recommendation M.2150-1.

ISG IPE (IPv6 Enhanced innovation), is working on DGR/IPE-004 (GR IPE 004) IPv6 based enterprise networking and Industrial Internet and DGR/IPE-008 (GR IPE 008) IoT & 6TiSCH.

ISO

ISO/TC 184 deals with industrial automation technologies, including automated manufacturing equipment, control systems and the supporting information systems, communications and physical interfaces required to integrate them in the world of e-business

http://www.iso.org/iso/iso_technical_committee%3Fcommid%3D54110

Projects include:

ISO 6983-1:2009 — Automation systems and integration -- Numerical control of machines -- Program format and definitions of address words -- Part 1: Data format for positioning, line motion and contouring control systems

ISO 14649 (series of standards): Industrial automation systems and integration -- Physical device control -- Data model for computerized numerical controllers

ISO 22093:2011 — Industrial automation systems and integration -- Physical device control -- Dimensional Measuring Interface Standard (DMIS)

ISO 23570 (series of standards): Industrial automation systems and integration -- Distributed installation in industrial applications

ISO 29002 Industrial automation systems and integration — Exchange of characteristic data

ISO 13584 (series of standards): Industrial automation systems and integration -- Parts library

ISO 10303 (series of standards): Industrial automation systems and integration -- Product data representation and exchange

ISO 16100 (series of standards): Industrial automation systems and integration -- Manufacturing software capability profiling for interoperability

ISO 8000 (series of standards): Data quality

ISO 8000-110:2021 Data quality — Part 110: Master data: Exchange of characteristic data: Syntax, semantic encoding, and conformance to data specification

IEC/TC 3/SC3D" Product properties and classes and their identification"

ISO Strategic Advisory Group Industry 4.0/Smart manufacturing (ISO /SAG)

ISO/TC 261 works on standardisation in the field of additive manufacturing concerning their processes, terms and definitions, process chains (hard- and software), test procedures, quality parameters, supply agreements and all kind of fundamentals.

IEC

IEC/TC 65 "Industrial process measurement, control and automation", with its sub-committees, provides an extensive set of standards for manufacturing, including standards addressing cyber security (IEC 62443 series), functional safety (e.g. IEC 61508, IEC 61511) or interoperability (e.g. IEC 62541 (OPC)), and others.

Several groups of IEC/TC 65 and its subcommittees are involved in the development of standards for advanced manufacturing, foundational/structuring groups like IEC TC65/ahG4 that created a requirement list for IEC CDD according to IEC 61360 (all parts) and got a reply by IEC SC3D and coordinating in TC65 the class and properties for IEC CDD, TC 65/WG 23 "Smart manufacturing framework and system architecture", TC 65/WG24 "Asset Administration Shell for industrial application", TC 65/JWG 21 "Smart Manufacturing reference models", SC 65E/JWG 5 "Enterprise-control system integration", SC 65E/WG 9 "AutomationML — Engineering Data Exchange Format", operational groups like TC 65/WG 16 "Digital Factory", TC 65/WG 19 "Life-cycle management for systems and products", SC 65E/WG 8 "OPC" and communication groups, including real-time communications work, SC 65C/WG 9 "Industrial networks — Fieldbusses", WG18 TSN profile for IA (IEC/IEEE 60802) and the associated conformance assessment project (IEC 61802), SC 65C/WG 16 "Wireless" and SC 65C/WG 17 "Wireless coexistence".

The wireless coexistence in the draft IEC 62657 (all parts) is also pushing the framework of metadata usage by proposing content to the IEC CDD (see CR 000042).

The SyC COMM aims at facilitating and advising in the domain of communication technologies and architectures to converge communication technology related activities in the IEC. It will closely collaborate with IEC Committees to support their ongoing work on communication technologies according to clause 2 in AC/17/2018.

A paramount element in the scope of the Syc COMM is the harmonization of communication systems by:

Providing a mapping of existing drafts and publications specifying communication systems (including functional safety, security, resilience, etc.).

Asking IEC TCs about their future use cases for communication systems to avoid duplications and advice on future communication system technologies suitable for the described use cases.

Collecting requirements on radio spectrum to find commonalities, so that a broad market relevance will have a chance on dedicated spectrum or dedicated spectrum usage.

SyC SM provides coordination and advice in the domain of Smart Manufacturing to harmonize and advance Smart Manufacturing activities in the IEC, other SDOs and Consortia according to clause 2 in AC/22/2017 superseded by the AC/17/2018.

Among its tasks, SyC SMwill focus on:

providing an inventory of existing standards and current standardisation projects under the management of IEC, ISO and other SDOs.

expanding on the definition of common value chains within a smart manufacturing enterprise, as identified in SG 8, and identifying associated use-cases which will assist in determining the state of the art in the industry, and the identification of potential gaps where IEC standardisation is needed with respect to smart manufacturing.

establishing an initial roadmap of smart manufacturing standardisation, architecture and prospective standardisation and conformity assessment projects to be conducted by the SyC member TCs and partners.

delivering a dashboard to cross reference the project work items to documented use-cases within particular value chains to assist standards developers and industry stakeholders to navigate the domain

ISO/IEC JTC 1

ISO/IEC JTC 1/WG 12 3D Printing & Scanning:
WG 12's focus is on the ICT foundational aspects of 3D printing standardisation. In the area of 3D printing and scanning, WG 12 develops standards and/or suggests work for other existing JTC 1 subgroups. WG 12 makes recommendations to JTC 1 to suggest delegation of work to other existing JTC 1 subgroups. It also leads or coordinates JTC 1 liaisons with ISO, IEC and external organizations working on projects in 3D printing and scanning.

Current projects: JTC 1/WG 12 has commended standardisation development in the area of additive manufacturing service platforms and medical image-based modelling

IEEE

IEEE has standards activities relevant to the digitisation of industry/advanced manufacturing, including basic horizontal standards applicable to many industry domains, such as standards for networking and sensors, as well as specific standards addressing the needs of the manufacturing sector, like production process automation in a plant.

IEEE Working Groups evolve legacy standards and start new standardisation projects for smart manufacturing in support of:

Industrial Services

Intelligent Factories

Intelligent Equipment

These are complemented by standards for the

Industrial Internet

Industrial Software and Big Data

Some key enabling standards for Digitisation of European Industry include the following:

The IEEE 802.1 Time-Sensitive Networking (TSN) family of standards provides deterministic connectivity to time and mission-critical industrial applications over IEEE 802.3 Ethernet networks. A joint Working Group with IEC SC 65C is developing IEC/IEEE 60802 TSN Profile for Industrial Automation to enable the logical configurations and re-configurations of communication systems supporting advanced manufacturing.

The "Standard for Sensor Performance Parameter Definitions" Working Group develops IEEE 2700 "IEEE Standard for Sensor Performance Parameter Definitions", a common framework for sensor performance specification including terminology, units, conditions and limits.

The "Quality of Data in the IoT Environment" Working Group is developing the IEEE P2510 "Standard for Establishing Quality of Data Sensor Parameters in the Internet of Things Environment" project to define quality metrics such as speed, location, and temperature for sensor data needed to improve the quality of the analytics decisions being made.

The "Intelligent Process Automation" Working Group develops a family of standards for software-based intelligent process automation technologies. IEEE Std 2755-2017 specifies terms, capabilities and concepts and IEEE 2755.1-2019 classifies approximately 150 features and functions across five core technology areas, and IEEE P2755.2 "Recommended Practice for Implementation and Management Methodology for Software Based Intelligent Process Automation (SBIPA)" is under development.

The "Online Detection" Working Group is developing IEEE P2671 "Standard for General Requirements of Online Detection Based on Machine Vision in Intelligent Manufacturing" project and the "Mass Customization" Working Group is developing the IEEE P2672 "Guide for General Requirements of Mass Customization".

The "Digital Representation" Working Group is developing IEEE P2806 "System Architecture of Digital Representation for Physical Objects in Factory Environments".

The "DevOps" Working Group is developing IEEE P2675 "Standard for DevOps: Building Reliable and Secure Systems Including Application Build, Package and Deployment" to specify technical

principles and practices to build, package and deploy systems and applications reliably and securely. Its process outcomes and activities are aligned with the process model specified in ISO/IEC/IEEE 12207:2017 "Systems and software engineering - Software life cycle processes", and in ISO/IEC/IEEE 15288:2015 "Systems and software engineering — System life cycle processes".

The IEEE 62659-2015: IEC/IEEE International Standard - Nanomanufacturing -- Large scale manufacturing for nanoelectronics.

The Standardization Committee of the IEEE Industry Application Society has developed many standards for various industries. There are many ongoing standardization projects. An overview is available at https://ias.ieee.org/standards/ieee-ias-sponsored-standards-being-developed.html

The Technical Committee on Standards of the IEEE Industrial Electronics Society has completed many standards and holds numerous standards activities throughout the year. Lists of completed standards and ongoing standardization activities are available at https://standards-tc.ieee-ies.org/ongoing.html

For a list of these and other standardisation activities on the Digitisation of European Industry, please visit: https://ieeesa.io/eu-rolling-plan

ITU

ITU-T SG20 on "Internet of Things and smart cities and communities (SC&C)" provides a specialized IoT standardisation platform for the development of a cohesive set of international standards on IoT and smart manufacturing. ITU-T SG20 has approved Recommendation on "Overview of smart manufacturing in the context of the industrial Internet of things" (ITU-T Y.4003), Recommendation ITU-T Y.4482 on "Requirements and framework for smart livestock farming based on the Internet of things", Recommendation Y.4488 "Requirements and functional architecture of data services provided via IoT-based technologies for the safety of manufacturing-related working environments", Technical Report YSTR.DataModelling-Agri "Data processing, management and analytics with AI for digital agriculture", Supplement 82 "Standardization gaps and roadmap for AI and IoT in digital agriculture", Supplement 76 "ITU-T Y.4000-series - Use cases of IoT based smart agriculture" and Supplement 83 "Optimizing Digital Agriculture with Best Practices for Integrating AI and IoT". It also has ongoing work on: "Conceptual data model of smart livestock farming service" (Y.DM-SLF), on "Requirements and framework of Industrial IoT (IIoT) infrastructure for smart manufacturing" (Y.4228 (ex Y.IIoT-infra-SM-fr)), on "Functional architecture enhancement with network capability exposure to support flexible QoS/QoE requirements from enterprise IoT services and applications" (Y.NCE.arch.EIoT), on "Key performance evaluation models of smart manufacturing" (Y.KPEM-SM), on "ITU-T Y.4000-series – Use cases of IoT-based smart aquaculture" (Y.Sup.SmartAqua-usecases), on "Maturity model of digital management capability of industrial equipment used in smart sustainable cities" (Y.Sup.MM-EDMC-SSC) on "Requirements and framework of data processing for smart manufacturing with Artificial Intelligence of Things" (Y.AIoT-dpsm) and "Requirements of metaverse-based emergency response in chemical industrial parks" (Y.CIP).
More info: https://itu.int/go/tsg20

ITU-T SG13 approved Recommendations ITU-T Y.2238 on Overview of Smart Farming based on networks, Y.2623 with requirements and framework of industrial Internet networking based on future packet based network evolution, Y.2246 on application of a u-learning environment to the smart farming and Y.2248 on Service model for Entry-level Smart Farm. SG13 has a work in progress on Unmanned Smart Farm (Y.ous). Also ITU-T SG13 developed Recommendations ITU-T Y.3091 "Digital twin network - Capability levels and evaluation methods" and is working on:

Requirements and framework for NGN evolution to support digital twin (NGNe-DT-reqts)

Framework and functional requirements of data domain in network digital twin layer (DTN-DataFrame)

General technical requirements of model domain in digital twin layer (DTN-ModelReq)

Digital twin network- functional requirements and architecture of service platform for non-public networks (DTN-NPNsp).

Supplement 67 to Y.3000-series of ITU-T Recommendations "Representative use cases and key network requirements for Network 2030" elaborates the use case description and key network requirements for digital twin.
http://itu.int/go/tsg13

OASIS

The OASIS Production Planning and Scheduling TC develops common object models and corresponding XML schemas for production planning and scheduling software, which can communicate with each other in order to establish collaborative planning and scheduling on intra and/or inter enterprises in manufacturing industries.

The OASIS Product Life Cycle Support (PLCS) TC established structured data exchange and sharing to support complex engineered assets throughout their total life cycle. It created Data Exchange Specifications (DEXs) based upon ISO 10303 (STEP) Application Protocol 239 (Product Life Cycle Support), in liaison with ISO TC 184/SC4.

ONEM2M

The oneM2M Basic Ontology specification enables semantic and syntactic interoperability across the IoT. This will become increasingly important as greater quantities of data are generated and shared across the IoT.

oneM2M has been designed for interworking: so it lends itself to be used as a factory hub aggregating modern equipment (e.g. OPC-UA based), legacy controllers and the plethora of sensors that are being added to equipment to provide input for innovative applications and whose characteristics and usage do not match well with many of the controllers that are commonly used.
It is used, e.g., in BaSys 4.0, the Industrie 4.0 open-source middleware that has been funded by the German Federal Ministry of Education and Research (BMBF) since 2016, whose implementation is available as Eclipse Project BaSyx.

Furthermore, the interconnection capabilities that facilitate interoperability among smart cities also enable oneM2M to be used to support the operations of distributed, coupled supply chains.

These characteristics have been outlined in a recent study by ETSI (ETSI TR 103 536 - Strategic / technical approach on how to

achieve interoperability/interworking of existing standardized IoT Platforms)

W3C

Web of Things

http://www.w3.org/WoT/

IIC

Developing test beds and contributing to reference architecture and use-case development

http://www.iiconsortium.org/test-beds.htm

(C.2) ADDITIONAL INFORMATION

The following list is a non-exhaustive overview of initiatives at a national level:

Ireland strategy for Industry 4.0

- https://enterprise.gov.ie/en/Publications/Irelands-Industry-4-Strategy-2020-2025.html

French strategy for factories of the future

- http://proxy-pubminefi.diffusion.finances.gouv.fr/pub/document/18/17721...

The German initiative Plattform Industrie 4.0, including over 350 experts from politics, businesses, industry associations, science and labour unions.

- https://www.plattform-i40.de/I40/Navigation/EN/Home/home.html

Austrian Industrie 4.0 Platform

- https://plattformindustrie40.at/

R&D initiatives like:

- "PAiCE" (https://www.digitale-technologien.de/DT/Navigation/DE/Foerderprogramme/PAiCE/paice.html),
- "Autonomik für Industrie 4.0" (https://www.digitale-technologien.de/DT/Navigation/EN/Foerderprogramme/Autonomik_fuer_Industrie/autonomik_fuer_industrie.html),
- "it's OWL" (http://www.its-owl.com/home/news/2-forum-produktion-im-mittelstaendischen-maschinenbau/)
- SmartFactory KL (http://smartfactory.dfki.uni-kl.de/en)

IT initiative

- "Piano nazionale Impresa 4.0"
- http://www.sviluppoeconomico.gov.it/index.php/it/industria40

NL initiative "Smart Industry"

- http://www.smartindustry.nl/

UK initiative "High Value Manufacturing Catapult"

- https://hvm.catapult.org.uk/

UK Foresight Study "Future of manufacturing: a new era of opportunity and challenge for the UK"

- https://www.gov.uk/government/publications/future-of-manufacturing

US Advanced Manufacturing National Program Office (AMNPO)

- http://manufacturing.gov/amnpo.html

CN "Made in China 2025" strategic plan

- http://english.gov.cn/2016special/madeinchina2025/

The Swedish innovation partnership programme Digital transformation of industry

- https://www.government.se/government-policy/the-governments-innovation-partnership-programmes/innovation-partnership-programme-digital-transformation-of-industry

The strategic research and innovation agenda of Sweden "Made in Sweden 2030"

- https://www.vinnova.se/globalassets/mikrosajter/strategiska-innovationsprogram/agendor/made-in-sweden-2030-eng.pdf?cb=20170714133725

A comprehensive list of ongoing national initiatives is published at:

- https://ec.europa.eu/futurium/en/implementing-digitising-european-industry-actions/national-initiatives-digitising-industry
- https://ec.europa.eu/digital-single-market/en/cordination-european-national-regional-initiatives.

(C.3) ADDITIONAL INFORMATION

There are three basic principles behind standardisation of advanced manufacturing technologies:

accelerate the dissemination and commercialisation of advanced manufacturing technologies,

boost the demand for advanced manufacturing technologies, and

reduce skills shortages and competence deficits.

In industrial automation, it is essential for the vast variety of systems from various manufacturers to interact in a reliable and efficient manner. The users, operating globally, expect to be able to source

their usual products and systems everywhere in the world. In order to ensure this global usability and consistency across different systems, international standardisation in industrial automation has always been regarded as especially important and pursued as a matter of a priority. Nowadays, standards are available or are at least being drafted to cover important issues in industrial automation. But again and again new technologies and new requirements create a new demand for standardisation. This requires the development of a host of new concepts and technologies. However, it will only be possible to implement these new concepts and technologies in industrial practice if they are backed by standards based on consensus. Only such standards are able to create the necessary security for investments and confidence among manufacturers and users.

Development of new technologies and intensifying the relationships between more and different actors in the value chain require not only new standards but also updating, maintenance and even re-design and integration of existing standards.

Additional communication capabilities and a (partial) autonomy to react to external influences and internally stored specifications are transforming mechatronic systems into cyber-physical systems. The objectives derived from that transformation are developments and adjustments in ICT for manufacturing applications: robustness, resilience, information security and real-time capability. In addition, increasing improvement is aimed for energy and resource efficiency, and in the adjustment of industry to accommodate the social demands arising from demographic change.

With regard to machine-to-machine communication, consideration should be given to the framework of metadata. There may be a role for standards in developing an accepted architecture building on existing agreed terminology.

[1] See also https://ec.europa.eu/futurium/en/implementing-digitising-european-industry-actions/national-initiatives-digitising-industry

CEN & CENELEC

CEN/CLC/WS EFPFInterOp on European Connected Factory Platform for Agile Manufacturing Interoperability

3.4.7 Robotics and autonomous systems

A Policy and legislation

(A.1) POLICY OBJECTIVES

The importance of robotics and autonomous systems (RAS) lies in its strong economic contribution as an industrial and commercial activity in its own right and its broad and disruptive socioeconomic impact across diverse market sectors worldwide. Advanced robotics and autonomous (automated or fully automated) vehicles are expected to have an increasing annual economic impact.

Industrial robotics has already become a cornerstone in several of Europe's high-value manufacturing industries, such as the automotive industry, keeping these industries in Europe. This trend must be maintained, strengthened and extended to all other main industries in Europe. Robotics technology also has an impact on a broad range of end-user markets and applications. The robotics professional and consumer service sectors are expected to achieve double-digit growth in the next decade, for example thanks to advanced manufacturing applications, and SMEs will play a key role e.g. in opening new markets. In addition to manufacturing, important future application domains for robots, with a high impact on everyday life, will include healthcare, agriculture, civil, commercial or consumer sectors, logistics and transport.

The EU actively promotes research, job creation and innovation through better and safer robots, while safeguarding ethical aspects of the progress achieved. The importance of robotics lies in its wide-ranging impact on Europe's capacity to maintain and expand a competitive manufacturing sector with millions of related jobs at stake. Robotics also offers new solutions to societal challenges from ageing to health, smart transport, security, energy and environment. The European Commission's focus is on building on our continuous effort to develop a strong scientific base for pushing the limits of the technology, and exploiting such results in real world applications.

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

The robotics market is set to exceed 90 billion EUR by 2030, with almost 13% CAGR from 2019 (source: SMART Report 2018/0053). Robotics standardisation has continued its work in all fronts in both the International- and the European- Standardisation Organisations (ISOs, ESOs). R&D projects on robotics funded by the EU Framework for Research and Innovation set the scientific basis for new key technologies, interoperability between robots, and the use of robots to achieve societal challenges.

The impact of artificial intelligence (AI) techniques is set to vastly improve the capacities and autonomy of robots. The AI Act entered into force on 1 August 2024, and lays down an horizontal framework to regulate AI systems. The Machinery Regulation was published in the OJ on 29 June 2023, covers i.a. robotics and has brought the specifications up to the current state of the art. The use of AI as regards its possible impact on safety within any type of machinery would in principle make the machinery subject to, on the one hand the obligations set out under the proposed AI Act, and on the other hand to the revised Machinery Regulation. To consolidate the objectives, while ensuring full consistency and coherency with the AI Act, the Machinery Regulation introduces specific AI categories in its high-risk list, which will lay down the specific obligations for compliance with the appropriate legislative requirements. For this purpose, the use of future harmonised standards on AI can be expected to greatly facilitate the process of demonstrating compliance with the envisioned legislative requirements. Furthermore, because of various initiatives to cooperate on global level in standardisation efforts, it will boost EU industry's innovation and competitiveness.

The AI Act is conceived so as to smoothly interact with EU existing safety legislation (notably by avoiding unnecessary duplications). In particular the requirements of the AI Act (which are applicable to the AI system part) will be checked as part of the conformity assessment of the product foreseen under sectorial legislation (resulting in one unique conformity assessment).

In June 2021, the European Commission signed a Memorandum of Understanding with the AI, data and Robotics Association (ADRA), setting up a public-private partnership that will support the development of the European AI, data and robotics ecosystem and uptake of AI, data and robotics solutions. By engaging stakeholders, the ADRA PPP can be a relevant forum from which to coordinate and collect needs in terms of standardisation.

Since 2019 ISO has issued eight new documents on robotics:

ISO 8373:2021 Robotics — Vocabulary

ISO 18646-2:2024 Robotics — Performance criteria and related test methods for service robots — Part 2: Navigation,

ISO 18646-3:2021 Robotics — Performance criteria and related test methods for service robots — Part 3: Manipulation

ISO 18646-4:2021 Robotics — Performance criteria and related test methods for service robots — Part 4: Lower-back support robots

ISO 22166-1:2021 Robotics – Modularity for service robots – Part 1: General requirement

ISO 11593:2022 Robotics — Robots for industrial environments — Automatic end effector exchange systems — Vocabulary

ISO 22166-201:2024 Robotics — Modularity for service robots — Part 201: Common information model for modules

ISO 5363:2024 Robotics — Test methods for exoskeleton-type walking RACA robot

ISO/TR 23482-1:2020 Robotics — Application of ISO 13482 — Part 1: Safety-related test method

ISO/TR 23482-2:2019 Robotics — Application of ISO 13482 — Part 2: Application guidelines

ISO/PAS 5672:2023 Robotique — Applications collaboratives — Méthodes d'essai pour mesurer les forces et les pressions dans les contacts homme-robot

Work is ongoing with additional ISO standards on robotics that will be published in the future.

This Rolling Plan calls for increased coordination in the standardisation work led by industry, notably through public-private partnerships.

Robotics and autonomous systems is a multidisciplinary scientific and technological domain for implementing complex systems with cognitive capabilities. These include mechatronics devices, power systems and drives, actuators, sensors, data communication systems, computer software, multi-agent technologies, signal processing techniques, artificial intelligence, semantic technologies and much more. Robots can be very small or very large and have many physical aspects; for instance, they can be similar to a crane, an arm, a

snake or a human body, they can have wheels or legs, and they can be vehicles able to move on the ground, in the air or under the water. Robots can also be used for a large variety of applications including industrial manufacturing, logistics, maintenance, precision farming, autonomous driving, space exploration, surveillance, emergency and rescue, commercial services, health care, rehabilitation, assistive living, entertainment, education and social interaction.

Therefore, the number of standards that affect robotic engineering is very large. Some of the required standards address the robotics field exclusively, but robotics also inherits standards from related technological domains such as electromechanical engineering, electronics, information technologies, telecommunications, production management, geographical information and so forth.

At the worldwide level, the most active international organisation on standardisation on robotics is ISO. It has appointed a technical committee specifically devoted to robotics: ISO/TC 299 Robotics. This Committee is structured in ten working groups.

WG 1 – Vocabulary and characteristics

WG 2 – Service robot safety

WG 3 – Industrial safety

WG 4 – Service robot performance

JWG 5 – Medical robot safety (joint with IEC/SC 62A and 62D)

WG 6 – Modularity for Service Robots

WG 7 – Management system for service robots

WG 8 – Validation methods for collaborative applications

WG 9 – Electrical interfaces for industrial robot end-effectors

WG 10 - Industrial mobile robot performance and test

WG 11 – Measuring energy consumption for industrial robots

The following link gives a catalogue of the standards developed by the technical committee ISO/TC299:

https://www.iso.org/committee/5915511/x/catalogue/

In field of certain industrial autonomous mobile robots ISO/TC110 SC2 Safety of powered industrial trucks also has relevant safety related standards.

At European level, the most active organisations are the European Committee for standardisation (CEN) and the European Committee for Electrotechnical standardisation (CENELEC). CEN & CENELEC provides European standards on robotics by means of its Sector Forum on Machinery Safety. The following link gives a list of harmonised European standards on machinery including several standards specifically designed for robotic machines:

https://ec.europa.eu/growth/single-market/european-standards/harmonised-standards/machinery_en

In addition, associations such as IEEE and OCEANIS are also active in conducting technical studies and proposing standards, particularly in the area of ethics in autonomous and intelligent systems.

More generally, standardisation activities in robotics can be grouped in four main areas:

- Foundations. This set of standards covers vocabulary and characteristics that provide suitable definitions as a reference for other standards. It includes, among others, the following standards: ISO 89787 (Coordinate Systems), ISO 19649 (Vocabulary for Mobile Robots) and ISO 8373 (General terms and Definitions).
- Robotic safety. The bulk of robotic standards are connected with personal and functional safety and regulations for machinery such as EN/ISO 13849-1, IEC/EN 62061. However, the particularities of robotics and its applicability to industrial and non-industrial environments has made it necessary to develop more specific standards such as ISO/TS 15066 (Safety of collaborative robots) which builds further on EN/ISO 10218-1 and EN/ISO 10218-2 (Robots and robotic devices -- Safety requirements for industrial robots) or EN/ISO 13482 (Robots and robotic devices — Safety requirements for personal care robots), ISO/TS 15066 (Safety of collaborative robots), The increased autonomy of robots due to the adoption of Artificial Intelligence, and the application of robotics in non-industrial environments such as healthcare, agriculture, autonomous driving and private homes, must be accompanied by the revision of existing standards and the development of new safety standards addressing specific issues. As an example, the robotics community has requested recently the development of new safety standards that prescribe testing procedures for wearable robots, such as exoskeletons for rehabilitation and worker support. The last thread suggests defining a relationship between the safety and the performance characteristics of concerned products.
- Robotics system integration and interoperability.

Current robots can be made up of very different functional subsystems (dynamic control, perception, navigation, task planning, trajectory planning, human interaction, etc.) that must be integrated through complex interfaces. Also, robotic systems can cooperate with other systems by means of other interfaces. Many of the standards that define these interfaces are inherited from more general domains such as electromechanical engineering and ICT. But some standards are designed to fit robotics-specific requirements, for instance ISO 9409 (mechanical interfaces) and ongoing work in ISO/TC 299/WG6 (Modularity for service robots) and ISO/TC 299/WG10 (Industrial mobile robot performance and test). At least three areas need further development:

- Robot programming languages and communication protocols for robot controllers. This area is mostly dominated by proprietary standards developed by robot manufacturers, such as the robot programming languages Rapid (ABB), PDL2 (Comau), KRL (Kuka), etc. The increasing level of integration of robots in complex systems creates a need to standardise programming languages and communication protocols.
- Robot operating systems. Robot operating systems are software platforms run in conventional computers that connect various robotic subsystems (perception, control, reasoning, planning, etc.) to perform complex tasks. Strictly speaking, they are not actual operating systems, but a middleware layer. They determine and manage the environment for the interoperability of all the software components of the robotic system, irrespective of where they run (on standard computers, robot controllers or embedded systems). In the last 15 years, a number of robot operating systems have come out: ROS, Player, YARP, OROCOS, CARMEN, ORCA, MOOS, to name a few. Most have been developed and maintained as open source software by universities and non-profit research centres. The most successful ones have the potential to set the interoperability standards of the future robotic systems.
- Knowledge modelling. Robot autonomy is based on having appropriate representations of the objects that robots manipulate, the physical environment, the robot missions and the work plans. These involve a great variety of techniques such as signal processing, sensor data fusion, localization and mapping, artificial intelligence, constraint solving, and optimisation. All these techniques have something in common: they manage enormous amounts of data that must be contextualised and processed semantically. Much of this information is captured through complex sensor systems (e.g. image processing or speech recognition) but also from the web. The way how this information can be generated, processed and distributed depends on the availability of appropriate standards. There are already many standards on knowledge modelling, most of them inherited from the ICT field (e.g. SQL, JSON, XML, OWL, and RDF) and a few from other domains (e.g. ISO 10303 for product manufacturing information and ISO 11783 for precision farming), but knowledge modelling for robotics is still a research topic and lacks the stability needed to build a comprehensive set of accepted standards that cover the requirements of all potential applications.

- Ethics in Autonomous Intelligent Systems. Algorithms, sensors, big data, ubiquitous networking and technologies used in autonomous and intelligent systems are impacting our work and social environment today. The implications and consequences for our personal and social lives can lead to a loss of trust in technology from several issues. For example, there could be a loss of trust due to a perceived loss of agency over our digital identity and data, or due to ethical, transparency or accountability issues related to the operation of such systems. IEEE and others collaborating in OCEANIS have committed to identify and develop standards to address technical, societal and ethical implications of technology expansion.

(A.3) REFERENCES

- Regulation (EU) 2023/1230 of the European Parliament and of the Council of 14 June 2023 on machinery.
- Directive 2001/95/EC of the European Parliament and of the Council of 3 December 2001 on general product safety
- Regulation (EU) 2024/1689 of the European Parliament and of the Council of 13 June 2024 laying down harmonised rules on artificial intelligence (Artificial Intelligence Act)

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

ACTION 1: Ensure coordination of standardisation efforts on robotics and autonomous systems in Europe, promoting interaction of all stakeholders taking into account their vision and real needs (i.e. through public-private partnerships), while engaging on international level to lead and export the EU's objectives.

ACTION 2: Assess the need for standards for robotics in order to implement the high-level obligations in the proposed AI Act relevant for AI-powered robotics, and assess possible gaps to meet the needs of robot developers and producers to accelerate innovation and uptake.

ACTION 3: Promote the development of standards for risk assessment for advanced manufacturing robot applications, e.g. collaborative robotics (cobots), or service robotics.

ACTION 4: Standards should be developed to define the main characteristics for all levels of the interaction from mechanical to electrical to protocol to semantic levels between robot and tool to ensure the exchangeability and to enable the design of generic tooling (plug-and-play). There are 2 main types of End Effector. "Off-the-Shelf" and "bespoke". It is desirable that off-the-shelf end effectors operate on a single software protocol. There is a need for Industry 4.0 to standardise this. It would then become Plug-&-Play. For "Bespoke" end effectors (most commonly purchased) the system integrator specifies the software protocol for the Robot and End Effector.

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

The most relevant standards on robotics are led by ISO. Robotic markets are global and it does not make much sense to develop standards at national or regional level. So far, most standardisation efforts have been primarily driven by manufacturers of industrial robots and robotic components. Their engineering teams are well integrated in the various ISO technical committees. European manufacturers are very active in this field. Also, many outstanding European manufacturers of robotic components are involved in standardisation groups in their areas of expertise.

However, new players such as start-ups and SMEs developing highly innovative solutions and products suited to the next generation of robotics have not been involved in standardisation so far. Engaging and supporting them in participating in standardisation efforts and activities will strengthen Europe's position in the robotics industry.

EU-funded R&D projects also contribute to standardisation activities but to a lesser extent because their activities tend not to last enough to match the usually long timetables of standardisation work. When European projects are involved in standardisation, it tends to be through recipients of funding that are robot or robot-component manufacturers. It is important to strengthen the ties between EU R&I projects and SDOs, bringing project results into standardisation activities.

Standards development

CEN

CEN/TC 310 'Advanced automation technologies and their applications' is responsible for standardisation in the field of automation systems and technologies and their application and integration, to ensure the availability of the standards required by industry for design, sourcing, manufacturing and delivery, support, maintenance and disposal of products and their associated services. Areas of standardisation may include enterprise modelling and system architecture, information and its supporting systems, robotics for fixed and mobile robots and humanoid robots in industrial and specific non-industrial environments, automation and control equipment and software, human and mechanical aspects, integration technologies and system operational aspects. These standards may utilise other standards and technologies beyond the scope of CEN/TC 310, such as machines, equipment, information technologies, multi-media capabilities, and multi-modal communications networks and security which all contribute to ensure true integrated safe, secure, interoperable 'Cyber-Physical Systems' of current and emerging disrupt technologies. The Vienna Agreement process can be used to initiate work in Europe to exploit the results of R&D projects and promote them to the ISO level at the earliest opportunity.

EN ISO 13482:2014 'Robots and robotic devices - Safety requirements for personal care robots

Together with ISO, CEN/TC 310 is revising prEN ISO 10218-1 'Robots and robotic devices - Safety requirements for industrial robots - Part 1: Robots'; and prEN ISO 10218-2 'Robots and robotic devices - Safety requirements for industrial robots - Part 2: Robot systems and integration'.

CEN/TC 114 'Safety of Machinery' develops standards of general principles for safety of machinery incorporating terminology and methodology.

CENELEC

CLC/TC 44X 'Safety of machinery: electrotechnical aspects'

CLC/TC 63 'Electrical equipment in medical practice' is responsible for the EN IEC 80601 series, notably EN IEC 80601-2-77 'Particular requirements for the basic safety and essential performance of robotically assisted surgical equipment' and EN IEC 80601-2-78 'Particular requirements for basic safety and essential performance of medical robots for rehabilitation, assessment, compensation or alleviation'

ISO

ISO TC on Robotics: ISO/TC 299 — Robotics.

http://www.iso.org/iso/iso_technical_committee?commid=5915511

ISO/IEC JTC 1

The work ongoing in ISO/IEC JTC 1/SC 42 on Artificial Intelligence also has an impact on Robotics. (See chapter 3.1.9 on Artificial Intelligence).

ISO/IEC JTC1/SC 41 develops standards in the area of Internet of Things and Digital Twin, including their related technologies. ISO/IEC JTC 1/SC 41 has developed 4 standards on digital twins and continues to develop more. The list of ISO/IEC JTC 1/SC 41 projects can be found here: https://www.iec.ch/dyn/www/fp=103:23:709013714499062::::FSP_ORG_ID,FSP_LANG_ID:20486,25

IEEE

IEEE has activities in the field of robotics and automation, for functions like navigation, as well as ethical considerations for autonomous robots, and for a diversity of applications in medicine, manufacturing, etc.

The Standing Committee for Standards Activities of the IEEE Robotics and Automation Society has been actively working with the research and industrial communities and other SDOs to identify areas for standardisation in robotics and automation. The following standards and pre-standards work is ongoing:

- IEEE 1872, Core Ontology for Robotics and Automation (CORA), standardises ontologies for robotics and automation. Ontologies include key terms as well as their definitions, attributes, types, structures, properties, constraints, and relationships. IEEE
- IEEE 1872.1, Robot Task Representation, builds off of the CORA standard and addresses the way that hierarchical planners represent task knowledge which will allow them to better communicate among levels of the ontology hierarchy.
- IEEE 1872.2, Autonomous Robots, extends CORA ontology by defining additional ontologies appropriate for Autonomous Robotics (AuR) relating to: the core design patterns specific to AuRin common R&A sub-domains; general ontological concepts and domain-specific axioms for AuR; and general use cases and/or case studies for AuR.
- P1872.3, Standard for Ontology Reasoning on Multiple Robots
- IEEE 1873, Robot Map Data Representation and Navigation, provides specifications for representing 2D metric and topological maps. This standard defines a recommended format for exchanging map data among robots, computers, and other devices.
- IEEE 2730 was developed as a Standard for Terms, Definitions, and Classification of Medical Electrical Equipment/Systems Employing Robotic Technology.
- IEEE P2751, 3D Map Data Representation for Robotics and Automation (3D-MDR), defines data formats for representing three-dimensional maps.
- P3140.1, Standard for Semantic Maps for Autonomous Robots - Part 1: Use Cases and Requirements
- P3140.2, Standard for Semantic Maps for Autonomous Robots - Part 2: Framework and Application Development Interface
- IEEE P7007, Ontological Standard for Ethically Driven Robotics and Automation Systems, establishes a set of ontologies with different abstraction levels that contain concepts, definitions and axioms which are necessary to establish ethically driven methodologies for the design of Robots and Automation Systems.
- IEEE P7008, Ethically Driven Nudging for Robotic, Intelligent and Autonomous Systems, establishes a delineation of typical nudges (currently in use or that could be created). It contains concepts, functions and benefits necessary to establish and ensure ethically driven methodologies for the design of the robotic, intelligent and autonomous systems that incorporate them.
- P7017, Recommended Practice for Design-Centered Human-Robot Interaction (HRI) and Governance

The IEEE Robotics Automation Society Standards Committee has been focusing on additional areas of standardisation work including work on Human-Robot interactions:

- IEEE P3107, Standard Terminology for Human-Robot Interaction
- IEEE P3108, Human-Robot Interaction Design of Human Subject Studies
- IEEE P2940, Measuring Robot Agility

For more information please visit https://ieee-sa.imeetcentral.com/eurollingplan/.

ITU

ITU-T is active on a number of work items on Artificial Intelligence which have relevance to Robotics, as well. See the mentioning in chapter 3.1.11, section C1.

ITU-T SG16 has established the Focus Group on "AI for autonomous and assisted driving" (FG-AI4AD) to focus on AI performance evaluation in autonomous and assisted driving. The group aims to create an open framework for collaboration and sharing of expertise towards international harmonisation of a universal minimal performance threshold for AI-enabled driving functions (such as AI as a Driver), which is essential to building the global public trust required for widespread deployment of AI on our roads. https://itu.int/en/ITU-T/focusgroups/ai4ad

ITU-T SG11 is developing draft Recommendation Q.TSN "Testing of robotics based on a model network" which defines architecture and characteristics of a model network for testing a remote robotics control service over the network.

https://www.itu.int/itu-t/recommendations/index.aspx?ser=Y

SG13 approved Recommendation ITU-T Y.3177 "Architectural framework for artificial intelligence-based network automation for resource and fault management in future networks including IMT-2020 and ITU-T Y.3553 "Cloud computing - Functional requirements for robotics as a service".

ITU-T SG13 established the Focus Group on Autonomous Networks (FG-AN) in December 2020 and completed in March 2024. FG-AN led exploratory 'pre-standardization' studies to determine how ITU standards will support the realization and evolution of autonomous networks.

The group is studying autonomous networks based on the key concepts of exploratory evolution, real-time responsive online experimentation, and dynamic adaptation.

FG-AN produced a number of output documents, for example, (FGAN-O-013-R1) which is a collection of use cases presented and elaborated during FG-AN meetings. These use cases were published as a Technical Specification and a draft use case deliverable submitted to ITU-T SG13.

ITU-T SG13 during its July 2022 meeting has approved this as "Y.Sup71 : ITU-T Y.3000 series - Use cases for autonomous networks" available from https://www.itu.int/rec/T-REC-Y.Sup71-202207-P/en

For more information: https://www.itu.int/en/ITU-T/focusgroups/an/Pages/default.aspx

ITU-T SG20 approved Recommendation ITU-T Y.4471 "Functional architecture of network-based driving assistance for autonomous vehicles", Recommendation ITU-T Y.4215 "Use cases, requirements and capabilities of unmanned aircraft systems for the Internet of Things", Recommendation ITU-T Y.4421 "Functional architecture for unmanned aerial vehicles and unmanned aerial vehicle controllers using IMT-2020 networks", Recommendation ITU-T Y.4559 "Requirements and functional architecture of base station inspection services using unmanned aerial vehicles" , Recommendation ITU-T Y.4604 "Metadata for camera sensing information of autonomous mobile IoT devices", Recommendation ITU-T Y.4607 "Requirements for the interworking of autonomous urban delivery robots" and Recommendation Y.4487 "A functional architecture of roadside multi-sensor data fusion systems for autonomous vehicles". ITU-T SG20 is also working on draft Recommendation ITU-T Y.4506 (ex Y.DRI-arch) "Reference architecture for the interworking of autonomous urban delivery robots".

More info: https://itu.int/go/tsg20

(C.2) OTHER ACTIVITIES RELATED TO STANDARDISATION

OCEANIS

The Open Community for Ethics in Autonomous and Intelligent Systems (OCEANIS) is a global forum for discussion, debate and collaboration for organizations interested in the development and use of standards to further the development of autonomous and intelligent systems.

https://ethicsstandards.org

ADRA PPP

The European Partnership for AI, Data and Robotics (Adra PPP) is one of the European PPPs in digital, industry and space in Horizon Europe. The Partnership builds on a Strategic Research, Innovation and Deployment Agenda (SRIDA), prepared by a wide range of stakeholders brought together. Since December 2021, Adra is open to receiving membership applications. One of the areas that the PPP plans to focus on is standardisation.

https://ai-data-robotics-partnership.eu/

H2020 AND HORIZON EUROPE

R&D&I projects funded under Horizon2020 or Horizon Europe may produce relevant input for standardisation.

A list of possibly relevant projects would include at least: COVR, ROSIN, ROBMOSYS, EUROBENCH, OFERA, CROWDBOT.

Furthermore, the topic HORIZON-CL4-2021-HUMAN-01-02 has called for a Coordination and Support Action that will support, among other objectives, the work of the AI, data and robotics Public-Private Partnership in terms of standardisation.

STUDY ON STANDARDISATION NEEDS FOR AI-ENHANCED ROBOTICS

Completed in 2021, the study concludes that standards for AI-enhanced robotics must build on standards for AI and that further research is necessary to understand what are the gaps. The study proposes the need for a more integrated approach between AI and robotics in terms of standards.

EU-US TRADE AND TECHNOLOGY COUNCIL

The TTC is a transatlantic forum fostering cooperation on international trade and technology-related issues, based on shared priorities and values. Its list of priorities include promoting technology standards and trustworthy artificial intelligence. The dedicated working group translates political decisions into specific deliverables, coordinate technical work and report to the political level.

https://digital-strategy.ec.europa.eu/en/policies/trade-and-technology-council

VDA 5050 'Interface for the communication between automated guided vehicles (AGV) and a master control'.

OPC UA companion standard for Robots and visions systems.

SRCI over PROFINET - Standard Robot Command Interface.

(C.3) ADDITIONAL INFORMATION

Robotics PPP — EU Robotics: Strategic Research Agenda
http://roboproject.h2214467.stratoserver.net/cms/upload/PPP/SRA2020_SPARC.pdf

Robotics PPP — EU Robotics: Multiannual Roadmap (rolling document)

https://eu-robotics.net/sparc/about/roadmap/index.html

Plans robotics strategy early 2025

https://www.euronews.com/next/2024/01/22/commission-plans-robotics-strategy-early-2025#:~:text=The%20strategy%20will%20address%20all,initiative%2C%20and%20the%20AI%20Act.

International Federation of Robotics: Standardisation
http://www.ifr.org/standardisation/

US Occupational Safety and Health Administration: Robotics
https://www.osha.gov/SLTC/robotics/index.html

Adra PPP – Strategic Research, Innovation and Deployment Agenda

https://ai-data-robotics-partnership.eu/wp-content/uploads/2020/09/AI-Data-Robotics-Partnership-SRIDA-V3.0.pdf

3.4.8. Construction – building information modelling

A Policy and legislation

(A.1) POLICY OBJECTIVES

The construction sector is one of the pillars of the EU economy, contributing to 9% of the EU GDP and to 18 million jobs (see the EC construction sector portal). Construction is also a horizontal sector, interconnected with many other industries – the sector is, for instance, a major consumer of intermediate products (raw materials, chemicals, and electric equipment, etc.) and services, including banking (ref. WEF 2016).

While the construction sector is a key driver of the overall economy, it faces numerous challenges relating to, inter alia, competitiveness, labor shortage, resource efficiency and especially productivity. Digitalisation in construction is increasingly recognised as a game changer (see BCG 2016), which could contribute significantly to sustainable development within the European Green Deal and the "Europe fit for digital age" priorities.

According to the latest EC report on Digitalisation in the construction sector, market analysis showed that among data acquisition technologies, sensors are the technology with the highest level of market maturity and technological readiness; however, significant margins of improvement are present when it comes to their integration in existing buildings. 3D scanning is being increasingly used, while IoT is not yet widely adopted, although it is developing rapidly. Automating processes in the construction sector refer to the use of robots, 3D printing and drones to automate specific tasks in the construction sector. These technologies differ significantly in terms of development. Drones are being increasingly used, notably through the development and improvement of the sensors that they are equipped with. Robots are increasingly used to automate construction processes, especially those involving health risks for workers (applying shotcrete, digging tunnels, excavations,...). Recently, the use of Artificial Intelligence in construction started to increase.

Building Information Modelling (BIM) is more and more utilised in the construction sector; and an increasing number of Member States have a moderate to high uptake of BIM by public authorities and the private companies in the construction ecosystem. Digital Twins of buildings and even the built environment are increasingly being developed but the uptake by local authorities is still limited to some digitalisation champions.

The introduction of BIM is seen as the main solution to digitalization of the construction ecosystem, for all phases of the asset lifecycle: procurement, design, construction (including assembly), operation and maintenance. The development of BIM is advancing rapidly and requires the application of common standards to ensure interoperability and compatibility. In order to improve BIM adoption and allow public procurers to estimate monetary and non-monetary costs and benefits when introducing BIM in public tendering, the EC made available a methodology to conduct analysis and predictions, see EISMEA 2021. A recent project created 30 case studies of large building and infrastructure projects where BIM is used for lifecycle assessments.

Specifically when it comes to the management of the assets portfolios throughout their lifecycle, digital solutions can ensure that all actors (ex. clients and users) are better informed about the steps taken across the life cycle and take informed decisions, including when assets change owners. In this context, we observe the emergence of Digital Building's Logbooks and efforts on EU level to consolidate these (EU Framework for Buildings Digital Logbook, EASME 2019). In a recent study, a suggestion for an EU framework for Digital Building Logbooks was created.

The European Commission has thus supported, promoted and developed several policies and initiatives aiming to foster the digitalisation in the construction sector. The latest policy document underwriting these ambitions is the Transition Pathway for Construction (March 2023). Other initiatives include inter alia the the EU BIM Task Group and the proposal for the development of an EU framework for Digital Building Logbooks. Many trainings are The digitalisation of the construction sector is also integrated in other policy areas such as the EU directive on Public Procurement (Directive 2014/24/EU), which promotes the use of BIM in construction projects. Training courses are also organized within the project budget, such as these to support the uptake of Digital Building Permits by local authorities (project "Digitalization of the Built Environment), and these to support an accelerated uptake of digital technologies by SMEs (project

"Digitalization of Construction SMEs), both carried out by DG GROW in collaboration with EISMEA.

Further digitalisation of the construction ecosystem, including a wider uptake of BIM, better standardisation of BIM, an EU-wide roll-out of Digital Building Logbooks and the uptake of Digital Building Permits, would

- reduce barriers to operation and trade across the European market area and beyond
- reduce both the capital and operating cost of construction assets
- reduce the time wasted because of inefficient breaks between productive construction processes
- improve the reliability of construction output, with better quality and fewer defects
- improve the resource efficiency of construction products and materials, improving both operating and embodied carbon performance
- support improvements in team working and collaboration
- improve the operations processes of construction assets
- improve policy making aimed at a more sustainable built environment

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

CEN Technical Committee 442 on Building Information Modelling was officially kicked off in 2015. The aim is to help the construction sector to be more (cost) efficient and sustainable by developing standards that enables digitalization of the whole construction ecosystems value chain.

The objectives of CEN/TC 442 are:

- to deliver a structured set of standards, specifications and reports which specify methodologies to define, describe, exchange, monitor, record and securely handle asset data, semantics and processes with links to geospatial and other external data.
- to be the home for European BIM standardisation. CEN/TC 442 will be the central place to go for coordinating European BIM harmonisation.
- to coordinate the work with ISO under the Vienna Agreement, either adopting existing international standards at European level or developing new ones in parallel
- to receive and consider proposals for new deliverables and develop them within the TC structure of working groups for the different scopes

The Committee so far has adopted the most important ISO standards in the field of BIM as European standards: EN ISO 12006-2 - Framework for classification; EN ISO 12006-3 - Framework for object-oriented information; EN ISO 16739–1 Industry Foundation Classes (IFC) for data sharing in the construction and facility management industries - Part 1: Data schema; EN ISO 29481-1 – Information Delivery manual – Methodology and format; EN ISO 29481- 2 - Information Delivery manual – Interaction framework

Through the CEN/ISO Vienna Agreement with ISO lead (together with ISO/TC 59/SC 13) the following standards have been developed: EN ISO 19650 Information Management using Building Information Modelling together with ISO/TC 59/SC 13. Part 1 - Concept and Principles and part 2 – Delivery phase of an asset were published in December 2018. Part 3 Operation phase of an asset and Part 5 – Security Minded approach to information management was published in 2020. Part 4 – Information exchange is under development.

Through the CEN/ISO Vienna Agreement with CEN lead (together with ISO/TC 59/SC 13) the following standards have been developed: EN ISO 23386 – Methodology to describe, author and maintain properties in interconnected dictionaries; EN ISO 23387 - Data templates for construction objects used in the life cycle of any built asset - Part 1: Concepts and Principles. The standards was published in 2020; EN ISO 12006-3 revision - Framework for object-oriented information.

CEN/TC 442 also has a project through Vienna Agreement in collaboration with ISO/TC10/SC8.

(A.3) REFERENCES

- EC construction sector portal: https://ec.europa.eu/growth/sectors/construction_en
- McKinsey (2017). Reinventing construction https://www.mckinsey.com/~/media/mckinsey/business%20functions/operations/our%20insights/reinventing%20construction%20through%20a%20productivity%20revolution/mgi-reinventing-construction-executive-summary.pdf
- European Construction Sector Observatory - Analytical Report - Digitalisation in the construction sector – April 2021: https://ec.europa.eu/docsroom/documents/45547
- EISMEA 2021: Calculating costs and benefits for the use of Building Information Modeling in public

tenders - Methodology handbook https://data.europa.eu/doi/10.2826/048648

- EASME 2019: Study on the Development of an EU Framework for Buildings' Digital Logbook. https://op.europa.eu/en/publication-detail/-/publication/40f40235-509e-11eb-b59f-01aa75ed71a1/language-en/format-PDF/source-184010877
- COM(2012) 433 Communication from the Commission to the European Parliament and the Council on the Strategy for the sustainable competitiveness of the construction sector and its enterprises
- SWD(2012) 236 final Strategy for the sustainable competitiveness of the construction sector and its enterprises
- The EU BIM Task Group, http://www.eubim.eu/
- DigiPLACE, https://www.digiplaceproject.eu/
- EU Structural Reform Support Programme (SRSP). https://ec.europa.eu/info/funding-tenders/funding-opportunities/funding-programmes/overview-funding-programmes/structural-reform-support-programme-srsp_en
- Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on public procurement and repealing Directive 2004/18/EC, especially Art. 22.
- Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC.
- Handbook for the introduction of Building Information Modelling, by the European Public Sector (EU BIM Task Group, 2017). http://www.eubim.eu/handbook/
- The European Construction Sector Observatory. https://ec.europa.eu/growth/sectors/construction/observatory_en
- Digitalisation of Construction SMEs: https://digital-construction.ec.europa.eu/
- The Transition Pathway for Construction: https://ec.europa.eu/docsroom/documents/53854

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

ACTION 1: CEN/TC 442 collaborate with ISO/TC 59/SC 13 (ISO committee responsible for BIM standardisation) to align Business Plans and Work Programme as much as possible. The Business Plan will be updated regularly. SDOs to develop European standards when necessary (i.e. if functional gaps are found or international standards are not available). Where development of European standards is necessary because European priorities are incompatible with ISO planning (EC market needs, new research trends, etc.), later alignment should be achieved leveraging on Vienna agreement.

ACTION 2: SDOs to work on information exchange — Enhance and harmonize open data formats, structures and classification systems for model based working in the construction industry. This work is coordinated in CEN/TC 442 in collaboration with ISO/TC 59/SC 13 and buildingSMART and focuses on activities such as:

- The Industry Foundation Classes (IFC), EN ISO 16739 and its extension within the infrastructure sector. Important developments on a European and International Scale are ongoing for bridge, tunnel, road, rail and harbours with buildingSMART lead. A common neutral IFC based standard for infrastructure related asset management and construction activities supports a common European market and shall enable equal access to European IT companies
- Work Items in CEN/TC 442 on providing a framework for common catalogues, templates and exchange structures for harmonized product data including those who following the CPR directive. The work Item for a common structure for Construction Product Data is developed in collaboration with ISO/TC 59/SC 13 with CEN lead
- other national, domain specific, open data format for model based working with potential for European wide application. CEN/TC 442 has a preliminary Work Item to develop a transport data format for Product based in IFC. (IFCxml)

ACTION 3: SDOs to develop common information requirements for project and information management as part of construction service procurement standards:

- EN 17412 Level of Information. Needs a common European framework to express the requested information to be delivered during the project execution and project hand over as Work Item within

CEN/TC 442. To support this standard CEN/TC442 should realise the development of a "guide for application" and a standardised data schema.

  - Work Item to develop Guidelines on how to understand and utilise EN ISO 29481 in a European context

- EN ISO 19650 require use of a Common Data Environment – CDE. CDE is the BIM synonym for Information platforms that enable and enforce collaborative Information Exchange across all stakeholders and participants in the value chain of operation, planning and construction of built assets. CEN/TC 442 should develop guidance and standard to support implementation of CDE in the European marked:

  - Guidance, Framework and Implementation of Common Data Environment (CDE) Workflow and Solution in accordance with EN ISO 19650

  - Common Data Environments (CDE) for BIM projects – Open data exchange between platforms of different vendors via an open CDE API

ACTION 4: SDOs to support data dictionaries - Develop European standards for exchange of data on construction products, to ensure quality in data to support Regulation (EU) No 305/2011 CPR and trade of construction products in the European market. In specific, provide digital tools to support the collaborative development and European wide harmonization of terms and corresponding semantics for:

- written language in standards,
- names, classifications and properties of entities in object oriented data models,

Tools providing a mapping between national/European terms and their corresponding semantics are the basis for the development of a framework for harmonized European vocabulary for digital construction and its European and national implementation.

In the current dynamic development phase with many groups working in parallel there is a great risk that without such tools divergent definitions will be established permanently.

ACTION 5: Develop a framework for how CEN/TC 442 can support the use of BIM in other relevant TC's in CEN (e.g. construction products, energy analyses, acoustics)

- Other national, domain specific, open data format for model based working with potential for an European wide application. CEN/TC 442 has a preliminary Work Item to develop a transport data format for Product based in IFC (IFCxml).

ACTION 6: SDOs to consider the environmental aspects and, in particular, support circularity in development of BIM standards; see also the Circular Economy chapter in this document.

ACTION 7: SDOs to support and, when possible, undertake open source initiatives to support the adoption of BIM standards.

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

CEN

CEN/TC 442 "Building Information Modelling (BIM)" is about standardisation in the field of structured semantic life-cycle information for the built environment.

The committee has adopted a set of relevant ISO standards developed by ISO/TC59/SC13. Some of these standards are updated through Vienna Agreement in collaboration with ISO/TC59/SC13 (ISO lead) and some has been developed through Vienna Agreement in collaboration with ISO/TC59/SC13 (ISO lead). Standards that are originated in CEN/TC442 has been developed through Vienna Agreement in collaboration with ISO/TC59/SC13 with CEN lead.

CEN/TC 442 develops standards that support implementation of EU strategies for green, resilient, and digital construction ecosystem.

List of standards and technical reports from CEN/TC 442 grouped in use case categories:

Data model – schema and format

EN ISO 16739-1:2024 Industry Foundation Classes (IFC) for data sharing in the construction and facility management industries - Part 1: Data schema

buildingSMART IFC 4.3

Processes - how to work in the project using BIM

EN ISO 19650-1 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 1: Concepts and principles

EN ISO 19650-2 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 2: Delivery phase of the assets

EN ISO 19650-3 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 3: Operational phase of the assets

EN ISO 19650-4 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling — Part 4 : Information exchange

EN ISO 19650-5 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling — Part 5: Security-minded approach to information management

Documentation – process map

EN ISO 29481-1 Building information models - Information delivery manual - Part 1: Methodology and format

EN ISO 29481-2 Building information models - Information delivery manual - Part 2: Interaction framework

EN ISO 29481-3 Building information modelling — Information delivery manual — Part 3: Data schema and classification

Grouping data (Information container)

EN ISO 21597-1 Information container for linked document delivery - Exchange specification - Part 1: Container

EN ISO 21597-2 Information container for linked document delivery - Exchange specification - Part 2: Link types

Classification, terms

EN ISO 12006-2 Building construction — Organization of information about construction works — Part 2: Framework for classification

EN ISO 12006-3 Building construction — Organization of information about construction works — Part 2: Framework for classification

EN ISO 23386 Building information modelling and other digital processes used in construction - Methodology to describe, author and maintain properties in interconnected dictionaries

EN 17632-1 Building Information Modelling (BIM) - Semantic Modelling and Linking (SML) - Part 1: Generic modelling patterns

EN 17549-2 Building information modelling - Information structure based on EN ISO 16739 1 to exchange data templates and data sheets for construction objects - Part 2: Configurable construction objects and requirements

Structure and content of the information model (Level of information need)

EN 17412-1 Building Information Modelling - Level of Information Need - Concepts and principles is being revised through the Vienna Agreement and will become EN ISO 7817, expected to be published by end of 2024

Data templates, elements, products, catalogues

EN ISO 23387 Building information modelling (BIM) — Data templates for construction objects used in the life cycle of built assets — Concepts and principles

EN ISO 16757 Data structures for electronic product catalogues for building services - Part 1: Concepts, architecture and model

EN ISO 16757-2 Data structures for electronic product catalogues for building services - Part 2: Geometry

Guidelines

CEN/TR 17654 Guideline for the implementation of BEP and EIR on European level based on EN ISO 19650-1 and -2

CEN/TR 17439 Guidance on how to implement EN ISO 19650-1 and -2 in Europe

CEN/TR 17654 Guidance for understanding and utilize EN/ISO 29481-1 Building information models - Information delivery manual - Part 1: Methodology and format

CEN/TR 17920 BIM in infrastructure - standardization need and recommendations

CENELEC

CLC/TC 205 'Home and Building Electronic Systems (HBES) is exploring the need for standardising BIM attributes within its scope and in coordination with CEN/TC 442 (which has a coordinating role for BIM), CEN/TC 247 'Building automation, controls and building management', and CEN/TC 169 'Light and Lighting'

ISO

ISO ISO/TC 59/SC 13 "Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM)" is charged by TC 59 "Buildings and civil engineering works" to focus on international standardisation of information through the whole life cycle of buildings and infrastructure across the built environment to enable interoperability of information, to deliver a structured set of standards, specifications and reports to define, describe, exchange, monitor, record and securely handle information, semantics and processes, with links to geospatial and other related built environment information and to enable object-related digital information exchange.

Published standards:
https://www.iso.org/committee/49180/x/catalogue/p/1/u/0/w/0/d/0

ITU-T

SG20 approved Recommendation ITU-T Y.4478 "Requirements and functional architecture for smart construction site services". ITU-T SG20 is currently working on "Common requirements and capabilities of smart buildings from the IoT perspective" (Y.IoT-SmartBuild), "Requirements and capability framework of energy storage service for residential community in smart city" (Y.energy-storage), "Energy data model for city-level energy management platform" (Y.CL-EDM) and "Common requirements and capability framework of digital twin for smart complex and campus" (Y.dt-SComCam).

More info: https://itu.int/go/tsg20

ONEM2M

The oneM2M standard supports a multi domains/solutions integration that supports the integration of the construction

supporting systems and the building systems within the surrounding digital environment (e. g. the smart cities systems, infrastructure context, construction site, etc.). This includes both the construction of buildings and infrastructures (roads, dams, ports, industry plants, etc.) and the operational and management support of the built facilities). oneM2M Specifications are available at Specifications (onem2m.org).

Furthermore, the SAREF ontology makes use of oneM2M as communication framework and data collection for Building and Transport systems see ETSI TS 103 264 (Reference Ontology and oneM2M Mapping) and includes a specific extension for buildings ITS (ETSI TS 103 410-2). ETSI standards are available at https://www.etsi.org/standards-search.

ETSI

ETSI ISG CIM (cross-cutting Context Information Management) has published Group Specifications (GSs) for applications to publish, discover, update and access context information (ETSI GS CIM 009 V1.7.2), initially for a broad range of smart city applications and later for other areas, facilitated by a high-level information model for capturing the structure of physical environments as a graph which can be efficiently serialized as linked data (ETSI GS CIM 006 V1.2.1). New reports related to 'Usage of geo-information' (ETSI GR CIM 049), including consideration of CityGML and IFC as well as 'Using NGSI-LD in the context of Building Information Modelling (BIM)' (ETSI GR CIM 051) are planned for 2024.

ETSI ISG OEU (Operational energy Efficiency for User) is working with ICT users' support, industry and communities included, on suitable solutions for sustainable digital multiservice in communities, building, and campus. To achieve this and to produce digital twin applied to operation of connected buildings, data and applications need to be dissociated, and data must be perfectly interoperable with all applications.

(C.2) OTHER ACTIVITIES RELATED TO STANDARDISATION

H2020

DigiPLACE (Digital PLAtform for Construction in Europe). Call: H2020-DT-2018-2020 "Digitalising and transforming European industry and services: digital innovation hubs and platform" - Topic: DT-ICT-13-2019 "Digital Platform/Pilots Horizontal Activities"
Proposing future pilots in standardisation::

- COMMON LANGUAGE: Semantic web and linked data. Definition of construction domains, ontology, class, lexicon, taxonomy, etc.
- DIGITAL CONTRUCTION STANDARD: Technical standard. Definition of digital common structure of technical standard and EU Standard DB
- DIGITAL LAW STANDARD: Law standard. Definition of digital common structure of construction laws and EU Law DB

EU STUDIES AND INITIATIVES

1) Digitalisation of Construction SMEs: This study carried out by Ecorys (2022-2023) had as a main objective the support of construction SMEs in their pathway towards digitalisation and uptake of digital technologies. The deliverables of this project are on the project website (up and running until end of 2024): https://digital-construction.ec.europa.eu/

- Maturity scans
- 50 company cases
- Handbook on different technologies
  - BIM
  - Robots
  - Drone
  - 3D-printing
  - 3D-scanning
  - Mobile Devices
- Trainings with construction SMEs (full ecosystem) as a target group:
  - Specific technologies
  - Digital company culture
  - Digital transformation strategies

2) Digital Building Logbooks. This technical study started in April 2022 and ended in November 2023. We are currently working on 6 short videos that provide further explanation of the concept of Digital Building Logbooks and the deliverables that were created in the framework of this technical study. The deliverables of this study include:

- Data mapping of existing resources and existing DBLs
- Creating a framework for a EU Digital Building Logbook, with a semantic data model and dictionary
  - Semantics and functionalities
  - Interoperability with other systems
  - Interoperability with other databases: DPP (indirect), CPR (indirect), EPC, EPBD,...
- Design and visual identity for an on-line portal
- Guidelines for Member States
  - Costs and benefits from the point of view of implementing this framework by Member States:
  - Estimations of the resource needs for MS
  - Risks during implementation phase: how to deal with data governance, privacy issues,...

3) Feasibility study of the development and deployment of a Construction Digital Product Passport (DPP) system. The study kicked off in September 2023. Its aim is to evaluate the feasibility of different options to develop a Construction Digital Product Passport (DPP) system, enabling economic operators to digitally declare, store, and manage their combined Declaration of Performance/Conformity

4) Preparation for a European Construction Data Space. Within the framework of a broader study conducted by PWC ("Digitalization of the Built Environment; November 2022 - June 2024), Carsa carried out a preparatory study regarding a possible European Construction Data Space. Deliverables include:

- Main insights from interviews with stakeholders and experts in the field
- A mapping and analysis of existing initiatives in EU Member States related to Construction Data Spaces
- Overview of use cases for a Construction Data Space

- Suggestions for the European Commission on how to proceed towards a European Construction Data Space: steps to take, resources needed, and governance

5) BIM, digitalisation and sustainability in the EU Member States and projects across EU. Within the framework of a broader study conducted by PWC ("Digitalization of the Built Environment; November 2022 - June 2024), PWC Greece carried out a study on BIM. Key deliverables of the study were

- Analysis of the State of Play of BIM uptake across the 27 EU Member States; including a scan of the field of big buyers in the Member States that are proactively working with BIM in Public Procurement
- A definition and methodology of the different levels of maturity and the assignment of EU Member States to them
- 30 use cases of public projects using BIM for procurement and lifecycle management of built assets and infrastructure

6) Digital Building Permits. Within the framework of a broader study conducted by PWC ("Digitalization of the Built Environment; November 2022 - June 2024), PWC Luxembourg carried out a study on BIM. Technical University of the Shannon carried out trainings on Digital Building Permits geared towards local authorities, in 24 of the EU Member States. Deliverables of the project included

- A categorisation of the different digital building permit systems
- Mapping of the state of play on building permit systems across EU
- An analysis of 10 international front runner cases of Digital Building Permits
- An analysis of challenges and needs regarding digitalisation of building permits
- A toolkit for local authorities to start the process of digitalising their building permit system

7) European Construction Sector Observatory (ECSO)

Until 2021, the European Construction Sector Observatory gathered and disseminated a lot of construction-related data on the construction ecosystem, supplementary to data available through Eurostat, including data on economic performance and sector-related policies at Member State level. For every Member States, a summarising country fiche was compiled on a yearly basis. The ECSO was discontinued during the years 2022-2024. From 2025, ECSO will be restarted and the data and country fiches will be available for consultation again.

3.4.9 Water Management Digitalisation

A Policy and legislation

(A.1) POLICY OBJECTIVES

Global water challenges are critical for our society, including alterations in water quality and availability, the frequency of floods and droughts due to environmental/climatic changes, pollution trends and increased competition in water uses. Currently, these cause serious problems in 11% of the EU territory and this is expected to increase to 30% by 2030 (1). Moreover, **the usage of water is a key enabler for urban and rural urban/industrial activities that is expected to increase by 55% in 2050** (2). It is fundamental to improve integrated water resource protection and management in the man-made or natural environments by addressing integrated water and wastewater management, water reuse, circular economy, water system monitoring and reporting, pollution reduction and prevention, smart irrigation, resilience in the field of floods and droughts, leakage reduction and prevention, water governance, and awareness raising of the true value of water by all stakeholders.

For these reasons, it is essential to **develop and implement robust, smart, cost-effective, efficient and tailored water management systems**, solutions and multi-sectoral governance models in Europe and globally. Advanced digital technologies comprise transversal common topics: digital twins for the processes within the water sector as well as for the management of the sector actions/ operations and decision-making, big data-analytics, data sharing, privacy management, real-time and near-real-time monitoring, sensors, smart devices, decision support systems and water management tools, IoT, cloud and fog computing platforms, edge analytics, artificial intelligence and machine learning, algorithms, augmented reality and simulation tools, image and streaming data processing capabilities, reporting and consumer awareness tools and applications, cyber-security, system interoperability and standardisation solutions. These networked, intelligent systems help make better intertwin between water and their interrelated domains (e.g. energy). This is a relevant aspect due to the infrastructure's interrelation

permit to replicate and transfer operational and managerial decision-making procedures. As an example a challenge in this regards is to avoid unnecessary water losses and minimize the consumption of resources.

Since 2007, the organisation, infrastructure and management of environmental data has been standardised through the **INSPIRE Directive (**Directive 2007/2/EC), but implementation is lagging behind, in particular many efforts in thematic domains, such as data related water management are ongoing to **improve standardisation for interoperability** and to enhance sustainable digitalisation.

The 2019 **European Green Deal (**COM(2019) 640) recognises the potential of digitalisation to achieve the environment and climate aims and the necessity to explore sustainable digital technologies as essential enablers of the changes needed for a just green transition. Reference is made to digital technologies such as Artificial Intelligence (AI), 5G, cloud and edge computing and the Internet of Things (IoT) as having the potential to accelerate and maximise the impact of policies to protect the environment and to address climate change (COM(2019) 640, p.)

The Zero Pollution (ZP) initiative and ZP Action Plan "Towards Zero Pollution for Air, Water and Soil" (COM(2021) 400) announces a number of flagship initiatives of the Commission which will encourage the sustainable deployment of digital solutions and start an exchange of good practices. It fosters digitalisation of water sector to reach zero pollution ambition that for water. The vision and the key priorities in conjunction with the ICT4Water cluster - a community of 65 EU-funded research and innovation projects has been explicitly characterized in the Commission Staff Working Document '**On Digital solutions for zero pollution**' (SWD(2021) 140, see p.25-26).

The **green and digital transitions** can offer new opportunities for achieving environmental objectives provided that the environmental risks stemming from digitalisation are managed. Many such cases already exist and 25 of them have been illustrated in the Staff Working Document "Digital Solutions for Zero Pollution". These examples represent only a small amount of all digital solutions for zero pollution. **However, green digital transition is not possible without standardisation.** The key elements need standardisation and interoperability. Specially, those technologies that are related to e.g. digital wins, data visualisation and dissemination, for smartening water management in creating smart resilient cities and communities, to manage eHealth and environmental pollution of water, use of smart sensors, IoT in water monitoring, optimisation of water sector operations by employing e.g., Machine Learning, use of Augmented Reality applications for water, etc.

The ICT4Water cluster is a hub for EU-funded research and innovation projects developing digital solutions for the water sector (3). Since January 2018 the cluster is led by EASME/REA. The cluster supports its members in exchanging information and best practices, disseminating and exploiting project outputs, contributing to define digital water strategies and to policy development in digital and water domain. The cluster has 65 member projects, financed by Horizon 2020, the LIFE programme, the European Maritime and Fisheries Fund and the Climate-KIC's Pathfinder Programme. In the context of the cluster, several studies and reports on digital water have been published in previous years. Of the EU-funded projects, three main digital solution types, data driven intelligence, smart sensors/drones and models/simulation account for the 67% of the ICT technologies used so far. While there is an increase of digital adoption in water, the sector still lags behind other industries in integrating new, smart technologies into the whole water cycle and ecosystem. The interoperability and the standardisation are the issues for digitalisation of water sector. Currently, the cluster, with its seven action groups, among them Action Group (AG) on Smart water data interoperability and standardisation, collaborates with ETSI, and has worked on the SAREF extension for water as well as has worked in the extension of ETSI NGSI-LD API and the use of the ETSI NGSI-LD specification to provide interoperable cross-domains data exchange within the project use cases. Currently, this AG is focused on the extensions of SAREF4WATR ontology at different water value chains (e.g. industrial symbiosis, risk management, climate change and water quality monitoring). Projects have demonstrated the relevance of the ETSI NGSI-LD meta model and interface definition to handle Digital Twin representations of complex systems (such as water distribution networks). This directly contributed to an ETSI group report on the Digital Twins topic while these interfaces have also been identified by the International Data Spaces organisation as enablers of the new data spaces economy, which are expected to foster the emergence of the water data spaces to interlink EU infrastructures and economy.

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

The European Commission is working towards the definition of long-term regulatory strategy concerning

the adoption of smart water technologies in coordination with relevant stakeholders and standard organisations, to ensure smooth digitalisation of water services over the next decade.

Data are the centrepiece of the digital agenda. Digitalisation has already helped generate, share, manage and re-use data more efficiently but latest technologies offer radically new solutions, which are not yet commonplace.

The water sector is living a revolution in their infrastructure towards the digitalization and the adoption of novel digital technologies (e.g. edge computing, Big Data, semantic interoperability, continuum computing, etc.). Indeed, water sector is moving to the Industry 4.0 paradigm to ensure the commitments of EU water directives in drinking water, water quality, bathing quality, and groundwater quality. Moreover, the application of novel digital technologies will also pave the way to the commitment of green deal directive in terms of efficiency of resources and finally, impacting on the adaptation and mitigation of climate change.

Under this paradigm shift, standardisation has also produced a change in the water industry minds. The water sector, immersed in the adoption of private standards, has evolved to the adoption of open standards for water management and monitoring (even for physical or digital aspects). In this regards, newer semantic interoperable standards using SAREF4WATR and Smart-Data-Models have permitted the common representation of water data across systems. Complementary, the implementation of NGSI-LD Brokers based on the ETSI GS CIM 009 specification opens the innovation towards the adoption of common reference digital architectures. The combination of both aspects, open the way towards the adoption of a newer technological wave in Open Data Spaces. The Smart Data Models program offers standardised data models for water management that can work seamlessly with systems based on the ETSI GS CIM 009 specification.

However, there are still some gaps and challenges to cover towards making **water sector open and transparent**. Indeed, interoperability and data standardisation require for their **large-scale adoption** and the **generation of open and linked curated water data sets to sustain newer digital innovations**. This aspect will remove the generated barriers in information exchange caused by the lived fragmentation and heterogeneity of digital water infrastructures. Considering water data exchange, there is real evidence on the interrelation of water domain with their interrelated domains (e.g. energy, climate, land-use, etc.) demonstrated through projects like SIM4NEXUS. This will permit to **establish balanced policy and decision-making actions and also transfer some operational actions into water infrastructures**. Moreover, it also will permit to **transfer and replicable decision-making tools and strategies between domains**. The proliferation of AI driven tools has put on evidence the need to create trustworthy and transparent models. These aspects are currently available in the recently published EU Data Strategy and Artificial Intelligence Act. Subsequently, there is a **need to establish the basis to adopt those directives**. For that, main gap is the **lack of data sovereignty and non-discrimination algorithms to support this change**. All of these aspects highlight the **lack of newer digital business models** able to make the transition from traditional models towards data centred models.

EU needs to move towards the generation of common data places and their sustainable governance to enable not only free-flow of information but also the **elaboration of** digital data spaces to share datasets and knowledge at cross-domain. Under this vision, EU needs to **reduce the legislative and policy-making gaps that exist on data sharing across different countries** (Data Governance Act, COM(2020) 767). This aspect will facilitate a more cohesive EU in terms of **data transparency and data democracy**. These aspects applied into the water sector will permit to **unlock organizations and people potential to generate AI driven innovations from water sector**. Therefore, it will permit to introduce social innovations in water management, water quality management, and other relevant water value chains and domains.

Another key aspect in the Water Framework Directive towards the incorporation of Earth Observation and data-driven models as a part of the water technologies to monitor water resources and quality. A strategy and standardisation in this regard will permit to **open up the proliferation of standardized data-driven tools capable of improving existing monitoring methods protected under a standardized umbrella**.

Finally, while some open ICT standards cover some horizontal (e.g. water reuse and recycling across sectors) and vertical aspects of the water sector (from monitoring to data visualization), gaps remain in the standardisation of water data manipulation, knowledge generation and smart water markets. Overcoming these obstacles in the coming years would allow the adoption of technologies to rip the benefits from Smart water networks.

In the view of the available standards, there are the **following gaps** that can contribute to the Green Deal Transition and widely documented in ICT4Water Cluster report on "Digitalisation in the water sector– joint policy recommendations from the DW2020 projects". The gaps have been divided in the following subgroups:

- Technological. (i) the lack of citizen empowerment to elaborate standards in order to increase their adoption and acceptance; (ii) water market fragmentation due to lacks of standardisation and speed of innovation; (iii) slow progress in the transition to adopt open-source digital solutions for water management; (iv) the need to adopt the "agile standardisation" changing the paradigm from classical standardisation towards market/ stakeholders driven standardisation.
- Economic. (i) small water sector market difficulties the generation of a digital market exclusively; (ii) harsh environments inside water sector (e.g. wastewater) slows the generation of disruptive technology adoption (e.g. thin electronics or similar).
- Social. (i) there is a lack of newer social awareness and governance methodologies and paradigms; (ii) Digital literacy within water utilities and administration is oftentimes insufficient.
- Regulatory. (i) Security concept in is not sufficiently integrated in the EU policy framework; (ii) there is a need to strengthen data regulation across countries to facilitate data sharing and free-flow of information; (iii) the relation between standards and regulation framework is not clear.
- Environmental. there is a need for mainstream Zero Pollution and Nexus regulation to generate sustainable uses of the resources inside the water sector;.

In a digitalized water market, the speed of innovations exceeds current standardisation capabilities (in time). So, keeping the same approach will lead to a non-standardised market where individual players will adopt individual solutions or others led by main players in the market. Therefore, a complementary approach should be promoted and encouraged to cope with this situation. An early pre-standardisation, *agile standardisation*, activity should allow to identify of new data models from emerging markets and innovation projects (e.g. (R+D European projects) in a cross-domain approach. An agile pre-standardisation resource, should be also recommended to be used for the early moments of new markets or innovations considering the market speed especially for European R+D. This resource detects new needs, finds actual early adopter implementations, and creates an agile pre-standardisation approach that incentive other users to not reinvent the wheel. The time span for this agile pre-standardisation should be days/weeks instead of the tenths of months or year for current standardisation processes. An example of a viable approach to this is Smart Data Models Program (https://smartdatamodels.org). The results of the pre-standardisation activity should be an input for a final classical standardisation.

(A.3) REFERENCES

- The Water Framework Directive (WFD) and the Floods Directive (FD): Actions towards the 'good status' of EU water and to reduce flood risks"
- EC (2017). "The EU Floods Directive"
- EC (2017). "Fitness check of the Water Framework Directive and the Floods Directive."
- Zero Pollution Action Plan COM(2021) 400
- SWD on Digital solutions for zero pollution SWD(2021) 140
- A Europe fit for the digital age: Priorities for 2019-2024
- Shaping Europe's digital future – A European Strategy data
- European Data Governance Act COM92020) 767 final
- EU Water Framework Directive 2000/60/EC
- Naiades project Standardisation Web page.
- ICT4Water cluster (https://ict4water.eu/)
- ICT4WATER cluster - Vision and showcases (2021)
- "The need for digital water in a green Europe - EU H2020 projects' contribution to the implementation and strengthening of EU environmental policy"(2021)
- The study "Business models for digital water solutions - A study on the development of business models of digital solutions related to ICT4Water cluster projects"(2021)
- ICT4Water report on Recommendations for standards and standardisation in the European Smart Water Market (2015)
- 'Green Data for All' initiative' This initiative was announced in the European Data Strategy and it consists in evaluating and possibly reviewing the Directive establishing an Infrastructure for Spatial

Information in the EU (INSPIRE), together with the Access to Environment Information Directive. It will modernise the regime in line with technological and innovation opportunities, making it easier for EU public authorities, businesses and citizens to support the transition to a greener and carbon-neutral economy, and reducing administrative burden.

Other relevant references:

- General Union Environment Action Programme to 2030 COM(2020) 652
- The European Green Deal COM(2019) 640
- Commission Communication - Shaping Europe's digital future COM(2020) 67
- A European strategy for data COM(2020) 66
- WHITE PAPER On Artificial Intelligence - A European approach to excellence and trust COM(2020) 65
- A New Industrial Strategy for Europe COM(2020) 102
- Digitalisation in the water sector - recommendations for policy developments at EU Level. This publication is based on evidence from the development of 38 products and services as well as in 21 case studies of 5 'digital water' H2020 projects – the active ICT4Water cluster members – DWC, ScoreWater, Fiware4Water, NAIADES and aqua3S (the links to the projects websites are available at the end of the document).

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

The requested actions towards digitalisation of the water sector and implementation of ICT were defined in the scope of the ICT4Water Cluster:

ACTION 1: Guidelines for the definition of Open Water Data Spaces, powered by IoT technologies and standards, which contributes to decentralised, circular water and information flow. The concept of the Open Water Data Spaces was expected to be developed in the framework of ICT4Water Cluster running projects. Many standards organisations such as ETSI, CEN & CENELEC, AIOTI, OGC, OpenFog, BVDA, FIWARE Foundation, Water Europe (4) are expected to contribute in coordination with the EC.

ACTION 2: Include Zero Pollution and Nexus aspects into Digital water standardisations. Newer digital and physical standards should cover the interlink between water and interrelated infrastructures. As an example of agriculture, agricultural sectorial directives should be aligned with WFD or groundwater directives. In terms of data exchange and digital standards and practices, agricultural practices and strategies (planning, operational, etc) should be in harmony with (or support the elaboration of) water related strategies (win-win strategies) (DW2020, 2022).

ACTION 3: Enhance data sharing trustworthiness. The solution to deploy must support security of data and support non-repudiable and unambiguous agreements, the integration of privacy concerns in the development of the corresponding data platforms and data-sharing applications, and the integration of security and privacy requirements during the deployment of the platforms.

ACTION 4: Definition of open data models and open data through interoperable platforms. The first steps as a policy decision are made by the EC. Then SDOs have to define the architectures, data models, ontologies, standard interfaces and protocols to allow data sharing, platforms integration and interoperability. This can be enhanced by the EU policies and EU data spaces that foster the wider use of free open data exchange and standardisation platforms (e.g. FIWARE).

ACTION 5: Incentives for the adoption of Open Data standards, in order to be able to provide information in a transparent and up to date manner. This action is related to the policy of the EC but needs to be developed taking into account the security. Citizen's awareness is an important issue and is related to the developed open data models by standards organisations in Action 4.

ACTION 6: Enable the transition **to use open source (data exchange) software for water data management**. For example, benefits of using open data exchange platforms like FIWARE and open data models representation like Smart Data Models program should be clearly laid out and promoted. In addition, it is important to actively showcase working examples, guarantee stability and security of FIWARE software (DW2020, 2022).

ACTION 7: Enhance **user involvement to increase understanding and acceptance of digital solutions.** Digital transformation proceeds at the speed of trust. To get sufficient acceptance and promote the benefits of digital solutions, they must be presented in complete clarity and detail to the user. Specific situations in which digital solutions can foster public

involvement and / or environmental education and awareness and support policy goals (short - and long term) need to be further explored. The involvement of potential users in product development is another way forward.

ACTION 8: Underline the close relationship **between technical standards and legislation**. Since in recent years many regulatory and legislative reforms have been introduced, some uncertainty about the applicability and the legally binding nature of specific standards mainly due to the revision of obsolete standards and the publication of new sector regulations exist. Against this background, it is important to underline the close relationship between technical standards and legislation and clarify what results from this in practice. (DW2020, 2022).

ACTION 9: Highlighting **social, environmental and ethical aspects** in the development of digital solutions in the water sector. Water is still treated mostly as a 'technical matter' by most of the actors. Focus should be given to issues such as the inclusion of marginalised groups using new tools and a transparent communication of societal and environmental opportunities and challenges associated with the uptake of a respective digital solution. Water supply operators should be able to reflect on the legal and ethical implications of introducing digital solutions for the service they are providing.

ACTION 10: Mainstream **water security as a universally known and applied term**, in all its implication, without ambiguities into its definition. It should be ensured at a normative level that all the actors are aware of the different ramifications of water security, the presence and roles of the other actors involved in this topic as well as the main goals of other water security regulations. This is crucial to ensure that different aspects of water security are not treated as separate parallel matters, or even worse, contradicting each other.

ACTION 11: Reduce **adverse environmental and climate change impacts** in the water sector through digital solutions. Digital solutions have a huge potential to mitigate negative effects of digitalisation by improving water efficiency and reducing energy consumption. At EU, national and local levels, research, development, and adoption of Artificial Intelligence (AI) should be further stimulated to make use of resulting innovations to reduce the carbon footprint of the water sector. However, new challenges associated with switching to computationally expensive - and energy intensive digital solutions must be considered carefully. Solutions should consider the interlinkage between the water domain and associated domains such as energy or food, targeting global optimisation.

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

CEN-CENELEC-ETSI

A European Technical Report comprising a software and hardware open architecture for utility meters that supports secure bidirectional communication upstream and downstream through standardised interfaces and data exchange formats and allows advanced information and management and control systems for consumers and service suppliers. The Report identifies a **functional reference architecture for communications in smart metering systems**. and the standards relevant to meeting the technical / data communications requirements of Mandate M/441, in particular to assist the active participation of consumers. The architecture has been developed drawing on existing and planned implementations, but its generic nature should enable it to support future different implementations.

The Report is available at ftp://ftp.cen.eu/cen/Sectors/List/Measurement/Smartmeters/CENCLCETSI_TR50572.pdf

The latest work programme is available at ftp://ftp.cencenelec.eu/EN/Europeanstandardisation/Fields/EnergySustainability/Management/SmartMeters/Workprogramme2017.pdf

The previous CEN-CENELEC-ETSI Smart Meters Co-ordination Group has been merged into the similar structure dealing with smart energy grids co-ordination (see the relevant section of the Rolling Plan). Information on the new CEN-CENELEC-ETSI Co-ordination Group on Smart Grids (CG-SG) is available at https://www.cencenelec.eu/areas-of-work/cen-cenelec-topics/smart-grids-and-meters/cen-cenelec-etsi-coordination-group-on-smart-grids-cg-sg/

OGC®

HY_FEATURES: reference model defining real-world water-objects and the way they relate to each other according to hydro-science domain defined by semantics and network topology.

http://www.opengeospatial.org/projects/groups/hydrofeatswg

WaterML2.0. Standard information model for the representation of water observations data, with the intent of allowing the exchange of such data sets across information systems, using existing OGC standards.

http://www.opengeospatial.org/projects/groups/waterml2.0swg

ETSI

ETSI Industry Specification Group on cross-cutting Context Information Management (ISG CIM) has published Group Specifications (GSs) for applications to publish, discover, update and access context information (ETSI GS CIM 009 V1.8.1 "Context Information Management (CIM), ETSI NGSI-LD API"), initially for a broad range of smart city applications and later for other areas,

facilitated by a high-level information model for capturing the structure of physical environments as a graph which can be efficiently serialized as linked data (ETSI ISG CIM GS 006 V1.3.1). Demonstration of usage of ETSI NGSI-LD API for handling of Digital Twin in the context of water distribution networks has been described in ETSI GR CIM 017 V1.1.1 "Context Information Management (CIM); Feasibility of NGSI-LD for Digital Twins". Numerous Horizon 2020 (e.g. LOTUS 820881) and Horizon Europe (e.g. WATERVERSE 101070263 **and MARCLAIMED 101136799**) projects are demonstrating further innovative usages of ETSI NGSI-LD API for digitalisation of water industry.

SAREF extension for water (ETSI TR 103 547 V1.1.1 "SmartM2M; SAREF extension investigation; Requirements for the Water domain"): determining the requirements for an initial semantic model for the Water domain based on a set of use cases and from available existing data models.

Industry Specification Group "City Digital Profile" (ISG CDP) was doing work relevant to city standards for water management, but the ISG was closed September 2019.

https://portal.etsi.org/Portals/0/TBpages/CDP/Docs/ISG_CDP_ToR_DG_Approved_20171011.pdf

DW2020

DW2020. 2022 Draft Policy brief; Digitalisation in the water sector Joint policy recommendations from the DW2020 projects; submitted to EC; to be released in Q3 2022

INSPIRE

INSPIRE Directive. reference EU architecture for data sets sharing between EU countries.

http://inspire.ec.europa.eu

BUREAU OF INDIAN STANDARDS (BIS)

The Bureau of Indian Standards has included ETSI NGSI-LD API in its API specification for unified data exchanges. An on-going work contributed by the EU-India H2020 project LOTUS aims at evolving BIS standards (IS 3025, IS 3025 (Part 32)) to handle measurements from low cost multi-parameters probes.

Indian Urban Data Exchange (IUDX)

IUDX is an open source software platform that enables secure and authenticated exchange of data amongst various data platforms. It supports data quality, privacy, marketplace, and e-governance for smart cities and urbanisation. IUDX has worked together with BIS (Bureau of Indian Standards) the national standards body of India, and has released and ratified two papers on IUDX architecture model and API specifications via Standard number IS 18003. ETSI NGSI-LD API has been adapted as the standard for Data Exchange and Open Data.

ISO/IEC

Generic Sensor networks Application Interfaces (ISO/IEC 30128). International Standard that depicts operational requirements for generic sensor network applications, description of sensor network capabilities, and mandatory and optional interfaces between the applications.

https://webstore.iec.ch/preview/info_isoiec30128%7Bed1.0%7Den.pdf

https://www.iso.org/standard/53248.html

ITU-T

The ITU-T Focus Group on Smart Water Management (FG-SWM) issued a series of deliverables including the following:

- The Role of ICT in Water Resource Management
- Smart Water Management Stakeholders Map
- Smart water management project classification
- Smart water management stakeholder challenges and mitigation report on the KPI to assess the impact of the use of ICT in SWM

https://www.itu.int/en/ITU-T/focusgroups/swm/Pages/default.aspx

Recommendation ITU-T F.747.6 elaborates on the "Requirements for water quality assessment services using ubiquitous sensor networks (USNs)" https://www.itu.int/rec/T-REC-F.747.6-201410-I/en

ITU-T SG20 is currently working on draft Recommendations on "Framework of monitoring of water system for smart fire protection" (Y.water-SFP), "Requirements and capability framework of digital twin for intelligent water conservancy system" (Y.dt-IWCS) and draft Supplement "ITU-T Y.4000-series – Use cases of IoT-based smart aquaculture" (Y.Sup.SmartAqua-usecases).

More info: https://itu.int/go/tsg20

ITU-R

ITU-R Working Party (WP) 5B is responsible for studies related to the maritime mobile service, including the Global Maritime Distress and Safety System (GMDSS), the aeronautical mobile service and the radiodetermination service, including both radiolocation and radionavigation services. It studies communication systems for the maritime mobile and aeronautical mobile services and radar and radiolocation systems for the radiodetermination service.

ITU-R WP5B is the group responsible for conducting studies in response to WRC-23 agenda items 1.8 and 1.10:

- WRC-23 agenda item 1.8 is to consider appropriate regulations with a view to reviewing and if necessary, revising Resolution 155 (Rec. WRC-19) to accommodate the use of fixed-satellite service (FSS) networks by control and non-payload communications of unmanned aircraft systems taking into account the progress obtained by the International Civil Aviation Organization (ICAO) in the completion of SARPs on the use of FSS for the UAS CNPC links.
- WRC-23 agenda item 1.10 is to conduct studies on spectrum needs, coexistence with radiocommunication services and regulatory measures for possible new allocations for the aeronautical mobile service for the use of non-safety aeronautical mobile applications, in accordance with Resolution 430 (WRC-19) on "Studies on frequency-related matters, including possible additional allocations, for the possible introduction of new non-safety aeronautical mobile applications".

ITU-R WP1C is the in charge of spectrum monitoring, including the development of techniques for observing the use of the spectrum, measurements techniques, inspection of radio stations, identification of emissions and location of interference sources.

ITU-R WP1C completed the work on Report ITU-R SM.2486 on "Use of commercial drones for ITU-R spectrum monitoring

tasks" in June 2021. This Report details the common elements, considerations on the uncertainty, possible missions as well as use cases of spectrum monitoring and measurement procedures that are assisted by commercial drones.

ISO

ISO/TC 282: standardisation of water re-use of any kind and for any purpose. It covers both centralised and decentralised or on-site water re-uses, direct and indirect ones as well as intentional and unintentional ones. It includes technical, economic, environmental, and societal aspects of water re-use. Water re-use comprises a sequence of the stages and operations involved in uptaking, conveyance, processing, storage, distribution, consumption, drainage, and other actions related to the handling of wastewater, including the water re-use in repeated, cascaded, and recycled ways.

https://www.iso.org/committee/4856734.html

PSA

WITS Standard Protocol: standard method dedicated to water industry telemetry control and monitoring. This standard protocol makes interoperable equipment from different manufacturers by using features of the DNP3 protocol to satisfy water industry specific functional requirements.

http://www.witsprotocol.org

ONEM2M

oneM2M was launched in 2012 as a global initiative to ensure the most efficient deployment of Machine-to-Machine (M2M) communications systems and the Internet of Things (IoT) and it includes several SDOs and representatives of different industry sectors. The latest technical specifications can be found on their website http://www.onem2m.org/technical

The oneM2M standards supports a multi domains/solutions integration that supports Water Management digitalisation requirements, and in particular the integration with the other services and systems that are building the Digital Single Market (e.g. the integration with Smart Cities and with Smart Agriculture solutions). The SAREF ontology makes use of oneM2M as a communication framework (ETSI TS 103 264 (Reference Ontology and oneM2M Mapping) and a specific Smart Watering extension (ETSI TS 103 410-10) is available at https://www.etsi.org/standards-search

SMART DATA MODELS

The Smart Data Models program offers open-licensed data models for several smart domains, including, but not limited to, smart water, smart energy, smart agrifood , smart cities, and smart environment. The data models are compliant with FIWARE NGSI version 2 and ETSI ISG CIM NGSI-LD and also exported in other formats like SQL or YAML.

AIOTI

High Level Reference Architecture: reference ICT architecture and semantic data model based on the ISO/IEC/IEEE 42010 standard for representing IoT entities and services. This reference architecture is transversal to several domains, including water. https://aioti.eu/wp-content/uploads/AIOTI-HLA-Report-R6-Final.pdf.

W3C

Web of Things Working Group: RDF and Linked Data vocabularies to reduce the fragmentation generated in the IoT devices. Moreover, this group is also focused on providing best practices and corresponding APIs to enable semantic interoperability within the Smart City.

Iot-Schema.org. Extension of schema.org data model towards modelling IoT entities with focus on energy, transport, and water infrastructures.

https://www.w3.org/

IEEE

IEEE has standard focusing on measurement around usage of resources including water:

- IEEE P7100 Standard for Measurement of Environmental Impacts of Artificial Intelligence Systems

IEEE has two chapters of its Compendium document, Strong Sustainability by Design: Prioritizing Ecosystem and Human Flourishing with Technology-Based Solutions featuring issues related to water and water management:

- Rivers and Lakes
- Oceans and Coasts

(1) "EC (2015). The Water Framework Directive (WFD) and the Floods Directive (FD): Actions towards the 'good status' of EU water and to reduce flood risks"

(2) "OECD(2017). Aid for Trade at a Glance 2017"

(3) Action Plan for a DSM for Water Services on the discussion platform Futurium: https://ec.europa.eu/futurium/en/content/ict4water-road-maps-action-plan

(4) Water Europe - https://watereurope.eu/

3.4.10 Single European Sky

A Policy and legislation

(A.1) POLICY OBJECTIVES

The EU has established the Single European Sky (SES) framework, aimed at harmonising and improving the performance of ATM through five pillars: Economic regulation, airspace organisation/network management, technological innovation, safety and human dimension. These pillars are interrelated and interdependent.

The technological pillar of the SES is the SESAR project (Single European Sky ATM Research), an essential enabler for all other components of the SES. The SES and SESAR are also key enablers for the EU's Sustainable and Smart Mobility Strategy, which fosters the green and digital transition of the transport sector. The objective of this twin transition is to reduce emissions and to facilitate connectivity in a seamless and resilient multimodal transport network. This is crucial in reaching climate neutrality by 2050 and a reduction of greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels.

SESAR aims to modernise ATM and to develop and deploy technological and operational innovations in support of the SES and EU policies. The SESAR project comprises three interrelated collaborative phases that define, develop and deploy innovative technological systems and operational procedures in view of achieving the Digital European Sky.

These phases constitute the ATM Innovation Cycle:

- The definition phase is based on the European ATM Master Plan (ATM MP), the roadmap for ATM modernisation. It defines the Digital European Sky, which is the Union's vision for establishing a safe, sustainable and efficient ATM system and sets development priorities and deployment objectives to be achieved by 2040. The ATM MP is regularly updated through collaborative process, in order to respond to the evolving aviation needs and constraints.
- The development phase relies on a public-private partnership, the SESAR 3 Joint Undertaking (currently the third edition), established under the Horizon Europe Research programme. This EU body is tasked to coordinate the tasks of the SESAR definition phase, to implement the R&D aspects of the ATM MP, and to facilitate an accelerated market uptake of SESAR solutions, notably by organising and coordinating large-scale demonstrations activities and by supporting the related standardisation activities, in close cooperation with standardisation bodies and the European Union Aviation Safety Agency (EASA).
- The Deployment phase: a SESAR deployment framework has been developed to facilitate and accelerate the implementation of essential ATM functionalities based on solutions stemming from the development phase. Under this framework, the SESAR Deployment Manager is responsible for the coordination of the implementation of the most essential SESAR operational improvements through Common Projects. A Common Project is an extraction from the European ATM MP, based on mature SESAR Solutions to be deployed in a synchronized and timely manner across Europe, translated into EU legislation.

Implementing Regulation (EU) No 2021/116 on the establishment of a first common project to support the implementation of the ATM Master Plan ("CP1 Regulation") has mandated the deployment of a group of ATM functionalities that required standardisation. The CP1 regulation has replaced the previous Pilot Common Project, but the functionalities were not significantly changed. These functionalities are as follows:

- Extended Arrival Management and integrated arrival management ('AMAN')/ departure management ('DMAN') in the High Density Terminal Manoeuvring Areas;
- Airport Integration and Throughput;
- Flexible Airspace Management and Free Route Airspace;
- Network Collaborative Management;
- System Wide Information Management;
- Initial Trajectory Information Sharing or i4D.

The deployment of the SESAR solutions by Air Navigation Services Providers (ANSPs), airports and airlines require in many cases the use of standards, recognised within the EASA certification and declaration frameworks to ensure safety and interoperability of the systems deployed. In this context, standards remain a fundamental part of the ATM innovation cycle to ensure the seamless and timely transition from the R&D phase to deployment.

The standardisation related activities in support of SES are coordinated by the European ATM Standards Coordination Group (EASCG). It works to develop, monitor and maintain an overarching European ATM standardisation rolling development plan (A-RDP), based on the standardisation needs stemming from the SESAR framework, and inputs from its members. The group facilitates the sharing of work among the European Standardisation Organisations (CEN & CENELEC, ETSI) and other sectoral standards developing organisations such as EUROCAE or Eurocontrol, thus avoiding overlapping developments and identifying gaps. Although the coherence between the standardisation needs in Europe and internationally is already addressed in the European ATM MP, the EASCG takes into account information regarding progress and issues and raise them to the appropriate bodies for follow up as necessary. Two additional groups have also been set up to develop, coordinate and maintain similar Standardisation Rolling Development Plans in the areas of unmanned aviation and aviation cybersecurity.

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

The new legislative initiative on the overall SES framework (SES2+) that is expected to be adopted in October 2024 will bring several improvements in the performance, organisation, and management of European airspace. In particular, this initiative recognizes the 'SESAR project' as an essential enabler for the SES: the project to modernise air traffic management in Europe, which aims providing the Union with a high performance, standardised and interoperable air traffic management infrastructure.

A campaign to update the European ATM Master Plan was launched in October 2023, with a target date for adoption of the updated version in December 2024. This updated Master Plan, which will focus on the activities to be undertaken from now on till 2040, will have sustainability at its core, given the urgent need to decarbonise the aviation sector to make Europe's economy carbon-neutral by 2050. It will set out the vision to modernise Europe's air traffic management system to make the SES the most efficient and environmentally-friendly sky to fly in the world. In that context, standardisation activities represent an important enabler for an accelerated market uptake by a critical mass of early movers on innovative solutions.

With the adoption of the new EASA Basic Regulation (Regulation (EU) 2018/1139), Regulation (EC) 552/2004 was repealed and the essential requirements for interoperability of ATM systems and constituents have been transferred to it. A new framework for conformity assessment of ground equipment used for ATM to assess compliance with applicable requirements for safety and interoperability has been adopted in 2023. It addresses several aspects, including the conditions and procedures for certification and declaration of ATM/ANS equipment, or the establishment of the detailed specifications that systems must meet. The European Union Aviation Safety Agency (EASA) can make extensive use of standards as the central element of the detailed specifications it adopts as the technical requirements against which certification or declarations are performed.

The EUSCG is continuing to coordinate works to determine standard development needs and priorities in support of SESAR implementation, in particular those related to the CP1 implementation, and the different activities performed by the standards development organisations.

(A.3) REFERENCES

- Single European Sky initiative
- Regulation (EU) 2024/...of the European Parliament and of the Council of xxx on the implementation of the Single European Sky
- Regulation (EU) 2018/1139 of the European Parliament and of the Council of 4 July 2018 on common rules in the field of civil aviation and establishing a European Union Aviation Safety Agency, and amending Regulations (EC) No 2111/2005, (EC) No 1008/2008, (EU) No 996/2010, (EU) No 376/2014 and Directives 2014/30/EU and 2014/53/EU of the European Parliament and of the Council, and repealing Regulations (EC) No 552/2004 and (EC) No 216/2008 of the European Parliament and of the Council and Council Regulation (EEC) No 3922/91
- Council Regulation (EU) 2021/2085 of 19 November 2021 establishing the Joint Undertakings under Horizon Europe and repealing Regulations (EC) No 219/2007, (EU) No 557/2014, (EU) No 558/2014, (EU) No 559/2014, (EU) No 560/2014, (EU) No 561/2014 and (EU) No 642/2014
- Commission Implementing Regulation (EU) No 409/2013 of 3 May 2013 on the definition of common projects, the establishment of governance and the identification of incentives supporting the implementation of the European Air Traffic Management Master Plan
- Commission implementing Regulation (EU) 2021/116

of 1 February 2021 on the establishment of the Common Project One supporting the implementation of the European Air Traffic Management Master Plan provided for in Regulation (EC) No 550/2004 of the European Parliament and of the Council, amending Commission Implementing Regulation (EU) No 409/2013 and repealing Commission Implementing Regulation (EU) No 716/2014

- Commission Implementing Regulation (EU) 2021/116 of 1 February 2021 on the establishment of the Common Project One supporting the implementation of the European Air Traffic Management Master Plan provided for in Regulation (EC) No 550/2004 of the European Parliament and of the Council, amending Commission Implementing Regulation (EU) No 409/2013 and repealing Commission Implementing Regulation (EU) No 716/2014
- Implementing Regulation (EU) No 116/2021 on the establishment of a first common project to support the implementation of the ATM Master Plan ("CP1 Regulation")
- Commission Delegated Regulation (EU) 2023/1768 of 14 July 2023 laying down detailed rules for the certification and declaration of air traffic management/air navigation services systems and air traffic management/air navigation services constituents
- Commission Implementing Regulation (EU) 2023/1769 of 12 September 2023 laying down technical requirements and administrative procedures for the approval of organisations involved in the design or production of air traffic management/air navigation services systems and constituents and amending Implementing Regulation (EU) 2023/203
- European ATM Master Plan online portal

B Requested actions

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

EUROCAE

The Commission decided to award periodic financial support in a form of grants to EUROCAE in support of the development of standards and technical specifications for ATM systems and constituents, including SESAR technologies and standards using EGNOS and Galileo in aviation. These grants are in support of the development of the required standards or revision of existing ones in support of the Single European Sky with a view to accelerating the transition from development to deployment of SESAR solutions, and supporting end-to-end product/system standardisation.

COORDINATION ACTIVITIES EASCG / EUSCG / ECSCG

European ATM Standards Coordination Group (EASCG) coordination of ATM standardisation activities in support of SES and SESAR deployment maintains a Rolling Development Plan (A-RDP) that can be found in the link: https://www.eascg.eu/rdp/

European Unmanned Standard Coordination Group (EUSCG) coordination of drone standardisation activities and their integration with UTM and ATM maintains a Rolling Development Plan (U-RDP) that can be found in the link: https://www.euscg.eu/rdp/

European Cybersecurity Standard Coordination Group (ECSCG) coordination of cybersecurity standardisation activities maintains a Rolling Development Plan (C-RDP) that can be found in the link: https://www.ecscg.eu/rdp/ (note that this Group is confined to ATM cybersecurity issues)

The three above mentioned SDPs are regularly updated to reflect the current situation of standardisation developments.

CEN-CENELEC-ETSI

The Commission has mandated European Standardisation Organisations to develop some standards, consistent with the ATM Master Plan in support of the SES.

EASA

In accordance with the Basic Regulation, EASA issues certification and detailed specifications as applicable requirements for design and manufacturing of ATM/ANS systems and constituents. When developing these specifications EASA will make use of industry standards as acceptable means of compliance. In order to ensure timely availability of industry standards that can be referred to by EASA in these regulatory activities, close coordination among all organisations developing relevant standards and EASA is key, and the EASGC is an appropriate forum for this activity.

3.4.11 U-space

A Policy and legislation

(A.1) POLICY OBJECTIVES

Drones are a promising source of innovative services for the society, from safer infrastructure inspections to more efficient transport and mobility solutions. Drones also offer an opportunity to green aviation and optimise deliveries. The aim of the Commission is to promote a transport system that is accessible, affordable, efficient, safe, secure and environmentally friendly and to create the conditions for a competitive industry generating growth and jobs. This is why, in perspective of the foreseen increase in drone traffic in Europe, the Commission's Directorate-General for Mobility and Transport is addressing the safe operations and management of drone traffic in the wider context of aviation safety.

In response to the expanding drone market and the clear need for detailed rules on drone operations and technical requirements, particularly for smaller drones the U-space regulator framework was adopted in 2021. This framework serves as the foundation for managing drone traffic in a safe and efficient manner, positioning Europe as the pioneering region to implement such comprehensive system.

U-space consists of a set of services and procedures based on high levels of digitalisation and automation of functions, while facilitating their coexistence with manned aircraft in certain airspaces.

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

The impact of the digitalisation cannot be underestimated. Aviation moves from a human-centric system - where safety ultimately depends on pilots and air traffic controllers – towards an information-centric system, where highly automated aircraft can fly safely based on information flowing on mobile telecommunication networks.

As the aviation and mobile telecommunication worlds converge, the need for ICT standard will increase in aviation. This is particularly observable in the field of drones and unmanned aircraft traffic management solution, which are a laboratory for digital aviation solutions.

U-Space is such an unmanned aircraft traffic management solution which will allow the scaling up of the volume of drone operations that are complex, in environments that are challenging. This would include transport and mobility applications in urban environments, or close to airports.

On the basis of the Opinion 01/2020 published by EASA on a high-level regulatory framework for the U-space, the Commission has adopted three Implementing Regulations on a regulatory framework for the U-space. They cover the roles and responsibilities of the organisations involved in the definition of U-space airspace, the provision of U-space airspace services, including common information, and the minimum necessary services that need to be provided for unmanned aircraft in order to operate in the U-space airspace, the roles and responsibilities of Air Traffic Service Providers for the dynamic reconfiguration of airspace and the electronic conspicuity of manned aviation when entering a U-space airspace in non-controlled airspace.

On 29 November 2022, the Commission adopted its Drone Strategy 2.0 where it underlines the need to facilitate the roll-out of the initial U-space regulatory framework. To that end, U-space stakeholders should agree on the necessary protocols to exchange information and prioritise the development of the related standards.

Furthermore, after extended negotiations, the European Parliament approved the SES II+ package on October 22, 2024, with the final act, including Article 12 on Common Information Service pricing, published on November 11, 2024. This marks a pivotal step in advancing efforts to optimize air traffic management and ensure transparent, efficient pricing for U-space services.

For what standardisation concerns, the European Commission established the European UAS Standardisation Coordination Group (EUSCG), a joint coordination and advisory group coordinating the drone-related, including U-space, standardisation activities across Europe, and essentially stemming from the EU regulations and EASA rulemaking initiatives. EUSCG has been strengthened and supported by the efforts of the AW-Drones Horizon 2020 project, which developed an open repository of unmanned aircraft standards and validated the suitability of technical standards for compliance with existing regulations for drone operations. Currently, the EUSCG has published the 8th version of the Rolling Development Plan (U-RDP v8.0), which outlines the work programs of various standard developing organizations across variety areas related to drones. While some actions within

this plan have been published, other remain ongoing. The resulting Drone Standards Information Portal is available online and is continuously maintained under an EASA contract.

(A.3) REFERENCES

- Commission Implementing Regulation (EU) 2021/664 of 22 April 2021 on a regulatory framework for the U-space
- SES II+ Final Act, Article 12: Common Information Service Pricing. Official Journal of the EU, 23 Oct. 2024.
- U-space Blueprint, SESAR Joint Undertaking, SESAR Joint Undertaking, 2017, ISBN: 978-92-9216-087-6.
- DRONES AMSTERDAM DECLARATION, Amsterdam - 28 November 2018.
- EASA Opinion 01/2020 on a High-level regulatory framework for the U-space, 13 March 2020.
- EUSCG Rolling Development Plan – continuously maintained (www.euscg.eu).
- AW-Drones – ongoing (www.aw-drones.eu)
- A Drone strategy 2.0 for Europe to foster sustainable and smart mobility A Drone strategy 2.0 for Europe to foster sustainable and smart mobility (europa.eu)
- Drone Standards Information Portal https://standards.aw-drones.eu/

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

ACTION 1: Based on the U-space regulatory framework, and in coordination with the European UAS Standardisation Coordination Group (EUSCG), standardise semantic and technical interoperability specifications to exchange U-space information and operational data:

- between air navigation service providers, common information service providers and U-space service providers; and
- between U-space service providers and UAS operators.

ACTION 2: The following complementary actions could be developed in addition to the standardisation action:

- Development of a reference implementation of U-space software components to facilitate the adoption of U-space.
- Development of a testing platform to assess whether the U-space interfaces developed by service providers comply with the standardised specifications.

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

CEN

CEN/TC 377 'Air Traffic Management' has concentrated in the past on the introduction and update of EN 16495 "Air Traffic Management - Information security for organisations supporting civil aviation operations". The standard represents a variant of the transversal ISO 27002 security standard. It adds a concept of evidence-based trust in the implementation of the security measures of the different stakeholders involved in air traffic management.

While U-Space represents a new discipline of airspace user management adding new "players" and thus new complexities, from a security point of view the fundamental approach of EN 16495 can be applied also with U-space regarding the integration of conventional ATM and U-space management.

ETSI

TC MSG/TFES : https://www.etsi.org/committee/MSG. After CEPT published ECC Decision(22)07 related to the " Harmonised technical conditions for the usage of aerial UE for communications based on LTE and 5G NR in the bands 703-733 MHz, 832-862 MHz, 880-915 MHz, 1710-1785 MHz, 1920-1980 MHz, 2500-2570 MHz and 2570-2620 MHz harmonised for MFCN", TC MSG has initiated a new Harmonized Standard on "Aerial User Equipment". The term aerial UE refers to a UE supporting Uncrewed Aircraft Systems (UAS) features and services and requiring an aerial subscription. An aerial UE is installed either on-board an Unmanned Aircraft (e.g. drones) or on-board manned aircraft (e.g. helicopter). It identifies itself to the mobile network as being in this class.

IEEE

IEEE has many efforts underway to develop standards for drones and UASs (Unmanned Aerial Systems):

The Standards Committee: PE/T&D – 'Power and Energy/ Transmission and Distribution' published a Guide for 'Unmanned Aerial Vehicle-Based Patrol Inspection System for Transmission Lines' (IEEE 2821-2020: https://standards.ieee.org/standard/2821-2020.html)

The 'COM/AccessCore – Communication/Access and Core Networks' Standards Committee published a Standard for 'Interface Requirements and Performance Characteristics of

Payload Devices in Drones' (IEEE 1937.1-2020, https://standards.ieee.org/standard/1937_1-2020.html)

More standardisation projects are in the drafting stage and several proposals have been approved:

Standards Committee: COM/AccessCore-SC - Access and Core Networks:

- IEEE P1936.1TM, Draft Standard for Drone Applications Framework
- IEEE P1936.2 - Photogrammetric Technical Standard of Civil Light and Small Unmanned Aircraft Systems for Overhead Transmission Line Engineering
- IEEE P1937.3TM, Draft Protocol for the Flight Data Transmission of Civil Unmanned Aerial Vehicle Based on BeiDou Short Message

Standards Committee: COM/AccessCore-SC - Access and Core Networks,
Co-Standards Committee: AES/UAS/UAV/SC, SASB/SCC42:

- IEEE P1939.1TM, Draft Standard for a Framework for Structuring Low Altitude Airspace for Unmanned Aerial Vehicle (UAV) Operations

Standards Committee: COM/MobiNet-SC - Mobile Communication Networks Standards Committee:

- IEEE P1920.1 - Aerial Communications and Networking Standards
- IEEE P1920.2 - Standard for Vehicle to Vehicle Communications for Unmanned Aircraft Systems

Standards Committee: IM/RNIS - TC45 - Radiation and Nuclear Instrumentation and Systems:

- IEEE PN42.63 - Recommended Practice for Unmanned Aerial Radiation Measurement Systems (UARaMS)

Standards Committee: Communications Society/Access and Core Networks:

- IEEE P1936.3 Standard for Unmanned Aircraft Systems (UAS) using Light Detection and Ranging (LiDAR) for above 110 kV Overhead Transmission Line Survey and Design
- IEEE P1936.4 Standard for Technical Requirements for the Maintenance of Multi-rotor UAS used for Power Grid Inspection
- IEEE P1936.5 Standard for Technical Requirements for Intelligent Hangar Housing UAS used for Power Grid Inspection
- IEEE P1936.7 Standard for Mesh Deployment of Multi-Rotor Unmanned Aircraft Systems for Inspection of Overhead Transmission and Distribution, and Outdoor Substation Facilities
- IEEE P1936.8 Standard for Monitoring of Photovoltaic Power Stations Using Unmanned Aircraft Systems
- IEEE P1936.11 Standard for Requirements of Laying Out Pilot Ropes by Unmanned Aircraft Systems for Overhead Power Line Installations
- IEEE P1936.12 Standard for Verification of Pilot Line Deployment Devices Based on Unmanned Aircraft Systems for Overhead Power Line Installations
- IEEE P1936.13 Recommended Practice for Image Collection during the Inspection of Overhead Distribution Lines by Unmanned Aircraft Systems
- IEEE P1936.14 Standard for Multi-Spectral Scanning of Overhead Transmission Lines by Unmanned Aircraft Systems

Standards Committee: Communications Society/Mobile Communication Networks:

- IEEE P1954 Standard for Self-Organizing Spectrum-Agile Unmanned Aerial Vehicles Communications

Other activities include e.g. the 2022 IEEE Autonomous Unmanned Aerial Vehicles (UAV) Competition https://www.computer.org/publications/tech-news/events/uav-2022

For more information, go to https://ieeesa.io/eu-rolling-plan

IEFT

The Drone Remote ID Protocol (drip) WG has recently formed in the IETF. Civil Aviation Authorities (CAAs) worldwide have initiated rule making for Unmanned Aircraft Systems (UAS) Remote Identification (RID). CAAs currently promulgate performance-based regulations that do not mandate specific techniques, but rather cite industry-consensus technical standards as acceptable means of compliance. One key standard is ASTM International (formerly the American Society for Testing and Materials) WK65041. This technical specification defines UAS RID message formats, and transmission methods. Network RID defines a set of information for UAS to be made available globally via the Internet. Broadcast RID defines a set of messages for UAS to send locally one-way over Bluetooth or Wi-Fi. WK65041 does not address how to populate/query registries, how to ensure trustworthiness of information, nor how to make the information useful.

DRIP's goal is to specify how RID can be made trustworthy and available in both Internet and local-only connected scenarios, especially in emergency situations. Some UAS operate in environments where the network or the devices or both are severely constrained in terms of processing, bandwidth (e.g., Bluetooth 4 beacon payload is 25 bytes long), or battery life, and DRIP aims to function in these environments. The specifications produced by the WG will need to balance public safety authorities' need to know trustworthy information with UAS operators' and other involved parties' privacy.

The working group will primarily leverage Internet standards (including HIP, EPP, RDAP, and DNS) and infrastructure as well as domain name registration business models. The WG will track and align with the requirements being developed by regulatory authorities, e.g., the International Civil Aviation Organization the European Union Aviation Safety Agency (EASA) delegated and implementing regulations, and the US Federal Aviation Administration (US FAA).

https://wiki.ietf.org/en/group/iab/Multi-Stake-Holder-Platform#h-3412-u-space

ISO

ISO/TC 020/SC 016, Unmanned aircraft systems, includes work on UAS Traffic Management (WG4).

WG4 published:

- ISO/TR 23629-1:2020, UAS traffic management (UTM) — Part 1: Survey results on UTM

WG4 is working on:

- ISO/WD 23629-5, UAS traffic management (UTM) — Part 5: UTM functional structure

- ISO/CD 23629-7, UAS traffic management (UTM) — Part 7: Data model for spatial data
- ISO/WD 23629-12, UAS traffic management (UTM) — Part 12: Requirements for UTM services and service providers

ITU

ITU-T SG11 is developing a new standard Q.UAMS-SRA "Signalling requirements and architecture for urban air mobility (UAM) service environment" which describes signalling architecture, reference points connecting different functional blocks, signalling requirements for connectivity and service scenarios of UAM.

ITU-R Working Party (WP) 5B is responsible for studies related to the maritime mobile service, including the Global Maritime Distress and Safety System (GMDSS), the aeronautical mobile service and the radiodetermination service, including both radiolocation and radionavigation services. It studies communication systems for the maritime mobile and aeronautical mobile services and radar and radiolocation systems for the radiodetermination service.

ITU-R WP 5B has developed the following publications:

- Report ITU-R M.2171 on "Characteristics of unmanned aircraft systems and spectrum requirements to support their safe operation in non-segregated airspace"
- Report ITU-R M.2204 on "Characteristics and spectrum considerations for sense and avoid systems use on Unmanned Aircraft Systems (UAS)"
- Report ITU-R M.2205 on "Results of studies of the AM(R)S allocation in the band 960-1 164 MHz and of the AMS(R)S allocation in the band 5 030-5 091 MHz to support control and non-payload communications links for unmanned aircraft systems"
- Report ITU-R M.2229 on "Compatibility study to support line-of-sight control and non-payload communications links for unmanned aircraft systems proposed in the frequency band 15.4-15.5 GHz"
- Report ITU-R M.2230 on "Frequency sharing between unmanned aircraft systems for beyond line of sight control and non-payload communications links and other existing and planned services in the frequency bands 13.25-13.40 GHz, 15.4-15.7 GHz, 22.5-22.55 GHz and 23.55-23.60 GHz"
- Report ITU-R M.2233 on "Examples of technical characteristics for unmanned aircraft control and non-payload communications links"
- Report ITU-R M.2236 on "Compatibility study to support the line of sight control and non-payload communication links for unmanned aircraft systems proposed in the frequency bands 5 000-5 010 and 5 010-5 030 MHz"
- Report ITU-R M.2237 on "Compatibility study to support the line-of-sight control and non-payload communications link(s) for unmanned aircraft systems proposed in the frequency band 5 030-5 091 MHz"
- Report ITU-R M.2238 on "Compatibility study to support line of sight control and non-payload communications links for unmanned aircraft systems proposed in the frequency band 5 091-5 150 MHz"

ITU-R Study Group 1 (WP 1C) produced Report ITU-R SM.2486 on "Use of commercial drones for ITU-R spectrum monitoring tasks".

EUROCAE

EUROCAE WG-105, Unmanned aircraft systems, includes work on UAS Traffic Management (SG3)

WG-105 published:

ED-269 - Minimum Operational Performance Standard for UAS geo-fencing

ED-270 - Minimum Operational Performance Standard for UAS geo-caging

ED-282 - Minimum Operational Performance Standard for UAS e-reporting

ASTM INTERNATIONAL

ASTM committee FC38, Unmanned aircraft systems, includes work on UAS Traffic Management (in subcommittee FC38.02, Flight Operations).

FC38.02 published:

- ASTM F3411 – 19, Standard Specification for Remote ID and Tracking

FC38.02 is working on:

- WK63418, New Specification for Service provided under UAS Traffic Management (UTM)

3.4.12 Circular economy and sustainability

A Policy and legislation

(A.1) POLICY OBJECTIVES

Circular Economy (CE) is a top priority of the European Green Deal, which is one of the pillars of the twin transitions. As the term "twin transitions" implies, achieving the objectives of a Circular Economy will go hand-in-hand with the further progressing of the digital transformation. Circular Economy is described as a systematic approach to the design of processes, products (including services) and business models, enabling sustainable economic growth by managing resources effectively as a result of making the flow of materials more circular and reducing and ultimately eliminating waste. It requires a systemic approach that includes all levels from the collection of raw material to the full circle of use and re-use. The entire productive system must be totally "redesigned" with this new paradigm. The most evident and profound transformations are and will be represented by the great re-conversions in the Energy, Industrial (Automotive, Engineering, Iron and Steel), Construction, and Agricultural sectors and in the processes with greater consumption and impact on resources and raw materials (e.g. Supply Chains).

As part of the twin transitions, circular economy is a key aspect of the renewal of industry by driving green innovation and increasing competitiveness. Effective ways of handling scarcity of resources will help decrease dependencies. It has the potential of putting industrial development on fundamentally new grounds.

Digital technologies have revolutionised the possibilities for generating, storing, accessing, and using product-related information. The possibility to tag and identify products means that such useful information – both static and dynamic - can be linked to individual products, down to the level of the individual components and materials. Therefore, both the European Green Deal and the New Circular Economy Action Plan (CEAP) identify *inter alia* product passports as a way to contribute to an effective product policy and empower professional users and consumers to make more sustainable choices. The European Green Deal notes that "Digitalisation can also help improve the availability of information on the characteristics of products sold in the EU. For instance, an electronic product passport could provide information on a product's origin, composition, repair and dismantling possibilities, and end of life handling".

ICT standards play a critical role in this context. They are of relevance at very different levels. For example standards are relevant for identifying, capturing, collecting, sharing, classifying, analysing and transferring data, providing data formats and defining IT/network infrastructure. Standards also support tools to work with data as well as tools for design. Standards define methods as well as metrics, e.g for testing and benchmarking. Standards also lay down rules for data governance. And many more areas.

The ICT sector, therefore, plays a key role in supporting interoperability and innovation of production processes related to industrial transformation and standardisation can make a significant contribution in supporting industry, in particular SMEs, in successfully undertaking the green transformation towards a circular economy. This is not just about "digitalisation" of processes: a real digital transformation is needed, processes have to be redesigned "thinking digital" and starting from digital since their (re) conception. The "digital by design" principle must be applied systematically and consistently in many sectors, including policy measures and legislation. There will be an unprecedented need of collaboration between traditional sectors and ICT, especially in standardisation activities.

(A.2) EC PERSPECTIVE AND PROGRESS REPORT

The European Commission Communication "A new Circular Economy Action Plan for a cleaner and more competitive Europe" (COM(2020) 98 final) identifies a number of areas where digital transformation plays a key role in enabling the circular economy - in particular:

- Designing sustainable products and business models: mobilising the potential of digitalisation of product information, including solutions such as Digital Product Passports, tagging and watermarks (Chapter 2.1) as well as enabling circular business models such as product-as-a-service;
- Circularity in production processes: promoting the use of digital technologies for tracking, tracing and mapping of resources (Chapter 2.3);
- Construction and buildings: promoting measures to improve the durability and adaptability of built assets in line with the circular economy principles for

buildings design and developing digital logbooks for buildings (Chapter 3.6);

- Driving the transition through research, innovation and the digital transformation: Digital technologies can track the journeys of products, components, and materials and make the resulting data securely accessible. The European data space for smart circular applications will provide the architecture and governance system to drive applications and services such as product passports, resource mapping and consumer information (Chapter 6.3).

On 30th March 2022 the Commission adopted a proposal for a Regulation on Ecodesign of Sustainable Products (ESPR). That became the Regulation (EU) 2024/1781 establishing a framework for the setting of Ecodesign requirements for sustainable products. This new legislation repeals the existing Ecodesign Directive, expanding its scope both in terms of product groups covered but also in terms of circularity and sustainability aspects included. The Regulation also introduce the digital product passport (DPP), a decentralised new tool that will make available relevant information to different stakeholders based on a 'need to know' principle. Article 10 of the Regulation introduce the essential requirements that any DPP will have to comply with. The essential requirements will be used to draft a standardisation mandate to ESOs in view of making the DPP operational by 2025. The DPP will be mandatory for all product groups regulated under the new ESPR, with few exceptions listed in article 8.4.

The Digital Europe Programme is supporting a Coordination and Support Action to define Digital Product Passports in the areas of batteries, electronics, and textiles. Pilots related to dataspaces for manufacturing will also be supported in 2022.

The MSP study group on Circular Economy (SGCE) has made a thorough analysis of the information and actions proposed via the Rolling Plan 2020. In general, a large number of topic areas covered in the Rolling Plan and specific proposed actions relate to digital transformation. This ranges from topic areas with high attention like Cloud or Internet of Things (IoT), addresses issues around security and privacy, but is also true for many topic areas where the digital transformation can help to reduce waste and - even better - to identify potentials for re-use. The analysis has shown that there are many actions that are relevant to circular economy, yet not are all are immediately recognisable as such, so some context setting and sharpening of this relation would be important.

In May 2021, 26 Member States and Norway and Iceland have signed a declaration to accelerate the use of green digital technologies for the benefit of the environment. They will deploy and invest more green digital technologies to achieve climate neutrality and accelerate the green and digital transition.

(A.3) REFERENCES

- ESRP Regulation (EU) 2024/1781 of the European Parliament and of the Council of 13 June 2024 establishing a framework for the setting of ecodesign requirements for sustainable products
- COM/2019/640 final Commission Communication The European Green New Deal
- Circular Economy Action Plan For a cleaner and more competitive Europe
- Report of the MSP Circular Economy Study Group

B Requested actions and progress in standardisation

(B.1) REQUESTED ACTIONS

ACTION 1: SDOs to do a detailed landscaping of the standards that are available or under way to support circular economy objectives and identify gaps. The MSP may facilitate cooperation in this respect including on the work of respective standardisation roadmaps.

ACTION 2: SDOs to cooperate and start work in the areas of data carriers, identifiers, vocabularies, semantics, taxonomies, ontologies for circularity and sustainability of products along the life cycle. SDOs to describe further the approaches for a Digital Nameplate based on the concept of the Asset Administration Shell and semantic properties of IEC and ISO Common Data Dictionary (CDD).

ACTION 3: SDOs to start activities that support the sustainable product initiative objectives like ecodesign and its applications based on wider sustainability criteria to priority product groups and key value chains.

ACTION 4: SDOs to build on existing work and progress towards adding standardisation activities for circular economy objectives around the Digital Product Passport.

ACTION 5: Existing product identifier systems used in industry should be identified and the potential for interworking should be explored. The conversion from existing "island" solutions into a mesh of interworking data elements and finally into a (few) major product

identifier catalogues is a long process best handled within the ESO and international standardisation systems. The Digital Product Passport concept – allowing identification of products and components throughout a full product lifecycle from manufacture to recycling – could have beneficial economic and environmental aspects.

ACTION 6: SDOs to standardize the interfaces and sub-models of Asset Administration Shell based on IEC 63278 series (for plants and products) for the input of current maintenance information (repairs, maintenance, conversions) into the systems of condition monitoring and predictive maintenance.

ACTION 7: SDOs to cooperate on developing an Open Architecture Framework for Digital Product Passport and circular economy.

ACTION 8: CEN & CENELEC and ETSI to progress their work on energy-related products towards further addressing needs and supporting objectives of circular economy.

ACTION 9: SDOs to cooperate on developing use cases for new and emerging technologies like AI and Blockchain in the context of circular economy, also with relevant stakeholders such as Open Source and EC funded Projects working on Blockchain, and to start respective standardisation activities in order to support making these technologies available fast to support a circular economy.

ACTION 10: SDOs to work on metrics and setting criteria for the assessment of the environmental impact of equipment in the context of green financing.

ACTION 11: The European Commission, with the support of the MSP and relevant stakeholders, to facilitate the production of a landscape overview of ongoing open source projects in the area of circular economy that complement standardisation activities.

ACTION 12: SDOs to cooperate on adapting/developing standards to make the Commission digital product passport operational. In particular, standards should be adapted/developed in the following areas: access right management, interoperability (technical semantic, organisational) including data exchange protocols and formats, data storage, data processing, data authentication, data reliability, data integrity, data security and data privacy.

ACTION 13: SDOs to develop standards or expand available standardisation efforts for including topics of relevance to circular economy, in particular long-term traceability of material to enable re-use and recycling.

C Activities and additional information

(C.1) RELATED STANDARDISATION ACTIVITIES

CEN & CENELEC

The CEN & CENELEC Strategic Advisory Body on Environment (SABE) launched a new Joint Group on Circular Economy (JG-CE). The purpose of this Group is to provide advice and coordinate CEN & CENELEC's standardisation activities related to the Circular Economy. https://www.cencenelec.eu/news/brief_news/Pages/TN-2020-018.aspx More than 20 CEN & CENELEC Technical Committees are developing standards in support of various Ecodesign and Ecolabelling product regulations (through standardisation requests/mandates). Approximately 150 ENs were published (covering products such as: computer and computer servers, televisions, external power supplies, etc.). standardisation work related to energy efficiency mainly focused on the energy efficiency of products during their use phase. Moreover, as part of the Circular Economy Action Plan published in 2015, the European Commission requested to develop standards on material efficiency that would establish future ecodesign requirements on, amongst others, durability, reparability and recyclability of products. CEN/CLC/JTC10: Energy-related products - Material Efficiency Aspects for Ecodesign

A full list of new standards - EN 4555X - was recently released addressing specific aspects of circular economy:

EN 45552:2020 'General method for the assessment of the durability of energy-related products';
EN 45553:2020 'General method for the assessment of the ability to remanufacture energy related products';
EN 45556:2019 'General method for assessing the proportion of reused components in energy related products';

EN 45557:2020 'General method for assessing the proportion of recycled material content in energy-related products';

EN 45558:2019 'General method to declare the use of critical raw materials in energy-related products';
EN 45559:2019 'Methods for providing information relating to material efficiency aspects of energy-related products'. https://www.cenelec.eu/dyn/www/f?p=104:7:2648015834401701::::FSP_LANG_ID,FSP_ORG_ID:25,2240017#1

Further on battery and circular economy: https://www.cencenelec.eu/news/publications/Publications/

CEN & CENELEC 'Standardisation in a Circular Economy – Closing the loop'
https://www.cencenelec.eu/news/publications/Publications/CEN-CENELECCircularEconomyAccess_rev2020-05-V1.pdf
CircularEconomyAccess_rev2020-05-V1.pdf

CEN/TC 319 'Maintenance': various working groups, etc. are currently working on standards for "Maintenance Management" and "Maintenance Engineering". These standards are intended to concretise and standardise basic tasks, role definitions and methods in the maintenance process of Industry 4.0 installations

ECMA INTERNATIONAL

Standard ECMA-328 - Determination of Chemical Emission Rates from Electronic Equipment - Part 1 (using-consumables) and Part 2 (not using-consumables). This Standard (all parts) specifies methods to determine chemical emission rates of analyte from ICT & CE equipment during intended operation in an Emission Test Chamber (ETC). This Standard (all parts) includes specific methods for equipment using consumables, such as printers, and equipment not using consumables, such as monitors and PC's. http://www.ecma-international.org/publications/standards/Ecma-328.htm

ETSI

ETSI TC ATTM (Access, Terminals, Transmission and Multiplexing) issued EN 305 174-8, based on EU WEEE (Waste Electrical and Electronic Equipment) and RoHS (Restriction of Hazardous Substance) Directives. This EN and the TS 105 174-8 Series are some fundamental steps to improve the collection and treatment of ICT WEEE, promoting the circular economy regarding the amount of e-waste generated each year. The content of WEEE needs to be processed carefully due to the presence of both hazardous and precious substances. ETSI TC EE (Environmental Engineering) has produced TR 103 476 "Circular Economy (CE) in Information and Communication Technology (ICT); Definition of approaches, concepts and metrics" and is producing an EN on "Assessment of material efficiency of ICT network infrastructure goods (circular economy)" in the scope of Mandate M/543 on Material Efficiency on which the work is done in coordination with CEN/CLC/JTC10. Furthermore, EN deliverables are in preparation for the circular economy requirements specific to servers.

GREEN ELECTRONICS COUNCIL

EPEAT is an IT sector ecolabel for purchasers, manufacturers, resellers and others wanting to find or promote environmentally preferable products. The EPEAT program provides independent verification of manufacturers' claims through Conformity Assurance Bodies evaluating products against EPEAT criteria. The EPEAT criteria are developed through a balanced voluntary consensus process. Standards that the EPEAT Program has historically adopted were created by Standards Development Organisations (SDOs) employing balanced voluntary consensus processes but are now developed through the Green Electronics Council Dynamic Standards Development Process (DSDP). The EPEAT online Registry lists sustainable products from a broader range of manufacturers than any comparable ecolabel. National governments and thousands of private and public institutional purchasers around the world use EPEAT as part of their sustainable procurement decisions. See https://greenelectronicscouncil.org/epeat/epeat-overview/

GS1

GS1 (https://www.gs1.org/) is a global standardisation body driven by industry. Its global and open standards provide a universal language for identifying, capturing, and sharing supply chain data about products, locations, assets, and more. Companies usually combine different GS1 standards to ensure compliance and to streamline processes (https://www.gs1.org/standards).

GS1 is engaging in sustainability, having already established global and sector-oriented data models and registries where product, location and entity data can be checked. We also see the potential value in developing a cross-sector data semantics for circularity and sustainability, in partnership with industry (https://www.gs1.org/docs/gs1-sustainability-position-paper-feb2022.pdf). See also Traceability standard - https://www.gs1.org/standards/traceability/traceability/2-0

GS1 standards for identification, automatic identification and data capture (AIDC), and data sharing support ESPR requirements of the European Union and other jurisdictions as well. To increase understanding of GS1 standards conformant systems, GS1 is also providing a White Paper explaining the different aspects of how GS1 standards, widely implemented today or planned for implementation by 2027, can support the evolving circular economy with little to no disruption to industry.

The original version of the GS1 in Europe White Paper which focused on Web-Enabled, Structured Path Product Identification and AIDC Carriers has now been expanded to begin the discussion of Economic Operator ID (EOID), Facility ID (FID) and GS1 Data Sharing standards. Please find the current version here.

Some initiatives GS1 is involved in:

- After successfully participating in CIRPASS, GS1 is a proud member of CIRPASS-2. CIRPASS-2 is an EU-funded consortium aiming to demonstrate functioning Digital Product Passports in real settings through circular pilot deployments and use cases in textiles, electrical and electronic equipment, tyres and construction value chains. GS1 is involved in many of the tasks, with a specific focus being sub-task leader of T3.2A on textiles ontologies (part of Work Package 2 on Lighthouse Pilots). Follow the link here: https://cirpass2.eu/
- On April 25th, 2023, GS1 opened a Mission Specific Work Group, with a focus on addressing the EU Ecodesign for Sustainable Product Regulation (ESPR) and advancing the circular business model. The MSWG's standards development efforts are structured around three key areas:
  - Automatic Identification and Data Capture (AIDC) application standards,
  - data sharing standards (e.g., Product Master Data, EPCIS),
  - and implementation guidelines.

As per the established timeline, the Circularity/DPP MSWG is developing an AIDC Application Standard, in light of the ESPR being published in summer 2024.

This working group is open to all entities, including non-GS1 members, and is accessible upon registration

- At this page: https://www.gs1.org/standards/development-work-groups (name of the group: GSMP GS1 Circularity - Digital Product Passport - WR 23-103)

or by following this direct link:https://xchange.gs1.org/_login/default.aspx?ReturnUrl=%2fcr%2fgsmp%2fmswg%2fg-smpgs1cdppmswg%2f_layouts%2f15%2fAuthenticate.aspx%3fSource%3d%252Fcr%252Fgsmp%252Fmswg%252Fg-smpgs1cdppmswg&Source=%2Fcr%2Fgsmp%2Fmswg%2Fg-smpgs1cdppmswg

IEC

The following horizontal standards are available or being developed:

EN IEC 60086-6:2020 'Primary batteries - Part 6: guidance on environmental aspects'

EN IEC 63115-1 'Secondary cells and batteries - Sealed nickel-metal hybrid cells and batteries for use in industrial applications - part 1: Performance'

prEN IEC 63218 'Secondary cells and batteries - Secondary lithium ion, nickel cadmium and nickel metal hybrid cells and batteries for portable applications - guidance on environmental aspects'

IEC TS 61851-3-7 'Electric vehicles conductive power supply systems - particular requirements for EV supply equipment - battery system communication'

prEN IEC 62933-4-4 'Electrical energy storage systems - environmental requirements for BESS using reused batteries in various installations and aspects of life cycles'

Predictive maintenance is another current standardisation with focus on maintainability. Ongoing activities are IEC 63270 ED1 "Industrial automation equipment and systems – Predictive maintenance" within IEC/SC 65E.

IEEE

IEEE has created Planet Positive 2030, an output of the Sustainable Infrastructures and Community Development program (IEEE SICDP), that brings together a global, open community of experts to chart a path for all people to achieve a flourishing future for 2030 and beyond. Planet Positive 2030's current compendium document, Strong Sustainability by Design: Prioritizing Ecosystem and Human Flourishing with Technology-Based Solutions features information on the Circular Economy, and Circular and Regenerative design in multiple chapters.

The program has also inspired a number of standards ideas, including the recently approved Standards Working Groups:

- IEEE P7800, Recommended Practice for Addressing Sustainability, Environmental Stewardship and Climate Change Challenges in Professional Practice.
- IEEE P7801, Recommended Practice for Technical Knowledge Commons Initiatives and Platforms
- IEEE P7802, Standard for Measurement and Verification of Reduction of Greenhouse Gases for Climate Action Projects and Solutions
- IEEE P7803, Recommended Practice for Inclusive Sustainable Smart Cities

Current IEEE 1680 family of standards include:

- IEEE 1680.1, Standard for Environmental Assessment of Personal Computer Products, including Notebook Personal Computers, Desktop Personal Computers, and Personal Computer Displays
- IEEE P1680.2, Standard for Environmental Assessment of Imaging Equipment
- IEEE P1680.3, Standard for Environmental Assessment of Televisions
- IEEE P3469 Standard for an Environmental Liability Process Model for Accounting in Systems Engineering

Current IEEE 2883 Sanitizing Storage family of standards include:

- IEEE 2883, Standard for Sanitizing Storage
- IEEE P2883.1, Recommended Practice for Use of Storage Sanitization Methods
- IEEE P2883.2, Recommended Practice for Virtualized and Cloud Storage Sanitization

For more information, go to https://ieee-sa.imeetcentral.com/eurollingplan/.

ISO

ISO/TC 323, Circular economy, was formed in 2018 to address standardisation in the field of Circular Economy to develop frameworks, guidance, supporting tools, and requirements for the implementation of activities of all involved organisations to maximise the contribution to Sustainable Development. The following working groups are active:

WG1: Framework, principles, terminology, and management system standard.
WG2: Guidance for implementation and sectoral applications.
WG3: Measuring circularity.
WG4: Specific issues of circular economy type of business models (PSS,....). https://www.iso.org/committee/7203984.html
WG5: Product circularity data sheet - ISO/AWI 59040 "Circular Economy — Product Circularity Data Sheet" is a new standard under development to provide a methodology and format for reporting and exchanging information about the circular economy aspects of products. More information available at https://pcds.lu/"

ISO/TC 324, Sharing economy, was formed in 2019 to address standardisation in the field of sharing economy. The following working group is active: WG1: Terminology and principles. https://www.iso.org/committee/7314327.html
ISO 13374 on condition monitoring and diagnostics of machines during the processing, exchange and presentation of data. https://www.iso.org/standard/37611.html
ISO 13381 describes the principles for prognosis in the context of condition monitoring and diagnostics of machines. https://www.iso.org/standard/51436.html

ITU

The ITU has developed a series of international standards that support the transition to circular economy at city level and encourage re-use, recycling and circular design, and more in the ICT industry, including:

- Recommendation ITU-T L.1016 "Method for evaluation of the environmental health and safety performance of true wireless stereo headphones"
- Recommendation ITU-T L.1020 "Circular economy: Guide for operators and suppliers on approaches to migrate towards circular ICT goods and networks"
- Recommendation ITU-T L.1022 "Circular economy: Definitions and concepts for material efficiency for information and communication technology"
- Recommendation ITU-T L.1023 "Assessment method for Circular Scoring"
- Recommendation ITU-T L.1024 "Effect for global ICT of the potential of selling Services instead of Equipment on the waste creation and environmental impacts"
- Recommendation ITU-T L.1100 "Procedure for recycling rare metals in information and communication technology goods"
- Recommendation ITU-T L.1050 "Methodology to identify the key equipment in order to assess the environmental impact and e-waste generation of different network architectures".

- Recommendation ITU-T L.1032 "Guidelines and certification schemes for e-waste recyclers"
- Recommendation ITU-T L.1021 "Extended producer responsibility - Guidelines for sustainable e-waste management"
- Recommendation ITU-T L.1031 "Guideline on implementing the e-waste reduction target of the Connect 2020 Agenda"
- Recommendation ITU-T L.1033 "Guide for the institutions of higher learning to contribute in the effective life cycle management of e-equipment and e-waste"
- Recommendation ITU-T L.1034 "Adequate assessment and sensitisation on counterfeit ICT products and their environmental impact"
- Recommendation ITU-T L.1035 "Sustainable management of batteries"
- Recommendation ITU-T L.1036 "Scheduled waste management for a base station (inclusive of e-waste)"
- Recommendation ITU-T L.1040 "Effects of ICT enabled autonomy on vehicles longevity and waste creation"
- Recommendation ITU-T L.1060: General principles for the green supply chain management of information and communication technology manufacturing industry

Recently ITU and ETSI have finalized **Recommendation ITU-T L.1070 "Global digital sustainable product passport opportunities to achieve a circular economy"** which is under approval process and approved Recommendation ITU-T L.1027 "Assessment of material efficiency of ICT network infrastructure goods (circular economy). Part 5: Server and data storage product disassembly and disassembly instruction"

ITU-T Study Group 5 "Environment, EMF and Circular Economy" developed Recommendation ITU-T L.1061 "Circular public procurement of information and communication technologies" which is accompanied with a guide on Circular and sustainable public procurement – ICT equipment guide and an e-learning training. ITU-T SG5 has also produced ITU-T L.Suppl.20 on Green public ICT procurement.

OASIS

The eDelivery Building Block of the Connecting Europe Facility uses implementation guidelines for various OASIS technical specifications, in particular a profile of the OASIS AS4 standard (also ISO 15000-2). It is widely used in the public and private sector, not just to replace paper, but also to support innovative business processes and services. As a relevant example, eDelivery is used by suppliers of electrical products to register products in the European Product Database for Energy Labelling (EPREL) and for the Poison Centres Notifications of the European Chemicals Agency. While these are central systems, eDelivery also supports distributed, peer-to-peer exchanges, so market participants could also use it more widely for exchange of product or other circular economy related data.

OASIS UBL v 2.1 (ISO/IEC 19845:2015) enables public sector procurement, with granular item description information structures that represent materials data exchange. UBL version 2.4 was published as an OASIS standard in June 2024, and has been submitted to ISO/IEC JTC 1 for additional approval. See 3.3.1 eProcurement and 3.3.2 e-Invoicing. To help fulfill sustainability and circularity policy goals, the UBL TC launched a Commodities subcommittee in 2024 to respond to significant demand for better product information on commodity sources, traceability, trading, and re-use. While some streams of products and raw materials may eventually be supported by more metadata certification systems, in the short term, the subcommittee seeks to provide simple and global solutions by extending existing widely-used secure e-invoice methods like UBL, which is extensible and can carry certifications or attestations as additional payload.

The OASIS Product Life Cycle Support (PLCS) TC developed and issued structured data exchange templates ("DEX") in coordination with the product management works of ISO TC 184/SC4 on industrial data, particularly ISO 10303 ("STEP"), to support complex engineered assets throughout their total life cycle. The Product Life Cycle Support specification v1.0 was issued by OASIS in 2013; sets of specific industrial data exchange DEX templates coordinated with ISO 10303 were issued as Product Life Cycle Support DEXs Version R5.

TEKOM IIRDS CONSORTIUM

The iiRDS standard (intelligent information Request and Delivery Standard) enables the provision of intelligent maintenance-relevant information independent of industries and manufacturers. One goal of the iiRDS consortium, founded in 2018, is the specification of standardised mechanisms and a standardised vocabulary, which, in the context of Industry 4.0, make it possible to generate situation-specific and context-specific information for the cases occurring throughout the product life cycle.

The following functions, among others, are to be fulfilled:

- dynamically adapt to the user and application context
- provide targeted information for all life cycle phases, from specification to maintenance
- match the delivered system, even after configuration changes and updates
- dynamically integrate assistance and sensor information and operating parameters
- support various search and filter functions

The metadata of the iiRDS thus represent a standardised vocabulary for technical documentation. The iiRDS consortium is currently cooperating with the committee responsible for VDI 2770 to ensure the compatibility of that guideline.

UN ECE

Circular economy is one of the key themes of the work of the United Nations Economic Commission for Europe; it will be the main discussion theme of the commission session in April 2021. As input to discussions a Briefing Note on the United Nations Economic Commission for Europe – United Nations Centre for Trade Facilitation and Electronic Business Contribution to Advance Circular Economy Actions has been developed outlining policy positions as well as activities in standardisation with relevance to the circular economy: http://www.unece.org/fileadmin/DAM/cefact/cf_plenary/2020_Plenary/ECE_TRADE_C_CEFACT_2020_24E-UNCEFACTdeliverablesCE.pdf

UNECE & UN CEFACT, in a project co-funded by the European Union, aim at developing the recommendations and tools for transparency and traceability in the apparel & footwear industry (https://www.unece.org/info/media/news/trade/2019/transparency-

in-fashion-unece-mobilizing-industry-and-experts-to-develop-blockchain-traceability-tool-and-policy-framework-under-eu-funded-project/doc.html).

This exercise involves the development under the aegis of UN CEFACT of a standard for communicating along value chains relevant information allowing to substantiate claims.

W3C

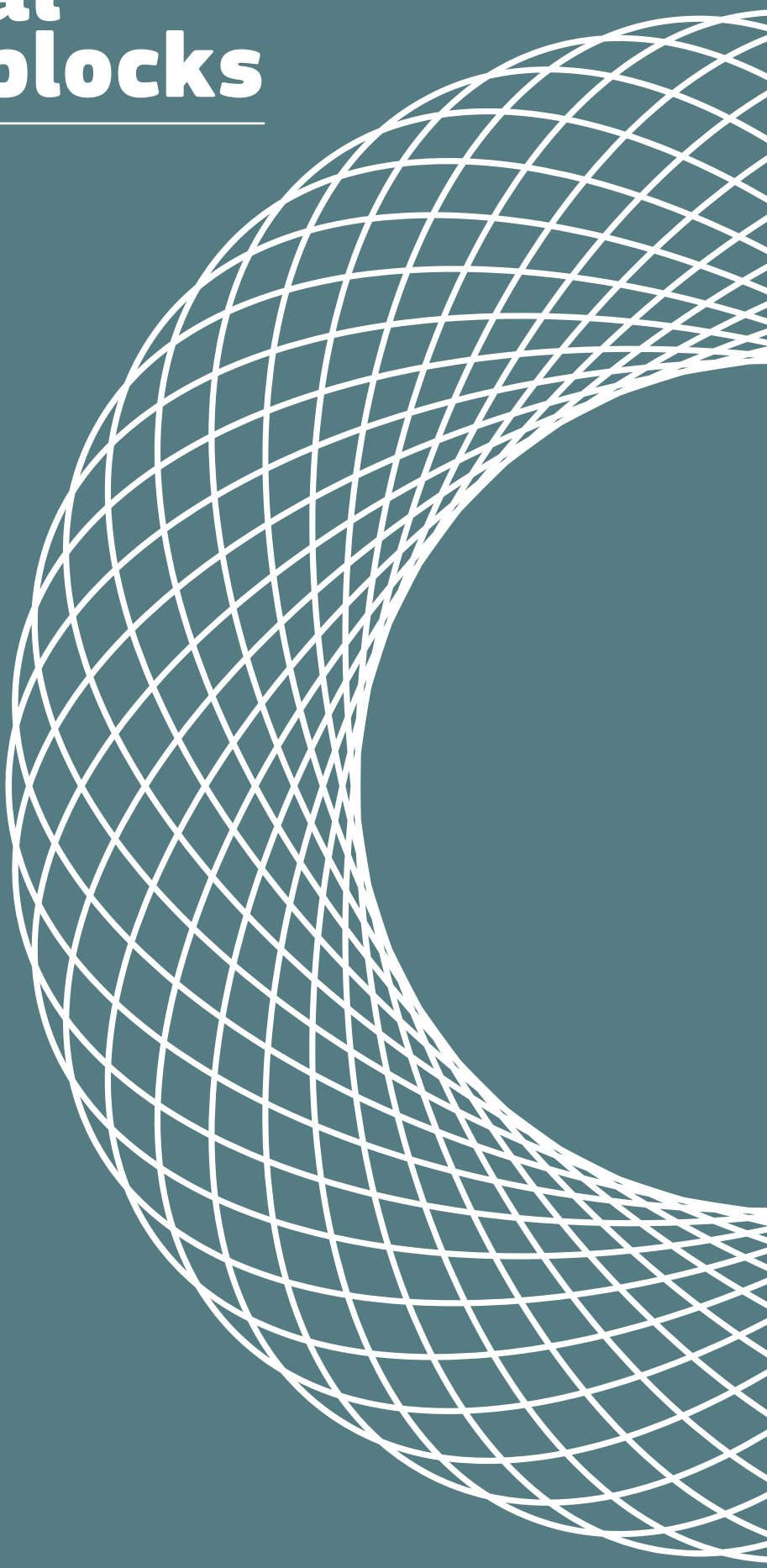
By building a web of data, W3C's strategy of data interoperability is directly and crucially relevant to the circular economy. The initiative is based on the Linked Data stack already specified that allow for re-use of existing tools like the specification on provenance of data. Relevant ongoing is work on is taking place especially in the Web of Things WG and in the Data Privacy Vocabulary CG.45

(C.2) ADDITIONAL INFORMATION

ZERO DEFECTS IN MANUFACTURING

Horizon 2020 project https://www.zdmp.eu/

4 Horizontal building blocks



Original text published in the 2017 Rolling Plan is available here.

4.1. ICT drives innovation in all economic sectors

The disruptive potential of ICT results from its nature as a general purpose technology. It is all about communicating and processing of digital data. Digital data may represent all kinds of information, including numbers, symbols, voice, audio, pictures, video, etc. Digital data are therefore exchanged and processed for many different purposes. Major applications include making phone calls, watching films, calculating and simulating physical world phenomena and publishing knowledge and news, to name a few.

In the 1990s, the first wave of ICT based convergence of industries has blurred the boundaries of the telecommunication, the computer and the broadcasting sectors. Today, consumers take this convergence as a given and expect to watch news on their smartphone, to make voice calls using a notebook or tablet, and to surf the Internet with their television set.

Distributed processing of digitized voice, moving pictures and other information on networked computers has driven the first wave of convergence and disrupted prior separate vertical consumer markets. However, these previously separated vertical markets for telephony, computing and television have not converged into a single much larger market. The opposite holds true, ICT-based technology convergence resulted in accelerated market segmentation. Today, many alternative products and services coexist for telephony and TV, not mentioning the many new services never anticipated like social networks or e-commerce.

The processing power has continued to grow exponentially according to Moore's Law. The amount of data is exploding at unprecedented speed since whatever can be digitized has been and is digitized. Moreover, connecting what can be connected further boosts the exponential, self-amplifying, combined potential of ICT at large to embrace new application areas.

The combinatorial effect of more powerful general purpose computing platforms, an unprecedented abundance of digital data, including sensor data, and connectivity of all kinds of devices and objects are redefining other industries by transforming businesses and society. Thus, ICT drives innovation in all sectors, from the smart home to the smart city, from the smart grid to smart transportation, from smart healthcare to smart manufacturing in all kinds of industry sectors.

4.2. New wave of convergence

A second wave of convergence is under way and building speed. It is based on the integration of distributed processing of information and operation of equipment.

While the first wave of ICT based convergence revolutionized mainly consumer markets, the second wave of convergence will heavily impact critical infrastructure, industry, and business-to-business markets. The activities of economic actors in all sectors, whether manufacturers, service providers, administrations and their customers will be dramatically altered. Some examples are:

- interfaces between product and service suppliers and their customers, whether these are other businesses, governments or end-consumers will change profoundly. In this process, particularly close attention must be paid to the over-arching issues such as security, data protection and privacy and sometimes accessibility in order to make these changes fully acceptable and manageable for those outside the ICT industries themselves.
- in the case of industrial companies, many must rely on time-sensitive local area networks operated as private networks in order to ensure highly available and reliable closed loop control operating side-by-side with less critical information services. Operation of all kinds of systems, including utilities, will be increasingly automated and will be more and more autonomous - mainly by adding Artificial Intelligence (AI);
- regarding data value chains, common, semantically enriched data formats as well as common semantics are critical to enable the free flow of data both vertically and horizontally within industry domains and across industry sectors. This is needed as an accelerator for digitisation, e.g. in the context of the Internet of Things (IoT), for digitising industry, for smart cities and for digitisation in public services;

- many of these more conventional economic sectors such as transportation, utilities, manufacturing, agriculture, or healthcare are more regulated than various segments of ICT markets. Software, appliances, machines, and robots increasingly make decisions and act accordingly in an unsupervised manner, being more and more autonomous in their operation. They need to smoothly integrate into societies and interact with humans in alignment, not only with laws, but also with ethical principles. Trust is inevitable for the adoption of smart infrastructure. Regulatory requirements may change or have to be adapted.

Enhanced ICT enables a smarter world and is an inevitable means to reach crucial European policy goals. ICT is the basis of the European Digital Single Market and the key enabler for digitizing European industry and indeed society as a whole.

4.3. Integrated solutions for different industry domains

The power and disruptive potential of ICT results from being a general purpose technology advancing exponentially in a combinatorial manner. More and more powerful ICT products and services are available for

- digitizing analog information
- data management
- symbolic computing and machine learning

These may be integrated into domain-specific platforms or be used as part of a solution for various different industry domains. Generic standardized solutions to exchange data, to analyze data, to decide and act upon knowledge extracted from data are applicable in many sectors, from transportation to manufacturing to agriculture. In this respect, ICT may be regarded as a common horizontal technology. The process of applying more and more such horizontal ICT technologies as an integral part of by now tightly vertically integrated industry domain specific infrastructures is known as 'Digital Transformation'.

Business drivers for the digital transformation include the following:

1. cost reduction (OPEX mainly)
2. new services (easy deployment)
3. productivity gains
4. less vendor lock-in
5. economies of scale
6. mass production of personalized products

It is, however, not straight forward how to benefit from digital transformation. There will not be a single end-to-end standardized system solution, but many instances tailored to company needs will coexist. The digital transformation is an innovation race to gain competitive advantages.

It is not obvious how to apply standardized ICT platforms or parts thereof to solve specific problems in manufacturing, transportation, agriculture, health care, or in other domains.

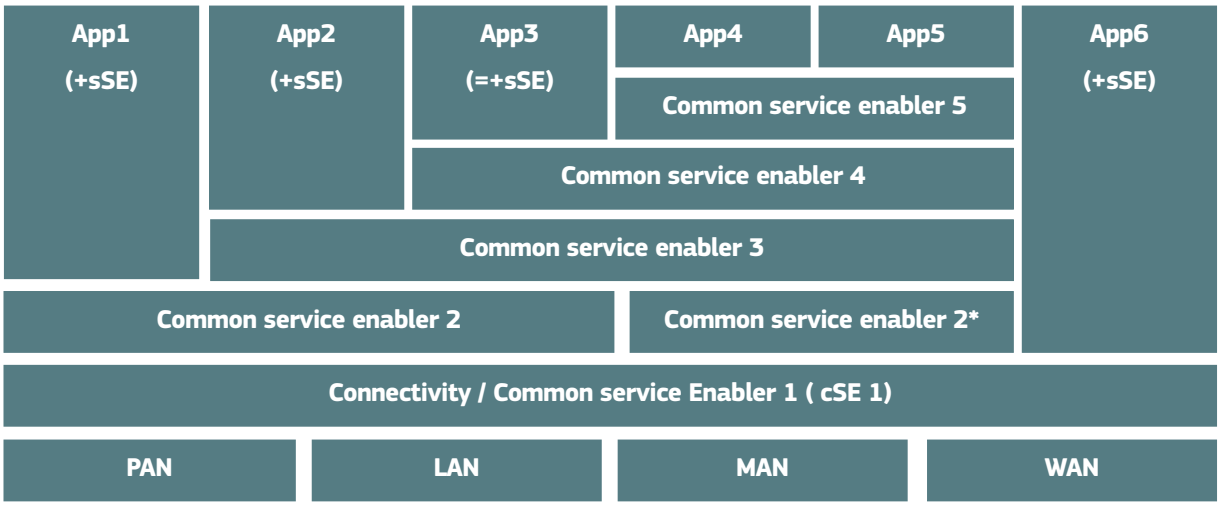


Figure 1: Examples for horizontally versus vertically integrated solutions for different industry domains (cSE=common Service Enabler, sSE=specific Service Enabler)

- From an ICT industry viewpoint the challenge is to enable novel solutions for various vertical industries based on common solution elements.
- From a vertical industry sector viewpoint the challenge is to reuse standardized ICT as enablers for innovations.

Common horizontal ICT building blocks will not be introduced in one go, but used and integrated step-by-step according to the needs of a particular industry. It is all about a process of adoption of off-the-shelf ICT solution elements depending on industry domain specific requirements. It is an evolution with revolutionary results rather than a revolution from the start.

See figure 1.

Various combinations of integrated horizontal and vertical building blocks for diverse industries will coexist, as is illustrated in Figure 1. The challenge, however, persists how to combine as many common horizontal building blocks as possible with as many vertical building blocks as necessary to maximize benefits.

Provided the digital transformation of industries works out as a smooth transition process, economy and society at large will benefit from achieving policy goals like

1. customer choice
2. protection of consumers and SME users of ICT solutions, both to ensure (physical and electronic) security and data protection and in the sense of ensuring citizens' rights, service quality etc.
3. vibrant innovative eco-system
4. business opportunities for new entrants
5. economic growth

In these processes, the standardisation system will be challenged.

- ICT standardization is characterised by its fragmentation, with the involvement of multiple organisations, both formal and informal.
- On the other hand, in the other sectors that will be more and more influenced by ICT, standardization is typically a slow and formal process.
- Ways need to be found to ensure collaboration between the involved SDOs, and that participants in standardisation committees have the necessary competences.

Annex I
List of Member States' Work Plans and Strategies

This Annex provides a list of links to strategy documents, policies and work plans on ICT standardisation that are available in the Member States, sometimes comprising several links depending on the respective document structuring in Member States. This list is for reference only. It does not claim completeness and only represents a current snap shot.

FRANCE

French webportal for digital economy policy : https://www.entreprises.gouv.fr/fr

Framework for interoperability and security: http://references.modernisation.gouv.fr/interoperabilite

GERMANY

German Digital Strategy: http://www.digital-made-in.de

ITALY

Ministry of Enterprises and Made in Italy - Directorate-General for Communications Technology and Information Security: https://www.mise.gov.it/index.php/it/direzioni-generali?view=structure&id=17:

Department for Digital Transition: https://innovazione.gov.it

eGovernment plan 2022-2024: https://www.agid.gov.it/agenda-digitale

NETHERLANDS

Dutch Digitization Strategy (November 2019): https://www.nederlanddigitaal.nl/documenten/publicaties/2019/11/13/english-version-of-the-dutch-digitalisation-strategy-2.0

Digital Government Agenda, NL DIGIbeter (2019): https://www.nldigitalgovernment.nl/digital-government-agenda/

Dutch National Interoperability Framework: https://www.noraonline.nl/wiki/NORA_online

Netherlands Standardisation Forum / list open standards: https://www.forumstandaardisatie.nl/open-standaarden

Testing website and email compliance with modern and reliable Internet Standards: https://en.internet.nl/

SLOVENIA

Slovenian digital strategy (https://www.gov.si/assets/ministrstva/MJU/DID/Strategija-razvoja-informacijske-druzbe-2020.pdf)

Frequency management strategy 2022 (https://www.akos-rs.si/en/radio-frequency-spectrum/explore/radio-frequency-spectrum-management-strategy)

National broadband strategy 2020 (https://www.gov.si/assets/ministrstva/MJU/DID/NGO-2020)

Cyber security strategy (https://www.gov.si/assets/ministrstva/MJU/DID/08af71a0e6/Strategija-kibernetske-varnosti.pdf)

The Slovenian Digital Coalition (http://digitalna.si/en)

Digital Innovation Hub Slovenia (https://dihslovenia.si/en)

The Blockchain Think Tank Slovenia (https://blockchainthinktank.si/)

National interoperability framework (https://nio.gov.si/nio/vstopna.nio?lang=en)

SPAIN

Digital Agenda for Spain: https://espanadigital.gob.es/en#:~:text=The%20Digital%20Spain%20agenda%20is,and%20territorial%20cohesion%20and%20drives

Spanish National Cybersecurity Strategy: http://www.lamoncloa.gob.es/documents/20131332estrategiadeciberseguridadx.pdf

National Security Framework:
English version: https://administracionelectronica.gob.es/dam/jcr:eb23ff83-ebdb-487e-abd2-8654f837794f/RD_311-2022_of-3_May_ENS.pdf

Original Spanish version: https://www.boe.es/diario_boe/txt.php?id=BOE-A-2022-7191

Spanish National Interoperability Framework, English version: https://administracionelectronica.gob.es/ctt/resources/Soluciones/145/Descargas/Spain-National-Interoperability-Framework-NIF-English-version.pdf?idIniciativa=145&idElemento=71

Original Spanish version: https://www.boe.es/boe/dias/2010/01/29/pdfs/BOE-A-2010-1331.pdf

Strategy on Technical Interoperability Standards: http://administracionelectronica.gob.es/pae_Home/pae_Estrategias/pae_Interoperabilidad_Inicio/pae_Normas_tecnicas_de_interoperabilidad.html#.UnI2QlPFnzs

National Interoperability Framework: https://administracionelectronica.gob.es/pae_Home/pae_Estrategias/pae_Interoperabilidad_Inicio/pae_Esquema_Nacional_de_Interoperabilidad.html

Technical Interoperability Standard for the Catalogue of Standards - Official Spanish version: https://www.boe.es/diario_boe/txt.php?id=BOE-A-2012-13501 plus https://www.boe.es/diario_boe/txt.php?id=BOE-A-2013-455

SWEDEN:

Swedish Digitalisation Strategy: https://www.regeringen.se/regeringens-politik/digitaliseringspolitik/

Annex II
List of Links to Standards Bodies' Web Sites With Up-to-date Information on Ongoing Work

This Annex provides a list of links to repositories of standards development organisations where information on projects and ongoing work relevant to the EU policy priorities can be found. The list does not claim completeness and may incrementally be increased.

CEN

About: https://www.cencenelec.eu/about-cen/

Areas of work: https://www.cencenelec.eu/areas-of-work/cen-sectors/

Areas of work with CENELEC: https://www.cencenelec.eu/areas-of-work/cen-cenelec-topics/

CENELEC

About: https://www.cencenelec.eu/about-cenelec/

Areas of work: https://www.cencenelec.eu/areas-of-work/cenelec-sectors/

Areas of work with CEN: https://www.cencenelec.eu/areas-of-work/cen-cenelec-topics/

ECMA INTERNATIONAL

About: https://www.ecma-international.org/

Areas of work: https://www.ecma-international.org/about-ecma/areas-of-work/

Technical Committees: https://ecma-international.org/technical-committees/

ETSI

About: https://www.etsi.org/about

ETSI work programme: http://www.etsi.org/about/etsi-work-programme

GS1

About: https://www.gs1.org/about

IEC:

About: https://www.iec.ch/about-us

IEEE:

IEEE SA Wiki for the European Rolling Plan on ICT standardisation: https://ieee-sa.imeetcentral.com/eurollingplan/

IETF:

IETF entry to standardisation activities relevant to the Rolling Plan: http://trac.tools.ietf.org/group/iab/trac/wiki/Multi-Stake-Holder-Platform

ISO:

About: https://www.iso.org/about-us.html

ISO/IEC JTC1:

About: https://www.iso.org/committee/45020.html

ITU-T:

ITU Telecommunication Standardization Sector: https://www.itu.int/en/ITU-T/Pages/default.aspx

OASIS

About: https://www.oasis-open.org/org/

Approved standards: https://www.oasis-open.org/standards/

Current standards projects: https://www.oasis-open.org/projects-committees/

UNECE-UN/CEFACT

http://www.unece.org/cefact

Main standards page: https://www.unece.org/uncefact/mainstandards.html

Recommendations page: https://unece.org/trade/uncefact/cl-recommendations

Trade Facilitation Implementation Guide: http://tfig.unece.org/

W3C:

Current list of W3C active Groups: https://www.w3.org/Consortium/activities

Annex III
Term Definitions and Main Abbreviations

TERM DEFINITIONS

EUROPEAN STANDARDS ORGANISATIONS (ESO)

The three European standards organisations are listed in Annex I to Regulation 1025/2012/EU, i.e. CEN, CENELEC and ETSI. Among other activities, they adopt European standards.

EUROPEAN MULTI-STAKEHOLDER PLATFORM ON ICT STANDARDISATION (MSP)

The MSP is an advisory group to the Commission on matters relating to the implementation of standardisation policy for information and communications technology (ICT), including its work programme, priority-setting in support of legislation and policies, and identification of specifications developed by global ICT standard development organisations. It is composed of members of the national authorities of Member States and EFTA countries, industry associations, societal stakeholders and organisations representing ICT standardisation stakeholders.

http://ec.europa.eu/transparency/regexpert/index.cfm?do=groupDetail.groupDetail&groupID=2758

ANNUAL UNION WORK PROGRAMME ON EUROPEAN STANDARDISATION (AUWP)

The AUWP is a formal document adopted by the Commission identifying the strategic priorities for European standardisation, taking into account Union long-term strategies for growth.
http://ec.europa.eu/growth/single-market/european-standards/policy/index_en.htm

MAIN ABBREVIATIONS

AAL	Active assisted living
ADMS	Asset Description Metadata Schema
AG	Amsterdam Group
AIOTI	Alliance for Internet of Things Innovation
AM	Additive manufacturing
AMNPO	Advanced Manufacturing National Program Office
AMQP	Advanced message queuing protocol
APT	Asian Pacific Telecommunication
BDVA	Big Data Value Association
BIM	Building information modelling
BSI	British Standards Institution
CAM	Connected and Automated Mobility
CBOR	Concise Binary Object Representation
CCEV	Core Criteria/Evidence Vocabulary
CEF	Connecting Europe Facility
CERIF	Common European research information format
CII	Cross-Industry Invoice
CIP	Competitiveness and innovation framework programme
CIS	Consent & information sharing
CISE	Common Information Sharing Environment
C-ITS	Cooperative ITS Communication Standards
CMS	Content management systems
COAP	Constrained Application Protocol
COC	Code of conduct
CORE	Constrained Restful Environments
CPS	Cyber-physical systems
CSA	Coordination and support action
CSC	Cloud Standards Coordination
CSCC	Cloud Standards Customer Council
CSI	Cities Standards Institute
DECT	Digital enhanced cordless telecommunications
DLT	Distributed-Ledger Technology
DOA	Digital object architecture
DSM	Digital single market
DSRC	Dedicated short-range communications
EBA	European Banking Authority
ECC	Electronic Communications Committee
ECEP	European common enforcement priorities
EEAP	European electronic access point
EETS	European Electronic Toll Service
EFC	Electronic fee collection
EFFRA	European Factories of the Future Research Association
EMSFEI	European Multi-Stakeholder Forum on e-Invoicing
EPC	European Payment Council
EPS	Electric Power System
ERN	European Reference Networks
ERPB	Euro retail payments board
ESEF	European single electronic reporting format
ESMA	European securities and market authority
ESO	European standardisation organisation
ESOP	European Statement of Principles
ESPD	European single procurement document

EUPP	Energy using and producing products
EV	Electric vehicles
EXEP	Expert group on e-Procurement
FIBO	Financial industry business ontology
GDC	Green Digital Charter
GDPR	General Data Protection Regulation
GICTF	Global Inter-Cloud Technology Forum
HAN	Home automation networks
HLF	High Level Forum
HMI	Human-Machine-Interaction
HON	Health On the Net
HRM	Human resources management
HTG	Harmonisation Task Groups
IAB	Internet architecture board
IBOPS	Identity-based attestation and open exchange
ICT	Information and communication technologies
IDM	Information delivery manual
IDMP	Identification of medicinal products
IFC	Industry foundation classes
IFM	Interoperable fare management
IFRS	International financial reporting standards
IMF	Interoperable master format
INSPIRE	Infrastructure for Spatial Information in the European Community
IOT	Internet of Things
ISA	Interoperability solutions for public administrations
ISMS	Information security management systems
ITLET	Information Technology for Learning, Education and Training
ITS	Intelligent Transport Systems
JISC	Japanese Industrial Standards Committee
KET	Key enabling technologies
KMIP	Key management interoperability protocol
KPI	Key performance indicators
KTN	Knowledge Transfer Network
LOD	Linked open data
LSP	Large scale pilot
MOOC	Massive open online course
MOU	Memorandums of understanding
MQTT	Message Queuing Telemetry Transport
MSP	European Multi-Stakeholder Platform on ICT Standardisation
NFC	Near field communication
NSF	Network security function
OAM	Officially appointed mechanisms
OASC	Open & Agile Smart Cities
OCC	Open Cloud Consortium
OGC	Open Geospatial Consortium
OGF	Open Grid Forum
OMG	Object Management Group
PACS	Picture archive and communication systems
PCHA	Personal Connected Heath Alliance
PDL	Permissioned Distributed Ledger
PII	Personally identifiable infomation
PLC	Power line communication
PMRM	Privacy management reference model
PO	Publications Office
POS	Point of sale
PPP	Public-Private Partnership
PPS	Production planning & scheduling
PSA	Programme Support Action
PSAP	Public safety answering point
PSI	Public sector information
QKD	Quantum key distribution
QOE	Quality of experience
QOS	Quality of service
QSC	Quantum safe cryptography
RED	Radio Equipment Directive
RAN	Radio access networks
RAS	Robotics and autonomous systems
RDA	Research Data Alliance
RE	Renewable Energy
REEIF	Refined eHealth European Interoperability
RES	Renewable energy sources
RTS	Regulatory technical standards
SAGA	Strategic Advisory Group on Accessibility
SAML	Security assertion markup language
SBR	Standard business reporting
SCIM	System for Cross-domain Identity Management
SDO	Standards Development Organisation
SEIF	Semantic energy information framework
SEPA	Single euro payments area
SGCC	State Grid Corporation of China
SIP	Strategic Implementation Plan
SLA	Service level agreement
SME	Small and medium-sized enterprises
SMPTE	Society of Motion Picture and Television Engineers
SNIA	Storage Networking Industry Association
SSP	Smart Secure Platform
STA	Smart Ticketing Alliance
STIR	Secure Telephone Identity Revisited
TARV	Telematics applications for regulated commercial freight vehicles
TC	Technical committee
TGF	Transformational Government Framework
TOSCA	Topology and Orchestration Specification for Cloud Applications
TR	Technical Report
TS	Technical specification
TSP	Trust service providers
UAAG	User Agent Accessibility Guidelines
ULE	Ultra-low energy
UPS	Uninterruptible power sources
VIN	Vehicle Identification Number
VOT	Vectors of Trust
VRU	Vulnerable Road Users
WAVE	Wireless Access in Vehicular Environments
WCAG	Web Content Accessibility Guidelines
WCPS	Web coverage processing service
XDI	XRI data interchange

European Commission
DG Communications Networks, Content and Technology