Hi-Drive

Designing Automation

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Minimum set of standards applicable to Hi-Drive

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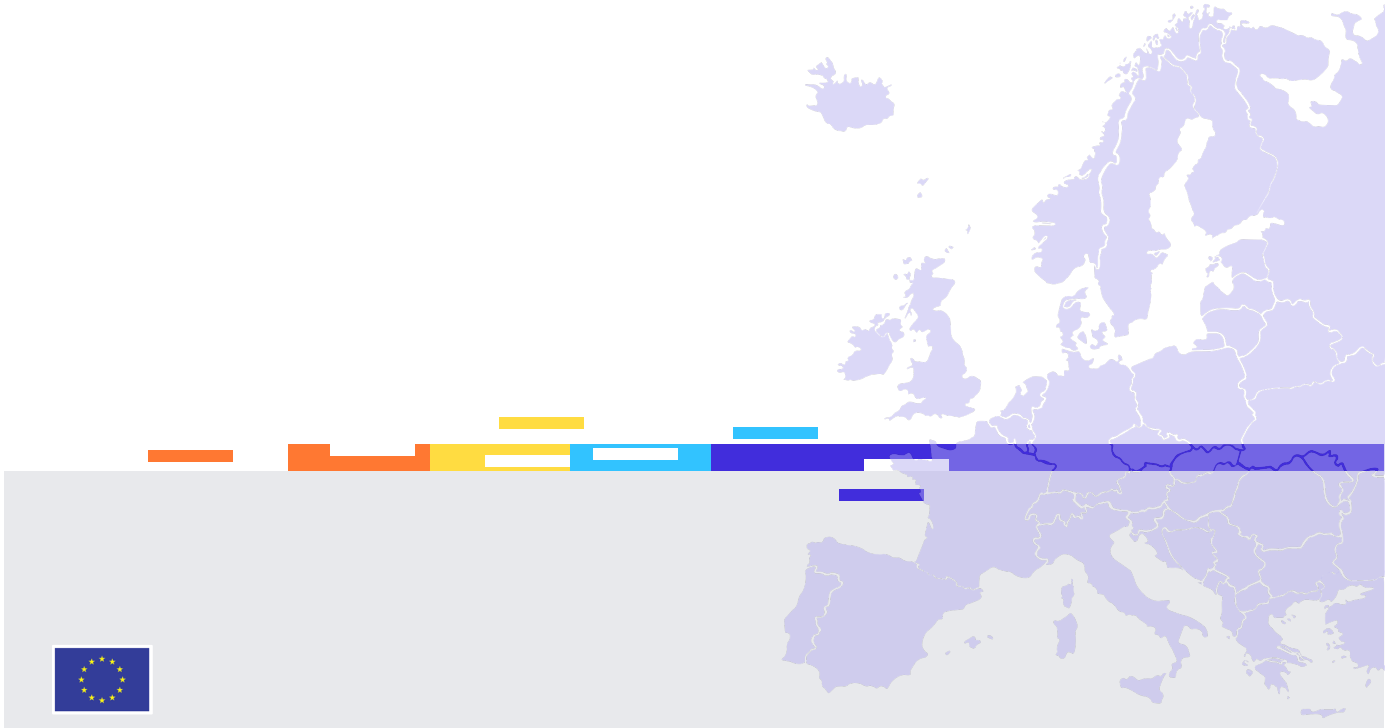

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Executive summary

The main objective of Hi-Drive is to make driving automation robust and reliable by taking intelligent vehicles technology to conditions and scenarios neither extensively tested nor demonstrated earlier in European and overseas traffic.

In this Deliverable D8.4 *Minimum set of standards applicable to Hi-Drive* work package WP8.5 established the base line of standards that are implemented for the Automated Driving Functions (ADF) in the Hi-Drive project.

The standards were identified during the preparatory phase of the project with the active participation of the different subprojects through extensive interaction between the different teams. The team of WP8.4 provided detailed instructions and requirements to the different SPs and in return a list of identified standards was collected. Among these standards we identified technology enabler relevant standards, generic AD relevant standards and other standards which are common to the automotive industry (e.g. the functional safety – FuSa ISO 26262 series standards). The document also lists the potential targets that may be considered as input to standardisation by the standardisation experts participating in the project. For this purpose, Hi-Drive project may establish formal liaison to the Standard Developing Organisations (SDOs). The outcome and the follow-up of this deliverable will help to improve the quality of the CAD relevant standards feeding back information and lessons learned to the developing SDOs.

1 Introduction

Connected and Automated Driving (CAD) has become a megatrend in the digitalisation of society and the economy. CAD has the potential to drastically change transportation and to create far-reaching impacts. SAE L3 automated functions were piloted in Europe by the L3Pilot project in 2017-2021. Hi-Drive builds on L3Pilot results and advances the European state-of-the-art from SAE L3 'Conditional Automation' further up towards 'High Automation' by demonstrating in large-scale trials the robustness and reliability of CAD functions in demanding and error-prone conditions with special focus on:

- CAVs travelling in challenging conditions covering variable weather and traffic scenarios
- connected and secure automation providing vehicles/their operators with information beyond the line of sight and on-board sensor capabilities
- complex interaction with other road users in normal traffic
- factors influencing user preferences and reactions including comfort and trust – and eventually, enabling viable business models for AD.

The project's ambition is to extend considerably the operational design domain (ODD) from the present situation, which frequently demand take over the vehicle control by a human driver. As experienced in the EU flagship pilot project L3Pilot, on the way from A to B, a prototype AV will encounter several ODD factors, leading to fragmented availability of the AD function. Hi-Drive addresses these key challenges, which are currently hindering the progress of vehicle automation. The concept builds on reaching a widespread and continuous ODD, where automation can operate for longer periods, and the interoperability is assured across borders and brands. Hi-Drive strives to extend the ODD and reduce the frequency of the takeover requests by selecting and implementing technology enablers leading to highly capable CAD functions, operating in diverse driving scenarios including, but not limited to, urban traffic and motorways. The removal of fragmentation in the ODD is expected to give rise to a gradual transition from a conditional operation towards higher levels of automated driving.

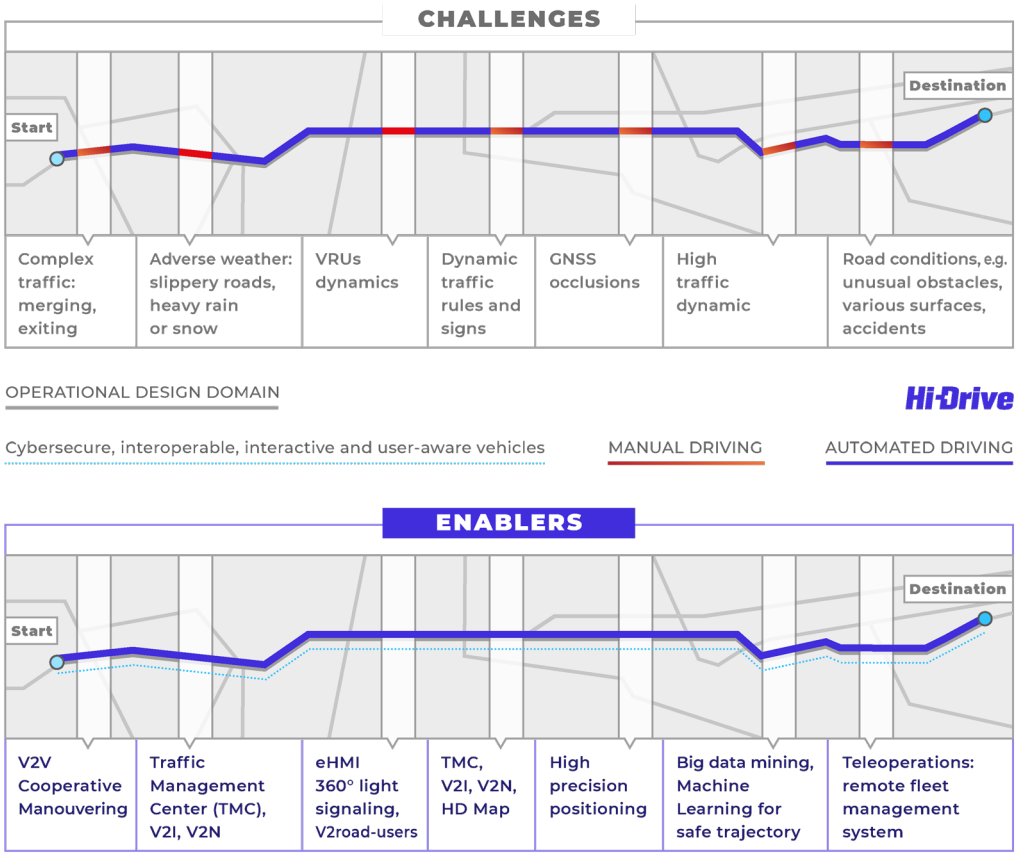

Figure 1.1: Hi-Drive addressing ODD defragmentation against challenges

The work started with the collection and description of the different automated driving functions, enabling technologies and ODDs. When testable functions and use cases are defined, research questions and hypotheses are formulated leading to specification of data needed for evaluation and then actual recording of vehicle-driver behavior. Testing will focus on eight evaluation areas: 1) Users; 2) AD performance; 3) Safety; 4) Efficiency; 5) Environment 6) Mobility; 7) Transport system; 8) Society. Furthermore, these assessments serve as input to determine whether the socio-economic benefits outweigh the costs. The project also engages in a broad dialogue with the stakeholders and the general public to promote Hi-Drive results. Dissemination and communication are boosted by a demonstration campaign to show project achievements.

Overall, Hi-Drive strives to create deployment ecosystem by providing a platform for strategic collaboration. Accordingly, the work includes EU-wide user education and driver training campaign and series of Code of Practices (CoPs) for the Development of ADFs and Road-Testing Procedures, while also leading the outreach activities on standardisation, business innovation, extended networking with the interested stakeholders and coordinating parallel activities in Europe and overseas.

1.1 Purpose of this document

Vehicle automation and more specifically Hi-Drive project pays particular attention to the use and implementation of available technical standards to facilitate development, testing, verification and validation of vehicles, services, and functionalities. To establish a baseline of available published and draft standards Hi-Drive created a team within the project to collect and monitor standardisation activities. Basic approach is to identify the relevant organisations, which are taking care of the standardisation work and carefully study their work program and work items to find the most important and most relevant ones for the project. We identified technology enablers' relevant work items, enabler independent generic work items (such as ODD, testing and safety relevant specifications). It is also our intention to keep this list as limited as possible knowing the landscape of connected, cooperative and automated mobility (CCAM) consists of several hundreds or even thousands of standards, technical specifications, technical reports, publicly available specifications and standards and de-facto standards. Our approach does not concern parts of road environment, vehicles, driving outside of AD. Our goal has been to make an efficient sorting mechanism and point towards the documents, which are the best fit for the purpose of Hi-Drive project.

A snapshot of a location-based services, map data and communication related standardisation ecosystem is provided by Figure 1.2.

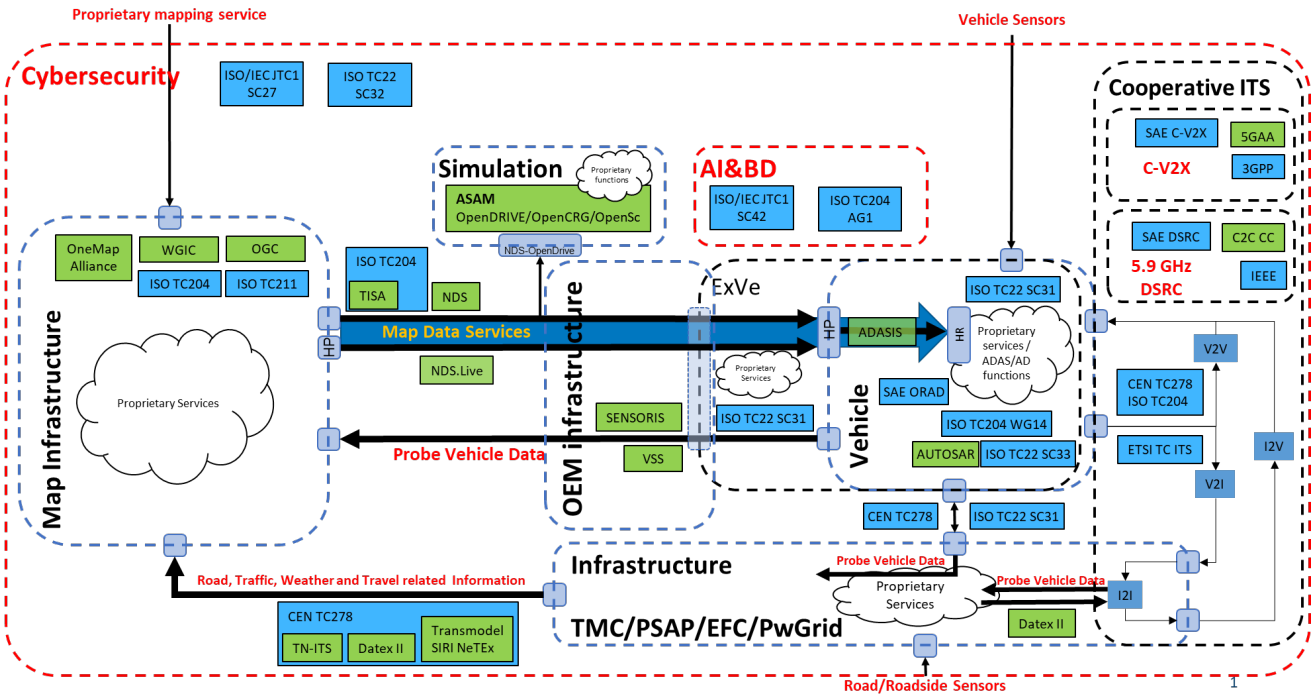

Figure 1.2: Map-centric CCAM standards' ecosystem [1]

In Figure 1.2 the fragmented and complex nature of the CCAM related standardisation is clearly visible therefore this document tries to provide a comprehensive guidebook from the perspective of the Hi-Drive project.

1.2 Methodology

In order to efficiently identify and list the technical standards relevant for the Hi-Drive project the team of WP8.5 established close cooperation with the different SPs in order to motivate the project participants to take into consideration the work of the different SDOs while working in their respective tasks, WPs and SPs. WP8.5 members are also participating in other parts of the project which provided us with direct interaction opportunities particularly with SP2, SP3, SP4, SP5. One of the most important tasks was the collection of the standards used for the development of technology enablers in SP2. Thanks to the SP2 management, the team of the deliverable D2.1 integrated our request for contribution into the technology enabler cards, which was proven fundamental for the development of D8.4.

Cross SP workshops were also organised to help other WP team members to help in the identification of relevant standards and individual SP - WP8.5 calls were also organised for this purpose. The development of D8.4 was very much depending on the deliverable D2.1 which provided more than 90% of the identified standards.

WP8.5 also delivered relevant presentation during the technical kick-off meeting of the project helping to clarify the goal of the WP and the way the project participants can contribute to and interact with the standardisation bodies.

1.3 Technical background

CCAM/CAD technologies are grouped around the following major groups defined by the CCAM Association in its 2021 released Strategic Research and Innovation Agenda [2]:

Vehicle technologies (Cluster 2) which focuses on the development of technologies on-board of connected and automated vehicles (CAVs) to perceive the environment and take decisions, enabling safe interaction with other road users and providing protection in the case of emergency while also ensuring the comfort and well-being of the vehicle occupants.

Key enabling technologies (Cluster 5) which focuses on enabling technologies, driven by digitalisation and extending the application of these technologies beyond the individual vehicle in a system's approach. In case of e.g. AI, it has the capacity to go way beyond on-board decision-making, based on data from in-vehicle sensors. Data from other vehicles, infrastructure and back offices can be used in decision making in complex scenarios including safety critical situations, ranging up to traffic management, emission management, charging of vehicles and provision of

many new and emerging mobility services. The following key enabling technologies were identified:

- Cybersecure components and systems
- Robustness and resilience
- Explainable concepts and training of AI for CCAM applications
- AI for situational awareness
- System architecture for data sharing

Validation (Cluster 3) which focuses on several different items related to other technology groups:

- Validation methods applicable and recommendation of validation maturity necessary for FOTs and Living Labs
- Validation methodologies for application to vehicle technologies (to ensure the safe operation of CAVs and enable societal acceptance)
- Requirements for validation methodology for cybersecurity of CCAM

Integration of the vehicles in the transport system (Cluster 4) which focuses on the following items:

- Provisioning of digital information from all road transport operators and actors incl. private and commercially used individual vehicles to enable automated vehicles in mixed traffic
- Developing connectivity and communication solutions to be integrated in vehicle technologies for sensor fusion, supporting on-board decision making, and enabling new HMI and active safety solutions
- Delivering approaches and requirements regarding connectivity and communication towards cyber security or data sharing
- Providing feedback on user needs and societal expectations (to Cluster 6) and further coordination needs

The Hi-Drive project identified and categorized the technology enablers in its SP2 to close the gaps within the Operational Design Domain of the CAD as follows:

CAD Connectivity based on direct communication (ITS-G5/PC5) or on cellular communication (4G/5G)

- Vehicle to Vehicle Communications
- Vehicle to Infrastructure and Infrastructure to Vehicle Communications
- Vehicle to Cloud (Edge and Core) Communication

- Vehicle Intention Communication

CAD high precision positioning techniques

- Geo-referenced cloud services
- Sensor fusion for localisation
- Positioning relying on ranging signals

Cybersecurity: shielding from V2X cyber-attacks

- Threat analysis and risk assessment
- V2X cyber-risks mitigation

CAD Machine Learning Techniques

- CAD ML Toolkit for ML developers
- CAD ML Perception, object detection and classification
- CAD ML Decision-making
- CAD ML Driver Monitoring

In addition, there are enabler independent areas, which are also supported by standards and standardisation, which are key for the success of the project. These areas consist of the Operational Design Domain (ODD) description, the CAD testing and safety. These will be added to the list of relevant standards as generic work items.

Other Hi-Drive SPs are using standards that are also included in the deliverable.

2 Standardisation related to Connected and Automated Driving

Connected and Automated Driving is one of the most important challenges in standardisation. This is a relatively new, emerging technology with a high number of already existing standards. CAD technologies are evolving very quickly while the relevant standards are issued by a multitude of standardisation organisations that sometimes are lacking the necessary flexibility and agility to address the needs of the industry. With this fragmented CAD standardisation landscape, which was shown on Figure 1.2, the industry and the policymakers are struggling to keep the focus on items which are needed most urgently. In order to keep track of the different standardisation activities and work items several EU co-funded projects took the initiatives to create a knowledge-base on the status of standardisation. Just few examples: the FP7 iCarSupport project released the "ITS Standardisation handbook", its follow-up project the iMobilitySupport published a bi-annual deliverable under the title of "D3.5 Standardisation handbook". The EU's Horizon 2020 ARCADE project (**A**ligning **R**esearch & Innovation for **C**onnected and **A**utomated **D**riving in **E**urope) [3] developed a very detailed but even so incomplete list of standards developing organisations (SDO) [4] and list of related standards [5]. We will use the ARCADE results as the basis of our exercise to present and to explain the relevance of involved SDOs and their published and/or draft standards, technical specifications, technical reports.

2.1 Understanding standardisation

To understand what standards are, how standards are developed and more particularly how the standardisation processes are working we would like to provide a short introduction. Standards may provide technology specification, study reports, compliance testing procedures and/or requirements. In addition, the format of standards may be different according to the maturity of the technology, to the market or legislative needs or to the scope of the development process, which usually reflects the motivations. See the different standardisation deliverable formats in Annex 1 and the SDO specific development and approval processes in Annex 2. Standardisation itself can be driven by different motivations such as economic need or regulatory mandate.

2.2 Standards Developing Organisations (SDOs)

Standards Developing Organisations or Standardisation Organisations are bodies that specialize in the development of standards through the process of consensus and participate in the regional and international standardisation process.

2.2.1 International Standardisation Organisations

2.2.1.1 International Standardisation Organisation (ISO)

Area of responsibility: International

Members: National Standardisation Organisations

Description: ISO is an independent, non-governmental international organisation with a membership of 167 national standards bodies such as DIN, AFNOR, BSI, NEN, NBN, ANSI, etc. Through its members, it brings together experts to share knowledge and develop voluntary, consensus-based, market relevant International Standards that support innovation and provide solutions to global challenges.

In ISO the standardisation work is done in domain specific Technical Committees (TC) which are managed by the Technical Management Board (TMB). ISO Technical Committees are numbered in the order in which they were created. The first, TC1, deals with screw threads and was created back in 1947. While, more recently, TC 323 was created to standardize the circular economy.

From the CAD perspective, there are several relevant Technical Committees some of which have several Sub-Committees (SC) which are listed in Table 2.1.

Table 2.1: Relevant ISO Technical Committees [6]

Technical Committee	Scope
ISO/IEC JTC 1 SC 27 Information security, cybersecurity and privacy protection	The development of standards for the protection of information 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.
ISO/IEC JTC 1 SC 41 Internet of things and digital twin	Standardisation in the area of Internet of Things and related technologies. • Serve as the focus and proponent for JTC 1's standardisation programme on the Internet of Things and Digital Twin, including their related technologies. • Provide guidance to JTC 1, IEC, ISO and other entities developing Internet of Things and Digital Twin related applications.
ISO/IEC JTC 1 SC 42 Artificial Intelligence	Standardisation in the area of Artificial Intelligence

Technical Committee	Scope
	• Serve as the focus and proponent for JTC 1's standardisation program on Artificial Intelligence • Provide guidance to JTC 1, IEC, and ISO committees developing Artificial Intelligence applications
ISO/TC 22 Road Vehicles	All questions of standardisation concerning compatibility, interchangeability and safety, with particular reference to terminology and test procedures (including the characteristics of instrumentation) for evaluating the performance of the following types of road vehicles and their equipment as defined in the relevant items of Article 1 of the convention on Road Traffic, Vienna in 1968 concluded under the auspices of the United Nations: • mopeds (item m); • motorcycles (item n); • motor vehicles (item p); • trailers (item q); • semi-trailers (item r); • light trailers (item s); • combination vehicles (item t); • articulated vehicles (item u).
ISO/TC 22 SC 31 Communication	Data communication for vehicle applications. This includes: • Data buses and protocols (including dedicated sensor communication) • V2X communication (including V2G) • Diagnostics • Test protocols • Interfaces and gateways (including those for nomadic devices) • Data formats • Standardized data content
ISO/TC 22 SC 32 Electrical and electronic components and general system aspects	Electrical and electronic (E/E) components and cross-sectional specifications for E/E systems and components. This includes: • Wiring harness (e.g cables, connectors, interconnections) • Dedicated connectors (e.g trailer connectors, OBD-connector) • Dedicated E/E components and parts (e.g. alternators, fuses, ignition equipment) • EMC • Environmental conditions • Functional safety • Cybersecurity • Dedicated optical components • Software update

Technical Committee	Scope
ISO/TC 22 SC 33 Vehicle dynamics and chassis components	Lateral and longitudinal vehicle dynamics and controls/ systems/ functions affecting vehicle dynamics, such as chassis components, wheels, steering, brakes, and suspension. This includes automated driving, means and performance of collision avoidance and mitigation.
ISO/TC204 Intelligent Transport Systems	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. Excluded: in-vehicle transport information and control systems (IS /TC 22). Note: ISO/TC 204 is responsible for the overall system aspects and infrastructure aspects of intelligent transport systems (ITS), as well as the coordination of the overall ISO work programme in this field including the schedule for standards development, considering the work of existing international standardisation bodies.
ISO/TC 211 Geographic information/Geomatics	Standardisation in the field of digital geographic information. Note: This work aims to establish a structured set of standards for information concerning objects or phenomena that are directly or indirectly associated with a location relative to the Earth. These standards may specify, for geographic information, methods, tools and services for data management (including definition and description), acquiring, processing, analysing, accessing, presenting and transferring such data in digital / electronic form between different users, systems and locations. The work shall link to appropriate standards for information technology and data where possible and provide a framework for the development of sector-specific applications using geographic data.

2.2.1.2 International Telecommunication Union (ITU)

Area of responsibility: International

Members: Public authorities, telecom companies, academia

Description: International Telecommunication Union (ITU) is the United Nations specialized agency for information and communication technologies – ICTs.

Founded in 1865 to facilitate international connectivity in communications networks, we allocate global radio spectrum and satellite orbits, develop the technical standards that ensure networks and technologies seamlessly interconnect, and strive to improve access to ICTs to underserved communities worldwide. Every time you make a phone call via the mobile, access the Internet or send an email, you are benefitting from the work of ITU. ITU has several Sectors. The Hi-Drive relevant Sector of ITU is ITU-T.

The ITU Telecommunication Standardisation Sector (ITU-T) coordinates standards for telecommunications and Information Communication Technology such as X.509 for cybersecurity, Y.3172 and Y.3173 for machine learning, and H.264/MPEG-4 AVC for video compression, between its Member States, Private Sector Members, and Academia Members.

ITU-T is organising its work in different groups: Study Groups, Regional Groups, Focus Groups, Intersector Rapporteur Groups, Collaboration on ITS Communication Standards:

Study Groups are technical groups in which representatives of the ITU-T membership develop Recommendations (standards) applicable to various fields of information and communications technologies (ICTs).

Regional Groups - within ITU-T Study Groups, regional groups aim to ensure that ITU-T Recommendations address the needs of all the world's regions.

Focus Groups - groups formed in response to immediate ICT standardisation demands; open to organisations outside ITU's membership and afforded great flexibility in their chosen deliverables and working methods.

Joint Coordination Activities - For a given subject, in consultation with ITU-R and ITU-D, JCAs coordinate standardisation work across ITU-T Study Groups and act as the first point of contact for organisations interested in contributing to ITU-T's work.

Intersector Rapporteur Groups (IRGs) - IRGs (WTSA-12 Res.18) study cross-sector topics of interest involving experts from ITU-R, ITU-T and ITU-D.

Collaboration on ITS Communication Standards - The intent of the Collaboration is to provide a globally recognized forum for the creation 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.

Table 2.2: Relevant ITU-T groups [7]

Group	Scope
ITU-T Study Group 16 - Multimedia coding, systems and applications / JPT VDS	The ISO/ITU Joint Project Team on Vehicular Domain Service was established in October 2019 by ITU-T SG16 and ISO TC22/SC31 to develop technically aligned standards for ITU-T Recommendations | ISO International Standards for vehicle domain service technologies that will enhance the current V2X communication mechanisms.
ITU-T Focus Group on AI for autonomous and assisted driving (FG-AI4AD)	The ITU-T Focus Group on AI for autonomous and assisted driving (FG-AI4AD) was established in October 2019 to support standardisation activities of AI evaluation in autonomous and assisted driving. To this end, the FG aims to create an open framework for collaboration and sharing of expertise that leads towards

Group	Scope
	international harmonisation on the definition 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. The FG-AI4AD deliverables will focus upon the behavioural evaluation of AI responsible for the dynamic driving task in accordance with the 1949 and 1968 Convention on Road Traffic of the UNECE Global Forum for Road Safety.
Collaboration on ITS Communication Standards	The intent of the Collaboration is to provide 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.

2.2.2 European Standardisation Organisations

2.2.2.1 European Committee for Standardisation (CEN)

Area of responsibility: European

Members: National Standardisation Organisations

Description: The European Committee for Standardisation is one of three European Standardisation Organisations (together with CENELEC and ETSI) that have been officially recognized by the European Union and by the European Free Trade Association (EFTA) as being responsible for developing and defining voluntary standards at European level.

CEN is an association that brings together the National Standardisation Bodies of 34 European countries and provides a platform for the development of European Standards and other technical documents in relation to various kinds of products, materials, services, and processes.

CEN supports standardisation activities in relation to a wide range of fields and sectors including air and space, chemicals, construction, consumer products, defence and security, energy, the environment, food and feed, health and safety, healthcare, ICT, machinery, materials, pressure equipment, services, smart living, transport, and packaging.

The organisation of CEN is similar to the one explained at ISO. CEN is organising its work in domain specific Technical Committees which are the following from the CAD perspective:

Table 2.3: Relevant CEN Technical Committees [8]

Technical Committee	Scope
CEN/TC 278 Intelligent Transport Systems	Standardisation in the field of intelligent transport systems, encompassing services and techniques to achieve road safety, environmental sustainability and traffic efficiency, and to improve the travel experience, applying information and communication technologies between vehicles/infrastructure/other road users. The following are included: aspects of cooperation (C-ITS); intermodality and multimodality; traffic management; mobility information; mobility integration; mobility as a service; systems and services for vulnerable road users; ITS services for automated vehicles; parking management; user fee collection; public transport management; eCall; after-theft vehicle recovery systems; kerbside and pavement management. Mobility accessibility for all users is an important aspect of ITS standardisation.
CEN/TC 301 Road vehicles	Preparation of road vehicle European Standards answering essentially to European mandates. Since the automotive industry is acting globally, the international level (ISO/TC 22 Road vehicles) shall have top priority for any other standardisation projects.

2.2.2.2 European Electrotechnical Committee for Standardisation (CENELEC)

The European Electrotechnical Committee for Standardisation is one of three European Standardisation Organisations (together with CEN and ETSI) that have been officially recognized by the European Union and by the European Free Trade Association (EFTA) as being responsible for developing and defining voluntary standards at European level.

Table 2.4: Relevant CENELEC Committee [9]

Technical Committee	Scope
CEN/CENELEC/TC5 Space	This joint TC covers all standardisation activities in CEN and CENELEC related to space, including dual use aspects, systems of systems, as well as upstream and downstream applications, inasmuch as these topics are not covered by any other existing technical body in CEN or CENELEC or by the European Cooperation for Space Standardisation (ECSS) or ETSI, therefore it is important and necessary that it coordinates its work with relevant technical bodies in ETSI. It develops European Standards that are needed to support the implementation of EU-level space projects.

2.2.2.3 European Telecommunication Standardisation Institute (ETSI)

Area of responsibility: European

Members: public authorities, companies, academia

Description: ETSI is a European Standards Organisation (ESO). ETSI is the recognized regional standards body dealing with telecommunications, broadcasting and other electronic communications networks and services.

ETSI has a special role in Europe. This includes supporting European regulations and legislation through the creation of Harmonised European Standards. Only standards developed by the three ESOs (CEN, CENELEC and ETSI) are recognized as European Standards (ENs).

ETSI has a slightly different organisation: the participation in some of our technical groups (Technical Committees, ETSI Project) is reserved to our members whereas the participation to other technical groups (ETSI Partnership Project such as 3GPP, Industry Specification Group, Open Source Group) is possible for both members and non-members.

Table 2.5: Relevant ETSI Technical Committees [10]

Technical Group	Scope
ETSI TC ITS Intelligent Transport systems	ETSI TC ITS is responsible for standardisation to support the development and implementation of Intelligent Transport Systems (ITS) service provision across the network, for transport networks, vehicles and transport users, including interface aspects, multiple modes of transport and interoperability between systems. It is also helping to accelerate the introduction of ITS services and applications and to maximize their benefits by developing common European standards and technical specifications to enable interoperability. TC ITS is leading the drive to achieve international standards.
3GPP Third Generation Partnership Project	3GPPTM is a partnership project bringing together national Standards Development Organisations (SDOs) from around the globe initially to develop technical specifications for the 3rd generation of mobile, cellular telecommunications, UMTS. We took over the maintenance of the (2nd generation) GSM specifications already brought to maturity by ETSI TC SMG, and which had formed the basis for 3G development. We later instigated 4th generation mobile with LTE and more recently the 5th generation, 5G. Technologies developed and maintained by 3GPP include EDGE, HSPA, Carrier Aggregation, NR, EPC and NG-CN, descriptions of which can be found in the Technologies pages. 3GPP now encompasses seven SDOs: ETSI (Europe and rest of world), ATIS (USA), ARIB and TTC (Japan), TTA (South Korea), CCSA (China) and TSDSI (India). Technical input comes from around 2000 delegates representing member organisations of these SDOs. ETSI provides the 20-person secretariat which coordinates some 140 meetings per year handling 100,000 contribution documents. The running costs are divided amongst the SDOs, and several regional "Friends of 3GPP" groups fund the meetings in their respective regions.

2.2.3 Industry Standardisation Organisations

2.2.3.1 SAE International (SAE)

Area of responsibility: International

Members: individuals

Description: SAE International is a United States-based, globally active professional association and standards developing organisation for engineering professionals in various industries. Its membership consists of more than 128,000 engineers and related technical experts in the aerospace, automotive and commercial vehicle industries. The association's competencies are life-long learning and voluntary consensus standards development.

The internal structure of SAE International is organised around domain specific Technical Standards Committees such as Aerospace Technical Committee, Automotive Technical Committee. The Automotive Technical Committee's hosts different internal councils (e.g. Motor Vehicle Council, Truck and Bus Council, Materials, Processes and Parts Council, Specialized Vehicle and Equipment Council, etc.). The Councils are composed of Steering Committees (e.g., Driver Assistance systems Steering Committee) which are hosting the working Committees (e.g., On-Road Automated Driving Committee). This hierarchical organisation allows the experts to focus on the development of very specialized standardisation work resulting highly relevant standards such as the famous J3016 defining the terminology and the different levels of automation of Automated Driving systems.

Table 2.6: Relevant SAE Committees [11]

Committee	Scope
On-Road Automated Driving (ORAD) committee	The ORAD committee is responsible for developing and maintaining SAE standards, recommended practices, and information reports related to motor vehicle driving automation system features across the full range of levels of driving automation.
Cooperative Driving Automation (CDA) Committee	The committee's work focuses on Cooperative Driving Automation (CDA), which enables equipped vehicles to communicate with other vehicles, infrastructure, cyclists and pedestrians by using machine-to-machine communication technology to enable cooperation between two or more traffic participants operating in close proximity. This information can be used by those entities to coordinate their respective movements, or change their state, thereby reducing the risk of collision, as well as facilitating the mobility goals of each participating entity.

2.2.3.2 Institute of Electrical and Electronics Engineers (IEEE)

Area of responsibility: International

Members: individuals

Description: The Institute of Electrical and Electronics Engineers (IEEE) is a professional association for electronic engineering and electrical engineering (and associated disciplines) with its corporate office in New York City and its operations centre in Piscataway, New Jersey. It was formed in 1963 from the amalgamation of the American Institute of Electrical Engineers and the Institute of Radio Engineers.

The internal structure of IEEE is reflecting the global interest of the members and are based around different domain specific Societies. These Societies are developing standards through their Standards Committee under the supervision and leadership of IEEE Standards Association. There are 39 Societies in IEEE from which we will focus the Hi-Drive relevant ones.

Table 2.7: Relevant IEEE Societies [12]

Society	Scope
IEEE Vehicular Technology Society (VTS)	The IEEE Vehicular Technology Society (VTS) develops standards under the auspices of the IEEE-SA. This is accomplished through the VTS Standards Committee. This committee is the Sponsor Committee, and is responsible for the development of standards within the Field of Interest of the Vehicular Technology Society. The Committee receives guidance from the VTS Board of Governors. In addition, the VTS Standards Committee may also be requested by IEEE-SA to develop standards in the field of Vehicular technology.
IEEE Computer Society (CS) Technical Committee on Computer Communications (TCCC)	TCCC sponsors the "802" series of Local and Metropolitan Area Networks Standards. It also annually sponsors the IEEE Computer Society's Conference on Local Computer Networks and the Computer Networking Symposium.

2.2.4 National Standardisation Organisations (NSOs)

Area of responsibility: National

Members: companies, public authorities, academia

Description: National Standardisation Organisations (or National Standards' Bodies) are implementing national standardisation strategy which is a policy roadmap for a country to make certain that its national strategic priorities are supported by relevant national, regional (eg. European) and International Standards. Examples to these national bodies are DIN (in Germany, AFNOR in France, ANSI in the USA, NEN in the Netherlands, NBN in Belgium.

The NSO's members are delegating experts into the NSO's internal committees which are mirroring the committees of International, regional SDOs (thus they are called mirror committees) they are members of. These national experts are this way delegated to the work of the different SDOs participating the international, regional or domain specific standard setting efforts.

NSOs' are also developing CAD relevant standards independently from the SDOs' work for which the most relevant example is the standardisation of description of ODD at BSI. Therefore, we will consider some specific national work items in this deliverable.

2.2.5 Industry standardisation consortia

Industry standardisation is driven by the market. Industry stakeholders are joining their forces, forming an industry association and proposing a technical solution to the market which will be specified and agreed within the industry association. Sometimes these industry associations are competing each other until market acceptance decide which one becomes the industry de-facto standard. A classic example for this is the competition between VHS vs Betamax vs. Video 2000. Very often industry consortia are liaising with SDOs to increase the wider acceptance of their specification. We will provide some relevant examples from Hi-Drive perspective.

2.2.5.1 Car 2 Car Communication Consortium (C2C CC)

Area of responsibility: International

Members: companies, research institutes, government research agencies

Description: The objective of the C2C-CC also extends to worldwide harmonisation and promotion of C-ITS as far as required enabling C-ITS to exploit its full potential. Therefore, the C2C-CC contributes to European and International standardisation and harmonisation activities for development of technical specifications, required for Cooperative Intelligent Transport System (C-ITS) including V2X communication.

The Consortium has been founded in 2002 by vehicle manufacturers with the objective of developing European standards for C-ITS, as prerequisite for interoperability of systems improving road safety and road efficiency. Moreover, the Consortium discussed realistic deployment strategies and maintains the developed phased deployment roadmap. Related business models are considered for speeding-up the cooperative V2X market penetration. In close collaboration with other international stakeholders, especially from the US and Japan, the Consortium pushes the harmonisation of cooperative V2X standards world-wide to save lives by avoiding as much accidents as possible striving towards accident-free traffic (vision zero) everywhere at any time becoming reality at the earliest possible date.

2.2.5.2 5G Automotive Association (5GAA)

Area of responsibility: International

Members: companies, research institutes, government research agencies, academia

Description: The 5G Automotive Association (5GAA) is 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.

Created on September 2016, the 5GAA unites a large member base, including 8 founding members: AUDI AG, BMW Group, Daimler AG, Ericsson, Huawei, Intel, Nokia, and Qualcomm Incorporated.

Since its inception, 5GAA has rapidly expanded to include 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. More than 130 companies have now joined 5GAA.

Diverse both in terms of geography and expertise, 5GAA's members are committed to helping define and develop the next generation of connected mobility and automated vehicle solutions. [13]

Vehicles sharing information to make transportation safer, greener, and more enjoyable are at our doorstep. The technologies associated with this concept are collectively known as Cooperative Intelligent Transportation Systems (C-ITS). The impact on road safety alone is sufficiently important to make C-ITS a priority

A key enabling technology of C-ITS is wireless communication, covering vehicle-to-vehicle (V2V) communication, vehicle-to-infrastructure (V2I) communication, vehicle-to-network (V2N), and vehicle-to-pedestrian (V2P) communication. Collectively, these wireless transactions are referred to as V2X communication (vehicle-to-everything).

The 5GAA supports the idea that 5G will be the ultimate platform to enable C-ITS and the provision of V2X. 5G will be able to better carry mission-critical communications for safer driving and further support enhanced V2X communications and connected mobility solutions.[14]

2.2.5.3 C-Roads Platform (C-ROADS)

Area of responsibility: European

Members: EU member states' public authorities, academia, companies as associated members

Description: Through the C-Roads Platform, authorities and road operators join together to harmonise the deployment activities of cooperative intelligent transport systems (C-ITS) across

Europe. The goal is to achieve the deployment of interoperable cross-border C-ITS services for road users.

The C-Roads Platform is steered by the C-Roads Steering Committee which is composed by Member State representatives. With the support of the Supporting Secretariat, decisions for achieving the goal of the implementation of interoperable end-user services are done. In this respect specifications, which are proposed and recommended by specific Working Groups, are approved. These specifications are the basis for the single pilot activities. This especially goes with technical decisions, which influence deployment and procurement decisions at pilot sites.

Working Groups are installed as decision support for the Steering Committee to ensure proper decisions towards interoperable deployments. Individual experts participating in the single pilots work together in these Working Groups to prepare proposals and recommendations.

Also, members of the single pilot activities as well as of the C-Roads-Working Groups actively contribute to the work of the EU-C-ITS-Platform.

Additionally, the European Commission and the European Climate, Infrastructure and Environment Executive Agency (CINEA) as well as associated member State representatives are invited to follow and actively participate to discussions at all C-Roads Platform levels.

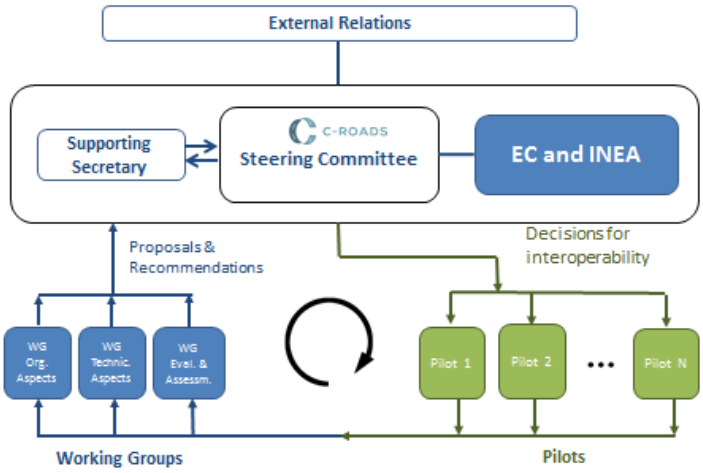

Figure 2.1: C-Roads' structure and governance [15]. The graphic is from a 2018 whitepaper by C-ROADS. In the meantime, INEA no longer exists and has been replaced by CINEA. (C-ROADS will be notified by the Hi-Drive consortium).

Table 2.8: Relevant C-Roads Working Groups [16]

Working group	Scope
WG Technical Aspects	The focus of this Working Group are technical standardisation and interfacing issues in order to be able to provide a common standard repository in the shape of a web service, incorporating interface description to data and services within the pilot sites. This includes dedicated monitoring of standards, identification of relevant aspects and alignment with respective pilot requirements. Traffic management issues, such as usage and processing of data for traffic management, will be identified and integrated into the overall picture of influencing factors, which will also contain the link to urban environments. To ensure C-ITS service consistency for users, recommendations from the road operator's point of view on the visualisation or presentation of messages on HMIs will be discussed. Overall goals of the working group are, among others: • to give recommendations on driver information through C-ITS services • the harmonisation of current and future C-ITS services (Day 1, Day 1.5 and later) • to contribute to the definition and implementation of a harmonised communication profile for C-ITS pilot services on road infrastructures all across Europe Solutions to be elaborated include: • a harmonised C-ITS road infrastructure communication profile for all C-Roads pilots covering the day one services • a C-Roads approach for dealing with security issues for C-ITS service provision and secure communication within the EU C-ITS Trust model • a C-ITS road infrastructure profile for improving traffic safety for "on railway level" crossings • Common Test and Validation procedures for implementing C-ITS Services in Europe • how drivers can effectively be supported in understanding C-ITS messages delivered via different channels and consistent with their driving environment • the methodology for dissemination of C-ITS messages by different communication technologies and their interactions with changing service platforms • mechanisms to distribute communication certificates to all C-ITS-stations in a secure way and enable trustful communication in the C-ITS network
WG Digital Transport Infrastructure	The DTI Working Group will focus on the infrastructure needs for a digital infrastructure, including Traffic Management as well as HD maps. Existing standards will be reflected (TN-ITS and/or the work on METR - Management for Electronic Traffic Regulations) and recommendations to infrastructure operators will be given. A close liaison with ongoing initiatives (e.g., DATEX II) is foreseen to produce recommendations.

2.2.6 Other organisations

2.2.6.1 Organisation for the Advancement of Structured Information Standards (OASIS)

Area of responsibility: International

Members: companies, research institutes, government research agencies, academia

Description: OASIS is a non-profit consortium that works on the development, convergence, and adoption of open standards for cybersecurity, block chain, Internet of things (IoT), emergency management, cloud computing, legal data exchange, energy, content technologies, and other areas. [17]

OASIS Open offers four key programs to support and amplify your work.

- Technical Committees. Develop specifications in an open, lightweight process with a path to recognition in international policy and procurement—with both integrity and rapid progress.
- Open Projects. Work in an environment of cross-organisational sharing and collaboration, where you can develop open-source code and standards, too.
- Foundation-as-a-Service. Get the infrastructure and fiscal agency services to quickly form and run an independent foundation.
- Technical Advisory Groups to ISO: Represent U.S. interests in global standards produced by ISO

Table 2.9 Relevant OASIS Technical Committees [18]

Technical Committee	Scope
Message Queuing Telemetry Transport (MQTT) TC	Providing a lightweight publish/subscribe reliable messaging transport protocol suitable for communication in M2M/IoT contexts where a small code footprint is required and/or network bandwidth is at a premium.
Advanced Message Queuing Protocol (AMQP) TC	Defining a ubiquitous, secure, reliable, and open internet protocol for handling business messaging.

2.2.6.2 Association for Standardisation of Automation and Measuring Systems (ASAM)

Area of responsibility: International

Members: companies, research institutes, government research agencies, academia

Description: ASAM is a standardisation organisation where experts from OEMs, Tier-1s, tool vendors, engineering service providers, and research institutes meet to commonly standardize development and test systems for the automotive industry.

Project Groups develop and maintain the standards. ASAM member companies can send their technical experts to project groups for active participation. It is expected that experts bring in their use-cases, requirements, technical concepts, and proposals for solution. In regular project meetings, the input is presented, consolidated and a consensus is reached about what shall become the Standard. Many groups use a paid service provider, who implements all decisions of the project group, e.g., writing of the Standard, developing data models or creating other supplementary artefacts such as Schema files or examples. The project group members review the Standard deliverables and vote on their technical release.

Table 2.10: Relevant ASAM Project Groups [19]

Project Groups	Scope
Open Data Services (ODS)	This project group plans to develop a new interface to external measurement files, as well as a specification for stream data for videos and other ADAS data. Additionally, it is planned to add some extensions to the associated standard "Instrumentation".
OpenSCENARIO	ASAM is planning to further develop ASAM OpenSCENARIO 1. This project shall improve usability and provide maintenance for manufacturers using the standard. It also shall advance the convergence with ASAM OpenSCENARIO 2.
OpenSCENARIO V2.0	The ASAM OpenSCENARIO 2.0 project is aimed at taking the concepts specified in the OpenSCENARIO concept document (releasing after Mar 12) and continue and develop the next generation of the OpenSCENARIO standard: OpenSCENARIO 2.0. A rough estimate is that the development of such a standard can be achieved within a year, aiming at release in Q2 of 2021.
OpenDrive	This project group focusses on implementing important features of the ASAM OpenDRIVE Concept project. Among others it foresees the implementation of direct links, junction model, environmental model, road geometry and semantic traffic signs. Due to the urgent need for some of the functions, there will be an early release of V1.7.0 already in Jul 2021.
OpenODD	ASAM OpenODD (Operational Design Domain) is still a very young standardisation initiative within the ASAM Simulation domain. The aim is to provide a format that is capable of representing a defined Operational Design Domain for connected automated vehicles (CAV).

Project Groups	Scope
	An Operational Design Domain Definition (ODD) should be valid throughout the entire operating life of a vehicle and is part of its safety and operational concept. The ODD is used for the functional specification of connected automated vehicles. It specifies what environment parameters (static and dynamic) the CAV must be able to manage. They include all types of traffic participants, the weather conditions, the infrastructure, the location, the time of day and everything else that can have an impact on the driving situation.
Measurement Data Format (MDF)	MDF (Measurement Data Format) is a binary file format to store recorded or calculated data for post-measurement processing, off-line evaluation or long-term storage. The format has become a de-facto standard for measurement & calibration systems (MC-systems), but is also used in many other application areas.

2.3 Summary

In Chapter 2 a detailed description of the different type of standardisation organisations is provided. These details may help to understand the complexity of the standardisation landscape and help to find the appropriate SDO if a new standard is needed, and a suitable proposal is available. More details about the specific standardisation deliverables and the processes used for the development of standards can be found in the Annex 1 and 2 respectively. These details will help the project to create the necessary informal and formal liaison to SDOs which will be used by WP8.5 during the project lifetime.

3 Hi-Drive relevant standards

This chapter will provide the list of standards selected to be part of the baseline used for the Hi-Drive project. All standards in this chapter will be used or will be considered during the project. In addition, we will try to identify draft standards being specified or standardisation initiatives, which may be highly relevant for the project as, subject of the activity of WP8.5 contribution to standardisation. Project partners with contributing experts to different SDOs will provide the necessary liaison to fulfil the need of collaboration. Also, the project leadership may consider direct liaison to relevant SDO' units (TCs, WGs, etc.) which also act as facilitator of such a collaborative contribution to standardisation.

Following the ARCADE project's standards' classification scheme used in the list of standards [5] we will use these technology domains: AD/ADAS functions, Connectivity, Human Interaction, In-Vehicle Systems, Networks, Data and Interface Definition, Management/ Engineering Standards, Map and positioning, Privacy & Security, Safety, Terms & Definitions, Testing, Verification & Validation. In case additional technology domains are identified they will be reported back to the maintainers of the list of standards [5].

The potential subjects for contribution to standardisation are identified in the lists as "Candidates" in the "Contribution" column. These standards are currently under development. In case the Hi-Drive project identifies missing standards, gaps in standardisation, they will be reported back to the relevant SDOs.

3.1 Hi-Drive's technology enablers related standards

According to the description of work the goal of the project is to select, adapt and adopt the most-advanced technology enablers to make CAD vehicle functions able to operate in defragmented ODDs and in various driving scenarios including but not limited to urban and motorways. SP2 will work on an extended-robust-resilient CAD perception-decision-action and on CAD collaborative situation awareness: networking among vehicles, other road actors, digital road infrastructure and backbone services. The goal is to provide the Hi-DRIVE CAD with a digital shell:

- Extending ODDs of the ADF and anticipating ODDs exit/entry.
- Addressing V2X communication white spots (areas where there is no coverage or the required quality of service cannot be provided) by using hybrid and technology neutral communication for enabling robust V2X (V2V, V2I, V2P, V2N) for CAD functions.
- Addressing quality of data: data content, data quality, data accessibility, data trustworthiness.
- Adopting a common approach of SOTIF (Safety Of The Intended Function).

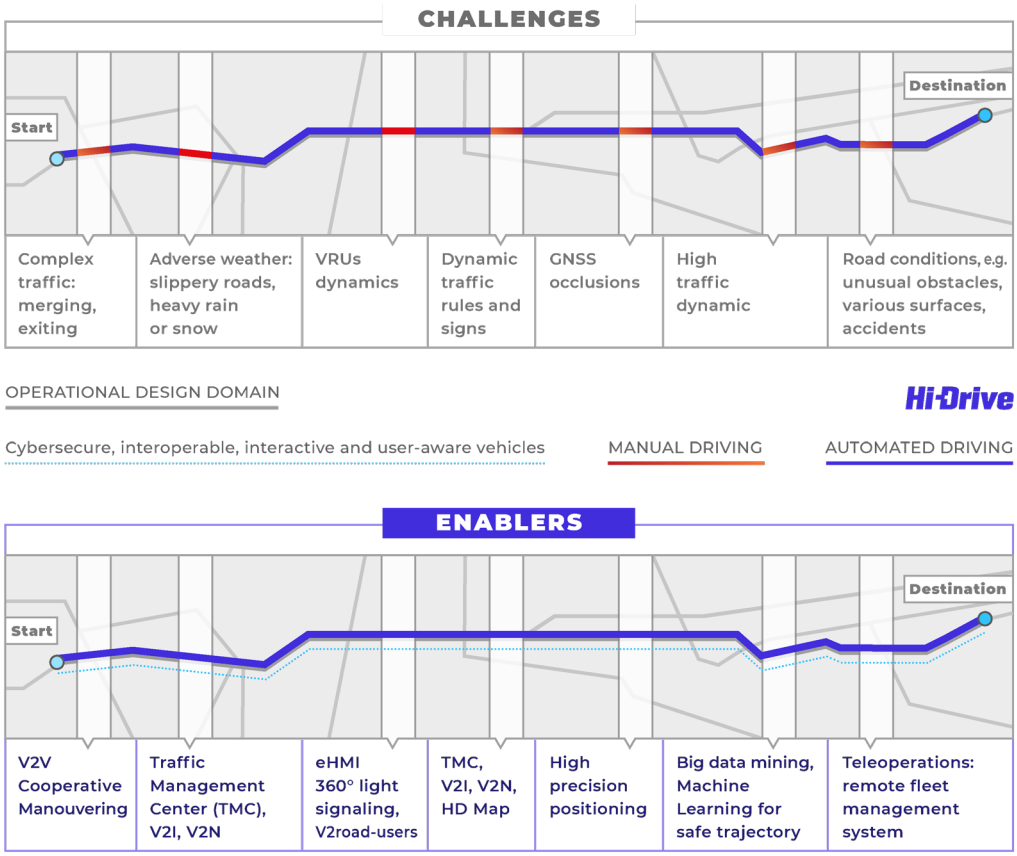

Figure 3.1: How technology enablers can defragment ODD

The description and details of technology enablers identified by the Hi-Drive project is out of the scope of this deliverable. They are described by the deliverable D2.1 "Enablers description and how they support AD/CAD functions". The present deliverable is using the results of the development process of D2.1 thanks to the interaction established between SP2 and SP8 but has no intention to provide further details on the technology enablers. Please refer to the deliverable D2.1 for more details. The next four chapters follow the grouping presented in D2.1 and mentioned in chapter 1.3.

3.1.1 CAD Connectivity based on direct communication (ITS-G5/PC5) or on cellular communication (4G/5G)

Ubiquitous connectivity of CAVs using ITS G5 based- or cellular V2X technologies together with low latency services provide safety relevant information about the vicinity of the ego vehicle extending its horizon with external status, perception, and intention data. Standardisation of Day 1 to Day 3 [20] V2X services is intended to contribute strongly to the extension of ODD.

Relevant standards for CAD connectivity are listed in Table 3.1. The listed standards mostly refer to descriptions of application data (e.g. CAMs, DENMs, CPMs, IVIMs, MCMs, SPATEM; MAPEM, etc.)

exchanged by V2X communicating actors and used for realisation of ADFs at CAVs. Standards regarding lower layers of the communication stack (down to the access layer) and necessary associated profiling documents from industrial organisations like 5GAA, C2C-CC and C-ITS deployment platforms like C-Roads are also reported.

Table 3.1: CAD connectivity related identified standards

ID	Version	Title	Domain	Contribution
3GPP TR 21.914	V14.0.0	3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Release 14 Description; Summary of Rel-14 Work Items (Release 14)	Connectivity	
3GPP TR 21.915	V15.0.0	3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Release 15 Description; Summary of Rel-15 Work Items (Release 15)	Connectivity	
C-ROADS	V2.0.0	C-ITS IP Based Interface Profile	Connectivity	
C-ROADS	V2.0.0	C-ITS Message Profiles	Connectivity	
C-ROADS	V2.0.0	Common C-ITS Service and Use Case Definitions	Connectivity	
ETSI EN 302 637-2	V1.4.1	Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 2: Specification of Cooperative Awareness Basic Service	Connectivity	
ETSI EN 302 637-3	V1.3.1	Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 3: Specifications of Decentralized Environmental Notification Basic Service	Connectivity	
ETSI TR 103 562	V2.1.1	Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Analysis of the Collective Perception Service (CPS); Release 2	Connectivity	
ETSI TR 103 578	V0.0.7	Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Informative Report for the Manoeuvres' Coordination Service	Connectivity	Candidate
ETSI TS 103 301	V2.1.1	Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Facilities layer protocols and communication requirements for infrastructure services	Connectivity	
ETSI TS 103 561	V0.0.1	Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Manoeuvre Coordination Service	Connectivity	Candidate

ID	Version	Title	Domain	Contribution
ETSI TS 103 324	V0.0.24	Intelligent Transport System (ITS); Cooperative Perception Services	Connectivity	Candidate
ISO/IEC 19464	v1.0	Information technology — Advanced Message Queuing Protocol (AMQP) v1.0 specification	Connectivity	
ISO/TS 19321	Ed. 2	Intelligent transport systems - Cooperative ITS - Dictionary of in-vehicle information (IVI) data structures	Connectivity	
ISO/TS 19091	Ed. 2	Intelligent transport systems — Cooperative ITS — Using V2I and I2V communications for applications related to signalized intersections	Connectivity	Candidate
MQTT	5.0	Message Queuing Telemetry Transport	Connectivity	
SAE J2735		V2X Communications Message Set Dictionary	Connectivity	
C2C-CC	Rel 1.6.2	Basic System Profile	Connectivity	

3.1.2 CAD high precision positioning techniques

CAVs with different level of automation (2, 2+) are being used in an increasingly diverse range of real-world applications. However, all CAD applications share a common need. All must know the absolute and relative position of host and other vehicles in 3D space and how they are changing in real time. Some CAD applications need more precise positioning information than others. In addition to this GNSS services may be obscured in challenging environments such as city canyons, tunnels, high mountains. Hi-Drive's technology enablers will allow to evaluate the solutions using already existing standardised technologies and proprietary approaches.

Relevant standards for CAD high precision positioning techniques are listed in Table 3.2.

Table 3.2: CAD high precision positioning techniques related identified standards

ID	Version	Title	Domain	Contribution
CEN/TR 17447		Space — Use of GNSS-based positioning for road Intelligent Transport System (ITS) — Mathematical PVT error model	Map and positioning	
CEN EN 16803-1	2020	Space - Use of GNSS-based positioning for road Intelligent Transport Systems (ITS) - Part 1: Definitions and system engineering procedures for the establishment and assessment of performances	Map and positioning	
CEN EN 16803-2	2020	Space - Use of GNSS-based positioning for road Intelligent Transport Systems (ITS) - Part	Map and positioning	

ID	Version	Title	Domain	Contribution
		2: Assessment of basic performances of GNSS-based positioning terminals		
CEN EN 16803-3	2020	Space - Use of GNSS-based positioning for road Intelligent Transport Systems (ITS) - Part 3: Assessment of security performances of GNSS-based positioning terminals	Map and positioning	
ISO 20078-1	Ed.2	Road vehicles – Extended vehicle (ExVe) web services – Part 1: Content	Connectivity	
ISO 20078-2	Ed.2	Road vehicles – Extended vehicle (ExVe) web services – Part 2: Access	Connectivity	
ISO/AWI 23792-1		Intelligent transport systems — Motorway chauffeur systems (MCS) — Part 1: Framework and general requirements	AD/ADAS functions	Candidate
NHTSA		A Framework for AD System Testable Cases and Scenarios	Management/ Engineering	
PD CEN/TR 17465		Space – Use of GNSS-based positioning for road Intelligent Transport Systems (ITS) – Field tests definition for basic performance	Map and positioning	
ETSI TS 103 246-1	V1.3.1	Satellite Earth Stations and Systems (SES); GNSS based location systems; Part 1: Functional requirements	Map and positioning	
ETSI TS 103 246-2	V1.3.1	Satellite Earth Stations and Systems (SES); GNSS based location systems; Part 2: Reference Architecture	Map and positioning	
ETSI TS 103 246-3	V1.3.1	Satellite Earth Stations and Systems (SES); GNSS based location systems; Part 3: Performance requirements	Map and positioning	
ETSI TS 103 246-4	V1.3.1	Satellite Earth Stations and Systems (SES); GNSS based location systems; Part 4: Requirements for location data exchange protocols	Map and positioning	
ETSI TS 103 246-5	V1.3.1	Satellite Earth Stations and Systems (SES); GNSS based location systems; Part 5: Performance Test Specification	Map and positioning	
NDS.Classic	2.5.x	Navigation Data Standard classic	Map and positioning	

3.1.3 Cybersecurity: shielding from V2X cyber-attacks

Cybersecurity is a critical element to protect connected vehicles from malicious attacks. The automotive industry has established a working group, which develops relevant technologies in ISO TC22[1].

The V2X technology itself has also its own cyber protection designed in its architecture however both initiatives need to be integrated to prove their efficiency. The V2X cyber resilience is tested by the implemented enablers using the standards identified during the project.

Relevant standards for cybersecurity are listed in Table 3.3.

Table 3.3: Cybersecurity related identified standards

ID	Version	Title	Domain	Contribution
ETSI EN 302 637-2	V1.4.1	Intelligent Transport Systems (ITS) - Vehicular Communications - Basic Set of Applications - Part 2: Specification of Cooperative Awareness Basic Service	Connectivity	
ETSI EN 302 637-3	V1.3.1	Intelligent Transport Systems (ITS) - Vehicular Communications - Basic Set of Applications - Part 3: Specifications of Decentralized Environmental Notification Basic Service	Connectivity	
ETSI TR 102 893	V1.2.1	Intelligent Transport Systems (ITS); Security; Threat, Vulnerability and Risk Analysis (TVRA)	Privacy / Security	
ETSI TS 102 940	V2.1.1	Intelligent Transport Systems (ITS) - Security - ITS communications security architecture and security management	Privacy / Security	
ETSI TS 102 941	V1.4.1	Intelligent Transport Systems (ITS) - Security - Trust and Privacy Management	Privacy / Security	
ENISA		Good Practices For Security Of Smart Cars	Privacy / Security	
ISO/AWI 23792-1		Intelligent transport systems — Motorway chauffeur systems (MCS) — Part 1: Framework and general requirements	AD/ADAS function	Candidate
ISO/PWI 23792-2		Intelligent transport systems — Motorway chauffeur systems (MCS) — Part 2: Requirements and test procedures for discretionary lane change	AD/ADAS function	Candidate

[1] ISO TC22 Road vehicles, Subcommittee 32 Electrical and electronic components and general system aspects, Working Group 11 Cybersecurity

ID	Version	Title	Domain	Contribution
ISO/SAE 21434	Ed.1	Road vehicles — Cybersecurity engineering	Privacy / Security	

3.1.4 CAD Machine Learning Techniques

Machine learning and other Artificial Intelligence technologies basics are being standardised in ISO/IEC Joint Technical Committee's Subcommittee 42. The work has been kicked-off in 2018 and since then lots of work is targeting the reliability, the accountability and the trustworthiness of AI systems. However, these are yet not very well known by the industry as the standardisation work results are just start to be published and available for consideration Therefore a number of AI relevant work items are listed in the Generic part of the document, the ones here were provided by the teams of the SP2's work package WP2.6.

Relevant standards for CAD Machine Learning techniques are listed in Table 3.4.

Table 3.4: CAD Machine Learning techniques related identified standards

ID	Version	Title	Domain	Contribution
3GPP TR 38+A116:E144.857	V17.0.0	Technical Report -- Study on NR Positioning Enhancements (Release 17)	Map and positioning	
3GPP TS 37.355	V16.7.0	Technical Specification -- LTE Positioning Protocol (LPP) (Release 16)	Map and positioning	
NHTSA	N/A	A Framework for AD System Testable Cases and Scenarios	Management/ Engineering	
ASAM MDF	V4.2.0	Measurement Data Format	Connectivity	
ASAM ODS	V6.1.1	Open Data Services	Connectivity	
ASAM OODD		OpenODD	Management/ Engineering	
ASAM OSC	V1.1.1	OpenSCENARIO	Management/ Engineering	
BSI PAS 1883		Operational design domain (ODD) taxonomy for an automated driving system (ADS). Specification	Management/ Engineering	
ETSI TR 103 562	V2.1.1	Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Analysis of the Collective Perception Service (CPS); Release 2	Connectivity	
ETSI TR 103 578	V0.0.7	Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of	Connectivity	

ID	Version	Title	Domain	Contribution
		Applications; Informative Report for the Manoeuvres' Coordination Service		
ISO 20078-1		Road vehicles – Extended vehicle (ExVe) web services – Part 1: Content	Connectivity	
ISO 20078-2		Road vehicles – Extended vehicle (ExVe) web services – Part 2: Access	Connectivity	
ISO/AWI 34504		Road vehicles — Scenario attributes and categorisation	Management/ Engineering	Candidate
ISO/AWI TR 23720		Road Vehicles — Methods for evaluating other road user behaviour in the presence of automated vehicle external communication.	Human Interaction	Candidate
ISO/AWI TR 23735		Road vehicles — Ergonomic design guidance for external visual communication from automated vehicles to other road users	Human Interaction	Candidate
ISO/IEC DTS 4213.2		Information technology — Artificial Intelligence — Assessment of machine learning classification performance		Candidate
ISO/IEC TR 24029-1		Artificial Intelligence (AI) — Assessment of the robustness of neural networks — Part 1: Overview		
ISO/TR 23049		Road Vehicles — Ergonomic aspects of external visual communication from automated vehicles to other road users	Human Interaction	
SAE J3134	201905	Automated Driving System (ADS) Marker Lamp	In-Vehicle Systems, Networks, Data and Interface Definition	
GRVA-09-07e		What is the standard? New Assessment/Test Method for Automated Driving (NATM) Guidelines for Validating Automated Driving System (ADS) ??		

3.2 Complete list of standards identified by SP2 Enablers

Table 3.5 provides the complete list of standards, which were mentioned by the different technology enablers identified by the development within the SP2 of Hi-Drive project by the implementers of these technologies. Table 3.5 contains a reference of the different enabler group(s) to every single standard, which also highlights the uptake of the standards by project's implementation, and potential deployment of CAD solutions.

Table 3.5: Complete list of standards applicable for Hi-Drive enablers

No.	ID	Title	Enabler group(s)
1	3GPP TR 21.914	3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Release 14 Description; Summary of Rel-14 Work Items (Release 14)	CAD Connectivity
2	3GPP TR 21.915	3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Release 15 Description; Summary of Rel-15 Work Items (Release 15)	CAD Connectivity
3	3GPP TR 38+A116:E144.857	Technical Report -- Study on NR Positioning Enhancements (Release 17)	CAD Machine Learning Techniques
4	3GPP TS 37.355	Technical Specification -- LTE Positioning Protocol (LPP) (Release 16)	CAD Machine Learning Techniques
5	Ad-hoc consortium	Safety first for automated driving (replaced by ISO/TR 4804)	CAD high precision positioning techniques
6	ASAM MDF	Measurement Data Format	CAD Machine Learning Techniques
7	ASAM ODS	Open Data Services	CAD Machine Learning Techniques
8	ASAM OODD	OpenODD	CAD Machine Learning Techniques
9	ASAM OSC	OpenSCENARIO	CAD Machine Learning Techniques
10	BSI PAS 1883	Operational design domain (ODD) taxonomy for an automated driving system (ADS). Specification	CAD Machine Learning Techniques
11	CEN EN 16803-1	Space - Use of GNSS-based positioning for road Intelligent Transport Systems (ITS) - Part 1: Definitions and system engineering procedures for the establishment and assessment of performances	CAD high precision positioning techniques
12	CEN EN 16803-2	Space - Use of GNSS-based positioning for road Intelligent Transport Systems (ITS) - Part 2:	CAD high precision positioning techniques

No.	ID	Title	Enabler group(s)
		Assessment of basic performances of GNSS-based positioning terminals	
13	CEN EN 16803-3	Space - Use of GNSS-based positioning for road Intelligent Transport Systems (ITS) - Part 3: Assessment of security performances of GNSS-based positioning terminals	CAD high precision positioning techniques
14	CEN TR 17447	Space — Use of GNSS-based positioning for road Intelligent Transport System (ITS) — Mathematical PVT error model	CAD high precision positioning techniques
15	PD CEN/TR 17465	Space – Use of GNSS-based positioning for road Intelligent Transport Systems (ITS) – Field tests definition for basic performance	CAD high precision positioning techniques
16	ETSI TS 103 246-1	Satellite Earth Stations and Systems (SES); GNSS based location systems; Part 1: Functional requirements	CAD high precision positioning techniques
17	ETSI TS 103 246-2	Satellite Earth Stations and Systems (SES); GNSS based location systems; Part 2: Reference Architecture	CAD high precision positioning techniques
18	ETSI TS 103 246-3	Satellite Earth Stations and Systems (SES); GNSS based location systems; Part 3: Performance requirements	CAD high precision positioning techniques
19	ETSI TS 103 246-4	Satellite Earth Stations and Systems (SES); GNSS based location systems; Part 4: Requirements for location data exchange protocols	CAD high precision positioning techniques
20	ETSI TS 103 246-5	Satellite Earth Stations and Systems (SES); GNSS based location systems; Part 5: Performance Test Specification	CAD high precision positioning techniques
21	C-ROADS	C-ITS IP Based Interface Profile	CAD Connectivity
22	C-ROADS	C-ITS Message Profiles	CAD Connectivity
23	C-ROADS	Common C-ITS Service and Use Case Definitions	CAD Connectivity
24	ENISA	Good Practices For Security Of Smart Cars	Cybersecurity
25	ETSI TR 102 893	Intelligent Transport Systems (ITS); Security; Threat, Vulnerability and Risk Analysis (TVRA)	Cybersecurity
26	ETSI TR 103 562	Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Analysis of the Collective Perception Service (CPS); Release 2	CAD Connectivity CAD Machine Learning Techniques
27	ETSI TR 103 578	Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications;	CAD Connectivity CAD Machine Learning Techniques

No.	ID	Title	Enabler group(s)
		Informative Report for the Manoeuvres' Coordination Service	
28	ETSI TS 102 940	Intelligent Transport Systems (ITS) - Security - ITS communications security architecture and security management	Cybersecurity
29	ETSI TS 102 941	Intelligent Transport Systems (ITS) - Security - Trust and Privacy Management	Cybersecurity
30	ETSI TS 103 301	Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Facilities layer protocols and communication requirements for infrastructure services	CAD Connectivity
31	ETSI TS 103 561	Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Maneuver Coordination Service	CAD Connectivity
32	ETSI TS 103 324	Intelligent Transport System (ITS); Cooperative Perception Services	CAD Connectivity
33	ISO 20078-1	Road vehicles – Extended vehicle (ExVe) web services – Part 1: Content	CAD high precision positioning techniques CAD Machine Learning Techniques
34	ISO 20078-2	Road vehicles – Extended vehicle (ExVe) web services – Part 2: Access	CAD high precision positioning techniques CAD Machine Learning Techniques
35	ISO/AWI 23792-1	Intelligent transport systems — Motorway chauffeur systems (MCS) — Part 1: Framework and general requirements	CAD high precision positioning techniques Cybersecurity
36	ISO/AWI TR 23720	Road Vehicles — Methods for evaluating other road user behaviour in the presence of automated vehicle external communication.	CAD Machine Learning Techniques
37	ISO/AWI TR 23735	Road vehicles — Ergonomic design guidance for external visual communication from automated vehicles to other road users	CAD Machine Learning Techniques
38	ISO/CD 34503	Road vehicles — Taxonomy for operational design domain for automated driving systems	CAD Connectivity CAD high precision positioning techniques CAD Machine Learning Techniques
39	ISO/IEC 19464	Information technology — Advanced Message Queuing Protocol (AMQP) v1.0 specification	CAD Connectivity

No.	ID	Title	Enabler group(s)
40	ISO/IEC DTS 4213.2	Information technology — Artificial Intelligence — Assessment of machine learning classification performance	CAD Machine Learning Techniques
41	ISO/IEC TR 24029-1	Artificial Intelligence (AI) — Assessment of the robustness of neural networks — Part 1: Overview	CAD Machine Learning Techniques
42	ISO/PWI 23792-2	Intelligent transport systems — Motorway chauffeur systems (MCS) — Part 2: Requirements and test procedures for discretionary lane change	Cybersecurity
43	ISO/TR 4804	Road vehicles — Safety and cybersecurity for automated driving systems — Design, verification and validation	CAD high precision positioning techniques
44	ISO/TS 19321	Intelligent transport systems - Cooperative ITS - Dictionary of in-vehicle information (IVI) data structures	CAD Connectivity
45	NHTSA	A Framework for AD System Testable Cases and Scenarios	CAD high precision positioning techniques CAD Machine Learning Techniques
46	SAE J2735	V2X Communications Message Set Dictionary	CAD Connectivity
47	SAE J3016	Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles	CAD connectivity
48	SAE J3016	Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles	CAD high precision positioning techniques
49	NDS.Classic	Navigation Data Standard	CAD Connectivity
50	C2C-CC	Basic System Profile	CAD Connectivity

A total of 50 Hi-Drive technology enabler relevant standards were identified and set as baseline for the project.

3.3 Generic AD relevant standards for Hi-Drive

This paragraph will provide the list of generic standards, which are not closely linked to the technology enablers but are needed for the implementation of ADFs. These were identified by the WP8.5 team and are part of the implementation. Table 3.6 contains the list of standards, which were identified as generic AD relevant. These standards are also subject of usage by other SPs e.g. SP3.

Table 3.6: List of non-Hi-Drive technology enabler specific, AD relevant standards

No.	ID	Version	Title	Domain	Contribution
1	ETSI TS 103 723	V1.1.1	Intelligent Transport Systems (ITS); Profile for LTE-V2X Direct Communication	Connectivity	
2	ETSI EN 302 571*	2.1.1	Intelligent Transport Systems (ITS); Radio communications equipment operating in the 5 855 MHz to 5 925 MHz frequency band; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive.	Connectivity	
3	ETSI EN 302 663*	1.3.1	Intelligent Transport Systems (ITS); Access layer specification for Intelligent Transport Systems operating in the 5 GHz frequency band.	Connectivity	
4	ETSI EN 302 665*	1.1.1	Intelligent Transport Systems (ITS); Communications Architecture	Connectivity	
5	ETSI EN 302 890-2*	2.1.1	Intelligent Transport Systems (ITS); Facilities Layer function; Part 2: Position and Time management (PoTi); Release 2	Connectivity	
6	ETSI EN 302 931*	1.1.1	Vehicular Communications; Geographical Area Definition.	Connectivity	
7	ETSI TS 102 636-4-2*	1.4.1	Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 4: Geographical addressing and forwarding for point-to-point and point to-multipoint communications; Sub-part 2: Media dependent functionalities for ITS-G5	Connectivity	
8	ETSI TS 102 687*	1.2.1	Decentralized Congestion Control Mechanisms for Intelligent Transport Systems operating in the 5 GHz range; Access layer part.	Connectivity	
9	ETSI TS 102 792*	1.2.1	Intelligent Transport Systems (ITS); Mitigation techniques to avoid interference between European CEN Dedicated Short Range Communication (CEN DSRC) equipment and Intelligent Transport Systems (ITS) operating in the 5 GHz frequency rang.	Connectivity	

No.	ID	Version	Title	Domain	Contribution
10	ETSI TS 102 965*	1.5.1	Intelligent Transport Systems (ITS); Application Object Identifier (ITS – AID); Registration list.	Connectivity	
11	ETSI TS 103 248*	1.3.1	Intelligent Transport Systems (ITS); GeoNetworking; Port Numbers for the Basic Transport Protocol (BTP)	Connectivity	
12	ISO 8855:2021		Road vehicles - Vehicle dynamics and road-holding ability - Vocabulary	Management/ Engineering Standards	
13	IEEE 802.11p	2016	IEEE Standard for Information technology-- Local and metropolitan area networks-- Specific requirements-- Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 6: Wireless Access in Vehicular Environments	Connectivity	
14	ISO/IEC AWI TS 5471		Artificial intelligence — Quality evaluation guidelines for AI systems	Artificial Intelligence	Candidate
15	ISO/IEC AWI TR 5469		Artificial intelligence — Functional safety and AI systems	Artificial Intelligence	Candidate
16	ISO/IEC FDIS 23053		Framework for Artificial Intelligence (AI) Systems Using Machine Learning (ML)	Artificial Intelligence	Candidate
17	ISO/IEC FDIS 22989		Information technology — Artificial intelligence — Artificial intelligence concepts and terminology	Artificial Intelligence	Candidate
18	ISO/IEC TR 24027	2021	Information technology — Artificial intelligence (AI) — Bias in AI systems and AI aided decision making	Artificial Intelligence	Candidate
19	ISO/IEC DIS 23894		Information technology — Artificial intelligence — Risk management	Artificial Intelligence	Candidate
20	ISO/IEC TR 24029-1	2021	Artificial Intelligence (AI) — Assessment of the robustness of neural networks — Part 1: Overview	Artificial Intelligence	Candidate
21	ISO/IEC TR 24028	2020	Information technology — Artificial intelligence — Overview of trustworthiness in artificial intelligence	Artificial Intelligence	Candidate
22	ISO/IEC AWI TS 8200		Information technology — Artificial intelligence — Controllability of automated artificial intelligence systems	Artificial Intelligence	Candidate

No.	ID	Version	Title	Domain	Contribution
23	ISO/IEC AWI 5339		Information Technology — Artificial Intelligence — Guidelines for AI applications	Artificial Intelligence	Candidate
24	ISO/IEC CD 5338		Information technology — Artificial intelligence — AI system life cycle processes	Artificial Intelligence	Candidate
25	ISO/IEC DTR 24368		Information technology — Artificial intelligence — Overview of ethical and societal concerns	Artificial Intelligence	Candidate
25	ISO 26262-x	2018	Road vehicles — Functional safety - Part 1-12	Management/ Engineering Standards	
26	ISO/IS 21448	2022	Road vehicles — Safety of the intended functionality	Management/ Engineering Standards	
27	ISO/AWI TS 5083		Road vehicles — Safety for automated driving systems — Design, verification and validation	Management/ Engineering Standards	Candidate
28	ISO/DIS 34501		Road vehicles — Terms and definitions of test scenarios for automated driving systems	Management/ Engineering Standards	Candidate
29	ISO/DIS 34502		Road vehicles — Scenario-based safety evaluation framework for Automated Driving Systems	Management/ Engineering Standards	Candidate
30	ISO/DIS 34503		Road Vehicles — Test scenarios for automated driving systems — Taxonomy for operational design domain	Management/ Engineering Standards	Candidate
31	ISO/AWI 34504		Road vehicles — Scenario attributes and categorisation	Management/ Engineering Standards	Candidate
32	ISO/SAE 21434	2021	Road vehicles — Cybersecurity engineering	Cybersecurity	
33	ISO/SAE PAS 22736	2021	Taxonomy and definitions for terms related to driving automation systems for on-road motor vehicles	Management/ Engineering Standards	
34	ASAM OSI	2021	ASAM Open Simulation Interface	Testing, Verification & Validation	

Source*: https://www.car-2-car.org/fileadmin/documents/Basic_System_Profile/Release_1.6.1/C2CCC_RS_2052_References.pdf

34 generic standards have been identified and set as baseline for the project.

3.4 Need for standards identified so far

SP3 'Vehicles' has reported two needs where standards are not clear:

- Automated driving functions and related V2X services: Valet-Parking type 2 - standards for messages between vehicle and infrastructure. This also concerns plant marshalling. Messages are called PCVM (Park Control Vehicle Message) and PCIM (Park Control Infrastructure Message).
- V2X services e.g. CAM, DENM, SPAT, MAPEM (see in the enabler specific list and in the generic standards' list): The format follows the standard SAE J2735. Message format is part of standard but the content and quality requirements of messages is not defined. An ADF adapting via V2X with traffic lights needs therefore to understand all signal dialects.

SP4 'Methodology' has reported to use the FESTA methodology developed by the FOT-net project.

SP5 has reported no AD relevant standard.

SP6 has reported no AD relevant standard.

3.5 Summary and conclusions

The deliverable D8.4 compiled a list of standards which helps to identify the existing published standards and the ones which are currently under development. This work has just started with the identification of technology enablers, and it will continue while these enablers will be developed by the project. The list of standards in this document will undergo changes during the lifetime of Hi-Drive. This is a result of the life cycle of technology standards: (proposal – development – approval – publication – periodical review – revision – publication etc. see Figure 3.2 for a snapshot of the development of the number of AD relevant standards).

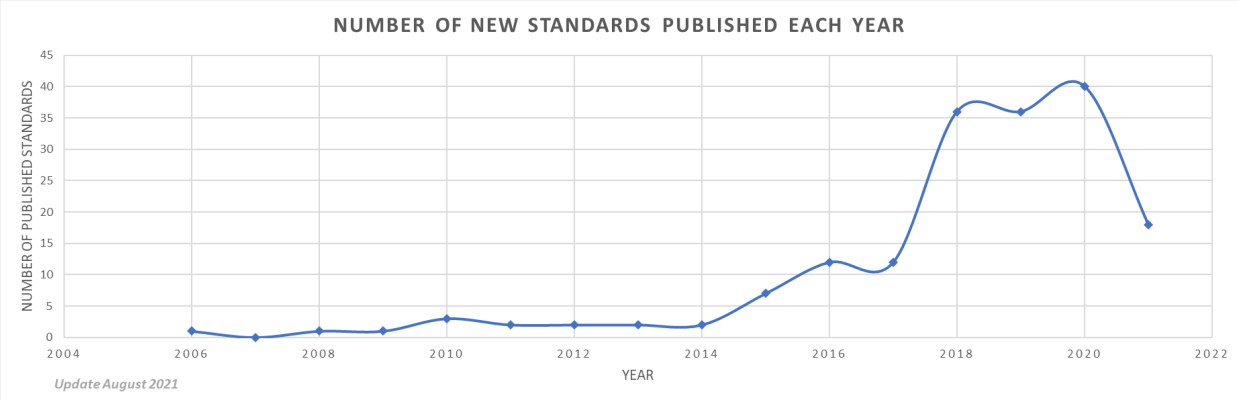

Figure 3.2: Number of published AD relevant standards (source: ARCADE project)

As the development of AD relevant standards is on-going, we identified a number of potential candidate work items which could benefit from lessons learned and the results of the Hi-Drive project's implementation in the form of feedback, direct contribution and other interactions (dissemination, publications, conference papers, etc.).

The follow-up of this work item (D 8.5 Contribution to standardisation) will report on the contribution of the project to the relevant and important standards development efforts. The project will formally need to liaise to some of the organisations via project experts to provide input on missing or unclear items.

The high number of identified standards and the ongoing work on the basic elements of AD such as the standardisation of the ODD description, the Machine Learning techniques, extension of the functional safety (FuSa, SOTIF, SaFAD, etc.) makes the contribution even more important for the large-scale deployment of Level 3 and higher automated vehicles.

The current work is based on the needs of the Hi-Drive project, but this work will be essential for the wider scope standardisation of AD technologies, which will use other technology enablers for the same purpose: to defragment the Operational Design Domain.

Further information about the standardisation processes of the specific SDOs and the different type of deliverables can be found in the Annex 1 and Annex 2.

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List of abbreviations and acronyms

Abbreviation	Meaning
3GPP	3rd Generation Partnership Project
5GAA	5G Automotive Association
AD	Automated Driving
AFNOR	Association Française de Normalisation (French Standardisation Association)
AI	Artificial Intelligence
AMQP	Advanced Message Queuing Protocol
ASAM	Association for Standardisation of Automation and Measuring Systems
AVSC	Automated Vehicle Safety Consortium
AWI	Approved Work Item
BSI	British Standards Institution
C2C CC	Car to Car Communication Consortium
CAD	Connected and Automated Driving
CAV	Connected Automated Vehicle
CAM	Cooperative Awareness Message
CCAM	Connected, Cooperative and Automated Mobility
CD	Committee Draft
CEN	Committé Européen de Normalisation (European Committee for Standardisation)
CENELEC	Comité européen de normalisation en électronique et en électrotechnique (European Committee for Electrotechnical Standardisation)
C-ITS	Cooperative Intelligent Transport systems
CPS	Collective Perception Service
DENM	Decentralized Environmental Notification Message
DIN	Deutsches Institut für Normung (German Standardisation Institute)
DIS	Draft International Standard
DTR	Draft Technical Report
DTS	Draft Technical Specification
EFTA	European Free Trade Association
EMC	Electromagnetic Conditions
EN	Europäische Norm (European Standard)
ENISA	European Network and Information Security Agency

Abbreviation	Meaning
ESO	European Standards Organisation
ETSI	European Telecommunication Standardisation Institute
FDIS	Final Draft International Standard
FG	Focus Group
FOT	Field Operational Test
FuSa	Functional Safety
GLOSA	Green Light Optimal Speed Advisory
GNSS	Global Navigation Satellite System
ICT	Information and Communications Technology
IEC	International Electrotechnical Commission
IEEE	Institute of Electronic and Electrical Engineers
IRG	Intersector Rapporteur Group
IS	International Standard
ISO	International Standardisation Organisation
ITS	Intelligent Transport Systems
IVI	In-Vehicle Information
ITU	International Telecommunication Union
MCM	Maneuver Coordination Message
MDF	Measurement Data Format
ML	Machine Learning
NEN	Nederlands Normalisatie-Instituut (Royal Netherlands Standardisation Institute)
NHTSA	National Highway Traffic Safety Administration
NSO	National Standards Organisation
ODD	Operational Design Domain
ODS	Open Data Services
PAS	Publicly Available Standard
PWI	Preliminary Work Item
SAE	Society of Automotive Engineers
SaFAD	Safety First for Automated Driving
SC	Sub-Committee
SDO	Standards Developing Organisation
SG	Study Group

Abbreviation	Meaning
SOTIF	Safety Of The Intended Functionality
SPAT	Signal Phase And Timing
TC	Technical Committee
TR	Technical Report
TS	Technical Specification
TMB	Technical Management Board
V2G	Vehicle to Grid
V2I	Vehicle to Infrastructure
V2P	Vehicle to Pedestrian
V2V	Vehicle to Vehicle
V2X	Vehicle to Everything
WG	Working Group
WP	Work Package
WTSA	World Telecommunication Standardisation Assembly

Annex 1 Deliverable types in standardisation

The output of standardisation work is the document, which is specifying the objectives defined in the scope of the standard. There are several different document types, which are sometimes organisation specific. Therefore, we provide the definitions:

International Standardisation Organisation (ISO)

- **International Standards** (IS) - An International Standard provides rules, guidelines or characteristics for activities or for their results, aimed at achieving the optimum degree of order in a given context. It can take many forms. Apart from product standards, other examples include: test methods, codes of practice, guideline standards and management systems standards.
- **Technical Specification** (TS) - A Technical Specification addresses work still under technical development, or where it is believed that there will be a future, but not immediate, possibility of agreement on an International Standard. A Technical Specification is published for immediate use, but it also provides a means to obtain feedback. The aim is that it will eventually be transformed and republished as an International Standard.
- **Technical Report** (TR) - A Technical Report contains information of a different kind from that of the previous two publications. It may include data obtained from a survey, for example, or from an informative report, or information of the perceived "state of the art".
- **Publicly Available Specification** (PAS) - A Publicly Available Specification is published to respond to an urgent market need, representing either the consensus of the experts within a working group, or a consensus in an organisation external to ISO. As with Technical Specifications, Publicly Available Specifications are published for immediate use and also serve as a means to obtain feedback for an eventual transformation into an International Standard. Publicly Available Specifications have a maximum life of six years, after which they can be transformed into an International Standard or withdrawn.
- **International Workshop Agreements** (IWA) - An International Workshop Agreement is a document developed outside the normal ISO committee system to enable market players to negotiate in an "open workshop" environment. International Workshop Agreements are typically administratively supported by a member body. The published agreement includes an indication of the participating organisations involved in its development. An International Workshop Agreement has a maximum lifespan of six years, after which it can be either transformed into another ISO deliverable or is automatically withdrawn.

- **Guides** - Guides are just that. They help readers understand more about the main areas where standards add value. Some Guides talk about how, and why, ISO standards can make it work better, safer, and more efficiently. Full list of Guides available in the ISO Catalogue.

International Telecommunication Union (ITU)

- **ITU-T Recommendation** – The main products of ITU-T are Recommendations (ITU-T Recs) - standards defining how telecommunication networks operate and interwork. These can be accessed through the links below. ITU-T Recs have non-mandatory status until they are adopted in national laws. The level of compliance is nonetheless high due to international applicability and the high quality guaranteed by ITU-T's secretariat, and members from the world's foremost information and communication technology (ICT) companies and global administrations.

European Committee for Standardisation (CEN)

- **European Standard** (EN) – the European Standard is leading to full implementation, as national standard, Europe-wide, which may also serve the European regulatory purposes of the New Approach;
- **Technical Specification** (CEN/TS) – the Technical Specification is serving as normative document in areas where the actual state of the art is not yet sufficiently stable for a European Standard;
- **Technical Report** (CEN/TR) – Technical Report is used for information and transfer of knowledge;
- **CEN Workshop Agreement** (CWA) – the CEN Workshop Agreement aims at bringing about consensual agreements based on deliberations of open Workshops with unrestricted direct representation of interested parties;
- **Guide (CEN Guide)** – the Guide gives information about standardisation principles and policies and guidance to standards writers.

European Electrotechnical Committee for Standardisation (CENELEC)

Same as in CEN.

European Telecommunication Standardisation Institute (ETSI)

- **ETSI Technical Specification** (ETSI TS) - high quality specifications delivered early to the market adopted by the responsible Technical Body
- **ETSI Technical Report** (ETSI TR) – study report adopted by the responsible Technical Body

- **ETSI Standard** (ETSI ES) - high quality standards supported by the whole ETSI global membership adopted after ETSI membership weighted voting
- **ETSI Guide** (ETSI EG) - adopted after ETSI membership weighted voting
- **European Standard** (ETSI EN) - European harmonized standard adopted after ETSI membership national weighted voting
- **ETSI Special Report** (ETSI SR) - an information document used for various purposes, including giving public availability to information not produced within a Technical Body
- **ETSI Group Specification** (ETSI GS) – technical specification produced by an Industry Specification Group
- **ETSI Group Report** (ETSI GR) – study report produced by an Industry Specification Group

SAE International (SAE)

SAE Technical Reports play a key role in market access, safety, reducing costs, increasing productivity, improving market position, and advancing new technologies. Participation in the standards development process provides the opportunity to voice your ideas, express concerns, and present technologies.

SAE Technical Reports are developed by the organisation's more than 700 Technical Committees. Participation is open to all interested parties.

Identifying a Need: New technical reports begin when a need is identified by producers, purchasers, or anyone in industry. A proposal to create a new technical report requires concurrence from the respective committee. All projects must be in compliance with SAE Intellectual Property Policy.

- Types of Technical Reports:
- **SAE Standards**: These Technical Reports are a documentation of broadly accepted engineering practices or specifications for a material, product, process, procedure, or test method.
- **SAE Recommended Practices:** These Technical Reports are documentations of practice, procedures and technology that are intended as guides to standard engineering practice. Their content may be of a more general nature, or they may propound data that have not yet gained broad acceptance.
- **SAE Information Reports:** These Technical Reports are compilations of engineering reference data or educational material useful to the technical community.

- **SAE Aerospace Material Specifications:** These Technical Reports identify material and process specifications conforming to sound, established engineering and metallurgical practices in aerospace sciences and practices.

Institute of Electrical and Electronics Engineers (IEEE)

There are a few types of standards projects. The standard to be produced can be either a standard containing mandatory requirements, a recommended practice outlining preferred procedures, or a guide offering suggestions for working with a technology. Projects involve either new standards, revisions of existing standards, corrigenda for existing standards, or amendments to existing standards. Standards have a ten-year life, or in the case of trial-use standards, two years, after which they can be considered for full status or revision. IEEE standards include but are not limited to:

- Lists of terms, definitions, or symbols, applicable to any field of science or technology within the scope of IEEE;
- Expositions of scientific methods of measurement or tests of the parameters or performance of any device, apparatus, system, or phenomenon associated with the art, science, or technology of any field within the scope of IEEE;
- Characteristics, performance, and safety requirements associated with devices, equipment, and systems with engineering installations; and/or
- Recommendations reflecting current state-of-the-art in the application of engineering principles to any field of technology within the scope of IEEE.

National Standardisation Organisations (NSOs)

National organisations are adopting, localising (eventually translating) international and regional standards, technical specifications, technical reports, and other deliverables. NSOs may also develop their own deliverables suitable for their local market, adapted to local regulation, and fit for stakeholder needs. The form and the type of these local deliverables depend on the NSO developing it (recommendations, essentials, addenda, etc.)

Industry Standardisation Organisations

Industry standardisation organisations are providing their specifications as is. Generally, they provide specifications, guidelines, test suites and other various documents and deliverables.

Annex 2 Development and approval processes in standardisation

International Standardisation Organisation (ISO)

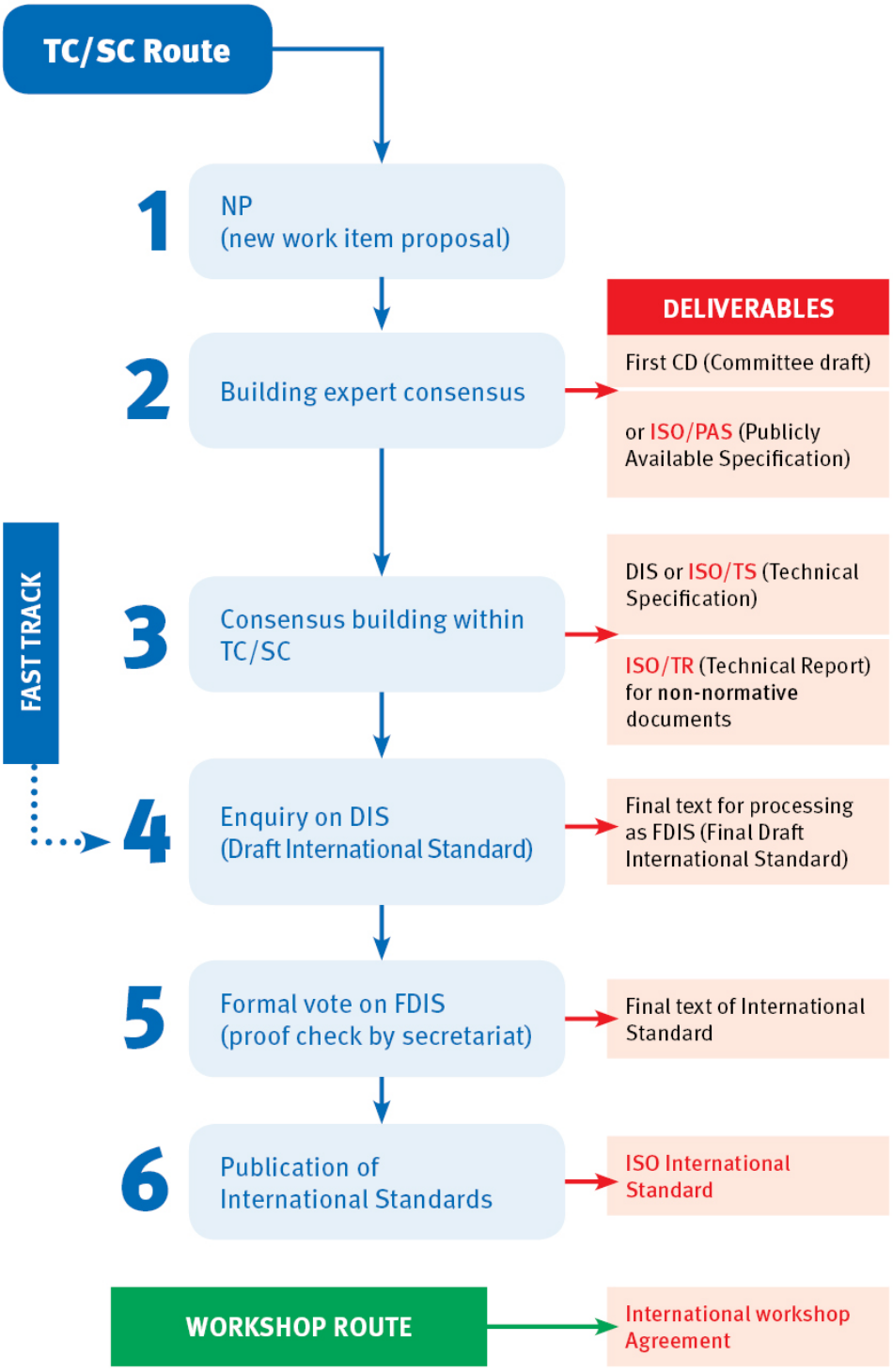

Figure A2.1: ISO standards' development and approval process [21]

The International Organisation for Standardisation has a six-stage process for developing standards. The stages include the following:

1. **Proposal stage.** The first step in developing a new standard starts when industry associations or consumer groups make a request. The relevant ISO committee determines whether a new standard is indeed required.
2. **Preparatory stage.** A working group is set up to prepare a working draft of the new standard. The working group is composed of subject matter experts and industry stakeholders; when the draft is deemed satisfactory, the working group's parent committee decides which stage occurs next.
3. **Committee stage.** This is an optional stage during which members of the parent committee review and comment on the draft standard. When the committee reaches consensus on the technical content of the draft, it can move to the next stage.
4. **Enquiry stage.** The draft standard at this stage is called a Draft International Standard (DIS). It is distributed to ISO members for comments and, ultimately, a vote. If the DIS is approved at this stage without any technical changes, ISO publishes it as a standard. If not, it moves to the approval stage.
5. **Approval stage.** The draft standard is submitted as a Final Draft International Standard (FDIS) to ISO members. They vote to approve the new standard.
6. **Publication stage.** If ISO members approve the new standard, the FDIS is published as an official international standard.

ISO participating members vote on standards approvals. A standard must receive affirmative votes from at least two-thirds of participating members and negative votes from no more than one fourth of participating members. [22]

International Telecommunication Union (ITU)

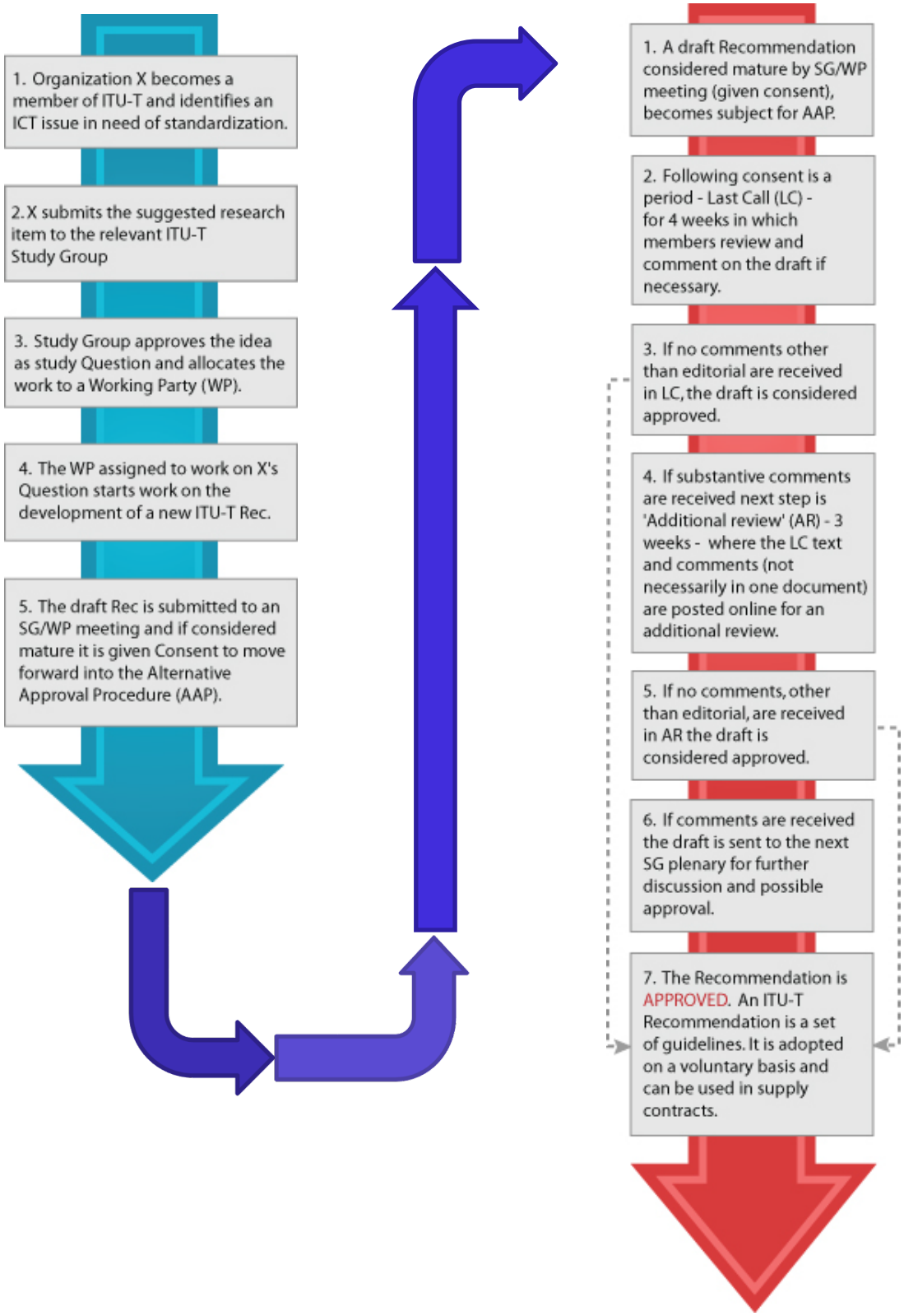

Figure A2.2: ITU standards' development [23] and approval process [24]

1. Contribution is the term used to describe membership input into a Study Group. This input can be on any relevant topic but is typically limited to suggesting new work areas, draft Recommendations, changes to existing Recommendations.
2. Study Groups drive their work primarily in the form of study Questions. Each of these addresses technical studies in a particular area of telecommunication standardisation. Each SG has a chairman and a number of vice-chairmen appointed by the World Telecommunication Standardisation Assembly (WTSA).
3. To assist in the organisation of the work, the SG may be organized into several working parties. The working party is the next organisational unit down within the study group (SG). It coordinates a number of study Questions on a related theme, e.g., the Media Coding Working Party in Study Group 16 deals with all study Questions relating to coding of speech, audio and video streams that we use every day for Internet calls, DVDs, etc.
4. The team of experts working on a specific Question is known as the rapporteur group. Their meetings are chaired by the relevant rapporteur. Considering the text of the Question and guidance from the SG, the participants determine what Recommendations are required and develop text for these Recommendations taking all relevant inputs into account and consulting other relevant parts of ITU-T. During a meeting of the parent WP or SG, the experts will normally meet to progress the work, but they may also meet independently of the parent WP or SG, in a more informal setting, when required.
5. A Question is the basic project unit within ITU-T. The area of study of the project is defined by the text of the Question, and this is generally approved by the study group itself. For a new Question to be established, it is necessary that a number of Members commit to support the work. Questions address technical studies in a particular area of telecommunication standardisation and are driven by contributions. A Question is normally terminated once the defined work has been completed, or the task is revised in the light of developments, which can be technical, market-oriented, network or service driven.
6. The “Alternative Approval Process” (AAP) is a fast-track approval procedure that was developed to allow standards to be brought to market in the timeframe that industry now demands.
7. Once the text of a draft Recommendation prepared by Study Group (SG) experts is considered mature, it is submitted for review to a SG or Working Party (WP) meeting. If agreed by the meeting it is given Consent. This means that the SG or WP has given its consent that the text is sufficiently mature to initiate a final review process leading to approval of the draft Recommendation. After this Consent has been achieved, the Director of ITU-T's secretariat, the Telecommunication Standardisation Bureau (TSB), announces the start of the AAP procedure

by posting the draft text to the ITU-T web site and calling for comments. This gives the opportunity for all members to review the text.

8. This phase, called Last Call, is a four-week period in which comments can be submitted by Member States and Sector Members. If no comments other than editorial corrections are received, the Recommendation is considered approved since no issues were identified that might need any further work. However, if there are any comments, the SG chairman, in consultation with TSB, sets up a comment resolution process by the concerned experts. The revised text is then posted on the web for an Additional Review period of three weeks.

9. Like the Last Call phase, in Additional Review the Recommendation is considered as approved if no comments are received. If comments are received, it is apparent that there are some issues that still need more work, and the draft text and all comments are sent to the next Study Group meeting for further discussion and possible approval.

10. After a Last Call in which comments were received, if the SG Chairman sees that there is insufficient time for comment resolution and an Additional Review period, the draft Recommendation and unresolved comments can be sent directly to the next meeting of the SG for resolution and agreement.

European Committee for Standardisation (CEN)

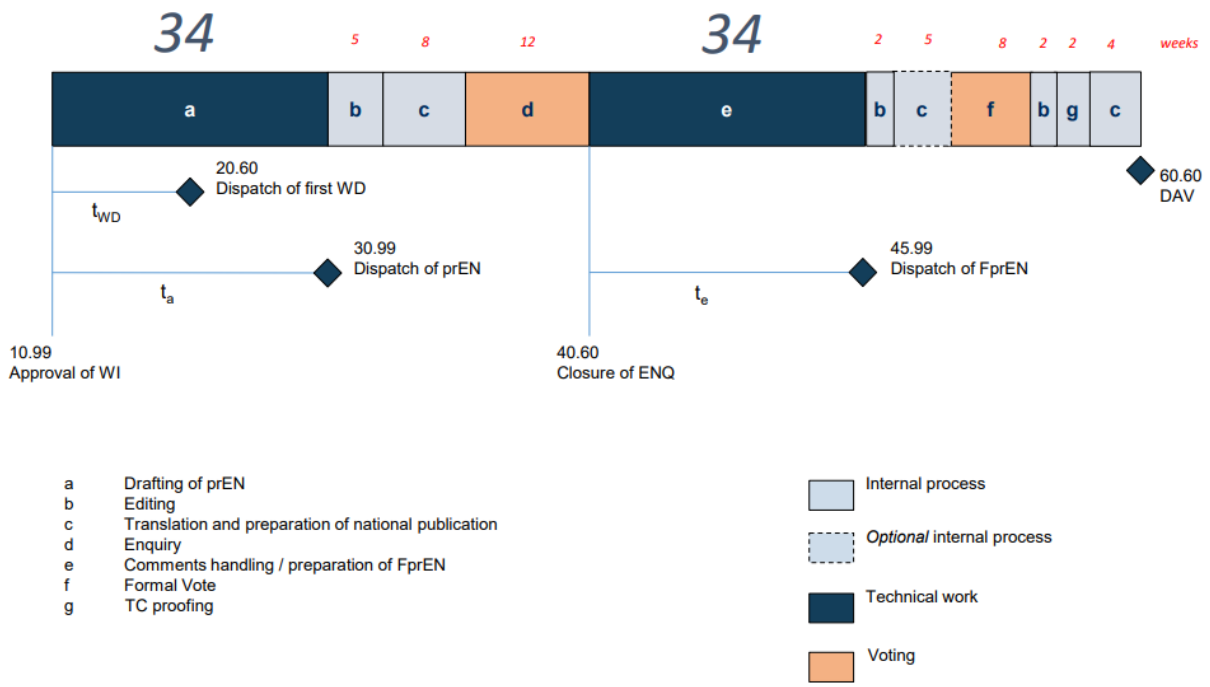

Figure A2.3: CEN standards' development and approval process [25]

The description below shows the typical process for the proposal, development, adoption and publication of a European Standard by a Technical Committee. [26]

1. Proposal stage - A proposal for a European Standard may come from any interested party. The European Commission can also request the CEN to prepare a standard in support a European legislation. This type of standardisation activity is 'mandated' by the European Commission.
2. Drafting stage - Once a standardisation project has been accepted by the TC, national work is put on hold to allow all efforts to be focused on European harmonisation. The proposal is allocated to one of the TC Working Groups for the drafting of the standard. The working groups are composed of experts nominated by CEN national members. The experts in the working group are representatives of national stakeholders.
3. Public Enquiry - Once the draft of a European Standard is deemed ready by the TC, the draft standard is sent to the national standardisation organisations for comment. This process is known as 'Enquiry'.
4. Approval stage - The final draft standard is drawn up considering the comments and is then forwarded to the NSOs for a vote on whether or not to adopt the draft as a standard. The voting process is based upon weighted votes, based upon the population of the Member State.
5. Publication - After adoption, the European standard is published as a national standard by the NSOs without any change and conflicting national standards are withdrawn.

Practice of voting

A key feature in the development of a European Standard, and one from which it gains strengthened legitimacy, is agreement of all interested parties. The degree of consensus is evaluated and measured at different stages, at different levels and in different ways during the development of a European Standard.

1. The first stage to reach consensus is when adopting a new work item. A EN or a TS can only be adopted when minimal 65% of the weighted counted votes are positive. The decision for a TR shall be taken by simple majority. In all cases the commitment of a least 5 Member States is required. The first stage ensures that there is a real need for the proposed work item and that the necessary resources are available.
2. The second stage to reach consensus at the Working Group (WG) level amongst the WG members. Before a draft is submitted to the TC for further processing, the level of consensus within the WG is evaluated by the WG Convenor.
3. Once the TC Secretary and TC Chairperson have approved the finalized draft, the draft is forwarded to the CEN members for voting and comments. This process is known as CEN

Enquiry. Consensus at TC level amongst the CEN Members is assessed by the TC Secretary at the close of the CEN Enquiry.

4. The final draft standard is drawn up considering the comments and is then forwarded to the CEN members for a Formal vote on whether or not to adopt the draft as a standard. The voting process is based upon weighted votes. When voting at the Formal Vote, CEN National Members have only three possibilities: approval, disapproval, or abstention. It is essential for the CEN National Members to reflect in their vote the balance of the opinions/positions of all interested parties in their country.

European Electrotechnical Committee for Standardisation (CENELEC)

Same as at CEN.

European Telecommunication Standardisation Institute (ETSI)

1. **Proposal:** A proposal to start an item of work, such as to create a new standard or to update an existing one, must come from at least four members of ETSI and be agreed by the relevant standards group.
2. **Development:** Technical committees or other types of working groups, made up of representatives of our members and led by a 'Rapporteur', draft most of standards. Members may participate in any group and work activity (other than certain security-related work where participation is controlled by the ETSI Board).

   Specialist Task Forces (STFs) set up to accelerate the work where there is an urgent need. STFs are groups of technical experts who come together for a defined period to work intensively on specific items.

   Industry Specification Groups offering an effective alternative to industry fora. They can be set up quickly to address specific technology areas.
3. **Approval:** Different approval procedures are used depending upon document type and type of standard being created.

The below process descriptions are from the ETSI process description web site [27]

Technical Specifications (TS), Technical Reports (TR), Group Specifications (GS), Group Reports (GR) and Special Reports (SR)

After the Technical Committee or the Industry Specification Group has approved the draft, it submits it to the ETSI Secretariat which publishes the standard.

Description of publication process from work item creation over drafting and approval to publication of ETSI SR, GS, GR, TS, TR see Figure A2.4.

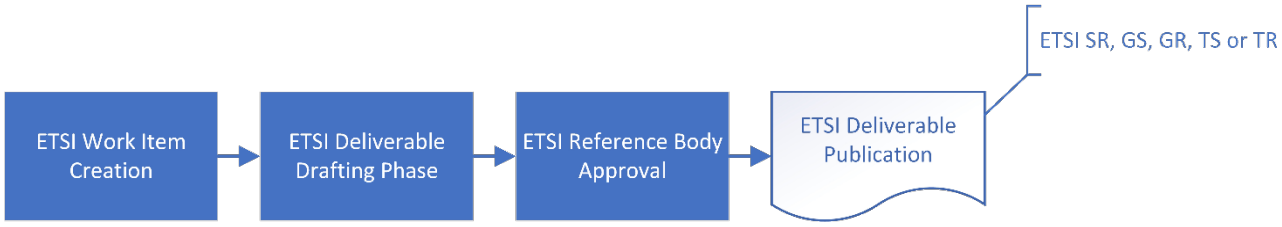

Figure A2.4: ETSI's development and approval process for TS, TR, GS, GR and SR

ETSI Guides (EG) and ETSI Standards (ES)

These documents are approved by the full ETSI membership, using the 'Membership Approval Procedure':

- After the Technical Committee has approved the draft, the ETSI Secretariat makes the document available to the Members.
- Each ETSI full and associate member may vote as to whether the standard should be adopted.
- If the vote is successful the ETSI Secretariat publishes the standard; if not, it is referred to the committee.

Description of publication process from work item creation over drafting, approval and membership approval to publication of ETSI ES and EG see Figure A2.5.

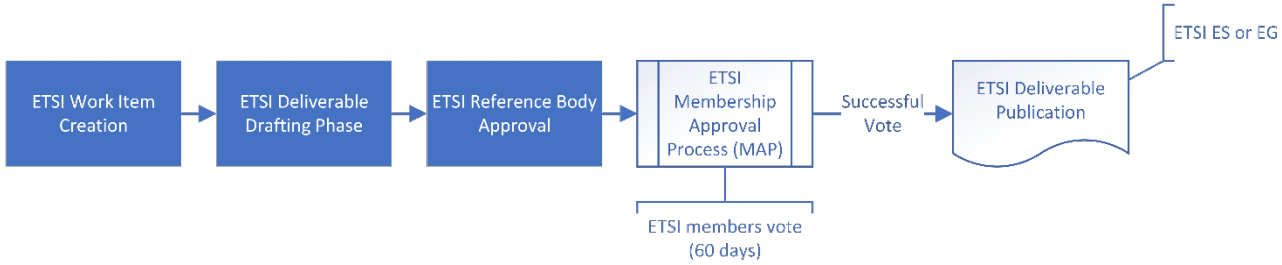

Figure A2.5: ETSI's development and approval process for EG and ES

European Standards (EN)

EN Approval Procedure – most ENs follow this procedure which comprises a Public Enquiry and a weighted national Vote performed in a single process:

- After the Technical Committee has approved the draft, the ETSI Secretariat makes the document available to the National Standards Organisations (NSOs).
- The NSOs carry out the Public Enquiry. This involves consultation and submission of the national position (the weighted national 'vote') on the standard.

- If this vote is successful, and if no substantial comments are received as a result of this consultation, the ETSI Secretariat finalizes the draft and publishes the standard.
- Any technical comments received during Public Enquiry are considered by the Technical Committee, which may revise the draft and resubmit it to the Secretariat.
- If the changes are significant, the Secretariat may initiate another Public Enquiry; otherwise the draft will be presented directly to a second vote.
- After a successful vote, the Secretariat publishes the standard.

Description of publication process from work item creation over drafting, approval and EN Approval process to publication of ETSI EN can be see on Figure A2.6.

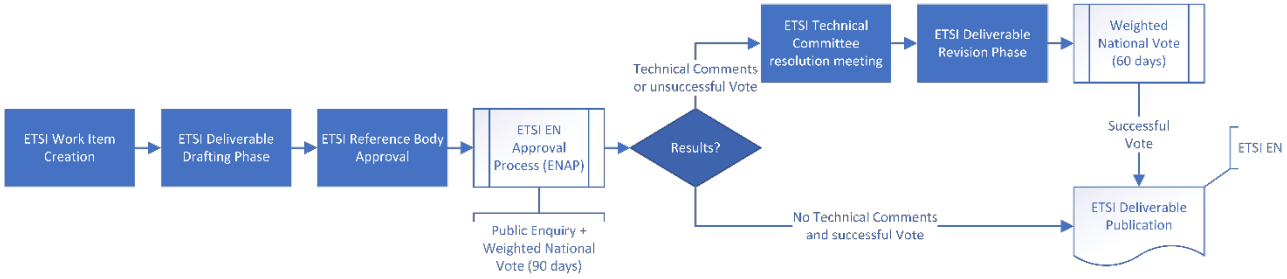

Figure A2.6: ETSI's development and approval process for EN

1. **Voting:** Votes are successful if at least 71% of the weighted votes cast are in favour of the draft. This applies to all types of documents, except for some Group Specifications. For European Standards the vote of each nation is weighted as agreed by the ETSI General Assembly. For other types of documents, the vote of each ETSI member is weighted as agreed between the members.
2. **Publication**: The approved standard is published by the ETSI Secretariat, our permanent staff based at our headquarters. The Secretariat works closely with those drafting the document and is responsible for ensuring that the relevant procedures have been followed. This helps to guarantee the high quality of the final document.
3. **Maintenance:** Maintenance is an important part of the standardisation process. It is how ETSI adapts its standards to evolving technology and the developing needs of the marketplace.

SAE International (SAE)

The SAE's development and approval process is visualized by Figure A2.7.

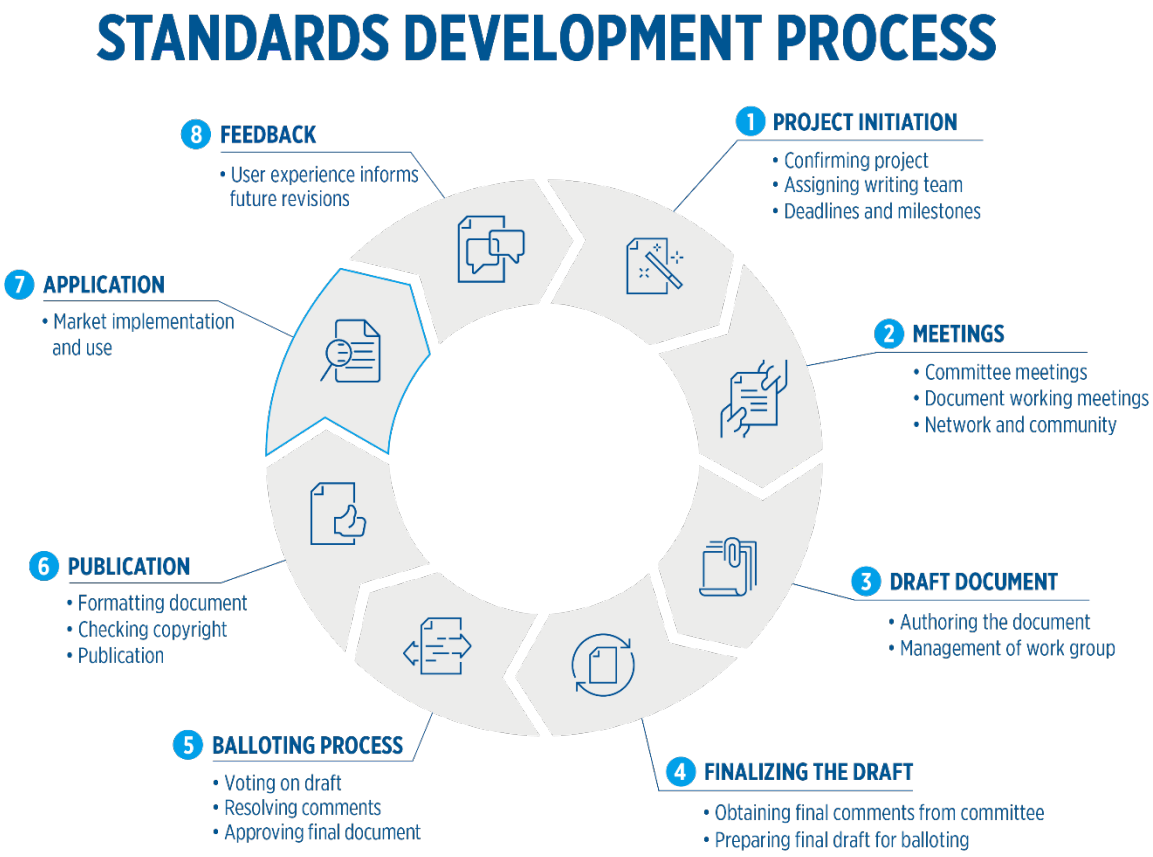

Figure A2.7: SAE's development and approval process [28]

Technical Report Approval Process:

1. The document sponsor will submit a draft to SAE for balloting in accordance with the official SAE consensus ballot process.
2. Committee members will vote and provide comments on the draft.
3. Sponsor will attempt to resolve all comments.
4. The technical report will then be balloted to the governing body of the initiating committee for a process level review.
5. Once approved by the governing body, SAE will publish the technical reports.

Institute of Electric and Electronics Engineers (IEEE)

IEEE's development and approval process is visualized by Figure A2.8.

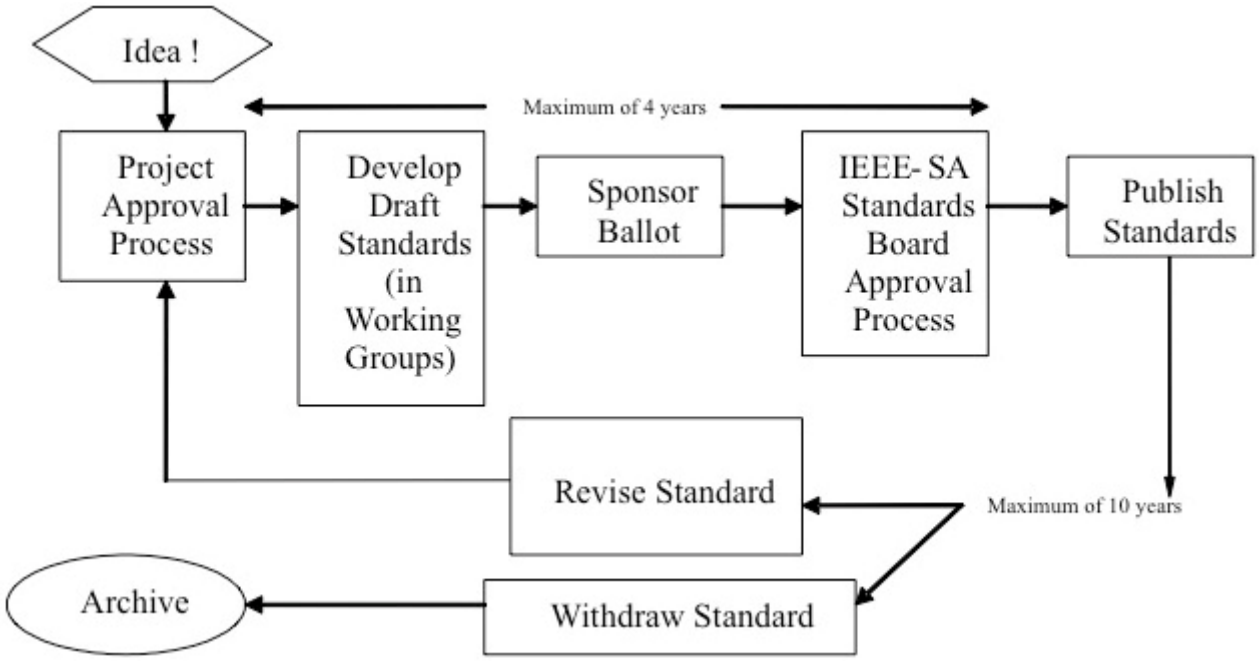

Figure A2.8: IEEE's development and approval process [29]

1. **Initiating the Project:** An IEEE SA Standards Board approved standards committee must oversee a standardisation project. The Standards Committee provides transparent oversight for the standard from inception to completion. The standards committees are supported by the technical societies within IEEE. To gain authorisation for the standard a Project Authorisation Request (PAR) is submitted to the IEEE SA Standards Board. The New Standards Committee (NesCom) of the IEEE SA Standards Board reviews the PAR and makes a recommendation to the Standards Board about whether to approve the PAR.
2. **Mobilizing the Working Group:** After the approval of a PAR, a working group of experts affected by, or interested in, the future standard is organized to work on the development of the standard. IEEE SA rules ensure that all Working Group meetings are open and that anyone has the right to attend and contribute to the meetings.
3. **Drafting the Standard:** The Working Group prepares a draft of the proposed standard. Generally, the draft follows the IEEE Standards Style Manual that sets guidelines for the clauses and format of the standards document.
4. **Balloting the Standard:** Once a draft of the standard is finalized in the Working Group, the draft is submitted for Balloting approval. The IEEE Standards Department sends an invitation-

to-ballot to any individual who has expressed an interest in the subject matter of the standard. Anyone who responds positively to the invitation-to-ballot becomes a member of the balloting group, as long as the individual is an IEEE Standards Association member or has paid a balloting fee. The IEEE requires that a proposed draft of the standard receive a response rate of 75% (i.e., at least 75% of potential ballots are returned) and that, of the responding ballots, at least 75% approve the proposed draft of the standard. If the standard is not approved, the process returns to the drafting of the standard step in order to modify the standard document to gain approval of the balloting group.

5. **Gaining Final Approval:** After getting 75% approval, the draft standard, along with the balloting comments, are submitted to the IEEE SA Standards Board Review Committee (RevCom). The RevCom reviews the proposed draft of the standard against the IEEE SA Standards Board Bylaws and the stipulations set forth in the IEEE SA Standards Board Operations Manual. The RevCom then makes a recommendation about whether to approve the submitted draft of the standard document. Each member of the IEEE SA Standards Board places a final vote on the submitted standard document. It takes a majority vote of the Standards Board to gain final approval of the standard.
6. **Maintaining the Standard:** A standard has a validity period of ten years from the date of IEEE SA Standards Board approval. Amendments that offer minor revisions or extensions to the standard, and corrigenda that makes corrections to the standard can be developed and balloted, but the creation of amendments and corrigenda does not affect the ten-year validity rule. At the end of this period, one of two things has to happen: revision or withdrawal. If no action is taken, the standard will be moved to inactive-reserved status. Sometimes a standard may need a technical or editorial correction to be made. As part of the standards development process, IEEE can accommodate this by issuing a corrigenda or errata Sheet.

National Standardisation Organisations (NSOs)

National Standardisation Organisations may have different processes for country specific development. Few examples are available on the following links:

- BSI (UK) https://www.bsigroup.com/en-GB/our-services/developing-new-standards/standard-development-process/
- ANSI (USA) - https://share.ansi.org/shared%20documents/standards%20activities/american%20national%20standards/procedures,%20guides,%20and%20forms/ans_steps_080818.pdf

Industry Standardisation Consortia

The standardisation process of industry consortia are regulated by internal by-laws providing transparent and comprehensive processes to the participating members. For the sake of simplicity and due to the lack of time and space we are not discussing in detail the development methodologies of these organisations.