



ARETE – DELIVERABLE

“WP - Deliverable 3.6: Report on the standardization landscape and applicable standards”

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under Grant Agreement No 856533

Deliverable number:	D3.6
Due date:	M26
Nature ¹ :	R
Dissemination Level:	PU
Work Package:	WP3
Lead Beneficiary:	NUID UCD
Beneficiaries:	UCD, CLB, WWL, ULE, VIC, TOU, UDUR

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Nature:

R = Report, P = Prototype, D = Demonstrator, O = Other

Dissemination level

PU = Public

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Document History

Version	Date	Description
0.1	25/05/2020	0.1v UCD
0.2	18/05/2021	0.2v UCD, UNE UNE has presented at the following ARETE consortium meetings: 28-29/11/2019 21/08/2020 19/11/2020 18/05/2021
0.3	01/10/2021	0.3v UCD
0.4	20/10/2021	Review from partners
0.5	15/11/2021	Review from Coordinator
0.6	01/12/2021	Review from UNE
0.7	17/12/2021	Submission from UCD

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List of Abbreviations

<ul style="list-style-type: none">● 3D: Three-dimensional● 3GPP: Third Generation Partnership Project● 5G: Fifth-Generation● ACM: Association for Computer Machinery● ADL: Advanced Distributed Learning● AR: Augmented Reality● AREA: Augmented Reality for Enterprise Alliance● ARF: Augmented Reality Framework● ARLEM: Augmented Reality Learning Experience Model● CCMC: CEN/CENELEC Management Centre● CEN: European Committee for Standardization● CENELEC: European Committee for Standardization in the Electrical field● CWA: CEN Workshop Agreement● DCMI: Dublin Core Metadata Initiative● EC: European Commission● EFTA: European Free Trade Association● EG: ETSI Guide● EN: European Standards● ES: ETSI Standard● ESMA: European Computer Manufacturers Association● ETSI: European Telecommunications Standards Institute● GSMA: Global System for Mobile Communications● HCI: Human Computer Interaction● HTML: HyperText Markup Language● ICS: International Classification for Standards● ICT: Information Communication Technology● IEEE: Institute of Electrical and Electronics Engineers● IEC: International Electrotechnical Commission● IMS GLC: IMS Global Learning Consortium● IS: International Standards● ISF: Information Security Forum	<ul style="list-style-type: none">● ISG: Industry Specification Group● ISO: International Organization for Standardization● ISO/IEC JTC 1: Joint Technical Committee 1 of ISO/IEC● ITU: International Telecommunications Union● ITU-T: International Telecommunication Union - Telecommunication Sector● JSON: JavaScript Object Notation● LOM: Learning Object Metadata● LT: Learning Technology● MEC: Multiple Edge Computing● MPEG: Moving Picture Experts Group● MR: Mixed Reality● NSB: National Standardization Body● OAI: Open Archives Initiative● PAR: Performance and Accountability Report● RDF: Resource Description Framework● S2ESC: Software and Systems Engineering Standards Committee● SC: Subcommittee● SCORM: Sharable Content Object Reference Model● SDO: Standard Development Organisation● TC: Technical Committees● TR: Technical Report● TS: Technical Specification● UNE: Spanish Association for Standardization● W3C: World Wide Web Consortium● WG: Working Group● WP: Work Package● xAPI: Experience Application Programming Interface● XHTML: Extensible HyperText Markup Language● XML: Extensible Markup Language● XR: Extended reality● XR-LPA: Extended Reality for Learning and Performance Augmentation
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Executive Summary

The standards and expectations for educational attainment has risen globally although the diversification of the IT infrastructure of the public educational systems has declined and has not followed the trends of the XR advancements. The young population has advanced aspirations and expectations in terms of IT support in schools, which is essential to achieve their goals for educational attainment and their goals for learning. One of the critical issues around the articulation of the increasingly technological “demands” is the lack of awareness of the stakeholders of the standards around the new technologies.

Deliverable D3.6 “Report on Standardization landscape and applicable standards” (M26) is the deliverable for Task 3.4 Standardization landscape and applicable standards within WP3 (Interactive Augmented Reality Toolkit). The main objective of this task is to facilitate the awareness of existing standards in the market within the consortium and utilize the plans for further standardization activities. The information within this deliverable is the background work for information towards the development within the rest of the WPs to ensure the interoperability and compatibility with existing standards in terms of the following tasks:

- Three-dimensional (3D) Augmented Reality (AR) Objects’ creation.
- Institute of Electrical and Electronics Engineers (IEEE) Standards for AR Objects’ content ratings and descriptors.
- IEEE Standard for AR learning experience models.

This document is a guide for the ARETE partners on information about the context and purpose of utilizing existing standards related to Augmented Reality Enhanced Teaching Experience (ARETE) project. A high-level overview of standardization activities in Augmented Reality (and Extended Reality (XR)) within educational systems is paramount before presenting the ARETE standardization plan, based on general standardization processes in Europe and Internationally. The activities on standardization have been initiated within the consortium at an early stage to highlight the importance of compliance and interoperability and is ongoing within the authoring toolkit development activities (WP3) with an aim to make an impact visible internationally at the end of the project.

Nowadays, the impact of Augmented Reality (AR) in the educational systems has been shown to be effective in various aspects. Interoperability facilitates the work of an AR educational system programmer in terms of authoring, publishing, and integration. In addition, interoperability could benefit users in subjects of discovery, sharing and consuming. Although there is a plethora of learning object metadata standards such as IEEE- Learning Object Metadata (LOM), Sharable Content Object Reference Model (SCORM) and DUBLIN CORE, there is lack of standards in terms of interoperability specification and AR educational systems’ support. Augmented Reality Learning Experience Model (ARLEM) is an IEEE Computer Society open metadata standard that supports interoperability and can additionally support augmented reality education systems.



The compatibility within existing standards and the activities for the investigation of new standards, within the horizon of standards and research projects, act as a dissemination tool as well for the project results within the research community and the market stakeholders. Deliverable D3.6 is focusing on the landscape of existing applicable standards, while deliverable D7.6 (Draft CEN Workshop Agreement) complements D3.6, through the WP7 task on exploration of new standards development within the scope for an IEEE AR Learning Object's Interactivity as well as the CEN Workshop Agreement (CWA) (standard) based on the AR interactive technologies within ARETE. The CWA will be produced in line with CEN's technology workshop protocol proceedings (M42). The participation of a Standardization Body, representing European Committee for Standardization (CEN) and European Committee for Standardization in the Electrical field (CENELEC), provides the relevance, knowledge and experience in the standardization system and its internal procedures. The Spanish Association for Standardization, Spanish Association for Standardization (UNE), as National Standardization Body (NSB), member of CEN-CENELEC has been subcontracted by ARETE (University College Dublin– the coordinator) to provide support regarding the standardization tasks included in the project (WP7 – Dissemination, Exploitation, and Communication).

1. Introduction - Standardization

DEFINITION

“A standard defines requirements, specifications, guidelines or characteristics for a determined material, product, process or service. Standards are developed by SDOs (Standards Development Organizations), which involve selected stakeholders in the item to be standardized, such as manufacturers, providers, consumers, and regulators, with possible contributions from academics and professional users. SDOs put in place procedures to guarantee a fair standards development process, which is aimed at building consensus among the stakeholders involved and ensuring the quality of the final deliverables”² [1].

Within the standards, a set of minimum requirements are defined, to meet the set of requirements defined from the contributors to achieve a certain level of performance. Standards are not intended to be a setting stone rule, but a guide instead to accommodate the potential of innovative contributions for new products and or services. Prior to addressing the standardization landscape within the ARETE H2020 project, it is of high importance for the consortium to have a level of understanding of the main SDO types and objectives in order to select the most relevant standards within the development of the project. The initial clustering of the SDOs within the Information Communication Technology (ICT) ecosystem that refers to the work within our project is based on the geographical coverage, the type of affiliates and the technical scope of activities within each SDO. The geographical location of interests of SDOs have been grouped in international, regional and national. SDOs produce

² https://www.etsi.org/images/files/Education/Understanding_ICT_Standardization_LoResPrint_20190125.pdf



valuable technical material and for the purposes of ARETE H2020 we have refined the relevant SDOs based on the following:

TECHNICAL SCOPE:

eXtended Reality (XR) is the umbrella for Virtual, Mixed, and Augmented Reality (VR/MR/AR), relating in varying degree from the use of digital overlays to fully rendered immersive alternate views of a physical world, where objects are registered in 3D and user interaction is responsive to the user's surrounding in real-time. XR is increasingly used in education and training to support learning, practice, or even guide performance. Standards, however, are scarce, incomplete, with existing work scattered across standardisation bodies and committees. For example, existing relevant standards work is not necessarily conducted under the auspices of learning technology standards committees but can also be found in hardware-oriented, industry-focused, or human-computer interaction sponsorship. Moreover, several existing standards applicable to learning technologies at large focus on web and mobile apps and thus fall short of taking into account specificities of the new XR medium, delivery and interaction devices, and related management and usage protocols.

Within this project, we plan to identify and elaborate a comprehensive canon of standards for the creation, delivery, and use of XR learning activities and 3D learning objects for education and training. These services inform educational managers, intermediaries, and regulators (like departments of education on member state level, educational infrastructure providers, school systems) so they can systematically identify appropriate enhancing actions and ensure effective allocation of digital learning resources for the provision of education anytime anywhere. Setting of targets for education and training services and augmented infrastructure implies the ability to:

1. measure the current online service provision and resilience of students & educators
2. define a process to set the target for implementation of augmented reality based educational platform;
3. define specific targets based on impact assessment within specific educational subjects.

Some works exist already on each of these research areas within small silo products, which lack the utilization of standardized impact assessment. Within the literature the general process of setting targets for disruptive education is scarce. Nevertheless, given the relevant SDOs with existing ICT technical scope we have identified European Telecommunications Standards Institute (ETSI), International Organization for Standardization (ISO), IEEE and CEN as the most relevant to our work. The Standardization Bodies, consist of many Technical Committees (TC), which deal with different areas of interest, and each Technical Committee (TC) may have a few Subcommittees (SCs) or Working Groups (WGs) according to its need.

GEOGRAPHICAL SCOPE

SDOs and also the work within ARETE project, due to the nature of the project domain, do not constrain the geographical scope of their specifications.



TYPE OF AFFILIATION

There is no hierarchy among SDOs, and compliance with standards is on a voluntary basis. We understand that there may be overlaps among different SDOs that might share the technological area of XR development in educational settings and due to this complexity, the standardization landscape of SDO activities is continuously monitored throughout the lifetime of the project.

Because of the complexity of the standardization institutions' landscape, SDO activities and relationships need to be continuously monitored. To keep the whole picture up to date for the project, the collaboration of all WP leaders with the subcontracted Spanish Association for Standardization "UNE", is essential ("UNE" has been the successful bid through the EU tender procedure). The Coordinator will work closely with UNE for the delivery of the CEN Workshop Agreement and will facilitate the preparation of all pre-standards' documentation for CEN/CELENIC. The subcontracted activities, on a fee phased basis, will specifically focus on the delivery of a draft CEN CWA standards document based on the AR interaction technology within ARETE and in line with CEN's technology workshop protocol proceedings. The undertaking has begun at the start of the project and is planned to end by month 42.

Table 1: Standards' Organisations relevant to H2020 ARETE Project

Organization	HQs	Geographical Scope	Domain	Affiliated Members	Contributes to (SDOs)
ISO	Geneva (CH)	International	ICT	National SDO	ITU ³
ETSI	Geneva (CH)	International (EU regional recognition)	ICT	National SDO/Industry/research Institutes/Government Bodies	ITU
CEN	Brussels (BE)	Regional (Europe)	ICT	National SDO	ISO
IEEE	New York (US)	International	ICT		

³ International Telecommunications Union



The project coordinator has followed the rationales for integrating standardisation within ARETE project since the kick off meeting of the project, as indicated from CEN-CENELEC.

Table 2: Rationales for integrating standardisation in ARETE H2020 (adapted from CEN-CENELEC⁴)

What are the needs of ARETE	What can standardisation contribute?	What is included in ARETE R&I project?
Starting point of ARETE: Kick off meeting November 2019	Identify State of the Art existing standards for XR in Education	Screening of existing standards at early stages of the project
Ensure methodological robustness	Ensure compatibility with existing products in the market	
Ensure quality of project's activities and outcomes	Comply with recognised methods, user and health and safety requirements	Standardisation subcontractor (UNE)
Ensure broad applicability of ARETE results		
Increase impact of the project	Provide access to discuss and promote the project outcomes with stakeholders and potential customers	Tasks within WP1, WP3 and WP7 aimed at contributing to new standards
Long term dissemination results	Disseminate the results to a relevant EU and World-wide group of stakeholders	
Ensure market acceptance of project results	Ensure that the project results are known and used beyond the duration of the project	Standardisation subcontractor (UNE)

⁴ CEN-CENELEC (n.d.): Increase the Impact of your R&I project by Integrating Standardization, https://www.cencenelec.eu/media/CEN-CENELEC/Get%20Involved/Research_Innovation/standardization-in-research-projects.pdf



2. Technical Committees (TCs) / Working Groups (WGs)

At early stages of the ARETE project, once the relevant standards were identified and the respective WPs the consortium focus on specifying in which WP those standards would be used, how those standards would influence/impact the project implementation and opportunities/risks from technical and business perspectives. The analysis of current standards in the area of AR and educational systems encouraged the coordinator and partners to interact with Standardization TCs during the standards analysis and it took place through:

- **IEEE 1589-2020 – IEEE Standard for Augmented Reality Learning Experience Model⁵ – Published 2020-04-17:** The participation of Prof. Fridolin Wild (ARETE Partner: The Open University), as Chair of the WG ARLEM (The Augmented Reality Learning Experience Model), IEEE Standards Association, which specifies how to represent activities in which the user interacts with both the real world and virtual augmentations presented in a display. ARLEM defines the dynamic layout and behaviour of the augmentations relative to the physical environment and to the user as well as in response to events. The ARLEM specification is defined as a device-independent standardized interchange format in order to lower barriers for designing, authoring/developing, deploying, using, maintaining/updating, and reusing learning experiences that involve interaction with the real world, sensors, computer vision, and web applications. Sponsor Committee: IEEE Learning Technology Standards Committee (LTSC).
- **ETSI ISG ARF (Industry Specification Group Augmented Reality Framework)⁶:** The participation of the coordinator (Prof. Eleni Mangina) as active member with ETSI ISG ARF since 2019 in order to define a framework for the interoperability of Augmented Reality (AR) components, systems and services that specifies relevant components and interfaces required for an AR solution and provide feedback to the consortium in terms of compliance with interoperability standards within WP3. The development of a modular architecture will allow components from different providers to interoperate through the defined interfaces. Transparent and reliable interworking between different AR components is key to the successful roll-out and wide adoption of AR applications and services.
- **IEEE Standards Association (IC – Industry Connections) – The IEEE Global Initiative on Ethics of Extended Reality (XR)⁷.** The participation of the coordinator (Prof. Eleni Mangina) as Chair of the IEEE XR Ethics report (7 chapters) to be published in 2022, and Chapter leader on “XR Ethics of Education” with 42 recommendations identified. The goal of this Industry Connections activity is to continue and proliferate the existing efforts of The IEEE Standards Association focused on the ethical issues related to XR as outlined in the Extended Reality chapter of Ethically Aligned Design⁸ while inviting Working Group members from the multiple standards Working Groups focused on augmented and virtual reality and the spatial web and additional subject matter experts from industry

⁵ <https://standards.ieee.org/standard/1589-2020.html>

⁶ <https://www.etsi.org/committee/1420-arf>

⁷ <https://standards.ieee.org/industry-connections/ethics-extended-reality.html>

⁸ <https://beyondstandards.ieee.org/prioritizing-ethical-considerations-in-the-design-of-autonomous-and-intelligent-systems/>



and policy to create white papers, workshops, and Performance and Accountability Reports (PARs) related to this work to ensure these technologies move from perilous to purposeful.

- On 14 October, 2021, the IEEE’s Global Initiative for Ethical Extended Reality hosted a policy-focused digital event that brings together expert voices to explore issues surrounding extended reality in education. The event looked into “AR in the classroom” and “VR as the classroom”, highlighted work from the multidisciplinary ethics initiative addressing various policy aspects of XR-and-education, and will feature expert voices and practitioner commentary. Featuring speakers whose expertise bring together a wide range of policy perspectives, the event provided an opportunity for an immersive discussion of considerations for an important use case of emerging technology in the public sphere. **Ellyse Dick**, of the non-profit Information Technology and Innovation Foundation; **Victoria Copeland**, a researcher and fellow at University of California, Los Angeles; Prof. **Eleni Mangina**, who is a member of the Global Initiative’s Executive Committee and Chair of XR Ethics report and XR-in-education expert at University College Dublin (UCD) who coordinates multiple European funded projects; as well as Prof. **Fridolin Wild**, of The Open University, and one of the main driving forces behind the XR-in-education focused ARLEM metadata standards.
- **[IEEE P2048] IEEE VR/AR Working Group⁹**: The participation of the coordinator (Prof. Eleni Mangina) as active member . The scope of the Standards Committee is to develop and maintain standards, recommended practices and guides for virtual reality and augmented reality, using an open and accredited process, and to advocate them on a global basis. Its technical scope is intended to be flexible and is ultimately determined by the sum of its approved PARs.
- **IEEE P1228 – Standard for Software Safety¹⁰**: The participation of the coordinator (Prof. Eleni Mangina) and Prof. Effie Law (ARETE Partner) as active members and leaders of the Human Computer Interaction (HCI) Working Subgroup. This standard applies to software safety during the development, procurement, maintenance, and retirement of safety-critical software; for example, software products whose failure could cause loss of life, serious harm, or have widespread negative social impact. This standard requires that software safety be considered within the context of the system safety program throughout the software lifecycle. The scope of this standard includes only the safety aspects of the software. This standard also discusses aspects of software safety related to interoperation with other systems or constituents of a system of systems. Sponsor Committee: IEEE Software and Systems Engineering Standards Committee (S2ESC).
- **ISO/IEC JTC 1/SC 24/WG 11 - Health, safety, security and usability of Augmented & Virtual Reality (AR/VR)¹¹**: The participation of coordinator Prof. Fridolin Wild as convenor until the end of 2024. WG11 is tasked with developing standards to ensure various forms of immersive technologies can be safely and efficiently used by enterprises and consumers,

⁹ <https://sagroups.ieee.org/2048wg/>

¹⁰ <https://standards.ieee.org/project/1228.html>

¹¹ <https://www.iso.org/committee/45252.html>



including: Health & Safety for AR/VR, including immersion Ensuring the safe usage of Personal Protective Equipment with AR/VR Hygiene related to AR/VR Ensuring diversity, equality and inclusion. Both business processes and diversity consideration for software/hardware Robustness of AR/VR devices Processes related to AR/VR content capture, processing, and postproduction Cyber security/privacy/on-line harms specific to AR/VR.

- **IEEE Experience API (xAPI) Working Group¹²**: Participation of UCD and Vicomtech partners' software developers. The purpose of the xAPI Working Group is to develop a standard to provide an interoperable means to store and retrieve learning experience data as required by modern, data-intensive learning technologies. This project includes the standardization of the existing xAPI Specification and closely related technologies to create an interoperable environment for learning data. In 2020 9274.2.1 xAPI Profile Standard officially begun standardization activities
- **IEEE P2881 Standard for Learning Metadata Working Group¹³**: Participation of UCD and TOU (The Open University) partners' software developers. This standard intentionally builds on the IEEE 1484.12.1 standard but is explorative to new learning paradigms and modern technology practices. This standard will specify a conceptual data schema that defines the structure of a metadata instance. This conceptual data schema specifies the data elements which compose a metadata instance for multiple learning types. This standard does not define how a learning technology system implements the data schema. (Sponsor Committee: IEEE LTSC)

Standardization is an open activity and all interested parties within the consortium may participate in a CEN/ETSI/ISO/IEEE activities in order to make technical contributions to their works. The dissemination of the ARETE Project progress takes place through the reports and presentations to the relevant WGs meetings.

3. Relevant Standards

There are also different kinds of standardization documents. The most widespread is the standard, which has a different code depending on the organization under which it was developed, e.g. EN for European Standards, IS for International standards. Other types of documents are Technical Specifications (TS), Technical Reports (TR) and workshop agreements (such as CEN Workshop Agreements). Further Amendments to the standards are identified by adding A1, A2, etc. at the end of the standard code.

For analysis of standardization landscape and identification of existing standards and standard documents under development relating to the project, the following methodology has been designed and taken for understanding the key concepts of the project and assessing the identification of standardization areas. The list of key concepts have been agreed with UNE, ARETE partners and the coordinator, who initiated the process.

¹² <https://sagroups.ieee.org/9274-1-1/>

¹³ <https://standards.ieee.org/project/2881.html#Working>



1. Augmented Reality Authoring Toolkits
2. Information models for Augmented Reality
3. Augmented Reality content for educational systems
4. Interoperability for Augmented Reality Systems
5. Augmented Reality learning experiences
6. Learning Objects Metadata
7. XR Ethics in Education

Because of all the process described above, a list of relevant and applicable standards relating to the ARETE project have been specified and they can be used as guidelines. It would be interesting to keep them in mind as they could be helpful, but they will not represent a requirement. The highlighted ones need to be considered as a compliance requirement and represent a requirement for the WP developments during design/development phases.

- Augmented Reality
- Augmented Reality Education
- Educational metadata



Figure 1. Relevant SDOs to ARETE H2020 Project (ETSI, ISO, IEEE and CEN)

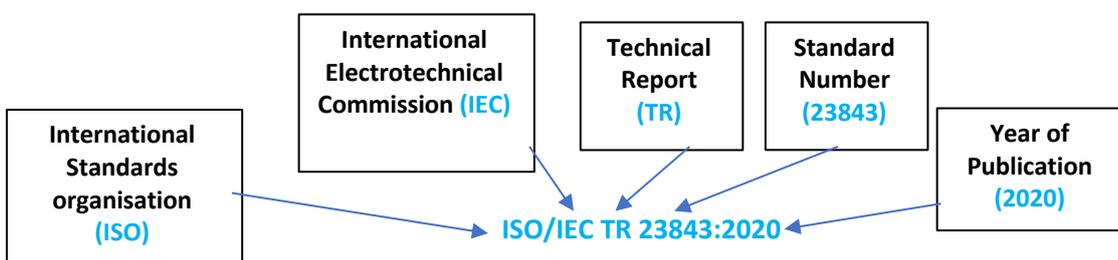


Figure 2: Example of the elements in the identifier code of a standard



3.1 Relevant Standards on “Augmented Reality”

Table 3: Relevant standards to “Augmented Reality” - H2020 ARETE Project

SDO	Standard Number	Standard Title	Status
ISO	ISO/IEC TR 23843:2020	Information technology for learning, education and training — Catalogue model for virtual, augmented and mixed reality content ICS : 35.240.90 TC : ISO/IEC JTC 1/SC 36	Published (60.60)
ISO	ISO/IEC 18040:2019	Information technology — Computer graphics, image processing and environmental data representation — Live actor and entity representation in mixed and augmented reality (MAR) ICS : 35.140 TC : ISO/IEC JTC 1/SC 24	Published (60.60)
ISO	ISO/IEC 18038:2020	Information technology — Computer graphics, image processing and environmental representation — Sensor representation in mixed and augmented reality ICS : 35.140 TC : ISO/IEC JTC 1/SC 24	Published (60.60)
ISO	ISO/IEC 23000-13:2017	Information technology - Multimedia application format (MPEG-A) — Part 13: Augmented reality application format ICS : 35.040.40 TC : ISO/IEC JTC 1/SC 29	Published (60.60)
ISO	ISO 9241-940:2017	Ergonomics of human-system interaction — Part 940: Evaluation of tactile and haptic interactions ICS : 13.180 , 35.180 TC : ISO/TC 159/SC 4	Published (60.60)
ISO	ISO/IEC 18039:2019	Information technology — Computer graphics, image processing and environmental data representation — Mixed and augmented reality (MAR) reference model ICS : 35.140 TC : ISO/IEC JTC 1/SC 24	Published (60.60)
ISO	ISO/IEC 18520:2019	Information technology — Computer graphics, image processing and environmental data representation — Benchmarking of vision-based spatial registration and tracking methods for mixed and augmented reality (MAR) ICS : 35.140	Published (60.60)



		TC : ISO/IEC JTC 1/SC 24	
ISO	ISO/IEC/IEEE 26511:2018	Systems and software engineering — Requirements for managers of information for users of systems, software, and services ICS : 35.080 TC : ISO/IEC JTC 1/SC 7	Published (60.60)
ISO	ISO/IEC TR 23842-1:2020	Information technology for learning, education and training — Human factor guidelines for virtual reality content — Part 1: Considerations when using VR content ICS : 35.240.90 TC : ISO/IEC JTC 1/SC 36	Published (60.60)
ISO	ISO/IEC PRF TS 23884	Information technology — Computer graphics, image processing and environmental data representation — Material property and parameter representation for model-based haptic simulation of objects in virtual, mixed and augmented reality (VR/MAR) ICS : 35.140 TC : ISO/IEC JTC 1/SC 24	Under development (50.20)
ISO	ISO/IEC AWI TR 23488-2	Image based Object/Environmental Representation for Virtual/Mixed and Augmented Reality (VR/MAR) — Part 2: Constructs for Visual Positioning Systems TC : ISO/IEC JTC 1/SC 24	Under development (20.00)
ISO	ISO/IEC DIS 3721-1	Information technology — Computer graphics, image processing and environmental data representation — Information model for Mixed and Augmented Reality Contents — Part 1: Core Objects and Attributes ICS : 35.140 TC : ISO/IEC JTC 1/SC 24	Under development (40.20)
ISO	ISO/IEC CD 3721-2	Information model for mixed and augmented reality: — Part 2: Augmentation Style Specification' ICS : 35.140 TC : ISO/IEC JTC 1/SC 24	Under development (30.99)
ISO	ISO/IEC DIS 23488	Information technology — Computer graphics, image processing and environment data representation — Object/Environmental Representation for Image based Rendering in Virtual/Mixed and Augmented Reality (VR/MAR) ICS : 35.140 TC : ISO/IEC JTC 1/SC 24	Under development (40.20)



ETSI	ETSI GR ARF 001 V1.1.1 (2019-04)	Augmented Reality Framework (ARF); AR standards landscape	Published
ETSI	ETSI GR ARF 004-1 V1.1.1 (2021-09)	Augmented Reality Framework (ARF) Interoperability Requirements for AR components, systems and services; Part 1: Overview	Published
ETSI	ETSI GS ARF 003 V1.1.1 (2020-03)	Augmented Reality Framework (ARF) AR framework architecture	Published
ETSI	ETSI GS ARF 004-2 V1.1.1 (2021-08)	Augmented Reality Framework (ARF) Interoperability Requirements for AR components, systems and services Part 2: World Storage and AR Authoring functions	Published
ETSI	ETSI EG 202 848 V1.1.1 (2011-02)	Human Factors (HF); Inclusive eServices for all: Optimizing the accessibility and the use of upcoming user-interaction technologies	Published
SDO	Standard Number	Standard Title	Status
IEEE	IEEE P2048.6	Standard for Virtual Reality and Augmented Reality: Immersive User Interface	Under development
IEEE	IEEE P2048.7	Standard for Virtual Reality and Augmented Reality: Map for Virtual Objects in the Real World	Under development
IEEE	IEEE P2048.8	Standard for Virtual Reality and Augmented Reality: Interoperability between Virtual Objects and the Real World	Under development
IEEE	IEEE P2048.9	Standard for Virtual Reality and Augmented Reality: Immersive Audio Taxonomy and Quality Metrics	Under development
IEEE	IEEE P2048.10	Standard for Virtual Reality and Augmented Reality: Immersive Audio File and Stream Formats	Under development
IEEE	IEEE P2048.12	Standard for Virtual Reality and Augmented Reality: Content Ratings and Descriptors	Under development
SDO	Standard Number	Standard Title	Status



CEN	CEN/TR 16710-1:2015 (WI=00122210)	Ergonomics methods - Part 1: Feedback method - A method to understand how end users perform their work with machines	Published
CEN	prEN ISO 9241-394 (WI=00122274)	Ergonomics of human-system interaction - Part 394: Ergonomic requirements for reducing undesirable biomedical effects of visually induced motion sickness during watching electronic images (ISO 9241-394:2020)	Under approval
CEN	prEN ISO 9241-940 (WI=00122276)	Ergonomics of human-system interaction - Part 940: Evaluation of tactile and haptic interactions (ISO 9241-940:2017)	Under approval

3.2 Relevant Standards on “Augmented Reality & Educational Systems”

Table 4: Relevant standards to “Augmented Reality & Educational Systems” - H2020 ARETE Project

SDO	Standard Number	Standard Title	Status
ISO	ISO/IEC TR 23843:2020	Information technology for learning, education and training — Catalogue model for virtual, augmented and mixed reality content ICS : 35.240.90 TC : ISO/IEC JTC 1/SC 36	Published (60.60)
ISO	ISO/IEC TR 23842-1:2020	Information technology for learning, education and training — Human factor guidelines for virtual reality content — Part 1: Considerations when using VR content ICS : 35.240.90 TC : ISO/IEC JTC 1/SC 36	Published (60.60)
ETSI	ETSI GR ARF 002 V1.1.1 (2019-07)	Augmented Reality Framework (ARF) Industrial use cases for AR applications and services	Published
ETSI	ETSI EG 202 848 V1.1.1 (2011-02)	Human Factors (HF); Inclusive eServices for all: Optimizing the accessibility and the use of upcoming user-interaction technologies	Published



ETSI	ETSI TR 101 568 V1.1.1 (2012-02)	Human Factors (HF); A study of user context dependent multilingual communications for interactive applications	Published
ETSI	ETSI EG 203 602 V1.1.1 (2019-04)	User Group; User Centric Approach: Guidance for users; Best practices to interact in the Digital Ecosystem	Published

3.3 Relevant Standards on “Educational Metadata”

Table 5: Relevant standards to “Educational Metadata” - H2020 ARETE Project

SDO	Standard Number	Standard Title	Status
ISO	ISO/IEC TR 15938-11:2005	Information technology — Multimedia content description Interface — Part 11: MPEG-7 profile schemas ICS : 35.040.40 TC : ISO/IEC JTC 1/SC 29	Published (90.93)
ISO	ISO/IEC 19788-3:2011/AMD 1:2016	Information technology — Learning, education and training — Metadata for learning resources — Part 3: Basic application profile — Amendment 1 ICS : 03.100.30 , 35.240.90 TC : ISO/IEC JTC 1/SC 36	Published (60.60)
ISO	ISO/IEC 15938-9:2005	Information technology — Multimedia content description interface — Part 9: Profiles and levels ICS : 35.040.40 TC : ISO/IEC JTC 1/SC 29	Published (90.93)
ISO	ISO/IEC TR 19788-11:2017	Information technology — Learning, education and training — Metadata for learning resources — Part 11: Migration from LOM to MLR ICS : 03.100.30 , 35.240.90 TC : ISO/IEC JTC 1/SC 36	Published (60.60)
ISO	ISO/IEC 23127-1:2021	Information technology — Learning, education, and training — Metadata for facilitators of online learning — Part 1: Framework ICS : 03.180 , 35.240.90 TC : ISO/IEC JTC 1/SC 36	Published (60.60)
ISO	ISO/IEC 19788-2:2011	Information technology — Learning, education and training — Metadata for learning resources — Part 2: Dublin Core elements ICS : 03.100.30 , 35.240.90 TC : ISO/IEC JTC 1/SC 36	Published (90.20)



ISO	ISO/IEC 19788-1:2011/AMD 1:2014	Information technology — Learning, education and training — Metadata for learning resources — Part 1: Framework — Amendment 1 ICS : 03.100.30 , 35.240.90 TC : ISO/IEC JTC 1/SC 36	Published (60.60)
ISO	ISO/IEC 19788-8:2015	Information technology — Learning, education and training — Metadata for learning resources — Part 8: Data elements for MLR records ICS : 03.100.30 , 35.240.90 TC : ISO/IEC JTC 1/SC 36	Published (90.93)
ISO	ISO/IEC 19788-9:2015	Information technology — Learning, education and training — Metadata for learning resources — Part 9: Data elements for persons ICS : 03.100.30 , 35.240.90 TC : ISO/IEC JTC 1/SC 36	Published (90.93)
ISO	ISO/IEC 24751-3:2008	Information technology — Individualized adaptability and accessibility in e-learning, education and training — Part 3: "Access for all" digital resource description ICS : 03.100.30 , 35.240.90 TC : ISO/IEC JTC 1/SC 36	Published (90.93)
ISO	ISO/IEC TR 23843:2020	Information technology for learning, education and training — Catalogue model for virtual, augmented and mixed reality content ICS : 35.240.90 TC : ISO/IEC JTC 1/SC 36	Published (60.60)
ISO	ISO/IEC 19788-7:2019	Information technology — Learning, education and training — Metadata for learning resources — Part 7: Bindings ICS : 03.100.30 , 35.240.90 TC : ISO/IEC JTC 1/SC 36	Published (60.60)
ISO	ISO/IEC 19788-3:2011	Information technology — Learning, education and training — Metadata for learning resources — Part 3: Basic application profile ICS : 03.100.30 , 35.240.90 TC : ISO/IEC JTC 1/SC 36	Published (90.93)
ISO	ISO/IEC 19788-1:2011	Information technology — Learning, education and training — Metadata for learning resources — Part 1: Framework ICS : 03.100.30 , 35.240.90 TC : ISO/IEC JTC 1/SC 36	Published (90.92)
ISO	ISO/IEC 19788-4:2014	Information technology — Learning, education and training — Metadata for learning resources — Part 4: Technical elements ICS : 03.100.30 , 35.240.90 TC : ISO/IEC JTC 1/SC 36	Published (90.93)



ISO	ISO/IEC 19788-5:2012	Information technology — Learning, education and training — Metadata for learning resources — Part 5: Educational elements ICS : 03.100.30 , 35.240.90 TC : ISO/IEC JTC 1/SC 36	Published (90.93)
ISO	ISO/IEC 19788-2:2011/AMD 1:2016	Information technology — Learning, education and training — Metadata for learning resources — Part 2: Dublin Core elements — Amendment 1: Non-literal content value data elements ICS : 03.100.30 , 35.240.90 TC : ISO/IEC JTC 1/SC 36	Published (60.60)
SDO	Standard Number	Standard Title	Status
IEEE	IEEE 1589-2020	IEEE Standard for Augmented Reality Learning Experience Model C/LT – Learning Technology	Published
IEEE	IEEE 1484.12.1-2020	IEEE Standard for Learning Object Metadata	Published
IEEE	IEEE 1484.12.3-2020	IEEE Standard for Learning Technology--Extensible Markup Language (XML) Schema Definition Language Binding for Learning Object Metadata	Published
IEEE	IEEE 1484.13.1-2012	IEEE Standard for Learning Technology--Conceptual Model for Resource Aggregation for Learning, Education and Training	Published
IEEE	IEEE 1484.11.2-2020	IEEE Standard for Learning Technology--ECMAScript Application - Programming Interface for Content to Runtime Services Communication	Published
IEEE	IEEE 1876-2019	IEEE Standard for Networked Smart Learning Objects for Online Laboratories	Published



3.4 Other Relevant Standards and Specifications with ARETE H2020 project

Table 6: Other relevant standards - H2020 ARETE Project

SDO	Standard Number	Standard Title	Status
IEEE	IEEE P7000	Model Process for Addressing Ethical Concerns During System Design	Published
IEEE	IEEE P7001	Transparency of Autonomous Systems	Under development
IEEE	IEEE P7002	Data Privacy Process	Under development
IEEE	IEEE P7004	Standard on Child and Student Data Governance	Under development
IEEE	IEEE P7006	Standard for Personal Data Artificial Intelligence (AI) Agent	Under development
IEEE	IEEE P7007	Ontological Standard for Ethically Driven Robotics and Automation Systems	Under development
IEEE	IEEE P7008	Standard for Ethically Driven Nudging for Robotic, Intelligent, and Automation Systems	Under development
IEEE	IEEE P7009	Standard for Fail-Safe Design of Autonomous and Semi-Autonomous Systems	Under development
IEEE	IEEE P7010	Wellbeing Metrics Standard for Ethical Artificial Intelligence and Autonomous Systems	Published
DCMI	2020-01-20	DCMI Metadata Terms	Published
DCMI	2007-06-04	DCMI Abstract Model	Published
DCMI	2008-01-14	Expressing Dublin Core™ metadata using the Resource Description Framework (RDF)	Published
DCMI	2008-08-04	Expressing Dublin Core™ metadata using HTML/XHTML meta and link elements	Published
IMS GLC	V1.1.4	Content Packaging Specification	Published
IMS GLC	V1.3	IMS Common Cartridge® Specification	Published
IMS GLC	V1.3	Learning Tools Interoperability Core Specification	Published
IMS GLC	V3.0	IMS Question & Test Interoperability (QTI)	Candidate
IMS GLC	V2.0.1	IMS Global Learning Information Services Specification	Published
IMS GLC	V1.1	IMS OneRoster®: CSV Tables	Published
IMS GLC	V1.1.2	IMS OneRoster® Specification	Published



IMS GLC	V2.0	Open Badges	Published
IMS GLC	V1.0	Competencies and Academic Standards Exchange (CASE)	Published
IMS GLC	V1.2	Caliper Analytics	Published
IMS GLC	V1.0	IMS Simple Sequencing	Published
ADL	V1.0.3	Experience API (xAPI)	Published
ADL	Quartz - 1st Edition	cmi5 Specification Profile for xAPI	Published
OAI	V1.0	Object Reuse and Exchange (ORE)	Published
OAI	V2.0	The Open Archives Initiative Protocol for Metadata Harvesting	Published
ISO	ISO/IEC 24751-1:2008	Information technology — Individualized adaptability and accessibility in e-learning, education and training — Part 1: Framework and reference model ICS : 03.100.30 TC : ISO/IEC JTC 1/SC 36	Published (90.93)
ISO	ISO/IEC 24751-2:2008	Information technology — Individualized adaptability and accessibility in e-learning, education and training — Part 2: "Access for all" personal needs and preferences for digital delivery ICS : 03.100.30 TC : ISO/IEC JTC 1/SC 36	Published (90.93)
ISO	ISO/IEC AWI 5927	AR/VR safety-- guidance on safe immersion, set up and usage TC : ISO/IEC JTC 1/SC 24	Under development (20.00)
ISO	ISO/IEC AWI 5236	Use of AR/VR with Personal Protective Equipment (PPE) and cleanliness — guidance on ensuring devices enhance use of existing PPE and cleanliness requirements TC : ISO/IEC JTC 1/SC 24	Under development (20.00)
ISO	ISO/TS 22591:2021	Space systems — Space-based services for a high accuracy positioning system with safety requirements TC : ISO/TC 20/SC 14 ICS : 49.140	Published (60.60)
ISO	ISO 9241-392:2015	Ergonomics of human-system interaction — Part 392: Ergonomic recommendations for the reduction of visual fatigue from stereoscopic images	Published (90.93)



		TC : ISO/TC 159/SC 4 ICS : 13.180	
ISO	ISO/DTR 9241-380	Ergonomics of human-system interaction — Part 380: Survey result of HMD (Head-Mounted Displays) characteristics related to human-system interaction TC : ISO/TC 159/SC 4 ICS : 13.180	Under development (30.20)
ISO	ISO/WD 9241-381	Ergonomics of human-system interaction — Part 381: Requirements for optical characteristics of head-mounted displays related to human-system interaction TC : ISO/TC 159/SC 4	Under development (20.00)
ISO	ISO/WD 9241-382	Ergonomics of human-system interaction — Part 382: General requirements for reducing undesirable biomedical effects during visual interactive tasks using head-mounted displays TC : ISO/TC 159/SC 4	Under development (20.00)
ISO	ISO/TR 9241-393:2020	Ergonomics of human-system interaction — Part 393: Structured literature review of visually induced motion sickness during watching electronic images TC : ISO/TC 159/SC 4 ICS : 13.180	Published (60.60)
ISO	ISO/TR 9241-810:2020	Ergonomics of human-system interaction — Part 810: Robotic, intelligent and autonomous systems TC : ISO/TC 159/SC 4 ICS : 13.180	Published (60.60)
ISO	ISO/IEC AW1 29187-1	Information technology — Identification of privacy protection requirements pertaining to learning, education and training (LET) — Part 1: Framework and reference model TC : ISO/IEC JTC 1/SC 36	Under development (20.00)
CEN	EN ISO/IEC 29100:2020	Information technology - Security techniques - Privacy framework TC : CEN/CLC/TC 13 ICS : 35.030	Published
ISO	ISO/IEC 29100:2011	Information technology — Security techniques — Privacy framework ICS : 35.030 TC : ISO/IEC JTC 1/SC 27	Published (90.93)
ISO	ISO/IEC 27017:2015	Information technology — Security techniques — Code of practice for information security controls based on ISO/IEC 27002 for cloud services ICS : 35.030	Published (90.93)



		TC : ISO/IEC JTC 1/SC 27	
ISO	ISO/IEC 27018:2019	Information technology — Security techniques — Code of practice for protection of personally identifiable information (PII) in public clouds acting as PII processors ICS : 35.030 TC : ISO/IEC JTC 1/SC 27	Published (60.60)
ISO	ISO/IEC 27000:2018	Information technology — Security techniques — Information security management systems — Overview and vocabulary ICS : 35.030 TC : ISO/IEC JTC 1/SC 27	Published (60.60)
ISO	ISO/IEC 27001:2013	Information technology — Security techniques — Information security management systems — Requirements ICS : 35.030 TC : ISO/IEC JTC 1/SC 27	Published (90.93)
ISO	ISO/IEC FDIS 27002	Information security, cybersecurity and privacy protection — Information security controls ICS : 35.030 TC : ISO/IEC JTC 1/SC 27	Under development (50.00)

4. ETSI ISG ARF

ETSI produces a range of publications, each with its own particular purpose, which is encoded in the first two letters of the document's code; e.g.: EN – the document is intended to meet needs specific to Europe and requires transposition into national standards, or the document is required under a mandate from the European Commission (EC)/European Free Trade Association (EFTA). ETSI Standard (ES) and TS – the document contains technical requirements (the difference between ESs and TSs lies in different approval rules). ETSI Guide (EG) – identifies guidance to ETSI in general on the handling of specific technical standardization activities. TR – the document contains explanatory material

ETSI Industry Specification Group (ISG) Augmented Reality Framework (ARF)¹⁴ is a working group that focuses on the availability of an interoperability framework for AR that:

- will encourage an ecosystem with a diverse range of solution providers including smaller players, new entrants and academics
- will prevent market fragmentation and break vertical siloes
- will enable providers to offer part(s) of an overall AR solution
- will give end-users confidence to invest in future proof AR solutions knowing that they can swap technology as and when the need arises.

¹⁴ <https://www.etsi.org/committee/1420-arf>



The purpose of the ISG ARF is to define a framework for the interoperability of AR components, systems and services. The framework under development is referenced as “AR framework” and defines an overall functional reference architecture, identifying key components and interfaces for an AR solution. The AR framework will allow AR components from different providers to interoperate through the defined interfaces. This will in turn avoid vertical siloes and market fragmentation and enable players in the ecosystem to offer part(s) of an overall AR solution.

The main objectives of ISG ARF are:

- to ensure that Augmented Reality services and platforms will be easier to design, deploy and operate than today taking into account the advent of fifth-generation (5G) networks,
- to enable the development of high-performance Augmented Reality components which are portable between different hardware vendors, different providers of software solutions and platforms,
- to achieve co-existence of legacy and proprietary platforms whilst enabling an efficient migration path to fully interoperable platforms.

ISG ARF will complete the specification of the AR framework started during the initial 2-year period and produce a set of interoperability requirements for AR components, systems and services. Based on the standards landscape group report¹⁵, relevant standards will be mapped onto the reference architecture. The set of interoperability requirements will be used to identify interfaces essential to achieve interoperability. Together, this will be used to focus specification work on these interfaces.

Where existing standards have been identified and fulfil the interface requirements, they will be referenced by the AR framework. Where existing standards have been identified but extensions are required, the requirements will be contributed to the corresponding standards organisations where appropriate. Where interfaces in the reference architecture have been identified as key interoperability points but no standards could be identified, new technical specifications relating to APIs, interfaces or data models will be developed within ETSI or in external groups if deemed more appropriate.

Other groups included in ETSI Information Security Forum (ISF) ARF effort are: ETSI ISG Multiple Edge Computing (MEC); 3rd Generation Partnership Project (3GPP)/SA4-Codec; IEEE; ISO Moving Picture Experts Group (MPEG); World Wide Web Consortium (W3C) AR Community Group; International Telecommunication Union - Telecommunication Sector (ITU-T); Khronos; The Augmented Reality for Enterprise Alliance (AREA); Global System for Mobile Communications (GSMA) Cloud AR/VR.

¹⁵ https://www.etsi.org/deliver/etsi_gr/ARF/001_099/001/01.01.01_60/gr_ARF001v010101p.pdf

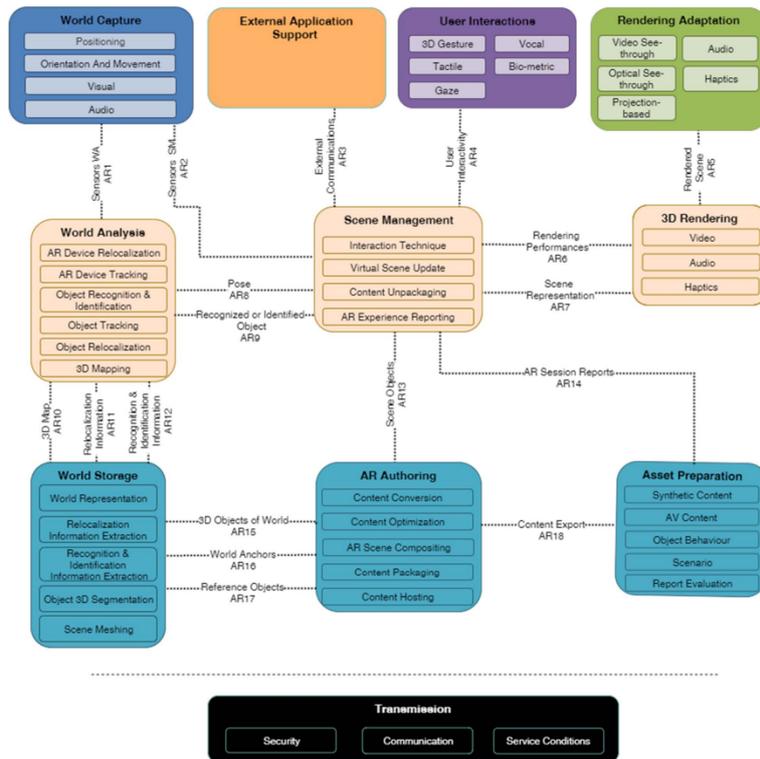


Figure 3: Diagram of functional reference architecture (ETSI GS ARF 003 V1.1.1 (2020-03))¹⁶

4.1 AREA Research

ETSI ISG ARF introduced recently to the ARETE consortium the AREA’s Enterprise AR Research Agenda¹⁷, which is a living resource that focuses the attention of enterprise AR stakeholders on gaps in industry knowledge and obstacles to widespread adoption of AR in industry. The target audiences for this Research Agenda include research organizations, governmental and non-governmental funding organizations and planners who are establishing or updating their research priorities to address enterprise AR ecosystem needs.

AREA’s Research Agenda identifies the topics on which research has high potential for impact based on prioritization of gaps in documented research and shared knowledge. Prioritization of gaps is established using data science and the following sources:

- **FindAR** – a searchable database of nearly 5300 articles about enterprise AR in Association for Computer Machinery (ACM) and IEEE publication databases since January 2017. AREA members can search for keywords in articles or explore themes in publications about enterprise AR using FindAR. FindAR search results are the titles,

¹⁶ https://www.etsi.org/deliver/etsi_gs/ARF/001_099/003/01.01.01_60/gs_ARF003v010101p.pdf

¹⁷ <https://thearea.org/area-research/area-research-agenda/>



abstracts and relevant URL links of full publications, and graphical information about enterprise AR research.

- Past AREA Research Project candidate topics submitted by AREA members.
- AREA members' research interests were gathered while preparing this Research Agenda.
- Research Agenda Project Team members' collective expertise.

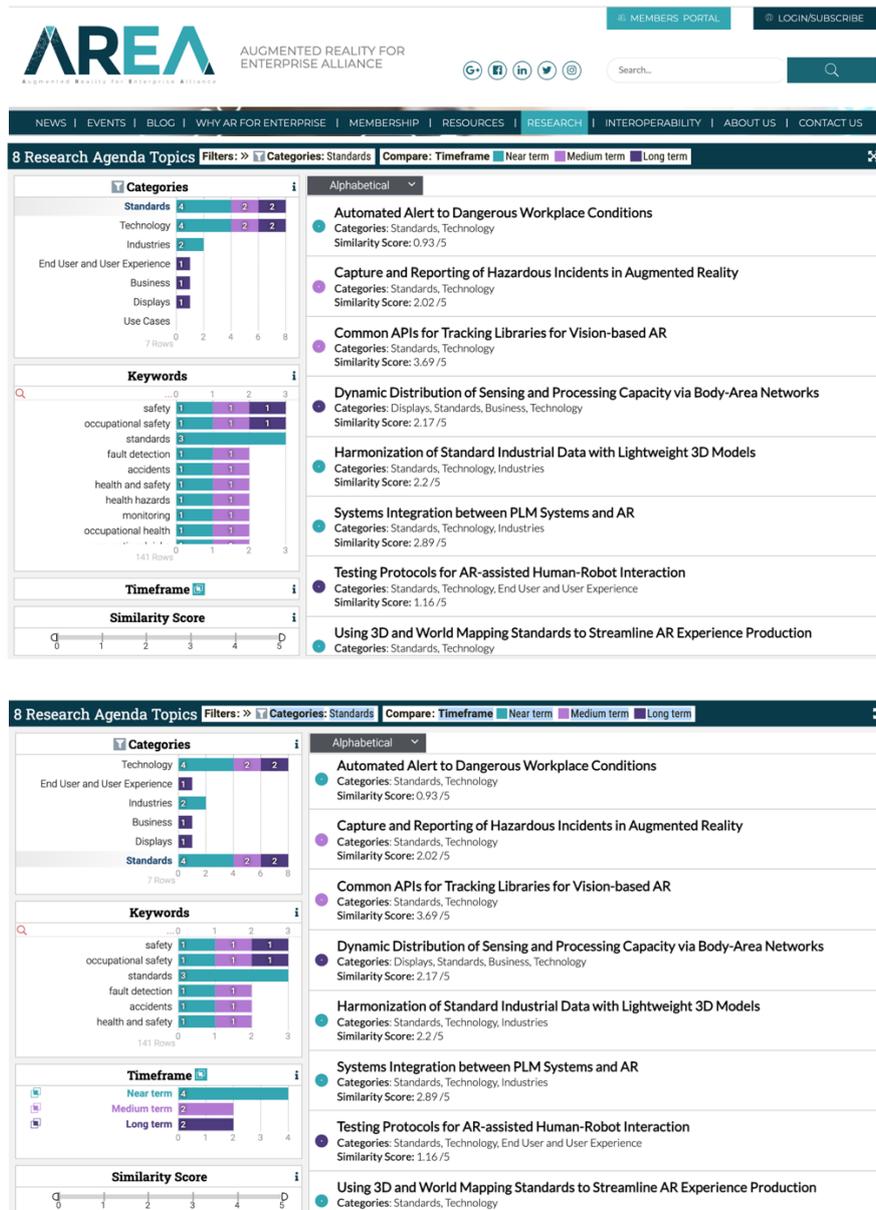


Figure 4: AREA – Augmented Reality for Enterprise Alliance searchable database



5. IEEE ARLEM

Various IEEE projects have focused on advanced manufacturing standardization activities. The integration of technology-based processes in a manufacturing environment helps to automate the production of consistent product quality. “*IEEE Standard for Augmented Reality Learning Experience Model*”¹⁸ (ARLEM) is a recent standard developed to support implementation of AR training systems by providing a comprehensive conceptual model and the corresponding data model specifications for the representation of activities, learning context and environment for AR-enhanced learning activities. It was first approved by the IEEE Standards Association Standards Board in January 2020 and was published later in April. The standard was developed under the Augmented Reality Learning Experience Model (AR-LEM) working group and is still active.

The conceptual model can be used for describing interactions between the user, the physical world, digital information, the context for AR-assisted learning and other parameters of the environment in a standardized interchange format. The standardized interchange format aims to link the learning activities with the environment in which an AR-enhanced training system may perform said activities, thus enhancing the process of writing real-world learning experiences using sensors, computer vision, Internet of Things and web applications.

ARLEM defines two data models and their binding to Extensible Markup Language (XML) and JavaScript Object Notation (JSON) for expressing augmented reality (AR) learning activities and the environment on which they are performed (also known as workplace).

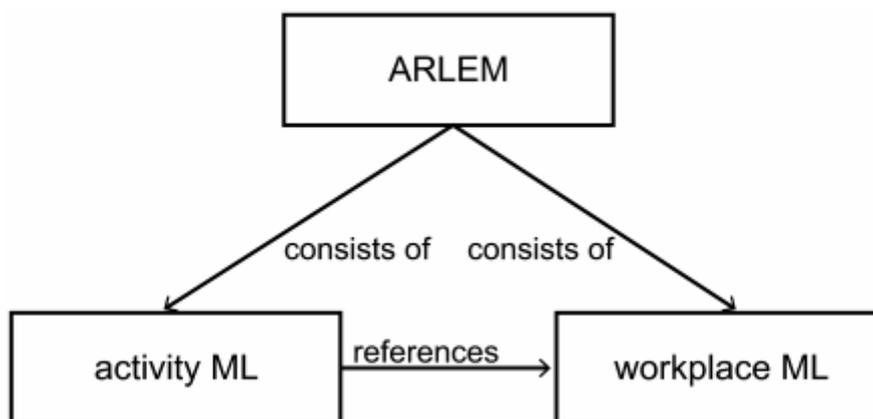


Figure 5: Two modelling languages of ARLEM ([IEEE P1589-2020](#))

¹⁸[IEEE 1589-2020 - IEEE Standard for Augmented Reality Learning Experience Model](#)



Learning activities are a series of descriptions of actions related to learners' interactions with real and virtual objects. A domain-specific “*activity modeling language*” (*activityML*) is used to describe the learning activities. Workplace models provide information about when, where and how an activity will take place, thus they are referenced by the activity models.

Each activity contains the sequence of action steps that need to be followed for its completion along with the metadata that describe the overall activity. Each action step of an activity defines the activation and/or deactivation of the augmentations as well as the triggering mechanisms that activate the change of status from enter to exit. Additionally, each step optionally specifies messages for the communication with other devices handled by the user or other users as well as queries and logic for analysing and reacting to observed user behaviour.

Workplace descriptions consist of data about the real and virtual elements that appear in the experience. The specific workplace language (*workplaceML*) accompanies the activity representation language to achieve the interoperability of applications interpreting *activityML*. Workplaces, describe the tangible things, persons and places as well as the virtual objects in a concrete workplace. Moreover, they describe software and hardware with which interactions may take place, including specifying how specific apps may be launched or which particular delivery devices are supported by the workplace.

Additionally, workplace models define the possible detectables such as markers that can be detected using a computer vision system, overlay primitives, predicates and supported warnings signs. Predicates are reusable instructional augmentations that configure a specific augmentation primitive for its use in activities. An overlay primitive, for example, specifies, how the predicate “rotate” should be visually depicted.

The ARLEM standard distinguishes slowly changing environment data from rapidly changing ones for step-by-step guidance. It supports reuse and repurposing of existing learning content thus facilitating the creation of both experience repositories and online marketplaces for augmented reality learning content. Moreover, it can support interoperability for content used in “mixed” reality experiences that combine real-world guidance with traditional learning material such as video or existing web applications.

The IEEE Standard for Augmented Reality Learning Experience aims to support the discovery, retrieval, transfer and execution of AR-enabled learning content, thus facilitating repositories and open online marketplaces that provide augmented reality learning systems.



Table 7: From the IEEE P1589 working group: Feature-Benefit overview by stakeholders.

Feature	Benefits for end-users	Benefits for content providers	Benefit for service providers to the design and development process
Standard export/Import format	Portability of experience description across vendor platforms: reduces risks, vendor lock-in, and lifetime costs.	Single version runs on all conformant platforms, thus drastically enlarging the market.	Established and powerful way to package content and turn app into server-based app
High-level conceptual model of the experience	Quality content Improves user experience (explain) Enables Evidence-based instructional design (see, e.g., https://3starlearningexperiences.wordpress.com/tag/4c-id/) Supports Cognitive Apprenticeship Engaging user experience Enables practice	Greater ability to create and maintain longer and more complex experiences More rapid development Enables authoring directly by instructional designers Easier re-use of component segments across experiences	Easier implementation
Server-based vs. app-based deployment	Longer, more-complex training experiences	Moving beyond single-purpose apps towards player-like apps	Standard Open Source repository servers available
Performance Analytics	Provides real-time formative feedback	Interfaces with other content standards: xAPI Directly logs meaningful data	Compatible with a wide range of products, links with the other, non-AR learning

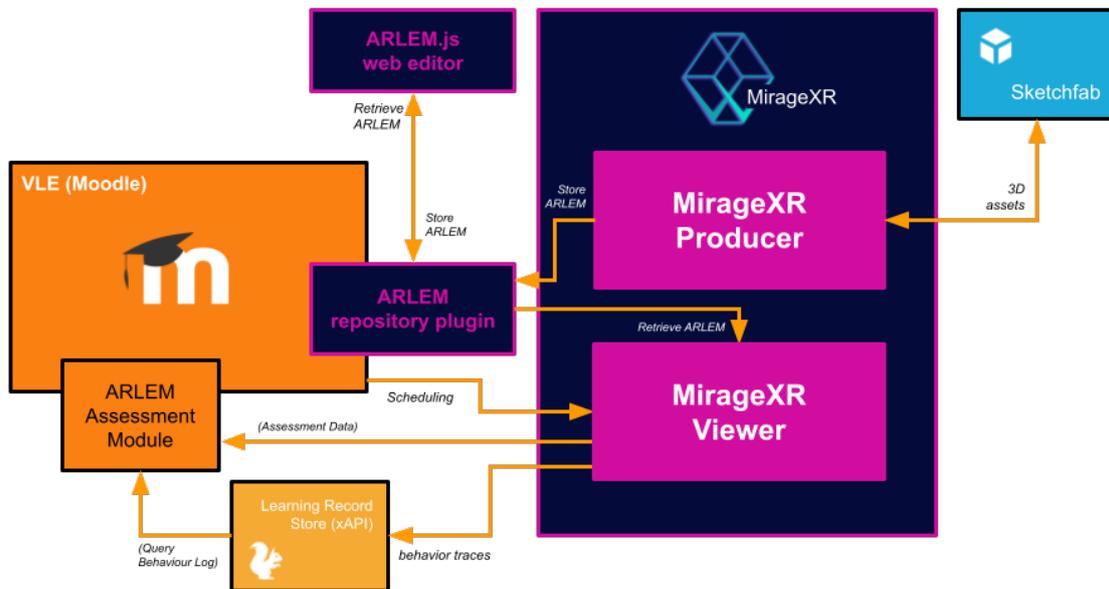


Figure 6: System landscape for IEEE P1589 explained.

6. ARETE Standards' Methodology

The standardization process at CEN/CENELEC is a typical application of the top-down standards development approach described in the previous paragraphs. The different phases are identified as: proposal from relevant national members, technical bodies, the European Commission (EC) or the EFTA secretariat; drafting and consensus building; public enquiry from national members and partner organizations, followed by a formal vote; consideration of comments; approval and final ratification; and finally, publication of the standard and announcement for national endorsement.

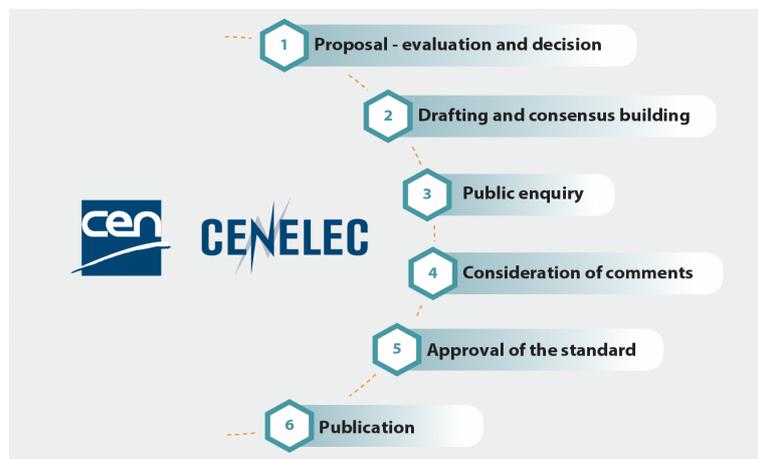


Figure 7: Standardization process at CEN/CENELEC (CEN 2016)



The consortium is liaising with "UNE", which has been the successful bid after European Union tender procedure¹⁹ (Fig. 6). A 'CEN Workshop' promoted by ARETE project is planned for the last months of the project. Such a Workshop is not an event, it is a Working Group aimed to write one or more standards (CWA, CEN-CENELEC Workshop Agreement). The Workshop is open to any interested participant from outside the project, increasing the open collaboration and transparency of the process.

We have predefined the roles in terms of the activities within the "CEN Workshop:

- **UNE:** Secretariat of the group, interaction with CEN-CENELEC, procedural and managerial advice
- **Partners:** Chair (Prof. Dr. Fridolin Wild), will provide technical inputs and contents

Intellectual property of the knowledge is associated with the ARETE partners; of the CWA itself (as a scalable publication): CEN-CENELEC. The final CWA will be freely downloadable from CEN-CENELEC webpage (after a compensation fee 2.368€ paid from the project coordinator - UCD).

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1.1) Name and addresses

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Internet address(es): <http://www.ucd.ie>
Main address: <http://www.ucd.ie>
Address of the buyer profile: <https://irl.eu-supply.com/ctm/Company/CompanyInformation/Index/1222>

Figure 8: ARETE EU Tender

The aim of the Workshop is to develop a CWA observatory report on the state of affairs of XR for learning and performance augmentation. Moreover, it will produce a CWA with a standard for 3D Augmented Reality objects for intensive educational processes, containing a methodology detailing the techniques that should be employed (authoring toolkit, educational assessment), through the different steps to be followed, and with the aim to

¹⁹ <https://irl.eu-supply.com/ctm/Supplier/PublicTenders/ViewNotice/227660>



advance knowledge retention and impact positive behaviour in Schools. The planning for the CEN workshop within the consortium activities is shown in Fig.7

This CWA will not define requirements related to educational aspects. A number of areas will be discussed as sub-topics of this workshop and include:

- Quality of digital 3D educational objects
- AR Learning Experience Model (linking with IEEE P1589)
- Metadata for AR based Learning Experiences, possibly including a LOM application profile
- Learner experience logging, possibly including an xAPI application profile
- Usability and effectiveness of AR based education
- Multi-user communications in AR educational settings
- Educational Data Analytics' advancement with 3D experiences
- Augmented Reality Authoring toolkit for educational purposes
- Ethical policy for XR Education
- Safe handling of smart glasses in education (linking with the according ISO initiative)
- Cleaning protocols for smart glasses in education Adaption of LOM in 3D learning experiences
- AR education cloud (linking with the OpenAR Cloud initiative)

The Workshop Agreement is the proposed approach in the CEN/CENELEC framework due to the following advantages:

- Agility: The time frames for the other standardization options do not match the planned schedule for this project.
- The Workshop Agreement provides the sought acknowledge of the industry across the EU by submitting the technical specification to the workshop process providing openness in process and visibility to all market players.
- The Workshop Agreement assures the involvement of the industry (laboratories, AR component and manufacturers, integrators, application developers) as the workshop is open to anyone, including non-European participants. The opportunity to participate is widely advertised in advance by CEN/CENELEC and its member bodies.
- The Workshop Agreement guarantees that the different views of the stakeholders interested in the document are considered.
- The Workshop Agreement ensures availability of information to all parties, enquiry among participants, involvement of CEN/CENELEC members during acceptance, and in summary a fully open and transparent process.



Activity description	Time	Place	Duration
Observatory report in ARETE	M26: Dec 2021		
Announcement of the CEN/WS on CEN website and call for experts	January 2022	N/A	90 days
CEN/WS Kick Off Meeting	Beginning of March 2022 online		
Extended observatory CWA	End of March 2022 - deliverable		
Consultation with WG			
First draft of the CWA deliverable circulation for comments (Standard of Standards: a holistic model)	April 2022	N/A	30 days
CEN/WS 2nd Plenary Meeting	June 2022 (GA) - Blended	Dublin, Ireland (& online if travel restrictions apply)	1 day
Approval of Draft of the CWA deliverable circulation for comments	August 2022	N/A	30 days
Outreach at Online Educa Berlin	December 2022		
Public commenting phase & Consultation via EUN with education ministerial representatives	September-October 2022	N/A	30 days
Publication of CWA deliverable after editorial check	December 2022	N/A	N/A
Candidate: ARLEM 2.0 / ARLEM 1.0 recognition (Technical)			
Candidate: xAPI Learning Analytics for AR (Application Profile) (Technical)			
Candidate: LOM extension (Technical)			
Candidate: XR Ethics for education (White Paper)			

Figure 9: ARETE CWA planned time frame



The table below includes the description of the expected activities to be implemented by UNE. They are organized in the following four groups: i) before setting up the Workshop; ii) during the development of the CWA; iii) after the CWA; and iv) horizontal aspects for the duration of ARETE.

Table 8: Expected Activities from UNE

BEFORE SETTING UP THE WORKSHOP
<ul style="list-style-type: none">● Support in the preparation of the project plan (such as assistance in refining the scope of the CWA and identifying the links with CEN TCs);● Support in carrying out a self-assessment as indicated in CEN/CENELEC Guide 29 Annex A;● Presentation to consortium partners on the CWA workshop preparation;● Ensure consistency of the project plan with the CEN framework (including Intellectual Property related issues);● Support in submitting the project plan to CEN
DURING THE DEVELOPMENT OF THE CWA
<ul style="list-style-type: none">● Assisting in the preparation and conduct of approximately four physical meetings and the web-based work on the CWA between Month 10 and Month 31 of ARETE project;● Support in identifying and inviting all the interested parties to the kick-off meeting;● Provide the template to be used for drafting the CWA;● Support the drafting of the CWA, e.g. in the referencing to relevant standards;● Provide an online tool to the Workshop to exchange working documents during the drafting phase;● Facilitate the gathering and dissemination of written comments on the draft CWA from the workshop members between each meeting (both physical and web based) of the workshop;● Support the project coordinator during all the meetings following the kick-off meeting, in particular in resolving the comments received and preparing the protocols of each meeting;● Produce a short meeting report after each meeting related to standards and CWA development;● Maintain the list of registered Workshop participants;● Maintain the meeting schedules and arrange the physical meeting locations in collaboration with the project coordinator and the general assembly;● Distribute the agenda and other documents for the Workshop meetings to the ARETE consortium partners;● Ensure the timely availability of the working documents for the meetings;● Ensure that the CWA is available in time on the appropriate CEN format;● Interface with the CEN-CENELEC Management Centre (CCMC) regarding strategic issues, problems arising, external relationships, etc.;● Upon request of the contractor, assist in carrying out a public consultation period (open commenting phase);● Ensure the creation of a comments resolution report that compiles all the received comments, if applicable;● Assist in submitting the approved CWA to CCMC ensuring that the format complied with CEN/CENELEC rules;● Assist with the necessary arrangements to make the CWA public.
AFTER THE CWA



A CWA is valid for 3 years, after which the Workshop Secretariat shall consult the Workshop participants and the relevant CEN/CENELEC technical bodies to determine whether the CWA shall be: confirmed for another 3 years; revised; transformed into another deliverable or withdrawn. The Workshop Secretariat shall inform CEN/CENELEC Management Centre (CCMC) of the decision.

Horizontal aspects for the duration of ARETE project

- Provide advice on the procedures, rules and dissemination of the work
- Flag to workshop participants in case the workshop Secretariat is made aware of any provisions going against European Standards.

We have already prepared a draft of the Project Plan for the CEN or CENELEC Workshop on “**eXtended Reality (XR) for Learning and Performance Augmentation – XR-LPA**”, which will be circulated to all interested parties and stakeholders publicly in 2022.

Summary

The motivation for the creation of the Workshop is foremost the dissemination of the RIA activities within the ARETE project. The resulting CWA will contain a methodology for educational providers to enable a common European disruptive educational approach and thus the possibility of sharing 3D content. It can also be used for investors to properly allocate resources to 3D content infrastructure. It is not intended to be used for certification purposes. In the framework of the research project ARETE, funded by the H2020 Program of the European Commission, existing standards were analysed regarding their ability to support the concept of 3D educational content platform. Identified gaps in these standards will be reported to the responsible technical body. But there are areas, identified as being critical for the success of a disruptive educational platform economy, not covered by the work program of existing European standardization/technical bodies. ARETE will support European companies to create and operate networks to address the needs for customisation and production of educational 3D content. The main objectives are:

- To foster the growth of a pan-European XR education and training ecosystem that enables the transition from silo subject-based to standardized content production with network effects
- To provide a unified methodology through which new and existing users can simply and seamlessly access the full range of services provided
- To support developers to create digital tools/services of direct added value to educational content
- To extend and align existing educational marketplace functionalities
- To avoid the fragmentation of European educational provision
- To establish standardized, industry-relevant platform architectures

The CWA is to be used by educational providers to establish targets for XR learning content services provided and boost resilience of the XR learning and performance augmentation infrastructure. It can be used to ensure that there is complete and systematic way of setting service for teaching and learning anytime anywhere with 3D experiences.