IEC TR 63614-3

Edition 1.0 2026-03

TECHNICAL REPORT

Multimedia systems and equipment for metaverse -
Part 3: Gap analysis

ICS 33.160.60

ISBN 978-2-8327-1082-1

IEC TR 63614-3:2026-03(en)

IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, …). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch
Discover our powerful search engine and read freely all the publications previews, graphical symbols and the glossary. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

Multimedia systems and equipment for metaverse - Part 3: Gap analysis

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at https://patents.iec.ch. IEC shall not be held responsible for identifying any or all such patent rights.

IEC TR 63614-3 has been prepared by IEC technical committee TC 100: Audio, video and multimedia systems and equipment. It is a Technical Report.

The text of this Technical Report is based on the following documents:

Draft	Report on voting
100/4408/DTR	100/4437/RVDTR

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this Technical Report is English.

A list of all parts in the IEC 63614 series, published under the general title *Multimedia systems and equipment for metaverse*, can be found on the IEC website.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

– reconfirmed,
– withdrawn, or
– revised.

INTRODUCTION

The term "metaverse" originated from the science fiction novel "Snow Crash," combining "meta" and "universe." It refers to a digital-based virtual world that extends the boundaries of the real world, allowing users to engage in various activities, including imagination and fantasy, within the virtual space. In the viewpoint of content/platform/network/device, the metaverse can also be defined as a technology in which a user (using a metaverse device) can access (through network) a virtual space (a metaverse platform) and experience all activities (metaverse contents) through an avatar.

At the time of writing, the global industrial metaverse market is experiencing significant growth. It is noted that the metaverse can be implemented and realized with multimedia systems and equipment. Accordingly, there is a crucial need for standardization on the subject of metaverse in IEC TC 100 as a leading standardization group in the area of multimedia systems and equipment.

The IEC 63614 series consists of the following parts:

– Part 1: General;

– Part 2: Classification; and

– Part 3: Gap analysis.

IEC TR 63614-1 [1] describes general considerations to be taken for standardization on multimedia systems and equipment for metaverse.

IEC TS 63614-2[2] describes the classification of metaverse in terms of C (contents), P (platform), N (network), D (device).

IEC TR 63614-3 (this document) describes the gap analysis for the existing standards on metaverse and the services/products in the metaverse-related industry.

[1] Under preparation. Stage at time of publication: IEC DTR 63614-1:2025

[2] Under consideration.

1 Scope

This document describes the gap analysis for metaverse systems and equipment, including examination of existing standards and services/applications within the metaverse domain. The analysis includes a comprehensive review of developments in various Standards Development Organizations (SDOs) and the relevant industry.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

– IEC Electropedia: available at https://www.electropedia.org/
– ISO Online browsing platform: available at https://www.iso.org/obp

3.1 Terms and definitions

No terms and definitions are listed in this document.

3.2 Abbreviated terms

AI	Artificial intelligence
AR	Augmented reality
API	Application programming interface
CPND	Content, Platform, Network, Device
DLT	Distributed ledger technology
glTF	Graphics Library Transmission format
HMD	Head-mounted display
ICT	Information and communication technology
IIDL	Interaction Information Description Language
IoT	Internet of Things
LAE	Live actor and entity
MAR	Mixed and augmented reality
MMORPG	Massively multiplayer online role-playing games
MR	Mixed reality
MTP	Motion to photon
NFT	Non-fungible token
NPC	Non-player character
OME	Object management entity
QoE	Quality of experience
SDK	Software development kit
SDO	Standard Development Organization
UI/UX	User interface/User experience

USD	Universal Scene Description
VR	Virtual reality
VRM	Virtual reality modelling
vSRT	Vision-based spatial registration and tracking

4 Analysis of existing standards on metaverse systems and equipment

4.1 Consideration for analysis

4.1.1 General

In this document, the CPND concept, one of the classifications of IEC TS 63614-2[3], is adopted to classify existing standards related to the metaverse. In the CPND concept, Content, Platform, Network, and Device each have the following meanings:

– Content: Within the metaverse, content refers to various experiences, environments, and services available to users. This spans the spectrum, encompassing user-generated content to a myriad of activities and services seamlessly offered within virtual worlds.

– Platform: The metaverse platform seamlessly consolidates content hosting, service delivery, and development tools, offering a comprehensive ecosystem. These platforms prioritize openness, ensuring flexibility and accessibility for both creators and users, thereby cultivating an environment that frequently sparks innovation and collaboration.

– Network: At the heart of the metaverse lies a high-speed, seamless communication network, constituting the essential foundation. This necessitates real-time connectivity bridging the virtual and physical realms, demanding cutting-edge communication technologies such as 5G or 6G to facilitate swift and efficient data transfer and interaction.

– Device: Within the realm of metaverse, devices encompass a diverse array of hardware, ranging from wearables to conventional virtual reality (VR) and augmented reality (AR) devices. This assortment of devices simplifies the user experience, providing effortless access and interaction with the expansive metaverse landscape.

4.1.2 Content

Content comprises technical elements aimed at delivering diverse virtual experiences and interactions to users in the metaverse. This encompasses not only content provided by service providers within virtual worlds but also user-generated content, spanning various forms of media, data, and interactions. Key technologies driving metaverse content include VR and AR, 3D modelling and animation, artificial intelligence (AI) and machine learning, user-generated content, distributed ledgers, and blockchain. These technologies, coupled with real-time communication, form the technological backbone of metaverse content.

VR and AR emerge as pivotal technologies within the metaverse, seamlessly blending the real and virtual worlds to offer users unparalleled experiences unattainable in reality. VR immerses users in entirely virtual worlds, achieved through VR headsets or bodysuits that block out the surroundings. On the other hand, AR enhances reality by overlaying virtual information or content onto the real world. Users typically engage with AR through smartphones, AR devices, or smart glasses. This synthesis of technologies underscores the dynamic landscape where the metaverse unfolds.

[3] Under consideration

4.1.3 Platform

Platform serves as a technological ecosystem where users engage in virtual interactions, share content, and play a pivotal role in delivering diverse services and experiences within the metaverse. This platform shapes the metaverse environment by seamlessly integrating functions such as hosting metaverse content, service provision, and user-customizable development tools. Facilitating a collaborative atmosphere, the open metaverse platform accommodates various content types, ranging from 3D models to virtual worlds and user-generated content.

Emphasizing openness and characteristics conducive to collaboration, the metaverse platform enables the active participation of developers and content creators, fostering the creation of novel ideas and experiences. This inclusivity extends beyond the offerings of the platform company, allowing users to immerse themselves in creative content generated by a multitude of contributors. To facilitate such creativity, the metaverse platform would aspire to offer an array of development tools and APIs, supporting content creators in the seamless development and integration of their contributions.

4.1.4 Network

Network infrastructure associated with the metaverse serves as a critical component, facilitating real-time connections between the virtual and real worlds. These networks play a pivotal role in enabling users to seamlessly engage, share content, and access a myriad of services within the virtual worlds. The metaverse demands a high-speed network environment, with a specific emphasis on advanced communication technologies like 5G and 6G. These technologies are instrumental in supporting rapid data transmission and fostering real-time interactions across the virtual and physical realms.

Security and personal information protection emerge as paramount considerations within the metaverse network. Given that users participate in social activities involving the exchange or sale of personal digital assets, safeguarding user data becomes imperative. Robust security technologies and encryption play a pivotal role in this endeavour, with blockchain technology being actively employed to fortify the protection of user data through its inherent security features. In pursuit of transparency and effective management of content ownership and transactions, some platforms leverage distributed ledgers and blockchain technology. These innovations provide a clear and secure framework for tracking ownership and facilitating transactions within the dynamic metaverse landscape.

4.1.5 Device

Devices for the metaverse encompass the hardware essential for users to partake in VR and AR experiences, serving as conduits to transmit users' senses into the virtual world and facilitate interaction. This category comprises VR, AR, and mixed reality (MR) equipment, alongside an array of wearable devices and full-body VR equipment. VR equipment serves to immerse users in the virtual world by isolating them from the real world, while AR equipment overlays virtual information onto the real world, aiding users in navigating their surroundings. Users engage with the metaverse by manipulating virtual objects within the real world. Notably, several gaming companies have introduced full-body VR devices, enhancing immersion through comprehensive tracking and reflection of the user's entire body movements. The utilization of sensors, cameras, and body suits is common in this setup, ensuring accurate tracking of the entire body for a heightened and immersive experience.

4.1.6 Standard Development Organizations (SDOs) for analysis

This document comprehensively addresses 131 metaverse-related standards, either published or in progress, across 6 Standard Development Organizations (SDOs): IEC, ISO, ISO/IEC JTC 1, ITU, IEEE SA, and IETF. As illustrated in Figure 1, using the CPND classification to analyse these standards, the findings reveal that 52 standards fall under Contents, 12 under Platform, 24 under Network, and 33 under Device. Additionally, there are 10 inclusive standards that align with general categories.

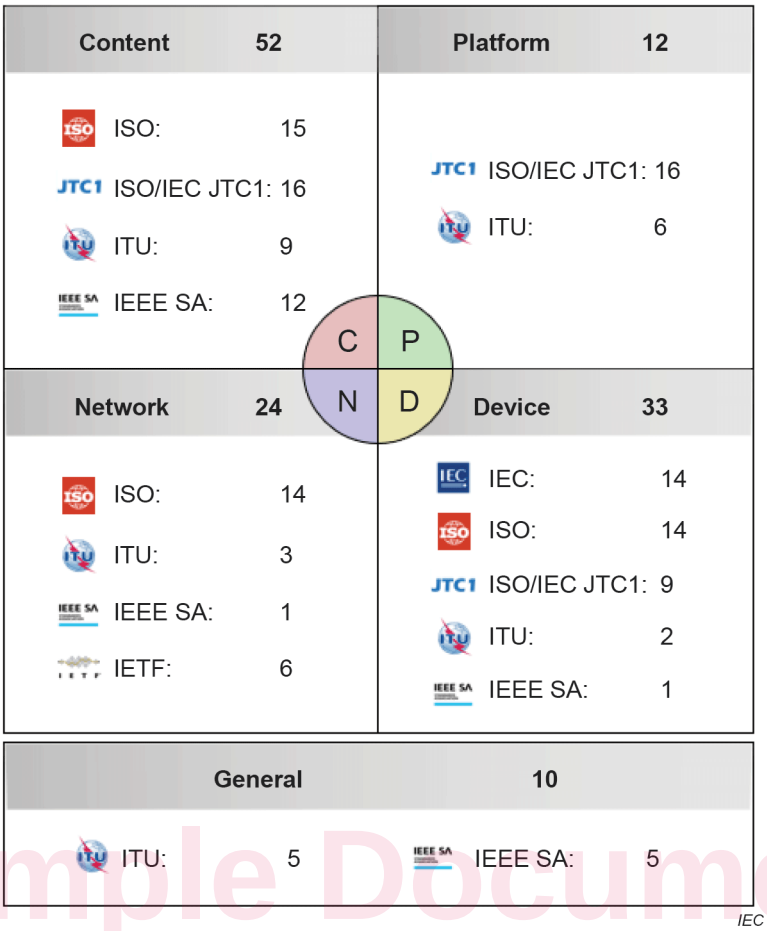

Figure 1 – Classification of standards on metaverse by many SDOs

4.2 Content

4.2.1 International Organization for Standardization (ISO)

ISO primarily focuses on developing standards for content applicable within the metaverse, rather than directly addressing metaverse-related standards. Notable instances include ongoing virtual simulation work within TC 8/SC 1 and TC 22/SC 36, along with the prominent development of digital fitting standards within TC 133.

Digital fitting, a key outcome of the efforts of TC 133, involves leveraging digital technology to virtually try on or create items like clothing and accessories. This innovative technology seamlessly merges the conventional in-store shopping experience with a digital realm, allowing consumers to preview the fit and style of a product in a virtual space beforehand. Within TC 133, various terms essential to digital fitting systems are defined, encompassing virtual fabric simulations, virtual fabric properties, virtual clothing patterns, virtual clothing pattern properties, virtual seam lines, virtual clothing, and virtual human body models for conformity evaluation. Furthermore, TC 133 provides valuable guidance for establishing service processes, catering to both online and offline retailers and 3D shopping platform developers, facilitating the distribution of digital fitting experiences.

The ISO 23247 series, originating from TC 184/SC 4, establishes a comprehensive digital twin framework tailored for the manufacturing sector. This series features a well-defined reference architecture incorporating both domain and entity perspectives. Within this framework, functional entities are presented, underpinned by a meticulously designed entity-based reference model, providing clarity and structure. The series further outlines essential information properties for object management entities (OMEs), offering practical examples and encompassing relevant standards. Additionally, it pinpoints precise technical requirements for information exchange across diverse networks within its purview, including user, service, access, and proximity networks. These networks intricately connect entities within the digital twin framework, ensuring a seamless and interconnected ecosystem. Table 1 presents a list of standard documents on metaverse content developed by ISO.

Table 1 – Metaverse Content classification standards developed by ISO

No.	TC	Document	Title
1	TC 8/SC 1	ISO 5476	*Ships and marine technology - Virtual reality and simulation training systems for lifesaving appliances and arrangements*
2	TC 22/SC 36	ISO/TR 21934-1	*Road vehicles - Prospective safety performance assessment of pre-crash technology by virtual simulation - Part 1: State-of-the-art and general method overview*
3	TC 133	ISO 18163	*Clothing - Digital fittings - Vocabulary and terminology used for the virtual garment*
4	TC 133	ISO 18825-1	*Clothing - Digital fittings - Part 1: Vocabulary and terminology used for the virtual human body*
5	TC 133	ISO 18831	*Clothing - Digital fittings - Attributes of virtual garments*
6	TC 133	ISO/TS 3736-1	*Digital fitting - Service process - Part 1: Ready-to-wear clothing online and offline*
7	TC 133	ISO/TS 3736-2	*Digital fitting - Service process - Part 2: Customized clothing online and offline*
8	TC 133	ISO 20947-1	*Performance evaluation protocol for digital fitting systems – Part 1: Accuracy of virtual human body representation*
9	TC 133	ISO 20947-2	*Performance evaluation protocol for digital fitting systems – Part 2: Virtual garment*
10	TC 133	ISO 20947-3	*Performance evaluation protocol for digital fitting systems – Part 3: Digital fitting performance - Gap*
11	TC 184/SC 4	ISO 23247-1	*Automation systems and integration - Digital twin framework for manufacturing - Part 1: Overview and general principles*
12	TC 184/SC 4	ISO 23247-2	*Automation systems and integration - Digital twin framework for manufacturing - Part 2: Reference architecture*
13	TC 184/SC 4	ISO 23247-3	*Automation systems and integration - Digital twin framework for manufacturing - Part 3: Digital representation of manufacturing elements*
14	TC 184/SC 4	ISO 23247-4	*Automation systems and integration - Digital twin framework for manufacturing - Part 4: Information exchange*
15	TC 184/SC 4	ISO/TR 24464	*Visualization elements of digital twin – Visualization fidelity*

4.2.2 ISO/IEC Joint Technical Committee (JTC) 1

ISO/IEC JTC 1/SC 24 establishes standards for "Computer graphics, image processing, and environmental data representation," with a scope that encompasses computer graphics, image processing, virtual reality, augmented reality, mixed reality, environmental data representation, and information visualization and interaction.

ISO/IEC 3721 specifically defines the information model for mixed and augmented reality content – core objects and attributes. ISO/IEC 3721 encompasses a virtual reality scene graph, physical objects designed for augmentation, and constructs for expressing associations between physical and virtual objects in the mixed and augmented reality (MAR) scene.

ISO/IEC 9234[4] outlines guidelines for developing education and training systems utilizing virtual reality (VR), augmented reality (AR), and mixed reality (MR) technologies. It establishes an information modelling framework for VR/AR/MR-based systems and provides procedures compliant with ISO/IEC JTC 1 standards for developing 3D VR/AR/MR-based education and training systems.

ISO/IEC 18520 defines a reference framework for benchmarking mixed and augmented reality (MAR) vision-based spatial registration and tracking (vSRT) methods.

ISO/IEC 20538[5] defines a human information data model tailored for VR-based smart cities. It incorporates concepts, data models, and integration methods for combining sensor-related information from individuals with a 3D virtual world. ISO/IEC 21145 focuses on the visual augmentation style in MAR, defining various styles of augmentation and presentation, with a specific emphasis on visual style in this context.

ISO/IEC 23488 introduces an image-based representation model meticulously designed for accurately and efficiently representing target objects or environments in graphics, virtual reality, and mixed reality applications. It encompasses terms for image-based representation and 3D reconstruction techniques, outlines essential elements for image-based representation, and details a method for representing the real world in virtual space using images.

ISO/IEC JTC 1/SC 29 focuses on the "Coding of audio, picture, multimedia, and hypermedia information" and develops standards pertaining to the efficient coding of digital representations of images, audio, and moving pictures, as well as the efficient coding of other digital information and digital information support. Notably, standards relevant to the metaverse within this scope encompass ISO/IEC 23000-13, ISO/IEC 23090-14, and ISO/IEC 23090-24. These International Standards articulate an extension to the existing scene description format, specifically tailored to support MPEG media for immersive metaverse content.

Moreover, ISO/IEC JTC 1/SC 36 is actively progressing on a standard related to Information Technology for learning, education, and training. The objective is to delineate considerations for using and creating content in virtual reality, alongside presenting a catalogue model for virtual, augmented, and mixed reality content. Simultaneously, ISO/IEC JTC 1/SC 41 primarily specializes in developing standards for digital twin technology, a cornerstone element of the metaverse. Table 2 presents standard documents related to metaverse content developed by ISO/IEC JTC 1.

---

4 Under preparation. Stage at time of publication: ISO/IEC FDIS 9234:2025.

5 Under preparation. Stage at time of publication: ISO/IEC FDIS 20538:2025.

Table 2 – Metaverse Content classification standards developed by JTC1

No.	SC	Document	Title
1	JTC 1/SC 24	ISO/IEC 3721	*Information technology - Computer graphics, image processing and environmental data representation - Information model for mixed and augmented reality content - Core objects and attributes*
2	JTC 1/SC 24	ISO/IEC 9234	*Information technology - Information modelling for VR/AR/MR based education and training systems*
3	JTC 1/SC 24	ISO/IEC 18520	*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)*
4	JTC 1/SC 24	ISO/IEC 20538[6]	*Human information data model for VR smart cities*
5	JTC 1/SC 24	ISO/IEC 21145	*Information technology - Computer graphics, image processing and environmental data representation - Style representation for mixed and augmented reality*
6	JTC 1/SC 24	ISO/IEC 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)*
7	JTC 1/SC 29	ISO/IEC 23000-13	*Information technology - Multimedia application format (MPEG-A) - Part 13: Augmented reality application format*
8	JTC 1/SC 29	ISO/IEC 23090-14	*Information technology - Coded representation of immersive media - Part 14: Scene description - Amendment 2: Support for haptics, augmented reality, avatars, Interactivity, MPEG-I audio, and lighting*
9	JTC 1/SC 29	ISO/IEC 23090-24	*Information technology - Coded representation of immersive media - Part 24: Conformance and reference software for scene description - Amendment 1: Conformance and reference software for scene description on haptics, augmented reality, avatars, interactivity and lighting*
10	JTC 1/SC 36	ISO/IEC TR 18121	*Information technology - Learning, education and training - Virtual experiment framework*
11	JTC 1/SC 36	ISO/IEC TR 23842-1	*Information technology for learning, education and training - Human factor guidelines for virtual reality content - Part 1: Considerations when using VR content*
12	JTC 1/SC 36	ISO/IEC TR 23842-2	*Information technology for learning, education, and training - Human factor guidelines for virtual reality content - Part 2: Considerations when making VR content*
13	JTC 1/SC 36	ISO/IEC TR 23843	*Information technology for learning, education and training - Catalogue model for virtual, augmented and mixed reality content*
14	JTC 1/SC 36	ISO/IEC TR 23844	*Information technology for learning, education, and training - Immersive content and technology*
15	JTC 1/SC 41	ISO/IEC TR 30172	*Internet of Things (IoT) - Digital Twin - Use cases*
16	JTC 1/SC 41	ISO/IEC 30173	*Digital Twin - Concepts and terminology*

[6] Under preparation. Stage at time of publication: ISO/IEC DIS 20538:2025.