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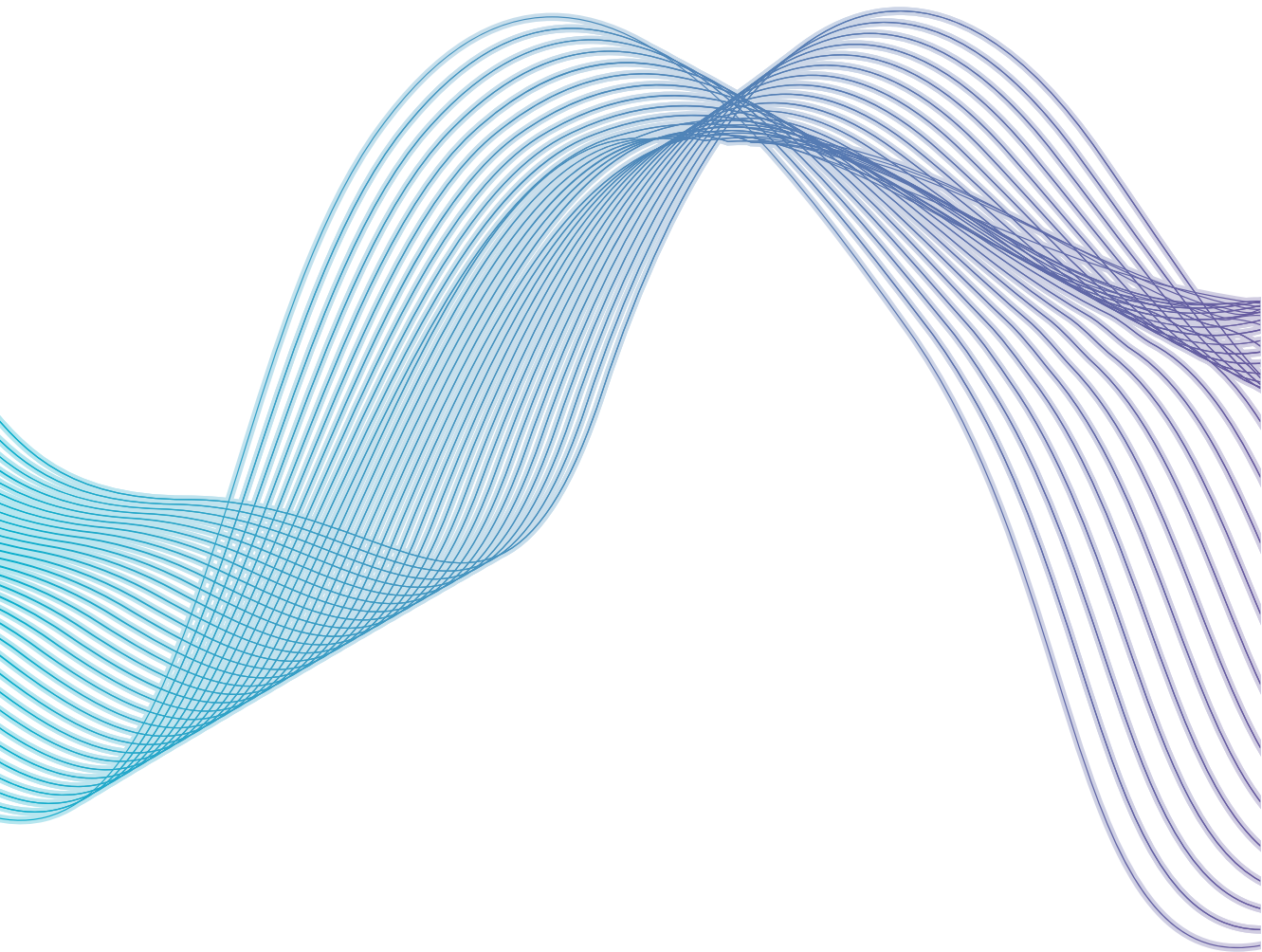
## Report of TWG Digital Twin: **Landscape of Digital Twin Standards**

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# ■ Introduction

Digital Twins represent one of the most novel and promising concepts within the general trend of digital transformation. They are a distinctly 21st century invention. The term is attributed to Prof. Michael Grieves of the University of Michigan in 2002, and the approach was adopted in particular by NASA around 2010. The concept has proved very powerful and has now been universally used across domains, and yet we have only scratched the surface of what they can or should do. While the current generation of digital twins are replicas of existing entities in the physical world, future twins will help design or invent things that have not yet been realized, bridging the gap to virtual reality.



As befits such a new approach, the definition of digital twins is not quite stable yet, and standards are only barely emergent. While Wikipedia defines a digital twin as “a virtual representation that serves as the real-time digital counterpart of a physical object or process,” various organizations have attempted to add more precision to the definition. The Digital Twin Consortium’s definition is “a virtual representation of real-world entities and processes, synchronized at a specified frequency and fidelity.” This is a more operational definition – one that insists on the nature of the link between the two twins – the digital one and the physical one. It has the merit of explaining that a digital twin is not just a simulation model – there are data and/or commands that get sent by one twin to the other.



Whenever a new technology emerges, standards are often at first controversial. They are seen as premature – potentially interfering with the exploratory nature of the new idea, and limiting the freedom of companies, especially technology suppliers, to invent and patent new intellectual property. Over time, the ideas and mechanisms that contribute to the technology tend to stratify: there is a layer of foundational components whose standardization increasingly appears useful to all parties, because such standards reduce the “friction” in the development of useful systems. For example, a multiplicity of data formats impedes the ingestion, combination, and processing of information. Conversely, the application level remains the one at which competition creatively rages and standardization continues to be considered harmful.



Digital twins have not even reached the point at which *specific, normative* standard specifications have emerged for components of the technology proper. However, there is a “primordial soup” of standards related to supporting technologies (systems modeling, security, communication protocols, data formats, etc.), as well as glossaries, guidelines, papers and reports that all serve to inform the work of developers and users of digital twins. Building a landscape of these documents is therefore a useful and timely endeavor – as long as the reader keeps in mind that this is a rapidly evolving situation and that this landscape will certainly need to be updated in a few years’ time. The interaction between twins is likely to be a fertile ground for the development of new technologies, and ultimately of new standards.

In creating this landscape, the authors and editors had to make sense not only of the large number of documents that seemed worthy of inclusion (over 250 items), but also of the multi-faceted taxonomy of these documents. In a linear report, it is hard to clearly expose the various dimensions of classification: by country or region, by originating body (ISO, national standards bodies, other standards development organizations, consortia, individual companies), by type of document (actual standard, report, paper, web page, etc.), and by industrial sector (manufacturing, construction, etc., or cross-sector). The editors of this landscape have provided indices to help the reader navigate through this complex web of information. They reflect the complex domain maze (see figure 1) and the complex integration maze (see figure 2). Future versions of this landscape may bring more classification, grouping, and analysis of current and future standards. We hope that the content of the landscape, as well as the way it is presented, will meet the needs of a broad range of actors, from industry and government alike, in the European Union and elsewhere.

**Antonio Kung, Claude Baudoin, Karim Tobich**



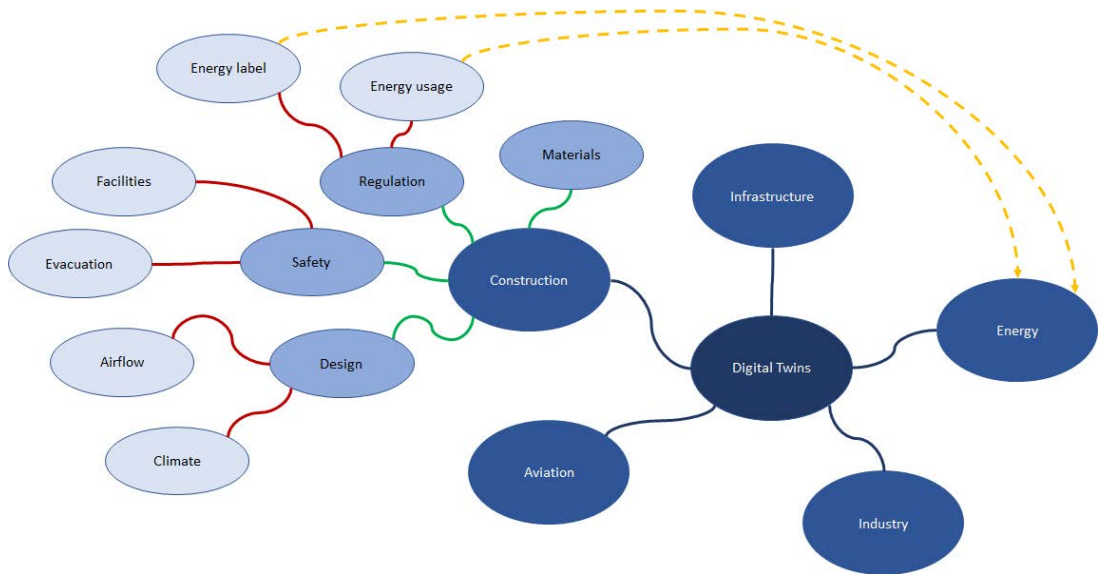


Figure 1 - The digital twin domain maze

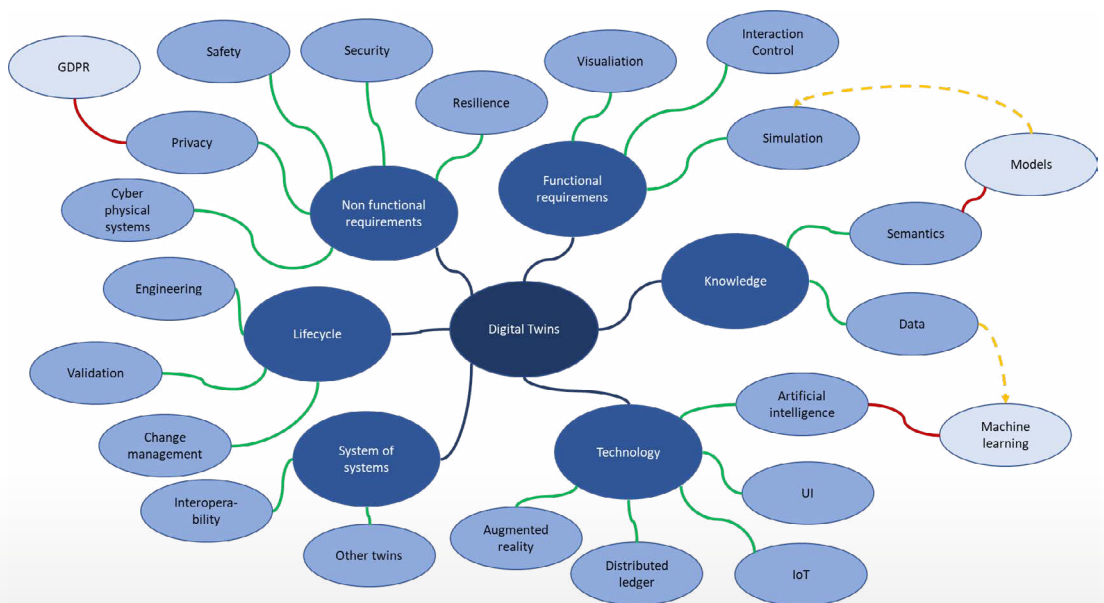


Figure 2 - The digital twin integration maze



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# ■ Foreword

As for most cutting-edge digital technologies (such as Cloud-Edge Continuum, Edge Intelligence, Artificial Intelligence, Machine Learning, Internet of Things, etc), Digital Twins – the constantly evolving digital replicas of the many environments surrounding us – sit at the forefront of the transformation of multiple areas of our society, by creating opportunities for a seamless interaction between physical and digital environments.

Pioneered in the aerospace industry, the use of Digital Twins is nowadays commonplace in our overall ecosystem: from research and innovation, to engineering and manufacturing, to supporting the digital transformation of energy, mobility, or agriculture, to smart cities and communities, buildings and construction, health care, environment and cultural heritage, etc.

Digital Twins are key in predicting manufacturing flaws in industrial models and forecasting usage and maintenance, with both improving efficiency and reducing costs. In the energy sector, they are used to better understand the interaction between the grid elements and to make better decisions, while accommodating topology changes brought into play by distributed energy sources and renewables, as well as electric vehicles. The use of Digital Twins in agriculture ensures productivity growth, food quality and overall production efficiency improvement. The Local Digital Twins will enable the next phase of smart and sustainable cities and communities. Moreover, Digital Twins will prove instrumental in developing a highly accurate digital model of the Earth to monitor, model and predict natural and human activity, and develop and test scenarios for more sustainable development. This has the potential to bring numerous positive societal effects, among which the possibility to predict natural disasters and the resulting socio-economic crises.

Digital Twins make our physical and digital worlds converge, they have high potential to facilitate the cross-sector integration and data sharing, and they can therefore play an important role in helping the European society and economy to successfully achieve their twin green and digital transformation. Supporting the development of Digital Twins is part of the European Commission's priorities, with substantial co-funding being available via its Horizon Europe and Digital programmes.

However, as outlined in the JRC Technical Report «*Destination Earth - Survey on "Digital Twins" technologies and activities, in the Green Deal area*» for the implementation and effective use of Digital Twins there is still a need to unify data standards and to share data models, as well as to establish collaborative forums to promote this work.

We therefore welcome the StandICT.eu 2023 Landscape Report on Digital Twin, which provides an exhaustive mapping of international standards with a thorough classification of related documents, originating bodies, and industrial domains. This is the fruit of the valuable activities carried out by the Technical Working Group on Digital Twins and will be crucial to stimulate thought leadership around standardization efforts in relation to Digital Twins, as well as to contribute to relevant policy initiatives.



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1 [Destination Earth - Publications Office of the EU \(europa.eu\)](#)

# ■ Table of Contents

<b>Introduction .....</b>	<b>1</b>
<b>Acknowledgements .....</b>	<b>3</b>
<b>Foreword .....</b>	<b>4</b>
<b>Landscape of Standards   Standardisation Documents.....</b>	<b>16</b>
<b>Horizontal / Cross-Domain .....</b>	<b>17</b>
Guideline   IIC   Global Industry Standards for Industrial IoT .....	17
Guideline   IIC   IoT Security Maturity Model (SMM) v1.2 .....	17
Landscape   Digital twin hub   A Survey of Industry Data Models and Reference Data Libraries.....	17
Landscape   Digital twin hub   Information Management Framework (IMF).....	17
Landscape   IBM Digital twin exchange .....	18
Landscape   ISG ZSM   ETSI GR ZSM 004 V2.1.1 (2022-01): Landscape .....	18
Report   AMRC   Untangling the requirements of a Digital Twin .....	18
Report   Azure Digital Twins documentation.....	18
Report   Digital twin hub   The Gemini Principles .....	18
Report   DTC   Digital Twin Capabilities Periodic Table .....	19
Report   DTC   Digital Twin Core: Essential Elements for Optimal/ Expansive Interoperability .....	19
Report   DTC   Digital Twin System Interoperability Framework .....	19
Report   DTC   DT Vocabulary.....	19
Report   DTC   Infrastructure Digital Twin Maturity: A Model for Measuring Progress .....	19
Report   ETRI   Characterization of digital twins.....	20
Report   ETRI   Digital Twin maturity model .....	20
Report   IIC   Digital Twin Architecture and Standards.....	20
Report   IIC   Digital Twin Journal of Innovation - 2018 June .....	20
Report   IIC   Digital Twin Journal of Innovation - 2019 Nov .....	20
Report   IIC   Digital Twin Journal of Innovation - 2021 March .....	21
Report   METI   The Cyber/Physical Security Framework .....	21
Report   NIST   NISTIR 8356 (Draft) Considerations for Digital Twin Technology and Emerging Standards .....	21
Report   Proprietary   Cheat sheet: What is Digital Twin?.....	21
Report   Proprietary   Digital twin computing .....	21
Report   Proprietary   Lifecycle Governance for Effective Digital Twins: A Joint Systems Engineering and IT Perspective.....	22
Report   Proprietary   Systems Architecture Design Pattern Catalog for Developing Digital Twins.....	22
Report   Proprietary   The Digital Twin Computing Reference Model, Version 2.0 .....	23
Specification   ISG CIM   DGR/CIM-0017: NGSI-LD for Digital Twins .....	23
Specification   ISG CIM   DGR/CIM-0021: Usage of external data models with NGSI-LD API.....	23
Specification   ISG CIM   ETSI GS CIM 009 V1.5.1 (2021-11): NGSI-LD API .....	23



Specification   TC USER   ETSI TR 103 604 V1.1.1 (2019-04): User centric approach; Qualification of the interaction with the digital ecosystem.....	24
Specification   TC 292   ISO 22301:2019 Security and resilience - Business continuity management systems - Requirements.....	24
Specification   TC 292   ISO 22313:2020 Security and resilience - Business continuity management systems - Guidance on the use of ISO 22301 .....	24
Specification   JTC 1/SC 27   ISO/IEC 20889:2018 - Privacy enhancing data de-identification terminology and classification of techniques.....	24
Specification   JTC 1/SC 27   ISO/IEC 27001:2013 - Information technology- Security techniques - Information security management systems - Requirements.....	25
Specification   JTC 1/SC 27   ISO/IEC DIS 27400 Cybersecurity - IoT security and privacy - Guidelines25	
Specification   JTC 1/SC 27   ISO/IEC TS 27110:2021 Information technology, cybersecurity and privacy protection - Cybersecurity framework development guidelines.....	25
Specification   JTC 1/SC 40   ISO/IEC 38505-1:2017 Information technology - Governance of IT - Governance of data - Part 1: Application of ISO/IEC 38500 to the governance of data .....	26
Specification   JTC 1/SC 41   ISO/IEC 21823-3:2021 Internet of Things (IoT) - Interoperability for IoT systems - Part 3: Semantic interoperability .....	26
Specification   JTC 1/SC 41   ISO/IEC 30147:2021 - Internet of Things (IoT) - Integration of IoT trustworthiness activities in ISO/IEC/IEEE 15288 system engineering processes .....	27
Specification   JTC 1/SC 41   ISO/IEC AWI 30172 Digital Twin : Use cases.....	27
Specification   JTC 1/SC 41   ISO/IEC AWI 30173 Digital Twin : Concepts and terminology.....	27
Specification   JTC 1/SC 41   PWI JTC1-SC41-5 Digital Twin - Reference Architecture.....	27
Specification   JTC 1/SC 41   PWI JTC1-SC41-6 Guidance for IoT and Digital Twin use cases.....	28
Specification   JTC 1/SC 42   ISO/IEC DIS 23894 Information technology - Artificial intelligence - Risk management.....	28
Specification   JTC 1/SC 42   ISO/IEC AWI 5339 Information Technology - Artificial Intelligence - Guidelines for AI applications .....	28
Specification   JTC 1/SC 42   ISO/IEC AWI 5392 Information technology - Artificial intelligence - Reference architecture of knowledge engineering.....	28
Specification   JTC 1/SC 42   ISO/IEC AWI TR 5469 Artificial intelligence - Functional safety and AI systems .....	29
Specification   JTC 1/SC 42   ISO/IEC CD 5338 Information technology - Artificial intelligence - AI system life cycle processes.....	29
Specification   JTC 1/SC 42   ISO/IEC FDIS 22989 Information technology - Artificial intelligence - Artificial intelligence concepts and terminology.....	29
Specification   JTC 1/SC 42   ISO/IEC FDIS 38507 Information technology - Governance of IT - Governance implications of the use of artificial intelligence by organizations.....	29
Specification   DTC   Glossary of Digital Twins.....	30
<b>Aeronautics, Aerospace .....</b>	<b>30</b>
Report   AIAA   DIGITAL TWIN: DEFINITION and VALUE, An AIAA and AIA Position Paper .....	30
Report   DTC   DT Framework for Aerospace-Defense .....	31
<b>Agriculture.....</b>	<b>31</b>
Report   Digital twins in smart farming.....	31
<b>Anatomy, medical .....</b>	<b>32</b>
Report   IEEE   Can we have a digital twin?.....	32

<b>Augmented reality .....</b>	<b>32</b>
Report   Proprietary   Augmented Reality and the Digital Twin: State-of-the-Art and Perspectives for Cybersecurity .....	32
Report   ISG ARF   ETSI GR ARF 002 V1.1.1 (2019-07): Augmented Reality Framework (ARF) Industrial use cases for AR applications and services.....	32
Specification   IEEE   P2048.8 - Standard for Virtual Reality and Augmented Reality: Interoperability between Virtual Objects and the Real World .....	33
<b>Automation system .....</b>	<b>33</b>
Specification   IEC TC65 Automation   IEC TR 62541-2:2020 RLV - OPC unified architecture - Part 2: Security Model .....	33
Specification   IEC TC65 Automation   IEC 61512-2:2001- Batch control - Part 2: Data structures and guidelines for languages.....	33
Specification   IEC TC65 Automation   IEC 62264-3:2016 - Enterprise-control system integration - Part 3: Activity models of manufacturing operations management .....	34
Specification   IEC TC65 Automation   IEC 62443-2- 4:2015+AMD1:2017 CSV Consolidated version - Security for industrial automation and control systems - Part 2-4: Security program requirements for IACS service providers .....	34
Specification   IEC TC65 Automation   IEC 62443-3-2:2020 - Security for industrial automation and control systems - Part 3-2: Security risk assessment for system design.....	34
Specification   IEC TC65 Automation   IEC 62443-3-3:2013 - Industrial communication networks - Network and system security - Part 3-3: System security requirements and security levels.....	35
Specification   IEC TC65 Automation   IEC 62443-4-1:2018 - Security for industrial automation and control systems - Part 4-1: Secure product development lifecycle requirements....	35
Specification   IEC TC65 Automation   IEC 62443-4-2:2019 Security for industrial automation and control systems - Part 4-2: Technical security requirements for IACS components.....	35
Specification   IEC TC65 Automation   IEC 62714-1:2018 - Engineering data exchange format for use in industrial automation systems engineering - Automation Markup Language - Part 1: Architecture and general requirements.....	36
Specification   IEC TC65 Automation   IEC 62890:2020 -Industrial- process measurement, control and automation - Life-cycle- management for systems and components .....	36
Specification   IEC TC65 Automation   IEC TR 62541-1:2020 - OPC Unified Architecture - Part 1: Overview and concepts.....	37
Specification   IEC TC65 Automation   IEC 62443-2-2 ED1 Security for industrial automation and control systems - Part 2-2: IACS Security Protection .....	37
<b>Building, Construction .....</b>	<b>37</b>
Report   bSI   A position paper from building SMART International for the construction industry .....	37
Report   Digital twin hub   Skill and competence framework .....	38
Report   DTC   Infrastructure Lifecycle: A Case for Change .....	38
Report   METI   Guidelines for Cyber-Physical Security Measures for Building Systems.....	38
Report   NSAI   Irish National Annex to I.S. EN ISO 19650 -2:2018, Organisation and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 2: Delivery phase of assets (ISO 19650-2:2018) .....	38
Report   Sphere   Digital Twins White Paper.....	39
Report   Towards a semantic Construction Digital Twin: Directions for future research .....	39
Specification   CEN TC 442 Building BIMs   prEN 17632:2021: Building Information	

Modelling (BIM) - Semantic Modelling and Linking (SML).....	39
Specification   JTC 1/SC 35   ISO/IEC DIS 17549-1 Information technology - User interface guidelines on menu navigation - Part 1: Framework.....	40
Specification   TC 59   ISO 15686-4:2014 Building Construction - Service Life Planning - Part 4: Service Life Planning using Building Information Modelling.....	40
Specification   TC 59 SC13   ISO 12006-2:2015 Building construction - Organization of information about construction works - Part 2: Framework for classification.....	40
Specification   TC 59 SC13   ISO 16739:2018 - Industry Foundation Classes (IFC) for data sharing in the construction and facility management industries.....	41
Specification   TC 59 SC13   ISO 16739-1:2018 Industry Foundation Classes (IFC) for data sharing in the construction and facility management industries - Part 1: Data schema.....	41
Specification   TC 59 SC13   ISO 16757-2:2016 Data structures for electronic product catalogues for building services - Part 2: Geometry .....	41
Specification   TC 59 SC13   ISO 19650-1:2018 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 1: Concepts and principles.....	42
Specification   TC 59 SC13   ISO 19650-2:2018 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 2: Delivery phase of the assets.....	42
Specification   TC 59 SC13   ISO 19650-2:2018 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 2: Delivery phase of the assets.....	42
Specification   TC 59 SC13   ISO 19650-3:2018 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 3: Operational phase of the assets.....	43
Specification   TC 59 SC13   ISO 19650-3:2020 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 3: Operational phase of the assets.....	43
Specification   TC 59 SC13   ISO 19650-5:2020 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 5: Security-minded approach to information management.....	43
Specification   TC 59 SC13   ISO 23386:2020 Building information modelling and other digital processes used in construction - Methodology to describe, author and maintain properties in interconnected data dictionaries.....	44
Specification   TC 59 SC13   ISO 23387:2020 - Building Information Modelling (BIM) - Data templates for construction objects used in the life-cycle of any built asset - Concepts and principles.....	44
Specification   TC 59 SC13   ISO 29481-1:2016 Building information modelling - Information delivery manual - Part 1: Methodology and format.....	45
Specification   TC 59 SC13   ISO 29481-2:2012 Building information models - Information delivery manual - Part 2: Interaction framework.....	45
Specification   TC 59 SC13   ISO/AWI 19650-6 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 6: Health and Safety.....	45
Specification   TC 59 SC13   ISO/DIS 12911 Organization and digitization of information	



about buildings and civil engineering works, including building information modelling (BIM) - Framework for specification of building information modelling (BIM) implementation.....	46
Specification   TC 59 SC13   ISO/DIS 19650-4 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 4: Information exchange.....	46
Specification   TC 59 SC13   ISO/DIS 29481-3 Building information models - Information delivery manual - Part 3: Data schema and code.....	46
Specification   TC 59 SC13   ISO/TR 3262:2021 GIS (geospatial) / BIM interoperability.....	47
Specification   TC 59 SC13   ISO/TR 23262:2021 GIS (geospatial) / BIM interoperability.....	47
Specification   TC 59 SC13   ISO/TS 12911:2012: Framework for building information modelling (BIM) guidance.....	47
Specification   TC 59 SC13   SO 19650-1:2018 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 1: Concepts and principles.....	47
Specification   TC 92   ISO/TR 24679-6:2017 Fire safety engineering - Performance of structures in fire - Part 6: Example of an eight- storey office concrete building.....	48
Specification   TC 59   ISO/FDIS 22057 Sustainability in buildings and civil engineering works - Data templates for the use of EPDs for construction products in BIM.....	48
Specification   TC 59 SC13   ISO 19650-4:2018 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling-Part 4: Information exchange.....	49
Specification   TC 59 SC13   ISO/DIS 7817 Building information modelling - Level of information need - Concepts and principles.....	49
<b>Building, Energy .....</b>	<b>50</b>
Legal   EC   Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency (Text with EEA relevance).....	50
Report   GOV_UK   Energy Performance of Building Regulations 2012.....	50
Report   GOV_Scotland   Building regulations - energy standards and associated topics - proposed changes: consultation .....	50
Report   IEA-EBC   Working Group on Building Energy Codes .....	50
Report   PNNL   Understanding Building Energy Codes and Standards.....	51
Report   SSSI Australia   Building Energy Standards and Codes .....	51
Guideline   Building energy performance analysis: A case study.....	51
Specification   TC 163   ISO 52000-1:2017 Energy performance of buildings - Overarching EPB assessment - Part 1: General framework and procedures .....	52
<b>Consumer goods and services .....</b>	<b>52</b>
Specification   PC 317   ISO/CD 31700 Consumer protection - Privacy by design for consumer goods and services.....	52
<b>Energy .....</b>	<b>52</b>
Guideline   DNV   DNV-RP-A204: Qualification and assurance of digital twins.....	52
Report   GE   Digital Twin Analytic Engine for the Digital Power Plant .....	53
Specification   IEC TC57 Power Systems   Communication networks and systems for power utility automation - ALL PARTS.....	53

Specification   IEC TC57 Power Systems   Communication networks and systems for power utility automation - Part 1-2: Guideline on extending IEC 61850.....	53
Specification   ISA/IEC   Quick start guide: An overview of the ISA/IEC 62443 Standards.....	53
Specification   TC 205   ISO 17800:2017 Facility smart grid information model.....	54
Specification   JTC 1/SC 27   ISO/IEC 27019:2017 Information technology - Security techniques - Information security controls for the energy utility industry.....	54
<b>Geographic Information Systems (GIS).....</b>	<b>55</b>
Specification   OGC   Indexed 3D Scene Layers (I3S).....	55
Specification   TC 211   ISO 19101-1:2014 Geographic information - Reference model - Part 1: Fundamentals.....	55
Specification   TC 211   ISO 19101-2:2018 Geographic information - Reference model - Part 2: Imagery.....	55
Specification   TC 211   ISO 19103:2015 Geographic information - Conceptual schema language.....	56
Specification   TC 211   ISO 19104:2016 Geographic information - Terminology.....	56
Specification   TC 211   ISO 19105:2000 Geographic information - Conformance and testing.....	56
Specification   TC 211   ISO 19106:2004 Geographic information - Profiles.....	57
Specification   TC 211   ISO 19107:2019 Geographic information - Spatial schema.....	57
Specification   TC 211   ISO 19108:2002 Geographic information - Temporal schema, with technical corrigendum.....	57
Specification   TC 211   ISO 19109:2015 Geographic information - Rules for application schema.....	57
Specification   TC 211   ISO 19110:2016 Geographic information - Methodology for feature cataloguing.....	58
Specification   TC 211   ISO 19111:2019 Geographic information - Referencing by coordinates, with amendment.....	58
Specification   TC 211   ISO 19112:2019 Geographic information - Spatial referencing by geographic identifiers.....	59
Specification   TC 211   ISO 19115-1:2014 Geographic information - Metadata - Part 1: Fundamentals, with amendment 1 and amendment 2.....	59
Specification   TC 211   ISO 19115-1:2014 Geographic information - Metadata - Part 1: Fundamentals.....	60
Specification   TC 211   ISO 19115-2:2019 Geographic information - Metadata - Part 2: Extensions for acquisition and processing.....	60
Specification   TC 211   ISO 19116:2019 Geographic information - Positioning services, with amendment.....	60
Specification   TC 211   ISO 19117:2012 Geographic information - Portrayal.....	61
Specification   TC 211   ISO 19118:2011 Geographic information - Encoding.....	61
Specification   TC 211   ISO 19119:2016 Geographic information - Services.....	61
Specification   TC 211   ISO 19123:2005 Geographic information - Schema for coverage geometry and functions.....	62
Specification   TC 211   ISO 19123-2:2018 Geographic information - Schema for coverage geometry and functions - Part 2: Coverage implementation schema.....	62
Specification   TC 211   ISO 19125-1:2004 Geographic information - Simple feature access - Part 1: Common architecture.....	62
Specification   TC 211   ISO 19126:2021 Geographic information - Feature concept dictionaries and registers.....	63

Specification   TC 211   ISO 19127:2019 Geographic information - Geodetic register .....	63
Specification   TC 211   ISO 19128:2005 Geographic information - Web map server interface .....	63
Specification   TC 211   ISO 19130-1:2018 Geographic information - Imagery sensor models for geopositioning - Part 1: Fundamentals .....	63
Specification   TC 211   ISO 19131:2007 Geographic information - Data product specifications, with amendment.....	64
Specification   TC 211   ISO 19132:2007 Geographic information - Location-based services - Reference model .....	64
Specification   TC 211   ISO 19133:2005 Geographic information - Location-based services - Tracking and navigation.....	65
Specification   TC 211   ISO 19134:2007 Geographic information - Location-based services - Multimodal routing and navigation.....	65
Specification   TC 211   ISO 19135-1:2015 Geographic information - Procedures for item registration - Part 1: Fundamentals, with amendment.....	65
Specification   TC 211   ISO 19136-1:2020 Geographic information - Geography Markup Language (GML) - Part 1: Fundamentals.....	65
Specification   TC 211   ISO 19136-2:2015 Geographic information - Geography Markup Language (GML) - Part 2: Extended schemas and encoding rules.....	66
Specification   TC 211   ISO 19137:2007 Geographic information - Core profile of the spatial schema.....	66
Specification   TC 211   ISO 19141:2008 Geographic information - Schema for moving features.....	67
Specification   TC 211   ISO 19142:2010 Geographic information - Web Feature Service.....	67
Specification   TC 211   ISO 19143:2010 Geographic information - Filter encoding .....	67
Specification   TC 211   ISO 19144-1:2009 Geographic information - Classification systems - Part 1: Classification system structure, with technical corrigendum.....	68
Specification   TC 211   ISO 19144-2:2012 Geographic information - Classification systems - Part 2: Land Cover Meta Language (LCML).....	68
Specification   TC 211   ISO 19145:2013 Geographic information - Registry of representations of geographic point location .....	68
Specification   TC 211   ISO 19146:2018 Geographic information - Cross-domain vocabularies .....	68
Specification   TC 211   ISO 19147:2015 Geographic information - Transfer Nodes.....	69
Specification   TC 211   ISO 19148:2021 Geographic information - Linear referencing .....	69
Specification   TC 211   ISO 19149:2011 Geographic information - Rights expression language for geographic information - GeoREL .....	69
Specification   TC 211   ISO 19150-2:2015 Geographic information - Ontology - Part 2: Rules for developing ontologies in the Web Ontology Language (OWL), with amendment.....	70
Specification   TC 211   ISO 19150-4:2019 Geographic information - Ontology - Part 4: Service ontology.....	70
Specification   TC 211   ISO 19152:2012 Geographic information - Land Administration Domain Model (LADM).....	70
Specification   TC 211   ISO 19154:2014 Geographic information - Ubiquitous public access - Reference model .....	71
Specification   TC 211   ISO 19155:2012 Geographic information - Place Identifier (PI) architecture	71
Specification   TC 211   ISO 19155-2:2017 Geographic information - Place Identifier (PI) architecture - Part 2: Place Identifier (PI) linking.....	71
Specification   TC 211   ISO 19156:2011 Geographic information - Observations and	



measurements.....	72
Specification   TC 211   ISO 19157:2013 Geographic information - Data quality, with amendment ..	72
Specification   TC 211   ISO 19160-1:2015 Addressing - Part 1: Conceptual model .....	73
Specification   TC 211   ISO 19160-3:2020 Addressing - Part 3: Address data quality.....	73
Specification   TC 211   ISO 19160-4:2017 Addressing - Part 4: International postal address components and template language .....	73
Specification   TC 211   ISO 19161-1:2020 Geographic information - Geodetic references - Part 1: International terrestrial reference system (ITRS) .....	74
Specification   TC 211   ISO 19162:2019 Geographic information - Well-known text representation of coordinate reference systems .....	74
Specification   TC 211   ISO 19165-1:2018 Geographic information - Preservation of digital data and metadata - Part 1: Fundamentals.....	74
Specification   TC 211   ISO 19165-2:2020 Geographic information - Preservation of digital data and metadata - Part 2: Content specifications for Earth observation data and derived digital products.....	75
Specification   TC 211   ISO 19168-1:2020 Geographic information - Geospatial API for features - Part 1: Core .....	75
Specification   TC 211   ISO 19170-1:2021 Geographic information - Discrete Global Grid Systems Specifications - Part 1: Core Reference System and Operations, and Equal Area Earth Reference System .....	75
Specification   TC 211   ISO 6709:2008 Standard representation of geographic point location by coordinates, with corrigendum.....	76
Specification   TC 211   ISO/TR 19121:2000 Geographic information - Imagery and gridded data .....	76
Specification   TC 211   ISO/TR 19167:2019 Application of ubiquitous public access to-geographic information to an air quality information service.....	76
Specification   TC 211   ISO/TR 19169:2021 Geographic Information - Gap-analysis: mapping and describing the differences between the current GDF and ISO/TC 211 conceptual models to suggest ways to harmonize and resolve conflicting issues.....	77
Specification   TC 211   ISO/TS 19115-3:2016 Geographic information - Metadata - Part 3: XML schema implementation for fundamental concepts.....	77
Specification   TC 211   ISO/TS 19129:2009 Geographic information - Imagery, gridded and coverage data framework.....	77
Specification   TC 211   ISO/TS 19130-2:2014 Geographic information - Imagery sensor models for geopositioning - Part 2: SAR, InSAR, lidar and sonar .....	78
Specification   TC 211   ISO/TS 19139-1:2019 Geographic information - XML schema implementation - Part 1: Encoding rules.....	78
Specification   TC 211   ISO/TS 19150-1:2012 Geographic information - Ontology - Part 1: Framework.....	78
Specification   TC 211   ISO/TS 19157-2:2016 Geographic information - Data quality - Part 2: XML schema implementation.....	78
Specification   TC 211   ISO/TS 19158:2012 Geographic information - Quality assurance of data supply .....	79
Specification   TC 211   ISO/TS 19159-1:2014 Geographic information - Calibration and validation of remote sensing imagery sensors and data - Part 1: Optical sensors.....	79
Specification   TC 211   ISO/TS 19159-2:2016 Geographic information - Calibration and validation of remote sensing imagery sensors and data - Part 2: Lidar .....	79
Specification   TC 211   ISO/TS 19159-3:2018 Geographic information - Calibration and	

validation of remote sensing imagery sensors and data - Part 3: SAR/InSAR.....	80
Specification   TC 211   ISO/TS 19163-1:2016 Geographic information - Content components and encoding rules for imagery and gridded data - Part 1: Content model.....	80
Specification   TC 211   ISO/TS 19163-2:2020 Geographic information - Content components and encoding rules for imagery and gridded data - Part 2: Implementation schema.....	80
Specification   TC 211   ISO/TS 19166:2021 Geographic information - BIM to GIS conceptual mapping (B2GM).....	80
Specification   OpenGIS   Web Map Service Interface Standard (WMS).....	81
Specification   OGC   Web Feature Service (WFS).....	81
Specification   Standards Australia   IT-004 : Geographical Information/Geomatics (Australian Mirror Committee).....	81
<b>Geographic Information Systems (GIS), Building .....</b>	<b>82</b>
Specification   TC 211   ISO/TS 19166:2021 Geographic information - BIM to GIS conceptual mapping (B2GM).....	82
<b>Industry.....</b>	<b>83</b>
Guideline   ISO/IEC GUIDE 77-2:2008 Guide for specification of product properties and classes - Part 2: Technical principles and guidance .....	83
Report   A review of smart manufacturing reference models based on the skeleton meta-model ....	83
Report   EC   ICT Standardisation supporting Circular Economy: Report of the Study Group Circular Economy - a sub-group of the EU Multi-Stakeholder Platform for ICT Standardisation.....	83
Report   DTC   Digital twins for Industrial Applications .....	84
Report   ETP4HPC   Real-time digital twins. A TransContinuum initiative use case .....	84
Report   GIZ   Use Case Equipment Lifecycle Management.....	84
Report   I4.0   Digital Twin and Internet of Things: Current Standards Landscape .....	84
Report   IEC   Smart manufacturing .....	85
Report   IIC   Digital Twin and Asset Administration Shell Concepts and Application in the Industrial Internet and Industrie 4.0 .....	85
Report   IIC   Digital Twins for Industrial Applications DEFINITION, BUSINESS VALUES, DESIGN ASPECTS, STANDARDS AND USE .....	85
Report   Platform Industrie 4.0   Usage View of Asset Administration Shell .....	86
Report   Platform Industrie 4.0   Usage View Seamless and Dynamic Engineering of Plants.....	86
Report   Proprietary   Digital Twin: Manufacturing Excellence through Virtual Factory Replication ..	86
Report   Proprietary   What is a Digital Twin? .....	86
Specification   IEC TC65 Automation   IEC 63278-1 Asset Administration Shell for industrial applications - Part 1: Asset Administration Shell structure.....	86
Specification   IEC TC65 Automation   IEC/TR 63283-2 Industrial- process measurement, control and automation - Smart Manufacturing - Part 2: Use cases.....	87
Specification   IEC TC65 Automation   IEC PAS 63088. (2017). .....	87
Specification   TC 10   IEC/DIS 81346-1 Industrial systems, installations and equipment and industrial products - Structuring principles and reference designations - Part 1: Basic rules.....	87
Specification   TC 184   ISO/TS 18101-1:2019: Oil and Gas Interoperability Technical Specification ...	88
Specification   TC184   ISO/TR 24464 Automation systems and integration - Industrial data - Visualization elements of digital twins .....	88
Specification   TC184 SC4   ISO 10303-209:2014 Industrial automation systems and integration - Product data representation and exchange - Part 209: Application protocol:	

Multidisciplinary analysis and design.....	88
Specification   TC184 SC4   ISO 10303-242:2020 Industrial automation systems and integration - Product data representation and exchange - Part 242: Application protocol: Managed model- based 3D engineering .....	88
Specification   TC184 SC4   ISO 23247-1 Automation systems and integration - Digital twin framework for manufacturing - Part 1: Overview and general principles.....	89
Specification   TC184 SC4   ISO 23247-2, Automation systems and integration - Digital Twin framework for manufacturing - Part 2: Reference architecture .....	89
Specification   TC184 SC4   ISO 23247-3, Automation systems and integration - Digital Twin framework for manufacturing - Part 3: Digital representation of manufacturing elements .....	89
Specification   TC184 SC4   ISO 23247-4, Automation systems and integration - Digital Twin framework for manufacturing - Part 4: Information exchange .....	89
Specification   TC SmartM2M   ETSI TR 103 507 V1.1.1 (2018-10): SAREF extension investigation; Requirements for industry and manufacturing domains .....	90
Specification   TC SmartM2M   ETSI TR 103 674 V1.1.1 (2021-02): Artificial Intelligence and the oneM2M architecture .....	90
Specification   TC SmartM2M   ETSI TR 103 778 V1.1.1 (2021-12): Use cases for cross-domain data usability of IoT devices.....	90
Specification   JTC 1/SC 27   ISO/IEC TR 27550:2019 Information technology - Security techniques - Privacy engineering for system life cycle processes .....	91
Specification   JTC 1/SC 7   ISO/IEC/IEEE CD 24641.2 Systems and Software engineering - Methods and tools for model-based software engineering .....	91
<b>Robotics .....</b>	<b>92</b>
Report   Proprietary   Digital twin based synchronised control and simulation of the industrial robotic cell using virtual reality .....	92
Specification   TC 159 SC4   ISO/TR 9241-810:2020 Ergonomics of human-system interaction - Part 810: Robotic, intelligent and autonomous systems .....	92
<b>Smart cities.....</b>	<b>93</b>
Report   Banque des territoire   Jumeau numerique des territoires, issu de la reflexion de la banque des territoires (Territorial digital twin, resulting from the investigations of the French Territorial Bank) .....	93
Report   EC   Destination Earth: Survey on Digital Twins technologies and activities, in the Green Deal area .....	93
Report   Proprietary   Beyond IoT: Digital Twins and Cyber-Physical Systems .....	93
Report   Smart Cities Council   Digital Twin Blueprint (DRAFT).....	94
Report   UNESCAP   Spatial Digital Twins Special Interest Group.....	94
Specification   IEC   City information modelling and urban digital twins .....	94
Specification   ISO TC 268 SC1   Smart Community Infrastructures: Development Guidelines for Information-based Systems of Smart Buildings.....	95
Specification   JTC 1/SC 27   ISO/IEC TS 27570:2021 Privacy protection - Privacy guidelines for smart cities.....	95
Specification   SG 20   Y.dt-interop Interoperability framework of digital twin systems in smart cities and communities.....	95
Specification   SG 20   Y.dt-smartfirefighting Requirements and capability framework of digital twin for smart firefighting .....	96
Specification   SG 20   Y.dtf.reqts Requirements for digital twin federation in smart cities and communities.....	96



Specification   SG 20   Y.scdt-reqts Requirements and capabilities of a digital twin system for smart cities.....	96
<b>Spatial data.....</b>	<b>97</b>
Report   ANZLIC   Foundation Spatial Data Framework .....	97
Report   ANZLIC   Principles for Spatially Enabled Digital Twins of the Built and Natural Environment in Australia .....	97
Report   CSIRO   Framework for Spatially Enabled Digital Twins .....	97
Report   Fiware   FIWARE for digital twins.....	98
<b>Transport.....</b>	<b>98</b>
Report   Digital twin hub   Data for the public good.....	98
Specification   SG 20   Y.dt-ITS Requirements and capability framework of digital twin for intelligent transport system.....	98
<b>Annex - Table of Documents.....</b>	<b>99</b>

# Landscape of Standards

## Standardisation Documents



# ■ Horizontal / Cross-Domain

## Guideline | IIC | Global Industry Standards for Industrial IoT

This whitepaper enumerates categories of standards and the organizations that produce them. It establishes a vision and strategy to drive and leverage standards. It provides concrete guidance to the industry on execution and governance of a standards program.

📖 CATEGORY Paper (guidelines)

📅 PUBLISHED 2021-06

📁 DOMAIN Horizontal / Cross-domain

## Guideline | IIC | IoT Security Maturity Model (SMM) v1.2

The goal of a Security Maturity Model (SMM) is to provide a path for Internet of Things (IoT) providers to know where they need to be and how to invest appropriately in sensible security mechanisms that meet their needs and requirements. It seeks to help organizations identify the appropriate approach for effective enhancement of these practices where needed.

📖 CATEGORY Paper (guidelines)

📅 PUBLISHED 2020-05

📁 DOMAIN Horizontal / Cross-domain

## Landscape | Digital twin hub | A Survey of Industry Data Models and Reference Data Libraries

A Survey of Industry Data Models and Reference Data Libraries to identify and assess existing Industry Data Models and Reference Data Libraries in terms of scope, quality and formalisation of the documentation, formalisation of the representation, maintenance frequency, usage, etc.

📖 CATEGORY Web (survey document)

📅 PUBLISHED 2021-06

📁 DOMAIN Horizontal / Cross-domain

## Landscape | Digital twin hub | Information Management Framework (IMF)

The pathway towards an Information Management Framework (IMF) report sets out the technical approach to deliver the Information Management Framework, a common language by which digital twins of the built and natural environment can communicate securely and effectively to support improved decision taking by those operating, maintaining and using built assets and the services they provide to society. The report outlines three building blocks based on the Gemini Principles to form an appropriately functioning technical core - Foundation Data Model (FDM) a consistent, clear understanding of what constitutes the world of digital twins - Reference Data Library (RDL) the particular set of classes and properties we will use to describe our digital twins - Integration Architecture (IA) the protocols that will enable the managed sharing of data.

📖 CATEGORY web (collection of papers)

📅 PUBLISHED 2021-06

📁 DOMAIN Horizontal / Cross-domain

## Landscape | IBM Digital twin exchange

Repository to ease access to digital twin data for equipment, facilities and IoT. The Digital Twin Exchange makes it easier to manage connected assets, equipment, and internet of things solutions.

🔗 CATEGORY Web (repository)

📅 PUBLISHED 2020-12

📁 DOMAIN Horizontal / Cross-domain

## Landscape | ISG ZSM | ETSI GR ZSM 004 V2.1.1 (2022-01): Landscape

The present report updates the existing ZSM004 landscape report, based on its current and future developments. It identifies and includes the information about activities in other bodies (such as Standards Developing Organizations, Open Source Communities, and Industry Associations) that are relevant to the work in ISG ZSM. Recommendations will be derived for the ISG ZSM work.

🔗 CATEGORY Standard

📅 PUBLISHED 2022-01

📁 DOMAIN Horizontal / Cross-domain

## Report | AMRC | Untangling the requirements of a Digital Twin

With the rise of digital technologies in manufacturing and the need to make sense of ever-growing data sets, the digital twin has arisen out of requiring more intuitive ways to organise information facilitated by digital transformations. However, with nebulous definitions and a lack of real-world use cases, the term digital twin is often seen as a buzzword that more frequently creates confusion and uncertainty amongst businesses. This document sets out to provide a clarification of the topic with a detailed definition, use-cases and case studies to alleviate confusion whilst demonstrating the value that digital twins deliver to businesses.

🔗 CATEGORY Paper (requirements)

📅 PUBLISHED 2020-10

📁 DOMAIN Horizontal / Cross-domain

## Report | Azure Digital Twins documentation

This web page explains how to use Azure Digital Twins to create a digital representation of your assets, environments and business systems, to build next generation IoT solutions that model the real world.

🔗 CATEGORY Product

📅 PUBLISHED online

📁 DOMAIN Horizontal / Cross-domain

## Report | Digital twin hub | The Gemini Principles

This paper sets out the “Gemini principles” to guide the UK national digital twin and the information management framework (IMF) that will enable it.

🔗 CATEGORY Paper (principles)

📅 PUBLISHED 2019-11

📁 DOMAIN Horizontal / Cross-domain

## Report | DTC | Digital Twin Capabilities Periodic Table

The Digital Twin Capabilities Periodic Table framework facilitate collaboration in multidisciplinary or fusion teams that need to create Digital Twins requirements specifications in large scale complex environments. The framework keeps the focus on the capability requirements of individual use cases, which can then be aggregated to determine the overall capability requirements digital twin platforms and other technology solutions that are required to address the specific business needs.

📁 CATEGORY paper (maturity framework)

📅 PUBLISHED Under Development

📁 DOMAIN Horizontal / Cross-domain

## Report | DTC | Digital Twin Core: Essential Elements for Optimal/ Expansive Interoperability

A Technical Report comprising usage scenarios, requirements, a conceptual model, an information model, a list of enabling technologies and architectures, a list of enabled applications, considerations of interoperability, and a section on how to build digital twin-enabled systems.

📁 CATEGORY Paper

📅 PUBLISHED Under development (expected June 2022)

📁 DOMAIN Horizontal / Cross-domain

## Report | DTC | Digital Twin System Interoperability Framework

The framework characterizes the multiple facets of system interoperability based on seven key concepts to create complex systems that interoperate at scale 1. System-Centric Design 2. Model-Based Approach 3. Holistic Information Flow 4. State-Based Interactions 5. Federated Repositories 6. Actionable Information 7. Scalable Mechanisms.

📁 CATEGORY Paper (white paper)

📅 PUBLISHED Under Development

📁 DOMAIN Horizontal / Cross-domain

## Report | DTC | DT Vocabulary

A list of terms and their definitions, adapted and/or adopted from other sources when appropriate, related to digital twins. This is being developed by the Technology Terminology and Taxonomy Working Group of the DTC.

📁 CATEGORY paper (vocabulary)

📅 PUBLISHED Under Development

📁 DOMAIN Horizontal / Cross-domain

## Report | DTC | Infrastructure Digital Twin Maturity: A Model for Measuring Progress

White paper describing the different levels of maturity of a digital twin based on the infrastructure domain. The maturity model describes five levels of maturity: Dinosaur, Average, Leader, Evangelist, Pioneer. The model also describes five categories that are tied to these levels organisational structure, organisational performance, evolution of the digital thread, integration of business functions, and the use of catalogs for repeatable elements.

📁 CATEGORY Paper (maturity model)

📅 PUBLISHED 2021-08

📁 DOMAIN Horizontal / Cross-domain



## Report | ETRI | Characterization of digital twins

This overview on digital twin and its characterization covers different aspects definitions and history, benefits, maturity level, and how a digital twin fits within other complementary technologies.

📖 CATEGORY Paper (characteristics)

📅 PUBLISHED 2021-01

📁 DOMAIN Horizontal / Cross-domain

## Report | ETRI | Digital Twin maturity model

Paper with a survey on different maturity models for functionality of Digital Twins and a resulting maturity model from ETRI that aspires to create a common understanding of the different levels of Digital Twins and the different types of Human interaction with the Twin. The paper also proposes a roadmap of how to continuously improve the levels of the digital twin.

📖 CATEGORY Paper (maturity model)

📅 PUBLISHED 2020-11

📁 DOMAIN Horizontal / Cross-domain

## Report | IIC | Digital Twin Architecture and Standards

This paper, authored by contributors from ABB for the Industry IoT Consortium's (IIC's) Journal of Innovation (Joi) describes digital twin capabilities with a focus on the required data access and storage capabilities. It proposes a tiered architecture for digital twins, describes the industrial challenges that a digital twin can address, and potential work within the Digital Twin Advisory Group of ISO/IEC JTC 1 to elaborate relevant standards, such as APIs for secure data access. Note, this paper is not an official position of the IIC.

📖 CATEGORY Paper

📅 PUBLISHED 2019-11

📁 DOMAIN Horizontal / Cross-domain

## Report | IIC | Digital Twin Journal of Innovation - 2018 June

The theme of this Journal of Innovation issue is "Innovation in Digital Twins." It contains articles related to Industrial IoT data and an overview of the Industry IoT Consortium's white paper on Endpoint Security Best Practices.

📖 CATEGORY Paper (multiple)

📅 PUBLISHED 2018-06

📁 DOMAIN Horizontal / Cross-domain

## Report | IIC | Digital Twin Journal of Innovation - 2019 Nov

The goal of this Journal of Innovation issue is to decipher digital twin. As such, it contains a robust number of articles covering many aspects of this topic from its applications to implementation challenges.

📖 CATEGORY Paper (multiple)

📅 PUBLISHED 2019-11

📁 DOMAIN Horizontal / Cross-domain

## Report | IIC | Digital Twin Journal of Innovation - 2021 March

This Journal of Innovation issue contains multiple papers \* Web-Based Digital Twin \* Open Source Drives Digital Twin Adoption \* Design and Implementation of a Digital Twin for Live Petroleum Production Optimization Data Processing and Simulation \* Digital Twin and IIoT in Optimizing Manufacturing Process and Quality Management.

🔗 CATEGORY Paper (multiple)

📅 PUBLISHED 2021-03

📁 DOMAIN Horizontal / Cross-domain

## Report | METI | The Cyber/Physical Security Framework

The Ministry of Economy, Trade and Industry (METI) aims to ensure security in the new supply chains (value creation processes) under Society 5.0, a national policy achieved by integrating cyberspace and physical space in a sophisticated manner, and Connected Industries, another national policy for creating new value added by connecting a variety of goods, industries and people. As part of the efforts to this end, METI formulated the Cyber/Physical Security Framework (CPSF), a well-organized overview of security measures that industries are required to take.

🔗 CATEGORY Paper (Japan national initiative)

📅 PUBLISHED 2019-04

📁 DOMAIN Horizontal / Cross-domain

## Report | NIST | NISTIR 8356 (Draft) Considerations for Digital Twin Technology and Emerging Standards

Digital twin technology enables the creation of electronic representations of real-world entities and the viewing of the state of those entities. Its full vision will require standards that have not yet been developed. It is relatively new although it uses many existing foundational technologies and, in many cases, appears similar to existing modeling and simulation capabilities. This report attempts to provide clarity in understanding the concept and purpose of digital twins. It offers a new definition for a digital twin, and describes characteristics, features, functions, and expected operational uses. The report then discusses novel cybersecurity challenges presented by digital twin architectures. Lastly, it discusses traditional cybersecurity challenges as well as trust considerations in the context of existing NIST guidance and documents.

🔗 CATEGORY Paper (NIST)

📅 PUBLISHED 2021-04

📁 DOMAIN Horizontal / Cross-domain

## Report | Proprietary | Cheat sheet: What is Digital Twin?

This blog contains material that presents an overall view of a digital twin and illustrates it with several examples of interest. Further links from this webpage provide the reader with an array of informative resources related to the Digital Twin.

🔗 CATEGORY Web (blog)

📅 PUBLISHED 2020-12

📁 DOMAIN Horizontal / Cross-domain

## Report | Proprietary | Digital twin computing

This paper sets down the Digital Twin Computing Vision - a vision that entails the use of high precision digital representations of humans and objects called digital twins to create diverse worlds in cyberspace that will exceed the limitations of the real-world. In this vision, the value obtained through

advanced computations and communications using these digital twins in cyberspace reflected back into the real world and enables collaboration among humans with expanded capabilities in cyberspace to achieve new digital societies.

🔗 CATEGORY Paper (white paper)

📅 PUBLISHED 2019-10

📁 DOMAIN Horizontal / Cross-domain

## Report | Proprietary | Lifecycle Governance for Effective Digital Twins: A Joint Systems Engineering and IT Perspective

Digital twins run concurrently with the assets and systems they mirror. They offer real-time execution of advanced control schemes, e.g., for smart buildings, but also various analysis tasks, e.g., for predictive maintenance that ensures resilience. In this, they need to cope with change. The physical twins they mirror operate in a highly dynamic environment with unknown or unexpected variables and impact factors to which they adapt or are adapted to via upgrades, maintenance, or behavioral changes. Keeping digital twins fit for their purpose over their lifecycle is thus a demanding governance challenge that needs to be addressed in tandem with the lifecycle management of the mirrored system. We argue that the best practices of Systems Engineering (SE) and Information Technology (IT), especially software development, need to be brought together to succeed. In this paper, we present a joint SE and IT lifecycle model called the Double Helix model. It highlights the concurrent governance processes of both twins, capturing the temporal dynamics of the environment and the system itself. It accents the important concept of the leading twin. The Double Helix model captures both design and operational phases of SE and management, going from cradle to grave, by empowering a shift from using data in offline simulations during design, to the online operational phase.

🔗 CATEGORY Paper

📅 PUBLISHED 2020-04

📁 DOMAIN Horizontal / Cross-domain

## Report | Proprietary | Systems Architecture Design Pattern Catalog for Developing Digital Twins

A digital twin is a digital replica of a physical entity to which it is remotely connected. A digital twin can provide a rich representation of the corresponding physical entity and enables sophisticated control for various purposes. Although the concept of the digital twin is largely known, designing digital twins based systems has not yet been fully explored. In practice, digital twins can be applied in different ways leading to different architectural designs. To guide the architecture design process, we provide a pattern-oriented approach for architecting digital twin-based systems. To this end, we propose a catalog of digital twin architecture design patterns that can be reused in the broad context of systems engineering. The patterns support the various phases in the systems engineering life cycle process, and are described using a well-defined pattern documentation template. For illustrating the application of digital twin patterns, we adopt a multi-case study approach in the agriculture and food domain.

🔗 CATEGORY Paper

📅 PUBLISHED 2020-09

📁 DOMAIN Horizontal / Cross-domain

# Report | Proprietary | The Digital Twin Computing Reference Model, Version 2.0

This document provides a reference model based on 4 layers (a) the first layer is the Cyber/Physical Interaction Layer, (b) the second layer is the Digital Twin Layer, (c) the third layer is the Digital World Presentation Layer, and (d) the final layer is the application layer.

🔗 CATEGORY Paper

📅 PUBLISHED 2021-03

📁 DOMAIN Horizontal / Cross-domain

## Specification | ISG CIM | DGR/CIM-0017: NGSI-LD for Digital Twins

This document identifies the various (historical) definitions and types and characteristics of Digital Twins (e.g. in areas of representing human actions, in health/biological areas, for smart manufacturing, etc) and considers the usage of the NGSI-LD information model and API for realising such systems. Special concern should be given to issues of privacy and leakage of data, depending on the use case and including the area of monitoring for handling pandemics. The purpose of the document is to show to what extent various Digital Twin types can be realized or facilitated by NGSI-LD and to identify new features for NGSI-LD which would make it more useful for such areas of usage. The document will identify from the SDO and research landscape a number of groups to contact for exchange of views. Contact with relevant ETSI groups such as SmartM2M, 3GPP, oneM2M, etc is expected.

🔗 CATEGORY Standard

📅 PUBLISHED Under Development

📁 DOMAIN Horizontal / Cross-domain

## Specification | ISG CIM | DGR/CIM-0021: Usage of external data models with NGSI-LD API

The document considers a selection of relevant and representative knowledge organisation systems, to provide an illustrative basis of data schemas and vocabularies relevant to be used in a NGSI-LD context. Illustration of their use with the NGSI-LD API in complex environments, such as system-of-system models for Digital Twins, is considered. The document provides recommendations for changes or enhancements to the NGSI-LD specification (API and data model).

🔗 CATEGORY Standard

📅 PUBLISHED Under Development

📁 DOMAIN Horizontal / Cross-domain

## Specification | ISG CIM | ETSI GS CIM 009 V1.5.1 (2021-11): NGSI-LD API

The present document formally describes the Context Information Management API (NGSI-LD) Specification. The Context Information Management API allows users to provide, consume and subscribe to context information in multiple scenarios and involving multiple stakeholders. Context information is modelled as attributes (properties and relationships) of context entities, also referred to as digital twins, representing real-world assets. It enables close to real-time access to information coming from many different sources (not only IoT data sources).

🔗 CATEGORY Standard

📅 PUBLISHED 2021-11

📁 DOMAIN Horizontal / Cross-domain

## Specification | TC USER | ETSI TR 103 604 V1.1.1 (2019-04): User centric approach; Qualification of the interaction with the digital ecosystem

This work item will define the qualifications of the interaction of the user with the digital ecosystem (e.g. authentication, security, privacy, single sign on, service composition, presentation, etc.).

🔗 CATEGORY Standard

📅 PUBLISHED 2019-04

📖 DOMAIN Horizontal / Cross-domain

## Specification | TC 292 | ISO 22301:2019 Security and resilience - Business continuity management systems - Requirements

This document specifies requirements to implement, maintain and improve a management system to protect against, reduce the likelihood of the occurrence of, prepare for, respond to and recover from disruptions when they arise. The requirements specified in this document are generic and intended to be applicable to all organizations, or parts thereof, regardless of type, size and nature of the organization. The extent of application of these requirements depends on the organization's operating environment and complexity. This document is applicable to all types and sizes of organizations that a) implement, maintain and improve a BCMS; b) seek to ensure conformity with stated business continuity policy; c) need to be able to continue to deliver products and services at an acceptable predefined capacity during a disruption; d) seek to enhance their resilience through the effective application of the BCMS. This document can be used to assess an organization's ability to meet its own business continuity needs and obligations.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2019-10

📖 DOMAIN Horizontal / Cross-domain

## Specification | TC 292 | ISO 22313:2020 Security and resilience - Business continuity management systems - Guidance on the use of ISO 22301

This document gives guidance and recommendations for applying the requirements of the business continuity management system (BCMS) given in ISO 22301. The guidance and recommendations are based on good international practice. This document is applicable to organizations that a) implement, maintain and improve a BCMS; b) seek to ensure conformity with stated business continuity policy; c) need to be able to continue to deliver products and services at an acceptable predefined capacity during a disruption; d) seek to enhance their resilience through the effective application of the BCMS. The guidance and recommendations are applicable to all sizes and types of organizations, including large, medium and small organizations operating in industrial, commercial, public and not-for-profit sectors. The approach adopted depends on the organization's operating environment and complexity.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2020-02

📖 DOMAIN Horizontal / Cross-domain

## Specification | JTC 1/SC 27 | ISO/IEC 20889:2018 - Privacy enhancing data de-identification terminology and classification of techniques

ISO/IEC 20889 2018 This document provides a description of privacy-enhancing data de-identification techniques, to be used to describe and design de-identification measures in accordance with the privacy principles in ISO/IEC 29100. In particular, this document specifies terminology, a classification of de-identification techniques according to their characteristics, and their applicability for reducing the risk of re-identification. This document is applicable to all types and sizes of organizations, including public and private companies, government entities, and not-for-profit organizations, that



are PII controllers or PII processors acting on a controller's behalf, implementing data de-identification processes for privacy enhancing purposes.

🔗 CATEGORY Standard (ISO/IEC)

📅 PUBLISHED 2018-11

📁 DOMAIN Horizontal / Cross-domain

## Specification | JTC 1/SC 27 | ISO/IEC 27001:2013 - Information technology- Security techniques - Information security management systems - Requirements

ISO/IEC 27001 2013 specifies the requirements for establishing, implementing, maintaining and continually improving an information security management system within the context of the organization. It also includes requirements for the assessment and treatment of information security risks tailored to the needs of the organization. The requirements set out in ISO/IEC 27001 2013 are generic and are intended to be applicable to all organizations, regardless of type, size or nature.

🔗 CATEGORY Standard (ISO/IEC)

📅 PUBLISHED 2013-10

📁 DOMAIN Horizontal / Cross-domain

## Specification | JTC 1/SC 27 | ISO/IEC DIS 27400 Cybersecurity - IoT security and privacy - Guidelines

Information security is a major concern of any information and communication technology (ICT) system and Internet of Things (IoT) systems are no exception. IoT systems present particular challenges for information security in that they are highly distributed and involve a large number of diverse entities. This implies that there are a very large attack surface and a significant challenge for the information security management system (ISMS) to apply and maintain appropriate security controls across the whole system. Privacy or personally identifiable information (PII) protection is a significant concern for some types of IoT systems. Where an IoT system acquires or uses PII, it is usually the case that there are laws and regulations that apply to the acquisition, storage and processing of PII, which the IoT system needs to comply with. Even where regulations are not a concern, the handling of PII by an IoT system remains a reputational and trust concern for the organizations involved, for example if the PII is stolen or is misused, potentially causing some form of harm to the people identified by the information. Security and privacy controls in this standard are developed for stakeholders in an IoT system environment, so as to be utilized by each IoT stakeholder, throughout the IoT system life cycle.

🔗 CATEGORY Standard (ISO/IEC)

📅 PUBLISHED Under Development

📁 DOMAIN Horizontal / Cross-domain

## Specification | JTC 1/SC 27 | ISO/IEC TS 27110:2021 Information technology, cybersecurity and privacy protection - Cybersecurity framework development guidelines

This document specifies guidelines for developing a cybersecurity framework. It is applicable to cybersecurity framework creators regardless of their organizations' type, size or nature.

🔗 CATEGORY Standard (ISO/IEC)

📅 PUBLISHED 2021-02

📁 DOMAIN Horizontal / Cross-domain

## Specification | JTC 1/SC 40 | ISO/IEC 38505-1:2017 Information technology - Governance of IT - Governance of data - Part 1: Application of ISO/IEC 38500 to the governance of data

ISO/IEC 38505-1 2017 provides guiding principles for members of governing bodies of organizations (which can comprise owners, directors, partners, executive managers, or similar) on the effective, efficient, and acceptable use of data within their organizations by - applying the governance principles and model of ISO/IEC 38500 to the governance of data, - assuring stakeholders that, if the principles and practices proposed by this document are followed, they can have confidence in the organization's governance of data, - informing and guiding governing bodies in the use and protection of data in their organization, and - establishing a vocabulary for the governance of data. ISO/IEC 38505-1 2017 can also provide guidance to a wider community, including executive managers, external businesses or technical specialists, such as legal or accounting specialists, retail or industrial associations, or professional bodies, internal and external service providers (including consultants), and auditors. While this document looks at the governance of data and its use within an organization, guidance on the implementation arrangement for the effective governance of IT in general is found in ISO/IEC/TS 38501. The constructs in ISO/IEC/TS 38501 can help to identify internal and external factors relating to the governance of IT and help to define beneficial outcomes and identify evidence of success. ISO/IEC 38505-1 2017 applies to the governance of the current and future use of data that is created, collected, stored or controlled by IT systems, and impacts the management processes and decisions relating to data. ISO/IEC 38505-1 2017 defines the governance of data as a subset or domain of the governance of IT, which itself is a subset or domain of organizational, or in the case of a corporation, corporate governance. ISO/IEC 38505-1 2017 is applicable to all organizations, including public and private companies, government entities, and not-for-profit organizations. This document is applicable to organizations of all sizes from the smallest to the largest, regardless of the extent of their dependence on data.

🔗 CATEGORY Standard (ISO/IEC)

📅 PUBLISHED 2017-04

📖 DOMAIN Horizontal / Cross-domain

## Specification | JTC 1/SC 41 | ISO/IEC 21823-3:2021 Internet of Things (IoT) - Interoperability for IoT systems - Part 3: Semantic interoperability

ISO/IEC 21823-3 2021 provides the basic concepts for IoT systems semantic interoperability, as described in the facet model of ISO/IEC 21823-1, including

- (1) requirements of the core ontologies for semantic interoperability;
- (2) best practices and guidance on how to use ontologies and to develop domain-specific applications, including the need to allow for extensibility and connection to external ontologies;
- (3) cross-domain specification and formalization of ontologies to provide harmonized utilization of existing ontologies;
- (4) relevant IoT ontologies along with comparative study of the characteristics and approaches in terms of modularity, extensibility, reusability, scalability, interoperability with upper ontologies, and so on; and
- (5) use cases and service scenarios that exhibit necessities and requirements of semantic interoperability.

🔗 CATEGORY Standard (ISO/IEC)

📅 PUBLISHED 2021-09

📖 DOMAIN Horizontal / Cross-domain

# Specification | JTC 1/SC 41 | ISO/IEC 30147:2021 - Internet of Things (IoT) - Integration of IoT trustworthiness activities in ISO/IEC/IEEE 15288 system engineering processes

This document provides system life cycle processes to implement and maintain trustworthiness in an IoT system or service by applying and supplementing ISO/IEC/IEEE 15288 2015. The system life cycle processes are applicable to IoT systems and services common to a wide range of application areas.

🔗 CATEGORY Standard (ISO/IEC)

📅 PUBLISHED 2021-05

📁 DOMAIN Horizontal / Cross-domain

# Specification | JTC 1/SC 41 | ISO/IEC AWI 30172 Digital Twin : Use cases

This document provides a collection of representative use cases of DT applications in a variety of domains.

🔗 CATEGORY Standard under development (ISO/IEC)

📅 PUBLISHED Under Development

📁 DOMAIN Horizontal / Cross-domain

# Specification | JTC 1/SC 41 | ISO/IEC AWI 30173 Digital Twin : Concepts and terminology

This document establishes terminology for Digital Twin (DT) and describes concepts in the field of Digital Twin, including the terms and definitions of Digital Twin, concepts of Digital Twin (e.g., Digital Twin ecosystem, lifecycle process for Digital Twin, and classifications of Digital Twin), Functional view of Digital Twin and Digital Twin stakeholders. This document can be used in the development of other standards and in support of communications among diverse, interested parties/stakeholders. This document is applicable to all types of organizations (e.g., commercial enterprises, government agencies, not-for-profit organizations).

🔗 CATEGORY Standard under development (ISO/IEC)

📅 PUBLISHED Under Development

📁 DOMAIN Horizontal / Cross-domain

# Specification | JTC 1/SC 41 | PWI JTC1-SC41-5 Digital Twin - Reference Architecture

This document provides an overview of Digital Twin, describes the capabilities, range, characteristics and requirements, and establishes a well-defined conceptual model, reference model and reference architectural views including usage view, functional view, and network view. This document is applicable to all types of organizations (e.g., commercial enterprises, government agencies, not-for-profit organizations).

🔗 CATEGORY Standard under development (ISO/IEC)

📅 PUBLISHED Under Development

📁 DOMAIN Horizontal / Cross-domain

## Specification | JTC 1/SC 41 | PWI JTC1-SC41-6 Guidance for IoT and Digital Twin use cases

Define a conceptual model for the building of use cases; specify a use case template ontology, i.e. vocabulary as well as conventions for describing and representing use case contents; provide guidance on building use case templates and on extending a use case ontology to cover the targeted standard; provide examples of use case templates and use cases; and specify an implementation scheme that will allow use cases to be stored and shared in a repository.

🔗 CATEGORY Standard under development(ISO/IEC)

📅 PUBLISHED Under Development

📁 DOMAIN Horizontal / Cross-domain

## Specification | JTC 1/SC 42 | ISO/IEC DIS 23894 Information technology - Artificial intelligence - Risk management

This document provides guidelines on managing risk faced by organizations during the development and application of artificial intelligence (AI) techniques and systems. The guidelines also aim to assist organizations to integrate risk management into their AI-related activities and functions. It moreover describes processes for the effective implementation and integration of AI risk management. The application of these guidelines can be customized to any organization and its context.

🔗 CATEGORY Standard under development (ISO/IEC)

📅 PUBLISHED Under development

📁 DOMAIN Horizontal / Cross-Domain

## Specification | JTC 1/SC 42 | ISO/IEC AWI 5339 Information Technology - Artificial Intelligence - Guidelines for AI applications

This document provides a set of guidelines for identifying the context, opportunities, and processes for developing and applying AI applications. It can be used by ISO, IEC, and JTC1 Technical Committees and Sub-Committees to build on this work in developing standards for AI applications in their areas of interest. The guidelines provide a macro level view of the AI application context, the stakeholders and their roles, relationship to the life cycle of the system, and common AI application characteristics. The guidelines will reference but not duplicate or overlap other AI-related standards to build details.

🔗 CATEGORY Standard under development(ISO/IEC)

📅 PUBLISHED Under development

📁 DOMAIN Horizontal / Cross-Domain

## Specification | JTC 1/SC 42 | ISO/IEC AWI 5392 Information technology - Artificial intelligence - Reference architecture of knowledge engineering

This document defines a reference architecture of Knowledge Engineering (KE) in Artificial Intelligence (AI). The reference architecture describes KE roles, activities, constructional layers, components and their relationships among themselves and other systems from systemic user and functional views. This document also provides a common KE vocabulary by defining KE terms.

🔗 CATEGORY Standard under development (ISO/IEC)

📅 PUBLISHED Under development

📁 DOMAIN Horizontal / Cross-Domain

## Specification | JTC 1/SC 42 | ISO/IEC AWI TR 5469 Artificial intelligence - Functional safety and AI systems

This document describes the properties, related risk factors, available methods and processes relating to

- 1) Use of AI inside a safety related function to realise the functionality
- 2) Use of non-AI safety related functions to ensure safety for an AI controlled equipment
- 3) Use of AI systems to design and develop safety related functions.

🔗 CATEGORY Standard under development (ISO/IEC)

📅 PUBLISHED Under development

📁 DOMAIN Horizontal / Cross-domain

## Specification | JTC 1/SC 42 | ISO/IEC CD 5338 Information technology - Artificial intelligence - AI system life cycle processes

This document defines a set of processes and associated terminology for describing the life cycle of AI systems. This document forms the foundation of a detailed AI system life cycle specification. It is based on ISO/IEC/IEEE 15288 and ISO/IEC/IEEE 12207 with substitutes for and additions of AI specific processes, whose foundation is based on ISO/IEC 22989 and ISO/IEC 23053. Selected sets of these processes can be applied throughout the life cycle for managing and performing the stages of an AI system's life cycle. This document provides processes that support the definition, control and improvement of the AI system life cycle processes used within an organization or a project. Organizations and projects can use these processes when developing or acquiring AI systems. When an element of an AI system is traditional software or a traditional system, the software life cycle processes in ISO/IEC/IEEE 12207 and the system life cycle processes in ISO/IEC/IEEE 15288 may be used to implement that element.

🔗 CATEGORY Standard under development (ISO/IEC)

📅 PUBLISHED Under development

📁 DOMAIN Horizontal / Cross-Domain

## Specification | JTC 1/SC 42 | ISO/IEC FDIS 22989 Information technology - Artificial intelligence - Artificial intelligence concepts and terminology

This document establishes terminology for Artificial Intelligence (AI) and describes concepts in the field of AI. This document can be used in the development of other standards and in support of communications among diverse, interested parties/stakeholders. This document is applicable to all types of organizations (e.g., commercial enterprises, government agencies, not-for-profit organizations).

🔗 CATEGORY Standard under development (ISO/IEC)

📅 PUBLISHED Under development

📁 DOMAIN Horizontal / Cross-Domain

## Specification | JTC 1/SC 42 | ISO/IEC FDIS 38507 Information technology - Governance of IT - Governance implications of the use of artificial intelligence by organizations

This document provides guidance for members of the governing bodies of organizations (which can comprise owners, directors, partners, executive managers, or similar) on the effective, efficient, and acceptable uses of artificial intelligence within their organizations by

- 1) providing a framework for understanding the implications, in a timely manner, of the use of AI;



- 2) equipping governing bodies to evaluate, direct and monitor the introduction and use of these technologies, applying the governance principles of ISO/IEC 38500;
- 3) assuring stakeholders that, if the guidance proposed by this document is followed, they can have confidence in the organizations use of AI;
- 4) providing appropriate terminology.

This document also provides guidance to a wider community, including executive managers; external businesses or technical specialists, such as legal or accounting specialists, retail or industrial associations, or professional bodies; - public authorities and policy-makers; - internal and external service providers (including consultants); auditors.

🔗 CATEGORY Standard under development (ISO/IEC)

📅 PUBLISHED Under development

📁 DOMAIN Horizontal / Cross-Domain

## Specification | DTC | Glossary of Digital Twins

A glossary of digital twins and digital twin technology from the Digital Twin Consortium. This glossary is not intended to cover industry-specific domains for which one might build a digital twin system. The glossary is a Work-In-Progress draft.

🔗 CATEGORY Web (glossary)

📅 PUBLISHED online

📁 DOMAIN Cross-domain

# ■ Aeronautics, Aerospace

## Report | AIAA | DIGITAL TWIN: DEFINITION and VALUE, An AIAA and AIA Position Paper

This paper, developed by members from academia, industry, and government, has four goals

- 1) provide the Aerospace community with a common definition of the Digital Twin,
- 2) illustrate Digital Twin capabilities through a number of applications and value examples,
- 3) discuss the alignment between the U.S. Department of Defense (DoD) Digital Engineering Strategy and aerospace industry viewpoints of the Digital Twin,
- 4) identify future focus areas and activities for accelerating value realization from the use of Digital Twins.

The paper defines a Digital Twin is a virtual representation of a connected physical asset and encompasses its entire product lifecycle. The value of a Digital Twin stems from the ability to shift work from a physical environment into a virtual or digital environment and from the capability to predict asset conditions in the future, or when physically not desirable, by leveraging the digital model. This in turns leads to significant decreases in the resources needed to design, produce, and keep aerospace assets operational. In particular, this paper recommends establishing a Digital Twin Center of Excellence for collaboration between Academia, Industry, the United States Government, and relevant Certification Authorities to tackle the business, technical and cultural needs, gaps, and challenges identified by the authors.

🔗 CATEGORY Paper (position paper)

📅 PUBLISHED 2020 – 12

📁 DOMAIN Aeronautics - Aerospace

## Report | DTC | DT Framework for Aerospace-Defense

An architectural framework for digital twins of physical entities or assets in the aerospace and defense industries.

📁 CATEGORY paper (framework)

📅 PUBLISHED Under Development

📁 DOMAIN Aeronautics - Aerospace

# Agriculture

## Report | Digital twins in smart farming

Digital Twins are very promising to bring smart farming to new levels of farming productivity and sustainability. A Digital Twin is a digital equivalent of a real-life object of which it mirrors its behaviour and states over its lifetime in a virtual space. Using Digital Twins as a central means for farm management enables the decoupling of physical flows from its planning and control. As a consequence, farmers can manage operations remotely based on (near) real-time digital information instead of having to rely on direct observation and manual tasks on-site. This allows them to act immediately in case of (expected) deviations and to simulate effects of interventions based on real-life data. This paper analyses how Digital Twins can advance smart farming. It defines the concept, develops a typology of different types of Digital Twins, and proposes a conceptual framework for designing and implementing Digital Twins. The framework comprises a control model based on a general systems approach and an implementation model for Digital Twin systems based on the Internet of Things Architecture (IoT-A), a reference architecture for IoT systems. The framework is applied to and validated in five smart farming use cases of the European IoF2020 project, focussing on arable farming, dairy farming, greenhouse horticulture, organic vegetable farming and livestock farming.

📁 CATEGORY Paper

📅 PUBLISHED 2021-04

📁 DOMAIN Agriculture

## ■ Anatomy, medical

### Report | IEEE | Can we have a digital twin?

This blog presents the idea of a digital twin of a human.

📖 CATEGORY Paper (position paper)

📅 PUBLISHED 2017-09

📁 DOMAIN Anatomy, medical

## ■ Augmented reality

### Report | Proprietary | Augmented Reality and the Digital Twin: State-of-the-Art and Perspectives for Cybersecurity

The rapid advancements of technology related to the Internet of Things and Cyber-Physical Systems mark an ongoing industrial revolution. Digital Twins (DT) and Augmented Reality (AR) play a significant role in this technological advancement. They are highly complementary concepts enabling the representation of physical assets in the digital space (Digital Twin) and the augmentation of physical space with digital information (Augmented Reality). Throughout the last few years, research has picked up on this and explored the possibilities of combining DT and AR. However, cybersecurity scholars have not yet paid much attention to this combined-arms approach, despite its potential. Especially, concerning contemporary security challenges, such as developing cyber situational awareness and including human factors into cybersecurity, AR and DT, offer tremendous potential for improvement. In this work, we systematize existing knowledge on AR-powered DTs and shed light on why and how cybersecurity could benefit from this combination.

📖 CATEGORY Paper (Journal of cybersecurity and privacy)

📅 PUBLISHED 2021-09

📁 DOMAIN Augmented reality

### Report | ISG ARF | ETSI GR ARF 002 V1.1.1 (2019-07): Augmented Reality Framework (ARF) Industrial use cases for AR applications and services

The present document summarizes the results of a questionnaire issued by the Industry Specification Group Augmented Reality Framework (ISG ARF) on industrial use cases and reviews of two workshops held by the ISG ARF, where a number of use cases were presented. These results are presented in categories such as (a) most relevant use cases; (b) challenges of AR; (c) scale of operation; (d) accuracy for the positioning of augmentation; (e) data sources for augmentation data; (f) data security; (g) data sharing; (h) mode of operation; (i) environmental conditions; etc. Based on this analysis it is possible to identify the most relevant parameters and operational conditions for Augmented Reality in the industry and thus elaborate a requirements document for industrial use cases.

📖 CATEGORY Standard

📅 PUBLISHED 2019-07

📁 DOMAIN Augmented reality

# Specification | IEEE | P2048.8 - Standard for Virtual Reality and Augmented Reality: Interoperability between Virtual Objects and the Real World

This standard specifies the requirements, systems, methods, testing and verification for the interoperability between virtual objects and the real world in Augmented Reality (AR) and Mixed Reality (MR) applications.

🔗 CATEGORY Standard (IEEE)

📅 PUBLISHED 2019-03

📁 DOMAIN Augmented reality

## ■ Automation system

### Specification | IEC TC65 Automation | IEC TR 62541-2:2020 RLV - OPC unified architecture - Part 2: Security Model

IEC 62541-2 2020 describes the OPC Unified Architecture (OPC UA) security model. It describes the security threats of the physical, hardware, and software environments in which OPC UA is expected to run. It describes how OPC UA relies upon other standards for security. It provides definition of common security terms that are used in this and other parts of the OPC UA specification. It gives an overview of the security features that are specified in other parts of the OPC UA specification. It references services, mappings, and Profiles that are specified normatively in other parts of the OPC UA Specification. It provides suggestions or best practice guidelines on implementing security. Any seeming ambiguity between this part and one of the other normative parts does not remove or reduce the requirement specified in the other normative part.

🔗 CATEGORY Standard (IEC)

📅 PUBLISHED 2020-11

📁 DOMAIN Automation

### Specification | IEC TC65 Automation | IEC 61512-2:2001- Batch control - Part 2: Data structures and guidelines for languages

This part of this standard on batch control defines data models that describe batch control as applied in the process industries, data structures for facilitating communications within and between batch control implementations and language guidelines for representing recipes. Refer to Annex A for an explanation of the UML notation that is used in this part of this standard. Refer to Annex B for a summary of all of the SQL definitions from clause 5

🔗 CATEGORY Standard (IEC)

📅 PUBLISHED 2001-11

📁 DOMAIN Automation

## Specification | IEC TC65 Automation | IEC 62264-3:2016 - Enterprise-control system integration - Part 3: Activity models of manufacturing operations management

IEC 62264-3 2016 defines activity models of manufacturing operations management that enable enterprise system to control system integration. The activities defined in this document are consistent with the object models definitions given in IEC 62264-1. The modelled activities operate between business planning and logistics functions, defined as the Level 4 functions and the process control functions, defined as the Level 2 functions of IEC 62264-1. IEC 62264-3 2016 defines activity models of manufacturing operations management that enable enterprise system to control system integration. The activities defined in this document are consistent with the object models definitions given in IEC 62264-1. The modelled activities operate between business planning and logistics functions, defined as the Level 4 functions and the process control functions, defined as the Level 2 functions of IEC 62264-1. This second edition cancels and replaces the first edition published in 2007.

🔗 CATEGORY Standard (IEC)

📅 PUBLISHED 2016-12

🏠 DOMAIN Automation

## Specification | IEC TC65 Automation | IEC 62443-2- 4:2015+AMD1:2017 CSV Consolidated version - Security for industrial automation and control systems - Part 2-4: Security program requirements for IACS service providers

IEC 62443-2-4 2015+A1 2017 specifies requirements for security capabilities for IACS service providers that they can offer to the asset owner during integration and maintenance activities of an Automation Solution

🔗 CATEGORY Standard (IEC)

📅 PUBLISHED 2017-08

🏠 DOMAIN Automation

## Specification | IEC TC65 Automation | IEC 62443-3-2:2020 - Security for industrial automation and control systems - Part 3-2: Security risk assessment for system design

IEC 62443-3-2 2020 establishes requirements for

- (a) defining a system under consideration (SuC) for an industrial automation and control system (IACS);
- (b) partitioning the SuC into zones and conduits;
- (c) assessing risk for each zone and conduit;
- (d) establishing the target security level (SL-T) for each zone and conduit; and (e) documenting the security requirements.

🔗 CATEGORY Standard (IEC)

📅 PUBLISHED 2020-06

🏠 DOMAIN Automation



## Specification | IEC TC65 Automation | IEC 62443-3-3:2013 - Industrial communication networks - Network and system security - Part 3-3: System security requirements and security levels

IEC 62443-3-3 2013 provides detailed technical control system requirements (SRs) associated with the seven foundational requirements (FRs) described in IEC 62443-1-1 including defining the requirements for control system capability security levels, SL-C(control system). These requirements would be used by various members of the industrial automation and control system (IACS) community along with the defined zones and conduits for the system under consideration (SuC) while developing the appropriate control system target SL, SL-T(control system), for a specific asset.

🔗 CATEGORY Standard (IEC)

📅 PUBLISHED 2013-08

🏠 DOMAIN Automation

## Specification | IEC TC65 Automation | IEC 62443-4-1:2018 - Security for industrial automation and control systems - Part 4-1: Secure product development lifecycle requirements

IEC 62443-4 2018 specifies the process requirements for the secure development of products used in industrial automation and control systems. This specification is part of a series of standards that addresses the issue of security for industrial automation and control systems (IACS). IEC 62443- 4 defines secure development life-cycle (SDL) requirements related to cyber security for products intended for use in the industrial automation and control systems environment and provides guidance on how to meet the requirements described for each element. The life-cycle description includes security requirements definition, secure design, secure implementation (including coding guidelines), verification and validation, defect management, patch management and product end-of-life. These requirements can be applied to new or existing processes for developing, maintaining and retiring hardware, software or firmware. Note that these requirements only apply to the developer and maintainer of the product, and are not applicable to the integrator or the user of the product. A summary list of the requirements is provided in Annex B.

🔗 CATEGORY Standard (IEC)

📅 PUBLISHED 2018-01

🏠 DOMAIN Automation

## Specification | IEC TC65 Automation | IEC 62443-4-2:2019 Security for industrial automation and control systems - Part 4-2: Technical security requirements for IACS components

IEC 62443-4-2 2019 provides detailed technical control system component requirements (CRs) associated with the seven foundational requirements (FRs) described in IEC TS 62443-1-1 including defining the requirements for control system capability security levels and their components, SL-C(component). As defined in IEC TS 62443-1-1 there are a total of seven foundational requirements (FRs)

- a) identification and authentication control (IAC),
- b) use control (UC),
- c) system integrity (SI),
- d) data confidentiality (DC),
- e) restricted data flow (RDF),
- f) timely response to events (TRE), and g) resource availability (RA).

These seven FRs are the foundation for defining control system security capability levels. Defining security capability levels for the control system component is the goal and objective of this document as opposed to SL-T or achieved SLs (SL-A), which are out of scope.

🔗 CATEGORY Standard (IEC)

## Specification | IEC TC65 Automation | IEC 62714-1:2018 - Engineering data exchange format for use in industrial automation systems engineering - Automation Markup Language - Part 1: Architecture and general requirements

IEC 62714-1 2018 RLV contains both the official IEC International Standard and its Redline version. The Redline version is available in English only and provides you with a quick and easy way to compare all the changes between the official IEC Standard and its previous edition. IEC 62714-1 2018 is a solution for data exchange focusing on the domain of automation engineering. The data exchange format defined in the IEC 62714 series (Automation Markup Language, AML) is an XML schema based data format and has been developed in order to support the data exchange in a heterogeneous engineering tools landscape. The goal of AML is to interconnect engineering tools in their different disciplines, e.g. mechanical plant engineering, electrical design, process engineering, process control engineering, HMI development, PLC programming, robot programming, etc. This second edition cancels and replaces the first edition published in 2014. This edition constitutes a technical revision. This edition includes the following significant technical changes with respect to the previous edition

- a) use of CAEX 3.0 according to IEC 62424 2016
- b) improved modelling of references to documents outside of the scope of the present standard,
- c) modelling of references between CAEX attributes and items in external documents,
- d) revised role libraries,
- e) modified Port concept,
- f) modelling of multilingual expressions,
- g) modelling of structured attribute lists or array,
- h) a new AML container format,
- i) a new standard AML attribute library.

 CATEGORY Standard (IEC)

## Specification | IEC TC65 Automation | IEC 62890:2020 -Industrial-process measurement, control and automation - Life-cycle-management for systems and components

IEC 62890 2020 establishes basic principles for Life-Cycle-Management of systems and components used for industrial-process measurement, control and automation. These principles are applicable to various industrial sectors. This standard provides definitions and reference models related to the life-cycle of a product type and the life time of a product instance, It defines a consistent set of generic reference models and terms. The key models defined are Life-Cycle-Model; structure model; compatibility model. This document also describes the application of these models for Life-Cycle-Management strategies. The content is used for technical aspects concerning the design, planning, development and maintenance of automation systems and components and the operation of the plant. The definitions of generic models and terms regarding Life-Cycle-Management are indispensable for a common understanding and application by all partners in the value chain such as plant user, product and system producer, service provider, and component supplier. The models and strategies described in this standard are also applicable for related management systems, i.e. MES and ERP.

 CATEGORY Standard (IEC)

# Specification | IEC TC65 Automation | IEC TR 62541-1:2020 - OPC Unified Architecture - Part 1: Overview and concepts

IEC TR 62541-1 2020 is available as IEC TR 62541-1 2020 RLV which contains the International Standard and its Redline version, showing all changes of the technical content compared to the previous edition. IEC 62541-1 2020 presents the concepts and overview of the OPC Unified Architecture (OPC UA). Reading this document is helpful to understand the remaining parts of this multi-part document set. Each of the other parts of IEC 62451 is briefly explained along with a suggested reading order.

🔗 CATEGORY Standard (IEC)

📅 PUBLISHED 2020-11

📁 DOMAIN Automation

# Specification | IEC TC65 Automation | IEC 62443-2-2 ED1 Security for industrial automation and control systems - Part 2-2: IACS Security Protection

There is no simple recipe for how to secure an industrial automation and control system (IACS) and there is a good reason for this. It is because security is a matter of risk management. Every IACS presents a different risk to the organization depending upon the threats it is exposed to, the likelihood of those threats arising, the inherent vulnerabilities in the system, and the consequences if the system were to be compromised. Furthermore, every organization that owns and operates an IACS has a different tolerance for risk. This document strives to give guidance for developing technical and process security measures applied to zones and conduits of an IACS and how to use relevant documents of the IEC 62443 series for this purpose. Readers are encouraged to familiarize themselves with the scope and concepts of IEC 62443-2-1, IEC 62443-2-4, IEC 62443-3-2, IEC 62443-3-3, IEC 62443-4-1, and IEC 62443-4-2 before reading this document.

🔗 CATEGORY Standard under development (IEC)

📅 PUBLISHED Under Development

📁 DOMAIN Automation

## ■ Building, Construction

# Report | bSI | A position paper from building SMART International for the construction industry

This white paper defines the digital twin, from the perspective of the built asset industry, as a “physical counterpart”. The paper aims to answer the following questions - How can building infrastructure be optimised for the challenging environmental conditions of the future? - Data and AI, IOT edge and cloud technologies exist today, but why is the industry hesitant to adopt them more broadly? buildingSMART International (bSI) develops open digital solutions and standards for the built asset industry. It aims at focusing on the digital twin ecosystem and solving the main issues related to the absence of a holistic view and of a mapping of information throughout a larger system to enable interoperability.

🔗 CATEGORY Paper (standards gaps)

📅 PUBLISHED 2020-06

📁 DOMAIN Building, Construction

## Report | Digital twin hub | Skill and competence framework

The Skills and Competency Framework presented in this paper, is the people enabler needed to develop and adopt the IMF - a core step in achieving the National Digital Twin. It aims to identify the skills and competencies needed across a range of relevant roles, helping the industry assess and resolve any gaps in skills. Roles do not map to jobs and it is likely that some people will perform a number of roles depending on organisational complexity and level of commitment.

📁 CATEGORY Paper

📅 PUBLISHED 2021-05

📁 DOMAIN Building, Construction

## Report | DTC | Infrastructure Lifecycle: A Case for Change

Technical brief on how the lifecycle for infrastructure needs to adapt to accommodate digital twins into the process and enable the benefits that digital twins can deliver. A digital twin approach enables a transformation of the lifecycle that unlocks new value and efficiency.

📁 CATEGORY Paper (lifecycle)

📅 PUBLISHED 2022-01

📁 DOMAIN Building, Construction

## Report | METI | Guidelines for Cyber-Physical Security Measures for Building Systems

As part of the efforts to ensure cybersecurity by the industry, the Ministry of Economy, Trade and Industry (METI) focused on the field of buildings with a number of control devices, such as elevators and air conditioners, and formulated the Guidelines for Cyber-Physical Security Measures for Building Systems (First Version), a systematic set of points to focus on and specific requirements when taking cybersecurity measures, with the aim of ensuring cybersecurity for building systems.

📁 CATEGORY Paper (Japan national initiative)

📅 PUBLISHED 2019-06

📁 DOMAIN Building, Construction

## Report | NSAI | Irish National Annex to I.S. EN ISO 19650 -2:2018, Organisation and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 2: Delivery phase of assets (ISO 19650-2:2018)

This document gives guidance for the implementation of I.S. EN ISO 19650-2 2018, within the national context of construction projects. It does not preclude reliance on other agreements or international cooperation. This document provides the structure for field identification and the metadata for information containers and information exchange standards requirements.

📁 CATEGORY Paper (NSAI)

📅 PUBLISHED 2021-02

📁 DOMAIN Building, Construction

## Report | Sphere | Digital Twins White Paper

Devised within the scope of the SPHERE EU Project, the proposed definitions aim to offer a standard framework for future development of Building Digital Twins, providing an environment for Smart, Connected Asset Systems (SCAS) throughout their entire life cycle.

📁 CATEGORY Paper (research project)

📅 PUBLISHED 2019-12

🏠 DOMAIN Building, Construction

## Report | Towards a semantic Construction Digital Twin: Directions for future research

As the Architecture, Engineering and Construction sector is embracing the digital age, the processes involved in the design, construction and operation of built assets are more and more influenced by technologies dealing with value-added monitoring of data from sensor networks, management of this data in secure and resilient storage systems underpinned by semantic models, as well as the simulation and optimisation of engineering systems. Aside from enhancing the efficiency of the value chain, such information-intensive models and associated technologies play a decisive role in minimising the lifecycle impacts of our buildings. While Building Information Modelling provides procedures, technologies and data schemas enabling a standardised semantic representation of building components and systems, the concept of a Digital Twin conveys a more holistic socio-technical and process-oriented characterisation of the complex artefacts involved by leveraging the synchronicity of the cyber-physical bi-directional data flows. Moreover, BIM lacks semantic completeness in areas such as control systems, including sensor networks, social systems, and urban artefacts beyond the scope of buildings, thus requiring a holistic, scalable semantic approach that factors in dynamic data at different levels. The paper reviews the multi-faceted applications of BIM during the construction stage and highlights limits and requirements, paving the way to the concept of a Construction Digital Twin. A definition of such a concept is then given, described in terms of underpinning research themes, while elaborating on areas for future research.

📁 CATEGORY Paper (future research)

📅 PUBLISHED 2020-03

🏠 DOMAIN Building, Construction

## Specification | CEN TC 442 Building BIMs | prEN 17632:2021: Building Information Modelling (BIM) - Semantic Modelling and Linking (SML)

This document discusses an integrated and unified approach for data aspects, specifically for assets in the built environment, using enterprise interoperability framework (EIF) terminology.

📁 CATEGORY Standard

📅 PUBLISHED Under development

🏠 DOMAIN Building, Construction

# Specification | JTC 1/SC 35 | ISO/IEC DIS 17549-1 Information technology - User interface guidelines on menu navigation - Part 1: Framework

This document provides a framework for ISO/IEC 17549 series describing user interface guidelines on menu navigation. This document specifies requirements and recommendations on how to design usable and consistent navigation through the interface component called menu. This document provides recommendations and requirements on how to select and validate elements displayed on menus. This document refers to design consistent navigation inside menus, and does not include testing nor organisation of menus.

🔗 CATEGORY Standard

📅 PUBLISHED Under development

🏠 DOMAIN Building, Construction

# Specification | TC 59 | ISO 15686-4:2014 Building Construction - Service Life Planning - Part 4: Service Life Planning using Building Information Modelling

ISO 15686-4 2014 provides information and guidance on the use of standards for information exchange for service life planning of buildings and constructed assets and their components as well as the required supporting data. It provides guidance on structuring information from existing data sources to enable delivery of their information content in a structure that conforms to international standards for information exchange. In particular, reference is made to ISO 16739. The Construction Operations Building Information Exchange (COBie) standard for the exchange of facility information in tabular data are used as an alternative representation. COBie is a tabular representation of a handover view of the IFC schema. ISO 15686-4 2014 is also applicable to the exchange of service life information between categories of design and information management software applications that have standards-based information exchange interfaces including BIM and CAFM Computer Aided Facilities Management.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2014-01

🏠 DOMAIN Building, Construction

# Specification | TC 59 SC13 | ISO 12006-2:2015 Building construction - Organization of information about construction works - Part 2: Framework for classification

ISO 12006-2 2015 defines a framework for the development of built environment classification systems. It identifies a set of recommended classification table titles for a range of information object classes according to particular views, e.g. by form or function, supported by definitions.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2015-05

🏠 DOMAIN Building, Construction



## Specification | TC 59 SC13 | ISO 16739:2018 - Industry Foundation Classes (IFC) for data sharing in the construction and facility management industries

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The Industry Foundation Classes, IFC, are an open international standard for Building Information Model (BIM) data that are exchanged and shared among software applications used by the various participants in the construction or facility management industry sector. The standard includes definitions that cover data required for buildings over their life cycle. This release, and upcoming releases, extend the scope to include data definitions for infrastructure assets over their life cycle as well.

📁 CATEGORY Standard (ISO)

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📅 PUBLISHED 2018-11

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🏠 DOMAIN Building, Construction

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## Specification | TC 59 SC13 | ISO 16739-1:2018 Industry Foundation Classes (IFC) for data sharing in the construction and facility management industries - Part 1: Data schema

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The Industry Foundation Classes, IFC, are an open international standard for Building Information Model (BIM) data that are exchanged and shared among software applications used by the various participants in the construction or facility management industry sector. The standard includes definitions that cover data required for buildings over their life cycle. This release, and upcoming releases, extend the scope to include data definitions for infrastructure assets over their life cycle as well.

📁 CATEGORY Standard (ISO)

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📅 PUBLISHED 2018-11

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🏠 DOMAIN Building, Construction

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## Specification | TC 59 SC13 | ISO 16757-2:2016 Data structures for electronic product catalogues for building services – Part 2: Geometry

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ISO 16757-2 2016 describes the modelling of building services product geometry. The description is optimized for the interchange of product catalogue data and includes – shapes for representing the product itself, - symbolic shapes for the visualization of the product's function in schematic diagrams, - spaces for functional requirements – surfaces for visualization and – ports to represent connectivity between different objects. The shape and space geometry is expressed as Constructive Solid Geometry (CSG) based on geometric primitives concatenated to boundary representations by Boolean operations. ISO 16757-2 2016 uses the applicable primitives from ISO 10303-42 and from ISO 16739 and adds primitives which are required for the special geometry of building services products. For symbolic shapes, line elements are also used. ISO 16757-2 2016 neither describes the inner structure and internal functionality of the product nor the manufacturing information because this is typically not published within a product catalogue. Building services products can have millions of variant dimensions. To avoid the exchange of millions of geometries, a parametric model is introduced which allows the derivation of variant-specific geometries from the generic model. This is necessary to reduce the data to be exchanged in a catalogue to a manageable size. The parametric model will result in smaller data files, which can be easier transmitted during data exchanges. The geometry model used does not contain any drawing information such as views, line styles or hatching.

📁 CATEGORY Standard (ISO)

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📅 PUBLISHED 2016-11

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🏠 DOMAIN Building, Construction

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# Specification | TC 59 SC13 | ISO 19650-1:2018 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 1: Concepts and principles

This document outlines the concepts and principles for information management at a stage of maturity described as \_building information modelling (BIM) according to the ISO 19650 series. This document provides recommendations for a framework to manage information including exchanging, recording, versioning and organizing for all actors. This document is applicable to the whole life cycle of any built asset, including strategic planning, initial design, engineering, development, documentation and construction, day-to-day operation, maintenance, refurbishment, repair and end-of-life. This document can be adapted to assets or projects of any scale and complexity, so as not to hamper the flexibility and versatility that characterize the large range of potential procurement strategies and so as to address the cost of implementing this document.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2018-12

🏠 DOMAIN Building, Construction

# Specification | TC 59 SC13 | ISO 19650-2:2018 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 2: Delivery phase of the assets

This document specifies requirements for information management, in the form of a management process, within the context of the delivery phase of assets and the exchanges of information within it, using building information modelling.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2018-12

🏠 DOMAIN Building, Construction

# Specification | TC 59 SC13 | ISO 19650-2:2018 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 2: Delivery phase of the assets

This document specifies requirements for information management, in the form of a management process, within the context of the delivery phase of assets and the exchanges of information within it, using building information modelling. This document can be applied to all types of assets and by all types and sizes of organizations, regardless of the chosen procurement strategy.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2018-12

🏠 DOMAIN Building, Construction

Specification | TC 59 SC13 | ISO 19650-3:2018 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 3: Operational phase of the assets

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This document specifies requirements for information management, in the form of a management process, within the context of the operational phase of assets and the exchanges of information within it, using building information modelling. This document can be applied to all types of assets and by organizations of all types and sizes involved in the operational phase of assets. The requirements in this document can be achieved through direct actions carried out by the organization in question or can be delegated to another party.

📁 CATEGORY Standard (ISO)

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📅 PUBLISHED 2020-07

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🏠 DOMAIN Building, Construction

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Specification | TC 59 SC13 | ISO 19650-3:2020 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 3: Operational phase of the assets

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This document specifies requirements for information management, in the form of a management process, within the context of the operational phase of assets and the exchanges of information within it, using building information modelling. This document can be applied to all types of assets and by organizations of all types and sizes involved in the operational phase of assets. The requirements in this document can be achieved through direct actions carried out by the organization in question or can be delegated to another party. This standard contributes to the following Sustainable Development Goal 9.

📁 CATEGORY Standard (ISO)

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📅 PUBLISHED 2020-07

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🏠 DOMAIN Building, Construction

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Specification | TC 59 SC13 | ISO 19650-5:2020 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 5: Security-minded approach to information management

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This document specifies the principles and requirements for security-minded information management at a stage of maturity described as building information modelling (BIM) according to the ISO 19650 series, and as defined in ISO 19650-1, as well as the security-minded management of sensitive information that is obtained, created, processed and stored as part of, or in relation to, any other initiative, project, asset, product or service. It addresses the steps required to create and cultivate an appropriate and proportionate security mindset and culture across organizations with access to sensitive information, including the need to monitor and audit compliance. The approach outlined is applicable throughout the lifecycle of an initiative, project, asset, product or service, whether planned or existing, where sensitive information is obtained, created, processed and/or stored. This document is intended for use by any organization involved in the use of information management and technologies in the creation, design, construction, manufacture, operation, management, modification, improvement, demolition and/or recycling of assets or products, as well as the provision of services, within the built environment. It will also be of interest and relevance to those

organizations wishing to protect their commercial information, personal information and intellectual property.

📖 CATEGORY Standard (ISO)

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📅 PUBLISHED 2020-06

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🏠 DOMAIN Building, Construction

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## Specification | TC 59 SC13 | ISO 23386:2020 Building information modelling and other digital processes used in construction - Methodology to describe, author and maintain properties in interconnected data dictionaries

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This document establishes the rules for defining properties used in construction and a methodology for authoring and maintaining them, for a confident and seamless digital share among stakeholders following a BIM process. Regarding the definition of properties and groups of properties, this document provides

- (a) definitions of properties and groups of properties as a list of attributes;
- (b) definitions of all the provided attributes.

Regarding the authoring and maintaining process, this document provides (a) definitions and roles of applicants;

- (b) definitions and roles of experts and the commission of experts;
- (c) definitions of request's attributes;
- (d) definitions of expert's attributes;
- (e) requirements to establish the management rules to interconnect data dictionaries through the mapping process for properties and groups of properties.

To apply the methodology of this document, dictionary; (b) a framework for a network of data dictionaries. It is not in the scope of this document to provide the content of the interconnected data dictionaries.

📖 CATEGORY Standard (ISO)

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📅 PUBLISHED 2020-03

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🏠 DOMAIN Building, Construction

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## Specification | TC 59 SC13 | ISO 23387:2020 - Building Information Modelling (BIM) - Data templates for construction objects used in the life-cycle of any built asset - Concepts and principles

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This document sets out the principles and structure for data templates for construction objects. It is developed to support digital processes using machine-readable formats using a standard data structure to exchange information about any type of construction object, e.g. product, system, assembly, space, building etc., used in the inception, brief, design, production, operation and demolition of facilities.

📖 CATEGORY Standard (ISO)

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📅 PUBLISHED 2020-07

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🏠 DOMAIN Building, Construction

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# Specification | TC 59 SC13 | ISO 29481-1:2016 Building information modelling - Information delivery manual - Part 1: Methodology and format

ISO 29481-1 2016 specifies - a methodology that links the business processes undertaken during the construction of built facilities with the specification of information that is required by these processes, and - a way to map and describe the information processes across the life cycle of construction works. ISO 29481-1 2016 is intended to facilitate interoperability between software applications used during all stages of the life cycle of construction works, including briefing, design, documentation, construction, operation and maintenance, and demolition. It promotes digital collaboration between actors in the construction process and provides a basis for accurate, reliable, repeatable and high-quality information exchange.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2010-05

🏠 DOMAIN Building, Construction

# Specification | TC 59 SC13 | ISO 29481-2:2012 Building information models - Information delivery manual - Part 2: Interaction framework

ISO 29481-2 2012 specifies a methodology and format for describing coordination acts' between actors in a building construction project during all life cycle stages. It therefore specifies a methodology that describes an interaction framework, an appropriate way to map responsibilities and interactions that provides a process context for information flow, a format in which the interaction framework should be specified. ISO 29481-2 2012 is intended to facilitate interoperability between software applications used in the construction process, to promote digital collaboration between actors in the building construction process, and to provide a basis for accurate, reliable, repeatable, and high-quality information exchange.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2012-12

🏠 DOMAIN Building, Construction

# Specification | TC 59 SC13 | ISO/AWI 19650-6 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 6: Health and Safety

This standard contributes to the following Sustainable Development Goals Technical Committee ISO/TC 59/SC 13 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM).

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED Under Development

🏠 DOMAIN Building, Construction

## Specification | TC 59 SC13 | ISO/DIS 12911 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Framework for specification of building information modelling (BIM) implementation

This standard establishes a framework for providing specifications for the internal commissioning and implementation of building information modelling (BIM) during both delivery and in-use phases. It is applicable to buildings, infrastructure, facilities and managed landscapes, of any size or complexity. Authors of BIM implementation specifications, including international and national institutions as well as individual organizations, can use this framework to document their expectations in a way that is clear, concise and checkable. Those supporting specific software application usage can also follow the framework. Implementers of information management processes will benefit from the clear structure and the ability to compare and merge BIM implementation specifications, potentially from multiple sources, to mobilize, execute and check their internal BIM implementations.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED Under Development

🏠 DOMAIN Building, Construction

## Specification | TC 59 SC13 | ISO/DIS 19650-4 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 4: Information exchange

ISO 19650-4 provides the detailed process and criteria for the decision points when executing an information exchange as defined by ISO 19650 so as to ensure the quality of the resulting project or asset information model. It promotes a proportional and sustainable approach to information exchange where the immediate delivery of information does not limit its future use. It details the implementation of the concepts in ISO19650-1 and is applicable to any information exchange within the delivery stages covered by ISO 19650-2 and operational events covered by ISO 19650-3. The use of appropriate quality assurance and quality control measures supports the fulfilment of a specific Exchange Information Requirement related to an individual information exchange by enumerating criteria relating to completeness, compliance to formal exchange schemas, the continuity of concepts between exchanges and the elimination of spatial and specification conflicts.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED Under Development

🏠 DOMAIN Building, Construction

## Specification | TC 59 SC13 | ISO/DIS 29481-3 Building information models - Information delivery manual - Part 3: Data schema and code

This part of ISO 29481 is the technical addition to the methodology set out in ISO 29481-1. It defines a specification to store, exchange and read IDM documents in a standardized and machine-readable way.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED Under Development

🏠 DOMAIN Building, Construction



## Specification | TC 59 SC13 | ISO/TR 3262:2021 GIS (geospatial) / BIM interoperability

This document investigates barriers and proposes measures to improve interoperability between geospatial and BIM domains, namely, to align GIS standards developed by ISO/TC 211 and BIM standards developed by ISO/TC 59/SC 13.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2021-05

🏠 DOMAIN Building, Construction

## Specification | TC 59 SC13 | ISO/TR 23262:2021 GIS (geospatial) / BIM interoperability

This document investigates barriers and proposes measures to improve interoperability between geospatial and BIM domains, namely, to align GIS standards developed by ISO/TC 211 and BIM standards developed by ISO/TC 59/SC 13. Where relevant this document takes into account work and documents from other organizations and committees, such as buildingSMART, International (bSI), Open Geospatial Consortium (OGC) and Comité Européen de Normalisation (CEN). The focus is to identify future topics for standardization and possible revision needs of existing standards. This document investigates conceptual and technological barriers between GIS and BIM domains at the data, service and process levels, as defined by ISO 11354 (all parts).

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2021-05

🏠 DOMAIN Building, Construction

## Specification | TC 59 SC13 | ISO/TS 12911:2012: Framework for building information modelling (BIM) guidance

ISO/TS 12911 2012 establishes a framework for providing specifications for the commissioning of building information modelling (BIM). It is applicable to any range of modelling of buildings and building-related facilities, from a portfolio of assets at a single site or multiple sites, to assets at a single small building and at any constituent system, subsystem, component or element. It is applicable to any asset type, including most infrastructure and public works, equipment and material. BIM processes are applicable across the entire life cycle of a portfolio, facility or component, which can span inception to end-of-use. The main user of the framework is the information manager, who utilizes the framework to assist in structuring an international-, national-project- or facility-level BIM guidance document. The framework can also be used for BIM guidance provided by application providers.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2012-09

🏠 DOMAIN Building, Construction

## Specification | TC 59 SC13 | ISO 19650-1:2018 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 1: Concepts and principles

This document outlines the concepts and principles for information management at a stage of maturity described as building information modelling (BIM) according to the ISO 19650 series. This document provides recommendations for a framework to manage information including exchanging, recording, versioning and organizing for all actors. This document is applicable to the whole life cycle of any built asset, including strategic planning, initial design, engineering, development, documentation

and construction, day-to-day operation, maintenance, refurbishment, repair and end-of-life. This document can be adapted to assets or projects of any scale and complexity, so as not to hamper the flexibility and versatility that characterize the large range of potential procurement strategies and so as to address the cost of implementing this document.

🔗 CATEGORY Standard (ISO)

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📅 PUBLISHED 2018-12

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🏠 DOMAIN Building, Construction

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## Specification | TC 92 | ISO/TR 24679-6:2017 Fire safety engineering - Performance of structures in fire - Part 6: Example of an eight-storey office concrete building

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An example of fire safety engineering design in the application of ISO 24679-1 to an office building. In ISO/TR 24679-6 2017, an overall structural analysis of a building is undertaken. It consists in a numerical assessment of the structural performance of an eight-storey concrete building when subjected to a fire. This analysis is performed in order to demonstrate that the fire safety objectives, for the relevant design fire scenarios, due to structural behaviour of building in the event of fire, are met with the trial plan for the safety of structure. With regards to this, a fully developed fire was studied. The purpose of this document is to assess the performance of an office building which is fully accessible to public in case of fire, using ISO 24679-1. In this respect, a critical design fire was identified and analysed using detailed fire modelling. A more detailed analysis was then performed for critical design fire using the finite element model. The advanced model provided all the comprehensive information necessary for analysing the given built environment with respect to fire safety. It is to be noted that this document only addresses the fire safety objectives related to the structural performance during fire. The analysis within this document is therefore only part of the overall building fire safety strategy.

🔗 CATEGORY Standard (ISO)

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📅 PUBLISHED 2017-12

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🏠 DOMAIN Building, Construction

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## Specification | TC 59 | ISO/FDIS 22057 Sustainability in buildings and civil engineering works - Data templates for the use of EPDs for construction products in BIM

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All types of assessment at construction works level are complex and building information modelling (BIM) provides a process for describing and displaying information required in the planning, design, construction and operation of constructed facilities. The BIM approach is expanding to encompass all aspects of the built environment, including civil infrastructure, utilities and public spaces. Designers, owners and other stakeholders in the construction sector are increasingly looking to BIM to enable them to address the environmental impacts of construction works. ISO 19650 sets out the recommended concepts and principles for business processes to support the management and production of information during the life cycle of constructed assets when using BIM. To do this, standardization is of the highest importance. Machine-interpretable data is essential to provide a reliable and sustainable exchange of information, and a data template supports the standardized provision of data in machine-interpretable data sheet formats for use in BIM. The data provided in EPDs, like other construction product data, is therefore needed in a machine-interpretable format to enable its use in BIM.

🔗 CATEGORY Standard under development (ISO)

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📅 PUBLISHED Under Development

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🏠 DOMAIN Building, Construction

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## Specification | TC 59 SC13 | ISO 19650-4:2018 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling-Part 4: Information exchange

Part 4 complements parts 1-3 and 5 by providing the explicit process and criteria for an individual information exchange. The intention is to secure the benefits arising from collaborative and interoperable BIM. EN 17412-1 describes a methodology for qualifying an exchange with criteria relating to completeness.

🔗 CATEGORY Standard under development (ISO)

📅 PUBLISHED Under Development

🏠 DOMAIN Building, Construction

## Specification | TC 59 SC13 | ISO/DIS 7817 Building information modelling - Level of information need - Concepts and principles

This document specifies concepts and principles to establish a methodology for specifying level of information need and information deliveries in a consistent way when using building information modelling (BIM). This document specifies the characteristics of different levels used for defining the detail and extent of information required to be exchanged and delivered throughout the life cycle of built assets. It gives guidelines for principles required to specify information needs. The concepts and principles in this document can be applied for a general information exchange and whilst in progress, for a generally agreed way of information exchange between parties in a collaborative work process, as well as for an appointment with specified information delivery. The level of information need provides methods for describing information to be exchanged according to exchange information requirements. The exchange information requirements specify the wanted information exchange. The result of this process is an information delivery. This document is applicable to the whole life cycle of any built asset, including strategic planning, initial design, engineering, development, documentation and construction, day-to-day operation, maintenance, refurbishment, repair and end-of-life.

🔗 CATEGORY Standard under development (ISO)

📅 PUBLISHED Under Development

🏠 DOMAIN Building, Construction

## ■ Building, Energy

### Legal | EC | Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency (Text with EEA relevance)

Update of European Directive on energy performance and energy efficiency. In line with the new EU strategy on carbon neutrality for 2050, each Member State shall establish a long-term renovation strategy to support the renovation of the national stock of residential and non-residential buildings, both public and private, into a highly energy efficient and decarbonised building stock by 2050, facilitating the cost-effective transformation of existing buildings into nearly zero-energy buildings.

🔗 CATEGORY Web (document)

📅 PUBLISHED 2018-05

🏠 DOMAIN Building, Energy

### Report | GOV\_UK | Energy Performance of Building Regulations 2012

This document is the Implementation Report (IR) of the Energy Performance of the Buildings (England and Wales) Regulations 2012 (S.I. 2012/3118)<sup>1</sup> (2012 regulations). The regulations enact, where necessary, the requirements of Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings (recast) (the EPB Directive)<sup>2</sup> and provisions enacting the original version of the EPB Directive<sup>3</sup> (the original Directive). The EPB Directive came into force on 8 June 2010. EU Member States were required to transpose the directive by 9 January 2013.

🔗 CATEGORY Paper

📅 PUBLISHED 2020-05

🏠 DOMAIN Building, Energy

### Report | GOV\_Scotland | Building regulations - energy standards and associated topics - proposed changes: consultation

Consultation on proposed changes to energy standards within Scottish building regulations, including related topics such as ventilation, overheating and electric vehicle charging provision. The review considers the technical, commercial and wider policy implications of improvements to energy standards and offers proposals, as part of broader action by the Scottish Government on climate change, to further our ambition of becoming a net-zero society by 2045. It also presents proposals on the provision for electric vehicle charging infrastructure or facilities in buildings.

🔗 CATEGORY Web

📅 PUBLISHED 2021-07

🏠 DOMAIN Building, Energy

### Report | IEA-EBC | Working Group on Building Energy Codes

This report synthesizes the experience to date with two major types of policies based on information from Building Energy Code Working Group members and the literature. The two key policy types are building energy codes and building energy performance standards. Both energy codes and performance standards are important policies for driving energy performance improvements in existing buildings and can be applied differently or together to achieve significant savings in the

substantial existing buildings stock. While there is more to be learned as new performance standards come into effect and results are better understood, there is strong potential that well designed codes and standards implemented together will be able to accomplish what neither would be able to accomplish on their own.

🔗 CATEGORY Web

📅 PUBLISHED Ongoing (2019 - 2022)

🏠 DOMAIN Building, Energy

## Report | PNNL | Understanding Building Energy Codes and Standards

An account of work sponsored by an agency of the United States Government (Pacific Northeast National Laboratory, operated by Battelle for the US). Department of Energy.

🔗 CATEGORY Paper (report)

📅 PUBLISHED 2003-03

🏠 DOMAIN Building, Energy

## Report | SSSI Australia | Building Energy Standards and Codes

This fact sheet has been produced by the United Nations in an initiative for a Low Carbon Green Growth Roadmap for Asia and the Pacific. It explains building energy standards and codes, focusing in two key points (a) Once a building is constructed, it is very costly and sometimes impractical to attain the efficiency that can be achieved cost-effectively at the time of construction, and (b) Energy-efficiency improvements in new buildings can have significant savings of energy for emerging countries.

🔗 CATEGORY Paper (report)

📅 PUBLISHED 2012

🏠 DOMAIN Building, energy

## Guideline | Building energy performance analysis: A case study

International standards, in particular the Italian one, evaluate buildings energy performance assuming steady-state working conditions currently, the study of the energy performance of buildings is based on a simplified calculation that estimates the energy demand using monthly or seasonal average outdoor temperatures. For this reason we have conducted a comparative analysis of the energy performances of an old building using a semi-stationary software and a dynamic one. The studied building is placed in the peripheral part of an historical city located in the center of Italy. We have performed three simulations considering transparent elements characterized by progressively improved properties of thermal transmittance and solar gain factor. A comparison between the outputs of the two codes, in order to highlight the different ways of evaluating the energy contributions to annual energy demand, has been performed. Finally, the models were validated by means of an in-situ measurement campaign using a heat flow meter, in order to measure the thermal transmittance of the opaque walls, and a thermographic camera. This modus operandi allowed us to appreciate how the use of a dynamic software is essential to deal with the inertial properties of the structure and to calculate in an accurate way the annual energy demand.

🔗 CATEGORY Research Paper

📅 PUBLISHED 2015-01

🏠 DOMAIN Building, energy

# Specification | TC 163 | ISO 52000-1:2017 Energy performance of buildings - Overarching EPB assessment - Part 1: General framework and procedures

ISO 52000-1 2017 establishes a systematic, comprehensive and modular structure for assessing the energy performance of new and existing buildings (EPB) in a holistic way. It is applicable to the assessment of overall energy use of a building, by measurement or calculation, and the calculation of energy performance in terms of primary energy or other energy-related metrics. It takes into account the specific possibilities and limitations for the different applications, such as building design, new buildings 'as built', and existing buildings in the use phase as well as renovation.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2017-06

🏠 DOMAIN Building, energy

## ■ Consumer goods and services

### Specification | PC 317 | ISO/CD 31700 Consumer protection - Privacy by design for consumer goods and services

This document establishes high-level requirements for privacy by design to protect privacy throughout the lifecycle of a consumer product, including data processed by the consumer.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED Under Development

🏠 DOMAIN Consumer goods and services

## ■ Energy

### Guideline | DNV | DNV-RP-A204: Qualification and assurance of digital twins

This document contains requirements and recommendations for assuring the quality and trustworthiness of digital twins, addressing all phases from concept to operation. The following topics are covered - maturity of the organizations developing and maintaining the digital twin - the quality of the digital twin - the risk of relying on the information provided by the digital twin - operation and maintenance of the digital twin.

🔗 CATEGORY Recommendation

📅 PUBLISHED Online

🏠 DOMAIN Energy



## Report | GE | Digital Twin Analytic Engine for the Digital Power Plant

This paper presents an industrial vision of digital twin within the power plant use case. Included in the Digital Twin models are all necessary aspects of the physical asset or larger system including thermal, mechanical, electrical, chemical, fluid dynamic, material, lifing, economic and statistical. These models also accurately represent the plant or fleet under a large number of variations related to operation - fuel mix, ambient temperature, air quality, moisture, load, weather forecast models, and market pricing.

🔗 CATEGORY Paper (GE implementation and use cases)

📅 PUBLISHED 2016

🏠 DOMAIN Energy

## Specification | IEC TC57 Power Systems | Communication networks and systems for power utility automation - ALL PARTS

This link regroups all the parts of communication networks and systems for power utility automation.

🔗 CATEGORY Standard (IEC)

📅 PUBLISHED 2021

🏠 DOMAIN Energy

## Specification | IEC TC57 Power Systems | Communication networks and systems for power utility automation - Part 1-2: Guideline on extending IEC 61850

IEC TS 61850-1-2 2020, which is a technical specification, is intended for any users but primarily for standardization bodies that are considering using IEC 61850 as a base standard within the scope of their work and are willing to extend it as allowed by the IEC 61850 standards. This document identifies the required steps and high-level requirements in achieving such extensions of IEC 61850 and provides guidelines for the individual steps.

🔗 CATEGORY Standard (IEC)

📅 PUBLISHED 2020-06

🏠 DOMAIN Energy

## Specification | ISA/IEC | Quick start guide: An overview of the ISA/IEC 62443 Standards

Standards for cybersecurity of OT devices an overview of ISA/IEC 62443 Standards.

🔗 CATEGORY Standard (IEC)

📅 PUBLISHED 2020-06

🏠 DOMAIN Energy

## Specification | TC 205 | ISO 17800:2017 Facility smart grid information model

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ISO 17800 2017 provides the basis for common information exchange between control systems and end use devices found in single - and multi-family homes, commercial and institutional buildings, and industrial facilities that is independent of the communication protocol in use. It provides a common basis for electrical energy consumers to describe, manage, and communicate about electrical energy consumption and forecasts.

📖 CATEGORY Standard (ISO)

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📅 PUBLISHED 2017-12

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🏠 DOMAIN Energy

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## Specification | JTC 1/SC 27 | ISO/IEC 27019:2017 Information technology - Security techniques - Information security controls for the energy utility industry

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ISO/IEC 27019 2017 provides guidance based on ISO/IEC 27002 2013 applied to process control systems used by the energy utility industry for controlling and monitoring the production or generation, transmission, storage and distribution of electric power, gas, oil and heat, and for the control of associated supporting processes. This includes in particular the following (1) central and distributed process control, monitoring and automation technology as well as information systems used for their operation, such as programming and parameterization devices; (2) digital controllers and automation components such as control and field devices or Programmable Logic Controllers (PLCs), including digital sensor and actuator elements; and (3) all further supporting information systems used in the process control domain, e.g. for supplementary data visualization tasks and for controlling, monitoring, data archiving, historian logging, reporting and documentation purposes.

📖 CATEGORY Standard (ISO/IEC)

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📅 PUBLISHED 2017-10

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🏠 DOMAIN Energy

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# ■ Geographic Information Systems (GIS)

## Specification | OGC | Indexed 3D Scene Layers (I3S)

A single I3S data set, referred to as a Scene Layer, is a container for arbitrarily large amounts of heterogeneously distributed 3D geographic data. Scene Layers are designed to be used in mobile, desktop, and server-based workflows and can be accessed over the web or as local files. The delivery format and persistence model for Scene Layers, referred to as Indexed 3d Scene Layer (I3S) and Scene Layer Package (SLPK) respectively, are specified in detail in this OGC Community Standard. Both formats are encoded using JSON and binary ArrayBuffers (ECMAScript 2015). I3S is designed to be cloud, web and mobile friendly. I3S is based on JSON, REST and modern web standards and is easy to handle, efficiently parse and render by Web and Mobile Clients. I3S is designed to stream large 3d datasets and is designed for performance and scalability. I3S is designed to support 3D geospatial content and supports the requisite coordinate reference systems and height models in conjunction with a rich set of layer types.

📁 CATEGORY Standard (Australia)

📅 PUBLISHED 2020-02

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO 19101-1:2014 Geographic information - Reference model - Part 1: Fundamentals

ISO 19101-1 2014 defines the reference model for standardization in the field of geographic information. This reference model describes the notion of interoperability and sets forth the fundamentals by which this standardization takes place. Although structured in the context of information technology and information technology standards, ISO 19101-1 2014 is independent of any application development method or technology implementation approach.

📁 CATEGORY Standard (ISO)

📅 PUBLISHED 2014-11

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO 19101-2:2018 Geographic information - Reference model - Part 2: Imagery

This document defines a reference model for standardization in the field of geographic imagery processing. This reference model identifies the scope of the standardization activity being undertaken and the context in which it takes place. The reference model includes gridded data with an emphasis on imagery. Although structured in the context of information technology and information technology standards, this document is independent of any application development method or technology implementation approach.

📁 CATEGORY Standard (ISO)

📅 PUBLISHED 2018-05

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO 19103:2015 Geographic information - Conceptual schema language

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ISO 19103 2015 provides rules and guidelines for the use of a conceptual schema language within the context of geographic information. The chosen conceptual schema language is the Unified Modeling Language (UML). ISO 19103:2015 provides a profile of the Unified Modelling Language (UML). The standardization target type of this standard is UML schemas describing geographic information.

🔗 CATEGORY Standard (ISO)

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📅 PUBLISHED 2015-12

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🏠 DOMAIN Geographic Information Systems (GIS)

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## Specification | TC 211 | ISO 19104:2016 Geographic information - Terminology

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ISO 19104 2016 specifies requirements for the collection, management and publication of terminology in the field of geographic information. The scope of this document includes - selection of concepts, harmonization of concepts and development of concept systems, - structure and content of terminological entries, - term selection, - definition preparation, - cultural and linguistic adaptation, - layout and formatting requirements in rendered documents, and - establishment and management of terminology registers. ISO 19104 2016 is applicable to International Standards and Technical Specifications in the field of geographic information.

🔗 CATEGORY Standard (ISO)

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📅 PUBLISHED 2016-10

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🏠 DOMAIN Geographic Information Systems (GIS)

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## Specification | TC 211 | ISO 19105:2000 Geographic information - Conformance and testing

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This International Standard specifies the framework, concepts and methodology for testing and criteria to be achieved to claim conformance to the family of ISO geographic information standards. It provides a framework for specifying abstract test suites (ATS) and for defining the procedures to be followed during conformance testing. Conformance may be claimed for data or software products or services or by specifications including any profile or functional standard. Standardization of test methods and criteria for conformance to geographic information standards will allow verification of conformance to those standards. Verifiable conformance is important to geographic information users, in order to achieve data transfer and sharing.

🔗 CATEGORY Standard (ISO)

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📅 PUBLISHED 2000-12

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🏠 DOMAIN Geographic Information Systems (GIS)

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## Specification | TC 211 | ISO 19106:2004 Geographic information - Profiles

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ISO 19106 2004 is intended to define the concept of a profile of the ISO geographic information standards developed by ISO/TC 211 and to provide guidance for the creation of such profiles. Only those components of specifications that meet the definition of a profile contained herein can be established and managed through the mechanisms described in this International Standard. These profiles can be standardized internationally using the ISO standardization process. This document also provides guidance for establishing, managing, and standardizing at the national level (or in some other forum).

🔗 CATEGORY Standard (ISO)

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📅 PUBLISHED 2004-07

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📁 DOMAIN Geographic Information Systems (GIS)

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## Specification | TC 211 | ISO 19107:2019 Geographic information - Spatial schema

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This document specifies conceptual schemas for describing the spatial characteristics of geographic entities, and a set of spatial operations consistent with these schemas. It treats `_vector_` geometry and topology. It defines standard spatial operations for use in access, query, management, processing and data exchange of geographic information for spatial (geometric and topological) objects. Because of the nature of geographic information, these geometric coordinate spaces will normally have up to three spatial dimensions, one temporal dimension and any number of other spatially dependent parameters as needed by the applications. In general, the topological dimension of the spatial projections of the geometric objects will be at most three.

🔗 CATEGORY Standard (ISO)

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📅 PUBLISHED 2019-12

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📁 DOMAIN Geographic Information Systems (GIS)

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## Specification | TC 211 | ISO 19108:2002 Geographic information - Temporal schema, with technical corrigendum

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ISO 19108 2002 defines concepts for describing temporal characteristics of geographic information. It depends upon existing information technology standards for the interchange of temporal information. It provides a basis for defining temporal feature attributes, feature operations, and feature associations, and for defining the temporal aspects of metadata about geographic information. Since this International Standard is concerned with the temporal characteristics of geographic information as they are abstracted from the real world, it emphasizes valid time rather than transaction time.

🔗 CATEGORY Standard (ISO)

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📅 PUBLISHED 2002-09

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📁 DOMAIN Geographic Information Systems (GIS)

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## Specification | TC 211 | ISO 19109:2015 Geographic information - Rules for application schema

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ISO 19109 2015 defines rules for creating and documenting application schemas, including principles for the definition of features. The scope of this International Standard includes the following

- (1) conceptual modelling of features and their properties from a universe of discourse;
- (2) definition of application schemas;
- (3) Use of the conceptual schema language for application schemas;
- (4) transition from the concepts in the conceptual model to the data types in the application schema; and
- (5) integration of standardized schemas from other ISO geographic information standards with the application schema.

The following are outside the scope:

- (a) choice of one particular conceptual schema language for application schemas;
- (b) definition of any particular application schema;
- (c) representation of feature types and their properties in a feature catalogue;
- (d) representation of metadata;
- (e) rules for mapping one application schema to another;
- (f) implementation of the application schema in a computer environment;
- (g) computer system and application software design; and
- (h) programming.

🔗 CATEGORY Standard (ISO)

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📅 PUBLISHED 2015-12

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📁 DOMAIN Geographic Information Systems (GIS)

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## Specification | TC 211 | ISO 19110:2016 Geographic information - Methodology for feature cataloguing

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ISO 19110 2016 defines the methodology for cataloguing feature types. This document specifies how feature types can be organized into a feature catalogue and presented to the users of a set of geographic data. This document is applicable to creating catalogues of feature types in previously uncatalogued domains and to revising existing feature catalogues to comply with standard practice. This document applies to the cataloguing of feature types that are represented in digital form. Its principles can be extended to the cataloguing of other forms of geographic data. Feature catalogues are independent of feature concept dictionaries defined in ISO 19126 and can be specified without having to use or create a Feature Concept Dictionary. ISO 19110 2016 is applicable to the definition of geographic features at the type level. This document is not applicable to the representation of individual instances of each type. This document excludes portrayal schemas as specified in ISO 19117. ISO 19110 2016 may be used as a basis for defining the universe of discourse being modelled in a particular application, or to standardize general aspects of real-world features being modelled in more than one application.

🔗 CATEGORY Standard (ISO)

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📅 PUBLISHED 2016-12

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📁 DOMAIN Geographic Information Systems (GIS)

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## Specification | TC 211 | ISO 19111:2019 Geographic information - Referencing by coordinates, with amendment

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This document defines the conceptual schema for the description of referencing by coordinates. It describes the minimum data required to define coordinate reference systems. This document supports the definition of

- (1) spatial coordinate reference systems where coordinate values do not change with time. The system may
  - (2) be geodetic and apply on a national or regional basis, or
  - (3) apply locally such as for a building or construction site, or
  - (4) apply locally to an image or image sensor;
- (5) be referenced to a moving platform such as a car, a ship, an aircraft or a spacecraft. Such a coordinate reference system can be related to a second coordinate reference system which is referenced to the Earth through a transformation that includes a time element;
- (6) spatial coordinate reference systems in which coordinate values of points on or near the surface of the earth change with time due to tectonic plate motion or other crustal deformation. Such dynamic systems include time evolution, however they remain spatial in nature;
- (7) parametric coordinate reference systems which use a non-spatial parameter that varies monotonically with height or depth;

(8) temporal coordinate reference systems which use date/Time, temporal count or temporal measure quantities that vary monotonically with time; and

(9) mixed spatial, parametric or temporal coordinate reference systems.

The definition of a coordinate reference system does not change with time, although in some cases some of the defining parameters can include a rate of change of the parameter. The coordinate values within a dynamic and in a temporal coordinate reference system can change with time. This document also describes the conceptual schema for defining the information required to describe operations that change coordinate values. In addition to the minimum data required for the definition of the coordinate reference system or coordinate operation, the conceptual schema allows additional descriptive information - coordinate reference system metadata - to be provided. This document is applicable to producers and users of geographic information. Although it is applicable to digital geographic data, the principles described in this document can be extended to many other forms of spatial data such as maps, charts and text documents.

📁 CATEGORY Standard (ISO)

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📅 PUBLISHED 2019-01

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📁 DOMAIN Geographic Information Systems (GIS)

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## Specification | TC 211 | ISO 19112:2019 Geographic information - Spatial referencing by geographic identifiers

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This document defines the conceptual schema for spatial references based on geographic identifiers. It establishes a general model for spatial referencing using geographic identifiers and defines the components of a spatial reference system. It also specifies a conceptual scheme for a gazetteer. Spatial referencing by coordinates is addressed in ISO 19111. However, a mechanism for recording complementary coordinate references is included in this document. This document enables producers of data to define spatial reference systems using geographic identifiers and assists users in understanding the spatial references used in datasets. It enables gazetteers to be constructed in a consistent manner and supports the development of other standards in the field of geographic information. This document is applicable to digital geographic data, and its principles may be extended to other forms of geographic data such as maps, charts and textual documents.

📁 CATEGORY Standard (ISO)

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📅 PUBLISHED 2018-02

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📁 DOMAIN Geographic Information Systems (GIS)

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## Specification | TC 211 | ISO 19115-1:2014 Geographic information - Metadata - Part 1: Fundamentals, with amendment 1 and amendment 2

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ISO 19115-1 2014 defines the schema required for describing geographic information and services by means of metadata. It provides information about the identification, the extent, the quality, the spatial and temporal aspects, the content, the spatial reference, the portrayal, distribution, and other properties of digital geographic data and services. ISO 19115-1 2014 is applicable to

(1) the cataloguing of all types of resources, clearinghouse activities, and the full description of datasets and services;

(2) geographic services, geographic datasets, dataset series, and individual geographic features and feature properties.

ISO 19115-1 2014 defines

(a) mandatory and conditional metadata sections, metadata entities, and metadata elements;

(b) the minimum set of metadata required to serve most metadata applications (data discovery, determining data fitness for use, data access, data transfer, and use of digital data and services);

(c) optional metadata elements to allow for a more extensive standard description of resources, if required;

(d) a method for extending metadata to fit specialized needs. Though ISO 19115-1 2014 is applicable to digital data and services, its principles can be extended to many other types of resources such as



maps, charts, and textual documents as well as non- geographic data. Certain conditional metadata elements might not apply to these other forms of data.

🔗 CATEGORY Standard (ISO)

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📅 PUBLISHED 2014-02

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📁 DOMAIN Geographic Information Systems (GIS)

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## Specification | TC 211 | ISO 19115-1:2014 Geographic information - Metadata - Part 1: Fundamentals

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- (2) geographic services, geographic datasets, dataset series, and individual geographic features and feature properties.

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- (b) the minimum set of metadata required to serve most metadata applications (data discovery, determining data fitness for use, data access, data transfer, and use of digital data and services);
- (c) optional metadata elements to allow for a more extensive standard description of resources, if required;
- (d) a method for extending metadata to fit specialized needs. Though ISO 19115-1 2014 is applicable to digital data and services, its principles can be extended to many other types of resources such as maps, charts, and textual documents as well as non-geographic data. Certain conditional metadata elements might not apply to these other forms of data.

🔗 CATEGORY Standard (ISO)

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📅 PUBLISHED 2014-04

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📁 DOMAIN Geographic Information Systems (GIS)

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## Specification | TC 211 | ISO 19115-2:2019 Geographic information - Metadata - Part 2: Extensions for acquisition and processing

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This document extends ISO 19115-1 2014 by defining the schema required for an enhanced description of the acquisition and processing of geographic information, including imagery. Included are the properties of measuring systems and the numerical methods and computational procedures used to derive geographic information from the data acquired by them. This document also provides the XML encoding for acquisition and processing metadata thereby extending the XML schemas defined in ISO/TS 19115-3.

🔗 CATEGORY Standard (ISO)

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📅 PUBLISHED 2019-01

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📁 DOMAIN Geographic Information Systems (GIS)

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## Specification | TC 211 | ISO 19116:2019 Geographic information - Positioning services, with amendment

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This document specifies the data structure and content of an interface that permits communication between position-providing device(s) and position-using device(s) enabling the position-using device(s) to obtain and unambiguously interpret position information and determine, based on a measure of the degree of reliability, whether the resulting position information meets the requirements of the intended use. A standardized interface for positioning allows the integration of reliable position

information obtained from non-specific positioning technologies and is useful in various location-focused information applications, such as surveying, navigation, intelligent transportation systems (ITS), and location-based services (LBS).

🔗 CATEGORY Standard (ISO)

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📅 PUBLISHED 2019-12

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📁 DOMAIN Geographic Information Systems (GIS)

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## Specification | TC 211 | ISO 19117:2012 Geographic information - Portrayal

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ISO 19117 2012 specifies a conceptual schema for describing symbols, portrayal functions that map geospatial features to symbols, and the collection of symbols and portrayal functions into portrayal catalogues. This conceptual schema can be used in the design of portrayal systems. It allows feature data to be separate from portrayal data, permitting data to be portrayed in a dataset independent manner.

🔗 CATEGORY Standard (ISO)

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📅 PUBLISHED 2012-12

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📁 DOMAIN Geographic Information Systems (GIS)

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## Specification | TC 211 | ISO 19118:2011 Geographic information - Encoding

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ISO 19118 2011 specifies the requirements for defining encoding rules for use for the interchange of data that conform to the geographic information in the set of International Standards known as the \_ISO 19100 series\_. ISO 19118 2011 specifies requirements for creating encoding rules based on UML schemas, requirements for creating encoding services, and requirements for XML-based encoding rules for neutral interchange of data. ISO 19118 2011 does not specify any digital media, does not define any transfer services or transfer protocols, nor does it specify how to encode inline large images.

🔗 CATEGORY Standard (ISO)

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📅 PUBLISHED 2011-10

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📁 DOMAIN Geographic Information Systems (GIS)

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## Specification | TC 211 | ISO 19119:2016 Geographic information - Services

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ISO 19119 2016 defines requirements for how platform neutral and platform specific specification of services shall be created, in order to allow for one service to be specified independently of one or more underlying distributed computing platforms. ISO 19119 2016 defines requirements for a further mapping from platform neutral to platform specific service specifications, in order to enable conformant and interoperable service implementations. ISO 19119 2016 addresses the Meta Service foundation of the ISO geographic information reference model described in ISO 19101-1 2014, Clause 6 and Clause 8, respectively. ISO 19119 2016 defines how geographic services shall be categorised according to a service taxonomy based on architectural areas and allows also for services to be categorised according to a usage life cycle perspective, as well as according to domain specific and user defined service taxonomies, providing support for easier publication and discovery of services.

🔗 CATEGORY Standard (ISO)

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📅 PUBLISHED 2016-01

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📁 DOMAIN Geographic Information Systems (GIS)

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## Specification | TC 211 | ISO 19123:2005 Geographic information - Schema for coverage geometry and functions

ISO 19123 2005 defines a conceptual schema for the spatial characteristics of coverages. Coverages support mapping from a spatial, temporal or spatiotemporal domain to feature attribute values where feature attribute types are common to all geographic positions within the domain. A coverage domain consists of a collection of direct positions in a coordinate space that may be defined in terms of up to three spatial dimensions as well as a temporal dimension. Examples of coverages include rasters, triangulated irregular networks, point coverages and polygon coverages. Coverages are the prevailing data structures in a number of application areas, such as remote sensing, meteorology and mapping of bathymetry, elevation, soil and vegetation. ISO 19123 2005 defines the relationship between the domain of a coverage and an associated attribute range. The characteristics of the spatial domain are defined whereas the characteristics of the attribute range are not part of ISO 19123 2005.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2005-08

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO 19123-2:2018 Geographic information - Schema for coverage geometry and functions - Part 2: Coverage implementation schema

This document specifies a concrete implementable, conformance-testable coverage structure based on the abstract schema for coverages defined in the ISO 19123 schema for coverage geometry. This document defines a structure that is suitable for encoding in many encoding formats. The term concrete is used here as a contrast to abstract in the sense described in the Introduction.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2018-10

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO 19125-1:2004 Geographic information - Simple feature access - Part 1: Common architecture

ISO 19125-1 2004 establishes a common architecture for geographic information and defines terms to use within the architecture. It also standardizes names and geometric definitions for Types for Geometry. ISO 19125-1 2004 does not place any requirements on how to define the Geometry Types in the internal schema nor does it place any requirements on when or how or who defines the Geometry Types. ISO 19125-1 2004 does not attempt to standardize and does not depend upon any part of the mechanism by which Types are added and maintained.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2004-08

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO 19126:2021 Geographic information - Feature concept dictionaries and registers

This document specifies a schema for feature concept dictionaries to be established and managed as registers. It does not specify schemas for feature catalogues or for the management of feature catalogues as registers. However, as feature catalogues are often derived from feature concept dictionaries, this document does specify a schema for a hierarchical register of feature concept dictionaries and feature catalogues. These registers are in accordance with ISO 19135-1.

📁 CATEGORY Standard (ISO)

📅 PUBLISHED 2021-05

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO 19127:2019 Geographic information - Geodetic register

This document defines the management and operations of the ISO geodetic register and identifies the data elements, in accordance with ISO 19111 2007 and the core schema within ISO 19135-1 2015, required within the geodetic register.

📁 CATEGORY Standard (ISO)

📅 PUBLISHED 2019-02

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO 19128:2005 Geographic information - Web map server interface

ISO 19128 2005 specifies the behaviour of a service that produces spatially referenced maps dynamically from geographic information. It specifies operations to retrieve a description of the maps offered by a server, to retrieve a map, and to query a server about features displayed on a map. ISO 19128 2005 is applicable to pictorial renderings of maps in a graphical format; it is not applicable to retrieval of actual feature data or coverage data values.

📁 CATEGORY Standard (ISO)

📅 PUBLISHED 2005-12

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO 19130-1:2018 Geographic information - Imagery sensor models for geopositioning - Part 1: Fundamentals

This document identifies the information required to determine the relationship between the position of a remotely sensed pixel in image coordinates and its geoposition. It supports exploitation of remotely sensed images. It defines the metadata to be distributed with the image to enable user determination of geographic position from the observations. This document specifies several ways in which information in support of geopositioning can be provided.

📄 It may be provided as a sensor description with the associated physical and geometric information necessary to rigorously construct a PSM. For the case where precise geoposition information is needed, this document identifies the mathematical equations for rigorously constructing PSMs that relate 2D image space to 3D ground space and the calculation of the associated propagated errors. This document provides detailed information for three types of passive electro-optical/ IR sensors (frame, pushbroom and whiskbroom) and for an active microwave sensing system SAR. It provides a framework by which these sensor models can be extended to other sensor types.

📄 It can be provided as a TRM, using functions whose coefficients are based on a PSM so that they provide information for precise geopositioning, including the calculation of errors, as precisely as the PSM they replace.

- It can be provided as a CM that provides a functional fitting based on observed relationships between the geositions of a set of GCPs and their image coordinates.
- It can be provided as a set of GCPs that can be used to develop a CM or to refine a PSM or TRM. This document does not specify either how users derive geoposition data or the format or content of the data the users generate.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2018\_09

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO 19131:2007 Geographic information - Data product specifications, with amendment

ISO 19131 2007 specifies requirements for the specification of geographic data products, based upon the concepts of other ISO 19100 International Standards. It also provides help in the creation of data product specifications, so that they are easily understood and fit for their intended purpose.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2007-04

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO 19132:2007 Geographic information - Location-based services - Reference model

ISO 19132 2007 defines a reference model and a conceptual framework for location-based services (LBS), and describes the basic principles by which LBS applications may interoperate. This framework references or contains an ontology, a taxonomy, a set of design patterns and a core set of LBS service abstract specifications in UML. ISO 19132 2007 further specifies the framework's relationship to other frameworks, applications and services for geographic information and to client applications. ISO 19132 2007 addresses, for an LBS system, the first three basic viewpoints as defined in the Reference Model for Open Distributed Processing (RM-ODP, see ISO/IEC 10746-1). These viewpoints are the Enterprise Viewpoint (detailing the purpose, scope, and policies of the system); Information Viewpoint (detailing the semantics of information and processing within the system); Computational Viewpoint (detailing the functional decomposition of the system). The fourth and fifth viewpoints are addressed only in requirements or examples. These are the Engineering Viewpoint (detailing the infrastructure for distribution); Technology Viewpoint (detailing the technology for implementation); Reference models and frameworks can be defined at a variety of levels, from conceptual design to software documentation. ISO 19132 2007 defines the conceptual framework for and the type of applications included within LBS, establishes general principles for LBS for both mobile and fixed clients, specifies the interface for data access while roaming, defines the architectural relationship with other ISO geographic information standards, and identifies areas in which further standards for LBS are required. ISO 19132 2007 does not address rules by which LBS are developed, nor general principles for roaming agreements for mobile clients and tracking targets.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2007-10

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO 19133:2005 Geographic information - Location-based services - Tracking and navigation

ISO 19133 2005 describes the data types, and operations associated with those types, for the implementation of tracking and navigation services. It is designed to specify web services that can be made available to wireless devices through web-resident proxy applications, but is not restricted to that environment.

📁 CATEGORY Standard (ISO)

📅 PUBLISHED 2005-10

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO 19134:2007 Geographic information - Location-based services - Multimodal routing and navigation

ISO 19134 2006 specifies the data types and their associated operations for the implementation of multimodal location-based services for routing and navigation. It is designed to specify web services that may be made available to wireless devices through web-resident proxy applications, but is not limited to that environment.

📁 CATEGORY Standard (ISO)

📅 PUBLISHED 2007-02

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO 19135-1:2015 Geographic information - Procedures for item registration - Part 1: Fundamentals, with amendment

ISO 19135-1 2015 specifies procedures to be followed in establishing, maintaining, and publishing registers of unique, unambiguous, and permanent identifiers and meanings that are assigned to items of geographic information. In order to accomplish this purpose, ISO 19135-1 2015 specifies elements that are necessary to manage the registration of these items.

📁 CATEGORY Standard (ISO)

📅 PUBLISHED 2015-10

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO 19136-1:2020 Geographic information - Geography Markup Language (GML) - Part 1: Fundamentals

The Geography Markup Language (GML) is an XML encoding in accordance with ISO 19118 for the transport and storage of geographic information modelled in accordance with the conceptual modelling framework used in the ISO 19100 series of International Standards and including both the spatial and non-spatial properties of geographic features.

This document defines the XML Schema syntax, mechanisms and conventions that

- 📁 provide an open, vendor-neutral framework for the description of geospatial application schemas for the transport and storage of geographic information in XML;
- 📁 allow profiles that support proper subsets of GML framework descriptive capabilities; (3) support the description of geospatial application schemas for specialized domains and information communities;
- 📁 enable the creation and maintenance of linked geographic application schemas and datasets;
- 📁 support the storage and transport of application schemas and datasets;
- 📁 increase the ability of organizations to share geographic application schemas and the information they describe.

Implementers can decide to store geographic application schemas and information in GML, or they can decide to convert from some other storage format on demand and use GML only for schema and data transport.

NOTE If an ISO 19109 conformant application schema described in UML is used as the basis for the storage and transportation of geographic information, this document provides normative rules for the mapping of such an application schema to a GML application schema in XML Schema and, as such, to an XML encoding for data with a logical structure in accordance with the ISO 19109 conformant application schema.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2020-01

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO 19136-2:2015 Geographic information - Geography Markup Language (GML) - Part 2: Extended schemas and encoding rules

The Geography Markup Language (GML) is an XML encoding in compliance with ISO 19118 for the transport and storage of geographic information modelled in accordance with the conceptual modelling framework used in the ISO 19100- series of International Standards and including both the spatial and non-spatial properties of geographic features. ISO 19136-2 2015 defines the XML Schema syntax, mechanisms and conventions that

(1) provide an open, vendor-neutral framework for the description of geospatial application schemas for the transport and storage of geographic information in XML;

🔗 support the description of geospatial application schemas for specialized domains and information communities;

🔗 enable the creation and maintenance of linked geographic application schemas and datasets;

🔗 support the storage and transport of application schemas and datasets;

🔗 increase the ability of organizations to share geographic application schemas and the information they describe.

Implementers may decide to store geographic application schemas and information in GML, or they may decide to convert from some other storage format on demand and use GML only for schema and data transport. ISO 19136-2 2015 builds on ISO 19136 2007 (GML 3.2), and extends it with additional schema components and requirements.

NOTE If an ISO 19109 conformant application schema described in UML is used as the basis for the storage and transportation of geographic information, this part of ISO 19136 provides normative rules for the mapping of such an application schema to a GML application schema in XML Schema and, as such, to an XML encoding for data with a logical structure in accordance with the ISO 19109 conformant application schema.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2015-08

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO 19137:2007 Geographic information - Core profile of the spatial schema

ISO 19137 2007 defines a core profile of the spatial schema specified in ISO 19107 that specifies, in accordance with ISO 19106, a minimal set of geometric elements necessary for the efficient creation of application schemata. It supports many of the spatial data formats and description languages already developed and in broad use within several nations or liaison organizations.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2007-05

📁 DOMAIN Geographic Information Systems (GIS)



## Specification | TC 211 | ISO 19141:2008 Geographic information - Schema for moving features

ISO 19141 2008 defines a method to describe the geometry of a feature that moves as a rigid body. Such movement has the following characteristics. The feature moves within any domain composed of spatial objects as specified in ISO 19107. The feature may move along a planned route, but it may deviate from the planned route. Motion may be influenced by physical forces, such as orbital, gravitational, or inertial forces. Motion of a feature may influence or be influenced by other features, for example the moving feature might follow a predefined route (e.g. road), perhaps part of a network, and might change routes at known points (e.g. bus stops, waypoints). Two or more moving features may be pulled together or pushed apart (e.g. an airplane will be refuelled during flight, a predator detects and tracks a prey, refugee groups join forces). Two or more moving features may be constrained to maintain a given spatial relationship for some period (e.g. tractor and trailer, convoy). ISO 19141 2008 does not address other types of change to the feature. Examples of changes that are not addressed include the following “The deformation of features”. The succession of either features or their associations. The change of non-spatial attributes of features. The feature's geometric representation cannot be embedded in a geometric complex that contains the geometric representations of other features, since this would require the other features' representations to be updated as the feature moves. Because ISO 19141 2008 is concerned with the geometric description of feature movement, it does not specify a mechanism for describing feature motion in terms of geographic identifiers. This is done, in part, in ISO 19133.

- CATEGORY Standard (ISO)
- 📅 PUBLISHED 2008-06
- 📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO 19142:2010 Geographic information - Web Feature Service

ISO 19142 2010 specifies the behaviour of a web feature service that provides transactions on and access to geographic features in a manner independent of the underlying data store. It specifies discovery operations, query operations, locking operations, transaction operations and operations to manage stored parameterized query expressions.

- CATEGORY Standard (ISO)
- 📅 PUBLISHED 2010-12
- 📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO 19143:2010 Geographic information - Filter encoding

ISO 19143 2010 describes an XML and KVP encoding of a system neutral syntax for expressing projections, selection and sorting clauses collectively called a query expression. These components are modular and intended to be used together or individually by other International Standards which reference ISO 19143 2010.

- CATEGORY Standard (ISO)
- 📅 PUBLISHED 2010-10
- 📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO 19144-1:2009 Geographic information - Classification systems - Part 1: Classification system structure, with technical corrigendum

ISO 19144-1 2009 establishes the structure of a geographic information classification system, together with the mechanism for defining and registering the classifiers for such a system. It specifies the use of discrete coverages to represent the result of applying the classification system to a particular area and defines the technical structure of a register of classifiers in accordance with ISO 19135.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2009-08

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO 19144-2:2012 Geographic information - Classification systems - Part 2: Land Cover Meta Language (LCML)

ISO 19144-2 2012 specifies a Land Cover Meta Language (LCML) expressed as a UML metamodel that allows different land cover classification systems to be described based on the physiognomic aspects. ISO 19144-2 2012 also specifies the detailed structure of a register for the extension of LCML but does not specify the maintenance of the register. ISO 19144-2 2012 recognizes that there exist a number of land cover classification systems. It provides a common reference structure for the comparison and integration of data for any generic land cover classification system, but does not intend to replace those classification systems.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2012-07

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO 19145:2013 Geographic information - Registry of representations of geographic point location

ISO 19145 2013 specifies the process for establishing, maintaining and publishing registers of representation of geographic point location in compliance with ISO 19135. It identifies and describes the information elements and the structure of a register of representations of geographic point location including the elements for the conversion of one representation to another. ISO 19145 2013 also specifies the XML implementation of the required XML extension to ISO/TS 19135-2, for the implementation of a register of geographic point location representations.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2013-02

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO 19146:2018 Geographic information - Cross-domain vocabularies

This document establishes a methodology for cross-mapping vocabularies. It also specifies an implementation of ISO 19135-1 2015 for the purpose of registering cross-mapped vocabulary entries. Methodologies for the development of ontologies and taxonomies that relate to geographic information and geomatics are not within the scope of this document.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2018-06

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO 19147:2015 Geographic information - Transfer Nodes

ISO 19147 2015 specifies the data types and code lists associated with those types for the implementation of transfer nodes and their services in transport modelling and location based services. It includes the following

- defines transfer nodes in a multimodal way so that the definition is general and valid for all types of transport means and modes;
- links transfer nodes to a location;
- focuses on the attributes defining the transfer node in relation to nodes in mode-specific networks;
- defines the attributes of transfer nodes that are relevant for travel planning and modelling of interoperable transport systems by transport planners;
- defines a set of services and facilities that may be related to transfer nodes and a way to provide information on accessibility, deviations and restrictions related to these services and facilities.

ISO 19147 2015 is applicable for transport infrastructure owners and operators when defining and/or describing their transport infrastructure and for transport-related Service Providers when providing information to travellers and others. It is limited to the transport of persons and is also limited to the static getting-on and getting-off points. The main focus is on transfer nodes being part of public transport networks, that are located in road networks, but this International Standard is also applicable for transfer nodes in rail networks and in air and sea transport networks.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2015-06

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO 19148:2021 Geographic information - Linear referencing

This document specifies a conceptual schema for locations relative to a one-dimensional object as measurement along (and optionally offset from) that object. It defines a description of the data and operations required to use and support linear referencing. This document is applicable to transportation, utilities, environmental protection, location-based services and other applications which define locations relative to linear objects. For ease of reading, most examples discussed in this document come from the transportation domain.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2021-04

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO 19149:2011 Geographic information - Rights expression language for geographic information - GeoREL

ISO 19149 2011 defines an XML-based vocabulary or language to express rights for geographic information in order that digital licenses can be created for such information and related services. This language, GeoREL, is an extension of the rights expression language in ISO/IEC 21000-5 and is to be used to compose digital licenses. Each digital license will unambiguously express those particular rights that the owners (or their agent) of a digital geographic resource extend to the holders of that license. The digital rights management system in which these licenses are used can then offer ex ante (before the fact) protection for all such resources. The proper use of a GeoREL includes the preservation of rights access by formula expressed in usage licenses. Thus, data in the public or private domain, when protected, remain in their respective domains if the usage rights granted so state. These rights are not always covered by copyright law, and are often the result of contracts between individuals that specify the proper and allowed uses of resources, as opposed to the threat of copyright litigations which is an ex post facto (after the fact) remediation measure, not an ex ante protection measure. ISO 19149 2011 is not a reflection of, or extension of, copyright law. Mechanisms for the enforcement and preservation of those contract rights are specified in ISO/IEC

21000, and it is not the intention of ISO 19149 2011 to replace nor redefine those mechanisms, but to use them as previously standardized.

🔗 CATEGORY Standard (ISO)

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📅 PUBLISHED 2011-11

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📁 DOMAIN Geographic Information Systems (GIS)

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## Specification | TC 211 | ISO 19150-2:2015 Geographic information - Ontology - Part 2: Rules for developing ontologies in the Web Ontology Language (OWL), with amendment

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ISO 19150-2 2015 defines rules and guidelines for the development of ontologies to support better the interoperability of geographic information over the Semantic Web. The Web Ontology Language (OWL) is the language adopted for ontologies. It defines the conversion of the UML static view modeling elements used in the ISO geographic information standards into OWL. It further defines conversion rules for describing application schemas based on the General Feature Model defined in ISO 19109 into OWL. It does not define semantics operators, rules for service ontologies, and does not develop any ontology.

🔗 CATEGORY Standard (ISO)

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📅 PUBLISHED 2015-07

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📁 DOMAIN Geographic Information Systems (GIS)

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## Specification | TC 211 | ISO 19150-4:2019 Geographic information - Ontology - Part 4: Service ontology

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This document sets a framework for geographic information service ontology and the description of geographic information Web services in Web Ontology Language (OWL). OWL is the language adopted for ontologies. This document makes use of service metadata (ISO 19115-1) and service definitions (ISO 19119) whenever appropriate. This document does not define semantics operators, rules for ontologies, and does not develop any application ontology. In relation to ISO 19101-1 2014, 6.2, this document defines and formalizes the following purpose of the ISO geographic information reference model

- 📁 geographic information service components and their behaviour for data processing purposes over the Web, and
- 📁 OWL ontologies to cast ISO/TC 211 standards to benefit from and support the Semantic Web. In relation to ISO 19101-1 2014, 8.3, this document addresses the Meta Service foundation of the ISO geographic information reference model.

🔗 CATEGORY Standard (ISO)

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📅 PUBLISHED 2019-05

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📁 DOMAIN Geographic Information Systems (GIS)

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## Specification | TC 211 | ISO 19152:2012 Geographic information - Land Administration Domain Model (LADM)

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ISO 19152 2012 defines a reference Land Administration Domain Model (LADM) covering basic information-related components of land administration (including those over water and land, and elements above and below the surface of the earth); provides an abstract, conceptual model with four packages related to parties (people and organizations); basic administrative units, rights, responsibilities, and restrictions (ownership rights); spatial units (parcels, and the legal space of buildings and utility networks); spatial sources (surveying), and spatial representations (geometry and topology); provides terminology for land administration, based on various national and international systems, that is as simple as possible in order to be useful in practice. The terminology allows a shared description of different formal or informal practices and procedures in various jurisdictions; provides a basis for national and regional profiles;

and enables the combining of land administration information from different sources in a coherent manner.

📁 CATEGORY Standard (ISO)

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📅 PUBLISHED 2012-12

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📁 DOMAIN Geographic Information Systems (GIS)

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## Specification | TC 211 | ISO 19154:2014 Geographic information - Ubiquitous public access - Reference model

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ISO 19154 2014 defines a reference model for ubiquitous public access (UPA) to geographic information. This reference model uses standard concepts from both the Open distributed processing? Reference model (RM-ODP) in ISO/IEC 10746-1 and ISO 19101. The reference model specified in ISO 19154 2014 defines the following

- 📁 conceptual models for ubiquitous public access (UPA) to geographic information;
- 📁 a reference model and framework to support current and future specification development in this area;
- 📁 the semantics of information and processing within systems and services for the UPA of geographic information;
- 📁 the architectural relationship between this International Standard and other ISO geographic information standards.

ISO 19154 is applicable to location-based services (LBS), ubiquitous computing environments, linked open data, and other domains that require a seamless public access to geographic information.

ISO 19154 2014 is independent of any application development method or technology implementation approach.

📁 CATEGORY Standard (ISO)

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📅 PUBLISHED 2014-11

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📁 DOMAIN Geographic Information Systems (GIS)

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## Specification | TC 211 | ISO 19155:2012 Geographic information - Place Identifier (PI) architecture

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ISO 19155 2012 specifies an architecture that defines a reference model with an encoding method for an identifier of a place. The concept of place within ISO 19155 2012 includes places not only in the real world but also those in the virtual world. These places are identified using either coordinate identifiers, geographic identifiers, or virtual world identifiers such as URI. In ISO 19155 2012, an identifier of a place is referred to as a Place Identifier (PI). The reference model defines a mechanism to match multiple Place Identifiers to the same place. In addition, a data structure and set of service interfaces are also defined in this reference model. ISO 19155 2012 is applicable to location-based services, emergency management services and other application domains that require a common architecture, across specific domains, for the representation of place descriptions using coordinate, geographic, or virtual world identifiers.

📁 CATEGORY Standard (ISO)

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📅 PUBLISHED 2012-11

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📁 DOMAIN Geographic Information Systems (GIS)

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## Specification | TC 211 | ISO 19155-2:2017 Geographic information - Place Identifier (PI) architecture - Part 2: Place Identifier (PI) linking

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ISO 19155-2 2017 defines the following three mechanisms for linking Place Identifiers (PIs) (see ISO 19155) to features or objects existing in other encodings

- 📁 Id attribute of a GML object (gml id) as defined in ISO 19136;
- 📁 Universally Unique Identifier (UUID) as defined in IETF RFC 4122;

🔗 Uniform Resource Locator (URL) as defined in IETF RFC 1738. These PI linking mechanisms are enabled using xlink href as defined in W3C XML Linking Language (XLink).

While the identifiers of these features or objects can sometimes identify a place, within the scope of this document, the identifiers of features or objects existing in other encoding domains are referred to conceptually as other identifiers. This document further defines that when PIs are encoded, as specified in ISO 19155, using the Geography Markup Language (GML) (ISO 19136), they are linked using gml id to other GML encoded features. The details of encoding GML instances using gml id are specified in a normative annex. Additional normative annexes define encodings for linking Place Identifiers to other identifiers using UUID and URL and present examples for their use. ISO 19155-2 2017 is applicable to location-based services, linked open data, robotic assisted services and other application domains that require a relationship between PIs and objects in either the real or virtual world. ISO 19155-2 2017 is not about creating a registry of Place Identifiers linked to specific features or objects, and support of linking mechanisms other than gml id, UUID, and URL is out of the scope of this document.

📖 CATEGORY Standard (ISO)

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📅 PUBLISHED 2017-08

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📁 DOMAIN Geographic Information Systems (GIS)

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## Specification | TC 211 | ISO 19156:2011 Geographic information - Observations and measurements

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ISO 19156 2011 defines a conceptual schema for observations, and for features involved in sampling when making observations. These provide models for the exchange of information describing observation acts and their results, both within and between different scientific and technical communities. Observations commonly involve sampling of an ultimate feature-of-interest. ISO 19156 2011 defines a common set of sampling feature types classified primarily by topological dimension, as well as samples for ex-situ observations. The schema includes relationships between sampling features (sub-sampling, derived samples). ISO 19156 2011 concerns only externally visible interfaces and places no restriction on the underlying implementations other than what is needed to satisfy the interface specifications in the actual situation.

📖 CATEGORY Standard (ISO)

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📅 PUBLISHED 2011-12

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📁 DOMAIN Geographic Information Systems (GIS)

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## Specification | TC 211 | ISO 19157:2013 Geographic information - Data quality, with amendment

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ISO 19157 2013 establishes the principles for describing the quality of geographic data. It - defines components for describing data quality; - specifies components and content structure of a register for data quality measures; - describes general procedures for evaluating the quality of geographic data; - establishes principles for reporting data quality. ISO 19157 2013 also defines a set of data quality measures for use in evaluating and reporting data quality. It is applicable to data producers providing quality information to describe and assess how well a data set conforms to its product specification and to data users attempting to determine whether or not specific geographic data are of sufficient quality for their particular application. ISO 19157 2013 does not attempt to define minimum acceptable levels of quality for geographic data.

📖 CATEGORY Standard (ISO)

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📅 PUBLISHED 2013-12

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📁 DOMAIN Geographic Information Systems (GIS)

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## Specification | TC 211 | ISO 19160-1:2015 Addressing - Part 1: Conceptual model

ISO 19160-1 2015 defines a conceptual model for address information (address model), together with the terms and definitions that describe the concepts in the model. Lifecycle, metadata, and address aliases are included in the conceptual model. The model is presented in the Unified Modeling Language (UML). The model provides a common representation of address information, independent of actual addressing implementations. It is not intended to replace conceptual models proposed in other specifications, but provides a means to cross-map between different conceptual models for address information and enables the conversion of address information between specifications. The model provides a basis for developing address specifications by individual countries or communities.

📁 CATEGORY Standard (ISO)

📅 PUBLISHED 2015-12

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO 19160-3:2020 Addressing - Part 3: Address data quality

This document

- a) is a profile of ISO 19157;
- (b) establishes a set of data quality elements and measures for describing the quality of address data;
- (c) describes procedures for reporting data quality; and
- (d) provides guidelines for the use of the established set of data quality elements and measures for describing the quality of address data.

This document can be used by those evaluating and reporting the quality of address data such as address data managers, address data aggregators, and address data users. This document does not attempt to define minimum acceptable levels of quality for address data.

📁 CATEGORY Standard (ISO)

📅 PUBLISHED 2020-02

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO 19160-4:2017 Addressing - Part 4: International postal address components and template language

ISO 19160-4 2017 defines key terms for postal addressing, postal address components and constraints on their use. Specifically, ISO 19160-4 2017 defines postal address components organized into three hierarchical levels - elements, such as organization name or postcode, which have well-defined conceptual meaning and are not themselves made up of subordinate components, though they may be sub-divided for technical purposes; - constructs, such as organization identification, which group elements into units form a logical portion of a postal address; - segments, such as addressee specification, which group-related postal address constructs and/or postal address elements into units with a specific defined function. ISO 19160-4 2017 also specifies a mechanism for creation of sub-elements, which correspond to either sub-divisions of element content, such as door type or door indicator or to multiple occurrences and locations of elements in an address, such as levels of administrative regions. ISO 19160-4 2017 does not specify the length of any component nor the value range of any component. Moreover, ISO 19160-4 2017 defines the codes to identify elements and sub-elements. Further, ISO 19160-4 2017 specifies postal address rendering rules. This includes identification and ordering of output lines in a rendered address, conditions for selection of candidate lines, the order and concatenation of postal address components, required and optional components, parameters to contextualize address for rendering and the formatting of the components, subject to constraints on the space available for that task. Postal address rendering rules are represented in ISO 19160-4 2017 as a postal address template. Finally, ISO 19160-4 2017 specifies language suitable for computer processing to formally express postal address templates.

📁 CATEGORY Standard (ISO)



## Specification | TC 211 | ISO 19161-1:2020 Geographic information - Geodetic references - Part 1: International terrestrial reference system (ITRS)

This document provides the basic information and the requirements related to the International Terrestrial Reference System (ITRS), its definition, its realizations and how to access and use these realizations. This document

(1) describes ITRS following the definitions and terminology adopted by the International Union of Geodesy and Geophysics (IUGG), the International Association of Geodesy (IAG) and the International Astronomical Union (IAU);

(2) describes different categories of ITRS realizations its primary realization, labelled the International Terrestrial Reference Frame (ITRF), other existing realizations of reference systems that are mathematically derived from the ITRS, and realizations that are aligned to the ITRF, such as GNSS-specific reference frames; and

(3) categorizes procedures for realizing the ITRS.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2020-01

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO 19162:2019 Geographic information - Well-known text representation of coordinate reference systems

This document defines the structure and content of a text string implementation of the abstract model for coordinate reference systems described in ISO 19111. The string defines frequently needed types of coordinate reference systems and coordinate operations in a self-contained form that is easily readable by machines and by humans. The essence is its simplicity; as a consequence there are some constraints upon the more open content allowed in ISO 19111. To retain simplicity in the well-known text (WKT) description of coordinate reference systems and coordinate operations, the scope of this document excludes parameter grouping and pass-through coordinate operations. The text string provides a means for humans and machines to correctly and unambiguously interpret and utilise a coordinate reference system definition with look-ups or cross references only to define coordinate operation mathematics. A WKT string is not suitable for the storage of definitions of coordinate reference systems or coordinate operations because it omits metadata about the source of the data and may omit metadata about the applicability of the information.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2019-07

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO 19165-1:2018 Geographic information - Preservation of digital data and metadata - Part 1: Fundamentals

ISO 19165-1 2018 defines a preservation metadata extension of ISO 19115-1. ISO 19165-1 2018 defines the requirements for the long-term preservation of digital geospatial data. These data also include metadata, representation information, provenance, context and any other content items that capture the knowledge that are necessary to fully understand and reuse the archived data. This document also refers to characteristics of data formats that are useful for the purpose of archiving. Geospatial data are preserved as a geospatial information package (IP). This document defines the requirements of the geospatial archival IP and details of the geospatial submission and the dissemination IPs. A geospatial archival IP is fully self-describing and allows a future reconstruction of the dataset without external documentation. The functional requirements

for a preservation archive are defined in Annex D. ISO 19165-1 2018 complements standards developed by ISO/TC 211 as well as other ISO standards such as ISO 14721.

🔗 CATEGORY Standard (ISO)

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📅 PUBLISHED 2018-05

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📁 DOMAIN Geographic Information Systems (GIS)

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## Specification | TC 211 | ISO 19165-2:2020 Geographic information - Preservation of digital data and metadata - Part 2: Content specifications for Earth observation data and derived digital products

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This document aims to extend the long-term preservation of digital geospatial data to provide details about content describing the provenance and context specific to data from missions that observe the Earth using spaceborne, airborne or in situ instruments.

🔗 CATEGORY Standard (ISO)

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📅 PUBLISHED 2020-07

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📁 DOMAIN Geographic Information Systems (GIS)

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## Specification | TC 211 | ISO 19168-1:2020 Geographic information - Geospatial API for features - Part 1: Core

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This document specifies the behaviour of Web APIs that provide access to features in a dataset in a manner independent of the underlying data store. This document defines discovery and query operations. Discovery operations enable clients to interrogate the API, including the API definition and metadata about the feature collections provided by the API, to determine the capabilities of the API and retrieve information about available distributions of the dataset. Query operations enable clients to retrieve features from the underlying data store based upon simple selection criteria, defined by the client.

🔗 CATEGORY Standard (ISO)

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📅 PUBLISHED 2020-09

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📁 DOMAIN Geographic Information Systems (GIS)

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## Specification | TC 211 | ISO 19170-1:2021 Geographic information - Discrete Global Grid Systems Specifications - Part 1: Core Reference System and Operations, and Equal Area Earth Reference System

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This document supports the definition of

- 🔗 Discrete Global Grid Systems (DGGs) core comprising - an RS using zonal identifiers with structured geometry, and - functions providing import, export and topological query,
- 🔗 Common spatio-temporal classes for geometry, topology, RS using zonal identifiers, zonal identifiers and zones, based on ISO 19111 CRS. The spatio-temporal scope is constrained to - spatial elements that are invariant through all time, and - temporal elements that are invariant across all space.
- 🔗 Equal-Area Earth Reference Systems (EAERSs) for Equal-Area Earth DGGs.

🔗 CATEGORY Standard (ISO)

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📅 PUBLISHED 2021-05

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📁 DOMAIN Geographic Information Systems (GIS)

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## Specification | TC 211 | ISO 6709:2008 Standard representation of geographic point location by coordinates, with corrigendum

ISO 6709 2008 is applicable to the interchange of coordinates describing geographic point location. It specifies the representation of coordinates, including latitude and longitude, to be used in data interchange. It additionally specifies representation of horizontal point location using coordinate types other than latitude and longitude. It also specifies the representation of height and depth that can be associated with horizontal coordinates. Representation includes units of measure and coordinate order. ISO 6709 2008 is not applicable to the representation of information held within computer memories during processing and in their use in registers of geodetic codes and parameters. ISO 6709 2008 supports point location representation through the eXtensible Markup Language (XML) and, recognizing the need for compatibility with the previous version of this International Standard, ISO 6709 1983, allows for the use of a single alpha-numeric string to describe point locations. For computer data interchange of latitude and longitude, ISO 6709 2008 generally suggests that decimal degrees be used. It allows the use of sexagesimal notations degrees, minutes and decimal minutes or degrees, minutes, seconds and decimal seconds. ISO 6709 2008 does not require special internal procedures, file-organization techniques, storage medium, languages, etc., to be used in its implementation.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2008-07

🌐 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO/TR 19121:2000 Geographic information - Imagery and gridded data

This Technical Report reviews the manner in which raster and gridded data is currently being handled in the Geomatics community in order to propose how this type of data should be supported by geographic information standards. This Technical Report identifies those aspects of imagery and gridded data that have been standardized or are being standardized in other ISO committees and external standards organizations, and that influence or support the establishment of raster and gridded data standards for geographic information. It also describes the components of those identified ISO and external imagery and gridded data standards that can be harmonized with the ISO 19100 series of geographic information/geomatics standards. A plan is presented for ISO/TC 211 to address imagery and gridded data in an integrated manner, within the ISO 19100 series of geographic information standards.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2000-10

🌐 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO/TR 19167:2019 Application of ubiquitous public access to-geographic information to an air quality information service

This document facilitates an understanding of the Ubiquitous Public Access (UPA) context information model, as defined in ISO 19154, to establish a UPA-to-Geographic Information (GI) environment. In addition, this document illustrates how the UPA context information model is designed and implemented to provide an air quality information service from a geographic information system (GIS)-based air quality information system. The UPA context information model for air quality information is only a sample of all possible examples to realize the UPA-to-GI that could satisfy the requirements of ISO 19154.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2019-12

🌐 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO/TR 19169:2021 Geographic Information - Gap-analysis: mapping and describing the differences between the current GDF and ISO/TC 211 conceptual models to suggest ways to harmonize and resolve conflicting issues

This document maps and describes the differences between GDF (ISO 20524 series), from ISO/TC 204, and conceptual models from the ISO 19100 family, from ISO/TC 211, and suggests ways to harmonize and resolve issues of conflict. Throughout this document, reference to GDF refers to GDF v5.1, ISO 20524-1 and ISO 20524-2, unless expressly identified otherwise. Where necessary, reference will be made to Part 1 or Part 2.

📁 CATEGORY Standard (ISO)

📅 PUBLISHED 2021-06

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO/TS 19115-3:2016 Geographic information - Metadata - Part 3: XML schema implementation for fundamental concepts

ISO/TS 19115-3 2016 defines an integrated XML implementation of ISO 19115-1, ISO 19115-2, and concepts from ISO/TS 19139 by defining the following artefacts

- 📄 a set of XML schema required to validate metadata instance documents conforming to conceptual model elements defined in ISO 19115-1, ISO 19115-2, and ISO/TS 19139;
- 📄 a set of ISO/IEC 19757-3 (Schematron) rules that implement validation constraints in the ISO 19115-1 and ISO 19115-2 UML models that are not validated by the XML schema;
- 📄 an Extensible Stylesheet Language Transformation (XSLT) for transforming ISO 19115-1 metadata encoded using the ISO/TS 19139 XML schema and ISO 19115-2 metadata encoded using the ISO/TS 19139-2 XML schema into an equivalent document that is valid against the XML schema defined in this document.

ISO/TS 19115-3 2016 describes the procedure used to generate XML schema from ISO geographic information conceptual models related to metadata. The procedure includes creation of an UML model for XML implementation derived from the conceptual UML model. This implementation model does not alter the semantics of the target conceptual model, but adds abstract classes that remove dependencies between model packages, tagged values and stereotypes required by the UML to XML transformation software, and refactors the packaging of a few elements into XML namespaces. The XML schema has been generated systematically from the UML model for XML implementation according to the rules defined in ISO/TS 19139 or ISO 19118.

📁 CATEGORY Standard (ISO)

📅 PUBLISHED 2016-08

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO/TS 19129:2009 Geographic information - Imagery, gridded and coverage data framework

ISO/TS 19129 2009 defines the framework for imagery, gridded and coverage data. This framework defines a content model for the content type imagery and for other specific content types that can be represented as coverage data. These content models are represented as a set of generic UML patterns for application schemas.

📁 CATEGORY Standard (ISO)

📅 PUBLISHED 2009-04

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO/TS 19130-2:2014 Geographic information - Imagery sensor models for geopositioning - Part 2: SAR, InSAR, lidar and sonar

ISO/TS 19130-2 2014 supports exploitation of remotely sensed images. It specifies the sensor models and metadata for geopositioning images remotely sensed by Synthetic Aperture Radar (SAR), Interferometric Synthetic Aperture Radar (InSAR), Light Detection And Ranging (lidar), and Sound Navigation And Ranging (sonar) sensors. The specification also defines the metadata needed for the aerial triangulation of airborne and spaceborne images. ISO/TS 19130-2 2014 specifies the detailed information that shall be provided for a sensor description of SAR, InSAR, lidar, and sonar sensors with the associated physical and geometric information necessary to rigorously construct a physical sensor model. For the case where precise geolocation information is needed, this Technical Specification identifies the mathematical formulae for rigorously constructing physical sensor models that relate two-dimensional image space to three-dimensional ground space and the calculation of the associated propagated error. ISO/TS 19130-2 2014 does not specify either how users derive geolocation data or the format or content of the data the users generate.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2014-01

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO/TS 19139-1:2019 Geographic information - XML schema implementation - Part 1: Encoding rules

This document defines XML based encoding rules for conceptual schemas specifying types that describe geographic resources. The encoding rules support the UML profile as used in the UML models commonly used in the standards developed by ISO/TC 211. The encoding rules use XML schema for the output data structure schema. The encoding rules described in this document are not applicable for encoding UML application schema for geographic features (see ISO 19136 for those rules).

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2019-03

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO/TS 19150-1:2012 Geographic information - Ontology - Part 1: Framework

ISO/TS 19150-1 2012 defines the framework for semantic interoperability of geographic information. This framework defines a high-level model of the components required to handle semantics in the ISO geographic information standards with the use of ontologies.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2012-11

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO/TS 19157-2:2016 Geographic information - Data quality - Part 2: XML schema implementation

ISO/TS 19157-2 2016 defines data quality encoding in XML. It is an XML schema implementation derived from ISO 19157 2013 and the data quality related concepts from ISO 19115-2.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2016-12

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO/TS 19158:2012 Geographic information - Quality assurance of data supply

ISO/TS 19158 2012 provides a framework for quality assurance specific to geographic information. It is based upon the quality principles and quality evaluation procedures of geographic information identified in ISO 19157 and the general quality management principles defined in ISO 9000. The framework defined in ISO/TS 19158 2012 enables a customer to satisfy itself that its suppliers, both internal and external, are capable of delivering geographic information to the required quality. Fundamental to the framework is the assurance of the supplier's ability to understand and meet the quality requirements. Through the quality assurance framework both the customer and the supplier are able to consider the quality required at the earliest opportunity in the production/update process. Principles and responsibilities of the relationship between the customer and the supplier that facilitate the framework are provided. The responsibility for the quality assessment procedure is shared between the customer and the supplier. ISO/TS 19158 2012 is applicable to customers and suppliers of all geographic information where the quality of the product may be impacted upon by the supplier's processes in any of the following scenarios

- there is an agreement or legislation for the supply of data acquisition services,
- data acquisition services are being tendered for, and
- one or more suppliers exist in the supply chain. ISO/TS 19158 2012 is not applicable for the supply of legacy datasets or 'off the shelf' products where there is no further data production or update activity to manage.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2012-10

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO/TS 19159-1:2014 Geographic information - Calibration and validation of remote sensing imagery sensors and data - Part 1: Optical sensors

ISO/TS 19159-1 2014 defines the calibration and validation of airborne and spaceborne remote sensing imagery sensors. The term calibration refers to geometry, radiometry, and spectral, and includes the instrument calibration in a laboratory as well as in situ calibration methods. The validation methods address validation of the calibration information.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2014-07

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO/TS 19159-2:2016 Geographic information - Calibration and validation of remote sensing imagery sensors and data - Part 2: Lidar

ISO/TS 19159-2 2016 defines the data capture method, the relationships between the coordinate reference systems and their parameters, as well as the calibration of airborne lidar (light detection and ranging) sensors. ISO/TS 19159-2 2016 also standardizes the service metadata for the data capture method, the relationships between the coordinate reference systems and their parameters and the calibration procedures of airborne lidar systems as well as the associated data types and code lists that have not been defined in other ISO geographic information international standards.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2016-04

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO/TS 19159-3:2018 Geographic information - Calibration and validation of remote sensing imagery sensors and data - Part 3: SAR/InSAR

This document defines the calibration of SAR/InSAR sensors and validation of SAR/InSAR calibration information. This document addresses earth based remote sensing. The specified sensors include airborne and spaceborne SAR/InSAR sensors. This document also addresses the metadata related to calibration and validation.

📁 CATEGORY Standard (ISO)

📅 PUBLISHED 2018-05

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO/TS 19163-1:2016 Geographic information - Content components and encoding rules for imagery and gridded data - Part 1: Content model

ISO/TS 19163-1 2016 classifies imagery and regularly spaced gridded thematic data into types based on attribute property, sensor type and spatial property, and defines an encoding-neutral content model for the required components for each type of data. It also specifies logical data structures and the rules for encoding the content components in the structures. The binding between the content and a specific encoding format will be defined in the subsequent parts of ISO 19163. ISO/TS 19163-1 2016 does not address LiDAR, SONAR data and ungeoreferenced gridded data. The logical data structures and the rules for encoding the content components will be addressed in the subsequent parts of ISO 19163.

📁 CATEGORY Standard (ISO)

📅 PUBLISHED 2016-01

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO/TS 19163-2:2020 Geographic information - Content components and encoding rules for imagery and gridded data - Part 2: Implementation schema

This document specifies an implementation schema based on the content models for geographic imagery and gridded thematic data defined in the ISO/TS 19163-1. This document defines a structure that is suitable for binding content components and specific encoding formats. It also provides an implementation schema for binding a concrete, implementable, conformance-testable coverage structure as defined in ISO 19123-2.

📁 CATEGORY Standard (ISO)

📅 PUBLISHED 2020-07

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | TC 211 | ISO/TS 19166:2021 Geographic information - BIM to GIS conceptual mapping (B2GM)

This document defines the conceptual framework and mechanisms for mapping information elements from Building Information Modelling (BIM) to Geographic Information Systems (GIS) to access the required information based on specific user requirements. The conceptual framework for mapping BIM information to GIS is defined with the following three mapping mechanisms

📁 BIM to GIS Perspective Definition (B2G PD);

📁 BIM to GIS Element Mapping (B2G EM);

📁 BIM to GIS LOD Mapping (B2G LM).



This document does not describe physical schema integration or mapping between BIM and GIS models because the physical schema integration or mapping between two heterogeneous models is very complex and can cause a variety of ambiguity problems. Developing a unified information model between BIM and GIS is a desirable goal, but it is out of the scope of this document. The scope of this document includes the following

- ❏ definition for BIM to GIS conceptual mapping requirement description;
- ❏ definition of BIM to GIS conceptual mapping framework and component;
- ❏ definition of mapping for export from one schema into another.

The following concepts are outside the scope

- ❏ definition of any particular mapping application requirement and mechanism;
- ❏ bi-directional mapping method between BIM and GIS;
- ❏ definition of physical schema mapping between BIM and GIS;
- ❏ definition of coordinate system mapping between BIM and GIS.

NOTE For cases involving requirements related to Geo-referencing for providing the position and orientation of the BIM model based on GIS, there exist other standards such as ISO 19111 and the Information Delivery Manual (IDM) from building SMART on Geo-referencing BIM. - definition of relationship mapping between BIM and GIS; - implementation of the application schema.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2021-05

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | OpenGIS | Web Map Service Interface Standard (WMS)

Provides a simple HTTP interface for requesting geo-registered map images from one or more distributed geospatial databases. A WMS request defines the geographic layer(s) and area of interest to be processed. The response to the request is one or more geo-registered map images (returned as JPEG, PNG, etc) that can be displayed in a browser application. The interface also supports the ability to specify whether the returned images should be transparent so that layers from multiple servers can be combined or not.

🔗 CATEGORY Standard (OGCS)

📅 PUBLISHED 2006-03

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | OGC | Web Feature Service (WFS)

WFS represents a change in the way geographic information is created, modified and exchanged on the Internet. Rather than sharing geographic information at the file level using File Transfer Protocol (FTP), for example, the WFS offers direct fine-grained access to geographic information at the feature and feature property level.

🔗 CATEGORY Standard (OGCS)

📅 PUBLISHED 2014-07

📁 DOMAIN Geographic Information Systems (GIS)

## Specification | Standards Australia | IT-004 : Geographical Information/Geomatics (Australian Mirror Committee)

Standardization in the field of digital geographic information. This work aims to establish a structured set of standards for information concerning objects or phenomena that are directly or indirectly associated with a location relative to the Earth. These standards may specify, for geographic information, methods, tools and services for data management (including definition and description), acquiring, processing, analyzing, accessing, presenting

and transferring such data in digital/electronic form between different users, systems and locations.

📁 CATEGORY Web (Australia)

📅 PUBLISHED Multiple Published and Adopted Standards by Australian Committee supporting GIS technologies

📁 DOMAIN Geographic Information Systems (GIS)

# Geographic Information Systems (GIS), Building

## Specification | TC 211 | ISO/TS 19166:2021 Geographic information - BIM to GIS conceptual mapping (B2GM)

This document defines the conceptual framework and mechanisms for mapping information elements from Building Information Modelling (BIM) to Geographic Information Systems (GIS) to access the required information based on specific user requirements. The conceptual framework for mapping BIM information to GIS is defined with the following three mapping mechanisms BIM to GIS Perspective Definition (B2G PD) BIM to GIS Element Mapping (B2G EM) BIM to GIS LOD Mapping (B2G LM) This document does not describe physical schema integration or mapping between BIM and GIS models because the physical schema integration or mapping between two heterogeneous models is very complex and can cause a variety of ambiguity problems. Developing a unified information model between BIM and GIS is a desirable goal, but it is out of the scope of this document. the scope includes definition for BIM to GIS conceptual mapping requirement description, definition for BIM to GIS conceptual mapping framework and component, definition of mapping for export from one schema into another.

📁 CATEGORY Standard (ISO)

📅 PUBLISHED 2021-05

📁 DOMAIN Geographic Information Systems (GIS), Building

# ■ Industry

## Guideline | ISO/IEC GUIDE 77-2:2008 Guide for specification of product properties and classes - Part 2: Technical principles and guidance

General advice and guidance for the description of products and their characteristics by the use of the ISO 13584 and IEC 61360 series of standards for the creation of computer-processable reference dictionaries. This description will provide the details of the products and their properties in an unambiguous manner capable of computer communication, in a form that is independent from any proprietary application software. ISO/IEC Guide 77 is intended to assist the objective of enabling the flow of technical information between internal and external business partners in a cost-effective and timely manner. The guidance given in ISO/IEC Guide 77-2 2008 contains technical recommendations intended to assist standardization committees and technical experts contributing their knowledge to the development of standard reference dictionaries compliant with the common ISO 13584/IEC 61360 dictionary model. It might also be useful for information experts responsible for the exchange of technical information between business partners or for the generation of applications of ISO 13584 and IEC 61360. ISO/IEC Guide 77-2 2008 is intended to support the achievement of industrial benefits of applications of the common ISO 13584/IEC 61360 dictionary model.

📅 PUBLISHED 2008-09

📁 DOMAIN Industry

## Report | A review of smart manufacturing reference models based on the skeleton meta-model

This document addresses how standards will allow interoperability among stakeholders in the upcoming super-connected world. A smart manufacturing reference model (SMRM) is under development inside JWG21 between ISO and IEC. Based on a dimensionality analysis and the skeleton meta-model, the eight proposed SMRMs are reviewed and compared. The SMRMs are classified according to the number of lifecycle axes and the number of dimensional axes. Also, how the concept of a digital twin can be accommodated in an SMRM is investigated.

📁 CATEGORY Paper

📅 PUBLISHED 2020-04

📁 DOMAIN Industry

## Report | EC | ICT Standardisation supporting Circular Economy: Report of the Study Group Circular Economy - a sub-group of the EU Multi-Stakeholder Platform for ICT Standardisation.

The digital transformation is a major pre-requisite for circular economy. ICT standards are key enablers. The EU Rolling Plan for ICT Standardisation 2020 kicks off actions for ICT standardisation relevant to accelerating the digital transformation. It addresses a number of topics of direct relevance to circular economy, namely in the context of ICT environmental impact, the digital transformation of industry/advanced manufacturing and water management. It provides the base for looking at structural and systemic areas, for example in areas such as smart cities, eGovernment, and eProcurement. A specific chapter on Circular Economy should be added to the Rolling Plan 2021. A significant number of standardisation activities of key relevance to circular economy are already ongoing in various standards bodies. They should be added and covered to the Rolling Plan 2021, covering product passport, digital twin, Energy-related products and material efficiency aspects for eco-design, batteries. There are many needs in the field of vocabularies, semantics, ontologies where work needs to start. In the areas of product passport, digital twin and batteries work can build on existing activities by putting a strong focus on the needs of the circular economy. It is recommended to start work on an open architecture

framework for circular economy. Further needs have been identified around assessing the ecological footprint, e.g. with methods and metrics that can be used in green financing.

📄 CATEGORY Paper (report)

📅 PUBLISHED 2020-12

🏠 DOMAIN Industry

## Report | DTC | Digital twins for Industrial Applications

Whitepaper providing practical guidance on the concept of a digital twins based on the previous work from IIC and IIoT. This includes the definition, benefits, architectures and the necessary building blocks to implement one explained with practical use-case examples.

📄 CATEGORY Paper (white paper)

📅 PUBLISHED 2020-02

🏠 DOMAIN Industry

## Report | ETP4HPC | Real-time digital twins. A TransContinuum initiative use case

White paper by TransContinuum that illustrates real-time use cases for digital twins of industrial assets and how different aspects such as data, models, knowledge and cybersecurity can be combined to create real-time digital twins for Industry 4.0.

📄 CATEGORY Paper (white paper)

📅 PUBLISHED 2021-09

🏠 DOMAIN Industry

## Report | GIZ | Use Case Equipment Lifecycle Management

The overall objectives of the Sino-German Sub-Working Group Industrie 4.0/Intelligent Manufacturing are the discussion of standardization aspects in the focus of Germany and China in order to intensify and deepen the Sino-German cooperation by defining concrete issues and steps to be taken. Business strategies and customer needs in the manufacturing industries manifested by concrete customer-projects are analyzed. The use case (Equipment Lifecycle Management) is part of the Baowu and Siemens Go to Industrie 4.0 (BSG2I4.0) project addressing the application of digital twins. This report is a result of the cooperation line "Use Cases and Applications" in the context of the Sino-German Sub-Working Group Industrie 4.0/Intelligent Manufacturing. The objective is to analyze business strategies and customer needs in the manufacturing industries manifested by concrete customer-projects.

📄 CATEGORY Paper

📅 PUBLISHED 2019-03

🏠 DOMAIN Industry

## Report | I4.0 | Digital Twin and Internet of Things: Current Standards Landscape

Industry 4.0 is revolutionizing industrial production by bridging the physical and the virtual worlds and further improving digitalization. Two essential building blocks in industry 4.0 are digital twins (DT) and the internet of things (IIoT). While IIoT is about connecting resources and collecting data about the physical world, DTs are the virtual representations of resources organizing and managing information and being tightly integrated with artificial intelligence, machine learning and cognitive services to further optimize and automate production. The concepts of DTs and IIoT are overlapping when it comes to describing, discovering and accessing resources. Currently, there are multiple DT and IIoT standards covering these overlapping aspects created by different organizations with different backgrounds and perspectives. With regard to interoperability, which is presumably the most

important aspect of industry 4.0, this barrier needs to be overcome by consolidation of standards. The objective of this paper is to investigate current DT and IoT standards and provide insights to stimulate this consolidation. Overlapping aspects are identified and a classification scheme is created and applied to the standards. The results are compared, aspects with high similarity or divergence are identified and a proposal for stimulating consolidation is presented. Consensuses between standards are found regarding the elements a resource should consist of and which serialization format(s) and network protocols to use. Controversial topics include which query language to use for discovery as well as if geo-spatial, temporal and historical data should be explicitly supported.

📁 CATEGORY Paper

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📅 PUBLISHED 2020-09

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📁 DOMAIN Industry

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## Report | IEC | Smart manufacturing

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This paper presents why we will need standards, which will cover the terminology, reference architecture and semantic interoperability of digital twins, in order to provide a foundational understanding for different stakeholders in diverse application areas.

📁 CATEGORY Paper (IEC)

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📅 PUBLISHED 2019-06

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📁 DOMAIN Industry

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## Report | IIC | Digital Twin and Asset Administration Shell Concepts and Application in the Industrial Internet and Industrie 4.0

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Digital twin (DT) is known to be a key enabler for various IIoT and Industry 4.0 use cases. Since many different flavors of digital twin for different use cases and industries currently exist, IIC has taken the first step to provide a clear and concise definition of digital twin along with its various technical aspects, standards and use cases. The Asset Administration Shell (AAS) is an implementation of a digital twin for industrial applications. It was specified and developed by Plattform Industrie 4.0 to enable cross-company-interoperability across the complete value stream.

📁 CATEGORY Paper

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📅 PUBLISHED 2020-09

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📁 DOMAIN Industry

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## Report | IIC | Digital Twins for Industrial Applications DEFINITION, BUSINESS VALUES, DESIGN ASPECTS, STANDARDS AND USE

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CASES An Industrial Internet Consortium White Paper

This whitepaper provides practical guidance on digital twin, including the definition, benefits, architectures and the necessary building blocks to implement one. We illustrate the relationships between an Industrial Internet of Things (IIoT) system and its twin with use cases.

📁 CATEGORY Paper (position paper)

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📅 PUBLISHED 2020-02

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📁 DOMAIN Industry

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## Report | Platform Industrie 4.0 | Usage View of Asset Administration Shell

The Asset Administration Shell is a technical foundation for implementation of e.g. digital twins. The purpose of the usage view was to fill the current gap between the scenarios resp. use cases discussions and the technical discussions, especially in the working group (Reference architectures, standards and norms) of Platform Industrie 4.0.

📄 CATEGORY Paper (report)

📅 PUBLISHED 2019-02

🏢 DOMAIN Industry

## Report | Platform Industrie 4.0 | Usage View Seamless and Dynamic Engineering of Plants

The overall principle of the business scenario "Seamless and Dynamic Engineering of Plants" is that in an initial engineering process for engineering and construction of a plant, an integrating plant model - also called digital twin - is created, which is maintained and kept consistent throughout the entire life of the real physical plant, documenting its permanently interrelated processes between engineering, operation and service of the plant. Which helps to underline the importance of the integrating plant model so that a broad community better understands the objectives of this concept to be able to generate benefits from its usage.

📄 CATEGORY Paper (report)

📅 PUBLISHED 2020-04

🏢 DOMAIN Industry

## Report | Proprietary | Digital Twin: Manufacturing Excellence through Virtual Factory Replication

This paper introduces the concept of a Digital Twin as a virtual representation of what has been produced. Compare a Digital Twin to its engineering design to better understand what was produced versus what was designed, tightening the loop between design and execution.

📄 CATEGORY Paper (Japan national initiative)

📅 PUBLISHED 2015-03

🏢 DOMAIN Industry

## Report | Proprietary | What is a Digital Twin?

This page provides an IoT manufacturer vision of a digital twin.

📄 CATEGORY Paper (position paper)

📅 PUBLISHED 2020-09

🏢 DOMAIN Industry

## Specification | IEC TC65 Automation | IEC 63278-1 Asset Administration Shell for industrial applications - Part 1: Asset Administration Shell structure

This document defines a standardized digital representation of an asset, called Asset Administration Shell. The Asset Administration Shell gives uniform access to information and services. The purpose of the Asset Administration Shell is to enable two or more systems or software applications to exchange 316 information and to mutually use the information that has been exchanged in a trusted and secure way. This document focusses on Asset Administration Shells representing assets of manufacturing

enterprises including produced products. It defines the related structures, information, and services. The Asset Administration Shell is suitable for any type of process (discrete manufacturing, continuous process, batch process, hybrid production) and any industrial sector applying industrial-process measurement, control and automation. The Asset Administration Shell covers the entire life cycle of assets from conception to disposal. The Asset Administration Shell applies to assets which are physical, digital, or intangible entities. Physical entities are e.g. equipment, raw material, parts components and pieces, supplies, consumables, physical products and waste. Digital entities are e.g. process definitions, business procedures or actual states. A software license is an example of an intangible asset.

🔗 CATEGORY Standard (IEC)

📅 PUBLISHED Under Development

📁 DOMAIN Industry

## Specification | IEC TC65 Automation | IEC/TR 63283-2 Industrial-process measurement, control and automation - Smart Manufacturing - Part 2: Use cases

This part provides an overview of Smart Manufacturing use cases. The claim of these use cases is that they cover the topic of smart manufacturing in a representative way. The purpose of these use cases is to propose recommendations for standardization in a systematic way. These use cases include Digital Twin use cases.

🔗 CATEGORY Standard (IEC)

📅 PUBLISHED Under Development

📁 DOMAIN Industry

## Specification | IEC TC65 Automation | IEC PAS 63088. (2017).

Smart Manufacturing - Reference Architecture Model Industry 4.0 (RAMI4.0). V1.0

IEC PAS 63088 2017(E) describes a reference architecture model in the form of a cubic layer model, which shows technical objects (assets) in the form of layers, and allows them to be described, tracked over their entire lifetime (or vita) and assigned to technical and/or organizational hierarchies. It also describes the structure and function of Industry 4.0 components as essential parts of the virtual representation of assets.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2017-03

📁 DOMAIN Industry

## Specification | TC 10 | IEC/DIS 81346-1 Industrial systems, installations and equipment and industrial products - Structuring principles and reference designations - Part 1: Basic rules

This part of IEC 81346, published jointly by IEC and ISO, establishes general principles for the structuring of systems including structuring of the information about systems. Based on these principles, rules and guidance are given for the formulation of unambiguous reference designations for objects in any system. The reference designation identifies objects for the purpose of creation and retrieval of information about an object, and where realized about its corresponding component. A reference designation labelled at a component is the key to find information about that object among different kinds of documents. The principles are general and are applicable to all technical areas (for example mechanical engineering, electrical engineering, construction engineering, process engineering). They can be used for systems based on different technologies or for systems combining several technologies.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2021-06

📁 DOMAIN Industry



## Specification | TC 184 | ISO/TS 18101-1:2019: Oil and Gas Interoperability Technical Specification

This document provides requirements, specifications and guidance for an architecture of a supplier-neutral industrial digital ecosystem. It includes a standardized connectivity and services architecture, and a standardized use case architecture with methods to specify atomically re-usable scenarios and events, which can be used to specify the characteristics of standardized industry use cases.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2019-06

🏢 DOMAIN Industry

## Specification | TC184 | ISO/TR 24464 Automation systems and integration - Industrial data - Visualization elements of digital twins

This document analyses visualization elements that are key components of the interface between the physical asset and the avatar (digital replica of the physical asset).

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2020-11

🏢 DOMAIN Industry

## Specification | TC184 SC4 | ISO 10303-209:2014 Industrial automation systems and integration - Product data representation and exchange - Part 209: Application protocol: Multidisciplinary analysis and design

Describes information for the multidisciplinary analysis and design of complex parts, including composites.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2014-12

🏢 DOMAIN Industry

## Specification | TC184 SC4 | ISO 10303-242:2020 Industrial automation systems and integration - Product data representation and exchange - Part 242: Application protocol: Managed model- based 3D engineering

This document specifies the application module for AP242 managed model based 3D engineering.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 43891

🏢 DOMAIN Industry

# Specification | TC184 SC4 | ISO 23247-1 Automation systems and integration - Digital twin framework for manufacturing - Part 1: Overview and general principles

This document provides an overview and general principles of a digital twin framework for manufacturing, including - terms and definitions; - requirements of the digital twin framework for manufacturing.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2021-10

🏢 DOMAIN Industry

# Specification | TC184 SC4 | ISO 23247-2, Automation systems and integration - Digital Twin framework for manufacturing - Part 2: Reference architecture

This document provides a reference architecture for digital twins in manufacturing, including (1) a reference model from the domain and entity point of view; and (2) a functional view specifying functional entities supported by the entity-based reference model.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2021-10

🏢 DOMAIN Industry

# Specification | TC184 SC4 | ISO 23247-3, Automation systems and integration - Digital Twin framework for manufacturing - Part 3: Digital representation of manufacturing elements

This document provides a list of basic information attributes for OMEs [Observable Manufacturing Elements]. Examples of information attributes are provided, and standards that can define these information attributes are discussed in Annex A.

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2021-10

🏢 DOMAIN Industry

# Specification | TC184 SC4 | ISO 23247-4, Automation systems and integration - Digital Twin framework for manufacturing - Part 4: Information exchange

This document identifies technical requirements for information exchange between entities within the manufacturing digital twin reference architecture specified in ISO 23247-2. The scope of this standard encompasses the requirements for information exchange in the following networks

- 🔗 the user network that connects the user entity and the digital twin entity;
- 🔗 the service network that connects sub-entities within the digital twin entity;
- 🔗 the access network that connects the device communication entity to the digital twin entity and to the user entity; (
- 🔗 the proximity network that connects the device communication entity to the observable manufacturing elements (OMEs).

🔗 CATEGORY Standard (ISO)

📅 PUBLISHED 2021-10

🏢 DOMAIN Industry

# Specification | TC SmartM2M | ETSI TR 103 507 V1.1.1 (2018-10): SAREF extension investigation; Requirements for industry and manufacturing domains

The present document specifies the requirements for an initial semantic model for industry and manufacturing domains based on a limited set of use cases and from available existing data model. It includes deployment and related services aspects. The present document is developed in close collaboration with AIOTI, the H2020 Large Scale Pilots and with ETSI activities in this domain. Further extensions are envisaged in the future to cover entirely the industry and manufacturing domains. The associated ETSI TS 103 410-5 [i.9] will define the extension (i.e. the semantic model) for the industry and manufacturing domains based on the requirements and use cases specified in the present document. This work is expected to be developed in close collaboration with AIOTI, the H2020 Large Scale Pilots and with ETSI activities in industry and manufacturing domains. Further extensions are envisaged in the future to cover entirely the industry and manufacturing domains.

🔗 CATEGORY Standard

📅 PUBLISHED 2018-10

🏠 DOMAIN Industry

# Specification | TC SmartM2M | ETSI TR 103 674 V1.1.1 (2021-02): Artificial Intelligence and the oneM2M architecture

Detailed description of selected use cases and identification of architectural evolutions (components, required mappings, etc.) to the oneM2M framework.

🔗 CATEGORY Standard

📅 PUBLISHED 2021-02

🏠 DOMAIN Industry

# Specification | TC SmartM2M | ETSI TR 103 778 V1.1.1 (2021-12): Use cases for cross-domain data usability of IoT devices

Current AI technologies based mainly on Machine Learning and on processing large amounts of data has led to a debate on data gathering, data ownership, data transparency, data bias that is going well beyond technical matters (privacy, regulation, remuneration schemes). The (negative) impact of poor-quality training data is very obvious, especially in health applications, road travel, etc. Due to the growing use of AI models in standards, ETSI Technical Bodies have decided to investigate means to assess the “quality” and usability of datasets needed to train and also to test the AI capabilities referenced by new standards [i.8] which is one of the motivations for this work. IoT devices and platforms also provide data that are used directly by human and very often non-technical users. This is the case for example for medical teams and their patients in the medical sector, mechanics in the automotive sector or first responders in the emergency sector. Trust in the IoT system can be ensured only if these data bring in a real added-value and are delivered in a non-ambiguous manner to these users. To analyze how this can be ensured is another motivation for this work.

🔗 CATEGORY Standard

📅 PUBLISHED 2021-12

🏠 DOMAIN Industry

## Specification | JTC 1/SC 27 | ISO/IEC TR 27550:2019 Information technology - Security techniques - Privacy engineering for system life cycle processes

This document provides privacy engineering guidelines that are intended to help organizations integrate recent advances in privacy engineering into system life cycle processes. It describes

- the relationship between privacy engineering and other engineering viewpoints (system engineering, security engineering, risk management); and
- privacy engineering activities in key engineering processes such as knowledge management, risk management, requirement analysis, and architecture design.

The intended audience includes engineers and practitioners who are involved in the development, implementation or operation of systems that need privacy consideration, as well as managers in organizations responsible for privacy, development, product management, marketing, and operations.

CATEGORY Standard (ISO/IEC)

PUBLISHED 2019-09

DOMAIN Industry

## Specification | JTC 1/SC 7 | ISO/IEC/IEEE CD 24641.2 Systems and Software engineering - Methods and tools for model-based software engineering

This International Standard, within the context of methods and tools for MBSSE

- Provides terms and definitions related to MBSSE;
- Defines MBSSE-specific processes for model-based systems and software engineering; the processes are described in terms of purpose, inputs, tasks, and outcomes;
- Defines methods to support the defined tasks of each process;
- Defines tool capabilities to automate/semi-automate tasks or methods.

The processes defined in this document are applicable for a single project, as well as for an organization performing multiple projects. These processes are applicable for managing and performing the systems engineering activities based on models within any stage in the life cycle of a system of interest.

CATEGORY Standard under development (ISO/IEC)

PUBLISHED Under development

DOMAIN Industry

# ■ Robotics

## Report | Proprietary | Digital twin based synchronised control and simulation of the industrial robotic cell using virtual reality

During the years common understanding of the possibilities and perspectives of Virtual Reality (VR) usage has been changed. It is thought that VR is mainly used in entertainment purposes, but it is being used already for many years in different industries, and now with easier access to the hardware it became a helpful and accessible tool that could be used and developed in any field of human activities. In manufacturing, immersive technologies are mainly used nowadays for the visualisation of processes and products combining those visuals into the factory Digital Twin (DT) which is possible to view from the inside look. This feature is already being used in several manufacturing simulation tools, which enable to view onto industrial line / robotic cells via Virtual Reality glasses. However, the potential of using simulations with VR in manufacturing is not fully uncovered. The main aim of this, industrial robotics targeted research is to enable besides simulation also universal control algorithms through Virtual Reality experience, produced by game engine Unity3D, which can be easily modified for a wide range of industrial equipment. The primary outcome of this work is the development of the synchronisation model of real and virtual industrial robots and experimental testing the developed model in Virtual Reality and shop floor labs.

📄 CATEGORY Paper

📅 PUBLISHED 2019-02

🏠 DOMAIN Robotics

## Specification | TC 159 SC4 | ISO/TR 9241-810:2020 Ergonomics of human-system interaction - Part 810: Robotic, intelligent and autonomous systems

This document addresses

- 📌 physically embodied RIA systems, such as robots and autonomous vehicles with which users will physically interact;
- 📌 systems embedded within the physical environment with which users do not consciously interact, but which collect data and/or modify the environment within which people live or work such as smart building and, mood-detection;
- 📌 intelligent software tools and agents with which users actively interact through some form of user interface;
- 📌 intelligent software agents which act without active user input to modify or tailor the systems to the user's behaviour, task or some other purpose, including providing context specific content/information, tailoring adverts to a user based on information about them, user interfaces that adapt to the cognitive or physiological state (ambient intelligence);
- 📌 the effect on users resulting from the combined interaction of several RIA systems such as conflicting behaviours between the RIA systems under the same circumstances; and
- 📌 the complex system-of-systems and sociotechnical impacts of the use of RIA systems, particularly on society and government.

This document is not an exploration of the philosophical, ethical or political issues surrounding robotics, artificial intelligence, machine learning, and intelligent machines or environments. For matters of ethics and political issues, see standards such as BS 8611 and IEC P7000. However, this document does identify where and why ethical issues need to be taken into account for a wide range of systems and contexts, and as such it provides information relevant to the broader debate regarding RIA systems. This document has a broader focus than much of the early work on autonomy that relates to the automation of control tasks and mechanization of repetitive physical or cognitive tasks, and centres on levels of automation. Although this document

addresses a wide range of technology applications, and sector and stakeholder views on the issues, the treatment of each can be incomplete due to the diverse and increasingly varied applications of RIA systems.

🔗 CATEGORY Standard (ISO)

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📅 PUBLISHED 2020-09

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📁 DOMAIN Robotics

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## ■ Smart cities

### Report | Banque des territoire | Jumeau numerique des territoires, issu de la reflexion de la banque des territoires (Territorial digital twin, resulting from the investigations of the French Territorial Bank)

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A digital twin is a virtual replica of a city which presents its territory and its operations, in 3D, using augmented reality. Digital twins have become representative projects of smart cities and are spurring interest. The best-known examples are Rennes and Singapore, and many other cities have rallied this movement. The Banque des Territoires (Territories Bank) conducted this study to allow local governments to - better understand what a digital twin of city is; - discover use cases from around the world; - obtain concrete answers on the requirements and necessary means to launch your own project. The document points out a series of challenges facing local authorities and concludes that a normative framework, such as the Gemini principles set up in Great Britain, seems to be an interesting approach.

🔗 CATEGORY Paper (principles)

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📅 PUBLISHED 2021-07

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📁 DOMAIN Smart cities

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### Report | EC | Destination Earth: Survey on Digital Twins technologies and activities, in the Green Deal area

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JRC Technical Report Destination Earth - Survey on “Digital Twins” technologies and activities, in the Green Deal area. An overview of EU projects and activities relating to Digital twins.

🔗 CATEGORY Paper (survey of green deal related digital twins)

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📅 PUBLISHED 2020-11

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📁 DOMAIN Smart cities

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### Report | Proprietary | Beyond IoT: Digital Twins and Cyber-Physical Systems

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Digital twins may be the buzz-phrase du jour, yet they first appeared, long before the current hype, as a highly specialized tool for aerospace engineering or product lifecycle management within these confines, they were understood as full-fledged numerical-simulation replicas of some physical contraption. They are now often understood, in a weaker sense, as digital proxies to the things they twin. Full-blown digital twins are not merely CAD-originating or CGI-like representations of factory prototypes of things they aim to be actionable simulations of actual instances of these things, in their real-world setting, mirroring their complete lifecycle evolution. In their more lightweight

incarnations, digital twins are content to be just some kind of digital one-stop shop, providing unified and contextualized high-level interfaces for digital applications that need to interact, in all possible ways, with a physical thing, system, or system of systems. They may forsake the mirror-image and multi-physics simulation objectives of heavyweight industrial twins, yet they should, crucially, retain some of their instantiated and historicized representation features. This digital-twin-lite concept is the one we elicit and elaborate on, relating it to our Thing in graph-based platform.

🔗 CATEGORY Product

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📅 PUBLISHED online

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📁 DOMAIN Smart cities

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## Report | Smart Cities Council | Digital Twin Blueprint (DRAFT)

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Blueprint providing an overview of the opportunities to build a Digital Twin marketplace across the Australia New Zealand region. It is not a strategy.

🔗 CATEGORY Paper (report)

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📅 PUBLISHED 2021-07

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📁 DOMAIN Smart cities

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## Report | UNESCAP | Spatial Digital Twins Special Interest Group

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The SSSI Spatial Digital Twin Special Interest Group (SDT-SIG) aims to educate, leverage and develop capabilities for surveying and spatial professionals in this emerging technology and to provide highly relevant learning and development opportunities for the members of SSSI.

🔗 CATEGORY Web (special interest group)

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📅 PUBLISHED Under Development

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📁 DOMAIN Smart cities

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## Specification | IEC | City information modelling and urban digital twins

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The development and delivery of smart cities involves many different systems, types of data, and sets of information. This complexity, and the dynamic interaction between the large numbers of stakeholders and city systems, makes planning and managing cities a great challenge. Without a tangible operational model to combine cross-sector data and information, the holistic, cross-boundary planning of cities, districts and neighbourhoods remains constrained. Therefore, new and effective tools are needed to enable the delivery of better city services and to make the urban environment more liveable, inclusive, safe, resilient and sustainable. City information modelling (CIM) and urban digital twins (UDT) are two emerging technologies for smart cities that aim to provide such tools. Both offer solutions for data processing, urban analysis, design, simulation and modelling. They connect all involved stakeholders and actors to collaboratively deliver the vision of a smart city a sustainable, inclusive, healthy, prosperous and participative city. They provide solutions for smart cities based on open standards and a multiscale and multitemporal database that integrates a wide variety of data sources presenting the full range of smart urban features, systems and processes.

🔗 CATEGORY Standard (ISO)

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📅 PUBLISHED 2021-12

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📁 DOMAIN Smart cities

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# Specification | ISO TC 268 SC1 | Smart Community Infrastructures: Development Guidelines for Information-based Systems of Smart Buildings

Smart Community Infrastructures: Development Guidelines for Information-based Systems of Smart Buildings.

🔗 CATEGORY Standard under development (ISO)

📅 PUBLISHED Under Development

📁 DOMAIN Smart cities

# Specification | JTC 1/SC 27 | ISO/IEC TS 27570:2021 Privacy protection - Privacy guidelines for smart cities

The document takes a multiple agency as well as a citizen-centric viewpoint. It provides guidance on

- 📄 smart city ecosystem privacy protection;
- 📄 how standards can be used at a global level and at an organizational level for the benefit of citizens; and
- 📄 processes for smart city ecosystem privacy protection.

This document is applicable to all types and sizes of organizations, including public and private companies, government entities, and not-for-profit organizations that provide services in smart city environments.

🔗 CATEGORY Standard (ISO/IEC)

📅 PUBLISHED 2021-01

📁 DOMAIN Smart cities

# Specification | SG 20 | Y.dt-interop Interoperability framework of digital twin systems in smart cities and communities

Digital twins can improve the efficiency and sustainability of cities and communities by creating a virtual representation of a city and using it to simulate challenges, emergencies and other situations that its counterpart may experience in the physical world. Digital twins provide a safe testing environment that enable city stakeholders to enhance operational efficiency across sectors, improve urban design, better prepared in disaster situations and among other benefits that are crucial for the transition to smart city and community and contribute to the achievement of the Sustainable Development Goals and other global objectives. Implementing digital twin technology in cities and communities involves creating a complex system that consists of a multitude of key functionalities including real-time monitoring, seamless connectivity, dynamic simulations, and predictions (e.g. preventive maintenance use cases) for safe and secured operation of cities and communities. To realize such system, digital twin cities need to take into consideration three key aspects. First, it is the data interoperability aspect by developing semantics, and modeling languages that would facilitate interoperability of data, effective data collection and management. Second, it is the digital data processing aspect which refers to the use of different digital technologies (e.g., 5G, AI, cloud, big data analytics etc.) to facilitate the operation of digital twins. And third, it is the infrastructure aspect which refers to the digital infrastructure required to enable connectivity among all connected and communities stakeholders to implement and operate digital twin technology based on the criteria of these three aspects.

🔗 CATEGORY Standard (ITU-T)

📅 PUBLISHED Under Development

📁 DOMAIN Transport

# Specification | SG 20 | Y.dt-smartfirefighting Requirements and capability framework of digital twin for smart firefighting

Through the IoT technology deployment and the information integration process, the digital twin can provide high fidelity digital representation of the fire scene, enable dynamic convergence between the physical entity and digital entity, and achieve comprehensive understanding and control of the past, present, and future of the fire scene. The current state of the art for firefighting lacks comprehensive dynamic sensing capability and prediction capability, it cannot provide delayed information, and adequate visibility of the interaction between personnel and fire scene. Through the deployment of gateways, sensors, high quality network, multi-physics simulation, dynamic analysis and prediction, 3D visualizations. The smart firefighting digital twin enables intelligent services such as personnel tracking, hazard tracking, fire scene dynamic analysis, rescue strategy optimization, pre-simulation, historical scene reconstruction, etc., these intelligent services can help to improve decision-making processes and reduce the casualties. This draft Recommendation specifies the requirements and capability framework of digital twin for smart firefighting.

🔗 CATEGORY Standard (ITU-T)

📅 PUBLISHED Under Development

🏠 DOMAIN Smart cities

# Specification | SG 20 | Y.dtf.reqts Requirements for digital twin federation in smart cities and communities

A digital twin is the digital representation of an observable object with data connections that enable convergence between the physical and digital states at an appropriate rate of synchronization. Also, a digital twin has the capabilities of connection, integration, analysis, simulation, visualization, optimization and provides an integrated view throughout the life-cycle of the observable objects. The digital twin can provide real-time monitoring and proactive control, predictive maintenance by data analytics, cost and downtime reduction, and so on. Due to these benefits, various industries have adopted the digital twin technology. The smart cities and communities may have many kinds of cross domain problems, such as manufacturing, transportation, energy and safety, and it is difficult to resolve these problems by individual digital twin system. To solve them, the digital twin systems in various domains can be federated. The federated digital twin systems collect and analyse the information of various domains, provide the solution for the problems, and simulate the effects. The functions for digital twin federation are registration, discovery, connection and utilization. First, each digital twin system registers its federation-related capabilities in registry. Then digital twin federation discovers specific digital twin which provides capabilities needed. After discovery, it can be connected and utilized to solve cross domain problems. This Recommendation defines the requirements for digital twin federation.

🔗 CATEGORY Standard (ITU-T)

📅 PUBLISHED Under Development

🏠 DOMAIN Smart cities

# Specification | SG 20 | Y.scdt-reqts Requirements and capabilities of a digital twin system for smart cities

A digital twin is defined as a pairing of virtual and physical worlds that allows analysis of data and monitoring of systems to head off problems before they occur, prevent downtime, and even plan for the future using simulations. A smart city digital twin can be defined as a digital twin for smart cities that can increase visibility of human-infrastructure-strategy interactions. Smart city digital twin allows the simulation of plans before implementing them, exposing problems before they become a reality. In other word, it is possible to conduct simulations on a digital replica of the city (virtual cities) before actually implementing the strategy on the real city. In this way, it is also possible to find the best strategies to achieve a specific goal or strategies that have similar effects while minimizing budget and resource usage. Therefore, a

smart city digital twin is tool for improving urban operations, efficiencies and resilience of a city.

🔗 CATEGORY Standard (ITU-T)

📅 PUBLISHED Under Development

📁 DOMAIN Smart cities

## ■ Spatial data

### Report | ANZLIC | Foundation Spatial Data Framework

FSDF is a change program on Australia's "common asset" of location information. Users rely heavily on the same trusted information to make decisions that affect people's safety, prosperity, and environment. Innovation will be enabled through discovery and access to reliable, trusted data from custodians. Suppliers will be able to leverage the best approaches for managing and supplying spatial data through shared experience. Roles and responsibilities will be recognised and supported.

🔗 CATEGORY Web

📅 PUBLISHED online

📁 DOMAIN Spatial data

### Report | ANZLIC | Principles for Spatially Enabled Digital Twins of the Built and Natural Environment in Australia

This paper outlines the vision of a federated ecosystem of securely connected, spatially enabled digital twins of the built and natural environment in Australia. It leverages foundation spatial (or location) data which are essential for effective decision-making across the built and natural environment, as well as the integration of this data with other information such as digital engineering models, Internet of Things (IoT) sensor data and environmental data to provide more holistic insights. Nine principles are proposed to achieve this vision public good, value, quality, adaptation, openness, security and privacy, curation, standards and federated model.

🔗 CATEGORY Paper (principles)

📅 PUBLISHED 2019-12

📁 DOMAIN Spatial data

### Report | CSIRO | Framework for Spatially Enabled Digital Twins

This is a Framework, released by ANZLIC in December 2019, to guide the development and operation of spatially enabled digital twins that align with the Principles for Spatially Enabled Digital Twins of the built and natural environment in Australia.

🔗 CATEGORY Paper (principles)

📅 PUBLISHED 2020-02

📁 DOMAIN Spatial data

## Report | Fiware | FIWARE for digital twins

Position paper on how FIWARE software building blocks and the NGSI-LD API can be used to create smart solutions based on the Digital Twin paradigm that integrate smart applications from multiple domains. Central in the vision, the NGSI-LD API is proposed as an open standard API for getting access to digital twin data and use of standard data models is promoted to ensure portability and replicability of solutions.

📁 CATEGORY Paper (fiware position paper)

📅 PUBLISHED 2021-06

📁 DOMAIN Spatial data

## ■ Transport

### Report | Digital twin hub | Data for the public good

Report on how data can be used for the public good, focusing on action in three areas collecting the right data; setting standards for data; and sharing that data securely. These actions can improve public services whilst saving society billions of pounds. The report also sets out a roadmap towards a national digital twin a digital model of our national infrastructure which will be able both to monitor our infrastructure in real-time, and to simulate the impacts of possible events.

📁 CATEGORY Paper (position paper)

📅 PUBLISHED 2019-12

📁 DOMAIN Transport

### Specification | SG 20 | Y.dt-ITS Requirements and capability framework of digital twin for intelligent transport system

By applying kinds of emerging technologies, digital twin for intelligent transport system which provides real digital representation of physical transportation world could be constructed. With the profound and full-scale understanding of historical, real-time and static traffic related data in digital twin for intelligent transport system, the awareness of physical transportation is significantly enhanced, problems of transportation system could be discovered earlier, various traffic situations could be simulated, different long term, medium, short term strategies could be properly decided, and a lot of applications supported by intelligent transport system, such as transportation planning and traffic optimization, could be provided better and more intelligent. This draft Recommendation specifies the requirements and capability framework of digital twin for intelligent transport system.

📁 CATEGORY Standard (ITU-T)

📅 PUBLISHED Under Development

📁 DOMAIN Transport

## ■ Annex - Table of Documents

Headline Title of Document	Webpage for access	Domain
Guideline   Building energy performance analysis: A case study	<a href="https://www.sciencedirect.com/science/article/abs/pii/S0378778814009426">https://www.sciencedirect.com/science/article/abs/pii/S0378778814009426</a>	Building, energy
Guideline   DNV-RP-A204: Qualification and assurance of digital twins,	<a href="https://www.dnv.com/oilgas/digital-twins/preview-DNV-RP-A204-qualification-and-assurance-of-digital-twins.html">https://www.dnv.com/oilgas/digital-twins/preview-DNV-RP-A204-qualification-and-assurance-of-digital-twins.html</a>	Energy
Guideline   IIC   Global Industry Standards for Industrial IoT	<a href="https://www.iiconsortium.org/pdf/IIC_Global_Standards_Strategy_Whitepaper.pdf">https://www.iiconsortium.org/pdf/IIC_Global_Standards_Strategy_Whitepaper.pdf</a>	Cross-domain
Guideline   IIC   IoT Security Maturity Model (SMM) v1.2	<a href="https://www.iiconsortium.org/stay-informed/SMM.htm">https://www.iiconsortium.org/stay-informed/SMM.htm</a>	Cross-domain
Guideline   ISO/IEC GUIDE 77-2:2008 Guide for specification of product properties and classes - Part 2: Technical principles and guidance	<a href="https://www.iso.org/standard/44070.html">https://www.iso.org/standard/44070.html</a>	Industry
Guideline   JTC 1/SC 42   ISO/IEC DIS 23894 Information technology - Artificial intelligence - Risk management	<a href="https://www.iso.org/standard/81228.html">https://www.iso.org/standard/81228.html</a>	Augmented reality
Landscape   Digital twin hub   A Survey of Industry Data Models and Reference Data Libraries	<a href="https://digitaltwinhub.co.uk/a-survey-of-idms-and-rdls-intro/">https://digitaltwinhub.co.uk/a-survey-of-idms-and-rdls-intro/</a>	Building
Landscape   Digital twin hub   Information Management Framework (IMF)	<a href="https://digitaltwinhub.co.uk/projects/imf/what-is-the-imf/">https://digitaltwinhub.co.uk/projects/imf/what-is-the-imf/</a>	Building
Landscape   IBM Digital twin exchange	<a href="https://digitaltwinexchange.ibm.com/">https://digitaltwinexchange.ibm.com/</a>	Cross-domain
Landscape   ISG ZSM   ETSI GR ZSM 004 V2.1.1 (2022-01): Landscape	<a href="http://webapp.etsi.org/workprogram/Report_WorkItem.asp?WKI_ID=59231">http://webapp.etsi.org/workprogram/Report_WorkItem.asp?WKI_ID=59231</a>	Cross-domain
Report   A position paper from buildingSMART International for the construction industry	<a href="https://buildingsmart-1xbd3ajdayi.netdna-ssl.com/wp-content/uploads/2020/06/Enabling-Digital-Twins-Positioning-Paper-Final.pdf">https://buildingsmart-1xbd3ajdayi.netdna-ssl.com/wp-content/uploads/2020/06/Enabling-Digital-Twins-Positioning-Paper-Final.pdf</a>	Building
Report   A review of smart manufacturing reference models based on the skeleton meta-model	<a href="https://academic.oup.com/jcde/article/7/3/323/5818506">https://academic.oup.com/jcde/article/7/3/323/5818506</a>	Industry

Headline Title of Document	Webpage for access	Domain
Report   AIAA   DIGITAL TWIN: DEFINITION and VALUE, An AIAA and AIA Position Paper	<a href="https://www.aiaa.org/docs/default-source/uploadedfiles/issues-and-advocacy/policy-papers/digital-twin-institute-position-paper-(december-2020).pdf">https://www.aiaa.org/docs/default-source/uploadedfiles/issues-and-advocacy/policy-papers/digital-twin-institute-position-paper-(december-2020).pdf</a>	Aeronautics
Report   AMRC   Untangling the requirements of a Digital Twin	<a href="https://www.amrc.co.uk/files/document/404/1604658922-AMRC_Digital_Twin_AW.pdf">https://www.amrc.co.uk/files/document/404/1604658922-AMRC_Digital_Twin_AW.pdf</a>	Cross-domain
Report   ANZLIC   Foundation Spatial Data Framework	<a href="https://www.anzlic.gov.au/resources/foundation-spatial-data-framework">https://www.anzlic.gov.au/resources/foundation-spatial-data-framework</a>	Spatial data
Report   ANZLIC   Principles for Spatially Enabled Digital Twins of the Built and Natural Environment in Australia	<a href="https://www.anzlic.gov.au/sites/default/files/files/principles_for_spatially_enabled_digital_twins_of_the_built_and_natural.pdf">https://www.anzlic.gov.au/sites/default/files/files/principles_for_spatially_enabled_digital_twins_of_the_built_and_natural.pdf</a>	Spatial data
Report   Augmented Reality and the Digital Twin: State-of-the-Art and Perspectives for Cybersecurity	<a href="https://www.mdpi.com/2624-800X/1/3/26/html">https://www.mdpi.com/2624-800X/1/3/26/html</a>	Augmented reality
Report   Azure Digital Twins documentation	<a href="https://docs.microsoft.com/en-us/azure/digital-twins/overview">https://docs.microsoft.com/en-us/azure/digital-twins/overview</a>	Cross-domain
Report   Banque des territoire   Jumeau numerique des territoires, issu de la reflexion de la banque des territoires (Territorial digital twin, resulting from the investigations of the French Territorial Bank)	<a href="https://www.banquedesterritoires.fr/miroir-miroir-le-jumeau-numerique-du-territoire-0">https://www.banquedesterritoires.fr/miroir-miroir-le-jumeau-numerique-du-territoire-0</a>	Smart cities
Report   Beyond IoT: Digital Twins and Cyber-Physical Systems	<a href="https://thinginthefuture.com/spip.php?article114#main_nav_fermer">https://thinginthefuture.com/spip.php?article114#main_nav_fermer</a>	Smart cities
Report   Cheat sheet: What is Digital Twin?	<a href="https://www.ibm.com/blogs/internet-of-things/iot-cheat-sheet-digital-twin/">https://www.ibm.com/blogs/internet-of-things/iot-cheat-sheet-digital-twin/</a> <a href="https://www.ibm.com/topics/what-is-a-digital-twin">https://www.ibm.com/topics/what-is-a-digital-twin</a>	Cross-domain
Report   CSIRO   Framework for Spatially Enabled Digital Twins	<a href="https://www.anzlic.gov.au/sites/default/files/files/Data61%20Digital%20Twin%20Framework%20Summary%20-%20February%202021.pdf">https://www.anzlic.gov.au/sites/default/files/files/Data61%20Digital%20Twin%20Framework%20Summary%20-%20February%202021.pdf</a>	Spatial data
Report   Digital Twin and Internet of Things: Current Standards Landscape	<a href="https://www.mdpi.com/2076-3417/10/18/6519/pdf">https://www.mdpi.com/2076-3417/10/18/6519/pdf</a>	Industry
Report   Digital twin based synchronised control and simulation of the industrial robotic cell using virtual reality	<a href="https://www.researchgate.net/publication/331233156_Digital_twin_based_synchronised_control_and_simulation_of_the_industrial_robotic_cell_using_virtual_reality">https://www.researchgate.net/publication/331233156_Digital_twin_based_synchronised_control_and_simulation_of_the_industrial_robotic_cell_using_virtual_reality</a>	Robotics

Headline Title of Document	Webpage for access	Domain
Report   Digital twin computing	<a href="https://www.rd.ntt/e/dtc/DTC_Whitepaper_en_2_0_0.pdf">https://www.rd.ntt/e/dtc/DTC_Whitepaper_en_2_0_0.pdf</a>	Cross-domain
Report   Digital twin hub   Data for the public good	<a href="https://digitaltwinhub.co.uk/files/file/4-data-for-the-public-good/">https://digitaltwinhub.co.uk/files/file/4-data-for-the-public-good/</a>	Transport
Report   Digital twin hub   Skill and competence framework	<a href="https://digitaltwinhub.co.uk/files/file/64-skills-competency-framework/">https://digitaltwinhub.co.uk/files/file/64-skills-competency-framework/</a>	Building
Report   Digital twin hub   The Gemini Principles	<a href="https://digitaltwinhub.co.uk/files/file/2-the-gemini-principles/">https://digitaltwinhub.co.uk/files/file/2-the-gemini-principles/</a>	Building
Report   Digital Twin: Manufacturing Excellence through Virtual Factory Replication	<a href="https://www.researchgate.net/publication/275211047_Digital_Twin_Manufacturing_Excellence_through_Virtual_Factory_Replication">https://www.researchgate.net/publication/275211047_Digital_Twin_Manufacturing_Excellence_through_Virtual_Factory_Replication</a>	Industry
Report   Digital twins in smart farming	<a href="https://www.sciencedirect.com/science/article/pii/S0308521X20309070#">https://www.sciencedirect.com/science/article/pii/S0308521X20309070#</a>	Agriculture
Report   DTC   Digital Twin Capabilities Periodic Table	<a href="https://www.digitalplaybook.org/index.php?title=Digital_Twin_Periodic_Table">https://www.digitalplaybook.org/index.php?title=Digital_Twin_Periodic_Table</a>	Cross-domain
Report   DTC   Digital Twin Core: Essential Elements for Optimal/ Expansive Interoperability	<a href="https://engage.iiconsortium.org/wg/IndustryWG/document/24464">https://engage.iiconsortium.org/wg/IndustryWG/document/24464</a>	Cross-domain
Report   DTC   Digital Twin System Interoperability Framework	<a href="https://www.digitaltwinconsortium.org/pdf/Digital-Twin-System-Interoperability-Framework-12072021.pdf">https://www.digitaltwinconsortium.org/pdf/Digital-Twin-System-Interoperability-Framework-12072021.pdf</a>	Cross-domain
Report   DTC   Digital twins for Industrial Applications	<a href="https://www.iiconsortium.org/pdf/IIC_Digital_Twins_Industrial_Apps_White_Paper_2020-02-18.pdf">https://www.iiconsortium.org/pdf/IIC_Digital_Twins_Industrial_Apps_White_Paper_2020-02-18.pdf</a>	Industry
Report   DTC   DT Framework for Aerospace-Defense	<a href="https://www.digitaltwinconsortium.org/working-groups/aerospace-and-defense.htm">https://www.digitaltwinconsortium.org/working-groups/aerospace-and-defense.htm</a>	Aerospace
Report   DTC   DT Vocabulary	<a href="https://www.digitaltwinconsortium.org/working-groups/technology-terminology-taxonomy.htm">https://www.digitaltwinconsortium.org/working-groups/technology-terminology-taxonomy.htm</a>	Cross-domain
Report   DTC   Infrastructure Digital Twin Maturity: A Model for Measuring Progress	<a href="https://www.digitaltwinconsortium.org/pdf/Infrastructure-Digital-Twin-Maturity-Model.pdf">https://www.digitaltwinconsortium.org/pdf/Infrastructure-Digital-Twin-Maturity-Model.pdf</a>	Cross-domain
Report   DTC   Infrastructure Lifecycle: A Case for Change	<a href="https://go.omgprograms.org/l/658223/2021-12-27/5hrpfm">https://go.omgprograms.org/l/658223/2021-12-27/5hrpfm</a>	Building



Headline Title of Document	Webpage for access	Domain
Report   EC   Destination Earth: Survey on “Digital Twins” technologies and activities, in the Green Deal area	<a href="https://op.europa.eu/en/publication-detail/-/publication/59ca21ec-2498-11eb-9d7e-01aa75ed71a1/language-en">https://op.europa.eu/en/publication-detail/-/publication/59ca21ec-2498-11eb-9d7e-01aa75ed71a1/language-en</a>	Smart cities
Report   EC   Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency (Text with EEA relevance)	<a href="https://lexpacency.org/eu/32018L0844/">https://lexpacency.org/eu/32018L0844/</a>	Building
Report   EC   ICT Standardisation supporting Circular Economy: Report of the Study Group Circular Economy - a sub-group of the EU Multi-Stakeholder Platform for ICT Standardisation.	<a href="https://ec.europa.eu/docsroom/documents/44089/attachments/1/translations/en/renditions/native">https://ec.europa.eu/docsroom/documents/44089/attachments/1/translations/en/renditions/native</a>	Industry
Report   ETP4HPC   Real-time digital twins. A TransContinuum initiative use case	<a href="https://zenodo.org/record/5470479#YZPlzWDMlAQ">https://zenodo.org/record/5470479#YZPlzWDMlAQ</a>	Industry
Report   ETRI   Characterization of digital twins	<a href="https://www.researchgate.net/publication/353930234_Characterization_of_Digital_Twin">https://www.researchgate.net/publication/353930234_Characterization_of_Digital_Twin</a>	Cross-domain
Report   ETRI   Digital Twin maturity model	<a href="http://dx.doi.org/10.13140/RG.2.2.28750.48967">http://dx.doi.org/10.13140/RG.2.2.28750.48967</a>	Cross-domain
Report   Fiware   FIWARE for digital twins	<a href="https://www.fiware.org/marketing-material/fiware-for-digital-twins/">https://www.fiware.org/marketing-material/fiware-for-digital-twins/</a>	Spatial data
Report   GE Digital Twin Analytic Engine for the Digital Power Plant	<a href="https://www.ge.com/digital/sites/default/files/download_assets/Digital-Twin-for-the-digital-power-plant-.pdf">https://www.ge.com/digital/sites/default/files/download_assets/Digital-Twin-for-the-digital-power-plant-.pdf</a>	Energy
Report   GIZ   Use Case Equipment Lifecycle Management	<a href="https://www.gpgi.org/vorschau-publikationen/use-case-equipment-lifecycle-management.html">https://www.gpgi.org/vorschau-publikationen/use-case-equipment-lifecycle-management.html</a>	Industry
Report   GOV_Scotland   Building regulations - energy standards and associated topics - proposed changes: consultation	<a href="https://www.gov.scot/publications/scottish-building-regulations-proposed-changes-energy-standards-associated-topics/pages/1/">https://www.gov.scot/publications/scottish-building-regulations-proposed-changes-energy-standards-associated-topics/pages/1/</a>	Building, Energy
Report   GOV_UK   Energy Performance of Building Regulations 2012	<a href="https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/885223/Implementation_Report_-_EPB_Regs_2012.pdf">https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/885223/Implementation_Report_-_EPB_Regs_2012.pdf</a>	Building, Energy

Headline Title of Document	Webpage for access	Domain
Report   IEEE   Can we have a digital twin?	<a href="https://cmte.ieee.org/futuredirections/2017/09/27/can-we-have-a-digital-twin/">https://cmte.ieee.org/futuredirections/2017/09/27/can-we-have-a-digital-twin/</a>	Anatomy, medical
Report   IIC   Digital Twin and Asset Administration Shell Concepts and Application in the Industrial Internet and Industrie 4.0	<a href="https://www.iiconsortium.org/pdf/Digital-Twin-and-Asset-Administration-Shell-Concepts-and-Application-Joint-Whitepaper.pdf">https://www.iiconsortium.org/pdf/Digital-Twin-and-Asset-Administration-Shell-Concepts-and-Application-Joint-Whitepaper.pdf</a>	Industry
Report   IIC   Digital Twin Architecture and Standards	<a href="https://www.researchgate.net/profile/Somayeh-Malakuti/publication/337673936_Digital_Twin_Architecture_and_Standards/links/5de4e2f0a6fdcc2837fd3bc1/Digital-Twin-Architecture-and-Standards.pdf">https://www.researchgate.net/profile/Somayeh-Malakuti/publication/337673936_Digital_Twin_Architecture_and_Standards/links/5de4e2f0a6fdcc2837fd3bc1/Digital-Twin-Architecture-and-Standards.pdf</a>	Cross-domain
Report   IIC   Digital Twin Journal of Innovation - 2018 June	<a href="https://www.iiconsortium.org/news/journal-of-innovation-2018-june.htm">https://www.iiconsortium.org/news/journal-of-innovation-2018-june.htm</a>	Cross-domain
Report   IIC   Digital Twin Journal of Innovation - 2019 Nov	<a href="https://www.iiconsortium.org/news/journal-of-innovation-2019-nov.htm">https://www.iiconsortium.org/news/journal-of-innovation-2019-nov.htm</a>	Cross-domain
Report   IIC   Digital Twin Journal of Innovation - 2021 March	<a href="https://www.iiconsortium.org/news/journal-of-innovation-2021-march.htm">https://www.iiconsortium.org/news/journal-of-innovation-2021-march.htm</a> <a href="https://www.iiconsortium.org/news/joi-march-2021.htm">https://www.iiconsortium.org/news/joi-march-2021.htm</a>	Cross-domain
Report   IIC   Digital Twins for Industrial Applications DEFINITION, BUSINESS VALUES, DESIGN ASPECTS, STANDARDS AND USE CASES An Industrial Internet Consortium White Paper	<a href="https://www.iiconsortium.org/pdf/IIC_Digital_Twins_Industrial_Apps_White_Paper_2020-02-18.pdf">https://www.iiconsortium.org/pdf/IIC_Digital_Twins_Industrial_Apps_White_Paper_2020-02-18.pdf</a>	Industry
Report   ISG ARF   ETSI GR ARF 002 V1.1.1 (2019-07): Augmented Reality Framework (ARF) Industrial use cases for AR applications and services	<a href="http://webapp.etsi.org/workprogram/Report_WorkItem.asp?WKI_ID=54069">http://webapp.etsi.org/workprogram/Report_WorkItem.asp?WKI_ID=54069</a>	Augmented reality
Report   Lifecycle Governance for Effective Digital Twins: A Joint Systems Engineering and IT Perspective	<a href="https://repository.tudelft.nl/islandora/object/uuid%3A89faa94f-8ef3-451f-9aac-c834604ed451">https://repository.tudelft.nl/islandora/object/uuid%3A89faa94f-8ef3-451f-9aac-c834604ed451</a>	Cross-domain
Report   METI   Guidelines for Cyber-Physical Security Measures for Building Systems	<a href="https://www.meti.go.jp/english/press/2019/0617_005.html">https://www.meti.go.jp/english/press/2019/0617_005.html</a> <a href="https://www.meti.go.jp/english/press/2019/pdf/0617_005a.pdf">https://www.meti.go.jp/english/press/2019/pdf/0617_005a.pdf</a>	building
Report   METI   The Cyber/Physical Security Framework	<a href="https://www.meti.go.jp/english/press/2019/0418_001.html">https://www.meti.go.jp/english/press/2019/0418_001.html</a> <a href="https://www.meti.go.jp/english/press/2019/pdf/0418_001b.pdf">https://www.meti.go.jp/english/press/2019/pdf/0418_001b.pdf</a>	Cross-domain

Headline Title of Document	Webpage for access	Domain
Report   NIST   NISTIR 8356 (Draft) Considerations for Digital Twin Technology and Emerging Standards	<a href="https://csrc.nist.gov/publications/detail/nistir/8356/draft">https://csrc.nist.gov/publications/detail/nistir/8356/draft</a>	Cross-domain
Report   NSAI   Irish National Annex to I.S. EN ISO 19650 -2:2018, Organisation and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 2: Delivery phase of assets (ISO 19650-2:2018)	<a href="https://shop.standards.ie/en-ie/standards/NA-2021-TO-I-S-EN-ISO-19650-2-2018-1206951_SAIG_NSAI_NSAI_2919352/">https://shop.standards.ie/en-ie/standards/NA-2021-TO-I-S-EN-ISO-19650-2-2018-1206951_SAIG_NSAI_NSAI_2919352/</a>	Construction
Report   Plattform Industrie 4.0   Usage View of Asset Administration Shell	<a href="https://www.plattform-i40.de/IP/Redaktion/DE/Downloads/Publikation/2019-usage-view-asset-administration-shell.html">https://www.plattform-i40.de/IP/Redaktion/DE/Downloads/Publikation/2019-usage-view-asset-administration-shell.html</a>	Industry
Report   Plattform Industrie 4.0   Usage View Seamless and Dynamic Engineering of Plants	<a href="https://www.plattform-i40.de/IP/Redaktion/EN/Downloads/Publikation/usage-view-seamless-and-dynamic-engineering-of-plantsx.html">https://www.plattform-i40.de/IP/Redaktion/EN/Downloads/Publikation/usage-view-seamless-and-dynamic-engineering-of-plantsx.html</a>	Industry
Report   PNNL   Understanding Building Energy Codes and Standards	<a href="https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-14235.pdf">https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-14235.pdf</a>	Building
Report   Smart manufacturing	<a href="https://storage-iecetech-prd-iec-ch.s3.eu-west-1.amazonaws.com/2020-05/etech_2019-06.pdf">https://storage-iecetech-prd-iec-ch.s3.eu-west-1.amazonaws.com/2020-05/etech_2019-06.pdf</a>	Industry
Report   SmartCitiesCouncil   Digital Twin Blueprint (DRAFT)	<a href="https://9c33efe3-90c0-472e-979b-d94bf191e8b6.filesusr.com/ugd/ec3523_51b5b29a33b04976875636486e1e9fc3.pdf">https://9c33efe3-90c0-472e-979b-d94bf191e8b6.filesusr.com/ugd/ec3523_51b5b29a33b04976875636486e1e9fc3.pdf</a>	Smart cities
Report   Sphere Digital Twins White Paper	<a href="https://sphere-project.eu/download/sphere-digital-twin-definitions-for-buildings/">https://sphere-project.eu/download/sphere-digital-twin-definitions-for-buildings/</a>	Building
Report   SSSI Australia   Building Energy Standards and Codes	<a href="https://www.unescap.org/sites/default/d8files/4.%20FS-Building-energy-standards-and-codes.pdf">https://www.unescap.org/sites/default/d8files/4.%20FS-Building-energy-standards-and-codes.pdf</a>	Building, energy
Report   Systems Architecture Design Pattern Catalog for Developing Digital Twins	<a href="https://www.researchgate.net/publication/344201505_Systems_Architecture_Design_Pattern_Catalog_for_Developing_Digital_Twins">https://www.researchgate.net/publication/344201505_Systems_Architecture_Design_Pattern_Catalog_for_Developing_Digital_Twins</a>	Cross-domain

Headline Title of Document	Webpage for access	Domain
Report   The Digital Twin Computing Reference Model, Version 2.0	<a href="https://www.rd.ntt/assets/pdf/iown/reference-model_en_2_0.pdf">https://www.rd.ntt/assets/pdf/iown/reference-model_en_2_0.pdf</a>	Cross-domain
Report   Towards a semantic Construction Digital Twin: Directions for future research	<a href="https://www.sciencedirect.com/science/article/pii/S0926580519314785">https://www.sciencedirect.com/science/article/pii/S0926580519314785</a>	Building
Report   UNESCAP   Spatial Digital Twins Special Interest Group	<a href="https://sssi.org.au/knowledge-hub/news/spatial-digital-twins-special-interest-group">https://sssi.org.au/knowledge-hub/news/spatial-digital-twins-special-interest-group</a>	Smart cities
Report   What is a Digital Twin?	<a href="https://www.preddiotech.com/what-is-a-digital-twin/">https://www.preddiotech.com/what-is-a-digital-twin/</a>	Industry
Report   Working Group on Building Energy Codes	<a href="https://www.iea-ebc.org/working-group/building-energy-codes">https://www.iea-ebc.org/working-group/building-energy-codes</a> <a href="https://www.iea-ebc.org/Data/Sites/1/media/docs/working-groups/building-energy-codes/ebc_wg_becs_codesothermandatoryolicies-existingbuildings_june_2021.pdf">https://www.iea-ebc.org/Data/Sites/1/media/docs/working-groups/building-energy-codes/ebc_wg_becs_codesothermandatoryolicies-existingbuildings_june_2021.pdf</a>	Energy
Specification   CEN TC 442 Building BIMs   prEN 17632:2021: Building Information Modelling (BIM) - Semantic Modelling and Linking (SML)	<a href="https://standards.iteh.ai/catalog/standards/cen/512f6571-2a12-4c4f-9027-793be26b1af5/pren-17632">https://standards.iteh.ai/catalog/standards/cen/512f6571-2a12-4c4f-9027-793be26b1af5/pren-17632</a>	Building
Specification   City information modelling and urban digital twins	<a href="https://www.iec.ch/basecamp/city-information-modelling-and-urban-digital-twins">https://www.iec.ch/basecamp/city-information-modelling-and-urban-digital-twins</a>	Smart cities
Specification   DTC   Glossary of Digital Twins	<a href="https://www.digitaltwinconsortium.org/glossary/glossary.html">https://www.digitaltwinconsortium.org/glossary/glossary.html</a>	Cross-domain
Specification   IEC TC57 Power Systems   Communication networks and systems for power utility automation - ALL PARTS	<a href="https://webstore.iec.ch/publication/6028">https://webstore.iec.ch/publication/6028</a>	Energy
Specification   IEC TC57 Power Systems   Communication networks and systems for power utility automation - Part 1-2: Guideline on extending IEC 61850	<a href="https://webstore.iec.ch/publication/59652">https://webstore.iec.ch/publication/59652</a>	Energy
Specification   IEC TC65 Automation   IEC 61512-2:2001- Batch control - Part 2: Data structures and guidelines for languages	<a href="https://webstore.iec.ch/publication/5529">https://webstore.iec.ch/publication/5529</a>	Automation system (iACS)
Specification   IEC TC65 Automation   IEC 62264-3:2016 - Enterprise-control system integration - Part 3: Activity models of manufacturing operations management	<a href="https://webstore.iec.ch/publication/33511">https://webstore.iec.ch/publication/33511</a>	Automation system (iACS)

Headline Title of Document	Webpage for access	Domain
Specification   IEC TC65 Automation   IEC 62443-2-2 ED1 Security for industrial automation and control systems - Part 2-2: IACS Security Protection	<a href="https://www.iec.ch/dyn/www/?p=103:38:714859621599532...FSP_ORG_ID.FSP_APEX_PAGE.FSP_PROJECT_ID:1250,23,102558">https://www.iec.ch/dyn/www/?p=103:38:714859621599532...FSP_ORG_ID.FSP_APEX_PAGE.FSP_PROJECT_ID:1250,23,102558</a>	Automation system (iACS)
Specification   IEC TC65 Automation   IEC 62443-2-4:2015+AMD1:2017 CSV Consolidated version - Security for industrial automation and control systems - Part 2-4: Security program requirements for IACS service providers	<a href="https://webstore.iec.ch/publication/61335">https://webstore.iec.ch/publication/61335</a>	Automation system (iACS)
Specification   IEC TC65 Automation   IEC 62443-3-2:2020 - Security for industrial automation and control systems - Part 3-2: Security risk assessment for system design	<a href="https://webstore.iec.ch/publication/30727">https://webstore.iec.ch/publication/30727</a>	Automation system (iACS)
Specification   IEC TC65 Automation   IEC 62443-3-3:2013 - Industrial communication networks - Network and system security - Part 3-3: System security requirements and security levels	<a href="https://webstore.iec.ch/publication/7033">https://webstore.iec.ch/publication/7033</a>	Automation system (iACS)
Specification   IEC TC65 Automation   IEC 62443-4-1:2018 - Security for industrial automation and control systems - Part 4-1: Secure product development lifecycle requirements	<a href="https://webstore.iec.ch/publication/33615">https://webstore.iec.ch/publication/33615</a>	Automation system (iACS)
Specification   IEC TC65 Automation   IEC 62443-4-2:2019 Security for industrial automation and control systems - Part 4-2: Technical security requirements for IACS components	<a href="https://webstore.iec.ch/publication/34421">https://webstore.iec.ch/publication/34421</a>	Automation system (iACS)
Specification   IEC TC65 Automation   IEC 62714-1:2018 - Engineering data exchange format for use in industrial automation systems engineering - Automation Markup Language - Part 1: Architecture and general requirements	<a href="https://webstore.iec.ch/publication/63059">https://webstore.iec.ch/publication/63059</a>	Automation system (iACS)
Specification   IEC TC65 Automation   IEC 62890:2020 - Industrial-process measurement, control and automation - Life-cycle-management for systems and components	<a href="https://webstore.iec.ch/publication/30583">https://webstore.iec.ch/publication/30583</a>	Automation system (iACS)

Headline Title of Document	Webpage for access	Domain
Specification   IEC TC65 Automation   IEC 63278-1 Asset Administration Shell for industrial applications - Part 1: Asset Administration Shell structure	<a href="https://www.iec.ch/ords/?p=103-38-511409853735526...FSP_ORG_ID.FSP_APEX_PAGE.FSP_PROJECT_ID:1250,23,103536#">https://www.iec.ch/ords/?p=103-38-511409853735526...FSP_ORG_ID.FSP_APEX_PAGE.FSP_PROJECT_ID:1250,23,103536#</a>	Industry
Specification   IEC TC65 Automation   IEC PAS 63088. (2017). Smart Manufacturing - Reference Architecture Model Industry 4.0 (RAMI4.0). V1.0	<a href="https://webstore.iec.ch/publication/30082">https://webstore.iec.ch/publication/30082</a>	Industry
Specification   IEC TC65 Automation   IEC TR 62541-1:2020 - OPC Unified Architecture - Part 1: Overview and concepts	<a href="https://webstore.iec.ch/publication/61109">https://webstore.iec.ch/publication/61109</a>	Automation system (iACS)
Specification   IEC TC65 Automation   IEC TR 62541-2:2020 RLV - OPC unified architecture - Part 2: Security Model	<a href="https://webstore.iec.ch/publication/68036">https://webstore.iec.ch/publication/68036</a>	Automation system
Specification   IEC TC65 Automation   IEC/TR 63283-2 Industrial-process measurement, control and automation - Smart Manufacturing - Part 2: Use cases	<a href="https://www.iec.ch/dyn/www/?p=103-38-516991544344125...FSP_ORG_ID.FSP_APEX_PAGE.FSP_PROJECT_ID:1250,23,103914">https://www.iec.ch/dyn/www/?p=103-38-516991544344125...FSP_ORG_ID.FSP_APEX_PAGE.FSP_PROJECT_ID:1250,23,103914</a>	Industry
Specification   IEEE   P2048.8 - Standard for Virtual Reality and Augmented Reality: Interoperability between Virtual Objects and the Real World	<a href="https://standards.ieee.org/news/2017/ieee_p2408/">https://standards.ieee.org/news/2017/ieee_p2408/</a>	Augmented reality
Specification   Indexed 3D Scene Layers (I3S)	<a href="https://www.ogc.org/standards/i3s">https://www.ogc.org/standards/i3s</a>	Geographic Information Systems (GIS)
Specification   ISG CIM   DGR/ CIM-0017: NGSI-LD for Digital Twins	<a href="https://portal.etsi.org/webapp/WorkProgram/Report_WorkItem.asp?WKI_ID=59463">https://portal.etsi.org/webapp/WorkProgram/Report_WorkItem.asp?WKI_ID=59463</a>	Cross-domain
Specification   ISG CIM   DGR/ CIM-0021: Usage of external data models with NGSI-LD API	<a href="https://portal.etsi.org/webapp/WorkProgram/Report_WorkItem.asp?WKI_ID=63597">https://portal.etsi.org/webapp/WorkProgram/Report_WorkItem.asp?WKI_ID=63597</a>	Cross-domain
Specification   ISG CIM   ETSI GS CIM 009 V1.5.1 (2021-11): NGSI-LD API	<a href="http://webapp.etsi.org/workprogram/Report_WorkItem.asp?WKI_ID=62538">http://webapp.etsi.org/workprogram/Report_WorkItem.asp?WKI_ID=62538</a>	Cross-domain
Specification   JTC 1/SC 27   ISO/IEC 20889:2018 - Privacy enhancing data de-identification terminology and classification of techniques	<a href="https://www.iso.org/standard/69373.html">https://www.iso.org/standard/69373.html</a>	Cross-domain



Headline Title of Document	Webpage for access	Domain
Specification   JTC 1/SC 27   ISO/IEC 27001:2013 - Information technology- Security techniques - Information security management systems - Requirements	<a href="https://www.iso.org/standard/54534.html">https://www.iso.org/standard/54534.html</a>	Cross-domain
Specification   JTC 1/SC 27   ISO/IEC 27019:2017 Information technology - Security techniques - Information security controls for the energy utility industry	<a href="https://www.iso.org/standard/68091.html">https://www.iso.org/standard/68091.html</a>	Energy
Specification   JTC 1/SC 27   ISO/IEC DIS 27400 Cybersecurity - IoT security and privacy - Guidelines	<a href="https://www.iso.org/standard/44375.html">https://www.iso.org/standard/44375.html</a>	Cross-domain
Specification   JTC 1/SC 27   ISO/IEC TR 27550:2019 Information technology - Security techniques - Privacy engineering for system life cycle processes	<a href="https://www.iso.org/standard/72024.html">https://www.iso.org/standard/72024.html</a>	Industry
Specification   JTC 1/SC 27   ISO/IEC TS 27110:2021 Information technology, cybersecurity and privacy protection - Cybersecurity framework development guidelines	<a href="https://www.iso.org/standard/72435.html">https://www.iso.org/standard/72435.html</a>	Cross-domain
Specification   JTC 1/SC 27   ISO/IEC TS 27570:2021 Privacy protection - Privacy guidelines for smart cities	<a href="https://www.iso.org/standard/71678.html">https://www.iso.org/standard/71678.html</a>	Smart cities
Specification   JTC 1/SC 35   ISO/IEC DIS 17549-1 Information technology - User interface guidelines on menu navigation - Part 1: Framework	<a href="https://www.iso.org/standard/78338.html">https://www.iso.org/standard/78338.html</a>	Building
Specification   JTC 1/SC 40   ISO/IEC 38505-1:2017 Information technology - Governance of IT - Governance of data - Part 1: Application of ISO/IEC 38500 to the governance of data	<a href="https://www.iso.org/standard/56639.html">https://www.iso.org/standard/56639.html</a>	Cross-domain
Specification   JTC 1/SC 41   ISO/IEC 21823-3:2021 Internet of Things (IoT) - Interoperability for IoT systems - Part 3: Semantic interoperability	<a href="https://webstore.iec.ch/publication/61088">https://webstore.iec.ch/publication/61088</a>	Cross-domain
Specification   JTC 1/SC 41   ISO/IEC 30147:2021 - Internet of Things (IoT) - Integration of IoT trustworthiness activities in ISO/IEC/IEEE 15288 system engineering processes	<a href="https://www.iso.org/standard/53267.html">https://www.iso.org/standard/53267.html</a>	Cross-domain



Headline Title of Document	Webpage for access	Domain
Specification   JTC 1/SC 41   ISO/IEC AWI 30172 Digital Twin : Use cases	<a href="https://www.iec.ch/dyn/www/?p=103:38:2868118221034...FSP_ORG_ID.FSP_APEX_PAGE.FSP_PROJECT_ID:20486,20,104881">https://www.iec.ch/dyn/www/?p=103:38:2868118221034...FSP_ORG_ID.FSP_APEX_PAGE.FSP_PROJECT_ID:20486,20,104881</a>	Cross-domain
Specification   JTC 1/SC 41   ISO/IEC AWI 30173 Digital Twin : Concepts and terminology	<a href="https://www.iec.ch/dyn/www/?p=103:38:2868118221034...FSP_ORG_ID.FSP_APEX_PAGE.FSP_PROJECT_ID:20486,20,104883">https://www.iec.ch/dyn/www/?p=103:38:2868118221034...FSP_ORG_ID.FSP_APEX_PAGE.FSP_PROJECT_ID:20486,20,104883</a>	Cross-domain
Specification   JTC 1/SC 41   PWI JTC1-SC41-5 Digital Twin - Reference Architecture	<a href="https://www.iec.ch/dyn/www/?p=103:38:2868118221034...FSP_ORG_ID.FSP_APEX_PAGE.FSP_PROJECT_ID:20486,20,104896">https://www.iec.ch/dyn/www/?p=103:38:2868118221034...FSP_ORG_ID.FSP_APEX_PAGE.FSP_PROJECT_ID:20486,20,104896</a>	Cross-domain
Specification   JTC 1/SC 41   PWI JTC1-SC41-6 Guidance for IoT and Digital Twin use cases	<a href="https://www.iec.ch/dyn/www/?p=103:38:2868118221034...FSP_ORG_ID.FSP_APEX_PAGE.FSP_PROJECT_ID:20486,20,104897">https://www.iec.ch/dyn/www/?p=103:38:2868118221034...FSP_ORG_ID.FSP_APEX_PAGE.FSP_PROJECT_ID:20486,20,104897</a>	Cross-domain
Specification   JTC 1/SC 42   ISO/IEC AWI 5339 Information Technology - Artificial Intelligence - Guidelines for AI applications	<a href="https://www.iso.org/standard/81120.html">https://www.iso.org/standard/81120.html</a>	Augmented reality
Specification   JTC 1/SC 42   ISO/IEC AWI 5392 Information technology - Artificial intelligence - Reference architecture of knowledge engineering	<a href="https://www.iso.org/standard/81228.html">https://www.iso.org/standard/81228.html</a>	Augmented reality
Specification   JTC 1/SC 42   ISO/IEC AWI TR 5469 Artificial intelligence - Functional safety and AI systems	<a href="https://www.iso.org/standard/81283.html">https://www.iso.org/standard/81283.html</a>	Augmented reality
Specification   JTC 1/SC 42   ISO/IEC CD 5338 Information technology - Artificial intelligence - AI system life cycle processes	<a href="https://www.iso.org/standard/81118.html">https://www.iso.org/standard/81118.html</a>	Augmented reality
Specification   JTC 1/SC 42   ISO/IEC FDIS 22989 Information technology - Artificial intelligence - Artificial intelligence concepts and terminology	<a href="https://www.iso.org/standard/74296.html">https://www.iso.org/standard/74296.html</a>	Augmented reality
Specification   JTC 1/SC 42   ISO/IEC FDIS 38507 Information technology - Governance of IT - Governance implications of the use of artificial intelligence by organizations	<a href="https://www.iso.org/standard/77304.html">https://www.iso.org/standard/77304.html</a>	Augmented reality

Headline Title of Document	Webpage for access	Domain
Specification   JTC 1/SC 7   ISO/IEC/IEEE CD 24641.2 Systems and Software engineering - Methods and tools for model-based systems and software engineering	<a href="https://www.iso.org/standard/79111.html">https://www.iso.org/standard/79111.html</a>	Industry
Specification   OpenGIS (copyright) Web Map Service Interface Standard (WMS)	<a href="https://www.ogc.org/standards/wms">https://www.ogc.org/standards/wms</a>	Geographic Information Systems (GIS)
Specification   PC 317   ISO/CD 31700 Consumer protection - Privacy by design for consumer goods and services	<a href="https://www.iso.org/standard/76772.html">https://www.iso.org/standard/76772.html</a>	Consumer goods and services
Specification   Quick start guide: An overview of the ISA/IEC 62443 Standards	<a href="https://gca.isa.org/isagca-quick-start-guide-62443-standards">https://gca.isa.org/isagca-quick-start-guide-62443-standards</a>	Energy
Specification   SG 20   Y.dt-ITS Requirements and capability framework of digital twin for intelligent transport system	<a href="https://www.itu.int/ITU-T/workprog/wp_item.aspx?isn=17116">https://www.itu.int/ITU-T/workprog/wp_item.aspx?isn=17116</a>	Transport
Specification   SG 20   Y.dt-smartfirefighting Requirements and capability framework of digital twin for smart firefighting	<a href="https://www.itu.int/ITU-T/workprog/wp_item.aspx?isn=16857">https://www.itu.int/ITU-T/workprog/wp_item.aspx?isn=16857</a>	Smart cities
Specification   SG 20   Y.scdt-reqts Requirements and capabilities of a digital twin system for smart cities	<a href="https://www.itu.int/ITU-T/workprog/wp_item.aspx?isn=16396">https://www.itu.int/ITU-T/workprog/wp_item.aspx?isn=16396</a>	Smart cities
Specification   Standards Australia   IT-004 : Geographical Information/Geomatics (Australian Mirror Committee)	<a href="https://www.standards.org.au/standards-catalogue/sa-snz/communication/it-004">https://www.standards.org.au/standards-catalogue/sa-snz/communication/it-004</a>	Geographic Information Systems (GIS)
Specification   TC 10   IEC/DIS 81346-1 Industrial systems, installations and equipment and industrial products - Structuring principles and reference designations - Part 1: Basic rules	<a href="https://www.iso.org/standard/82229.html">https://www.iso.org/standard/82229.html</a>	Industry
Specification   TC 159 SC4   ISO/TR 9241-810:2020 Ergonomics of human-system interaction - Part 810: Robotic, intelligent and autonomous systems	<a href="https://www.iso.org/standard/76577.html">https://www.iso.org/standard/76577.html</a>	Robotics
Specification   TC 163   ISO 52000-1:2017 Energy performance of buildings - Overarching EPB assessment - Part 1: General framework and procedures	<a href="https://www.iso.org/standard/65601.html">https://www.iso.org/standard/65601.html</a>	Building, energy

Headline Title of Document	Webpage for access	Domain
Specification   TC 184   ISO/ TS 18101-1:2019: Oil and Gas Interoperability Technical Specification	<a href="https://www.iso.org/standard/68521.html">https://www.iso.org/standard/68521.html</a>	Industry
Specification   TC 205   ISO 17800:2017 Facility smart grid information model	<a href="https://www.iso.org/standard/71547.html">https://www.iso.org/standard/71547.html</a>	Energy
Specification   TC 211   ISO 19101-1:2014 Geographic information - Reference model - Part 1: Fundamentals	<a href="https://www.iso.org/standard/59164.html?browse=tc">https://www.iso.org/standard/59164.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19101-2:2018 Geographic information - Reference model - Part 2: Imagery	<a href="https://www.iso.org/standard/69325.html?browse=tc">https://www.iso.org/standard/69325.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19103:2015 Geographic information - Conceptual schema language	<a href="https://www.iso.org/standard/56734.html?browse=tc">https://www.iso.org/standard/56734.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19104:2016 Geographic information - Terminology	<a href="https://www.iso.org/standard/63541.html?browse=tc">https://www.iso.org/standard/63541.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19105:2000 Geographic information - Conformance and testing	<a href="https://www.iso.org/standard/26010.html">https://www.iso.org/standard/26010.html</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19106:2004 Geographic information - Profiles	<a href="https://www.iso.org/standard/26011.html?browse=tc">https://www.iso.org/standard/26011.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19107:2019 Geographic information - Spatial schema	<a href="https://www.iso.org/standard/66175.html?browse=tc">https://www.iso.org/standard/66175.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19108:2002 Geographic information - Temporal schema, with technical corrigendum	<a href="https://www.iso.org/standard/26013.html?browse=tc">https://www.iso.org/standard/26013.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19109:2015 Geographic information - Rules for application schema	<a href="https://www.iso.org/standard/59193.html?browse=tc">https://www.iso.org/standard/59193.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19110:2016 Geographic information - Methodology for feature cataloguing	<a href="https://www.iso.org/standard/57303.html?browse=tc">https://www.iso.org/standard/57303.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19111:2019 Geographic information - Referencing by coordinates, with amendment	<a href="https://www.iso.org/standard/74039.html?browse=tc">https://www.iso.org/standard/74039.html?browse=tc</a>	Geographic Information Systems (GIS)

Headline Title of Document	Webpage for access	Domain
Specification   TC 211   ISO 19112:2019 Geographic information - Spatial referencing by geographic identifiers	<a href="https://www.iso.org/standard/70742.html?browse=tc">https://www.iso.org/standard/70742.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19115-1:2014 Geographic information - Metadata - Part 1: Fundamentals, with amendment 1 and amendment 2	<a href="https://www.iso.org/standard/53798.html?browse=tc">https://www.iso.org/standard/53798.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19115-1:2014 Geographic information - Metadata - Part 1: Fundamentals	<a href="https://www.iso.org/standard/53798.html">https://www.iso.org/standard/53798.html</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19115-2:2019 Geographic information - Metadata - Part 2: Extensions for acquisition and processing	<a href="https://www.iso.org/standard/67039.html?browse=tc">https://www.iso.org/standard/67039.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19116:2019 Geographic information - Positioning services, with amendment	<a href="https://www.iso.org/standard/70882.html?browse=tc">https://www.iso.org/standard/70882.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19117:2012 Geographic information - Portrayal	<a href="https://www.iso.org/standard/46226.html?browse=tc">https://www.iso.org/standard/46226.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19118:2011 Geographic information - Encoding	<a href="https://www.iso.org/standard/44212.html?browse=tc">https://www.iso.org/standard/44212.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19119:2016 Geographic information - Services	<a href="https://www.iso.org/standard/59221.html?browse=tc">https://www.iso.org/standard/59221.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19123:2005 Geographic information - Schema for coverage geometry and functions	<a href="https://www.iso.org/standard/40121.html?browse=tc">https://www.iso.org/standard/40121.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19123-2:2018 Geographic information - Schema for coverage geometry and functions - Part 2: Coverage implementation schema	<a href="https://www.iso.org/standard/70948.html?browse=tc">https://www.iso.org/standard/70948.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19125-1:2004 Geographic information - Simple feature access - Part 1: Common architecture	<a href="https://www.iso.org/standard/40114.html?browse=tc">https://www.iso.org/standard/40114.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19126:2021 Geographic information - Feature concept dictionaries and registers	<a href="https://www.iso.org/standard/78898.html?browse=tc">https://www.iso.org/standard/78898.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19127:2019 Geographic information - Geodetic register	<a href="https://www.iso.org/standard/67252.html?browse=tc">https://www.iso.org/standard/67252.html?browse=tc</a>	Geographic Information Systems (GIS)

Headline Title of Document	Webpage for access	Domain
Specification   TC 211   ISO 19128:2005 Geographic information - Web map server interface	<a href="https://www.iso.org/standard/32546.html?browse=tc">https://www.iso.org/standard/32546.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19130-1:2018 Geographic information - Imagery sensor models for geopositioning - Part 1: Fundamentals	<a href="https://www.iso.org/standard/66847.html?browse=tc">https://www.iso.org/standard/66847.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19131:2007 Geographic information - Data product specifications, with amendment	<a href="https://www.iso.org/standard/36760.html?browse=tc">https://www.iso.org/standard/36760.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19132:2007 Geographic information - Location-based services - Reference model	<a href="https://www.iso.org/standard/40601.html?browse=tc">https://www.iso.org/standard/40601.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19133:2005 Geographic information - Location-based services - Tracking and navigation	<a href="https://www.iso.org/standard/32551.html?browse=tc">https://www.iso.org/standard/32551.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19134:2007 Geographic information - Location-based services - Multimodal routing and navigation	<a href="https://www.iso.org/standard/32552.html?browse=tc">https://www.iso.org/standard/32552.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19135-1:2015 Geographic information - Procedures for item registration - Part 1: Fundamentals, with amendment	<a href="https://www.iso.org/standard/54721.html?browse=tc">https://www.iso.org/standard/54721.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19136-1:2020 Geographic information - Geography Markup Language (GML) - Part 1: Fundamentals	<a href="https://www.iso.org/standard/75676.html?browse=tc">https://www.iso.org/standard/75676.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19136-2:2015 Geographic information - Geography Markup Language (GML) - Part 2: Extended schemas and encoding rules	<a href="https://www.iso.org/standard/61585.html?browse=tc">https://www.iso.org/standard/61585.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19137:2007 Geographic information - Core profile of the spatial schema	<a href="https://www.iso.org/standard/32555.html?browse=tc">https://www.iso.org/standard/32555.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19141:2008 Geographic information - Schema for moving features	<a href="https://www.iso.org/standard/41445.html?browse=tc">https://www.iso.org/standard/41445.html?browse=tc</a>	Geographic Information Systems (GIS)

Headline Title of Document	Webpage for access	Domain
Specification   TC 211   ISO 19142:2010 Geographic information - Web Feature Service	<a href="https://www.iso.org/standard/42136.html?browse=tc">https://www.iso.org/standard/42136.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19143:2010 Geographic information - Filter encoding	<a href="https://www.iso.org/standard/42137.html">https://www.iso.org/standard/42137.html</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19144-1:2009 Geographic information - Classification systems - Part 1: Classification system structure, with technical corrigendum	<a href="https://www.iso.org/standard/32562.html?browse=tc">https://www.iso.org/standard/32562.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19144-2:2012 Geographic information - Classification systems - Part 2: Land Cover Meta Language (LCML)	<a href="https://www.iso.org/standard/44342.html?browse=tc">https://www.iso.org/standard/44342.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19145:2013 Geographic information - Registry of representations of geographic point location	<a href="https://www.iso.org/standard/32563.html?browse=tc">https://www.iso.org/standard/32563.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19146:2018 Geographic information - Cross-domain vocabularies	<a href="https://www.iso.org/standard/72217.html?browse=tc">https://www.iso.org/standard/72217.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19147:2015 Geographic information - Transfer Nodes	<a href="https://www.iso.org/standard/44874.html?browse=tc">https://www.iso.org/standard/44874.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19148:2021 Geographic information - Linear referencing	<a href="https://www.iso.org/standard/75150.html?browse=tc">https://www.iso.org/standard/75150.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19149:2011 Geographic information - Rights expression language for geographic information - GeoREL	<a href="https://www.iso.org/standard/32567.html?browse=tc">https://www.iso.org/standard/32567.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19150-2:2015 Geographic information - Ontology - Part 2: Rules for developing ontologies in the Web Ontology Language (OWL), with amendment	<a href="https://www.iso.org/standard/57466.html?browse=tc">https://www.iso.org/standard/57466.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19150-4:2019 Geographic information - Ontology - Part 4: Service ontology	<a href="https://www.iso.org/standard/72177.html?browse=tc">https://www.iso.org/standard/72177.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19152:2012 Geographic information - Land Administration Domain Model (LADM)	<a href="https://www.iso.org/standard/51206.html?browse=tc">https://www.iso.org/standard/51206.html?browse=tc</a>	Geographic Information Systems (GIS)



Headline Title of Document	Webpage for access	Domain
Specification   TC 211   ISO 19154:2014 Geographic information - Ubiquitous public access - Reference model	<a href="https://www.iso.org/standard/32572.html?browse=tc">https://www.iso.org/standard/32572.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19155:2012 Geographic information - Place Identifier (PI) architecture	<a href="https://www.iso.org/standard/32573.html?browse=tc">https://www.iso.org/standard/32573.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19155-2:2017 Geographic information - Place Identifier (PI) architecture - Part 2: Place Identifier (PI) linking	<a href="https://www.iso.org/standard/63593.html?browse=tc">https://www.iso.org/standard/63593.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19156:2011 Geographic information - Observations and measurements	<a href="https://www.iso.org/standard/32574.html?browse=tc">https://www.iso.org/standard/32574.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19157:2013 Geographic information - Data quality, with amendment	<a href="https://www.iso.org/standard/32575.html?browse=tc">https://www.iso.org/standard/32575.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19160-1:2015 Addressing - Part 1: Conceptual model	<a href="https://www.iso.org/standard/61710.html?browse=tc">https://www.iso.org/standard/61710.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19160-3:2020 Addressing - Part 3: Address data quality	<a href="https://www.iso.org/standard/71247.html?browse=tc">https://www.iso.org/standard/71247.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19160-4:2017 Addressing - Part 4: International postal address components and template language	<a href="https://www.iso.org/standard/64242.html?browse=tc">https://www.iso.org/standard/64242.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19161-1:2020 Geographic information - Geodetic references - Part 1: International terrestrial reference system (ITRS)	<a href="https://www.iso.org/standard/70655.html?browse=tc">https://www.iso.org/standard/70655.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19162:2019 Geographic information - Well-known text representation of coordinate reference systems	<a href="https://www.iso.org/standard/76496.html?browse=tc">https://www.iso.org/standard/76496.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19165-1:2018 Geographic information - Preservation of digital data and metadata - Part 1: Fundamentals	<a href="https://www.iso.org/standard/67325.html?browse=tc">https://www.iso.org/standard/67325.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19165-2:2020 Geographic information - Preservation of digital data and metadata - Part 2: Content specifications for Earth observation data and derived digital products	<a href="https://www.iso.org/standard/73810.html?browse=tc">https://www.iso.org/standard/73810.html?browse=tc</a>	Geographic Information Systems (GIS)



Headline Title of Document	Webpage for access	Domain
Specification   TC 211   ISO 19168-1:2020 Geographic information - Geospatial API for features - Part 1: Core	<a href="https://www.iso.org/standard/32586.html?browse=tc">https://www.iso.org/standard/32586.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 19170-1:2021 Geographic information - Discrete Global Grid Systems Specifications - Part 1: Core Reference System and Operations, and Equal Area Earth Reference System	<a href="https://www.iso.org/standard/32588.html?browse=tc">https://www.iso.org/standard/32588.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO 6709:2008 Standard representation of geographic point location by coordinates, with corrigendum	<a href="https://www.iso.org/standard/39242.html?browse=tc">https://www.iso.org/standard/39242.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO/TR 19121:2000 Geographic information - Imagery and gridded data	<a href="https://www.iso.org/standard/29775.html?browse=tc">https://www.iso.org/standard/29775.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO/TR 19167:2019 Application of ubiquitous public access to-geographic information to an air quality information service	<a href="https://www.iso.org/standard/75148.html?browse=tc">https://www.iso.org/standard/75148.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO/TR 19169:2021 Geographic Information - Gap-analysis: mapping and describing the differences between the current GDF and ISO/TC 211 conceptual models to suggest ways to harmonize and resolve conflicting issues	<a href="https://www.iso.org/standard/32587.html?browse=tc">https://www.iso.org/standard/32587.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO/TS 19115-3:2016 Geographic information - Metadata - Part 3: XML schema implementation for fundamental concepts	<a href="https://www.iso.org/standard/32579.html?browse=tc">https://www.iso.org/standard/32579.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO/TS 19129:2009 Geographic information - Imagery, gridded and coverage data framework	<a href="https://www.iso.org/standard/43041.html?browse=tc">https://www.iso.org/standard/43041.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO/TS 19130-2:2014 Geographic information - Imagery sensor models for geopositioning - Part 2: SAR, InSAR, lidar and sonar	<a href="https://www.iso.org/standard/56113.html?browse=tc">https://www.iso.org/standard/56113.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO/TS 19139-1:2019 Geographic information - XML schema implementation - Part 1: Encoding rules	<a href="https://www.iso.org/standard/67253.html?browse=tc">https://www.iso.org/standard/67253.html?browse=tc</a>	Geographic Information Systems (GIS)

Headline Title of Document	Webpage for access	Domain
Specification   TC 211   ISO/ TS 19150-1:2012 Geographic information - Ontology - Part 1: Framework	<a href="https://www.iso.org/standard/57465.html?browse=tc">https://www.iso.org/ standard/57465.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO/ TS 19157-2:2016 Geographic information - Data quality - Part 2: XML schema implementation	<a href="https://www.iso.org/standard/66197.html?browse=tc">https://www.iso.org/ standard/66197.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO/ TS 19158:2012 Geographic information - Quality assurance of data supply	<a href="https://www.iso.org/standard/32576.html?browse=tc">https://www.iso.org/ standard/32576.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO/ TS 19159-1:2014 Geographic information - Calibration and validation of remote sensing imagery sensors and data - Part 1: Optical sensors	<a href="https://www.iso.org/standard/60080.html?browse=tc">https://www.iso.org/ standard/60080.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO/ TS 19159-2:2016 Geographic information - Calibration and validation of remote sensing imagery sensors and data - Part 2: Lidar	<a href="https://www.iso.org/standard/64768.html?browse=tc">https://www.iso.org/ standard/64768.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO/ TS 19159-3:2018 Geographic information - Calibration and validation of remote sensing imagery sensors and data - Part 3: SAR/InSAR	<a href="https://www.iso.org/standard/74032.html?browse=tc">https://www.iso.org/ standard/74032.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO/ TS 19163-1:2016 Geographic information - Content components and encoding rules for imagery and gridded data - Part 1: Content model	<a href="https://www.iso.org/standard/32581.html?browse=tc">https://www.iso.org/ standard/32581.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO/ TS 19163-2:2020 Geographic information - Content components and encoding rules for imagery and gridded data - Part 2: Implementation schema	<a href="https://www.iso.org/standard/74930.html?browse=tc">https://www.iso.org/ standard/74930.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO/ TS 19166:2021 Geographic information - BIM to GIS conceptual mapping (B2GM)	<a href="https://www.iso.org/standard/78899.html?browse=tc">https://www.iso.org/ standard/78899.html?browse=tc</a>	Geographic Information Systems (GIS)
Specification   TC 211   ISO/TS 19166:2021 Geographic information - BIM to GIS conceptual mapping (B2GM)	<a href="https://www.iso.org/standard/78899.html">https://www.iso.org/ standard/78899.html</a>	Geographic Information Systems (GIS), Building

Headline Title of Document	Webpage for access	Domain
Specification   TC 268 SC1   Smart Community Infrastructures Development Guidelines for Information-based Systems of Smart Buildings	<a href="https://www.iso.org/standard/69259.html">https://www.iso.org/standard/69259.html</a>	Smart cities
Specification   TC 292   ISO 22301:2019 Security and resilience - Business continuity management systems - Requirements	<a href="https://www.iso.org/standard/75106.html">https://www.iso.org/standard/75106.html</a>	Cross-domain
Specification   TC 292   ISO 22313:2020 Security and resilience - Business continuity management systems - Guidance on the use of ISO 22301	<a href="https://www.iso.org/standard/75107.html">https://www.iso.org/standard/75107.html</a>	Cross-domain
Specification   TC 59   ISO 15686- 4:2014 Building Construction - Service Life Planning - Part 4: Service Life Planning using Building Information Modelling	<a href="https://www.iso.org/standard/59150.html">https://www.iso.org/standard/59150.html</a>	Building
Specification   TC 59   ISO/FDIS 22057 Sustainability in buildings and civil engineering works - Data templates for the use of EPDs for construction products in BIM	<a href="https://www.iso.org/standard/72463.html">https://www.iso.org/standard/72463.html</a>	Building
Specification   TC 59 SC13   -	<a href="https://www.iso.org/standard/70303.html">https://www.iso.org/standard/70303.html</a>	Construction
Specification   TC 59 SC13   ISO 12006-2:2015 Building construction - Organization of information about construction works - Part 2: Framework for classification	<a href="https://www.iso.org/standard/61753.html">https://www.iso.org/standard/61753.html</a>	Geographic Information Systems (GIS)
Specification   TC 59 SC13   ISO 16739:2018 - Industry Foundation Classes (IFC) for data sharing in the construction and facility management industries	<a href="https://www.iso.org/standard/70303.html">https://www.iso.org/standard/70303.html</a>	Building
Specification   TC 59 SC13   ISO 16739-1:2018 Industry Foundation Classes (IFC) for data sharing in the construction and facility management industries - Part 1: Data schema	<a href="https://www.iso.org/standard/70303.html">https://www.iso.org/standard/70303.html</a>	Building
Specification   TC 59 SC13   ISO 16757-2:2016 Data structures for electronic product catalogues for building services - Part 2: Geometry	<a href="https://www.iso.org/standard/62080.html">https://www.iso.org/standard/62080.html</a>	Building

Headline Title of Document	Webpage for access	Domain
Specification   TC 59 SC13   ISO 19650-1:2018 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 1: Concepts and principles	<a href="https://www.iso.org/standard/68078.html">https://www.iso.org/standard/68078.html</a>	Building
Specification   TC 59 SC13   ISO 19650-1:2018 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 1: Concepts and principles	<a href="https://www.iso.org/standard/68078.html">https://www.iso.org/standard/68078.html</a>	Building
Specification   TC 59 SC13   ISO 19650-2:2018 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 2: Delivery phase of the assets	<a href="https://www.iso.org/standard/68080.html">https://www.iso.org/standard/68080.html</a>	Building
Specification   TC 59 SC13   ISO 19650-2:2018 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 2: Delivery phase of the assets	<a href="https://www.iso.org/standard/68080.html">https://www.iso.org/standard/68080.html</a>	Building
Specification   TC 59 SC13   ISO 19650-3:2018 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 3: Operational phase of the assets	<a href="https://www.iso.org/standard/75109.html">https://www.iso.org/standard/75109.html</a>	Building

Headline Title of Document	Webpage for access	Domain
Specification   TC 59 SC13   ISO 19650-3:2020 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 3: Operational phase of the assets	<a href="https://www.iso.org/standard/75109.html">https://www.iso.org/standard/75109.html</a>	Building
Specification   TC 59 SC13   ISO 19650-4:2018 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling -Part 4: Information exchange	<a href="https://www.iso.org/standard/78246.html">https://www.iso.org/standard/78246.html</a>	Building
Specification   TC 59 SC13   ISO 19650-5:2018 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling Part 5: Security-minded approach to information management	<a href="https://www.iso.org/standard/74206.html">https://www.iso.org/standard/74206.html</a>	Building
Specification   TC 59 SC13   ISO 19650-5:2020 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 5: Security-minded approach to information management	<a href="https://www.iso.org/standard/74206.html">https://www.iso.org/standard/74206.html</a>	Building
Specification   TC 59 SC13   ISO 23386:2020 - Building information modelling and other digital processes used in construction	<a href="https://www.iso.org/standard/75401.html">https://www.iso.org/standard/75401.html</a>	Construction
Specification   TC 59 SC13   ISO 23386:2020 Building information modelling and other digital processes used in construction - Methodology to describe, author and maintain properties in interconnected data dictionaries	<a href="https://www.iso.org/standard/75401.html">https://www.iso.org/standard/75401.html</a>	Building

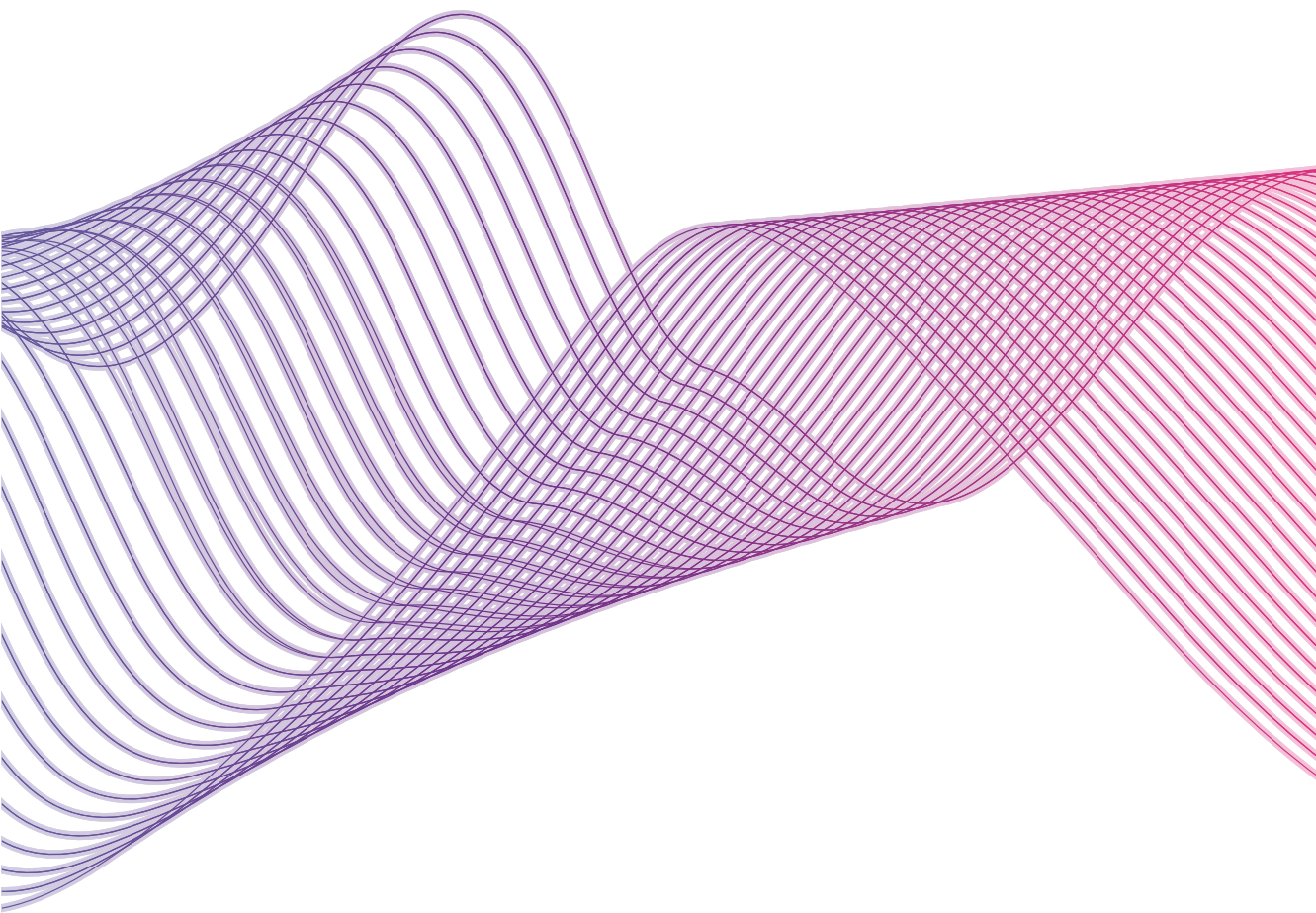
Headline Title of Document	Webpage for access	Domain
Specification   TC 59 SC13   ISO 23387:2020 - Building Information Modelling (BIM) - Data templates for construction objects used in the life-cycle of any built asset - Concepts and principles	<a href="https://www.iso.org/standard/75403.html">https://www.iso.org/standard/75403.html</a>	Building
Specification   TC 59 SC13   ISO 29481-1:2016 - Building information models - information delivery manual - Port 1: Methodology and format (IDM)	<a href="https://www.iso.org/standard/60553.html">https://www.iso.org/standard/60553.html</a>	Construction
Specification   TC 59 SC13   ISO 29481-1:2016 Building information modelling - Information delivery manual - Part 1: Methodology and format	<a href="https://www.iso.org/standard/45501.html">https://www.iso.org/standard/45501.html</a>	Building
Specification   TC 59 SC13   ISO 29481-2:2012 - Building information models - Information delivery manual - Part 2: Interaction framework	<a href="https://www.iso.org/standard/55691.html">https://www.iso.org/standard/55691.html</a>	Construction
Specification   TC 59 SC13   ISO 29481-2:2012 Building information models - Information delivery manual - Part 2: Interaction framework	<a href="https://www.iso.org/standard/55691.html">https://www.iso.org/standard/55691.html</a>	Building
Specification   TC 59 SC13   ISO/AWI 19650-6 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 6: Health and Safety	<a href="https://www.iso.org/standard/82705.html">https://www.iso.org/standard/82705.html</a>	Building
Specification   TC 59 SC13   ISO/DIS 12911 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Framework for specification of building information modelling (BIM) implementation	<a href="https://www.iso.org/standard/79692.html">https://www.iso.org/standard/79692.html</a>	Building
Specification   TC 59 SC13   ISO/DIS 19650-4 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 4: Information exchange	<a href="https://www.iso.org/standard/78246.html">https://www.iso.org/standard/78246.html</a>	Building

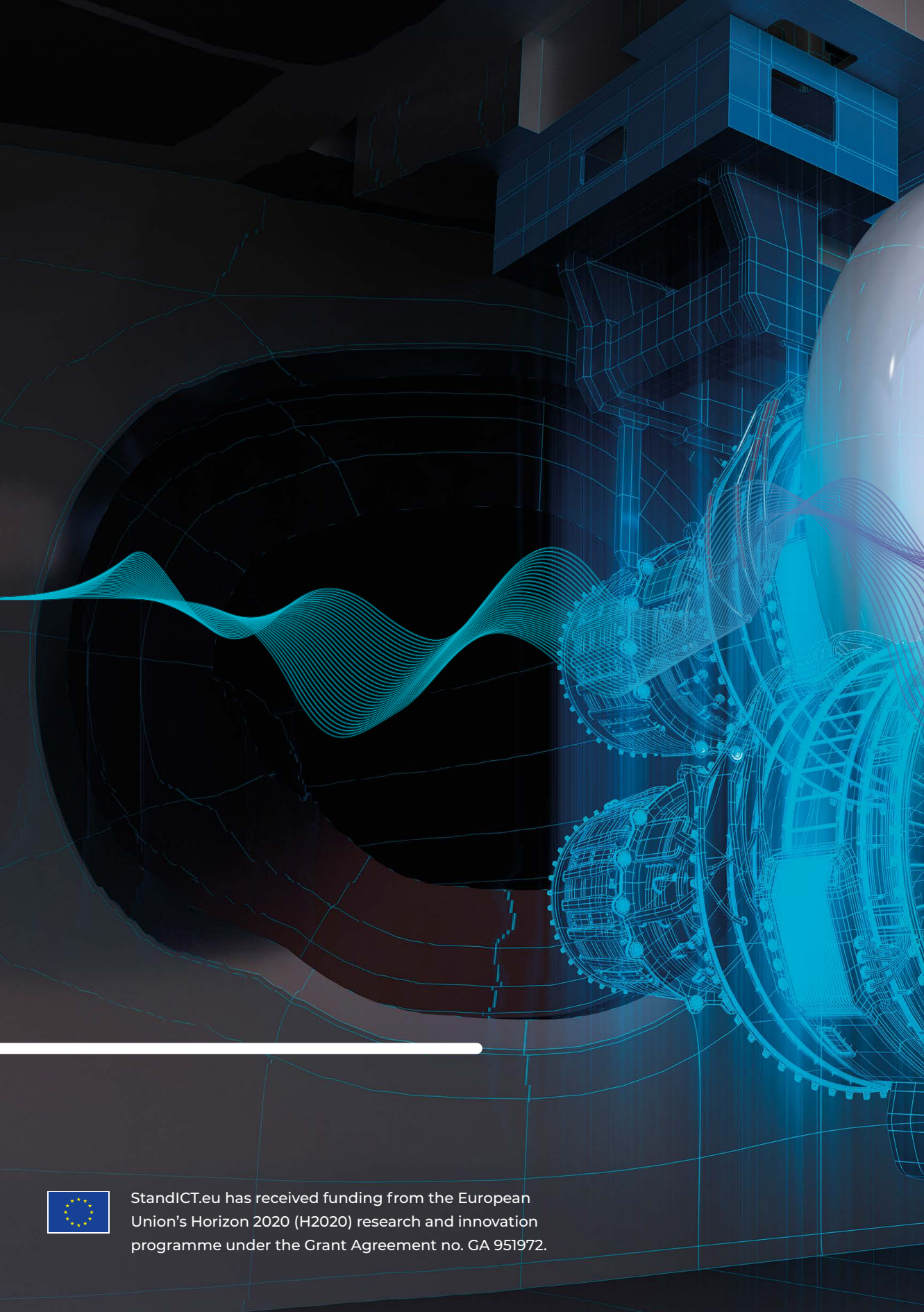
Headline Title of Document	Webpage for access	Domain
Specification   TC 59 SC13   ISO/DIS 29481-3 Building information models - Information delivery manual - Part 3: Data schema and code	<a href="https://www.iso.org/standard/81261.html">https://www.iso.org/standard/81261.html</a>	Building
Specification   TC 59 SC13   ISO/DIS 7817 Building information modelling - Level of information need - Concepts and principles	<a href="https://www.iso.org/standard/82914.html">https://www.iso.org/standard/82914.html</a>	Building
Specification   TC 59 SC13   ISO/TR 23262:2021 GIS (geospatial) / BIM interoperability	<a href="https://www.iso.org/standard/75105.html">https://www.iso.org/standard/75105.html</a>	Building
Specification   TC 59 SC13   ISO/TR 3262:2021 GIS (geospatial) / BIM interoperability	<a href="https://www.iso.org/standard/75105.html">https://www.iso.org/standard/75105.html</a>	Construction
Specification   TC 59 SC13   ISO/TS 12911:2012: Framework for building information modelling (BIM) guidance	<a href="https://www.iso.org/standard/52155.html">https://www.iso.org/standard/52155.html</a>	Building
Specification   TC 59 SC13   ISO 19650-1:2018 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 1: Concepts and principles	<a href="https://www.iso.org/standard/68078.html">https://www.iso.org/standard/68078.html</a>	Building
Specification   TC 92   ISO/TR 24679-6:2017 Fire safety engineering - Performance of structures in fire - Part 6: Example of an eight- storey office concrete building	<a href="https://www.iso.org/standard/63935.html">https://www.iso.org/standard/63935.html</a>	Building
Specification   TC SmartM2M   ETSI TR 103 507 V1.1.1 (2018-10): SAREF extension investigation; Requirements for industry and manufacturing domains	<a href="http://webapp.etsi.org/workprogram/Report_WorkItem.asp?WKI_ID=51400">http://webapp.etsi.org/workprogram/Report_WorkItem.asp?WKI_ID=51400</a>	Industry
Specification   TC SmartM2M   ETSI TR 103 674 V1.1.1 (2021-02): Artificial Intelligence and the oneM2M architecture	<a href="http://webapp.etsi.org/workprogram/Report_WorkItem.asp?WKI_ID=57866">http://webapp.etsi.org/workprogram/Report_WorkItem.asp?WKI_ID=57866</a>	Industry
Specification   TC SmartM2M   ETSI TR 103 778 V1.1.1 (2021-12): Use cases for cross-domain data usability of IoT devices	<a href="https://www.etsi.org/deliver/etsi_tr/103700_103799/103778/01.01.01_60/tr_103778v010101p.pdf">https://www.etsi.org/deliver/etsi_tr/103700_103799/103778/01.01.01_60/tr_103778v010101p.pdf</a>	Industry



Headline Title of Document	Webpage for access	Domain
Specification   TC USER   ETSI TR 103 604 V1.1.1 (2019-04): User centric approach; Qualification of the interaction with the digital ecosystem	<a href="http://webapp.etsi.org/workprogram/Report_WorkItem.asp?WKI_ID=52881">http://webapp.etsi.org/workprogram/Report_WorkItem.asp?WKI_ID=52881</a>	Cross-domain
Specification   TC184   ISO/TR 24464 Automation systems and integration - Industrial data - Visualization elements of digital twins	<a href="https://www.beuth.de/en/technical-rule/iso-tr-24464/332330659">https://www.beuth.de/en/technical-rule/iso-tr-24464/332330659</a>	Industry
Specification   TC184 SC4   ISO 10303-209:2014 Industrial automation systems and integration - Product data representation and exchange - Part 209: Application protocol: Multidisciplinary analysis and design	<a href="https://www.iso.org/standard/59780.html">https://www.iso.org/standard/59780.html</a>	Industry
Specification   TC184 SC4   ISO 10303-242:2020 Industrial automation systems and integration - Product data representation and exchange - Part 242: Application protocol: Managed model-based 3D engineering	<a href="https://www.iso.org/standard/66654.html">https://www.iso.org/standard/66654.html</a>	Industry
Specification   TC184 SC4   ISO 23247-1 Automation systems and integration - Digital twin framework for manufacturing - Part 1: Overview and general principles	<a href="https://www.iso.org/standard/75066.html">https://www.iso.org/standard/75066.html</a>	Industry
Specification   TC184 SC4   ISO 23247-2, Automation systems and integration - Digital Twin framework for manufacturing - Part 2: Reference architecture	<a href="https://www.iso.org/standard/78743.html">https://www.iso.org/standard/78743.html</a>	Industry
Specification   TC184 SC4   ISO 23247-3, Automation systems and integration - Digital Twin framework for manufacturing - Part 3: Digital representation of manufacturing elements	<a href="https://www.iso.org/standard/78744.html">https://www.iso.org/standard/78744.html</a>	Industry
Specification   TC184 SC4   ISO 23247-4, Automation systems and integration - Digital Twin framework for manufacturing - Part 4: Information exchange	<a href="https://www.iso.org/standard/78745.html">https://www.iso.org/standard/78745.html</a>	Industry
Specification   Web Feature Service (WFS)	<a href="https://www.ogc.org/standards/wfs">https://www.ogc.org/standards/wfs</a>	Geographic Information Systems (GIS)

Headline Title of Document	Webpage for access	Domain
Specification   Y.dtf.reqs Requirements for digital twin federation in smart cities and communities	<a href="https://www.itu.int/itu-t/workprog/wp_item.aspx?isn=17211">https://www.itu.int/itu-t/ workprog/wp_item. aspx?isn=17211</a>	Smart cities
Specification   Y.DT-interop Interoperability framework of digital twin systems in smart cities and communities	<a href="https://www.itu.int/itu-t/workprog/wp_item.aspx?isn=17112">https://www.itu.int/itu-t/ workprog/wp_item. aspx?isn=17112</a>	Transport





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