ISO/IEC TR 30172

Edition 1.0 2023-10

TECHNICAL REPORT

colour inside

Internet of things (IoT) - Digital twin – Use cases

ISO/IEC TR 30172:2023-10(en)

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 35.020; 35.240

ISBN 978-2-8322-7604-4

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INTERNET OF THINGS (IoT) – DIGITAL TWIN – USE CASES

FOREWORD

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ISO/IEC TR 30172 has been prepared by subcommittee 41: Internet of Things and Digital Twin, of ISO/IEC joint technical committee 1: Information technology. It is Technical Report.

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

Draft	Report on voting
JTC1-SC41/335/DTR	JTC1-SC41/363/RVDTR

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

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

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1, available at www.iec.ch/members_experts/refdocs and www.iso.org/directives.

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

This document provides use cases of digital twin applications in various domains using the template modified from IEC 62559-2 use case template and ISO/IEC TR 22417 use case template. Use case templates used in ISO/IEC JTC 1/AG 8, ISO/IEC JTC 1/AG 11 and ISO/IEC JTC 1/SC 41/AG 25 are also considered for the template in this document.

The use case template includes two parts: Description of use case; Drawings or diagrams depicting the use case. To collect use cases, the first step is to identify application domains of digital twin (DTw) systems and to provide a use case template. Contributors were requested to submit use cases using the provided template.

For improving the quality of the use case description, a guidance is provided to contributors. The guidance includes DTw concepts and reference models for preparing use cases.

By investigating use cases, it is possible to find the new technical requirements from the market, accelerating the transformation of science and technology achievements.

The use case template helps to group and categorize the use cases according to the identified application domains. Readers of this document can find use cases that relate to the desired application domain and can find original submissions of use cases in Annex A, which includes all submissions of use cases.

INTERNET OF THINGS (IoT) – DIGITAL TWIN – USE CASES

1 Scope

This document provides a collection of representative use cases of digital twin applications in a variety of domains, for example, smart manufacturing and smart cities.

This document is applicable to all types of organization (for example, commercial enterprises, government agencies, and not-for-profit organizations).

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

3.1
digital twin
DTw
digital representation of a target *entity* (3.2) with data connections that enable convergence between the physical and digital states at an appropriate rate of synchronization

Note 1 to entry: Digital twin has some or all of the capabilities of connection, integration, analysis, simulation, visualization, optimization, collaboration, etc.

Note 2 to entry: Digital twin can provide an integrated view throughout the life cycle of the target entity.

[SOURCE: ISO/IEC 30173:–, 3.1.1]

3.2
entity
<digital twin> thing (physical or non-physical) having a distinct existence

EXAMPLE Person, object, event, idea, process, etc.

[SOURCE: ISO/IEC 20924:2021, 3.1.18, modified – The domain "<digital twin>" and the example have been added.]

3.3
physical entity
entity in the physical world that can be the subject of sensing and/or actuating

[SOURCE: ISO/IEC 20924:2021, 3.1.27]

3.4
digital entity
computational element comprising data elements and procedural elements

[SOURCE: ISO/IEC 30173:–, 3.1.5]

3.5
life cycle
evolution of a system, product, service, project or other human-made entity from conception through retirement

[SOURCE: ISO/IEC/IEEE 15288:2023, 3.21]

3.6
conformity
process of analysis to determine whether a digital twin meets the specified requirements and to form a judgement as to whether the digital entity is fit for its corresponding physical entity

3.7
reliability
ability of an item to perform a required function under given conditions for a given time interval

[SOURCE: IEC 62657-1:2017, 3.1.12, modified – Note 1 to entry and note 2 to entry have been deleted.]

3.8
verification
confirmation, through the provision of objective evidence, that specified requirements have been fulfilled

[SOURCE: ISO 9000:2015, 3.8.12, modified – The notes to entry have been deleted.]

3.9
validation
confirmation, through the provision of objective evidence, that the requirements for a specific intended use or application have been fulfilled

[SOURCE: ISO 9000:2015, 3.8.13, modified – The notes to entry have been deleted.]

3.10
robustness
degree to which a system or component can function correctly in the presence of invalid inputs or stressful environmental conditions

[SOURCE: ISO/IEC/IEEE 24765:2017, 3.3555]

3.11
fidelity
ability to accurately describe the relevant aspects of the physical counterpart within a well-defined set of conditions by its digital model

3.12
traceability
ability to trace the history, application or location of an object

[SOURCE: ISO 9000:2015, 3.6.13, modified – Note 1 to entry and note 2 to entry have been deleted.]

3.13
synchronization
<digital twin>action of making the states of target and digital entity synchronized, using network for real time system

[SOURCE: ISO/IEC 30173:–, 3.1.20]

3.14
reconfigurability
ability of an artefact to be changed through configuration changes rather than having to modify its underlying structure or its code or both

3.15
interoperability
ability of two or more different systems to exchange information and to use the information that has been exchanged

[SOURCE: ISO/TS 27790:2009, 3.39, modified – In the definition, "systems or components" has been replaced by "different systems".]

4 Abbreviated terms

2D two dimensional
3D three dimensional
AI artificial intelligence
APP application
BIM building information modelling
DTw digital twin
ERP enterprise resource planning
GIS geographic information system
HVAC heating, ventilation, and air conditioning
IED intelligent electronic device
KPI key performance indicator
LGA land grid array
MES manufacturing execution system
MQTT message queuing telemetry transport
PC personal computer
PLC programmable logic controller
R&D research and development
SCADA supervisory control and data acquisition

5 Applications

5.1 Application domains

DTw application domains can be classified into industry-based categories, and specific use cases can serve as examples for each category. The application domains listed below are the targeted areas for collecting use cases related to DTw; however, there may be other areas that are not included in this list.

– building or construction

– urban
– energy
– healthcare
– manufacturing
– home appliance
– mining
– telecommunications
– aerospace
– marine
– environmental monitoring
– transport

5.2 Life cycle stage coverage

The following life cycle stages, based on ISO/IEC 30173:–[1], are considered as target phases to collect use cases:

– inception
– design and development
– verification and validation
– deployment
– operation and monitoring
– re-evaluation
– retirement.

6 Use cases

6.1 Overview

Twelve use cases, based on the use case template described in Annex A, have been collected in Annex B. Some use cases include trademarks such as company names, product names, or service names. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO or IEC.

The template provided in Annex A includes two parts: description of use case, and drawings or diagrams depicting the use case.

– Description of use case includes the following elements: name of use case, application area, version management, basic information to use case, scope of use case, objectives of use case, entities that need to be modelled as digital entities in use case, actors, life cycle of the digital twin system in use case, key performance indicators (KPIs) of use case, digital infrastructures.
– Drawings or diagrams depicting the use case includes the following elements: drawing of use case, data flow diagram of use case, sequence diagram(s) of use case, deployment diagram(s) of use case.

6.2 Properties

Description of the use case includes the following.

– Name of the use case to be provided by the contributor of the use code.

[1] Under preparation. Stage at the time of publication: ISO/IEC FDIS 30173:2023.

- Digital twin application area or context of use.
- Version management: the status of the version of the use case.
- Basic information to use case: descriptions of basic information of the use case that includes:
  1) conditions (limitations) of use;
  2) maturity of the use case, for example, in business operation, realized in demonstration project, realized in R&D, in preparation, visionary;
  3) generic, regional or national relation;
  4) vertical application area, for example, automotive industry, petrochemical industry, and aviation industry;
  5) keywords for classification, for example, system integration, performance evaluation, information exchange, IT security, and AI application.
- Scope of use case: the scope that defines the aspects covered by the limits use case or indicates the purview and limitations of the use case.
- Objectives of use case: the intention of the use case, in other words, what is to be accomplished and who will be benefited by the use case and how.
- Narrative of use case.
- Entities that need to be modelled as digital entities in the use case.
- Actors: people, organizations or systems.
- Life cycle of the digital twin system in use case: refers to 5.3 life cycle stage(s) or phase(s) coverage.
- Key performance indicators (KPIs) of use case.
- Digital infrastructures: description of digital infrastructures employed in the use cases.
- Referred standards and standardization committees.
- Referred papers or patent.
- Relation with other known use cases, for example, common requirements.
- Challenges and issues: descriptions of challenges and issues in the use case.
- Data security, privacy, and trustworthiness: issues relating to description of data, privacy, and trustworthiness in the use case.
- User requirements and interactions with other actors.

See Clause A.2 for details.

6.3 Basic statistics

6.3.1 Use cases by application domain

6.3.1.1 Use cases in Annex B

Distribution of use cases in Annex B by application domain is shown in Figure 1.

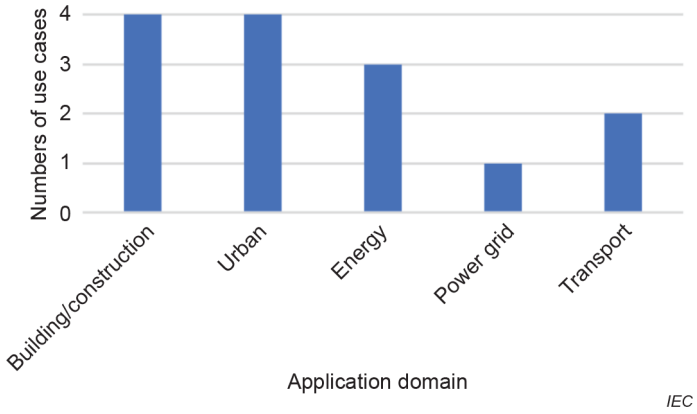

Figure 1 – Distribution of use cases collected in Annex B by application domains

6.3.1.2 Use cases in report of AG 11

Twenty-eight use cases have been collected from JTC 1/AG 11 report on DTw. The use case names and application fields are shown in Table 1. Statistics on distribution of use cases in JTC 1/AG 11 report by application domain are shown in Figure 2.

Table 1 – List of use cases in JTC 1/AG 11 report

Use case name	Application domain
Optimization of production execution	Manufacturing
Dicastal Morocco factory	Manufacturing
Product intelligent manufacturing production line	Manufacturing
Product Intelligent Assembly Process Simulation and Optimization	Manufacturing
Electro-hydraulic servo valve assembly process	Manufacturing
On Digital Twin in Additive Manufacturing	Manufacturing
Digital Twin for massive smart manufacturing	Manufacturing
Visual monitoring system for small and medium-sized machining automatic production line	Manufacturing
Visual monitoring system for assembly process	Manufacturing
The generative design and additive manufacturing of mass customized footwear lattices	Manufacturing
Research and Application of Digital Twin Technology in Joint Ship Hull Workshop	Manufacturing
Integrated Digital System for Smart Ship Pipeline Factory	Manufacturing
Luxury cruise sheet section turning device	Manufacturing
Dynamic scheduling of manufacturing tasks between multiple robots	Manufacturing
On-machine measurement for tool-life optimization	Manufacturing
Advanced Metrology	Manufacturing
Integrated Digital System for Smart Ship Pipeline Factory	Manufacturing
Digital Twin Technology Applied to the Automated Driving Test and Evaluation System	Manufacturing
Digital twin system of tobacco industry chain	Manufacturing
Research on the construction and application of digital twin in intelligent oil and gas pipeline network	Energy
Smart Cities with Digital Twin Technology	Urban
Digital Twin City Smart Control Cloud-Platform	Urban
Elderly Healthcare Services Using Digital Twin	Healthcare