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Automation systems and integration — Digital Twin framework for manufacturing —

Part 4: Information exchange

Partie 4: Echange d'informations

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 184, *Industrial automation systems and integration*, Subcommittee SC 4 *Industrial data*.

A list of all parts in the ISO 23247 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The ISO 23247 series defines a framework to support the creation of Digital Twins of observable manufacturing elements including personnel, equipment, materials, manufacturing processes, facilities, environment, products, and supporting documents.

The scopes of the four parts of this series are defined below:

— Part 1: Overview and general principles

  General principles and requirements for developing Digital Twins in manufacturing;

— Part 2: Reference architecture

  Reference architecture with functional views;

— Part 3: Digital representation of manufacturing elements

  List of basic information attributes for the observable manufacturing elements;

— Part 4: Information exchange

  Technical requirements for information exchange between entities within the reference architecture.

The framework is targeted to all types of manufacturing including discrete and continuous manufacturing of parts, assemblies and material. The actual type of manufacturing supported by a particular implementation depends on the standards and technologies available to model the observable manufacturing elements.

Digital Twin use cases that conform to the framework will be detailed in a series of technical reports attached to this series. Preliminary outlines for three use cases are given in the Annex of Part 4.

Automation systems and integration — Digital Twin framework for manufacturing —

Part 4:
Information exchange

1 Scope

This part of ISO 23247 identifies technical requirements for information exchange between entities within the reference architecture.

The ISO 23247 series defines a framework to guide the creation of Digital Twins of observable manufacturing elements including personnel, equipment, materials, processes, facilities, environment, products, and supporting documents.

The requirements for information exchange in the following networks are within the scope of this part of ISO 23247:

— User network that connects the User entity and Core entity;

— Service network that connects sub-entities within the Core entity;

— Access network that connects the Data collection and device control entity to the Core entity and to the User entity;

— Proximity network that connects the Data collection and device control entity to the observable manufacturing elements.

The following are described in other parts of ISO 23247:

— overview and general principles (Part 1);

— reference architecture (Part 2);

— digital representation of manufacturing elements (Part 3).

The following are outside of the scope of ISO 23247, but will be identified as use cases in technical reports.

— selection of the manufacturing devices and other resources to be represented by Digital Twins;

— selection of the manufacturing processes to be represented by Digital Twins;

— selection of the manufacturing products to be represented by Digital Twins.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 23247-1, *Automation systems and integration — Digital Twin framework for manufacturing — Part 1: Overview and general principles*

ISO 23247-2, *Automation systems and integration — Digital Twin framework for manufacturing — Part 2: Reference architecture*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 23247-1 apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

4 Networking view of Digital Twin reference architecture for manufacturing

4.1 Overview

ISO 23247-2 defines a reference model for the functional view of Digital Twins in manufacturing. This part describes the networking view.

Figure 1 shows four types of communication networks based on the reference architecture of ISO 23247-2.

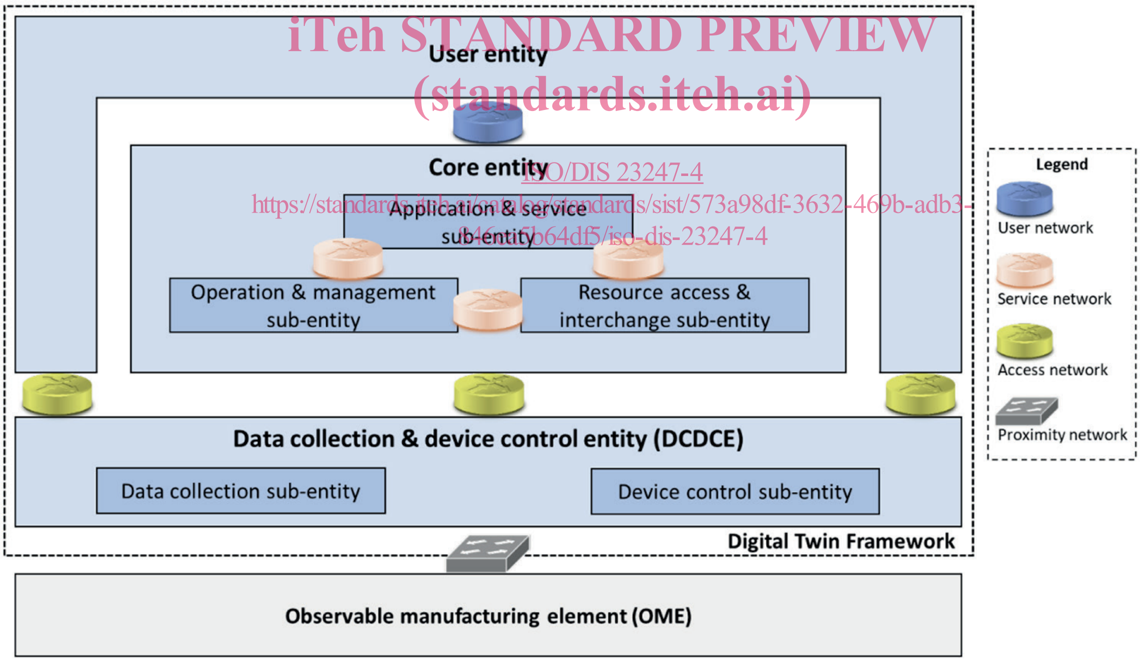

Figure 1 — Networking view of Digital Twin reference architecture for manufacturing

4.2 User network

The User network connects the User entity with the Core entity. Through this network, the User entity make use of the digital twin instances managed by the Core entity.

The User network can be both public Internet and also (private) Intranet in case that User entity and Core entity are implemented in a single private domain.

4.3 Service network

The Service network connects the operation and management sub-entity, application and service sub-entity, and resource access and interchange sub-entity. The service network is typically a wired network running IP-based protocols.

The Service network can include both public Internet and also (private) Intranet in case that the Core entity is implemented in a single private domain.

If the core entity is implemented as a single private system, then a Service network is not needed.

4.4 Access network

The Access network connects the Data collection and device control entity (DCDCE) to the Core entity and the User entity. Through this network, the Data collection sub-entity transmits data collected from the observable manufacturing elements (OME) to the Core entity. Through this network, the User entity and the Core entity transmit information to control the observable manufacturing elements.

The Access network can be a wired communication such as local area network (LAN) or wireless communication such as wireless LAN (WLAN) and mobile (cellular) network. The Access network generally adopts IP-based communication protocols regardless of communication type.

4.5 Proximity network

The Proximity network connects DCDCE with OME. Through this network, DCDCE transmits commands to industrial devices and receives results from sensors.

The Proximity network can be Industrial Ethernet or a proprietary network with a restricted configuration. Some networks use specialised protocols instead of generic protocols such as IP. However, if an OME is physically attached or integrated into the DCDCE then the Proximity network is not necessary.

5 Requirements for information exchange in the User network

5.1 Overview

The User network shall enable the exchange of information between the User entity and the Core entity for services and applications such as visualization, process monitoring, statistical analysis, and simulation.

5.2 Provisioning

The User network shall enable the delivery of information to configure a Digital Twin to an initial state.

EXAMPLE 1 The Digital Twin of a product is provisioned at the start of its life from information contained in Product lifecycle management (PLM). This information may include product requirements, 3D models, configuration, simulation models, and traceability.

EXAMPLE 2 The Digital Twin of a work cell is provisioned at the start of its life from information in PLM or other data sources. This information may include kinematics, capacity, capability, certification, and calibration

EXAMPLE 3 The Digital Twin of a process is provisioned at the start of its life from information in PLM or other data sources. This information may include high-level and low-level process plans, tolerances, fixture, and cutter requirements.

5.3 On-demand status acquisition

The User network shall enable the delivery of information on the current state of the Digital Twin.

The User network shall enable the delivery of information on the historical state of the Digital Twin.

EXAMPLE 1 A User entity queries a Core entity, so that it can show the current status of the machine in a remote location.

EXAMPLE 2 A User entity queries a Core entity, so that it can dynamically predict the remaining life for a cutter.

EXAMPLE 3 Upon decommissioning a Digital Twin informs related Digital Twin that it is no longer valid.

5.4 Standardized method for information exchange

The User network shall use standardized methods for exchanging information.

NOTE As described in Annex A.2.1, examples for standardized protocol include REST and HTTP.

5.5 Verification of exchanged digital model

The standardized method for information exchange should include methods for verifying the syntax and semantics of the exchanged model and validating its contents.

NOTE As described in Annex A.2.1, examples of information models with methods for checking syntax and semantics include STEP and QIF.

5.6 Security

The User network shall provide secure methods of communication in terms of authentication, authorization, data integrity, privacy, confidentiality, etc.

The User network shall provide methods such as digital signatures to authenticate that the correct information is delivered to the correct application.

The User network shall provide methods to ensure that Digital Twin can be accessed by authorized parties only.

5.7 Synchronization

The User network shall enable applications to operate on digital models that have been appropriately synchronized.

NOTE The rate of synchronization depends on the application. Information that is going to be used to prevent a collision must arrive before the collision. Information that is going to be used to determine a statistical trend for a quarterly report must arrive before the cut-off date of the report.

5.8 Exchange of digital models

The User network shall enable exchange of information about the digital representation of the OME. The communication shall allow applications to operate on common models of the OME. Depending upon the application, the types of elements shown in Figure 2 may need to be modelled for information exchange.

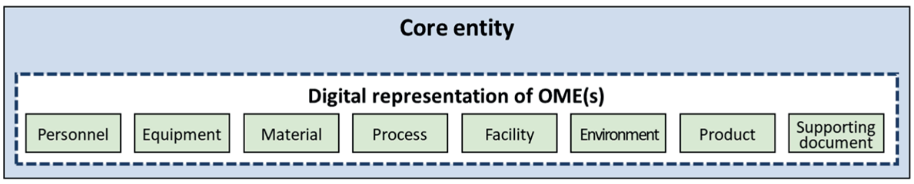

Figure 2 — Type of digital models for exchange

NOTE At the present time, several standards define information for one or more of the OME types but no single standard defines information for all the OME types.

6 Requirements for information exchange in the Service network

The Service network is used to transmit information between sub-entities of the core entity. As such this network can be private to a particular implementation of the Core entity and does not need to be defined by this standard.

NOTE If a Core entity is implemented by multiple organizations. then it can use the User Network to enable data sharing.

7 Requirements for information exchange in Access network

7.1 Overview

The Access network connects the DCDCE to other entities. The DCDCE collects information about the OME as they operate using an appropriate streaming protocol. The DCDCE controls the OME by sending commands in a language understood by the OME.

7.2 Connectivity

The Core entity and User entity are connected to the DCDCE by the Access network. Depending on the circumstances, the connection may be discovered dynamically using an appropriate protocol or statically using a known network address. In either case, the connection delivers data about the OME of interest to the Core entity.

EXAMPLE 1 In a static example, a MTConnect agent for a machine tool on the shop floor may be published to the network as URL 192.168.0.1:5000. In this case, the Digital Twin for the machine tool uses this address to listen for changes to its OME.

EXAMPLE 2 In a dynamic example, a MQTT subscriber discovers the availability of a data stream from the DCDCE responsible for an OME and uses the information to update its Digital Twin.

7.3 Standardized method for communication

The Access network shall provide a standardized method for delivering data to the Core entity. The method shall include information sufficient to identify the OME, and describe the change that has occurred.

EXAMPLE 1 The Access network may use MTConnect as a standardized method to transfer data to the Core entity from the DCDCE.

The Access network shall provide a standardized method for delivering data to control an OME through the DCDCE.

EXAMPLE 2 The Access network may deliver a CNC program described using ISO 6983 G-code formatting to the OME from the Core entity or the User entity.

7.4 Synchronization

The Access network shall enable the Digital Twin to be synchronized with the OME at an appropriate rate.

NOTE 1 The bandwidth of the Access network must be sufficient to support the required level of synchronization.

NOTE 2 The latency requirements for servicing an urgent fault or alarm are different than those for updating a 3D model.