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Industrial automation systems and integration — Product data representation and exchange —

Part 1:
Overview and fundamental principles

Systèmes d'automatisation industrielle et intégration — Représentation et échange de données de produits —

Partie 1: Aperçu et principes fondamentaux

PROOF

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

This third edition cancels and replaces the second edition (ISO 10303-1:2021), which has been technically revised.

The main changes are as follows:

— ~~—~~all terms removed, and included in ISO 10303-2[1];

— ~~—~~inclusion of STEP extended architecture.

A list of all parts in the ISO 10303 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~~www.iso.org/members.html.

[1] Under preparation. Stage at the time of publication: ISO/FDIS 10303-2:2023.

Introduction

The ISO 10303 series of International Standards describe the computer-interpretable representation of product information for the exchange of product data. The objective is to provide a neutral mechanism capable of describing products throughout their life cycle. This mechanism is suitable not only for neutral file exchange, but also as a basis for implementing and sharing product databases, and as a basis for archiving.

The information generated about a product during its design, manufacture, use, maintenance, and disposal is used for many purposes. The use can involve many information systems, including some that can be located in different organizations. In order to support such uses, organizations need to be able to represent their product information in a common computer-interpretable form that is required to remain complete and consistent when exchanged among different information systems.

This document is an overview of the ISO 10303 series. It specifies the overall scope of the ISO 10303 series and describes the ISO 10303 series architectures and structure. It describes the various parts of the ISO 10303 series and the relationships among them.

The ISO 10303 series is organized as a series of parts, each published separately.

Each part of the ISO 10303 ~~Standard~~series is a member of one of the following series: description methods, implementation methods, conformance testing methodology and framework, integrated generic resources, integrated application resources, Core model, application protocols (APs), abstract test suites (ATSs), application interpreted constructs (AICs), application modules (AMs) and application domain models (ADMs).

There is a set of standing documents that provide guidelines for developing International Standards produced by ISO/TC 184/SC 4. These are listed in the SC 4 organization handbook~~[1],~~[1].

Industrial automation systems and integration — Product data representation and exchange —

Part 1: Overview and fundamental principles

1 Scope

This document provides an overview of the ISO 10303 series.

This document defines the architectural principles of product information representation and exchange used in the ISO 10303 series. It specifies the characteristics of the various sets of parts in the ISO 10303 series and the relationships among them.

The following are within the scope of this document:

- scope statement for the ISO 10303 series as a whole;
- overview of the ISO 10303 series;
- architectures of the ISO 10303 series;
- structure of the ISO 10303 series;
- overview of data specification methods used in the ISO 10303 series;

NOTE This includes the EXPRESS data specification language and graphical presentation of product information models.

- introduction to the ISO 10303 series:
  - integrated resources (IRs);
  - application interpreted constructs (AICs);
  - application modules (AMs);
  - application domain models (ADMs);
  - Core model;
  - business object models (deprecated);
  - application protocols (APs);
  - implementation methods;
  - usage guides;
  - conformance testing methodology and framework;

— ——abstract test suites (ATSs);

— ——scheme for identification of schemas and other information objects defined in the ISO 10303 series.

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 10303-2:——[2], *Industrial automation systems and integration — Product data representation and exchange — Part 2: STEP Vocabulary*

ISO/IEC 8824-1, *Information technology — Abstract Syntax Notation One (ASN.1) — Part 1: Specification of basic notation*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 10303-2 apply.

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

— ——IEC Electropedia: available at ~~https://www.electropedia.org/~~https://www.electropedia.org/;

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

3.2 Abbreviated terms

AO	application object
CTC	core technical capability
DTD	document type definition
HDF	hierarchical data format~~[2]~~[2]
SDAI	standard data access interface~~[3]~~[3]
URL	uniform resource locator
UML	unified modeling language
XMI	XML metadata interchange~~[4]~~[4]
XML	extensible mark-up language
XLSX	Microsoft Excel open XML spreadsheet

4 Overview of the ISO 10303 series

4.1 Purpose

The purpose of the ISO 10303 series is to specify a form for the unambiguous representation and exchange of computer-interpretable product data throughout the life of a product. This form is independent of any specific computer system. This form enables consistent implementations across multiple applications and systems. The ISO 10303 series architecture permits different implementation

[2] Under preparation. Stage at the time of publication: ISO/FDIS 10303-2:2023.

methods to be used for storing, accessing, transferring, and archiving product data. The ISO 10303 series define a rigorous process for testing implementations for conformance.

4.2 Scope of the ISO 10303 series

The ISO 10303 series provides a representation of product information along with the necessary mechanisms and definitions to enable product data to be exchanged. The exchange is among different information systems and environments associated with the complete product life cycle, including product design, manufacture, use, maintenance and final disposition.

Specifically, the ISO 10303 series provides:

— representation of product information, including components and assemblies;

— implementation methods for exchange of product data, including storing, transferring, accessing, and archiving.

4.3 Fundamental principles

4.3.1 General

The ISO 10303 series separates the representation of product information from the implementation methods used for product data exchange, product data access and product data archival.

NOTE The following are assumed:

— data access is machine-to-machine sharing of data;

— data exchange is exchange of machine-interpretable files;

— data archival is persistent storage of machine-interpretable data and associated defining schemata.

EXAMPLE ISO 10303-22, Standard data access interface (SDAI), specifies data access.

The ISO 10303 series implements a three-layer architecture where the business concerns are separate from the specification of the information models, which are separate from implementation concerns[5].

A common resource provides a single representation of product information for many applications. This representation may be adapted to meet the needs of specific applications.

An application protocol (AP) specifies the representation of product information for one or more applications.

The ISO 10303 series specifies the implementation methods that support the exchange of product data defined in APs.

The ISO 10303 series uses EXPRESS or SysML[6] to specify the representation of product information. This use of the formal languages EXPRESS or SysML provides unambiguous and consistent representation and facilitates development of implementations. The representation of product information shall be annotated with a literal definition for each construct.

The ISO 10303 series provides a methodology and framework for conformance testing of implementations.

4.3.2 Integrated resources (IRs) and Core model

4.3.2.1 Integrated resources (IRs)

A set of IRs shall provide the specification of a representation of product information. Each IR comprises a set of descriptions, written in a formal data specification language, applicable to product data known as resource constructs. One set may be dependent on other sets for its definition. A single resource construct may represent similar information for different applications.

The IRs in the ISO 10303 series are divided into two groups: generic resources and application resources. The generic resources are independent of applications and may reference other resources. The application resources may reference other resources and may add other resource constructs for use by a group of similar applications. The IRs may reference product data descriptions written using EXPRESS from other International Standards.

4.3.2.2 Core model

The Core model shall provide the specification of a representation of product information that is independent of applications. It is equivalent to the IRs.

The Core information model is divided into a set of core technical capabilities (CTC). Each CTC comprises a set of objects, relationships and descriptions, written in a formal data specification language. One CTC may reference objects in other CTCs. A CTC can be reused in, or customised by, applications.

The Core model is mapped to the Reference ARM for SysML mapping (see ~~6.6~~6.6) using the artefact ARM in SysML. This relates it to the IRs.

4.3.3 Support for application protocols (APs)

The IRs and Core model each defines a generic information model for product information. They are not sufficient to support the information requirements of an AP without the addition of application specific constraints.

The ISO 10303 series defines APs in which the IRs or Core model are interpreted to meet the product information requirements of specific applications. The interpretation is achieved by selecting resource constructs from the IRs or the Core model, and their meaning may be refined by applying application specific constraints. In the modular architecture~~,~~ (see ~~5.2.3~~,5.2.3), this interpretation results in an application interpreted model (AIM) and a mapping specification. In the extended architecture~~, see 5.2.4~~, (see 5.2.4), this interpretation results in an application domain model (ADM). The AIM or ADM is documented as part of an AP.

The ISO 10303 series has a mechanism to ensure consistent interpretation when a resource construct represents the same information requirement in different APs. The mechanism uses application modules (AMs) that document the harmonized requirements along with the interpreted resource constructs.

NOTE 1 There is an alternative legacy mechanism that uses interpreted resource constructs appearing in more than one AP as a documented application interpreted construct (AIC). New AICs cannot be created.

NOTE 2 See ~~6.5~~, ~~6.6~~6.5, 6.6 and ~~6.9~~6.9 for more details on AICs, AMs and ADM~~s~~.

The scope and information requirements of the APs are specified using the terminology of the application domain. The AP provides a mapping to show how the interpretation of the IRs or Core model is used to meet the information requirements of the application domain.

The ISO 10303 series provides ADMs that present complex models in a form that can be more understandable to application experts.

4.3.4 Implementation methods

Each implementation method included in the ISO 10303 series (see ~~6.3.3.2)~~6.3.3.2) is specified by a mapping from a formal information modelling language used in ISO 10303 (such as the EXPRESS language) onto the formal language used for the method. The mapping is independent of the AP. The mapping is expressed in a formal notation, where the notation is defined in a description method for transformation (see ~~6.2.3).~~6.2.3).

NOTE Standardized implementation methods that do not have a mapping from the EXPRESS language can be used. These have a description method for transformation (see ~~6.2.3).~~6.2.3).

EXAMPLE Other standardized implementation methods are XML and Open API.

4.3.5 Implementations

An AP may specify one or more applicable implementation methods. These may be chosen from the set of implementation methods in the ISO 10303 series (see ~~6.3~~6.3), or other standardized implementation methods for which there is a transformation description method (see ~~6.2.3).~~6.2.3). An AP implementation shall apply one or more of the implementation methods specified in the AP.

4.3.6 Conformance testing

Conformance of an implementation to an AP is specified by the conformance requirements in the AP.

A set of tests, specified in an abstract test suite (ATS), may be defined for each AP. When associated with an abstract test method (ATM), these tests can be used to assess the conformance of an implementation. The overall framework for conformance assessment is specified in ISO 10303-31.

An ATM for each implementation method is specified in one of the conformance testing methodology and framework set of the ISO 10303 series.

The scope of conformance testing of a specific implementation is the requirements specified for the conformance classes claimed for the implementation in the protocol implementation conformance statement (PICS). The tests are selected from the ATS, based on the conformance class claimed by the implementation. Test results provide the basis for conformance assessment.

The ISO 10303 series contains ATSs and defines ATMs for performing conformance testing to provide a basis for test results that are repeatable, comparable, and auditable. Inclusion of conformance testing procedures in the ISO 10303 series is intended to promote widespread acceptance of test results.

5 Architecture of the ISO 10303 series

5.1 Overview

The ISO 10303 series architecture is designed to support the development of standards for product data exchange, product data access and product data archival. The architecture is constrained by the following concepts:

— ~~—~~the scope of what is standardized and what is conformance tested is set at the level of an application;

— ~~—~~information requirements are based on a model of a business activity;

— ~~—~~information requirements are standardized using a modelling language;

— ~~—~~a mapping is a specification of the data structures used from the IRs or the Core model and population constraints against that usage satisfying application requirements.

EXAMPLE 1 An ARM-AIM mapping of the AO Activity is a query against an AIM data population of the entity executed action. For each member of executed action in the data population, a member of Activity would be created.

EXAMPLE 2 A mapping from one entity in model X uses six entities as a target in model Y. It is not possible to map from one of the six entities in model Y to the entity in model X. Instead, a query is used to locate the six entities in model Y.

The ISO 10303 series is implemented through APs. An AP consists of the following major elements:

— an application activity model (AAM) describing the business process that the information model supports;

— an application data planning model (ADPM) describing the primary concepts of an application domain and the relationships among the concepts;

— an application reference model (ARM) specifying the information requirements (optional for the extended architecture[7][8][9][10]);[7][8][9][10];

— an information model based on the IRs, called an AIM, that is a basis for implementations of the ISO 10303 Standard. APs using the modular architecture[11][11] shall include an AIM. APs using the extended architecture may include an AIM;

— an information model for data structures, called an ADM, that is a basis for implementations of the ISO 10303 Standard. APs using the extended architecture shall include an ADM.

The architecture is based on standardizing industry information requirements and mapping those information requirements to an information model based on the IRs or the Core model. The Core model is mapped to a reference ARM that is then mapped to the IRs. The process of mapping information requirements to the IRs is known as "interpretation".

The ISO 10303 series architecture focuses on the information required by industrial processes rather than on the processes themselves, as the processes can change over time, while the underlying information requirements are longer lasting. This focus on information allows the ISO 10303 series to support data exchange, data access, as well as product data archival.

Whenever a resource construct is used to represent the same information requirement in different APs, the same interpretation of that resource construct shall be used.

5.2 Types of the architecture

5.2.1 General

The general architectural principles described in 5.15.1 have been elaborated into three architectures:

— the "initial architecture",

— the "modular architecture"", and

— the "extended architecture".

All architectures adhere to the fundamental principles described in 4.3.4.3.

NOTE The term "ISO 10303 series architecture", without qualification, refers to the general principles described in 5.15.1 and the common aspects of its elaborations.

An ISO 10303 series project may use the initial architecture, the modular architecture, or the extended architecture, although new projects are not encouraged to use the initial architecture.

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5.2.2 Sharing interpretations in the initial architecture

An AIC shall be used to specify a piece of an AIM that can be used to exchange product data common to two or more APs.

NOTE An AIC does not document the common information requirements or the mapping of those information requirements into the AIM.

An AP that complies with initial architecture is called a "monolithic AP".

5.2.3 Sharing interpretations in the modular architecture

5.2.3.1 General

Rather than relying on harmonization occurring as a by-product of consistent interpretation across APs, application requirements are first harmonized across domains and the resulting mappings are standardized in AMs. AMs are reused by other AMs and ultimately by APs.

The implementable portion of the modular architecture has two core components:

— AM:

  — a reusable data specification documented with an ARM;

  — mapping;

  — MIM;

  — and optional usage guide.

— AP: The use of a data specification to meet the requirements of business processes.

NOTE The business object model, originally included in the modular architecture, is deprecated.

The objectives and function of the architectural components are described in 5.2.3.2 and 5.2.3.3.5.2.3.2 and 5.2.3.3.

5.2.3.2 Application module (AM)

The design of an AM should maximize re-usability of the

a) a) harmonized requirements,

b) b) associated interpretation into the IRs,

c) c) data specification, and

d) d) software implementations.

The design shall support re-usability by the standards developer, implementer and user.

AMs replace AICs in the modular architecture. Each AIC shall be included in one AM. The objectives of AICs and AMs are similar. They both standardize interpretation results for reuse in multiple APs. However, AICs and AMs are created differently and have different content. AMs, unlike AICs, contain harmonized information requirements and specifications of the mappings of those requirements to the IRs. An objective of modularization is to document a concept one time and then to directly reuse that concept in other AMs. The modular architecture uses EXPRESS rather than natural language for the