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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



DRAFT International Standard

Automation systems and integration – Model-based standards authoring

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 document 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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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 184, Automation systems and integration, Subcommittee SC 5, Interoperability, integration, and architectures for enterprise systems and automation applications.

Introduction

A standard is a systemic specification. A standard document is a model that when implemented in a conforming manner, results in a system, or part thereof, which meets the requirements, recommendations and permissions contained in the specification of that system. International standards are supposed to be a solid source of authority and must therefore be explicit, reliable, readable with ease, and implementable. However, standards are often criticized as difficult to use for a variety of reasons, including inter- and intra-standard inconsistency, low accessibility, poor traceability, and ambiguity. A primary source of these problems is the fact that standards are authored mostly using free text, which is generally difficult to verify for consistency with other sections of the standard, with other standards, or with reference works. Further, the text is often accompanied by graphical annotations, illustrations, figures, or diagrams, which frequently do not match the text or conflict with other figures and tables in the same document,^[1] so instead of helping they can add confusion.

This document addresses these various difficulties by specifying a model-based mechanism to align a formal model of standardization using a complementary text and graphics methodology with the intent of the standard authors. To express this alignment, this document draws upon the success of Object-Process Methodology (OPM) ISO 19450:2024, which offers a holistic approach, backed by formal yet intuitive equivalent diagrammatic and textual representations for modelling standards. Using a bimodal model-based approach significantly increases completeness and reduces inconsistencies. The dual graphics-text equivalence, which lies at the basis of the method, enables deep cognitive analysis of the standard's technical content, thereby providing for a holistic and more consistent standard. ISO 19450:2024 Object-Process Methodology (OPM) offers a holistic approach, backed by a formal yet intuitive graphic and textual language, for modeling systems of all kinds, including standards. These standards are intended for such stakeholders as enterprise and system architects and executives, system integrators, service providers, device suppliers, and designers and developers of applications. These professionals are concerned with architecting and holistically integrating enterprises. Integration within and across enterprises encompasses systems that include supply chains, customer relations, the projects they execute, the products they deliver, the services they get and provide, the resources they utilize, the assets they maintain, and any other related components and processes needed to facilitate automation and integration of their web of systems. The document is intended to address primarily industrial automation and manufacturing systems. The generality of the framework and the methodology makes it appropriate for creating model-based standards in multiple other domains.

This document applies OPM according to ISO 19450:2024 as a methodology and modeling language to streamline, formalize, and explicate standards' ontology and glossary, making them more comprehensive, accessible, usable, and consistent, both internally, within each standard, and externally, across related standards. The approach applies to both existing and new standard documents.

This document, which applies to both existing and new standards, presents a formal procedure for authoring model-based standards through internal and external verification and validation processes. Documents created by following this document are based on an underlying unified formal OPM model that jointly and concurrently represents the structure of the modelled standard's technical content and the process of model-based authoring.

This document uses OPM for the examples in [Clause 4](#) to demonstrate its use to construct a system diagram (SD) and its aligned text for the "Scope" statement of this document. [Clause 5](#) uses OPM to elaborate that statement into a set of lower-level parts of the model for a standard consistent with that "Scope". Each model part includes an Object-Process Diagram (OPD) and associated Object-Process Language (OPL) text. In addition, a narrative elaboration of the OPL is given in the text that is consistent with the ISO/IEC Directives.

NOTE ISO has approved derogation of this document from certain ISO directives to comply with syntactic requirements of OPM as specified in ISO 19450:2024, specifically, the use of Arial bold font, capitalization, and lowercase to distinguish label names for OPM objects, processes, states, and link tags. Following ISO 19450:2024 regarding names of OPM things (objects or processes), bold, capitalized words and phrases in this document refer to names of things as they appear in the accompanying OPM model OPD and the corresponding OPL sentences. State names and user-defined tags are by default lowercase and bold. In the OPL (textual) parts of OPM models, the font colours may match their corresponding colours in the OPD. See [Figure 1](#) for example.

This document includes a set of examples in [Annex A](#) demonstrating how the MBSA approach facilitates clarifying models from several published and in-preparation standards. Some of these examples use modelling paradigms other than OPM, specifically SysML ISO/IEC 19514:2017.

Automation systems and integration – Model-based standards authoring

1 Scope

This document establishes a framework and methodology for an approach to model-based standards authoring (MBSA). MBSA improves the conciseness and completeness of future and existing standards by basing them on a formalized linkage of graphical and textual representations of a standard's content to enable dual-mode comprehension. This document also serves as an example of a model-based standard.

The document uses Object-Process Methodology (OPM), specified in ISO 19450:2024. This document explains the syntax and semantics of OPM as needed to understand the graphical Object-Process Diagrams (OPDs) presented and their Object-Process Language (OPL) textual equivalent.

NOTE While the MBSA approach can be applied using any modelling language, such as the System Modeling Language (SysML) ISO/IEC 19514:2017, this document applies OPM according to ISO 19450:2024.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes the 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 19450:2024, *Automation systems and integration — Object-Process Methodology*

3 Terms and definitions

For this document, the following terms and definitions apply.

3.1 function

combination of a *process* (3.9) and one or more *objects* (3.3) that undergo transforming by that process, providing value to the system beneficiary

3.2 model-based standards authoring MBSA

process of authoring a model-based standard according to this standard

3.3 object

OPM (3.4) thing that exists or might exist physically or informatically

3.4 Object-Process Methodology OPM

methodology and formal language that uses graphics and text to model systems with objects and processes

Note 1 to entry: OPM is specified in ISO 19450:2024

3.5**Object-Process Diagram****OPD**

OPM (3.4) graphic representation of *objects* (3.3) and *processes* (3.9) in the universe of interest along with the structural and procedural relationships that exist among them

3.6**OPD set**

collection of hierarchically organized *OPD* (3.5) of an *OPM* (3.4) model

3.7**Object-Process Language****OPL**

OPM (3.9) textual representation in a subset of a natural language of objects and processes in the universe of interest along with the structural and procedural relationships that exist among them

3.8**OPL specification****OPL Spec**

collection of OPL sentences that jointly specify an *OPM* (3.4) model

3.9**process**

OPM (3.4) thing that transforms or might transform an *object* (3.3)

3.10**state**

labelled situation of an *object* (3.3) during its life cycle

3.11**transforming**

yielding (creating, generating), consuming (destroying, eliminating), or affecting (changing the state of) an *object* (3.3)

4 Model-based standard authoring**4.1 Overview**

The discontinuity between figures and descriptive text is a major problem in using international standards for specifying abstract concepts or logical designs.^[1] Recognizing the value of the model-based approach to systems engineering, a growing number of ISs have been adopting this approach also to IS authoring. In the MBSA approach, ambiguity is resolved through a tight coupling between the figure and the descriptive text related to the figure, which is enabled by the bimodal graphics-text representation.

NOTE [Annex A](#) provides examples from existing and planned international standards authored by ISO and various other standardization organizations to demonstrate the value of the MBSA approach to streamline an IS and increase its precision and conciseness. For example, [Clause A.2](#) in [ANNEX A](#) demonstrates the use of a figure to express a logical configuration concept, which is also explained in the text, where the figure introduces ambiguity in interpreting the text for implementation and vice-versa.

To achieve this bimodal representation of a graphical figure and its textual expression, a formal correspondence between the graphical symbols, their shapes, annotations, and connections need to be governed by an explicit specification, which also enables efficient translation to regional languages.

NOTE The use of OPM for the expression of bimodal models, where the text (OPL) is derived automatically from the graphical part (OPD), is based upon the Extended Bachus Naur Form (EBNF) formalization of OPM according to ISO 19450:2024.

Reflectively applying the MBSE approach to the specification of this document, this clause specifies and explains the Model-Based Standard Authoring system model as the backbone of the IS.

NOTE OPCloud^[5] is the modelling environment used to create the models in this document.

4.2 The bimodal representation of a model-based standard

A model-based standard shall be bimodal, consisting of interrelated graphical diagrams and corresponding text, where the text can be derived from the diagrams and the diagrams can be derived from the text with little or no human intervention. This graphic and text dual modality expression specifies the requirements, recommendations, permissions, and possibilities within the standard.

NOTE In keeping with this concept of a model-based standard, this document is presented using OPM as specified in ISO 19450:2024 because OPM provides a tightly coupled graphical-textual model expression. Other modelling paradigms are beginning to provide such capabilities as well but do not have the extensive 20-year history of tightly coupled dual-mode expression for commercial and research use.

EXAMPLE To exemplify the graphics-text equivalence at the heart of the **Model-Based Standard Authoring** paradigm, the OPD construct marked 4 in [Figure 1](#) a) expresses graphically that the **Conciseness Level** of the **Model-Based Standard** changes from the less concise **free text** to the more concise **model-based**, improving the **Conciseness Level** of the **Model-Based Standard**. OPL sentence 4 in [Figure 1](#) b) expresses textually what this OPD construct expresses graphically.

4.3 Using a system diagram to establish scope

Like how the “Scope” clause of a standard establishes the context for the use of the standard, the development of a “system” begins with the elaboration of a context diagram to establish the boundaries of the system and its major interacting elements. By considering a standard to be a kind of system specification, standardization occurs by the adoption of the view that a standard document is a system model that is represented by both graphical and corresponding textual model expression. The modelling effort shall begin by defining the function of the standard—the high-level value-producing process and the operand (object) or operands it transforms. This definition characterizes the “scope” of the standard as a contextualizing system diagram and its corresponding text.

The system diagram for a standard shall identify environmental (non-systemic) objects and processes that interact with the standard, e.g., an authoring team or a normative reference, and the function of the standard as a process that transforms one or more objects, usually with the aid of enabling objects, into the specification that is the model-based standard. In addition, the system diagram shall capture object relationships that are expressible as factual propositions among these objects and the process that is the functional purpose of the standard.

The system diagram, along with its textual counterpart, shall be concise and contain only enough detail to distinguish the primary objects of the standard and their relationship to the value-generating process that is the function of the standard. The textual counterpart of the system diagram should have the form of a “Scope” clause for the standard.

EXAMPLE 1 A **System Diagram** (SD) – the top-level **Object-Process Diagram** (OPD), presented in [Figure 1](#) a) as an OPM SD, graphically describes the system function. [Figure 1](#) b) shows the **Object-Process Language** (OPL) for that SD, which provides a corresponding textual description of the system function.

NOTE Because OPL, the OPM textual modality, is a restricted modelling language, the OPL in documents is usually augmented with additional narrative text to improve readability. However, the facts conveyed by the **OPL** sentences must not be modified. See an example in [Annex A Clause A.9](#) for a recent use of ChatGPT to augment OPL.

EXAMPLE 3 In this document, the beneficiary is the **Model-Based Standard Authoring Team**. This team acts as an agent that enables the **Model-Based Standards Authoring** process. The benefitting attribute of the **Model-Based Standard Authoring Team** in this document is the **Model-Based Standard Authoring Ability**, which the process creates. The same **Model-Based Standard Authoring** process changes the **Conciseness Level** of the **Model-Based Standard** from **free text** to **model-based**.

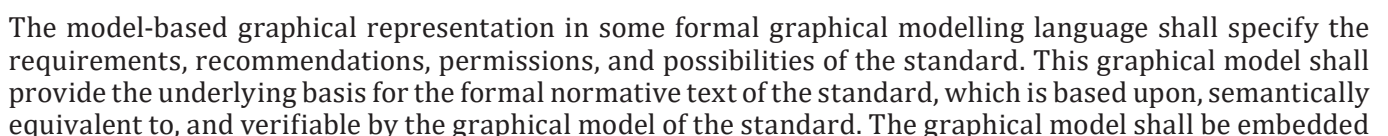


Figure 1 — System diagram (SD) for the Model-Based Standards Authoring OPM model

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in the normative text. Every normative statement in the graphical model shall be reflected in the normative text of the standard and vice versa. Other nominal statements in the text should be reflected in the graphical model and vice versa.

EXAMPLE 4 The object **Standard Graphical Model** in [Figure 1](#) a) is the model-based graphical representation in an OPM OPD that provides the overall context for specifying the requirements, recommendations, permissions, and possibilities of the standard. The **Standard Graphical Model** provides the underlying basis for the formal **Model-Based Standard**. **Model-Based Standard Text** is the text of the model, which is based upon, semantically equivalent to, and verifiable by the **Standard Graphical Model**. The **Standard Graphical Model** is embedded in the **Model-Based Standard Text**. Every normative statement in the **Standard Graphical Model** numbered 1 through 10 in [Figure 1](#), is reflected in the **Model-Based Standard Text** and vice versa. Other nominal statements in the **Model-Based Standard Text** should be reflected in the **Standard Graphical Model** and vice versa. As the bidirectional arrow link indicates, **Model-Based Standard Authoring** affects the **Domain Ontology Reference Base** by augmenting it with the new **Model-Based Standard**.

5 Elaborating the system diagram to furnish normative content

5.1 Elaboration in the context of a model-based standard

This clause elaborates the MBSA system diagram to expose more features and processes of MBSA.

Because MBSA approaches a standard as the specification for utilizing a functional process that generates value for beneficiaries, the natural way to elaborate that process is to identify the constituent subprocesses necessary to accomplish the completion of the system's function, which is to produce a concise, unambiguous, and complete specification of a standard. This approach to specifying a system is consistent with existing standards.

EXAMPLE ISO/IEC/IEEE 15288 specifies processes occurring during the life cycle of a system. ISO 15704 identifies a framework for which the functional viewpoint on a system has a prominent role in developing the system architecture.

In [Clause 4](#), the running example uses an OPM model that links the model features with the normative content of a narrative paragraph that appears before each example, separating requirements, recommendations, permissions, and possibilities from the model expression. This results in a duplication of effort since the normative content is also expressed in the model through the dual-mode combination of graphics and text.

To avoid this duplication, [Clause 5](#) eliminates the separation of normative statements from the model and instead uses the OPM-based model as the exclusive means for the expression of normative content. Each subclause focuses on a part of the OPM model, which comprises an OPD and the corresponding set of OPL sentences. The model part should be accompanied by a narrative rendition of the OPL sentences to clarify and elaborate on the OPL text. Thus, MBSA becomes a model-based standard expressed using OPM with optional textual elaboration.

NOTE OPM is not the only methodology that can be utilized for MBSA. However, the MBSA language and methodology need to have the means for the visual-textual dual-mode expression of a model and the ability to gradually increase the level of detail and granularity of expression like that provided by OPM constructs and methods.

5.2 Model-Based Standard Authoring elaboration

The next step in specifying the system diagram of a standard document is to elaborate the model by specifying the functional process and related objects. To maintain the coherency of relationships while still providing new information, the system model elaboration shall follow a prescribed modelling practice that retains connectivity to and consistency with parent processes, objects, and relations among them.

The **Model-Based Standard Authoring** process is elaborated in [Figure 2](#) a) into four subprocesses: **Standard Foundation Laying**, **Preliminary Standard Modeling**, **Standard Model Elaborating**, and **Model-Base Text Creating**, which are performed sequentially. The result of the first subprocess, **Standard Foundation Laying**, is a **Standard Definition**. This subprocess also affects the **Domain Ontology Reference Base**.

The next subprocess, **Preliminary Standard Modeling**, requires the **Domain Ontology Reference Base** and **Standard Definition** as two instruments, and it yields a **Preliminary Standard Model**.