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**Enterprise integration — Constructs  
for enterprise modelling**

*Entreprise intégrée — Constructions pour la modélisation d'entreprise*

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 19440 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 310, *Advanced manufacturing technologies*, in collaboration with Technical Committee ISO/TC 184, *Industrial automation systems and integration*, Subcommittee SC 5, *Architecture, communications and integration frameworks*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

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## Introduction

### 0.1 Background

This International Standard defines the generic concepts that are required to enable the creation of enterprise models for industrial businesses and to provide support for the use of frameworks by industrial enterprises. This International Standard builds upon ISO 19439 by defining and detailing a set of conformant user-oriented modelling language constructs, which provide common semantics and enable the unification of models developed by different stakeholders in the various phases of model development. Such models are aimed at model-based support of operational decision-making and can be employed for model-based operation monitoring and control.

The modelling language constructs defined in this International Standard can be specialized or organized or both into structures for specific purposes, for example for an industry sector or for a particular kind of enterprise concern such as maintenance. In turn, such structures and generic modelling language constructs can be used for developing particular models for a particular enterprise. Annex B contains further background, the rationale and benefit statements for this International Standard.

The general requirements that determine the characteristics of the core constructs necessary for computer-supported modelling of enterprises are

- the provision of an explicit model of Business Processes, with their dynamics, functions, information, resources, organization and responsibilities,
- sufficient detailing and qualification of enterprise components to allow the creation of a model for a specific enterprise,
- support for management of change, and
- end-user-oriented representation to enable operational use.

An illustrative example shown in Annex E demonstrates the use of the modelling language constructs.

Annex B provides a rationale for construct-based enterprise modelling and sets out the background to this International Standard and the framework for enterprise models on which it is based (see ISO 19349). The three dimensions of this framework are described in 0.2, 0.3 and 0.4 below.

Contributions to this International Standard have been received from members of the IFAC/IFIP Task Force on Enterprise Integration, the CIMOSA consortium and the European ATHENA research project.

NOTE Figures C.1 to C.6, D.1 to D.3 and D.5 to D.12 are computer-generated. Figures D.4 and E.1 to E.5 are line drawings.

### 0.2 Dimension of enterprise model views

ISO 19439 and ISO 15704 use enterprise model views (often shortened to “model views”) to provide a selective perception of an Enterprise that emphasizes some particular aspect of the matter under consideration and disregards others. Specifically, they identify four enterprise model views (Function, Information, Resource, Organization) that are to be addressed in a framework, architecture or methodology to allow the modelling of the major aspects of an enterprise. Additionally, as stated in ISO 15704:2000, A.3.1.5.3.2, “other ... views may be defined if needed ... and supported by the engineering tools”, e.g. economic views, decision views, purpose views and implementation views. In this case, the constructs defined in this International Standard can be augmented by additional attributes to support these other views, or

relevant new constructs might have to be defined. Therefore, the specifications of modelling language constructs have to accommodate their intended usage and representation in one or several particular model views. Automated tools are required to ensure consistency of construct instances that can appear in more than one view.

### **0.3 Dimension of enterprise model phase**

The life cycle of models and model components is addressed by the dimension of the enterprise model phase in ISO 19439. This dimension is concerned with the development and evolution of the model of the domain to be modelled, starting from the identification of the enterprise domain and progressing to a processable model and the decommissioning thereof. Therefore, the specifications of modelling language constructs have to accommodate their intended usage and representation in a particular model phase. Attributes of modelling language constructs need to be adaptable and selectable for the different model phases according to the envisioned needs.

### **0.4 Dimension of genericity**

Relative to the dimension of genericity defined in ISO 19439, constructs reside at the generic level and can be used at the partial and particular levels. At the partial level some attribute values can remain undefined for partial instances (e.g. inputs/outputs for Events for Domains and inputs/outputs for Business Processes). Such missing entries have then to be completed at the particular level.

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# Enterprise integration — Constructs for enterprise modelling

## 1 Scope

This International Standard specifies the characteristics of the core constructs necessary for computer-supported modelling of enterprises conforming to ISO 19439.

This International Standard focuses on, but is not restricted to, the computer integration of the information aspects of manufacturing, including the management and control technology and the required human tasks. It does not specify how these core constructs for model-based operations are to be implemented and, in particular, it does not include the control language needed to specify and execute (internal) activity behaviour, nor the mapping between functional operations and capabilities.

NOTE Computer-supported modelling of enterprises can form a precursor to computer integration or human-system intermediation.

## 2 Normative references

The following referenced documents are indispensable for the application 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/IEC 14977, *Information technology — Syntactic metalanguage — Extended BNF*<sup>1)</sup>

ISO 19439:2006, *Enterprise integration — Framework for enterprise modelling*

## 3 Terms, definitions and abbreviated terms

### 3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply. Terms defined in ISO/IEC 15288:2002, ISO 15531-1:2004, ISO 15704:2000 and ISO 19439:2006 and used in this International Standard are repeated below for convenience.

NOTE The names of terms representing constructs are capitalized throughout this International Standard to aid the reader in distinguishing them from general usages of the same term, specifically in order to distinguish the constructs Capability, Domain, Enterprise Activity, Event and Resource from general usage of capability, domain (or enterprise domain), enterprise activity, event and resource. These constructs are defined in 3.1 and specified in Clause 6.

#### 3.1.1

##### **aggregation**

process of, or result of, combining modelling language constructs and other model components into a whole entity

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1) ISO/IEC 14977 is a freely available International Standard that can be downloaded free of charge from [http://isotc.iso.org/livelink/livelink/fetch/2000/2489/Ittf\\_Home/PubliclyAvailableStandards.htm](http://isotc.iso.org/livelink/livelink/fetch/2000/2489/Ittf_Home/PubliclyAvailableStandards.htm).

NOTE 1 Modelling language constructs and other model components can be aggregated into more than one entity.

NOTE 2 Both Part\_of and Consists\_of attributes are used in the aggregation relationships described in Clause 5.

[ISO 19439:2006]

**3.1.2  
attribute**

piece of information stating a property of an entity

[ISO 15704:2000]

**3.1.3  
behavioural rule**

description of the logical sequencing relationships of constituent activities used in the specification of Business Process behaviour

**3.1.4  
Business Process**

⟨enterprise modelling⟩ construct that represents a partially ordered set of Business Processes or Enterprise Activities, or both, that can be executed to realize one or more given objectives of an enterprise or a part of an enterprise to achieve some desired end-result

**3.1.5  
capability**

⟨general⟩ quality of being able to perform a given activity

[ISO 15531-1:2004]

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**3.1.6  
Capability**

⟨enterprise modelling⟩ construct that represents the collection of capability characteristics (expressed as capability attributes) of either a Resource (its provided Capability) or an Enterprise Activity (its required Capability)

NOTE Capabilities can be aggregated.

**3.1.7  
class**

abstraction representing and encapsulating properties, relationships and behaviour, which distinguish a collection of similar phenomena

NOTE Class is used in a very general sense without any connotation for implementation or for use with a specific methodology.

**3.1.8  
classification**

process of arranging abstractions into a structure, organized according to their distinguishing properties, relationships and behaviour

**3.1.9  
component**

⟨general⟩ entity that is part of, or capable of becoming part of, a larger whole

NOTE Adapted from ISO 19439:2006.

**3.1.10  
component**

⟨system⟩ entity, with discrete structure within a system, that interacts with other components of the system, thereby contributing to the system properties and characteristics

NOTE Adapted from ISO/IEC 15288:2002.



**3.1.11****concept definition**

enterprise model phase that defines the business concepts of an enterprise domain to be employed in realizing its business objectives and its operation, including the necessary enterprise domain inputs and outputs

[ISO 19439:2006]

**3.1.12****constraint**

restriction or limitation or condition placed upon a system that originates from inside or outside the system under consideration

[ISO 19439:2006]

**3.1.13****construct-based modelling language**

set of constructs and rules for valid groupings, which define the syntax of the modelling language

**3.1.14****construct label**

literal string defined for each construct template, denoting the kind of construct

**3.1.15****construct template**

common structure that allows the identification and description of particular modelling language constructs and the assignment of their properties

**3.1.16****declarative rule**

set of objectives and constraints combined with a non-computational set of conditions

NOTE Declarative rules can be imposed within Domains on Business Processes.

**3.1.17****Decision Centre**

⟨enterprise modelling⟩ construct that represents a set of decision-making activities that are characterized by having the same time horizon and planning period and belonging to the same kind of functional category

NOTE The terminology used to describe aspects of Decision Centre is found in ISO 15704:2000/Amd.1:2005, Annex C, which defines [time] horizon as “the part of the future taken into account by a decision, i.e. the horizon is six months when a decision is taken on a time interval of six months” and [planning] period as “the time that passes between a decision and when this decision shall be re-evaluated”.

**3.1.18****decommission definition**

enterprise model phase that defines the final state of a decommissioned operational system, all its components for a particular enterprise domain and the processes employed to conduct the decommissioning, so enabling reuse or disposition of those components

[ISO 19439:2006]

**3.1.19****derivation**

⟨enterprise modelling⟩ process of elaborating enterprise models at successive enterprise model phases from the models established at preceding phases, reusing the available contents and extending them according to the needs expressed for the particular model phase

**3.1.20**

**design specification**

enterprise model phase that specifies the Business Processes together with Capabilities and rules that are to be performed to achieve the requirements

NOTE Adapted from ISO 19439:2006.

**3.1.21**

**Domain**

〈enterprise modelling〉 construct that represents the portion of an enterprise to be modelled providing for identification of the relevant information

**3.1.22**

**domain identification**

enterprise model phase that identifies the enterprise domain to be modelled with respect to its business objectives, the enterprise domain inputs and outputs and their respective origins and destinations

NOTE Adapted from ISO 19439:2006.

**3.1.23**

**domain operation**

enterprise model phase that encompasses the operational use of the domain model

NOTE Adapted from ISO 19439:2006.

**3.1.24**

**enterprise activity**

〈general〉 all, or part, of the lowest level of process functionality required by user objectives that consists of functional operations performed in the enterprise that consume inputs and allocate time and resources to produce outputs

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NOTE Adapted from ISO 19439:2006.

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**3.1.25**

**Enterprise Activity**

〈enterprise modelling〉 construct that represents a certain part of the lowest level of enterprise functionality required by user objectives and identifies the inputs needed for its execution and the outputs created as a result

**3.1.26**

**enterprise domain**

part of the enterprise considered relevant to a given set of business objectives and constraints for which an enterprise model is to be created

NOTE In this International Standard, “enterprise domain” is abbreviated to “domain” whenever it is used as a qualifier in such terms as “domain identification phase” and “domain model”. Other usages of “domain” have the normal dictionary meaning.

**3.1.27**

**enterprise model**

abstraction that represents enterprise entities, their interrelationships, decomposition and detailing, to the extent necessary to convey what the enterprise intends to accomplish and how it operates

NOTE Adapted from ISO 19439:2006.

**3.1.28**

**enterprise model phase**

life cycle phase of an enterprise model

[ISO 19439:2006]

**3.1.29****enterprise model view**

model view

selective perception or representation of an enterprise model, which emphasizes some particular aspect and disregards others

[ISO 19439:2006]

**3.1.30****Enterprise Object**

⟨enterprise modelling⟩ construct that represents a piece of information in the enterprise and that describes a generalized or a real or an abstract entity which can be conceptualized as being a whole

NOTE 1 The usage of Enterprise Object is restricted to those situations where only the information aspects of the entity under consideration are relevant.

NOTE 2 All other constructs in this International Standard represent entities that have specific semantics requiring particular attributes and additional descriptions.

NOTE 3 Adapted from ISO 19439:2006.

**3.1.31****Enterprise Object View**

Object View

⟨enterprise modelling⟩ construct that represents a collection of attributes of an Enterprise Object for some particular purpose

NOTE The collection is defined by a selection of attributes and possibly constraints on those attributes.

**3.1.32****entity**

any concrete or abstract thing in the domain under consideration

[ISO 19439:2006]

**3.1.33****Event**

⟨enterprise modelling⟩ construct that represents a solicited or unsolicited fact indicating a state change in the enterprise or its environment

NOTE An event can be associated with an Object View containing information related to the Event.

**3.1.34****function view**

enterprise model view that enables the representation and modification of the processes of the enterprise, their functionalities, behaviour, inputs and outputs

[ISO 19439:2006]

**3.1.35****Functional Entity**

⟨enterprise modelling⟩ construct that is a specialization of the Resource construct, which represents an aggregation of Resources and Operational Roles able to perform, completely on its own, a (class of) functional operation(s) required by an Enterprise Activity and to communicate with the related control system

NOTE A characteristic of a functional entity is its ability to receive, process, store and send information.

**3.1.36****functional category**

grouping of entities for expression of a common purpose or capability

**3.1.37**

**functional operation**

basic unit of work and lowest level of granularity in the function view

NOTE Functional operations are identified in the design specification phase following from a decomposition of the required capabilities of an Enterprise Activity (the task) into subtasks that can then be matched to the capabilities provided by the assigned Functional Entities.

**3.1.38**

**generalization**

specific concept modified for a more general extent, use or purpose, or act of removing or modifying detail from a specific concept to produce a generalization thereof

NOTE 1 Generalization is the inverse of specialization.

NOTE 2 Adapted from ISO 19439:2006.

**3.1.39**

**generic level**

collection of generic modelling language constructs for expressing descriptions that can be used to generate models at the partial and particular levels

[ISO 19439:2006]

**3.1.40**

**implementation description**

enterprise model phase that describes the final set of processes, resources and rules implemented to achieve the desired operational performance for execution of Business Processes and Enterprise Activities specified in the design specification phase

[ISO 19439:2006]

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**3.1.41**

**information technology component**

component that is required to undertake one or several of the collection, processing, distribution, storage or verification of data for Enterprise Activities in the enterprise

NOTE Adapted from ISO 19439:2006.

**3.1.42**

**information view**

enterprise model view that enables the representation and modification of the enterprise information as identified in the function view

NOTE 1 It is organized as a structure containing enterprise objects that represent the information-related entities of the enterprise (material and information).

NOTE 2 Adapted from ISO 19439:2006.

**3.1.43**

**instantiation**

creation of instances of modelling language constructs or partial models and the possible assignment of values to some or all attributes

NOTE A fully instantiated modelling language construct or model is one for which values have been assigned to all attributes.

[ISO 19439:2006]

**3.1.44****integrate**

ensure the interaction between all enterprise entities that is necessary to achieve a given purpose in a given constrained environment

NOTE Integration is the result of this method.

**3.1.45****integrity rule**

statement in the requirements definition phase concerning restrictions on information to ensure conformity to real-world reality.

NOTE Integrity rules are used to define these restrictions in terms of constraints on attributes of Enterprise Objects.

**3.1.46****life cycle**

set of distinguishable phases and steps within phases that an entity goes through from its creation until it ceases to exist

[ISO 19439:2006]

**3.1.47****life cycle phase**

stage of development in the life cycle of an entity

NOTE Adapted from ISO 19439:2006.

**3.1.48****manufacturing technology component**

component that is required to undertake one or several of the control, transformation, transport, storage or verification of raw materials, parts, (sub-)assemblies and end products

NOTE Adapted from ISO 19439:2006.

**3.1.49****model**

abstract description of reality in any form (including mathematical, physical, symbolic, graphical, or descriptive) that presents certain aspects of that reality

NOTE Adapted from ISO 19439:2006.

**3.1.50****modelling language construct**

construct

textual or graphical part of a modelling language devised to represent, in an orderly way, the diverse information on common properties and elements of a collection of enterprise entities

NOTE Adapted from ISO 19439:2006.

**3.1.51****objective**

statement of preference about possible and achievable future situations that influences the choices within some behaviour

[ISO 19439:2006]

**3.1.52**

**occurrence**

〈enterprise modelling〉 single, actual realization of a modelling language construct that represents a particular entity in the real world at the time the model is processed

**3.1.53**

**Operational Role**

〈enterprise modelling〉 construct that represents the relevant human skills and responsibilities required to perform those operational tasks that are assigned to the particular Operational Role

**3.1.54**

**Order**

〈enterprise modelling〉 construct that is a specialization of the Enterprise Object construct, which represents the information for planning and control of Business Processes in an enterprise

NOTE An Order can be represented by an Object View that is associated with an Event.

**3.1.55**

**Organizational Role**

〈enterprise modelling〉 construct that represents, within a given hierarchical structure of an enterprise, the organizationally relevant human skills and responsibilities required to perform those organizational tasks that are assigned to the particular Organizational Role

**3.1.56**

**Organizational Unit**

〈enterprise modelling〉 construct that represents an entity of the organizational structure of an enterprise, which is described by attributes of the organization and references to both lower- and higher-level organizational entities

NOTE Examples of Organizational Unit could be department or division.

**3.1.57**

**organization view**

enterprise model view that enables the representation and modification of the organizational and decisional structure of the enterprise and the responsibilities and authorities of the persons and organization units within the enterprise

NOTE Adapted from ISO 19439:2006.

**3.1.58**

**partial level**

collection of partial models

[ISO 19439:2006]

**3.1.59**

**partial model**

model used as a reference model in a specific type of industry segment or industrial activity

NOTE 1 A partial model is comprised of modelling language constructs or other partial models. Partial models also enable a modeller to reuse already existing models built for other domains.

NOTE 2 Adapted from ISO 19439:2006.

**3.1.60**

**particular level**

level at which a model is described for a particular, specific enterprise domain

[ISO 19439:2006]

**3.1.61****particularization**

process of specialization and instantiation by which more specific model components can be derived from more generic ones

[ISO 19439:2006]

**3.1.62****performance indicator**

a metric or measure by which the achievement of an objective can be assessed

**3.1.63****Person Profile**

⟨enterprise modelling⟩ construct that represents a set of personal skills and responsibilities that are required by an Organizational Unit or an Enterprise Activity, or both, and that are provided by a person

NOTE Person Profiles can be assigned to more than one person and conversely a person can fulfil more than one Person Profile for more than one Organizational Unit or Enterprise Activity.

**3.1.64****processable model**

model with specified syntax and semantics, which can be processed by a computer (for analysis, simulation or execution)

**3.1.65****Product**

⟨enterprise modelling⟩ construct that is a specialization of the Enterprise Object construct, which represents the desired output or by-product of the Business Processes of an enterprise

**3.1.66****relationship**

association between two or more entities that is significant for some intended purpose

**3.1.67****requirements definition**

enterprise model phase that defines the enterprise operations needed to achieve enterprise objectives and the conditions necessary to enable those operations, both being without reference to implementation options or implementation decisions

NOTE Adapted from ISO 19439:2006.

**3.1.68****resource**

⟨general⟩ enterprise entity that provides some or all of the capabilities required to execute an enterprise activity

NOTE In this International Standard, resource is used in the system theory sense of entities that provide capabilities required by the system and are an essential part of the system itself. The resource description includes the identification and description of consumables (such as energy, air, coolant) that are required to be present in sufficient quantities to operate the resource. In contrast, material is reserved for process inputs that are required by the various processes, such as raw materials, parts and assemblies. These inputs are identified in the function view, described in the information view, and have the associated management responsibilities identified in the organization view.

[ISO 19439:2006]

**3.1.69****Resource**

⟨enterprise modelling⟩ construct that is a specialization of the Enterprise Object construct, which represents the provided capabilities available to execute an Enterprise Activity

NOTE The Resource construct does not include human resources.