

DIN EN ISO 19440

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Ersatz für
DIN V ENV 12204:1996-05**Unternehmensintegration –
Konstrukte zur Unternehmensmodellierung (ISO 19440:2007);
Englische Fassung EN ISO 19440:2007**

Enterprise integration –
Constructs for enterprise modelling (ISO 19440:2007);
English version EN ISO 19440:2007

Entreprise intégrée –
Constructions pour la modélisation d'entreprise (ISO 19440:2007);
Version anglaise EN ISO 19440:2007

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Nationales Vorwort

Diese Norm wurde vom CEN/TC 310 „Fortgeschrittene Fertigungstechnologien“, dessen Sekretariat von BSI gehalten wird, in Zusammenarbeit mit dem ISO/TC 184 „Automation systems and integration“ erarbeitet.

Sie enthält unter Berücksichtigung des DIN-Präsidialbeschlusses 1/2004 den englischen Originaltext der europäischen Norm EN ISO 19440:2007. Vorwort, Einleitung und Anwendungsbereich wurden in Deutsch beigelegt.

Fachlich zuständig in Deutschland ist das nationale Arbeitsgremium 430.5 „Architektur, Integration und Kommunikation“ des Normenausschuss Maschinenbau (NAM) im DIN.

Diese Norm wurde unter der Leitung von CEN entsprechend des Wiener Abkommens in Zusammenarbeit von CEN/TC 310/WG 1 und ISO/TC 184/SC 5/WG 1 erarbeitet. Während der Arbeit wurden Beiträge von Mitgliedern der IEAC/IFAP Task Force on Enterprise Integration (IFAC/IFIP Arbeitsgruppe zur Unternehmensintegration) aufgenommen und berücksichtigt.

Dieses Dokument hebt ENV 12204:1996 „*Industrielle Automation und Integration — Systemarchitektur — Konstrukte für die Unternehmensmodellierung*“ auf, ersetzt und erweitert sie.

Der Anhang A dieses Dokuments ist normativ. Die Anhänge B, C, D und E sind informativ und dienen ausschließlich der Information.

Zur Unterstützung des Verständnisses und wurde die folgende Begriffsliste erarbeitet und zusammengestellt. Sie enthält in dieser Norm verwendete Begriffe.

Begriff in Englisch	Begriff in Deutsch
aggregation	Aggregation
attribute	Attribut
behavioural rule	Verhaltensregel
business process	Geschäftsprozess
capability	Leistungspotential Eignung/Fähigkeit
class	Klasse
classifizierung	Klassifizierung
component	Komponente
concept definition	Konzeptdefinition
constraint	Begrenzung, Einschränkung, Bedingung
construct-based modelling language	konstruktbasierte Modellierungssprache
construct label	Konstruktkenndatensatz
construct template	Konstruktmustervorlage Konstruktschablone/Mustervorlage

Begriff in Englisch	Begriff in Deutsch
declarative rule	deklarative Regel
decision center	Entscheidungszentrum
decommission definition	Ausmusterungsdefinition
derivation	Ableitung, Herleitung
design specification	Entwurfsfestlegung
domain	Domäne
domain identification	Domänenidentifizierung
domain operation	Domänenbetrieb
enterprise activity	Unternehmensaktivität
enterprise domain / domain	Unternehmensbereich / Bereich (Abteilung)
enterprise model	Unternehmensmodell
enterprise model phase	Unternehmensmodellphase
enterprise model view	Unternehmensmodellsicht
enterprise object	Unternehmensobjekt
enterprise object view object view	Unternehmensobjektsicht Objektsicht
entity	Entity / Entität
event	Ereignis
function view	Funktionssicht
functional entity	funktionale Einheit
functional category	funktionale Kategorie
generalization	Generalisierung
generic level	generische Ebene
implementation description	Realisierungsbeschreibung
information technology component	Komponente der Informationstechnik
information view	Informationssicht
instantiation	Instantiierung
integrate	integrieren
integrity rule	Integritätsregel
life cycle	Lebenszyklus
life cycle phase	Lebenszyklusphase
manufacturing technology component	Komponente der Fertigungstechnik
model	Modell
modelling language construct	Konstrukt der Modellierungssprache
objective	Ziel
occurrence	Auftreten

Begriff in Englisch	Begriff in Deutsch
order	Auftrag
organizational role	organisatorische Aufgaben (bereich)
orgnaizational unit	organisatorische Einheit
organization view	Organisationssicht
partial level	partielle Ebene
partial model	partiell Modell
particular level	individuelle Ebene
particularisation	Individualisierung
performance indicator	Leistungsindikator
person profile	Personenprofil
processable model	verarbeitbares Modell
product	Produkt
relationship	Relation
requirements definition	Anforderungsdefinition
resource	Ressource
resource view	Ressourcensicht
specialisation	Spezialisierung
system	System
universe of discourse	Grundgesamtheit der Darlegung

Die im Abschnitt 2 und den Literaturhinweisen zitierten Internationalen Normen, sofern sie nicht als DIN-EN-ISO-Normen mit gleicher Zählnummer veröffentlicht sind, gibt es keine nationalen Entsprechungen.

Änderungen

Gegenüber DIN V ENV 12204:1996-05 wurden folgende Änderungen vorgenommen:

- Kapitel 4 beschreibt zusätzlich zu den Anforderungen an die Konstrukte auch die Anforderungen an die Modellierungssprache.
- Die Kapitel 5, 6 und 7 wurden neugegliedert. Das Kapitel 5 legt den allgemeinen Aufbau von Konstrukten fest, während im Kapitel 6 formale Vorgaben für die Konstruktbeschreibung enthalten sind. Die Grundsätze zur Übereinstimmung sind im Kapitel 7 beschrieben.
- Die Anhänge A bis E sind informativ und wurden aufgenommen, um einer Hintergründe zur Erarbeitung dieser Norm zu vermitteln andererseits aber auch Einblicke in die Theorie zu geben.

Frühere Ausgaben

DIN V ENV 12204:1996-05

Nationaler Anhang NA (informativ)

Übersetzung des Europäischen Vorworts, der Einleitung und des Anwendungsbereiches

Vorwort

Dieses Dokument (EN ISO 19440:2007) wurde vom Technischen Komitee ISO/TC 184 „Automation systems and integration“ in Zusammenarbeit mit dem Technischen Komitee CEN/TC 310 „Fortgeschrittene Fertigungstechnologien“ erarbeitet, dessen Sekretariat vom BSI gehalten wird.

Diese Europäische Norm muss den Status einer nationalen Norm erhalten, entweder durch Veröffentlichung eines identischen Textes oder durch Anerkennung bis Juni 2008, und etwaige entgegenstehende nationale Normen müssen bis Juni 2008 zurückgezogen werden.

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Dieses Dokument ersetzt EN 12204:1996.

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Einleitung

0.1 Hintergrund

Diese Internationale Norm definiert die generischen Konzepte, die für die Erarbeitung von Unternehmensmodellen für industrielle Abläufe erforderlich sind und unterstützt die Anwendung von Rahmenwerken durch Industrieunternehmen. Sie baut auf der ISO 19439 auf, indem sie eine Reihe übereinstimmender Konstrukte der Modellierungssprache definiert und detailliert, die eine gemeinsame Semantik aufweisen und die Vereinheitlichung von Modellen ermöglichen, die in den zahlreichen Phasen der Modellentwicklung von den verschiedenen Interessenten entwickelt wurden. Solche Modelle haben den Zweck, als musterbasierte Unterstützung für eine Entscheidungsfindung für betriebliche Abläufe und die darauf basierende Betriebsüberwachung und -steuerung verwendet zu werden.

Die in dieser Internationalen Norm definierten Konstrukte der Modellierungssprache können für bestimmte Zwecke in Strukturen spezialisiert und/oder organisiert werden, beispielsweise für einen Industriesektor oder für eine bestimmte Art von Unternehmensbelangen wie z. B. die Instandhaltung. Auch können solche Strukturen und/oder generischen Konstrukte der Modellierungssprache für die Entwicklung von individuellen Modellen für ein individuelles Unternehmen angewendet werden. Anhang B enthält weitere Hintergrundinformationen, den Grundgedanken sowie Aussagen zum Nutzen dieser Norm.

Die allgemeinen Anforderungen die die Eigenschaften der notwendigen Basiskonstrukte zum rechnerunterstützten Unternehmensmodellierung sind:

- die Erstellung eines expliziten Modells der Geschäftsprozesse einschließlich der ihrer Dynamik, Funktionen, Informationen, Ressourcen, Organisation und Verantwortlichkeiten;
- ausreichende Detaillierung und Kennzeichnung der entsprechenden Komponenten, um die Erstellung eines Modells für ein bestimmtes Unternehmen zu ermöglichen;
- Unterstützung des Änderungsmanagements und
- endverbraucherorientierte Darstellung, so dass eine ablaufbezogene Anwendung möglich wird.

Ein illustratives Beispiel in Anhang E zeigt die Anwendung der Konstrukte dieser Modellierungssprache. Anhang B beschreibt ein Grundprinzip für die konstruktbasierende Unternehmensmodellierung und stellt den Zusammenhang dieser Internationalen Norm und dem Rahmenwerk für Unternehmensmodelle dar (siehe ISO 19349).

Die drei Dimensionen dieses Rahmenwerkes sind in den Abschnitten 0.2, 0.3 und 0.4 beschrieben.

Die Beiträge zu diesem internationalen Standard wurden von den Mitgliedern der IFAC/IFIP „Task Force on Enterprise Integration“, der CIMOSA Vereinigung und dem europäischen Forschung Projekt ATHENA eingereicht und berücksichtigt.

0.2 Maß von Unternehmenmodellansichten

In ISO 19439 und ISO 15704 werden Unternehmensmodellsichten (häufig abgekürzt zu „Modellsichten“) angewendet, um eine selektive Wahrnehmung eines Unternehmens darzustellen, die einige bestimmte Aspekte der betrachteten Materie hervorhebt und andere dabei vernachlässigt. Diese Normen identifizieren insbesondere vier Unternehmensmodellsichten (Funktionen, Informationen, Ressourcen, Organisation), die im Zusammenhang mit einem Rahmenwerk, einer Architektur oder einer Methodologie zu betrachten sind, um so die Modellierung der wichtigsten Aspekte eines Unternehmens zu ermöglichen. Darüber hinaus gilt, wie in ISO 15704:2000, A.3.1.5.3.1 angegeben: „weitere ... Sichten dürfen definiert werden, sofern sie erforderlich sind und durch die Konstruktionswerkzeuge unterstützt werden“, z. B. Entscheidungsicht, Zwecksichten und Realisierungssichten. In diesem Fall dürfen die in der vorliegenden Norm definierten Konstrukte durch zusätzliche Attribute ergänzt werden, um diese weiteren Sichten zu unterstützen. Die

Festlegungen der Konstrukte der Modellierungssprache müssen daher deren bestimmungsgemäße Anwendung und Darstellung in einer oder mehreren individuellen Modellsicht(en) berücksichtigen, und es müssen Software-Tools bereitgestellt werden, die die Einheitlichkeit von Konstruktionseinheiten sicherzustellen, die in mehr als einer Sicht genutzt werden können.

0.3 Dimension der Unternehmenmodellphase

Der Lebenszyklus der Modelle und Modellkomponenten wird in der Dimension der Unternehmensmodellphase in ISO 19439 behandelt. Bei dieser Dimension geht es um die Entwicklung und Fortentwicklung der zu modellierenden Domäne und der Teile, aus der sie zusammengesetzt ist, beginnend mit der Identifizierung der Domäne und weiter hin zu einem bearbeitbaren Modell und bis zu dessen Ausmusterung. Die Festlegungen der Konstrukte der Modellierungssprache müssen daher deren bestimmungsgemäße Anwendung und Darstellung in einer individuellen Modellphase berücksichtigen, und die Attribute der Konstrukte der Modellierungssprache müssen so angepasst/ausgewählt werden können, dass sie entsprechend den vorgesehenen Erfordernissen jeweils für die unterschiedlichen Modellphasen angemessen sind.

0.4 Dimension der Generität

Bezogen auf die in ISO 19439 definierte Dimension der Generität haben die Konstrukte ihren Ursprung auf der generischen Ebene und können auf der partiellen und der individuellen Ebene angewendet werden. Auf der partiellen Ebene können einige Attributwerte für partielle Instanzen undefiniert bleiben, zum Beispiel: Eingangs-/Ausgangsgrößen und Ereignisse bei Domänen sowie Eingangs-/Ausgangsgrößen bei Geschäftsprozessen. Solche fehlenden Einträge müssen zur Vervollständigung auf der individuellen Ebene ergänzt werden.

1 Anwendungsbereich

Diese Norm legt die Merkmale der für die rechnerunterstützte Modellierung von Unternehmen erforderlichen Schlüsselkonstrukte fest.

Diese internationale Norm legt den Schwerpunkt auf die Rechnerintegration der Informationsaspekte der Fertigung, einschließlich des Managements, der Steuerungstechnologie und der durch den Menschen auszuführenden Aufgaben, wobei sie jedoch nicht darauf beschränkt ist.

Sie spezifiziert nicht, wie diese Basiskonstrukte für den modell-basierten Betrieb zu implementieren sind. Insbesondere geht sie weder auf eine Steuerungssprache ein, die notwendig ist, die Ausführung eines Aktivitätsverhaltens zu beschreiben, noch den Zusammenhang von funktionalen Operationen und deren Eignung.

ANMERKUNG Die rechnerunterstützte Modellierung von Unternehmen kann eine Vorstufe bei der Rechnerintegration oder ein Zwischenglied bei der Mensch-System-Vermittlung darstellen.

— Leerseite —

English Version

Enterprise integration —
Constructs for enterprise modelling (ISO 19440:2007)

Entreprise intégrée —
Constructions pour la modélisation d'entreprise
(ISO 19440:2007)

Unternehmensintegration —
Konstrukte zur Unternehmensmodellierung
(ISO 19440:2007)

This European Standard was approved by CEN on 27 August 2007.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN Management Centre has the same status as the official versions.

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Foreword

This document (EN ISO 19440:2007) has been prepared by Technical Committee CEN/TC 310 "Advanced Manufacturing Technologies", the secretariat of which is held by BSI, in collaboration with Technical Committee ISO/TC 184 "Industrial automation systems and integration".

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2008, and conflicting national standards shall be withdrawn at the latest by June 2008.

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

This document supersedes ENV 12204:1996.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

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.

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*¹⁾

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

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]

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.

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]

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

NOTE Adapted from ISO 19439:2006.

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]

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.

3.1.70

resource view

enterprise model view that enables the representation and modification of enterprise resources and persons

NOTE 1 The resource view is organized as a structure containing Enterprise Objects representing the set of resources and set of persons required to execute enterprise operations.

NOTE 2 Adapted from ISO 19439:2006.

3.1.71

specialization

general concept modified for a more limited extent, specific use or purpose, or act of adding to, or modifying details of, a general concept to produce a specialization thereof

NOTE 1 Specialization is the inverse of generalization.

NOTE 2 When referring to a class, specialization involves the construction of subclasses within a class for a particular purpose, where the members of each subclass have one or more characteristics (attributes, relationships, behaviour or semantics) in common which are not shared by all other members of the class. When referring to a model, it refers to the progression from generic concepts to partial models and particular models.

NOTE 3 Adapted from ISO 19439:2006.

3.1.72

system

collection of real-world items organized for a given purpose

[ISO 19439:2006]

3.1.73

universe of discourse

collection of entities that ever have been, are, or always will be, in a selected portion of the real world or postulated world of interest that is being described by the models

3.2 Abbreviated terms

ATHENA	Advanced Technologies for interoperability of Heterogeneous Enterprise Networks and their Applications
CIM	Computer Integrated Manufacturing
GRAI	Graphes à Résultats et Activités Interreliés (Graphs of Interrelated Results and Activities)
IFAC	International Federation of Automatic Control
IFIP	International Federation for Information Processing
ODP	Open Distributed Processing
POP*	Process – Organization – Product – Others
PSL	Process Specification Language
XML	eXtensible Markup Language

4 Common characteristics of modelling language constructs

Modelling languages that are based on a set of common generic modelling language constructs simplify the creation of enterprise models, increase modelling efficiency and improve model understanding and interoperability across organizations and even across industries. Such constructs should be capable of representing the many different entities that exist in enterprises.

NOTE 1 The constructs defined in this International Standard are set out in Clause 6. A construct is an element of a modelling language, the syntax and semantics of which are defined as precisely as possible for the purposes of compliance testing as described in Clause 7. However, in its present stage of development this International Standard does not propose a formal notation for these purposes.

Adaptation of these constructs to different stakeholder languages appropriate for their purposes might require different forms of representation for some enterprise model phases, but such forms should maintain to the extent possible the underlying semantics of the constructs. In addition, the set of generic modelling language constructs may be augmented by more specialized construct classes to increase the modelling efficiency or to address requirements of any additional modelling views.

This International Standard is concerned with business process-oriented enterprise modelling. Therefore, the enterprise entities to be represented shall be Business Processes with their dynamics (control flow/process behaviour), functionalities (activities, inputs/outputs, control, resources) and organizational aspects. These entities shall be represented at the different model phases and described at the appropriate level of detail. In addition, the representation of aggregations shall be supported not only for the Business Process/Enterprise Activity relation, but also for the enterprise entities that are affected by those Business Processes. Function-, information-, resource- and organization-model views shall be used to provide the foundation for user-oriented modelling. Those model views shall allow the identification of relevant object hierarchies and relationships between the different classes and subclasses.

NOTE 2 EXPRESS^[1], PSL^[9] and Petri nets^[8] are single-view languages, while the Enterprise Language of ODP^[4], the ATHENA POP*^[10] and this International Standard support multi-view enterprise modelling. Petri nets target general discrete event systems modelling, including manufacturing systems. PSL is a neutral language for specifying manufacturing process information. EXPRESS is an abstract language (with syntax and semantics) for modelling a population of entities and their data attributes. Petri nets, PSL and EXPRESS are formal languages that are computer executable, while ODP's Enterprise Language and the constructs of this International Standard are neither. ODP^[4], POP*^[10] and this International Standard do not have the same viewpoints (known in this International Standard as model views) and coverage. POP* and this International Standard adopt a more process-oriented modelling approach aimed at producing an operational process monitoring and control model. In contrast, ODP has a broader coverage with its five viewpoints (Enterprise, Information, Computation, Engineering and Technology). The ODP Enterprise viewpoint is most relevant to this International Standard, focusing as it does on enterprise level concepts such as the purpose, scope and policies of the system.

Modelling of the enterprise shall be supported at all enterprise model phases by modelling language constructs as follows:

- at the domain identification phase, to identify the contents of the domain and its inputs and outputs, in such a way that the domain identification model can be used as the starting point for a derivation of a consistent concept definition model;
- at the concept definition phase, to define underlying missions, strategies, etc., and in such a way that the concept definition model can be used as the starting point for a derivation of a consistent requirement definition model;
- at the requirements definition phase, to describe the Business Processes of the Domain from a business viewpoint, in such a way that the requirements definition model can be demonstrated to be sufficient for use as the starting point for the derivation of a consistent design specification model. Therefore the requirements definition model shall also be capable of being processed;
- at the design specification phase, to specify the Business Processes with all their components from both a business and ICT viewpoint, in such a way that the design specification model can be demonstrated to be sufficient for use as the starting point for a consistent derivation of an implementation description model: therefore the design specification model shall also be capable of being processed; at the design specification phase, constructs shall be derived from those of the requirements definition phase by enriching them with attributes that reflect all resources and general ICT interfaces;
- at the implementation description phase, to describe the Business Processes with all their components as they are implemented in the actual system from both a business and ICT viewpoint, in such a way that the implementation model can be demonstrated to be sufficient for use in the operation of the enterprise for decision support and Business Process monitoring and control: therefore the implementation model shall also be capable of being processed; at the implementation description phase, constructs shall reflect the hardware/software platform or technology chosen to be consistent with design specification constructs;
- at the domain operation phase, to use the released model for operational purposes such as decision support, monitoring and control;
- at the decommission definition phase, to identify future use of the Business Process components, in such a way that the decommission definition model can be used, as appropriate, as the starting point for reuse at any model phase.

However, this does not mean there will be a different set of modelling language constructs required for each model phase. Constructs and construct instances are carried forward to subsequent model phases by providing an enhanced attribute list to capture additional needed information for representing and describing the enterprise entities at those model phases or by mapping onto different construct representations. Clause E.2 summarizes the identification and usage of constructs in each model phase.

NOTE 3 The applicability of the modelling language constructs is demonstrated in Annex D, using ODP and the ATHENA work on POP* as examples.

5 Representations, relationships, roles and complementary concepts

5.1 Range of representation

Modelling language constructs shall be represented in a form that is both understandable by humans and readable by machines²⁾. This means there is the need for both a visual (graphical, iconic) representation of structures³⁾ for use by model builders and business users, and a structured information-capturing representation for which this International Standard uses templates.

Representation shall be performed in the following four ways:

- representation by a common structure of the constructs of this International Standard (see 5.2);
- representation of the relationships between these modelling language constructs (see Annex C⁴⁾);
- representation by templates to organize attributes into a common format (see Clause 6);
- representation of dynamic behaviour by behavioural rules (see 6.3.5 and Annex A).

5.2 Common structure and template for modelling language constructs

To describe a particular modelling language construct, this International Standard uses a common structure that provides a consistent minimal assignment of attributes to each construct. This common structure shall have two constituents:

- a textual description consisting of brief text defining the modelling language construct in terms of a purpose, its description and its intended usage, and
- a construct template, which organizes and defines the attributes for this modelling language construct.

The template is described in an informal manner but using a common pro forma. In turn, the construct template shall have the form described below.

- a) Header part having the same attributes for each modelling language construct and containing attributes relating to the identity of a construct instance and to its context. It shall be structured as follows:
 - 1) construct label (a literal string denoting the kind of construct);
 - 2) identifier (a literal string that is unique for each occurrence of the modelling language construct within the model);
 - 3) name (the name of the instance of the modelling language construct);
 - 4) authority for model design (i.e. the identifier of the Organizational Role or Organizational Unit responsible for the design of this construct): for all constructs and for all attributes concerned with authorities or responsibilities, the identifier or name of the Organizational Unit may be omitted in the Concept Identification and Requirements Definition modelling phases.

NOTE These are the only phases in which NIL is an option for Organizational Unit. NIL is also an option for a Domain's Organizational Role, but not for any other construct.

2) Machine readability is not the subject of this International Standard, but has to be provided by the modeling tool.

3) Representation of modelling language constructs by graphics is not part of this International Standard.

4) Annex C contains an illustrative UML metamodel as an aid to the reader.

- b) Body part containing the particular attributes that are specific to each construct and whose description is derived from the particular modelling language construct definition. Body parts shall then be structured in two further partitions as follows:
- 1) descriptives, containing descriptive attributes that comprise
 - construct-identifying description in textual form,
 - construct attributes that are predefined,
 - additional construct attributes that may be defined by the user to meet particular needs, such as those required by additional model views, and
 - attribute qualifications – statements that are made about whether attribute values are mandatory or optional, when they are applicable, etc.
 - 2) relationships (further described in 5.4), containing relationship attributes that can include
 - Operational relationships, that are the responsibility and authority for model operation (i.e. the identifier of the Organizational Role and Organizational Unit responsible for the operational usage of this construct or authorized to change its usage),
 - Specialization_of relationships, representing relationships between a specialization and its generalization,
 - Part_of relationships, representing relationships between this construct instance and the whole aggregated from such instances,
 - Consists_of relationships, representing relationships between this construct instance and its constituent parts⁵⁾, and
 - Association relationships for other forms of relationship, either predefined or user-defined (such as provision or usage of a Capability instance by Resource or Enterprise Activity instances).

Both descriptives and relationships contain general attributes relevant for most or all enterprise model phases. Constraints on the relevance of attributes are indicated in the construct templates and general attributes are applicable to all enterprise model phases unless otherwise indicated. Both descriptives and relationships may also contain specific attributes and constraints that are relevant only for selected enterprise model phases. Additionally, both descriptives and relationships may be grouped as sets of attributes having some common characteristics, e.g. inputs/outputs or relationships to organizational concerns.

Version control of modelling language constructs is not supported by a specific attribute since it is seen to be a tool-provided responsibility⁶⁾.

NOTE 1 In the models of Annex C, Part_of and Consists_of relationships are shown explicitly, rather than as UML aggregations. UML associations are used to show Operational and Association relationships, and UML generalizations are used to show Specialization_of relationships.

NOTE 2 It is the responsibility of the tool-supporting software development to ensure consistency of Part_of and Consists_of relationships where both are used, and of Constraints and Integrity descriptives.

5.3 Representation of attributes

Each attribute shall be defined by its name and predefined data type (numbers, literals, strings, etc.).

5) It is accepted that Part_of and Consists_of are complementary relationships; depending on the purposes of the modeller, either or both may be used.

6) Version control has a significant impact on design and operation for enactable models.

NOTE 1 A data type can take on a range of permissible or actual values, such as a single identifier (id = 4711), value range (diameter 10 mm $\pm$ 0,05 mm) or value list (colour is yellow, red or green).

NOTE 2 Constructs can use XML schema ^{[13],[14],[15]} or EXPRESS ^[1] as a means for representing attributes and the related definition of data types, expressions and statements.

5.4 Representation of relationships

The purpose of a relationship is to model time-varying and other associations between run-time instances of modelling language constructs. Reflexive relationships shall be permitted, i.e. a relationship can be created between an instance and itself.

EXAMPLE 1 Relationships between entities might be those between a part and the machine which is used to produce it, or those between a worker and the order to which he or she has been assigned, as in: Produced_by (part, machine), Works_at (worker, order). Such relationships are represented through assignments as inputs and outputs of Enterprise Activities.

EXAMPLE 2 Illustrative relationships between constructs are those between a Domain and its Business Processes or those between a Business Process and its sub-processes and activities.

The concept of a user-defined relationship is dependent on the concept of Enterprise Object described in 6.6 and on the model entities derived from that Enterprise Object. A user-defined relationship is used to describe domain-dependent relationships as perceived and defined by the users, and hence to describe the way in which they group structuring and behavioural constructs in terms of their utilization within the enterprise. User-defined relationships can be expressed by Related_to lists in Enterprise Objects, Products, Orders and Object Views on Enterprise Object instances, or by additional user-defined attributes.

5.5 Specializations

Depending on the purpose of modelling, it may be helpful and necessary for the modeller to define specializations of the constructs defined in this International Standard. This can be achieved by

- selecting the most appropriate construct (and corresponding template) to specialize and adapting the header information accordingly,
- adding a new “Specialization_of” relationship attribute at the appropriate model phases(s),
- assigning appropriate values for the “Specialization_of” attribute and listing the construct (or, exceptionally constructs) of which it is a specialization,
- assigning or constraining values for existing attributes as appropriate, and
- adding additional attributes as required and assigning model-unique names for these.

Each construct can be further specialized into constructs of the same kind; for example an Enterprise Object can be specialized into particular kinds of Enterprise Object, Resource into further kinds of Resource, etc. A relationship “Specialization_of” is introduced to hold these specialization relationships.

Additionally, this International Standard predefines several specializations. Three constructs are specializations of the Enterprise Object construct (Product, Order, Resource), and a further construct (Functional Entity) is a specialization of Resource. This specialization can occur because the attributes and relationships of Enterprise Object exist whenever the object instance exists, even if some of those attributes and relationships are not shown as applicable to a particular modelling phase.

NOTE The concept of specialization used in this International Standard is less constrained than the specialization concept found in the domain of programming languages and object-oriented modelling.

5.6 Roles

The Oxford English Dictionary ^[16] defines a role as a “typical or characteristic function performed by someone or something”. The same entity may have different roles in different contexts (which may overlap in time and

place) and at different times over its life cycle. This role variation is especially true for the following examples of entities:

- for human resources, an employee can be in turn a subordinate in the structure of a given organization, a manager of other employees in the same structure and an external part-time consultant in the structure of another organization; this person may then provide different sets of capabilities when involved in his or her different roles;
- a machine has a different role when it is used as an operational resource providing machining functionalities during its normal utilization as opposed to when it is under maintenance or becoming a product as the result of its manufacturing process;
- for IT resources, a computer application can in turn be a client of another application and a server of a different application.

The modelling language constructs defined in this International Standard provide for the representation of roles as follows:

- a) the role of humans when supporting an Organizational Unit shall be represented by Person Profile and Organizational Role: the latter captures the various required responsibilities and capabilities (skills) and allows those to be matched with the ones provided by the Personal Profile and required by tasks (functional operations) assigned to the person;
- b) the role of humans when supporting an Enterprise Activity shall be represented by Operational Role and Person Profile: the former captures the required operational capabilities (skills) and allows those to be matched with the ones provided by the latter (Person Profile);
- c) the operational role of machines shall be represented by the construct Functional Entity which captures the operational capabilities and allows those to be matched to the ones required by functional operation to which the machine has been assigned; and
- d) the product role of machines shall be represented by the construct Object View which allows a selection from the Product of those attributes that are needed to describe input and output of the activities to be executed to change the state of the product.

5.7 Complementary concepts

The construct templates of Clause 6 make use of several terms for conceptual representations that are not themselves constructs, but are complementary and have a particular significance and semantics for the purposes of enterprise modelling. These complementary concepts, each of which is defined in Clause 3, are as follows:

- behavioural rule (see 6.3.5);
- constraint;
- declarative rule;
- functional operation (see 6.4.5);
- integrity rule;
- objective; and
- performance indicator.

Their occurrences in Clause 6 (except when they are used in the templates) are flagged in *italics*. Their usages in each of the construct templates (generally in more than one) are described in Clause E.3, where they are also flagged in *italics*.

6 The modelling language constructs

6.1 Overview of constructs

6.1.1 Modelling language constructs and their application areas

The modelling language constructs defined in this International Standard can be categorized according to their main application area into

- Function- and process-related: Domain, Business Process, Enterprise Activity, Event,
- Information-related: Enterprise Object, Enterprise Object View, Order, Product,
- Resource-related: Capability, Operational Role, Resource, Functional Entity, and
- Organization-related: Person Profile, Organizational Role, Organization Unit, and Decision Centre.

NOTE 1 The Organizational Unit is an organizational-entities-grouping concept. The Organizational Role is a responsibility and authority-grouping concept (i.e. assign responsibility and authority of a group of resources to one manager for example). Decision Centre is a decision-grouping (activity) concept. Decisions in Decision Centre(s) are taken by persons represented by Organizational Role(s) and the concerned Organizational Unit(s). Decisions taken in one Decision Centre can concern one or several Organizational Units. One manager can be responsible for taking decisions in one or several Decision Centres.

NOTE 2 The relations between constructs are demonstrated in Annex C, based on UML modelling concepts, and in Annex D, which shows relationships to the metamodel of modelling concepts in ISO/IEC 15414 and those developed in the European project ATHENA.

6.1.2 Purpose and applicability

This clause defines, describes and provides templates for generic modelling language constructs. These constructs form a modelling language with which a wide range of Business Process-based enterprise models can be created. Each template shall include the attributes that are pre-defined in this International Standard. Other attributes may be added to meet particular user needs (see 5.2 and 5.5) by a suitable extension of the template. Clause E.4 contains an example of order processing showing the use of the templates in enterprise model development.

Constructs are often applicable to several model views (as is evident in Annexes C and E) and are elaborated to different degrees at each of the modelling phases. Where the applicability of a construct, as defined in this International Standard, is limited to a certain model view or enterprise model phase, this is noted in remarks. Clause E.2 also shows how constructs and their templates may be used at different enterprise model phases.

NOTE Because of the interrelationships and dependencies between constructs, they cannot be specified in this International Standard in strict linear sequence (i.e. with no forward reference to not-yet-specified constructs). The sequence of text used herein has been chosen to minimize this forward reference problem and is as follows:

- start with Domain (the scope and boundary of the model);
- add functionality in terms of Business Processes, Enterprise Activities and Events;
- add information representation in terms of Enterprise Object and Object View, and the specializations Product and Order;
- provide for resourcing with Resource, Capability, and Functional Entity; and
- lastly, address organizational and role issues with Organizational Unit, Decision Centre, Person Profile, Operational Role and Organizational Role.

6.1.3 Notation used to describe template contents

Attributes are described with a combination of denotations and textual descriptions.

The notation used for this clause is that denotations are enclosed in angle brackets < and > and are either self-explanatory (e.g. <integer>) or explained in accompanying text (e.g. <item>, where item is ...). Literals in all upper case denote themselves as in DM, BP, EV, NIL, PHYSICAL, etc. The literal characters :, /, (, and) are denoted by “:”, “/”, “(” and “)” respectively. Where more than one choice is possible for a denotation, these are separated by | (read as *or*), as in <a> | | <c>. Square brackets [and] are used for convenience as a grouping container for one or more different items as in [<duration> <qual>] for the DURATION attribute of an Enterprise Activity.

Textual descriptions contain a brief definition of that attribute and, where it is felt appropriate, information providing additional details (shown in *italics*).

A non-empty list of <item> with an appropriate separator is written as [<item>]+, while a similar possibly empty list is written as [<item>]•. Within a list denotation, <item> may be further decomposed as in [<id> <multiplicity>]+ or [<measure> | <metric>]•.

NOTE More formally, the syntax⁷⁾ for lists is:

- list = non-empty list | possibly-empty list;
- non-empty list = item | item, separator, non-empty list; (* for convenience, abbreviated to [<item>]+ *)
- separator = “:”, “/”; (* any equivalent separator character may be used instead of semicolon *)
- possibly-empty list = NIL | non-empty list; (* for convenience, abbreviated to [<item>]• *)

EXAMPLE

From the Domain template, a Design Authority with values of Organization Role and possibly also Organization Unit would be expressed as [[<identifier> “/” <name>] [NIL]“:”<identifier> “/” <name>]]

From the Capability template, *data_store; id_1006453* would be valid for “[<id>]+, where <id> is one of <identifier> | <name> of Capability instances”. (*NIL* would not be valid.)

From the Enterprise Activity template, *NIL* or *max_load = 10Kg; max_temp = 100C* would be valid for “[<constraint>]• imposed on the Enterprise Activity instance”.

Some further examples follow (two- or three-letter codes refer to construct label, followed by attribute name), progressing from simpler to more complex cases:

EO: Nature of Object PHYSICAL | INFORMATION

CA: *Capabilities and capability attributes*

CA: Included Capabilities [<Capability instance>]•

CA: Function Related [<capability attribute>]•

CA: Entity Related [<capability attribute>]•

DM: Objectives [<objective>]+, strategic and operational business objectives of the Domain instance

EV: Object Views [<origin> “:” <identifier> “/” <name>]• of Object View instance defining information associated with occurrences of this Event instance

7) See Clause A.2 for a description of the syntax notation used.

EV: Generated_by	[<origin> ":" <identifier> "/" <name>]+ of the source of this Event instance
BP: Object View Inputs	[<origin> ":" <identifier> "/" <name>]+ of Object View instances, occurrences of which can be received by occurrences of the Business Process instance]
EA: Ending Statuses	[<value> <priority>]+, ending status values produced by occurrences of this Enterprise Activity instance and their significance, where <value> is a mandatory 0-argument predicate and <priority> is an integer in a range <min, max> where min and max are integers representing the lowest and highest priorities respectively. By default, highest priority
PR: Related_to	[<identifier> "/" <name> <multiplicity>]*, defining the Enterprise Object instances that are related to this Product instance, qualified by a multiplicity which is one of [0..*] (only for early modelling phases) or [1..1] or [1..n] or [m..n]

6.2 Domain

6.2.1 Purpose

A Domain represents the boundary and the content of an enterprise or a portion of an enterprise for which an enterprise model is to be created.

6.2.2 Description

Domains shall describe the parts of the enterprise to be modelled and their relationships with the external environment from a high-level management-oriented point of view. The model is subject to a given set of strategic and operational business *objectives* and *constraints*, and the purposes of the modelling. The relations between strategic and operational *objectives* should be made visible as much as possible. The Domain inputs and outputs and their origins and destinations define the domain boundaries and the relations between inputs and outputs identify the required functionalities – the business processes of the domain.

6.2.3 Usage

The construct Domain is used in all model phases. Its template shall enable

- a) the capturing of all inter- and intra-organizational-related information relevant for strategic planning and decision support, and
- b) its presentation in a form that is understandable by both humans and machines.

The descriptive attributes and relationships are described at a level of detail appropriate to the enterprise model phase applicable to the Domain construct's usage. The usage of an Object View or Event implies that the associated Enterprise Object is also defined at the model phase and at an appropriate level of detail.

6.2.4 Construct template for Domain

Header	
Construct label	DM
Identifier	<model-unique string>
Name	[<adjective> <noun> <noun>], the name of Domain, where <noun> indicates the functionality or purpose, and <adjective> optionally indicates the scope
Design Authority	[[NIL “.” <identifier> “/” <name>] [NIL “.” <identifier> “/” <name>]] of Organizational Role and Organizational Unit respectively, having authority to design or maintain this particular instance
Body	
A1 Descriptives relevant for all enterprise model phases	
Description	short textual description of the Domain
Business Process Descriptions	[<name> <name> <short textual description>]+, name and optionally short description of the main functionality needed to transform Domain inputs into Domain outputs <i>The Business Processes identified for a Domain construct are those required to achieve the Domain objectives</i>
Objectives ⁸⁾	[<objective>]+, strategic and operational business objectives of the Domain instance
Constraints	[<constraint>]* imposed on the Domain instance
A2 Descriptives relevant for different enterprise model phases	
A2.1 applicable at concept definition and later phases	
Domain Characterization	short textual description of the mission, vision and values of the Domain
Domain Operation	short textual description of the strategies, policies, operational concepts, business plans of the Domain
Decisional Authority	
Decision Function	[<verb> <noun> <noun>]*, name of the decision function or functions that belong to the Domain. <i>A decision function is a set of decision activities or decision centres having the same category of subjects being handled, such as “manage resources”, “manage products” and “plan production”.</i>
Decision Level	[<horizon> <period>]*, where <horizon> and <period> are specified in terms of days, weeks or years. <i><horizon> specifies the time interval upon which a decision taken stands and <period> specifies the reviewing frequency at the end of which a decision taken is to be revised.</i>
A2.2 applicable at requirement definition and later phases	
Performance Indicators	[<metric> <measure>]*, constraint or a textual string identifying a method. <i>Performance indicators are defined by identifying the required value or method by which achievement of the objectives can be assessed.</i>
B1 Relationships relevant for all enterprise model phases	
Inputs/Outputs	
Object View Inputs	[<origin ⁹⁾
Event Inputs	[<origin> “.” <identifier> “/” <name>]+ of all Events ¹⁰⁾ , instances of which can be received by occurrences of the Domain instance
Object View Outputs	[<identifier> “/” <name> “.” <destination ¹¹⁾

8) Derived objectives occur in Business Processes, Enterprise Activities, and Decision Centres as well; consistency has to be assured.

9) Here and in the following templates, <origin> denotes the Domain, Business Process or Enterprise Activity that is the source of the input. In the situation that the <origin> is an external Domain, only the name of the Domain is stated and its contents are not further defined.

10) It is the responsibility of the tool-supporting model development and maintenance to ensure that the Events listed as inputs or outputs are compatible with the Generated_by attributes of Event.

Event Outputs	<identifier> "/" <name> ":"<destination>]+ of all Events, instances of which can be generated by occurrences of the Domain instance
B2 Relationships relevant for different enterprise model phases	
B2.1 applicable at concept definition and later phases	
	Not applicable
B2.2 applicable at requirements definition and later phases	
Business Processes	[[NIL <domain> ":"] <identifier> "/" <name>]+ of Business Processes contained in this or a designated Domain instance ¹²⁾
B2.3 applicable at design specification and later phases	
Operational Relationships	
Operation Responsibility	[[<identifier> "/" <name>] [":" <identifier> "/" <name>]] of Organizational Role and Organizational Unit respectively, having responsibility for operation of this instance
Operation Authority	[[<identifier> "/" <name>] [":" <identifier> "/" <name>]] of Organizational Role and Organizational Unit respectively, having authority for operation of this instance

6.3 Business Process

6.3.1 Purpose

The Business Process represents all or part of the domain functionalities, its internal structure and its dynamic behaviour.

6.3.2 Description

A Business Process construct shall describe the functionalities needed to produce a desired result that satisfies one or more business *objectives* derived from business *objectives* defined for the enterprise domain. This result emerges from transformations or combinations, or both, of entities into new entities or into new states which require appropriate control and functional capacity.

The internal structure of a Business Process shall be described in terms of a set of functionalities, decomposed according to modelling criteria (reduction of complexity) and the needs of operational monitoring and control. These internal functionalities shall be characterized as combinations of constituent Business Processes or Enterprise Activities, or both, and their interconnections, arranged by ordering relationships and dependencies described by *behavioural rules*, which capture the process dynamics.

The result of a Business Process shall be observable or quantifiable¹³⁾. It can result in material entities (such as industrial products), or information entities (such as orders, documents or data), or newly designed processes, or can be defined as the achievement of one or more designated *objectives*.

6.3.3 Usage

The construct Business Process is used in all model phases. Its template shall enable

- the capturing of all process-related information relevant for model-based planning and decision support, and monitoring and control of operational processes, and
- its presentation in a form that is understandable by both humans and machines.

11) Here and in the following templates, <destination> denotes the Domain, Business Process or Enterprise Activity that is to receive the output.

12) It is the responsibility of the tool-supporting model development and maintenance to ensure that the Business Processes listed here are compatible with the Where_used attribute of Business Process.

13) However, in contrast with an Enterprise Activity, the template for a Business Process does not contain an ending status. Process completion is signalled by a behavioural rule FINISH action and possible exception.

The construct shall identify all constituent Business Processes or Enterprise Activities, or both, which represent the decomposition of the Business Process functionality into a number of ordered transformation actions, thus capturing relevant intermediate conditions of the entities to be changed. The construct shall describe in its *behavioural rule* set attribute the logical binding of its Business Processes or Enterprise Activities, or both, to the *behavioural rules* connecting these intermediate conditions, i.e. the logical sequence of transformation functions.

6.3.4 Construct template for Business Process

Header	
Construct label	BP
Identifier	<model-unique string>
Name	[<adjective> <noun> <noun>], name of Business Process instance, where <noun> indicates the scope of the Business Process, and <adjective> optionally qualifies the Business Process instance
Design Authority	[[<identifier> "/" <name>] [NIL ":" <identifier> "/" <name>]] of Organizational Role and Organizational Unit respectively, having the authority to design or maintain this particular instance

Body	
A1 Descriptives relevant for all enterprise model phases	
Description	textual description of functionalities and desired result
Objectives	[<objective>]+, strategic and operational business objectives to be fulfilled by the Business Process instance
A.2 Descriptives relevant for different enterprise model phases	
A2.1 applicable at concept definition and later phases	
	Not applicable
A2.2 applicable at requirements definition and later phases	
Constraints	[<constraint>]* imposed on the Business Process instance
Performance Indicators	[<metric> <measure>]* by which achievement of the objectives can be assessed
Declarative Rules	[<rule>]*, declarative rules applicable to this Business Process instance
Behavioural Rule Set	[<behavioural rule>]+, expressed using the syntax as defined in 6.3.5 and Annex A.
A.2.3 applicable at design specification and later phases	
Priority ¹⁴⁾	<integer> in a range <min, max> where min and max are integers representing the lowest and highest priorities respectively
B1 Relationships relevant for all enterprise model phases	
Where_used	[<identifier> "/" <name>]* of the Domain employing this Business Process instance
B2 Relationships relevant for different enterprise model phases	
B2.1 applicable at concept definition and later phases	
	Not applicable
B2.2 applicable at requirements definition and later phases	
Part_of	[<identifier> "/" <name>]* of Business Process instances in which this particular instance is involved in an aggregation. <i>The name of the Business Process instance being defined cannot be used in the list</i>
Consists_of	[<identifier> "/" <name>]+ of all Business Process and Enterprise Activity instances of which this Business Process instance is the aggregate
Inputs/Outputs	
Object View Inputs	[<origin> ":" <identifier> "/" <name>]+ of Object Views, instances of which are available for occurrences of the Business Process instance]
Event Inputs	[<origin> ":" <identifier> "/" <name>]+ of all Events ¹⁵⁾ , instances of which can be received by occurrences of the Business Process instance
Object View Outputs	[<identifier> "/" <name> ":" <destination>]+ of all Object Views, instances of which are made available by occurrences of the Business Process instance]
Event Outputs	[<identifier> "/" <name> ":" <destination>]+ of all Events, instances of which can be generated by occurrences of the Business Process instance
B2.3 applicable at design specification and later phases	
Operational Relationships	
Operation Responsibility	[[<identifier> "/" <name>] [":" <identifier> "/" <name>]] of Organizational Role and Organizational Unit respectively, having responsibility for operation of this instance
Operation Authority	[[<identifier> "/" <name>] [":" <identifier> "/" <name>]] of Organizational Role and Organizational Unit respectively, having authority for operation of this instance

14) Priority attributes are used at run-time to select which Business Process to activate first in the case of more than one Business Process being initiated by a Behavioural Rule set. They are also used to guide allocation of Resources to Enterprise Activities.

15) It is the responsibility of the tool-supporting model development and maintenance to ensure that the Events listed as Inputs or Outputs are compatible with the Generated_by attributes of Event.

6.3.5 Behavioural rules

6.3.5.1 Purpose

The purpose of the *behavioural rules* is

- a) to identify the start of the main Business Process, and
- b) describe the logical sequencing relationships of constituent Business Processes or Enterprise Activities, or both.

6.3.5.2 Description

The behaviour of a Business Process shall be described in its behavioural rule set attribute by a set of *behavioural rules* which control the sequence of constituent Business Processes and Enterprise Activities. Annex A provides a detailed description and syntax for these rules.

NOTE In contrast, the specification of the internal behaviour of an Enterprise Activity (the sequencing of its set of *functional operations*) is considered to be an implementation issue beyond the scope of this International Standard.

The logical sequencing may be more or less deterministic, corresponding to:

- well-structured processes, i.e. processes for which the expected result is known and the sequence of constituent Business Processes or Enterprise Activities, or both, is completely defined (and necessarily deterministic);
- semi-structured processes, i.e. processes for which the expected result is known and the sequence of constituent Business Processes or Enterprise Activities, or both, will be known only at run-time (semi-deterministic); and
- ill-structured processes, i.e. processes for which neither the result nor the sequence of constituent Business Processes or Enterprise Activities, or both, is completely known (non-deterministic).

6.3.5.3 Usage

The concept of *behavioural rules* is used in the requirements definition phase and later phases. The rules shall enable

- a) the capturing of all the conditions that control the sequencing and the dynamic behaviour of Business Processes, and
- b) their presentation in a form that is understandable by both humans and machines.

6.4 Enterprise Activity

6.4.1 Purpose

An Enterprise Activity represents the part of process functionality that is needed to realize a basic task within a Business Process of an enterprise domain. Enterprise Activities are the lowest level constituents of a Business Process (see 6.3) defined according to required user objectives for operational monitoring and control.

6.4.2 Description

An Enterprise Activity construct shall identify all things required for and produced by the execution of a particular task, which transforms function input(s) into function output(s) using control, operational role and resource inputs and optionally producing control, operational role and resource-related information outputs. The latter shall contain status information on the execution of the task as they relate to the activity itself and the resource, respectively. Operational Role inputs identify required skills to be provided by assigned person Profiles. Resource inputs shall identify the required and provided capabilities, respectively.

6.4.3 Usage

The construct Enterprise Activity is used in the requirements definition phase and later phases. Its template shall enable the capturing of all relevant information (inputs and outputs) needed and created in

- a) the execution of the identified functionality, and
- b) model-based planning and decision support, and monitoring and control of operational processes.

Such information should be presented in a form that is understandable by both humans and machines. In addition, the template shall identify all constituent *functional operations*, which represent the decomposition of the Enterprise Activity functionality and are needed for Resource and Operational Role assignments.

The Enterprise Activity required capability should be matched by the Capability of the Resources that should be supplied.

6.4.4 Construct template for Enterprise Activity

Header	
Construct label	EA
Identifier	<model-unique string>
Name	[<verb> <adjective> <noun> <verb> <noun> <verb>], name of Enterprise Activity instance, where <verb> characterizes the imperative nature of the Enterprise Activity, <adjective> and <noun> are optional qualifier and scope indications respectively of the Enterprise Activity
Design Authority	[[<identifier> "/" <name>] [NIL ":" <identifier> "/" <name>]] of Organizational Role and Organizational Unit respectively, having authority to design or maintain this particular instance.
Body	
A1 Descriptives relevant for all enterprise model phases	
	Not applicable
A2 Descriptives relevant for different enterprise model phases	
A2.1 applicable at concept definition and later phases	
	Not applicable
A2.2 applicable at requirements definition and later phases	
Description	textual description
Activity Behaviour	textual description of the algorithm ¹⁶⁾ specifying the control flow of the functional operations of which this Enterprise Activity is comprised – see 6.4.5
Objectives	[<objective>]+, operational business objectives to be fulfilled by the Enterprise Activity instance
Constraints	[<constraint>]• imposed on the Enterprise Activity instance
Performance Indicators	[<metric> <measure>]• by which achievement of the objectives can be assessed

16) The control flow of these subtasks, collectively called activity behaviour, can be defined in an algorithm which describes the input/output conditions for sequence control of the Functional Entities involved in the execution of the Enterprise Activity. The specification of the algorithm is considered to be an implementation issue beyond the scope of this International Standard.