INTERNATIONAL STANDARD

ISO 15704

Second edition
2019-12

Enterprise modelling and architecture — Requirements for enterprise-referencing architectures and methodologies

Modélisation et architecture d'entreprise — Exigences pour les architectures et les méthodologies de référencement d'entreprise

Reference number
ISO 15704:2019(E)

© ISO 2019



COPYRIGHT PROTECTED DOCUMENT

© ISO 2019

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword ..... **v**
Introduction ..... **vi**
1 Scope **1**
2 Normative references **1**
3 Terms and definitions **1**
4 Abbreviated terms **5**
5 Requirements for enterprise-referencing architectures and models **6**
5.1 General requirements 6
5.2 Applicability and coverage of enterprise architecture 7
5.2.1 Kinds of enterprise 7
5.2.2 Characterizing enterprise architecture 7
5.2.3 Enterprise engineering and architecting methodology 7
5.2.4 Enterprise design 8
5.2.5 Enterprise operation 8
5.3 Essential concepts for enterprise-referencing architecture 8
5.3.1 Span of conceptual orientation 8
5.3.2 Human oriented 8
5.3.3 Process oriented 8
5.3.4 Interoperation oriented 8
5.3.5 Decision oriented 8
5.3.6 Realization oriented 9
5.3.7 Technology oriented 9
5.3.8 Environment oriented 9
5.3.9 Lifetime oriented 9
5.3.10 Stakeholder oriented 10
5.3.11 Viewpoint oriented 10
5.3.12 Model oriented 11
5.3.13 Model view oriented 12
5.3.14 Enterprise interoperation oriented 13
5.3.15 Verification and validation oriented 13
6 Components of enterprise-referencing architectures **13**
6.1 Enterprise-referencing models 13
6.1.1 Purpose of enterprise-referencing models 13
6.1.2 Kinds of enterprise-referencing models 14
6.2 Modelling languages 16
6.2.1 Requirements for modelling languages and constructs 16
6.2.2 Expressiveness 16
6.2.3 Semantics and syntax of an enterprise-referencing model 16
6.2.4 Names, labels and glossary 17
6.2.5 Elements of interoperation 17
6.3 Models as representations 18
6.3.1 Representing enterprise characteristics 18
6.3.2 Concepts of internal structure 18
6.3.3 Compatibility of structuring approaches 18
6.3.4 Concepts of enterprise-referencing behaviour 19
6.3.5 Short-term and long-term behavioural change 19
6.3.6 Representation of behaviour 20
6.3.7 Concepts of hierarchy 20
6.3.8 Recursion in decomposition 21
6.3.9 Iteration 22
6.3.10 Availability and format of model information 22
6.3.11 Management of constituent parts 23

© ISO 2019 – All rights reserved

6.4 Impact of genericity ... 23
6.4.1 Generic enterprise elements ... 23
6.4.2 Partial enterprise models ... 23
6.4.3 Particular enterprise models ... 23
6.5 Enterprise perspectives and viewpoints ... 24
6.5.1 Primary concern perspectives ... 24
6.5.2 Additional concern perspectives ... 26
6.6 Enterprise-referencing modelling framework ... 26
6.7 Tools ... 27
6.8 Modules ... 27
6.9 Enterprise operational systems ... 27
6.10 Representation ... 27

Annex A (informative) **Key principles of enterprise integration and interoperation** ... **28**

Annex B (informative) **Generalized Enterprise Reference Architecture and Methodology (GERAM)** ... **32**

Annex C (informative) **Relationship of this document with other International Standards related to architecture for enterprise systems** ... **67**

Bibliography ... **70**

 © ISO 2019 – All rights reserved

Foreword

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

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

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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

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

This second edition cancels and replaces the first edition (ISO 15704:2000), which has been technically revised. It also incorporates the Amendment ISO 15704:2000/Amd.1:2005.

The main changes compared to the previous edition are as follows:

— alignment of terminology for consistency with other standards developed by ISO/TC 184/SC 5;

— incorporation of the rules and guidelines for modelling from ISO 14258 to express enterprise-referencing architecture methodologies;

— revision of content related to recursive structure and iterative methods;

— redrafting of life history concept to address enterprise change management;

— discussion of modelling dimensions necessary for user views, including the extent of detail and composite models that span dimensions;

— harmonization with ISO/IEC/IEEE 42010 and other International Standards related to architecture for enterprise systems;

— inclusion of discussion concerning the relationship of this document with other International Standards related to architecture for enterprise systems (ISO/IEC 10746, IEC 62264, ISO 15745);

— updating of Annex B on Generalized Enterprise Reference Architecture and Methodology (GERAM) in accordance with GERAM 1.6.3.

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

© ISO 2019 – All rights reserved

Introduction

0.1 Rationale for enterprise architectures and models

Industrial and information age enterprises create and modify manufacturing and business operations to improve performance in local and global markets. In operation they deploy a variety of resources including people, information systems, automated machinery and business services. Individually and collectively these resources provide the functional capabilities required to perform manufacturing and business processes and their constituent activities. The arrangement, targeting and interworking of resources need to accomplish the enterprise mission, which requires suitable business rules and organizational structures that enable the enterprise to provide products and services in conformance with agreed upon criteria.

Enterprises operate under uncertain and changing market and environmental conditions that make ongoing enterprise engineering beneficial. Enterprises cooperate within a heterogeneous environment with multiple constituents using different models and systems. In addition, most enterprises operate within the context of another enterprise with which it interoperates, as with a supply chain or the parent company. It follows that enterprise personnel have a variety of responsibilities in the conception and ongoing development of the mission, business rules, manufacturing and business processes, organizational structures, and supporting resources and services. Because of the complexity involved in enterprise engineering, invariably it becomes necessary to deploy means of assessing, structuring, coordinating and supporting these engineering activities, including means for collaboration support and interoperation.

Generalized enterprise-referencing architecture concerns and components of enterprise modelling constitute a reference base that provides a generally applicable means of arranging and coordinating enterprise engineering and associated technology development and deployment projects. By adopting and adapting such a reference base, enterprise personnel can cooperate in progressing enterprise engineering projects, improving the enterprise, improving stakeholder's communications and utilizing enterprise resources. By adopting appropriate tool sets, enterprise personnel can reuse in a practical way explicit enterprise designs and models to realize the benefits of enterprise engineering on a continual basis and realize further improvements in enterprise operation.

Such a reference base needs to include capabilities that:

— capture concerns of mission fulfilment stakeholders (manufacturing, transport, service delivery, etc.) and of business stakeholders;

— describe suitable solutions to identified problems within the enterprise;

— model the whole life history of an enterprise integration project from its initial concept through development, operation and finally decommissioning or obsolescence; and

— encompass the people, processes, resources and organizations involved in performing, managing, and controlling the enterprise mission.

From an enterprise engineering perspective, the following distinction is drawn:

— enterprise architecture refers to the arrangement of physical components, logical relationships, and human interactions involved in the development, implementation and operation for a programme such as enterprise integration or other enterprise related programme, usually including a set of projects; and

— system architecture refers to the arrangement of physical components and logical relations of a system that is a constituent of an enterprise; for example, the computer-control-system part of an overall enterprise or product.

This document does not present or adopt specific methodologies for creating or using enterprise architectures or models. The focus is on establishing a reference base capable of supporting specific enterprise programmes, rather than a design intended to fulfil the stated requirements.

 © ISO 2019 – All rights reserved

This document identifies an extensive collection of potential artefacts for expressing an enterprise-referencing architecture and its associated methodologies. Not all of these artefacts will be applicable, necessary or even desirable for all architecting efforts. The identification of these artefacts assures that this document meets the needs of the widest possible number of enterprise-referencing architecture and methodology situations. Users of this document need to assess not only the value of generating an identified artefact but also the value of maintaining that artefact under the changing circumstances of the referenced enterprise.

0.2 Rationale for this document

Well-designed standards in the domain of enterprise integration and modelling provide a point of reference for enterprise architects and designers, thereby significantly reducing the risk of investing in islands of integration. Where an island does exist, these standards assist the architect or designer to create the translation necessary for the island to interact within an established context. A standard for enterprise-referencing models enhances interoperability by establishing the elements that are required in a model intended to support enterprise architecture.

This document defines concepts, rules and requirements for architecture descriptions that refer to an enterprise, most often articulated as models, with the intent to guide and constrain other standards or implementations that do or will exist on the topic. To realize this intent, this document specifies the concepts to use when producing an enterprise-referencing architecture (see Clause 5) and when constructing enterprise-referencing models (see Clause 6). This document provides a reference base, guidelines and constraints for enterprise architecture and models to anyone engaged in enterprise activities where models are utilized.

0.3 Benefits of this document

The requirements of the reference base for enterprise-referencing architecture and models in this document allow assessment of an enterprise architecture framework or other approach as well as associated methodology and languages for completeness with respect to current and future purpose of the architecture effort. This document will help guide development programmes.

When conforming implementation designs have the same technology areas and nomenclature, or can map to them readily, the information from one enterprise or process is more readily sharable with information of another enterprise or process.

The benefit will be most relevant to any group charged with improving an enterprise infrastructure or its processes. Such a group will find it necessary to either select or create a reference architecture of its own with terminology that pertains specifically to the company, industry, and culture involved. This document will help guide that selection or creation.

This document expects users that are:

— enterprise planners, builders, modifiers, and analysts using the requirements to check completeness of their activity;

— enterprise-referencing model builders using the requirements to assure consistency between models to enable model interoperability; and

— developers of standards for enterprise representation using the requirements to assure consistency between their standards and this document.

NOTE While the requirements specified herein cover a broad range of enterprise considerations, many users find it advantageous to structure the topics considered into a specific framework for their own work. Such a framework is a methodological choice of the user and goes beyond the scope of this document. Annex B discusses a framework consistent with this document and other International Standards provide further framework guidance.

© ISO 2019 – All rights reserved

Enterprise modelling and architecture — Requirements for enterprise-referencing architectures and methodologies

1 Scope

This document specifies a reference base of concepts and principles for enterprise architectures that enable enterprise development, enterprise integration, enterprise interoperability, human understanding and computer processing. This document further specifies requirements for models and languages created for expressing such enterprise architectures.

This document specifies those terms, concepts and principles considered necessary to address stakeholder concerns and to carry out enterprise creation programmes as well as any incremental change projects required by the enterprise throughout the whole life of the enterprise. This document forms the basis by which enterprise architecture and modelling standards can be developed or aligned.

This document does not define standard enterprises, standard organizational structures, standard enterprise processes, or standard enterprise data. In addition, this standard does not specify enterprise modelling processes.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

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

3.1
architecture
conceptualization of the form, function, and fitness-for-purpose of an *enterprise* (3.4) in its *environment* (3.9), as embodied in the elements of the enterprise, the relationships between those elements, the relationship of the enterprise to its environment and the principles guiding the design and evolution of the enterprise

Note 1 to entry: Since architecture in an enterprise context, e.g. an enterprise architecture, is always conceptual, the expression of architecture as an architecture description is through models of the enterprise reality to which the architecture applies. Detailed designs conforming to an enterprise architecture description often take less abstract forms as they approach enterprise reality.

Note 2 to entry: The notion of fitness-for-purpose distinguishes architecture from other characteristics of design by adding the obligation of elegance in efficiency and effectiveness to design form and function — a distinguishing characteristic separating an ad hoc assemblage of parts necessary to conduct an enterprise from an intentional composition of constituent elements necessary to achieve and sustain superior enterprise performance.

[SOURCE: ISO/IEC/IEEE 42010:2011, 3.2, modified — Content of original definition has been adapted to the context of this document and Notes to entry have been added.]

© ISO 2019 – All rights reserved

3.2
aspect
distinguishing characteristic, manifest by content projection from an integrating *enterprise model* (3.6)

Note 1 to entry: In this document the term aspect usually refers to a collection of concerns that are better addressed by looking across various *views* (3.23), i.e. concerns best addressed by a view across other model views. The scale and scope of these kinds of broad-based concern collections are poorly handled by a single model representation but can be effectively rendered by selecting a composite view from existing model view content.

3.3
business process
partially ordered, often nested, set of *enterprise* (3.4) activities that can be executed to achieve some desired result in pursuit of a specified objective of an enterprise or a part of an enterprise

3.4
enterprise
human undertaking or venture that has explicit and clearly defined *mission* (3.13), goals, and objectives to offer products or services, or to achieve a desired project outcome or business outcome

Note 1 to entry: When in operation, an enterprise functions as a system that realizes the mission through life cycle activities within a life history.

Note 2 to entry: In this document, "enterprise" refers to concrete (e.g. company, project or extended supply chain enterprise) or abstract (e.g. virtual enterprise) entities.

Note 3 to entry: One or more organizational unit participates in an enterprise. For an enterprise involving more than one such unit, each brings various *resources* (3.21) forward for use, participating to the extent that it benefits from their involvement, which most often occurs to address some challenge that it is unable to address on its own.

3.5
enterprise engineering
discipline applied in carrying out any efforts to establish, modify, or reorganize any *enterprise* (3.4)

Note 1 to entry: An enterprise engineering and architecting methodology provides guidance for efforts to establish, modify, validate or reorganize an enterprise.

3.6
enterprise model
representation of an *enterprise* (3.4) as well as entities within an enterprise, their interrelationships, their decomposition and detailing to the extent necessary to convey what the enterprise intends to accomplish and how it operates

Note 1 to entry: An enterprise model, which is used to improve the effectiveness and efficiency of the enterprise, identifies and specifies essential components and elements to any necessary extent of detail, including any subsystems and constituent models of the enterprise, e.g. an enterprise *architecture* (3.1) model.

[SOURCE: ISO 19439:2006, 3.23, modified — The words "abstraction of an enterprise domain that represents enterprise entities" have been replaced with "representation of an enterprise as well as entities within an enterprise", the words "what it intends" have been replaced with "what the enterprise intends", and Note 1 to entry has been added.]

3.7
enterprise-referencing
applicable to an *entity* (3.8) that is, or includes, or is part of an *enterprise* (3.4)

Note 1 to entry: A generic enterprise *architecture* (3.1), an architecture for a specific enterprise, and an architecture that includes an enterprise as one of its elements are all enterprise-referencing architectures.

© ISO 2019 – All rights reserved

3.8
entity
concrete or abstract thing in the domain under consideration

[SOURCE: ISO 19439:2006, 3.29]

3.9
environment
context that determines the setting and circumstances of technological, business, operational, organizational, political, regulatory, social, and other critical influences and constraints upon an *enterprise* (3.4), which affect or are affected by its development and behaviour, but are not controllable by the enterprise itself

Note 1 to entry: In the case of a nested enterprise, its environment may be within the larger enterprise.

[SOURCE: ISO/IEC/IEEE 42010:2011, 3.8, modified — Content of original definition has been adapted to the context of this document, incorporating content from ISO 19439:2006, 3.30, and Note to entry has been added.]

3.10
framework
structure expressed in diagrams, text and formal rules which relates the elements of an *enterprise* (3.4) *architecture* (3.1) to each other

Note 1 to entry: The purpose of a framework is to guide creation of one or more enterprise architecture descriptions.

[SOURCE: ISO 19439:2006, 3.31, modified — The words "the components of a conceptual entity" have been replaced with "the elements of an enterprise architecture", and Note 1 to entry has been added.]

3.11
genericity
extent to which a concept generalizes entities in a category or group

3.12
life cycle
set of distinguishable phases and steps within phases which an *entity* (3.8) goes through from its creation until it ceases to exist

Note 1 to entry: The phases of a nested *enterprise* (3.4) can be steps within the life cycle of the containing enterprise.

[SOURCE: ISO 19439:2006, 3.42, modified — Note 1 to entry has been added.]

3.13
life history
actual, recorded and configuration managed sequence of phases and steps within phases that an *entity* (3.8) goes through during its lifetime

3.14
mission
characterization of the effect that an *enterprise* (3.4) expects to achieve through the fulfilment of functional requests for products or services

3.15
model
representation of certain entities and their characteristics either (a) using a formalism, or (b) using an established or ad hoc modelling paradigm, approach, or technique

Note 1 to entry: An ad hoc model is more difficult to implement using an established design technique.

Note 2 to entry: A model may be a subset of a broader model.

© ISO 2019 – All rights reserved

3.16
model-based
represented using a formalism which has a formal syntax and semantics, usually with a theoretical basis, and expressible in a symbolic language

Note 1 to entry: Presentation of such models is often graphical but the definition mandates that the graphical representation be translatable into a symbolic language, thereby constraining interpretation of the graphical representation.

Note 2 to entry: In order to satisfy specific *stakeholder* (3.22) concerns, "model-based" is often used as a qualifier to characterize a kind of design, or practice, e.g. model-based system engineering, model-based design, model-based specification.

3.17
modelling dimension
conceptual collection of *enterprise* (3.4) *entity* (3.8) *viewpoints* (3.24) related by kinds of architectural concerns and exhibiting reasonably distinct aggregating coordinates along a continuum

Note 1 to entry: Common modelling dimensions are life cycle, viewpoint, and *genericity* (3.11).

3.18
organization
distribution of responsibilities and authorities in the *enterprise* (3.4)

Note 1 to entry: Within an organization, people are often given role titles designating collections of responsibilities and authorities with roles arranged in an accountability hierarchy.

3.19
perspective
orientation of a *stakeholder* (3.22) or *model* (3.15) user relative to an identified domain

Note 1 to entry: A stakeholder's orientation can be formed by stakeholder concerns, as well as by their training, experience, cultural background, and their motivations.

3.20
reference base
source of information comprising descriptions of generalized *enterprise* (3.4) *architecture* (3.1) concepts, requirements and recommendations

3.21
resource
entity (3.8) that provides some or all of the capabilities required to execute an *enterprise* (3.4) activity

Note 1 to entry: In this document, 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 activities such as raw materials, parts and assemblies.

Note 2 to entry: In this document, the term "resource" applies to non-human entities involved in enterprise entity operation. The involvement of humans is described by roles they carry out in the enterprise entity operation.

[SOURCE: ISO 19439:2006, 3.60, modified — The word "enterprise" has been deleted at the start of the definition, the last sentence of Note 1 to entry has been removed, and Note 2 to entry has been added.]

3.22
stakeholder
individual, team, organizational unit, or class thereof, having concerns relative to their *perspective* (3.19) about an *enterprise* (3.4), or its *architecture* (3.1), or in an architecture *entity* (3.8) of the enterprise

Note 1 to entry: Typical enterprise stakeholders include enterprise owners, enterprise customers, and enterprise employees responsible for receiving or delivering either products or services, and those persons or *organizations* (3.18) partnering with the enterprise to achieve its mission.

© ISO 2019 – All rights reserved

Note 2 to entry: Enterprise architects are stakeholders of the enterprise architecture, but not necessarily stakeholders of the enterprise itself. A user of enterprise architecture or related models is an enterprise stakeholder. There can be observers of an enterprise that are not stakeholders for that enterprise.

[SOURCE: ISO/IEC/IEEE 42010:2011, 3.10, modified — Content of original definition has been adapted to the context of this document and Notes to entry have been added.]

3.23
view
work product expressing a selective perception or representation of a *model* (3.15), which emphasizes some specific feature or characteristic and disregards others

[SOURCE: ISO 19439:2006, 3.25, modified — Content of original definition has been adapted to the context of this document.]

3.24
viewpoint
identification of one or more kind of *model* (3.15) useful for addressing a collection of related *stakeholder* (3.22) concerns

Note 1 to entry: When the term viewpoint is used without any qualifier it refers to the general case. When the term viewpoint is used with a qualifier, the viewpoint applies to a specific collection of concerns, e.g. operational viewpoint, capability viewpoint, services viewpoint.

Note 2 to entry: A viewpoint identifies one or more models necessary and sufficient for expressing one or more *enterprise model* (3.6) *views* (3.23) that address the specific collection of related stakeholder concerns.

4 Abbreviated terms

CIM	Computer Integrated Manufacturing
CIMOSA	Computer Integrated Manufacturing Open Systems Architecture
EA	Enterprise Architecture
EAET	Enterprise Architecture and Engineering Tool
EAM	Enterprise Architecting, Engineering and integration Methodology
EI/EA	Enterprise Integration/Enterprise Architecture
EMEIS	Enterprise Model Execution and Integration Services
EML	Enterprise Modelling Language
EMO	Enterprise Module
EM	Enterprise Model
EOS	Enterprise Operational System
FIRO	Function, Information, Resource and Organization
GEM	GRAI Evolution Method
GEMC	Generic Enterprise Modelling Concept
GERA	Generalized Enterprise Reference Architecture
GERAM	Generalized Enterprise Reference Architecture and Methodology

© ISO 2019 – All rights reserved