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Building information models — Information delivery manual —

Part 1: Methodology and format

Modèles des informations de la construction — Contrat d'interchange —

Partie 1: Méthodologie et format

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Contents

Page

Foreword

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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).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 59, *Buildings and civil engineering works*, Subcommittee SC 13, *Organization of information about construction works*.

This second edition cancels and replaces the first edition (ISO 29481-1:2010), which has been technically revised.

ISO 29481 consists of the following parts, under the general title *Building information models — Information delivery manual:*

— *Part 1: Methodology and format*

— *Part 2: Interaction framework*

Introduction

This International Standard has undergone a major review in the light of refined approaches to the development of information delivery manuals and their technical implementation in software readable forms. It is important to note that these changes do not render existing information delivery manuals (IDM) invalid.

Building information modelling provides a digital technology for describing and displaying information required in the planning, design, construction and operation of constructed facilities. Increasingly, this modelling approach is expanding to encompass all aspects of the built environment, including civil infrastructure, utilities and public space. These are collectively referred to as construction processes. This approach to managing information brings together the diverse sets of information used during the life cycle of the built environment into a common information environment, reducing, and often eliminating the need for the many types of paper documentation currently in use.

This approach is commonly referred to as building information modelling (BIM; reflecting its initial application in the architectural domain), while the same acronym is used to refer to the product of the process, the information model itself, or building information model (BIM).

Though the focus of construction processes described above is on the physical fabric of the built environment, BIM technology can also benefit the processes associated with managing the use of space within buildings, urban neighbourhoods and cities at the broader scale, as well as infrastructure networks and facilities. These are referred to here as use cases.

An IDM provides help in getting the full benefit from a BIM. If the required information is available in the BIM to support a construction process or use case, and the quality of information is satisfactory, then the process itself will be greatly improved.

For this to happen, there needs to be a common understanding of the processes involved across the entire life cycle development of a built environment project, including the information that is required for and results from the execution of that process. This applies to any activity that results in an exchange of information and may not relate directly to a BIM, e.g. the process to arrive at a work plan or contractual agreement.

This part of ISO 29481 sets out a methodology for the provision of an integrated reference document that describes the processes and data required in the development or management of a constructed facility. It describes how to identify and describe the processes undertaken within that context, the information required for their execution and the results. This part of ISO 29481 also describes in general terms how this information can be further detailed to support solutions provided by software developers, enabling its reuse, and configured to meet national, local and project needs.

In summary, this part of ISO 29481 provides a basis for reliable information exchange/sharing for users so that they can be confident that the information they are receiving is accurate and sufficient for the activities they need to perform. The development of this part of ISO 29481 has been driven by the need of users for reliability in information exchange.

Building information models — Information delivery manual —

Part 1: Methodology and format

1 Scope

This part of ISO 29481 specifies

— a methodology that links the business processes undertaken during the construction of built facilities with the specification of information that is required by these processes, and

— a way to map and describe the information processes across the life cycle of construction works.

This part of ISO 29481 is intended to facilitate interoperability between software applications used during all stages of the life cycle of construction works, including briefing, design, documentation, construction, operation and maintenance, and demolition. It promotes digital collaboration between actors in the construction process and provides a basis for accurate, reliable, repeatable and high-quality information exchange.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6707-1, *Buildings and civil engineering works — Vocabulary — Part 1: General terms*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 6707-1 and the following apply.

3.1
actor
person, organization or organizational unit (such as a department, team, etc.) involved in a construction process

3.2
building information modelling
BIM
use of a shared digital representation of a built object (including buildings, bridges, roads, process plants, etc.) to facilitate design, construction and operation processes to form a reliable basis for decisions

Note 1 to entry: The acronym BIM also stands for the shared digital representation of the physical and functional characteristics of any construction works.

3.3
BIM software application
software application that is used to create, modify, analyze, manage, publish, share, expire, or otherwise manipulate elements of a BIM

3.4
business requirement
requirement that describes in business terms what needs to be delivered or accomplished

3.5
information constraint
statement that formally defines or constrains the scope of a piece of information due to some aspect of the business, a rule under which an organisation operates or a policy or decision that influences a process

3.6
class
type or collection of things that share common attributes

3.7
construction works
everything that is constructed or results from construction operations

[SOURCE: ISO 6707-1:2014, 3.1.1]

Note 1 to entry: This can refer to a building, piece of civil infrastructure (road, bridge, pipeline, etc.) or a landscape element and is extended to include aggregations of those elements to form an urban precinct, campus, or other institutional facility.

3.8
construction process
process that uses *construction resources* to achieve *construction results*

Note 1 to entry: Each construction process can be split up into its component processes.

3.9
exchange requirement
ER
defined set of information units that needs to be exchanged to support a particular business requirement at a particular process phase (or phases)/stage (or stages)

3.10
information delivery manual
IDM
documentation which captures the business process and gives detailed specifications of the information that a user fulfilling a particular role would need to provide at a particular point within a project

Note 1 to entry: This can be referred to as an information delivery specification (IDS).

3.11
IDM components
basic elements that form an IDM: interaction maps/transaction maps, process maps and exchange requirements

3.12
information unit
individual information item, such as a window identifier or a room depth

3.13
interaction map
representation of the roles and transactions relevant for a defined purpose

3.14
interaction framework
formal description of the elements of interaction, including definition of roles, transactions, messages in transaction, and data elements in messages

3.15
model
representation of a system that allows for investigation of the properties of the system

3.16
model view definition
MVD
computer-interpretable definition of an exchange requirement, specifically bound to one or more particular standard information schemas

Note 1 to entry: A model view definition (MVD) is also referred to as a view definition, a subset (of a schema) and a conformance class (CC) especially in ISO 10303.

3.17
object
part of the perceivable or conceivable world

Note 1 to entry: An object is something mental or physical toward which thought, feeling, or action is directed.

3.18
process map
PM
representation of the relevant characteristics of a process associated with a defined business purpose

3.19
role
functions being performed by an actor at a point in time

Note 1 to entry: The role of an actor is determined by action and outcome and not necessarily by the profession or trade followed by the actor.

3.20
transaction
communication event that fulfils a relationship between two roles

3.21
transaction map
representation of a set of messages that are exchanged between participating roles for a particular purpose

4 Information delivery manual

4.1 General

This Clause describes a series of concepts and principles that inform the development of an IDM.

4.2 Users of this part of ISO 29481

The main users are expected to be the IDM developers who create interaction maps, process maps, exchange requirements and information constraints using knowledge elicited from end users and solution providers.

In addition, some users of specific IDMs might identify needs for new IDMs and thus become users of this part of ISO 29481. These users include the following:

— professional IDM-developers and solution providers;

— information users, i.e. executive users and end users concerned with producing the content of the IDMs and benefiting from the result.

Another group of users will be those who use the documentation that results from the use of the standard, taking note of the business process and detailed specifications of the information that a user fulfilling a particular role would need to provide at a particular point within a project. Such users include the following:

— project manager, responsible for organizing the business process and ensuring that the information exchange is appropriately managed;

— BIM manager, making the necessary arrangements to support an exchange requirement;

— client, who initiates (develops) and includes an IDM in the contract;

— contractor/consultant, using the IDM to make the necessary arrangements to comply with the required business process and to comply with the required information delivery;

— business manager, using an IDM as a template or standard to be applied in many projects within its organization;

— construction organization, using an IDM for a specific project type as a template or standard to be applied in the sector.

4.3 Business context

Figure 1 shows an example of a business context that requires an IDM: a client (Role 1) engages a consultant (Role 2) to deliver some service. In such a scenario, there is a need to understand and formalize both the collaborative and contractual aspects of their relationship and how information will be delivered within that context. The IDM describes the information requirements associated with all the transactions (both ways) associated with that relationship. Some of that information will be held within a BIM, while other may originate from either party or from an external source.

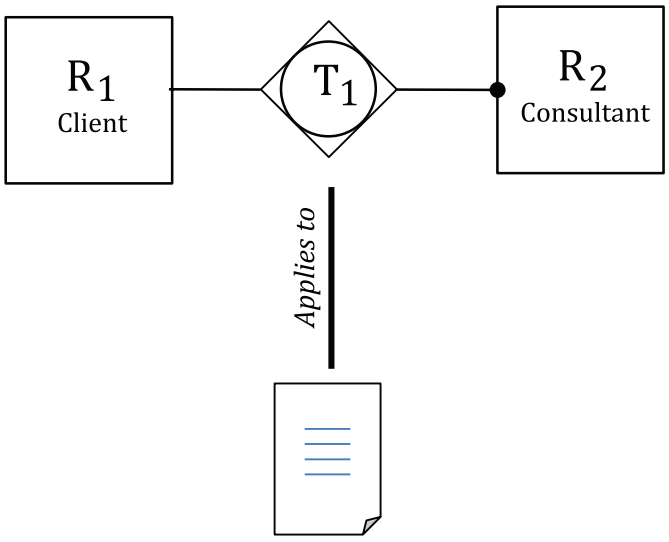


Figure 1 — Example of a simple business context requiring an IDM

The first step in developing an IDM is to consider the nature or context of the information exchange. There are two ways of looking at that, each with an associated methodology.

— Process maps are most useful when the focus is on the business processes (defined by activities executed by actors with roles) that need to be followed to deliver a service or produce an end product (such as a design). In this case, the information that is the focus of the IDM is associated with a business requirement.

— Interaction maps/transaction maps are most useful within a business process when the focus is on the interactions between actors with roles who are to deliver a service or product and the concern is to ensure that agreed communication protocols are in place to ensure that the project goals are achieved. In this case, the information that is the focus of the IDM is associated with a transaction.

These are complementary approaches and are explained in further detail in later sections. Within a given business context, it may be appropriate to use both methodologies: process mapping can be used to clarify the details of a transaction identified in an interaction mapping exercise, while an interaction map can be used to rigorously understand an information transaction defined in a process map.

4.4 Complete schema

Where the information requirements are satisfied by a BIM, a complete information schema that covers all of the information required for all actors throughout the construction process will be large and comprehensive. Such a schema is relevant in defining all of the project information needs for all business processes at all life cycle stages, but it is not the way that project information is usually delivered.

4.5 Breaking a complete schema to support requirements

It is more usual for information to be exchanged about a particular topic and the level of detail provided to be driven by the life cycle stage. This may be a single business process at a specific point in the project life cycle, but commonly consists of information units that may be relevant to more than one life cycle stage or business processes. This is commonly referred to as a model view and is a matter of deciding which components of the information schema should be used to meet requirements.

4.6 Supporting the building information modelling process

Elements of the overall information schema are used in a building information model (see Figure 2). For a particular business process, only certain classes of information are required. Multiple objects are derived from each class, each object having an identity (determined by a unique identifier) and a state (determined by the values given to each attribute of the object). The classes that support the business process form a unique and identifiable standard schema or model view.

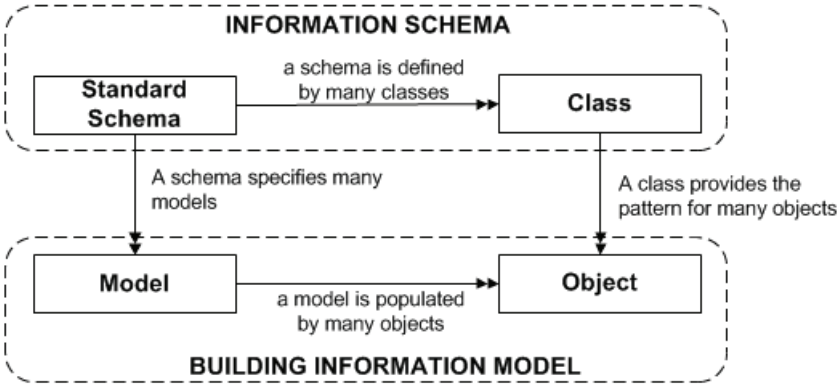


Figure 2 — Supporting the BIM process

4.7 Supporting the business process

To do this means that the set of information required to be exchanged to support a particular business process or interaction in the relevant life cycle stages (within a business process) shall be established. This is termed an exchange requirement.

An exchange requirement provides a description of the information to be exchanged in non-technical terms. An exchange requirement may support the communication of object information enabling

the construction and operation of a project or it may support the communication of management information that controls the project execution.

4.8 Supporting the software solution

Moving from the defined exchange requirement to a software implementation provided by a solution provider involves the development of a model view definition (MVD). This approach supersedes the need to implement functional parts as defined in earlier versions of this International Standard.

4.9 Content in the specific IDM

The content in a specific IDM shall

— describe the need for information exchange within the business context,

— identify the actors sending and receiving information,

— define, specify and describe the information being exchanged to satisfy the requirements at each point within the business context,

— ensure that definitions, specifications and descriptions are provided in a form that is useful and easily understood,

— create detailed specifications of the information captured within exchange requirements to facilitate the development of BIM software applications, and

— ensure that the information specifications can be made relevant to local working practices.

Guidance for development of content and the approach to follow is given in Annex A.

5 IDM Framework

5.1 General

An information delivery manual comprises (Figure 3) the following:

— an interaction map/transaction map and/or a process map;

— one or more exchange requirements.

The interaction map defines the roles involved and the transactions between roles. For each defined transaction, one role is initiator while another is executor. The corresponding transaction map defines the messages in a transaction and the rules that apply on the sequence of execution.

The process map shows a swim lane for each role and defines within the lane the relevant sequence of activities to be executed by that role. Activities undertaken by different roles may have relations that require an exchange of information in the form of a message. Such messages correspond to a message in a transaction shown in a transaction map.

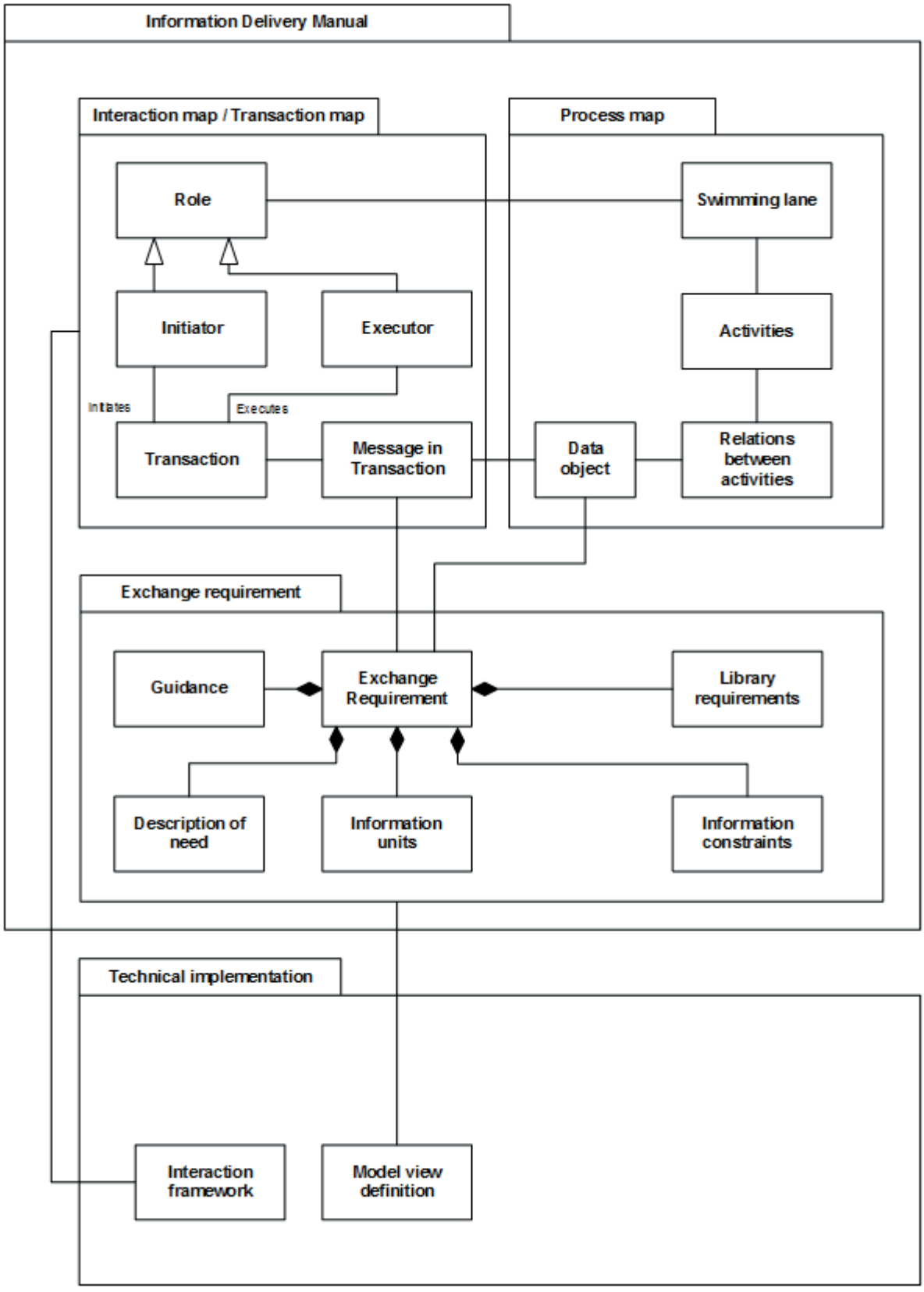


Figure 3 — IDM basic framework

Some messages can carry a package of BIM information, giving rise to the need to define an exchange requirement.

An exchange requirement comprises a comprehensive description of the information that shall be included in a BIM that is associated with a message passed between roles. It includes definitions of the information requirements, including references to library objects where relevant, as well as a description of need, guidance in its use and any information constraints that may apply.

The technical implementation of an exchange requirement is achieved through a model view definition. The technical implementation of an interaction map/transaction map is delivered in an interaction framework.

5.2 Basic framework

5.2.1 General

Each IDM component (process map, interaction/transaction map or exchange requirement) shall include header information and overview as follows.

5.2.2 IDM component header information

Each IDM component shall include at least the following administrative information:

— name or title conforming to the naming rules given in Table 1;

— unique identifier;

— project stage supported by the component;

— change log that identifies both creation and any change made together with the author and date.

Table 1 — Naming rules

Nr.	Naming rule
1	Each IDM component shall have a name.
2	The first part of the name is the prefix: — er_ for exchange requirement; — im_ for interaction map; — pm_ for process map; — tm_ for transaction map.
3	The name given to each IDM component is an imperative that has two parts: — the first part of the name is an action (or activity) required and is expressed as a verb; — the second part of the name is an object that receives the action and is expressed as a noun or noun phrase. This may be a direct object (as in “model wall”) or an implied indirect object (as in “associate material” which means associate {to wall} {the} material).
4	All identifiable words in a name are separated using an underscore character “_”.
5	IDM components may have parameters that enable further qualification. Parameters are expressed as a list within parentheses, for example, (a,b,c,d).

A project stage shall be identified through a life cycle stage. A reference for life cycle stages is given in Annex C.

With the delivery of each information unit, it may be expedient to make reference to the exchange requirement that specified the content.

5.2.3 IDM component overview

Each IDM component shall start with a short plain language description of the contents, use case, aims and scope that the component is intended to address or about which particular topic or business requirement information shall be exchanged.

Examples of simplified IDM components are given in Annex B.

5.3 Interaction map/transaction map

The purpose of an interaction map is to identify the relevant roles and transactions for a specific purpose, typically the completion of a team-based project task. IDM draws a distinction between a role that makes a request (initiator) and the role that gives effect to that request (executor). If there is such a required communication between two roles, then it is termed a transaction.

The approach recommended to prepare an interaction map is according to the CRISP Model (Dietz, J.L.G.: Enterprise Ontology, Springer, 2006).

In an interaction map, all transactions needed for the handling of required contributions of relevant roles to the BIM shall be included. All transactions within the interaction map have a unique identity and name.

A transaction map is a representation of the messages that can be exchanged between the participating roles in a particular transaction, including constraints on the sequence. The approach recommended to prepare a transaction map is UML (sequence diagram).

Messages are exchanged for a certain purpose (e.g. a request for change or the delivery of an information package). A message is a populated information model and contains data relevant for the process. A message can have one or more attachments.

Using transactions, the business cooperation and communication requirements are defined, allowing the contributions of relevant roles to the BIM to be controlled. For that purpose, in specific transactions, the following components can be added as attachments to specific messages:

— exchange requirement;

— information package (a set of object data which is the actual information delivery that satisfies an exchange requirement);

— window of authorization: in the context of a transaction, an executive role (executor) can access the BIM software applications. The window of authorization describes what information in this transaction by the role may be read or changed.

5.4 Process maps

The purpose of a process map is to describe the flow of activities within the boundary of a particular business process, the roles played by the actors involved together with the information required, consumed and produced.

The approach recommended for representing process maps is the Business Process Modelling Notation (BPMN). Further information on BPMN is given in Annex D.

Within an IDM, a process map

— sets the boundary for the extent of the information contained within the process,

— establishes the activities within the process, and

— shows the logical sequence of the activities.

The actual information that is within the process boundary is determined by the contents of the exchange requirements specified in the process.

A process map includes the following administrative information:

— the exchange requirements that are within the boundary of the process;

— an overview that provides a comprehensive description of the overall process. Diagrams may be used to illustrate particular points within the overview.

5.5 Exchange requirements

5.5.1 General

An exchange requirement defines the information that shall be exchanged to support a particular business process at a particular stage of a project. It is intended to provide a description of the information in non-technical terms. An exchange requirement shall be understandable to end users (architect, engineer, constructor, etc.). The exchange requirements are used to create an MVD, which is a technical specification that is used in software development and specified in 5.6.3.

An exchange requirement represents the connection between process and data. It describes a set of information from a process that has been performed by an actor in the role of initiator to enable a downstream process to be performed by another actor in the role of executor. It should be defined with a clear understanding of the information needs of the downstream actor.

5.5.2 Information units

The information required is provided in a set of information units. An information unit typically deals with one type of information or concept of interest. An information unit may be composed of an entity alone, such as project and wall or an entity (e.g. project) and its attribute (e.g. name), such as project name and wall lengths.

Preconditions for the exchange requirement are identified first. A precondition is an exchange requirement that should have been completed prior to the execution of the current exchange requirement.

Information units should be specified further to provide the following:

— a description of the information unit: The description should be as explicit as possible and unambiguous enough not to confuse MVD modellers with other concepts;

— the information which needs to be exchanged for the provisions of this information unit to be satisfied. This should include any special provisions, propositions or rules related to the information.

5.5.3 Information constraints

Information constraints specify the data type of an information unit, and a context, rules, and the restrictions on using the specified information unit. Here are some examples of the data type and rules.

— Data types

  — text, integer, number, 2D graphic, 3D model, etc.

— Context, rules, and the limits of use

  — a table shall have at least three legs,

  — a precast concrete piece shall have at least three identifiers: a piece mark (a production serial number), a mark number (a designed number), and an installation location identifier

  — a room area cannot be smaller than 0 m^2, and

— the largest panel size should not exceed 14 m to be delivered by a normal truck.

5.6 Technical implementation

5.6.1 General

This part of ISO 29481 is specifically concerned with the preparation of a common language description of the information requirements of business processes, particularly where those include the exchange of BIM data. These information specifications can be used as the basis for automated processes involving the use of software applications, referred to here as technical implementations.

This Clause describes the principles and scope of available technical implementations, each the subject of a separate part in this standard series.

5.6.2 Implementation of metadata

An overriding intention behind all technical implementations is that the specification shall be converted to a machine-readable form that includes key metadata (header, overview, classification) required for the automated process.

5.6.3 Interaction framework

An interaction framework is a formal description of the elements of interaction, including definition of roles, transactions, messages in transaction, the sequence of messages, and data elements in messages. The methodology for the development of an interaction framework and its format is included in ISO 29481-2.

5.6.4 Model view definition (MVD)

An MVD defines a data model or a subset of an existing data model that is necessary to support one or many specific data exchange requirements (Figure 4). MVDs are used in software development and should have a machine-readable representation. A MVD that is dedicated to a single IDM can be used to filter information in software tools to a specific exchange requirement. If information constraints are added to a MVD the combination can be used for data validation purposes. Software products supporting a number of exchange requirements may implement a consolidated MVD that refers to several IDMs. These MVDs are often used in certification of software products, but data validation should always be done on individual MVDs.

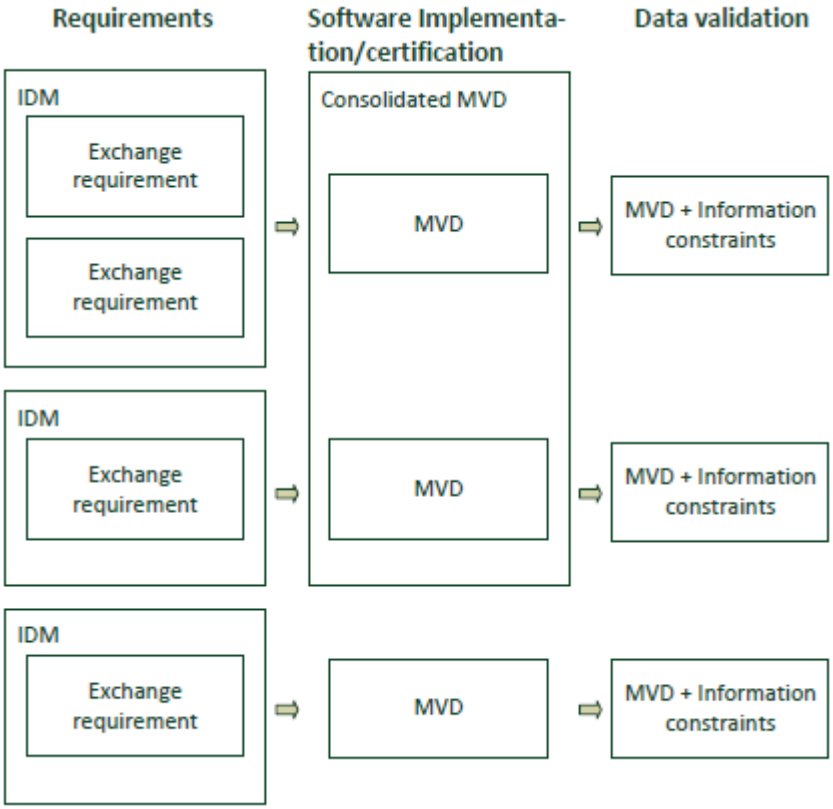


Figure 4 — Relation between IDM and MVD

Annex A
(informative)

IDM development process

A.1 Propose an IDM development

A.1.1 General information

A proposal to undertake an IDM development is a preliminary stage that sets the scene for work to be done. It is concerned with

— defining the scope,

— establish the development approach,

— identifying resources, and

— establishing a project plan.

A.1.2 Define scope

The scope should set the boundaries for the work that is to be done and provide a continuing reference to ensure that the work boundaries do not grow beyond a point at which the planned or available resource ceases to be sufficient.

The following questions should be answered in the preparation:

— What are the business needs for the information exchange?

— Who is able to describe these needs?

— Who are the actors and what are their roles and interests?

— How can the information exchange be prepared and handled?

— Will existing agreements, contractual conditions, standards, etc. support the information exchange?

The preparation ends up with an assessment of whether it is possible to reach the stated scope and success criteria. If the assessment is positive, the actual IDM development can be initiated. If the assessment turns out to be negative, you may choose to revise the use case or stop the development.

An overview of the existing resources should be provided, along with any prerequisite IT resources. The overview may show that the goals can be reached, enabling IDM development.

The overview may demonstrate that the business goals cannot be achieved. In that instance, goals shall be reviewed to fit available and possibly new IT resources specified. Conversely, the actors may choose not to proceed with the IDM development.

The practical and legal information exchange issues shall be described to clarify who is doing what, and who is responsible. Agreement and contractual conditions may prevent previously defined goals and success criteria from being met. Possibly, the goals can be revised to conform to the agreement and standard conditions.

A.1.3 Establish the development approach

The development approach selected will be determined by the extent of information, software or other exchange requirements available. The approaches are described under A.2.1.

A.1.4 Identify resources

Resources are the people who need to participate in an IDM development. Resources need to be properly balanced between project management, development of IDM components and industry knowledge to guide both component development and provision of software solutions. The balance of resources required will be affected by the development route that is selected.

A.1.5 Project plan

The project plan sets the period over which the development is to occur, determines the tasks to be undertaken, assigns the available resources and sets the deliverables required.

A.2 Undertake an IDM development

A.2.1 General information

There are three approaches to IDM development:

— process discovery;

— information constraint customisation;

— reverse engineering.

A.2.2 Process discovery

A.2.2.1 General information

Process discovery is the conventional approach used in IDM development. It assumes that there is no existing software from which requirements may be mined or other exchange requirements that may be customised.

The development approach is described below as a linear sequence. In practice, feedback between development stages and cyclic developments can be expected.

A.2.2.2 Discover process

There are two alternate methodologies proposed: process mapping and interaction mapping. A decision needs to be made about the approach most applicable to the business context.

The discover process involves working primarily with industry experts and specialist building information system providers to determine the defined scope, the process map or interaction framework.

This process usually requires several cycles of development and review to achieve a satisfactory conclusion. On completion, the process map or interaction framework may represent current practice or it may represent a proposal for an improved business practice. Whether to create an “as-is” process or a “to-be” process is a decision that needs to be taken as part of the development.

The process maps or interaction maps will identify the “packages” of data that need to be exchanged at various points in the business process. These are the exchange requirements.

A.2.2.3 Create exchange requirement

Exchange requirements should then be created. Wherever possible, they should re-use the resources of existing exchange requirements.

A.2.3 Information constraint customisation

A.2.3.1 Define information constraints

The set of information constraints that may need to be applied to further configure an existing (or newly defined) exchange requirement should be defined. These may be used to control properties to be asserted or values that can be assigned.

A.2.3.2 Information constraint localization

Information constraint localization assumes that an exchange requirement exists for the purpose required but that it does not meet the needs for use within a particular location. Location may be a place (country, region, etc.), a project or a framework of working agreed between members of a project team.

Information constraints are applied to individual units of information within the context of the exchange requirement to make it applicable at a particular location. Note that the same information unit may have different information constraints applied in the context of a different exchange requirement or for a different location.

A.2.4 Reverse engineering

A.2.4.1 General information

Reverse engineering assumes that software already exists that is capable of importing the information required to perform a target task, but the specific information items are not clearly documented. This process is not suitable for identifying the information requirement for export data because various information use cases of the export data may exist. Hence, the information requirement for export data should be specified from the receiving application perspective. The typical way of doing reverse engineering is to define each step in a software tool for achieving a target result and then work through the scenario to identify and specify individual data items that are required from upstream software applications.

A.2.4.2 Define scenario

Define each step to achieve the target result within a software application as a scenario. This scenario may be defined as a process map or as a detailed textual description that can be used as the overview description of an exchange requirement.

A.2.4.3 Identify required data

Work through the defined scenario within the software application and specify all the data required to achieve a target result. For each data item specified, check if it should be acquired from other software applications. If so, it should be included in an exchange requirement for import data.

A.2.4.4 Create exchange requirement

Create an exchange requirement using the defined scenario as the overview section and adding the identified data to the technical section. The scenario can be also specified as a process map.

A.2.4.5 Define Information constraints

The set of Information constraints that may need to be applied to further configure the exchange requirements should be defined. These may be used to control properties to be asserted or values that can be assigned.

A.2.4.6 Capture process

As one or more exchange requirements are reverse engineered from software applications, they can be captured in a process map or interaction map.

A.2.5 Implementation and use of IDMs

Once the IDM has been prepared and implemented, the information exchange can begin. The exchange shall be validated before sending and on receipt.

When the actors have gained adequate information exchange experience, an evaluation can be made. The evaluation covers the preparation, as well as the IDM development and practical implementation issues.

If the involved actors want software certification according to the developed IDM, specific actions shall be made. During the certification process, software products should demonstrate that they are able to export/import data according to the exchange requirements. In order to make it trustworthy, the certification process should be monitored by an independent organization. There needs to be a business case for the software vendors to apply for certification since the cost for preparation and certification itself can be high.

Annex B
(informative)

Examples of simplified IDM components

B.1 Business context of the examples

The following examples are provided to illustrate each of the components of an IDM using a simple business context where a client engages a consultant team to undertake a design task. The task is to define the layout of building facilities. The outcome is described by means of 3D bounding boxes. The actual information delivery is a set of bounding boxes and a cost estimation.

This example has been greatly simplified and is not intended to reflect real-world application.

B.2 Process map

Name: pm_29481_sample

Identification: pm_29481_sample_1

Project stage: Outline feasibility

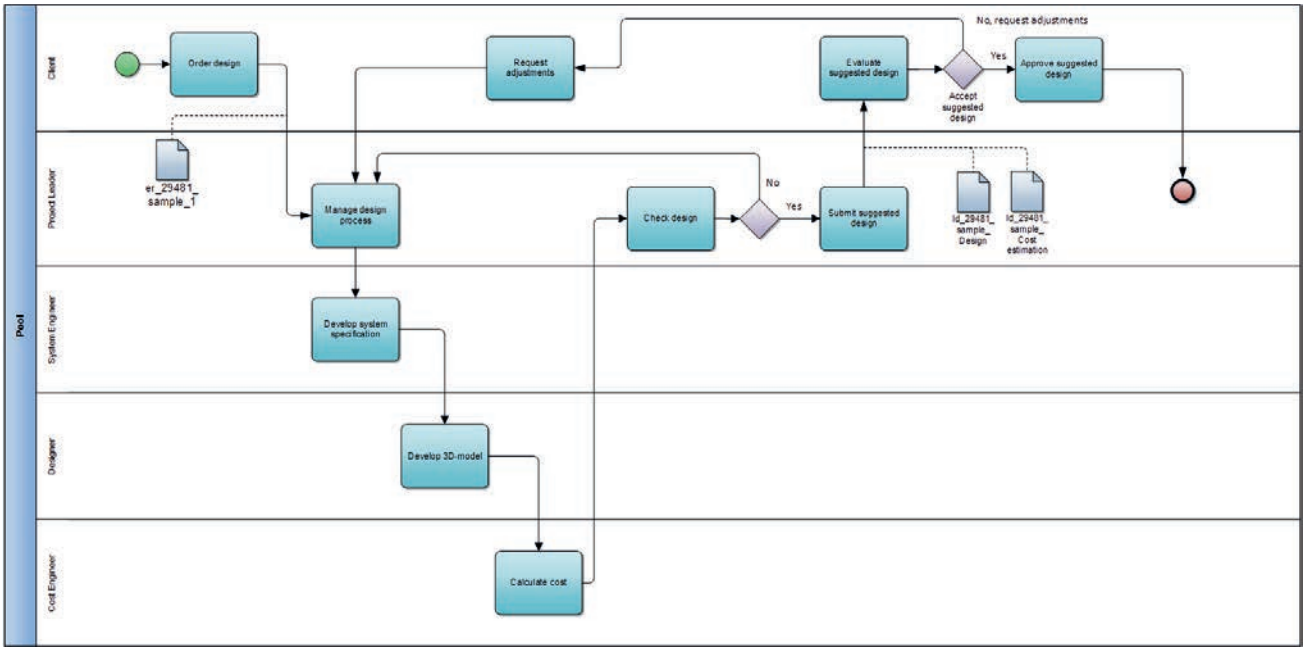


Figure B.1 — Process map

B.3 Interaction map

Name: im_29481_sample

Identification: im_29481_sample_1

Project stage: Outline feasibility

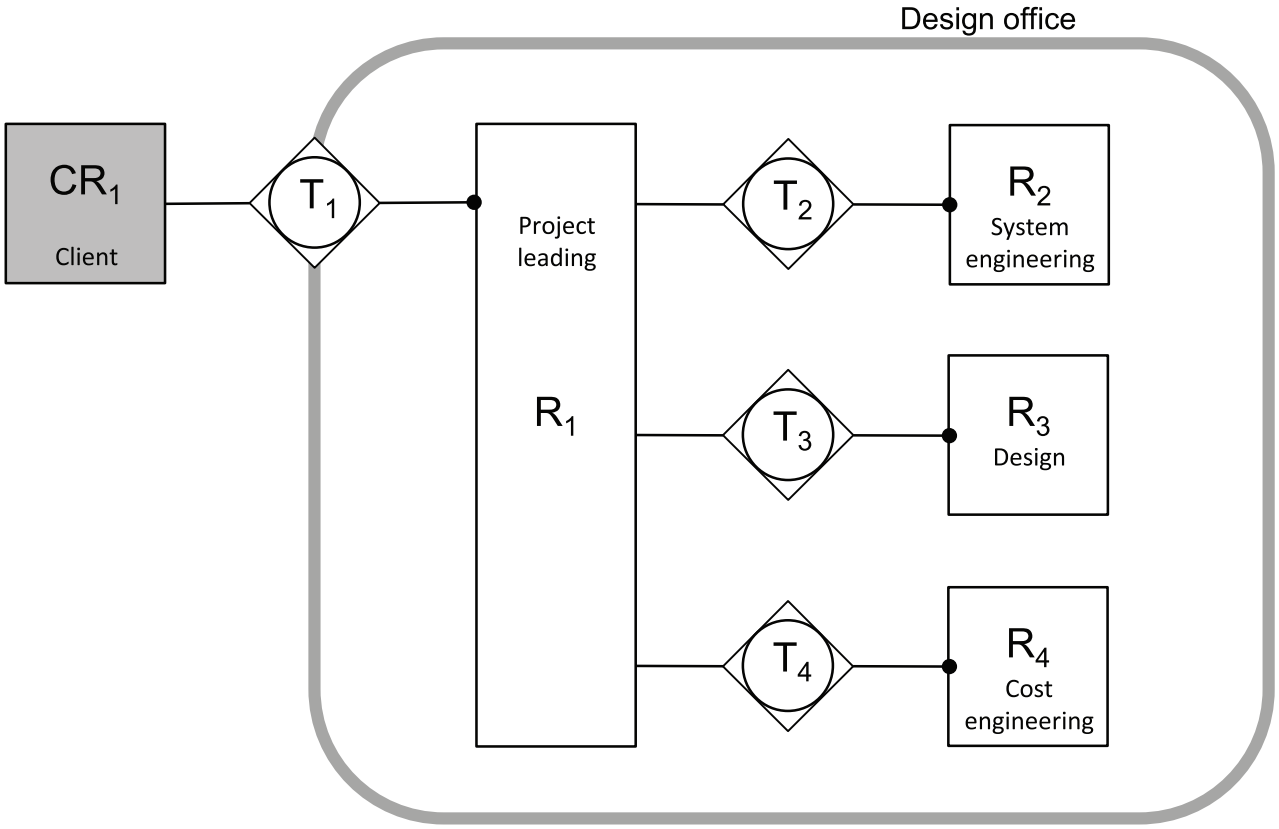


Figure B.2 — Interaction map

B.4 Transaction map

Name: tm_29481_sample

Identification: tm_29481_sample_1

Project stage: Outline feasibility

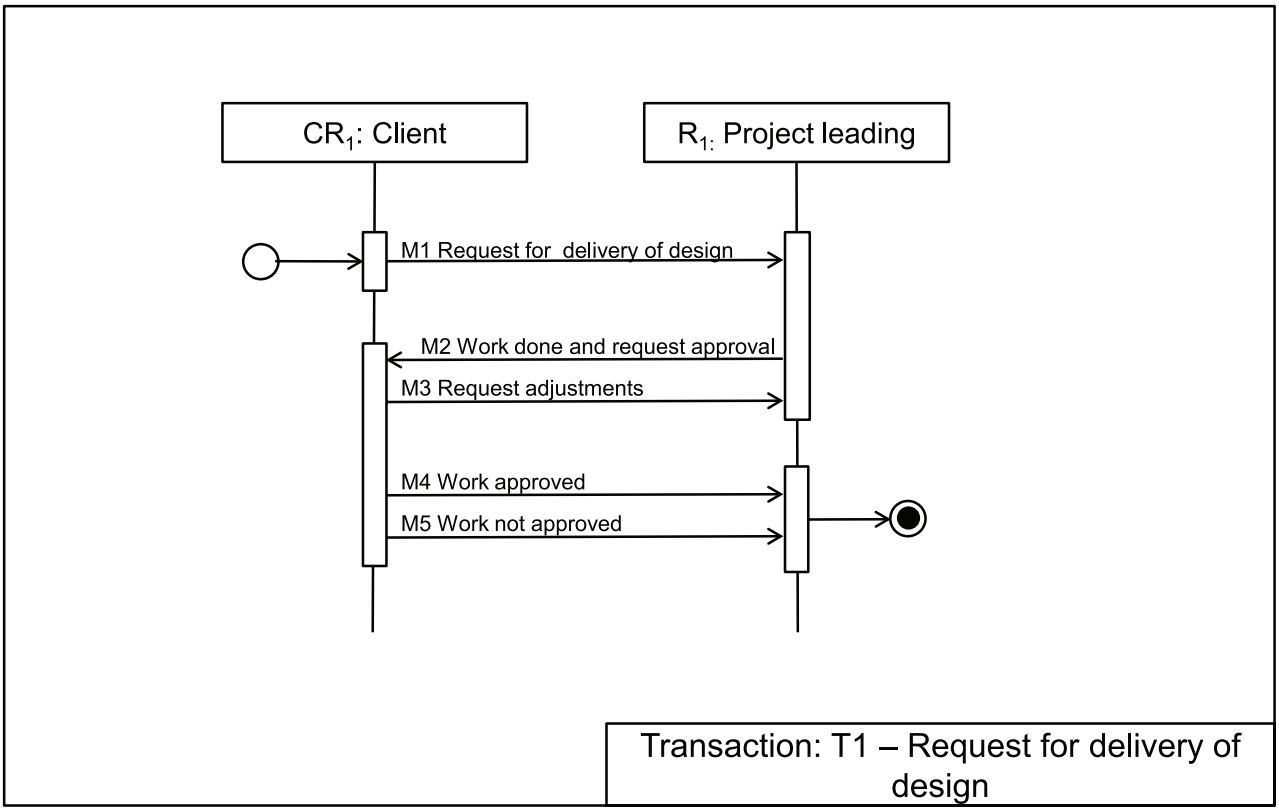


Figure B.3 — Transaction map

B.5 Exchange requirement

Name: er_29481_sample

Identification: er_29481_sample_1

Project stage: Outline feasibility

Guidance

This exchange requirement applies to the delivery of three-dimensional boxes representing the minimum or smallest bounding box of facilities.

Each instance of a facility requires a bounding box.

Each bounding box is referenced to a given central design orientation.

Description of need

The required information will be used for a feasibility study with regard to the physical layout of a building.

Information units

Table B.1 — Information units

Object type Property concept Property	Definition	Example and further explanations	Mandatory	Optional
Facility	Something designed, built, installed, etc., to serve a specific function affording a convenience or service:	Transportation facilities; educational facilities; a new research facility.		
3D Model	Three-dimensional bounding box	The minimum or smallest bounding or enclosing box is a term used in geometry, with plans parallel to the axis in a coordinate system.		
Identification	A short name used for reference purposes.		X	
Description	Optional description, provided for exchanging informative comments.			X
Length	Length of bounding box	Length measured, e.g. in mm.	X	
Width	Width of bounding box	Width measured, e.g. in mm.	X	
Height	Height of bounding box	Height measured, e.g. in mm.	X	
Location	Location of the bounding box in a coordinate system	Vector and rotation from the origin of the coordinate system to insertion point of the bounding box.	X	

Library requirements

All object types, property concepts and properties need to be structured according to the content of an object type library that will be made available by the client.

Information constraints

All information constraints, as defined in the object type library, shall be followed.

Meta information should be delivered according to Dublin core.

Format requirements

Information units shall be delivered in XML-format; all units may be packaged in one file.

Information units shall be delivered as an attachment of a message in transaction.

Meta information is supplied through the message in transaction.

Annex C
(informative)

Reference life cycle stages

C.1 Standard life cycle stages

Exchange requirements are identified as being relevant to particular stages in a project. For consistency, life cycle stages should always be defined on a common basis. The primary reference used for identifying life cycle stages here is ISO 22263 which suggests the following principal stage identification:

— inception;

— brief;

— design;

— production;

— maintenance;

— demolition.

For the purposes of this part of ISO 29481, the principal stages identified in ISO 22263 are further decomposed to provide a meaningful set of stages for the development of process maps and exchange requirements. The decomposed stages are shown below with a cross reference to the ISO 22263 stage name.

Table C.1 — Life cycle stages in ISO 22263

ISO 22263 name	Standard stage	Standard name	Standard definition
Pre-life cycle stages			
Inception	0	Portfolio requirements	Establish the need for a project to satisfy the clients business requirement
Brief	1	Conception of need	Identify potential solutions to the need and plan for feasibility
	2	Outline feasibility	Examine the feasibility of options presented in phase 1 and decide which of these should be considered for substantive feasibility
	3	Substantive feasibility	Gain financial approval
Pre-Construction stages			
Design	4	Outline conceptual design	Identify major design elements based on the options presented
	5	Full conceptual design	Conceptual design and all deliverables ready for detailed planning approval
	6	Coordinated design (and procurement)	Fix all major design elements to allow the project to proceed. Gain full financial approval for the project

Table C.1 *(continued)*

ISO 22263 name	Standard stage	Standard name	Standard definition
Construction stages			
Production	7	Production Information	Finalise all major deliverables and proceed to construction.
	8	Construction	Produce a product that satisfies all client requirements. Handover the building as planned.
Post-construction stages			
Maintenance	9	Operation and maintenance	Operate and maintain the product effectively and efficiently.
Demolition	10	Disposal	Decommission, dismantle and dispose of the components of the project and the project itself according to environmental and health/safety rules

C.2 Local life cycle stages

Life cycle stages are usually defined according to local process protocols. That is, the identification of life cycle stages in one place will differ from the identification of life cycle stages in another place. For example, project development is often organized according to the RIBA Plan of Work within the UK and according to the HOAI protocol in Germany.

The life cycle stages within a standard exchange requirement can be customised to reflect local practice in a localized exchange requirement. That is, the standard table can be replaced by a locally defined table. The exchange requirements can be defined according to this local protocol.

Where local protocols are used, the mapping between the stages in the local protocol and those within this part of ISO 29481 should be maintained. Either

— a single standard stage is decomposed into multiple stages in the local protocol, or

— multiple standard stages are composed into a single stage in the local protocol.

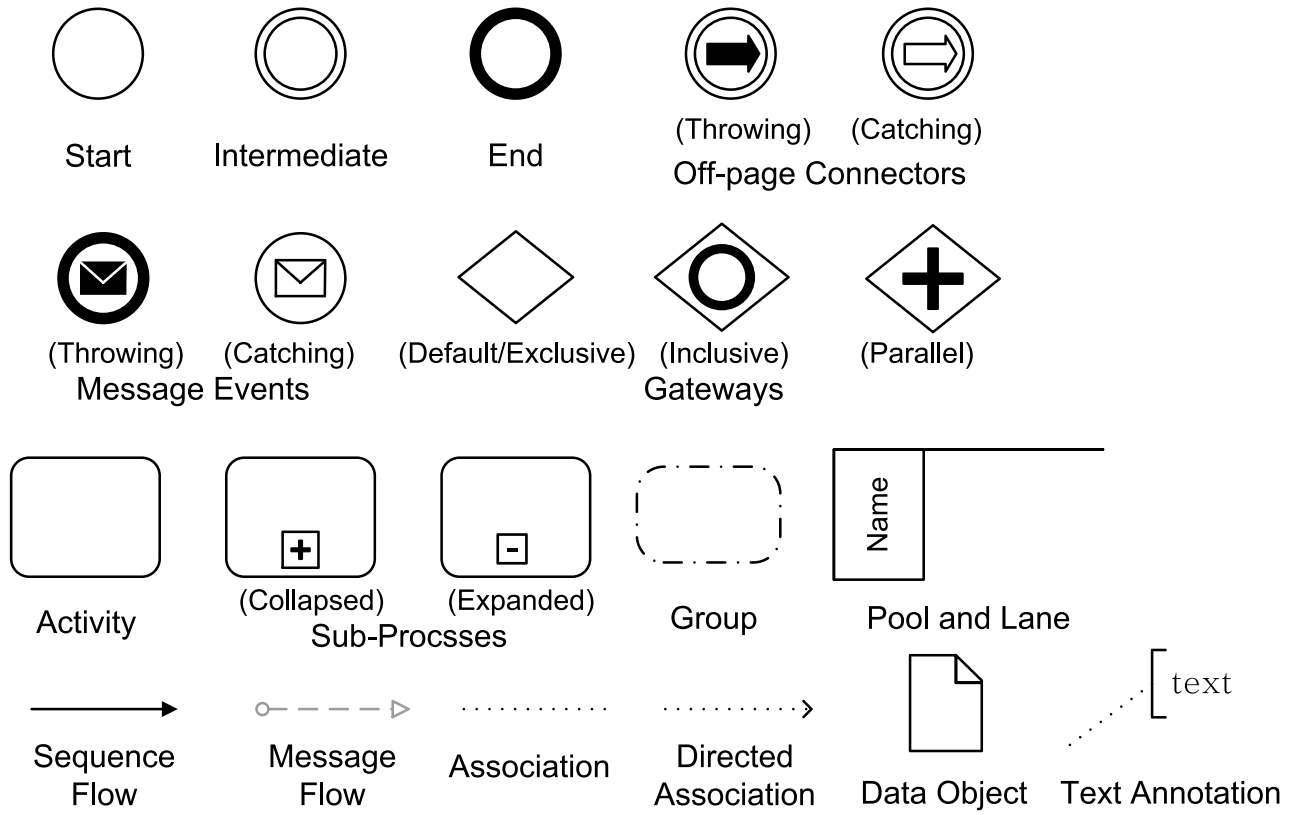
Standard stages and local protocol stages should always conform to boundaries such that there is a 1:1, 1:many or many:1 relationship between them. Life cycle stages should not cross boundaries, such that a stage in a local protocol starts part way through one standard stage and ends part way through another standard stage.

Annex D
(informative)

IDM use of BPMN methods

D.1 General information

IDM recommends (but does not mandate) the use of the 22 business process modelling notation (BPMN) symbols below for the development of process maps (Figure D.1). Table D.1 lists the definitions of the recommended BPMN symbols collected from the BPMN specification by the object management group (OMG).



NOTE Source: Lee, G., et al. (2013). "Extended Process to Product Modeling (xPPM) for integrated and seamless IDM and MVD development." Advanced Engineering Informatics 27(4): 636-651.

Figure D.1 — Recommended subset of BPMN symbols for process map development

Table D.1 — Definitions of the recommended subset of BPMN symbols

Element	Definition
Activity (Task)	A task is an atomic activity that is included within a process. A task is used when the work in the process is not broken down to a finer level of process detail.
Sub-process	A sub-process is a compound activity that is included within a process or choreography. It is compound in that it can be broken down into a finer level of detail (a process or choreography) through a set of sub-activities.
Sub-Process (Expanded)	The boundary of the sub-process is expanded and the details (a process) are visible within its boundary. Note that sequence flows cannot cross the boundary of a sub-process.
Sub-Process (Collapsed)	The details of the sub-process are not visible in the diagram. A "plus" sign in the lower-centre of the shape indicates that the activity is a sub-process and has a lower-level of detail.
Start Event	A start event indicates where a process will start. Start events can only react to "catch" a trigger.
Intermediate Event	An intermediate event indicates where something happens somewhere between the start and end of a process. Intermediate events can "catch" or "throw" triggers.
End Event	An end event indicates where a path of a process will end. End events can only create "throw" a result.
Start Event(Message)	A message arrives from a participant and triggers the start of the process. The actual participant from which the message is received can be identified by connecting the event to a participant using a message flow within the definitional collaboration of the process
Intermediate Event (Message/Catching)	A message intermediate event can be used to either send a message or receive a message. When used to "catch" the message, then the event marker shall be unfilled. This causes the process to continue if it was waiting for the message, or changes the flow for exception handling.
Intermediate Event (Message/Throwing)	A message intermediate event can be used to either send a message or receive a message. When used to "throw" the message, the event marker shall be filled (see the upper figure on the right). This causes the process to continue if it was waiting for the message, or changes the flow for exception handling.
End Event (Message)	This type of end indicates that a message is sent to a participant at the conclusion of the process. See page 91 for more details on messages.
Intermediate Event (Link/Catching)	Paired link events can also be used as "off-page connectors" for printing a process across multiple pages. They can also be used as generic "go to" objects within the process level. There can only be one target link event. When used to "catch" from the source link, the event marker will be unfilled. When used to "throw" to the target link, the event marker will be filled.
Intermediate Event (Link/Throwing)	
Gateway	A gateway is used to control the divergence and convergence of sequence flows in a process and in a choreography. Thus, it will determine branching, forking, merging, and joining of paths. Internal markers will indicate the type of behaviour control.
Gateway (Exclusive)	[XOR] when splitting, it routes the sequence flow to exactly one of the outgoing branches. When merging, it awaits one incoming branch to complete before triggering the outgoing flow.
Gateway (Parallel)	[And] when used to split the sequence flow, all outgoing branches are activated simultaneously. When merging parallel branches, it waits for all incoming branches to complete before triggering the outgoing flow.
Gateway (Inclusive)	[Or] when splitting, one or more branches are activated. All active incoming branches shall complete before merging.
Sequence Flow (Normal or Uncontrolled)	A sequence flow is used to show the order that activities will be performed in a process and in a choreography.

Table D.1 *(continued)*

Element	Definition
Message Flow	A message flow is used to show the flow of messages between two participants that are prepared to send and receive them. A message flow shall connect two separate pools. They connect either to the pool boundary or to flow objects within the pool boundary. They shall not connect two objects within the same pool.
Association	An association is used to associate information and artefacts with flow objects. Text and graphical non-flow objects can be associated with the flow objects and flow.
Data Association	A data association is used to move data between data objects, properties, and inputs and outputs of activities and processes. Data associations can be visually represented in the diagram by using the association connector style.
Pool	A pool is the graphical representation of a participant in a collaboration. A pool acts as the container for the sequence flows between activities (of a contained process). The sequence flows can cross the boundaries between lanes of a pool, but cannot cross the boundaries of a pool. That is, a process is fully contained within the pool. The interaction between pools is shown through message flows.
Lane	A lane is a sub-partition within a process (often within a pool) and will extend the entire length of the process level, either vertically or horizontally. Lanes are often used for such things as internal roles (e.g. manager, associate), systems (e.g. an enterprise application), an internal department (e.g. shipping, finance), etc.
Data Object	Data objects provide information about what activities require to be performed and/or what they produce. Data object elements shall be contained within process or sub-process elements. Data objects cannot specify states.
Group	A group is not an activity or any flow object, and, therefore, cannot connect to sequence flows or message flows. In addition, groups are not constrained by restrictions of pools and lanes.
Text Annotation	Text annotations are a mechanism for a modeller to provide additional information for the reader of a BPMN diagram. The text annotation object can be connected to a specific object on the diagram with an association, but does not affect the flow of the process.

The following sections are collections of the general principles and rules from the OMG's *BPMN Specification* below. The references below may be consulted for examples and details.

— Business Process Modelling Notation (BPMN), OMG, 2013, available at: < http://www.omg.org/bpmn/>.

— Silver, B., BPMN Method and Style: A levels-based methodology for BPM process modelling and improvement using BPMN 2.0, 2011, Cody-Cassidy Press.

D.2 Specification of processes and flows

In a process map, all of the diagrams and sub-diagrams created for describing the process shall be included. All processes within the process map have a unique identity and name.

Each process within the process map is described in such detail as required. The aim is to describe the purpose of the process to a reader. The followings are the rules specified in the BPMN specification associated with process flows and events.

Process flow

— It is best to pick a direction of sequence flows, either left to right or top to bottom, and then direct the message flows at a 90° angle to the sequence flows.

— The process flow is contained within the pool and cannot cross the boundaries of the pool.

— The interaction between pools is shown through message flows.

— If a sub-process has been expanded within a diagram, the objects within the sub-process cannot be connected to objects outside of the sub-process.

Sequence flow connections

— A connecting object that shows the order in which activities are performed in a process and is represented with a solid graphical line.

— Each flow has only one source and only one target.

— A sequence flow can cross the boundaries between lanes of a pool but cannot cross the boundaries of a pool.

— Only activities, gateways, and events can be the source and the target. And an artefact shall not be either a target or a source for a sequence flow.

Message Flow Connection

— A message flow shall connect two separate pools. They connect either to the pool boundary or to flow objects within the pool boundary.

— A message shall not connect two objects within the same pool.

— Message flows cannot connect to objects that are within the same pool.

— The interaction between pools is shown through message flows.

— Only pools/participants, activities, and events can be the source or target of a message flow. And an artefact shall not be either a target or a source for a message flow.

Association and data association

— Text and graphical non-flow objects can be associated with the flow objects and flow.

— An association is used to connect user-defined text (an annotation) with a flow object.

— A data association uses the same notation as a directed association.

— Data associations are used to move data between data objects, properties, and inputs and outputs of activities, processes.

— Data objects may be directly associated with a sequence flow connector.

— Activities define two sets of data associations, while events define only one.

D.3 Specification of events

An event indicates the state of an activity. The three basic events are start, intermediate and end events.

Start and end events

— A process is instantiated when one of its start events occurs.

— For a process instance to become completed, all tokens in that instance shall reach an end node, i.e. a node without outgoing sequence flows. If a token reaches a terminate end event, the entire process is abnormally terminated.

— The use of start and end events is independent for each level of the diagram.

— If there is a start event, then there shall be at least one end event. And if there is an end event, then there shall be at least one start event.

— If a start event is not used, then the implicit start event for the process shall not have a trigger.

— If a process is complex and/or the starting conditions are not obvious, then it is recommended that a start event be used.

— If an end event is not used, then the implicit end event for the process shall not have a result.

— The process shall not end until all parallel paths have completed.

D.4 Specification of data objects

A data object is a named collection of data. It may be a collection of data that is available from an external source (e.g. library data) or it may be data that is exported from an activity to enable other activities to occur (e.g. exchange requirement).

Data objects that are not exchange requirements shall have a name that is indicative of their purpose and a description that outlines their purpose and content. The followings are the rules specified in the BPMN specification associated with data objects.

Data objects

— Data object elements shall be contained within process or sub-process elements.

— Data associations are always contained within another element that defines when these data associations are going to be executed.

— A data object may not be either source or target of sequence flows and message flows.

— Data objects may be directly associated with a sequence flow connector.

D.5 Specification of exchange requirements within a process map

In BPMN models, an exchange requirement is represented using a data object within a process map.

Exchange requirements shall have

— a name that is indicative of their purpose following the IDM naming rules, and

— a description that outlines the purpose and content in a separate exchange requirement document.

Bibliography

[1] ISO 29481-2, *Building information models — Information delivery manual — Part 2: Interaction framework*

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