INTERNATIONAL STANDARD

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Third edition
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Information technology — Metamodel framework for interoperability (MFI) —

Part 1: **Framework**

Technologies de l'information — Cadre du métamodèle pour l'interopérabilité (MFI) —

Partie 1: Structure

Reference number
ISO/IEC 19763-1:2023(E)

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Foreword

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This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 32, *Data management and interchange*.

This third edition cancels and replaces the second edition (ISO/IEC 19763-1:2015), which has been technically revised.

The main changes are as follows:

— The document has been revised to take account of the changes caused by the modularization and technical revision of ISO/IEC 11179-3. The fourth edition of ISO/IEC 11179-3, published in 2023, is now *Information technology — Metadata registries (MDR) — Part 3: Metamodel for registry common facilities*;

— Annex B has been removed.

A list of all parts in the ISO/IEC 19763 series can be found on the ISO website.

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 and www.iec.ch/national-committees.

Introduction

Due to the proliferation of internet-enabled communication aided by mobile devices, social network systems and cloud computing, both the efficient and effective sharing of information and the handling of business transactions across countries and cultures has become easier.

In the private sector, the handling of these business transactions using Electronic Data Interchange (EDI) has been common for a long time. Companies hold large quantities of structured, semi-structured and unstructured data – the "Big Data" explosion. It is in their interest to make effective use of this data to extract business intelligence and knowledge.

In the public sector, governments in many countries and territories are working on the establishment of new schemes that enable interoperation and collaboration among different departments or agencies, materialising the semantic interoperability of data and surmounting border or language differences. At the same time, many governments and agencies are attempting to make their data available to their citizens over the internet, the "Open Data" initiatives. These "Open Data" initiatives can be the driver for similar innovations in the private sector. One of the issues for users is to access the various sets of open data easily and integrate them for analysis to create new value through added information or knowledge.

These trends have produced new needs for standards that enable effective information sharing in both private and public sectors.

One of the key enablers of this sharing of the information that is used by different communities through the interoperability of systems is a registry, or a network of inter-connected registries, that provides for the discovery and sharing of meta-information, such as metadata or models. The metamodel framework for interoperability (MFI) provides the specifications for such registries.

The metamodels specified in the ISO/IEC 19763 series each provides an extension for a metadata registry (MDR) as defined in the ISO/IEC 11179 series. ISO/IEC 11179-3[2] specifies the common facilities for a registry. These common facilities allow for items in the registry to be identified (assigned a unique identifier), designated (or named), defined and classified along with the recording of information about the provenance of the registered items. ISO/IEC 11179-6[3] specifies the registration procedures to be used with a registry.

This revised document provides a clear overview of the ISO/IEC 19763 series and illustrates the overall architecture of the metamodel framework for interoperability.

Each part of the ISO/IEC 19763 series is described in more detail in Annex A.

Information technology — Metamodel framework for interoperability (MFI) —

Part 1: Framework

1 Scope

This document provides an overview of the whole ISO/IEC 19763 series. This overview includes the purpose, the underlying concepts, the overall architecture and the requirements for the development of other standards within the 19763 series.

Collectively, the other parts of the ISO/IEC 19763 series provide a set of normative metamodels to enable the registration of many different types of model. Each of these metamodels is expressed both as a UML class diagram and, more formally, in text. The metamodels, along with the specification in ISO/IEC 11179-3, define the information about the models that is to be registered. The models themselves can be stored in a model repository or can just exist as paper documents.

The ISO/IEC 19763 series does not specify any physical structure of a registry where model information is to be recorded.

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 terminology databases for use in standardization at the following addresses:

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

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

3.1
model
representation of some aspect of a domain of interest using a normative *modelling language* (3.3) and *model constructs* (3.4)

Note 1 to entry: Models can be used to express a set of information requirements, processes, services, roles, goals or some other aspect of a domain of interest

3.2
model element
element or component in a *model* (3.1)

Note 1 to entry: Examples of model elements are a representation of an entity type in an *information model* (3.17), a representation of an event in a *process model* (3.21), a representation of a service operation in a *service model* (3.23), or a representation of an actor in a *role and goal model* (3.26).

3.3
modelling language
modelling facility
language or notation and associated rules that is used to model some aspect of a domain of interest

Note 1 to entry: UML is a typical example of a modelling language

3.4
model construct
unit of notation to represent a *model* (3.1)

Note 1 to entry: This is a more generic term for *model element* (3.2). Sometimes the term is used to include metadata, code and object patterns rather than the notations of a particular *modelling language* (3.3) such as UML.

3.5
metamodel
model (3.1) that explains a set of related models by defining the language for expressing such models

Note 1 to entry: In MFI, the metamodels are expressed using UML class diagrams and text.

3.6
metadata
data that defines and describes other data

[SOURCE: ISO/IEC 11179-1:2023, 3.2.30]

3.7
metadata item
instance of a *metadata object* (3.8) in a *metadata registry* (3.9)

[SOURCE: ISO/IEC 11179-3:2023, 3.2.58, modified — notes have been removed.]

3.8
metadata object
object type defined by a *metamodel* (3.5)

[SOURCE: ISO/IEC 11179-3:2023, 3.2.31, modified — notes have been removed.]

3.9
metadata registry
MDR
information system for registering *metadata* (3.6).

Note 1 to entry: The associated information store or database is known as a metadata register

[SOURCE: ISO/IEC 11179-3:2023, 3.2.55]

3.10
model registry
information system for registering *models* (3.1)

3.11
model repository
repository (3.13) where *models* (3.1) are stored

3.12
registry
information system for registration

Note 1 to entry: In ISO/IEC 19763, the registry is a model registry since the metadata items that are registered are models. This model registry uses facilities provided by a metadata registry as specified in ISO/IEC 11179-3.

[SOURCE: ISO/IEC 11179-1:2023, 3.2.34, modified — note to entry has been added.]

3.13
repository
place where, or receptacle in which, things are or can be stored

Note 1 to entry: In MFI, a repository is recognized as an information system that stores actual instances that conform to a particular metamodel or a particular set of metadata.

3.14
interoperability
capability to communicate, execute programs, or transfer data among various functional units in a manner that requires the user to have little or no knowledge of the unique characteristics of those units

[SOURCE: ISO/IEC 2382:2015, 2121317]

3.15
concept
unit of knowledge created by a unique combination of characteristics

Note 1 to entry: Concepts are not necessarily bound to particular natural languages. They are, however, influenced by the social or cultural background which often leads to different categorizations.

Note 2 to entry: A concept is independent of its representation.

[SOURCE: ISO/IEC 11179-3:2023, 3.2.7]

3.16
ontology
specification of concrete or abstract things, and the relationships among them, in a prescribed domain of knowledge

Note 1 to entry: The specification should be computer processable.

[SOURCE: ISO/IEC 19763-3:2020, 3.1.1.1]

3.17
information model
graphical and textual representation of entities and the relationships between them

Note 1 to entry: Can also be known as a data model, a conceptual data model, a logical data model, an entity relationship model**,** an object class diagram or a database definition.

[SOURCE: ISO/IEC 19763-12:2015, 4.2.24]

3.18
document
unit of data that is well-formed according to some agreed specification

Note 1 to entry: In the 19763 series, examples of a unit of data that is referred to as a document include, but are not restricted to, XML documents and JSON documents.

[SOURCE: ISO/IEC 19763-16:2021, 3.1.1, modified — Note 1 has been modified to make it relevant to this document.]

3.19
document model
document schema
formal specification of the structure of a *document* (3.18)

Note 1 to entry: The same model can be used for multiple documents

[SOURCE: ISO/IEC 19763-16:2021, 3.1.2, modified — ‘schema’ replaced by ‘model’.]

3.20
process
collection of related, structured activities or tasks that achieve a particular goal

[SOURCE: ISO/IEC 19763-5:2015, 3.1.12, modified — note has been deleted]

3.21
process model
representation of a *process* (3.20) using a specific *modelling language* (3.3) that represents *processes*

[SOURCE: ISO/IEC 19763-5:2015, 3.1.13, modified – "process modelling language" amended to read "modelling language that represents processes"]

3.22
service
application which encapsulates one or more computing modules and can be accessed through a specified interface

[SOURCE: ISO/IEC 19763-7:2015, 3.1.17]

3.23
service model
representation of a *service* (3.22) using a specific *modelling language* (3.3) that represents services

3.24
role
named specific behaviour of an entity participating in a particular context

[SOURCE: ISO/IEC 19763-8:2015, 3.1.7]

3.25
goal
intended outcome of user interaction with a *process* (3.20) or *service* (3.22)

[SOURCE: ISO/IEC 19763-8:2015, 3.1.1]

3.26
role and goal model
representation of a set of *roles* (3.24) and *goals* (3.25) using a specific *modelling language* (3.3) that represents *roles* and *goals*, the interactions between them and their interactions with specified *processes* (3.20) or *services* (3.22)

4 Abbreviated terms

BPMN	Business Process Model and Notation
IDEF1X	Integration DEFinition for Information Modeling
LOD	Linked Open Data
MDR	Meta Data Registry
MFI	Metamodel framework for interoperability (this series of standards (ISO/IEC 19763))
OMG	Object Management Group
RGPS	Role, Goal, Process and Service
ROR	Registry of Registries
RS	Registry Summary
SDO	Standards Developing Organization
UML	Unified Modeling Language
W3C	World Wide Web Consortium

XML	eXtensible Markup Language

5 Conformance

This document specifies no conformance requirements. Other parts of the ISO/IEC 19763 series specify their own conformance requirements as appropriate.

6 Purpose and objectives of metamodel framework for interoperability (MFI)

6.1 Purpose of MFI

The MFI provides a set of specifications that allow the registration of models to facilitate interoperability among systems or persons. In this context interoperability is interpreted in its broadest sense: the capability to communicate, execute programs, or transfer data among various functional units in a manner that requires the user to have little or no knowledge of the unique characteristics of those units. The models that are registered can be ontologies, information models, document models (for example, XML schemas), form designs, process models, service models, models of roles and goals or any other type of model specified within the ISO/IEC 19763 series.

Models are used widely within the information technology community to represent system requirements and system specifications. These models can be expressed using a variety of notations or languages. An information model can be expressed in any one of a number of entity-relationship notations (from the simplicity of the original entity-relationship notation proposed by Dr Peter Chen[18] through to the complexity of Express-G[1]), as a UML[5][6] class diagram, or even as a set of SQL CREATE TABLE statements. Similarly, process models can be expressed as BPMN models or as UML activity diagrams.

The sharing of these models is essential if interoperability is to be achieved. If two systems are to exchange information then not only should the formats in which the information is represented as data in those systems be known but the semantics underpinning that data and the processes that the systems are designed to support should also be unambiguously understood. If services are to be shared between interoperating systems then the processes that these services execute, with their goals and the roles of the people or organisations associated with these processes and services, also should be unambiguously understood.

The underlying purpose of MFI is to allow the sharing of these models. Each of the main parts of the ISO/IEC 19763 series provides a specification, in the form of a metamodel, for a model registry where information about the models, and the things, processes, etc that they are describing, can be registered. Once models have been registered it is possible for the mappings between models, or parts of models, to also be registered. In addition, because models are registered in a registry they can be discovered.

A metamodel within the MFI is an information model that provides a conceptual view of the information that is to be recorded when a model is registered. Each of these metamodels is expressed both as a UML class diagram and, more formally, in text.

It is not sufficient to register a model in a registry. The registry should also be discoverable, and enabling this discoverability of registries is also an important element of the MFI.

6.2 Strengthening interoperability and integration capability

6.2.1 Overview

High-level information sharing is necessary to achieve the required integration of data or services. This relies upon the strengthening of the capabilities to discover models. This is underpinned by two types of interoperability, as follows:

— system interoperability (see 6.2.2);

— semantic interoperability (see 6.2.3).

This is illustrated in Figure 1.

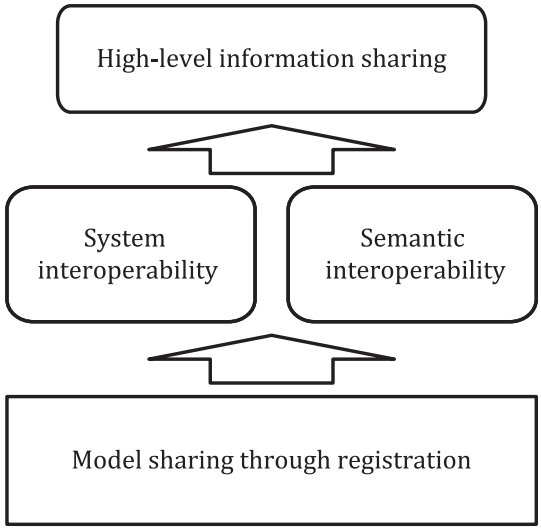


Figure 1 — Two types of interoperability

6.2.2 System interoperability

System interoperability in a heterogeneous network system requires the standardisation of the communication protocols to enable the lower level physical connection. It also requires the standardisation of both the message formats and the syntactic representation of the data to be exchanged. The syntactic representation of data is normally held as metadata.

Many de jure and de facto Standards Developing Organizations (SDO), such as ISO, IEC, UN, OMG and W3C, have developed and enforced many industry-specific metadata or registry standards. Examples exist in the e-business, healthcare, electronic parts, electronic documents and library areas, but most of these industry sector metadata or registry standards are incompatible with each other.

With this proliferation of standards, it is not easy to share information across different industries or domains without any specific mapping or translation tools. This is made worse if the metadata is registered in different registries. For this reason, it is almost impossible to have a global and dynamic supply chain that penetrates different industries across many countries.

For example, an electronics manufacturing company will have their own product database to handle the development, manufacture and sale of their products while the retailer will have their own item database which will be used to manage their stock and their purchases. Each database will have been developed independently, with each following the particular metadata standards, if any, that were specified by the industry consortium or some other SDO. In this situation, it is almost impossible to achieve interoperability between the manufacturer's system and the retailer's system. Figure 2 illustrates this problem.

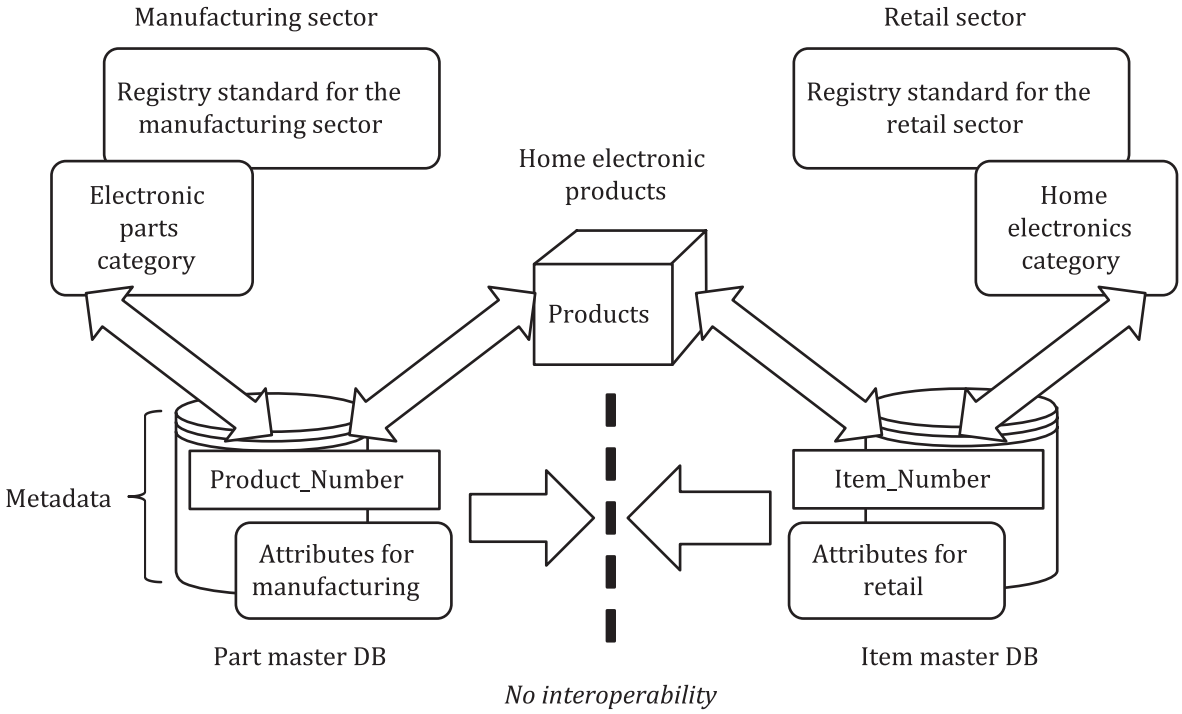


Figure 2 — Problems with cross-industries interoperation

To overcome this problem there should be a mapping between the database structures of the two systems. To achieve this mapping the information models, and perhaps the process models, need to be understood and compared. The mappings themselves then need to be registered.

In software development, information models are used to capture and document the information requirements that should then lead to the specification of a database design. Each of these information models will be expressed using one of the many notations available, for example as a UML Class Diagram or as an IDEF1X model. Since many engineers are normally involved in any software development, the sharing of models is common. Where this development involves collaborating engineers in different countries and languages, this model sharing should be supported by a specific platform or infrastructure.

In a model registry, MFI provides a basis for this model-sharing infrastructure. Model sharing can be made possible by registering these models in a model registry. This will make it easier to discover an appropriate model. See Figure 3 for an illustration of this concept.

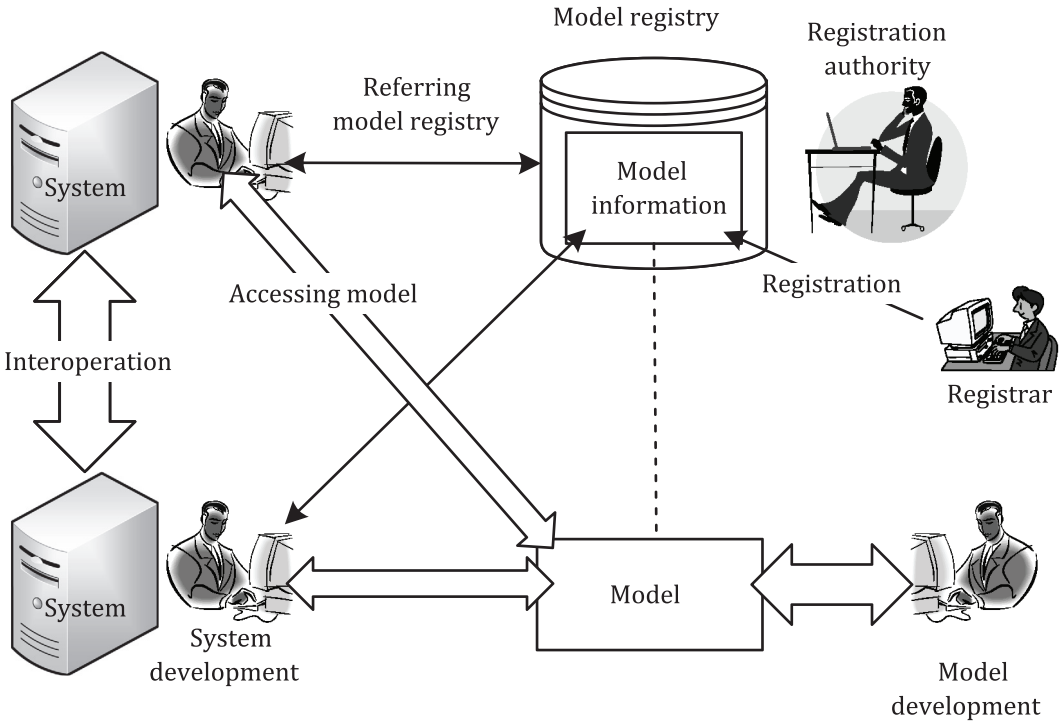


Figure 3 — Basic concept of model sharing through a model registry

6.2.3 Semantic interoperability

Many terminology dictionaries are available, some on the internet. Some of these are generic dictionaries while the others each provide a set of technical terminologies in a specific domain, such as healthcare.

ISO/IEC 11179-32[4] enables the registration of concept systems, where each concept system is a set of concepts structured in one or more related domains according to the concept relations among its concepts. In addition, ISO/IEC 11179-3 enables the registration of concepts irrespective of whether they are part of a concept system or not. In ISO/IEC 19763-10[14], there is provision for the annotation of each model or model element so that data sharing and model sharing can be based on the semantic understanding of the model or the information represented by the model or the model elements.

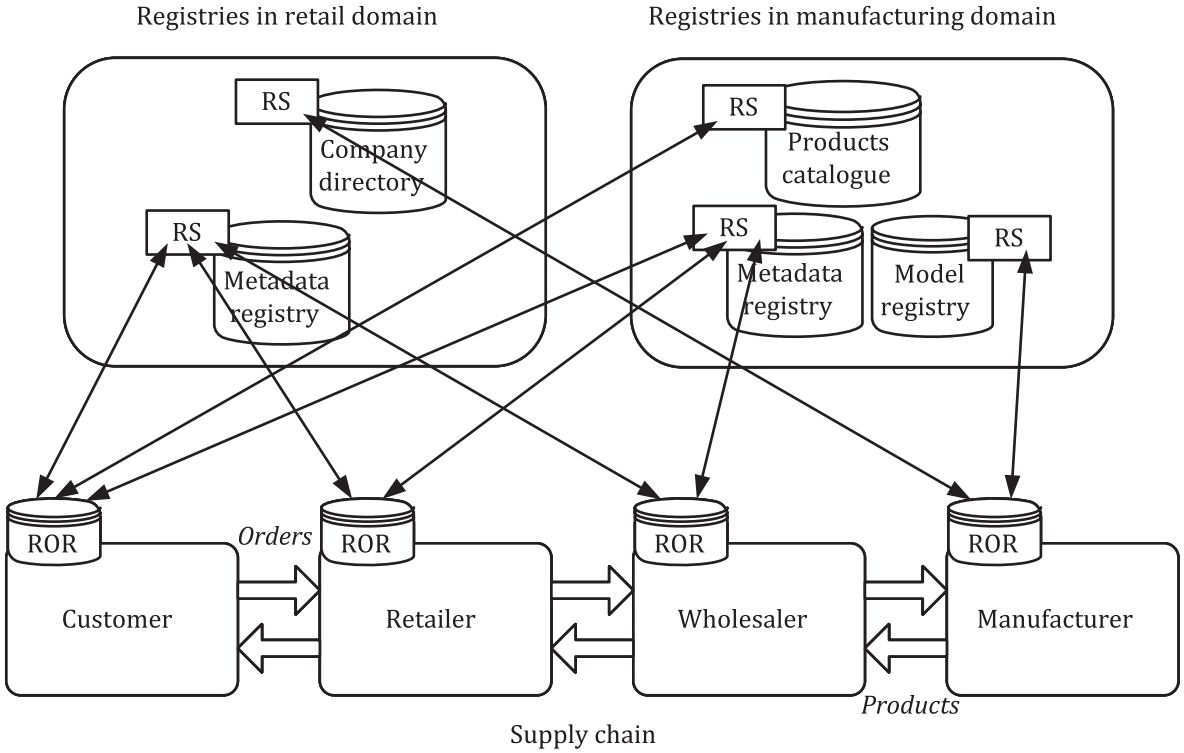
As well as aiding the understanding of the meaning of information, these facilities are also helpful in the definition of mapping rules between models and model elements. Mapping between models is achieved using the Item Mapping facilities specified in ISO/IEC 11179-3:2023, Clause 11.

6.3 Registry interoperability

Another major purpose of MFI is to enable interoperability between registries. Many metadata registries or model registries are in existence, each designed to support industry-specific business domains in many different countries or territories. Most of these registries conform to industry-specific standards, such as for e-business, healthcare, or library operations. However, those standards themselves are incompatible with each other and they have been developed to meet the requirements specific to their own domains. It means that a single company or user who belongs to a particular domain experiences difficulties in accessing registries in other, different, domains.

To enable system interoperability, it is necessary to share information registered in different registries across different domains. To achieve this MFI specifies, using a metamodel, a set of small XML artefacts, called a Registry Summary (RS). These artefacts record the nature of the registry and its content and also provide technical information to enable accessing the registry. The intention is that an RS should be attached to each registry.

Figure 4 illustrates a typical example of the use of Registry Summaries. Each registry in a particular domain can make their Registry Summary publicly available. Users in different domains, such as Manufacturing or Retailing, can then build their own dedicated registry that is a collection of Registry Summaries that are of interest to them. This special registry is called a Registry of Registries (ROR).



Key

ROR Registry of Registries

RS Registry Summary

Figure 4 — Registry interoperability using RS and ROR

6.4 Model discovery

There is a need for the smart and efficient discovery and integration of information objects that are available over networks. This is made more urgent in the era of the internet, cloud computing and linked open data (LOD), where there is a requirement for more sophisticated knowledge and service discovery.

MFI provides for this discovery through those parts that contribute to the Role, Goal, Process and Service (RGPS) facilities: the metamodel for process model registration, the metamodel for service model registration, and the metamodel for role and goal model registration. The use of these parts is brought together in ISO/IEC TR 19763-9[13] that explains the on demand model selection based on RGPS, as illustrated in Figure 5.

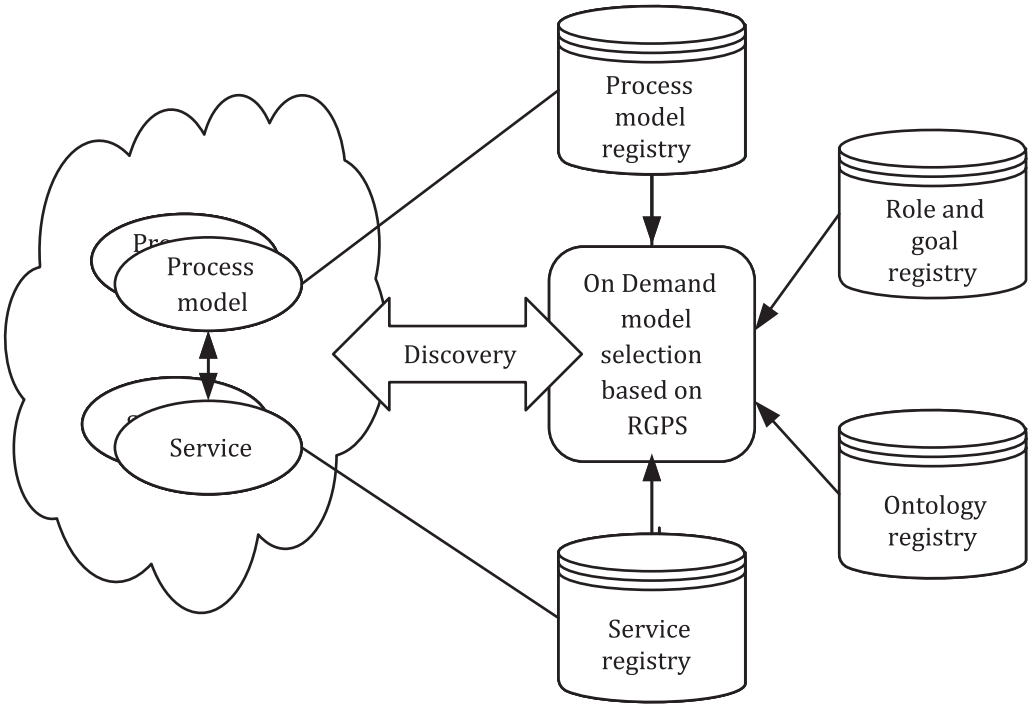


Figure 5 — Discovering services and processes based on RGPS

7 Model registration

7.1 Basic idea of an MFI metamodel

A metamodel is a model that is used to explain a set of related models by defining the language that is used for expressing such models. In MFI the metamodels specified in the different parts define the set of concepts described in the models under consideration that are important for interoperability and, therefore, need to be registered.

In MFI, all the metamodels are specified as UML Class Diagrams, which means that all of the MFI metamodels are described using the UML metamodel.

However, UML is not the only set of notations used for domain modelling. Other languages, such as IDEF1X for information modelling and BPMN[7] for business process modelling, are often used. All the MFI metamodels, therefore, are not designed for a specific domain modelling language but are able to accommodate generic concepts covered by the type of model concerned (ontologies, information modelling, process modelling, etc).

This is illustrated in Figure 6.

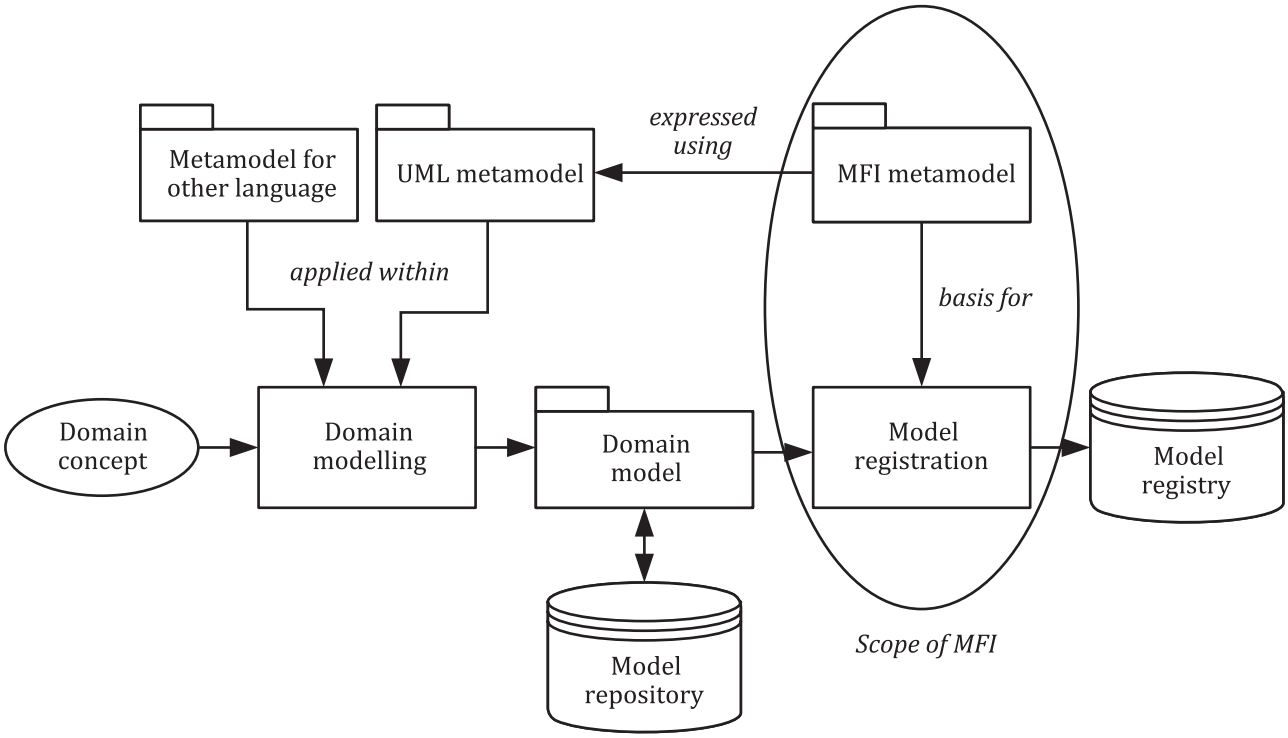


Figure 6 — MFI metamodels and the UML metamodel

7.2 Basic concept of model registration

MFI provides a set of metamodels specifying the structure of registries that can be used to register various types of models. The use of these MFI metamodels makes the model registration process easier. They also enable consistency in the information to be registered about the models.

Figure 7 shows the basic concept of the model registration. The MFI metamodels provide a registrar with a consistent view of model information that needs to be registered.

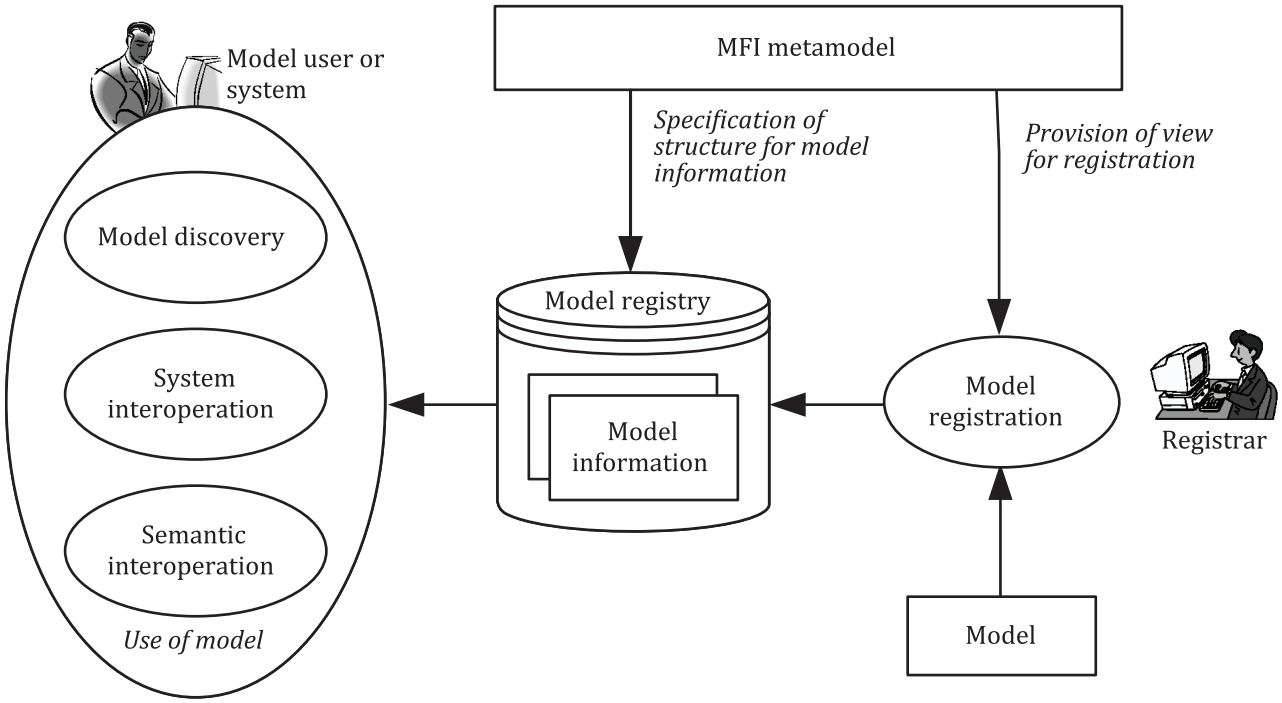


Figure 7 — Basic concept of MFI registration

The metamodel in ISO/IEC 19763-10 is a core model that provides common features that are used by all the other parts. The model constructs in the metamodels in the other parts are all specialisations of model constructs defined in the core model. The metamodels for the other parts provide details of the information to be registered for the various types of models covered by the MFI.

MFI does not specify any implementation requirements for a registry. Each metamodel only specifies the information that can be registered about a model. A registry does not store the actual model instance in its database; only the model information is stored.

The model information stored in a registry provides information about:

— the modelling language used to express the model;

— the model elements included in the model;

— the relationships among these model elements.

MFI assumes that the actual models to be shared are stored outside of MFI. This storage can be electronic in a model repository, or the models can be held as documents.

An MFI registry uses the registration facilities that are specified in ISO/IEC 11179-3. As such, for each model the information that can be recorded includes:

— details of the registration authority, including the registrar;

— the date of the registration;

— the registration status;

— the submitter and steward of the model;

— the context of the model;

— the elements within the model.

8 MFI architecture

8.1 Overall structure of MFI

This clause specifies the architecture of MFI. All parts of MFI adopt this architecture.

The MFI series (ISO/IEC 19763 series) consists of a number of parts, each of which (other than this document and any technical reports) specifies a metamodel. One part (ISO/IEC 19763-10) provides common facilities for the other parts: a core model. All of the other metamodels provide for the registration of a particular type of model.

MFI can be considered to provide a set of extension to a metadata registry (MDR). Figure 8 shows the basic overall structure of the MFI, including its relationship to an MDR and to the UML.

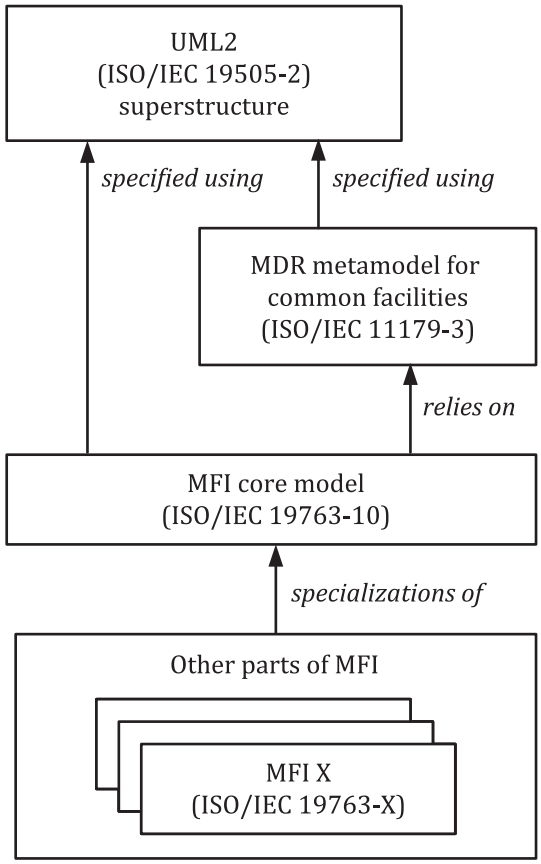


Figure 8 — Overall structure of MFI and its relationships to MDR and UML

8.2 Common modelling framework for MFI

To maintain consistency among the parts of the MFI series, ISO/IEC 19763-10 provides common modelling facilities. Figure 9 shows the concept of the core model. Central to the core model are three metaclasses:

— **Modelling_Language**;

— **Model**;

— **Model_Element**.

The inclusion of the **Modelling_Language** metaclass allows models expressed in any modelling language to be registered.

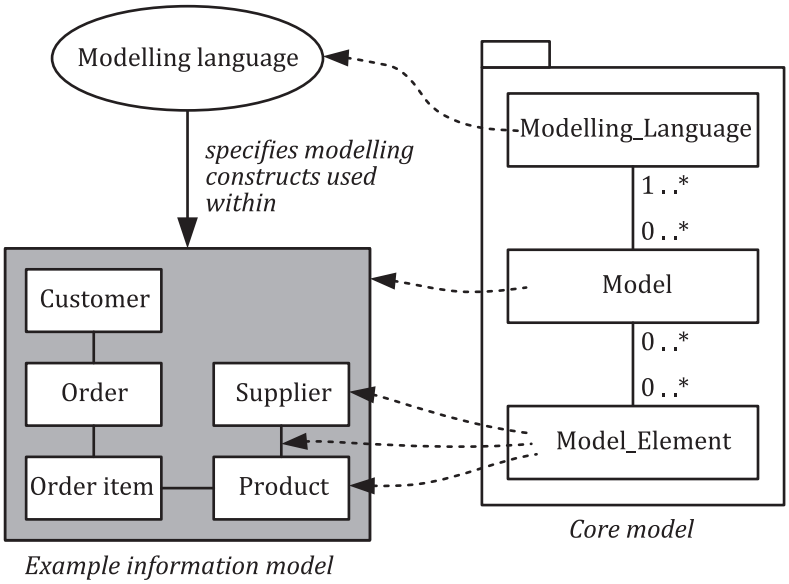


Figure 9 — Concept of the core model

The metaclasses in the metamodels specified in the other parts are all specialisations of one of the metaclasses in the core model, as shown in Figure 10. As new parts are developed, they will follow this structure, thus ensuring that the architecture is maintained.

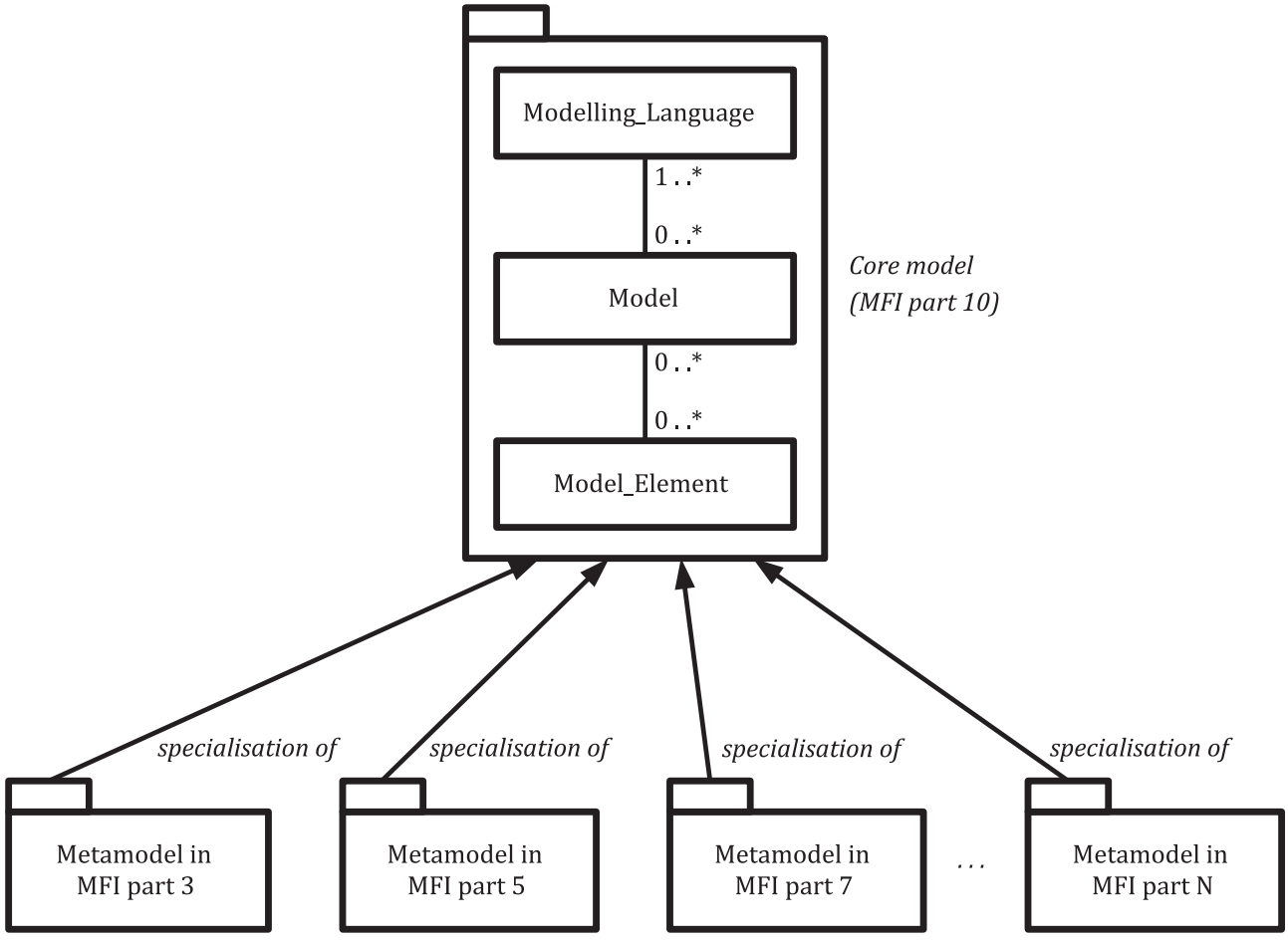
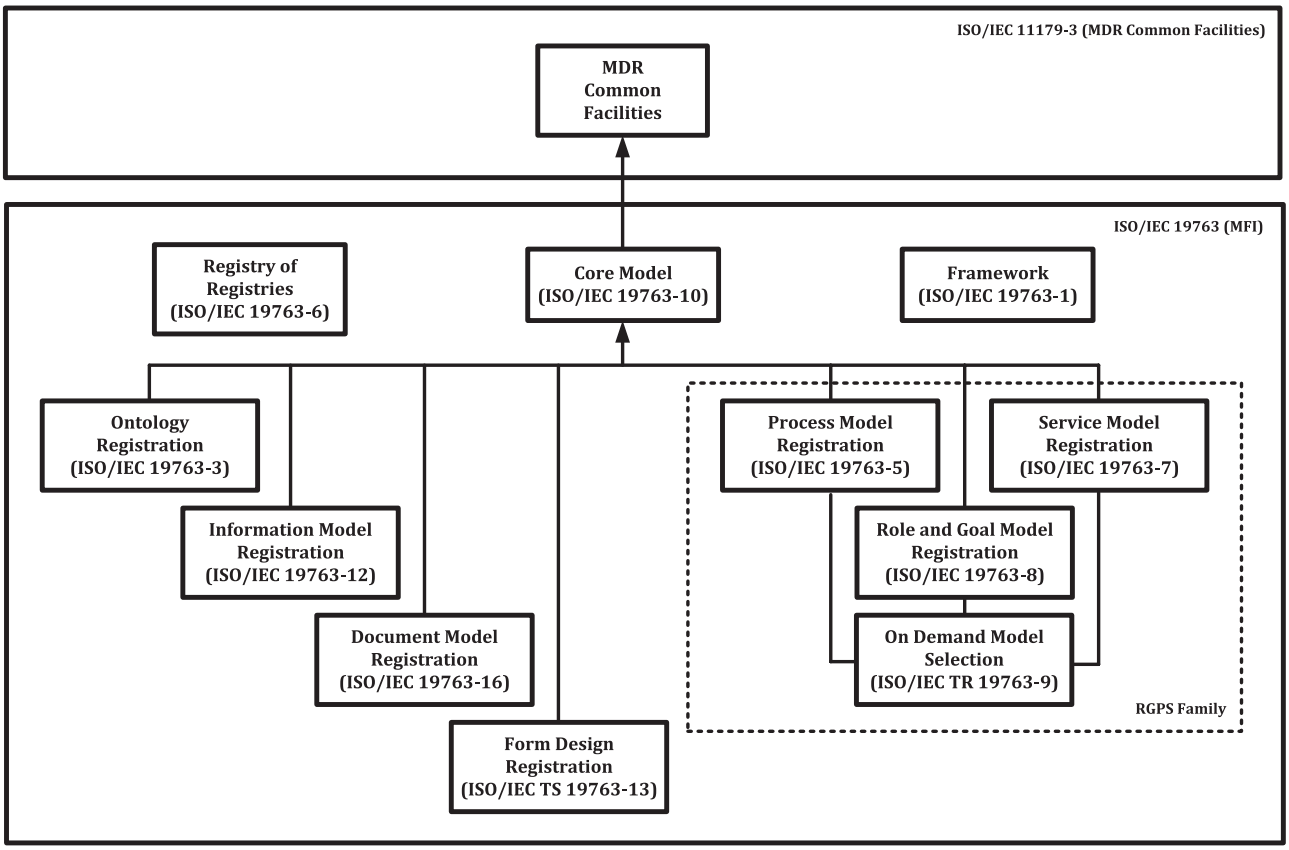


Figure 10 — Common base for MFI subparts

Annex A
(informative)

Internal structure of metamodel framework for interoperability (MFI)

This annex describes the parts of the MFI series.



NOTE The Role-Goal-Process-Service (RGPS) family forms a set of standards that together facilitate the discovery of services.

Figure A.1 — Relationship between parts within the MFI series

MDR Common Facilities

In order to maintain consistency in the registration of objects, such as models or model elements, all parts of MFI share the same administrative information that is defined in the common facilities, as specified in ISO/IEC 11179-3.[2] The common facilities include facilities to enable the mapping of models and model elements to other models, and their model elements, or other registered items.

Framework

ISO/IEC 19763-1 (this document) describes the concepts, including registration, and the overall architecture of the MFI series that is to be applied in the development of the individual metamodels specified in the other parts.

Core model and basic mapping

ISO/IEC 19763-10[14] specifies the core model that provides the framework for all other metamodels specified in the other parts. It also provides facilities to enable individual models and model elements to be annotated with concepts to enhance semantic interoperability.

Metamodel for ontology registration

ISO/IEC 19763-3[5] specifies a metamodel that provides for the registration of administrative information about ontologies.

Metamodel for information model registration

ISO/IEC 19763-12[15] specifies a metamodel for the registration of administrative information about information models, models that describe the information recorded in a system. These can be entity-relationship models, UML Class Diagrams or SQL table definitions.

Metamodel for document model registration

ISO/IEC 19763-16[17] specifies a metamodel for the registration of administrative information about document models, models that describe the information recorded in a document. XML schemas and JSON schemas are examples of document models.

Metamodel for form design registration

ISO/IEC TS 19763-13[16] specifies a metamodel for the registration of administrative information about the structure of forms, such as electronic health records or other legal or official forms.

Metamodel for process model registration

ISO/IEC 19763-5[9] specifies a metamodel that provides for the registration of administrative information about different kinds of process models. These process models can describe the processes supported by a system or can support the discovery of services through RGPS.

Metamodel for service model registration

ISO/IEC 19763-7[11] specifies a metamodel for the registration of administrative information about services. The main focus of this part is on web services but the metamodel can be used to register any service that is supported by a set of processes.

Metamodel for role and goal model registration

ISO/IEC 19763-8[12] specifies a metamodel for the registration of administrative information about the roles and goals that are associated with processes and services.

On demand model selection (Technical Report)

ISO/IEC TR 19763-9[13] is a technical report that explains how a registry, or a collection of interconnected registries, that is based the metamodels specified in ISO/IEC 19763-5, ISO/IEC 19763-7 and ISO/IEC 19763-8 can be used together to discover models, particularly models that represent services.

Registry of Registries

ISO/IEC 19763-6[10] specifies a metamodel of the registry summary information that can be added to any type of registry. This summary information can be collected together into a Registry of Registries (ROR).

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