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Information technology — Metamodel framework for interoperability (MFI) —

Part 1: Reference model

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

Partie 1: Modèle de référence

Reference number
ISO/IEC 19763-1:2007(E)

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

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

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

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

ISO/IEC 19763-1 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 32, *Data management and interchange*.

ISO/IEC 19763 consists of the following parts, under the general title *Information technology — Metamodel framework for interoperability (MFI)*:

— *Part 1: Reference model*

— *Part 2: Core model*

— *Part 3: Metamodel for ontology registration*

— *Part 4: Metamodel for model mapping*

Introduction

Due to the spread of E-business (EB) and E-commerce (EC) over the Internet, the effective exchange of business transactions and other related information across countries and cultures has become a prime concern for people both inside and outside the IT industry.

To follow the current trends of EB or EC, industrial consortia have engaged in the standardization of domain-specific objects including business process models and software components using common modeling facilities and interchange facilities such as UML and XML. They are very active in standardizing domain-specific business process models and standard modeling constructs such as data elements, entity profiles, and value domains.

Following these trends, many standardization activities have focused on the facilities or schema that could enable the collaborations among different organizations, such as

a) modeling facilities or modeling architectures such as UML or MDA;

b) E-Business procedures and exchange formats such as ISO/IEC 15944, ebXML, XMI and SOAP;

c) description facilities of information resources such as XML, RDF and WSDL;

d) business process integration facilities such as BPEL and BPMN;

e) registry facilities such as ISO/IEC 11179 (MDR), ebXML-R&R, UDDI;

f) meta-modeling facilities such as MOF;

g) ontology descriptive facilities such as OWL, DAML+OIL;

h) facilities for logic such as CL, CG and DL.

In addition to the above, other activities which focus on the contents to be treated by facilities have emerged as subjects of standardization.

These include

a) common models for various business domains, such as GCI, CPFR and HL7;

b) modeling profiles or modeling patterns such as UML profile for EDOC and EAI;

c) registry metamodels such as ebXML RIM and HL7 RIM;

d) metamodels such as CWM for data warehouse and ODM for ontology;

e) metadata specifications, such as Dublin Core or ebXML Core Component;

f) ontology models, such as SNOMED in healthcare, SUO in engineering and ISO/IEC 15944-4 E-Business economic and accounting ontology.

These contents could be stored in registries in order to enable the effective sharing among different organizations.

NOTE UML and OMG are trademarks of the Object Management Group.

Many registries and repositories have been developed and implemented. However, due to differences in their metamodels or disharmony in their semantics, effective collaboration among organizations or communities has been difficult. New facilities are required that enable a harmonized federation among these registries.

To satisfy these requirements, ISO/IEC 19763 provides the facilities for describing various types of registries or metamodels as a consolidated set of metamodel frameworks.

This consolidated metamodel framework will provide the following features:

a) metamodel registering mechanisms for enabling the federation of registries;

b) description and registering mechanisms for various modeling constructs to facilitate their reuse;

c) description and registering mechanisms for rules of model mapping and transformation to enable the harmonization of registry contents.

This part of ISO/IEC 19763 describes the basic concept of metamodel framework which should be used in the development of other parts of ISO/IEC 19763. The issues and requirements to be considered in this development are also described.

Information technology — Metamodel framework for interoperability (MFI) —

Part 1: Reference model

1 Scope

ISO/IEC 19763 specifies a framework for metamodel interoperability.

This part of ISO/IEC 19763 establishes general principles for the metamodel framework and gives guidelines for developments of other parts of ISO/IEC 19763.

The multiple parts of ISO/IEC 19763 are to be used in the development of a harmonized metamodel to facilitate the interoperation of existing registries or metamodels.

2 Conformance

ISO/IEC 19763-1 specifies no conformance requirement. Other parts of ISO/IEC 19763 specify their own conformance requirements, as appropriate.

3 Normative references

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

ISO/IEC 11179-1, *Information technology — Metadata registries (MDR) — Part 1: Framework*

ISO/IEC 11179-3, *Information technology — Metadata registries (MDR) — Part 3: Registry metamodel and basic attributes*

ISO/IEC 19502:2005, *Information technology — Meta Object Facility (MOF)*

4 Terms, definitions and abbreviated terms

4.1 Terms and definitions

4.1.1
domain object
object which represents an entity or a process in a particular domain

4.1.2
domain model
model which represents a particular domain

4.1.3
metadata
data which describes other data

NOTE See ISO/IEC 11179-1 and ISO/IEC 19502.

4.1.4
metamodel
model which describes other models

4.1.5
metamodel construct
model construct which is used in metamodels

cf. model construct

4.1.6
meta-modeling facility
modeling facility used for meta-modeling

NOTE MOF is an example of a meta-modeling facility.

cf. modeling facility

4.1.7
model
representation of a universe of discourse (UOD) using a normative modeling facility and modeling constructs

4.1.8
model construct
unit of notation for modeling

NOTE More generic term for modeling element. Sometimes the term is used to include metadata, code and object patterns rather than the notations of a particular modeling facility such as UML.

4.1.9
modeling facility
set of rules and notations for use when modeling

NOTE UML is a typical example.

4.1.10
ontology
description of a universe of discourse in a language that a computer can process

4.1.11
upper model
model which restricts or guides other models

NOTE See 4.1.3.

4.1.12
lower model
model which is restricted or guided by another (upper) model

4.2 Abbreviated terms

BPMN	Business Process Modeling Notation
BPEL	Business Process Execution Language
CWM	Common Warehouse Metamodel
GCI	Global Commerce Initiative
CPFR	Continuous Planning Forecasting and Replenishment
CL	Common Logic (see ISO/IEC 24707, to be published)
ebXML	electronic business XML (see ISO/TS 15000:2004)
EAI	Enterprise Application Integration
EDOC	Enterprise Distributed Object Computing (see bibliography item [12])
HL7	Health Level 7
IDEF1X	Integrated DEFnition Method
MDA	Model Driven Architecture
MOF	Meta Object Facility (see ISO/IEC 19502:2005)
MFI	Metamodel Framework for Interoperability (i.e. ISO/IEC 19763-1)
ODM	Ontology Definition Metamodel
OWL	Web Ontology Language
RDF	Resource Description Framework
SOAP	Simple Object Access Protocol
SUO	Standard Upper Ontology
SNOMED	Systematized NOmenclature of MEDicine
UDDI	Universal Description, Discovery and Integration
UML	Unified Modeling Language
UOD	Universe of Discourse
WSDL	Web Service Description Language
XMI	XML Metadata Interchange (see ISO/IEC 19503:2005)
XML	eXtended Markup Language

5 Metamodel framework architecture

This clause describes the structure of the ISO/IEC 19763 family of standards and the architecture of metamodel framework to be materialized with multiple parts of ISO/IEC 19763.

5.1 Structure of ISO/IEC 19763

Figure 1 illustrates the overall structure of ISO/IEC 19763. However, this structure does not exclude the possibility of future extensions adding other useful metamodels, such as a metamodel for model constructs or the registration procedure.

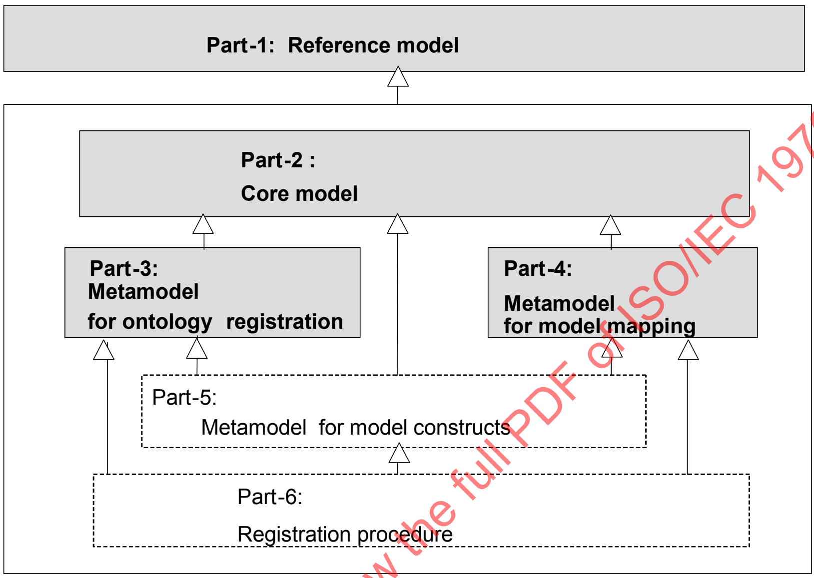

Figure 1 — Overall structure of ISO/IEC 19763

Part 1: Reference model

ISO/IEC 19763-1 specifies the concepts and an overall architecture of the metamodel framework standard to be applied in the development and the registration of the following individual metamodel frameworks.

Part 2: Core model

ISO/IEC 19763-2 specifies the core model of the metamodel framework to be used in the development of metamodel framework standards. The core model provides a mechanism for metamodel description and normative constructs to be used in the development of metamodel framework standards.

Part 3: Metamodel for ontology registration

ISO/IEC 19763-3 specifies a metamodel that provides a facility to register administrative information of ontologies.

Part 4: Metamodel for model mapping

ISO/IEC 19763-4 specifies a metamodel framework for describing any sort of mapping between objects such as metamodels, model elements or data elements.

NOTE Any project for Part 5 or Part 6 is not yet initiated at the first stage of standard development.

5.2 Objectives of ISO/IEC 19763

The objectives of the ISO/IEC 19763 family of standards are focused on improving the interoperability of metamodels defined by different standards groups in ISO or outside ISO, providing a normative metamodel framework for registering individual metamodels.

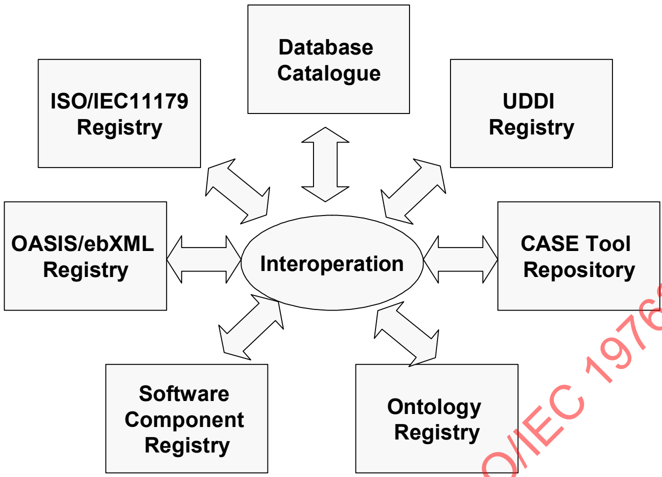

Figure 2 — Registry federation with metamodel framework

5.3 Exclusions

The following are not within the scope of the ISO/IEC 19763 family of standards:

a) standardization of the modeling methodologies;

b) standardization of the contents of the metamodel such as particular ontology schemes or object values;

c) standardization of the contents of model constructs.

5.4 Area of applicability

ISO/IEC 19763 is intended to be applied in the following areas.

5.4.1 Consistent model development

The major purpose of the metamodel technologies is providing a base for model development efforts in terms of clear semantics and syntax of the modeling facility to be used.

The standardization of the metamodel framework for a modeling facility could improve the efficiency of modeling efforts by avoiding unnecessary duplication in the model definitions and discrepancies between the modeling rules and models to be developed.

5.4.2 Model and software component sharing

Another purpose of the standardization of the metamodel framework is to encourage the sharing of various types of modeling constructs such as software components, modeling patterns and domain best practice models in the developments of software systems at an organization or among organizations.

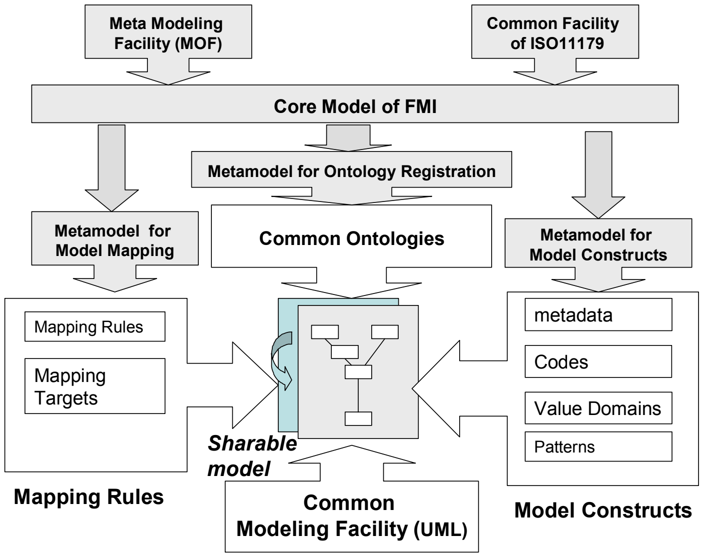

Figure 3 — Metamodel framework to support sharing of models

5.4.3 Business collaboration through E-business or E-commerce

E-business and E-commerce have proliferated over the world, facilitating specific standards such as ebXML or RosettaNet. By the nature of E-business, it is not limited to a single industrial domain or territory. Different domains are linked by the internet, and inevitably users or consumers will need to access different private individual registries (see Figure 4).

The ISO/IEC 19763 family of standards facilitates business collaborations through E-business or E-commerce by providing mechanisms for describing and registering domain specific metamodels in order that they may be shared among different business domains.

Particularly, ISO/IEC 19763-2 provides a mechanism for describing each different metamodel in local registries and make them to be sharable by different domains.

Also, ISO/IEC 19763-3 provides a common mechanism for registering administrative information of ontologies which will be defined in individual domains. This makes it possible to share an ontology by deferent domains in the E-business collaborations.

ISO/IEC 19763-4 provides a facility for registering mapping rules to enable federation among different registries.

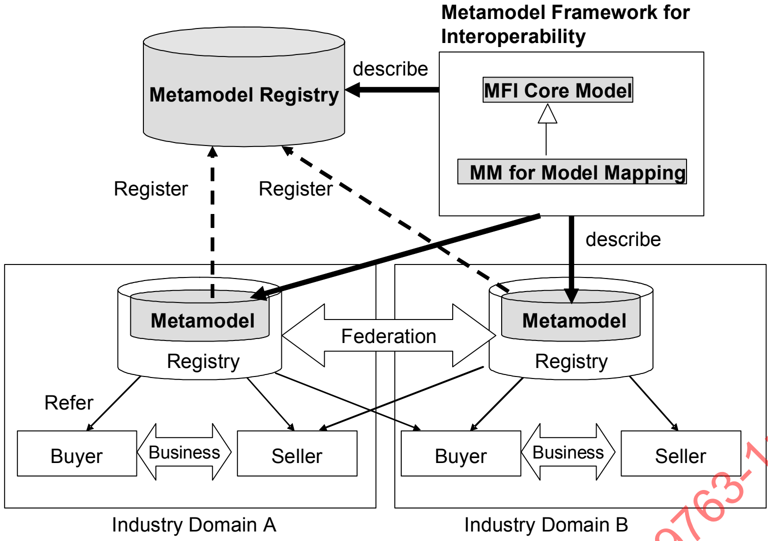

Figure 4 — Registry federation by the metamodel frameworks

5.5 Metamodel framework architecture

This subclause describes the structure of the metamodel framework architecture and the detail concept of both metamodel framework and the metamodel framework architecture.

The metamodel framework consists of a core model and several types of metamodels, such as a metamodel for ontology registration, a metamodel for model mapping and a metamodel for model constructs. However, other useful metamodels are expected to be proposed. (See Figure 5).

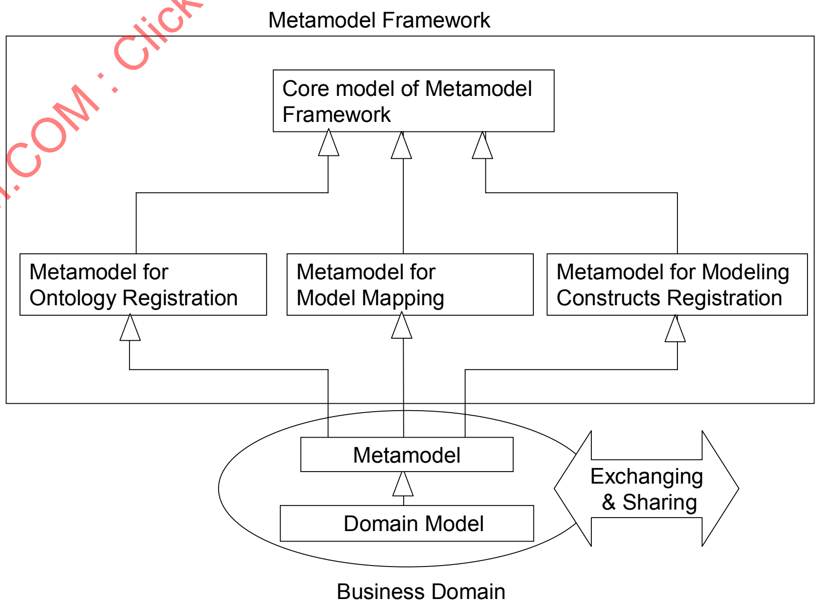

Figure 5 — Metamodel framework architecture

5.5.1 Definition of the metamodel

A metamodel is a model which describes other models. That is, a metamodel governs models, modeling facilities or modeling constructs to be integrated into a particular model instance.

To establish harmony and consistency among metamodels, a metamodel framework and a core model are defined in the ISO/IEC 19763 family of standards. Figure 6 illustrates the relationship among those models. (M0, M1, denotes meta hierarchy levels used in MOF).

In this context, “Govern” means that a metamodel should describe targets not only in a single aspect of the target, such as type or syntax, but also describe relationships to be applied among targets or model constructs specifying type of relationships or end of the relationship.

A metamodel could provide beneficial additional capabilities for the use of models. These are:

a) model expandability,

b) object polymorphism,

c) model integration and transformation,

d) parallel execution and model control,

e) model dynamism and flexibility.

Usually, in modeling or metamodeling efforts, some particular modeling aspects or modeling concerns regarding an UOD (Universe of Discourse) have to be captured by a model developer. Most of the difficulties in the sharing of models are caused by the inconsistency of the perspective of those aspect and concerns between model developers, even if they could use a normative modeling facility, such as UML.

In the traditional practical way for regulating the modeling activity, some sort of guidelines are produced which describe design rules or procedure using textual sentences.

One of the benefits of guiding people by metamodel mechanisms rather than using textual representation of rules or methods, is its clarity and elimination of ambiguity.

So the first priority for preparing metamodel frameworks is providing a common base for normalizing modeling aspects or concerns such as the following.

a) What kind of meta objects should be applied to represent a metamodel?

b) How to make relationships and what type of relationship should be used?

c) What type should be chosen for a selected meta object?

d) What kind of constructs should be used?

e) How to represent rules for mapping or transformation between objects?

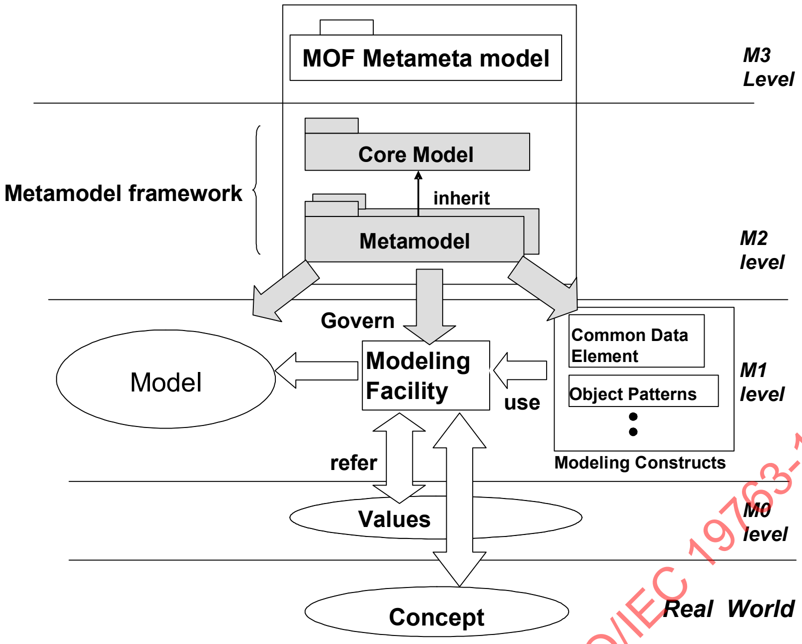

Figure 6 — Metamodel framework architecture and overall structure of meta hierarchy

The metamodel framework architecture defines an architectural view to the consolidation of metamodel standards to meet the objectives of this standard.

The metamodel framework architecture is a set of normative metamodel standards that could be used to registering individual metamodels produced by registry implementers in order to enable harmonized exchanging and reusing of various types of domain objects, by providing a unified view of the normative metamodels and the normative modeling aspects to be applied to capture the contents to be described in an individual metamodel.

The purpose of the metamodel framework architecture is to provide

a) a clear concept of the relationship between model and metamodel;

b) an unified view of the functional classification of metamodels;

c) a common infrastructure for different modeling facilities to establish interoperability between them.

5.5.2 Definition of a metamodel framework

A metamodel framework is a set of normative metamodels and metamodel constructs to be used in the development of a metamodel in the actual implementation of a registry. A normative metamodel has as its scope a particular meta-modeling concern or a metamodel domain, such as model mapping, registering models or model constructs.

The purpose of a metamodel framework is to provide

a) a normative use of metamodel to meet a particular metamodel concern;

b) a normative use of metamodel constructs specified by the core model to meet a particular metamodel concern.

5.5.3 Structure of the metamodel framework architecture

The metamodel framework architecture represents the concept that was described above with inheriting meta-meta model of MOF (ISO/IEC 19502) and the common facility of MDR (ISO/IEC 11179).

However, due to the nature of MOF, only abstract syntax of the metamodel constructs were provided by MOF; therefore, it is necessary to define specialized own metamodel constructs to represent metamodel frameworks (see Figure 7).

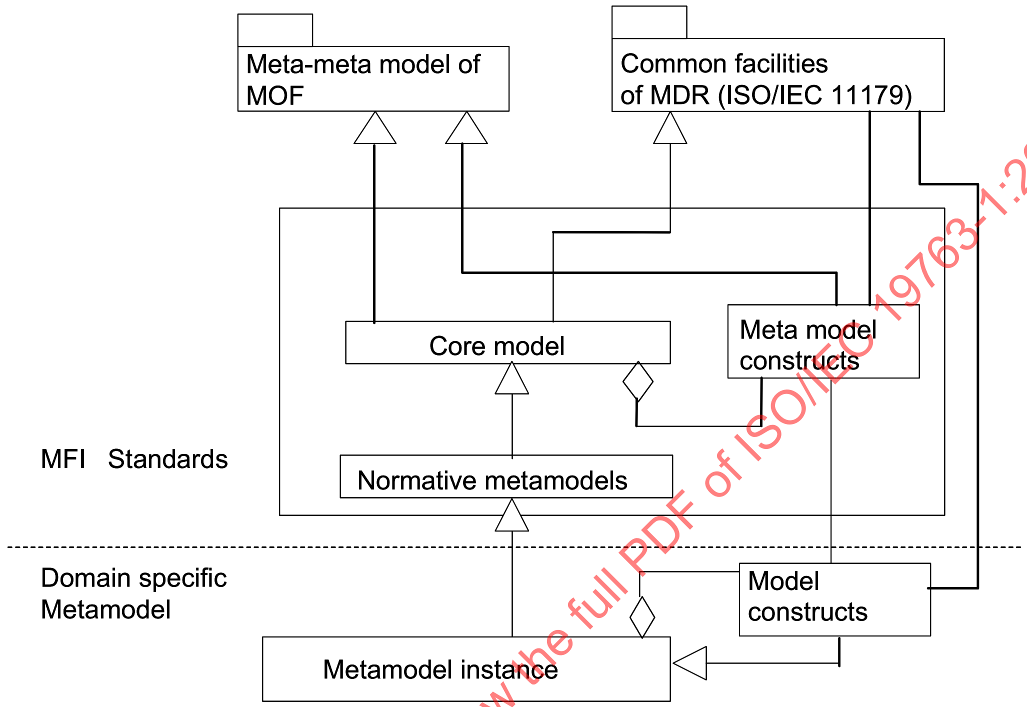

Figure 7 — Structure of the metamodel framework architecture

5.5.4 Concept of the registration

The ISO/IEC 19763 family of standards provides mechanisms for the registration of various types of models or metamodels. To understand mechanisms of the ISO/IEC 19763 core model, the concept of the registration should be clarified.

In ISO/IEC 19763, the registration is intended not only to record items for administrative attributes, but also it is needed to specify an upper model which provides an abstract syntax to the models to be registered as well.

To materialize sharing of models and basic object such as data elements, terminologies, basic classes, basic relationships, the common facility of ISO/IEC 11179-3 (MDR) which is consisted of a naming space or identification scheme and classification scheme should be able to be shared by different metamodels.

The common upper model for every instance of metamodel or model, must be the MOF model which provides an object oriented abstract syntax to them.

The registration also requires the detail modeling constructs which consist of a model or a metamodel to be registered. This implies that the models and metamodels should be developed using normative pre-existing constructs in order to materialize the shareability of the models (See Figure 8).

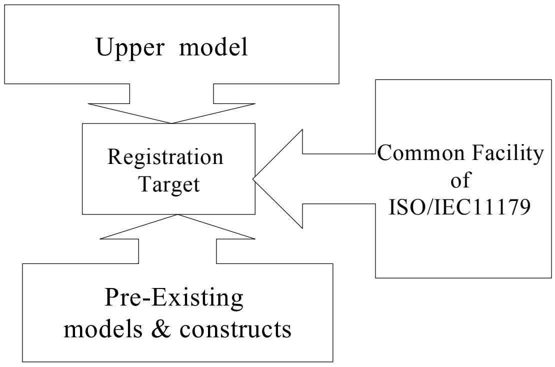

Figure 8 — MFI registration concept

5.6 Part 2: Core model

The core model (ISO/IEC 19763-2) is a vital part of this family of standards. It provides a common descriptive mechanism for each metamodel framework, such as the metamodel for ontology registration (ISO/IEC 19763-3) and the metamodel for model mapping (ISO/IEC 19763-4).

In the core model, the MOF is used as a meta modeling facility, and for an object defining facility, the common facilities of the MDR (Meta Data Registry: ISO/IEC 11179-3) metamodel is used, with some extensions to those facilities.

Since MDR provides a generic object defining scheme such as the concept, the conceptual domain, the element and the values, then the benefits of using the MDR metamodel in this standard come from the expandability of the representing object.

In this standard, key portion of the MDR is represented by using the MOF metamodel in order to add a capability to handle structured objects.

Figure 9 illustrates the meta-meta model which is materialized with the integration of both MDR and MOF facilities. For more detail, see ISO/IEC 19763-2.

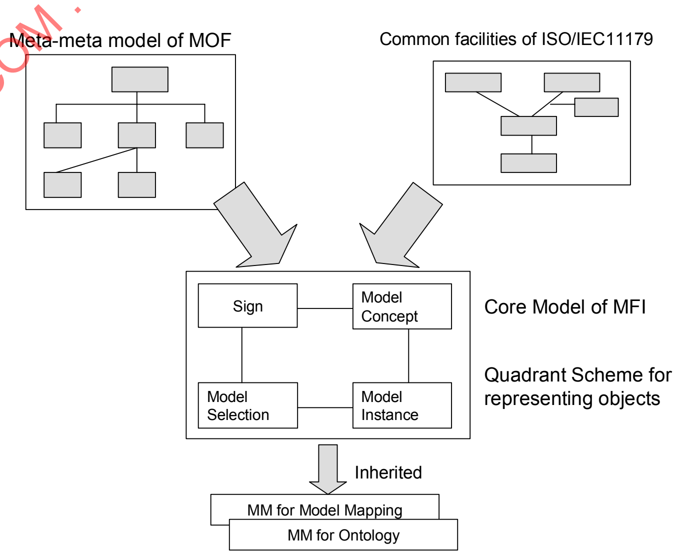

Figure 9 — Core model as a successor of both MOF and common facilities of MDR

5.6.1 Mechanism for the registrations

This standard defines a framework for registration describing the relationship between metamodel and model. In the layer M2 of the metamodel architecture, standards related to domain object models which are developed by standardization organizations, are registered specifying a certain namespace and definitions of concept.

In addition, the model instances conforming those standards, for instance, concrete stereotypes or model patterns also are registered. Users of the registry, such as model developers, select and use some stereotypes and patterns that are appropriate to build the own model in the localized standard layer. The localized standard layer has similar structure to the global standard layer, consisting of named element and namespace ("Sign"), model domain ("ModelDomainProfile") and model classifier ("ModelConcept"), model component ("ModelInstances") and selected model element ("ModelSelection").

As shown in Figure 10, the conceptualization of a registration target means that a particular name (sign) should be specified and some actual definitions should be provided to the target.

Specification of those concepts is defined through matamodels from various scopes, purposes and viewpoints. Then instances of the model governed by the metamodels can be referred to as referents. The sign stands for those referents.

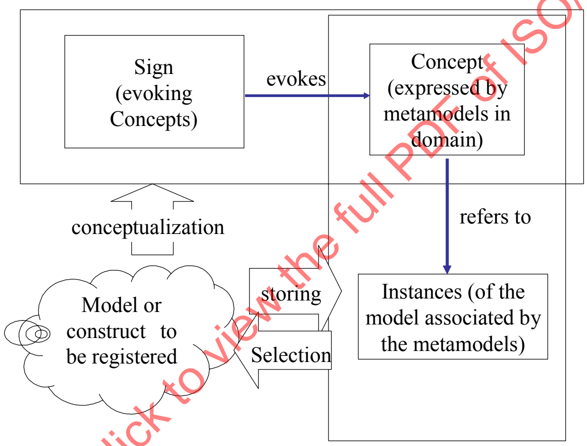

Figure 10 — Concept of the four quadrant registration scheme

One of the benefits of the quadrant scheme in the defining objects or models is that this scheme provides a base for defining an object by specifying it's concept by name (sign) and possible variations correspond to the concept.

In this way, the object could be defined from view points such as, the name, possible details and actual instance.

By those mechanisms, the core model could be able to describe models and metamodels which consist of many structured objects of various types of business domains.

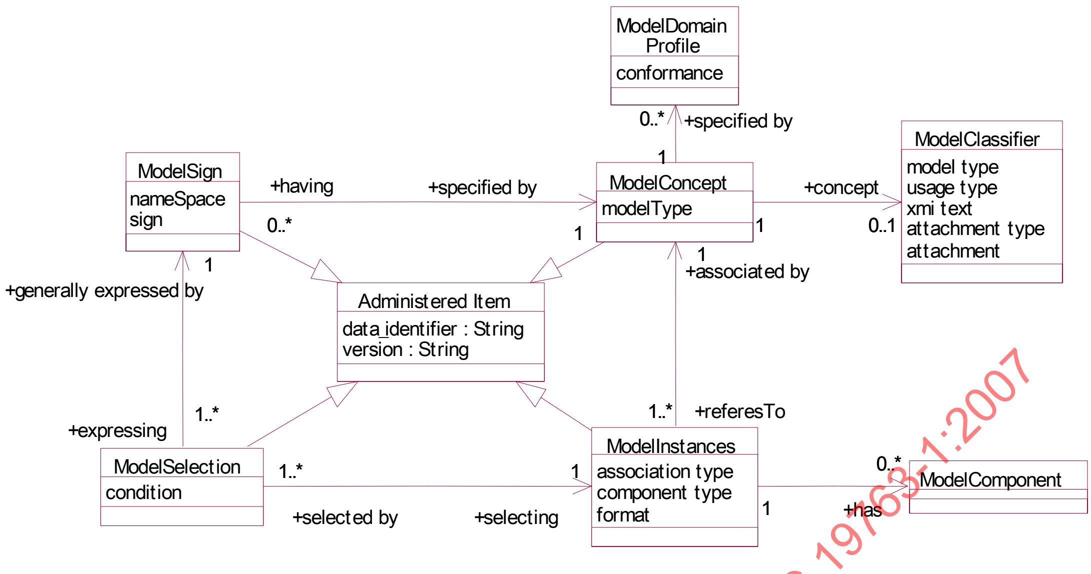

Figure 11 — High level view of MFI core model

5.6.2 Registration example

MFI core model provides a scheme which enables a registration of objects or models specifying an upper model to be inherited or model constructs to be used in the modeling. Figure 12 shows a basic concept of the metamodel for representing a target model which follows the representation scheme described in Figure 13.

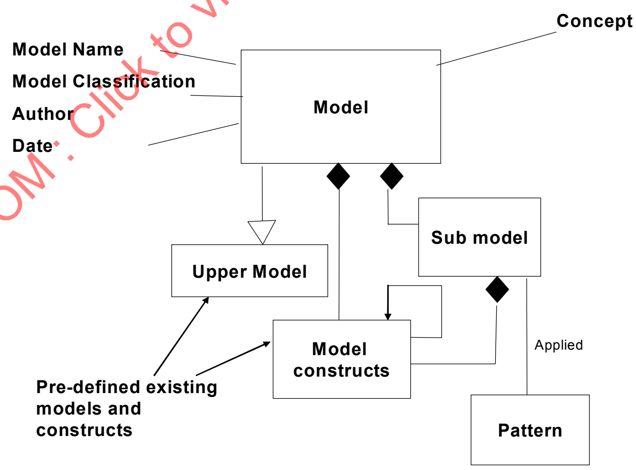

Figure 12 — Scheme for model registration

Figure 13 shows mechanism for the concept representation in the MFI core model. The concept of a metamodel or a model to be registered could be identified by a sign following a particular namespace. The concept of the model should be classified by a classifier and a model type specifying upper model. Detail information of the concept could be provided as a profile and actual documents.

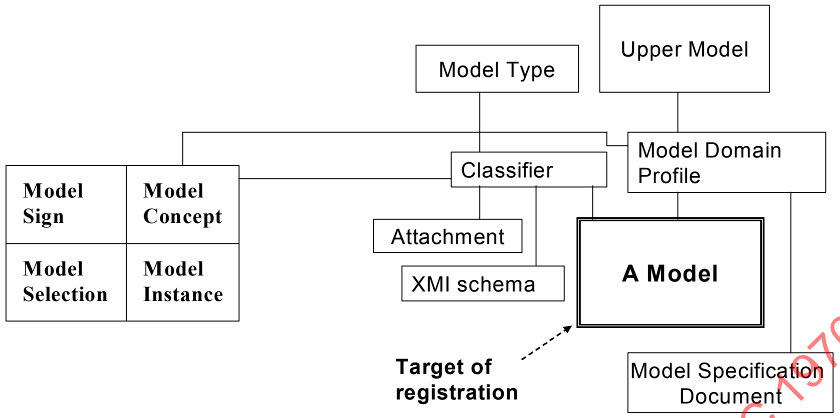

Figure 13 — Representation of concept

Figure 14 illustrates an actual registration of a domain metamodel which represents a software system in a particular domain such as an application system in an organization. At the registration, the MOF model provides an abstract syntax to the metamodel to be registered specifying a sign in a particular namespace and a concept which could be described by a profile.

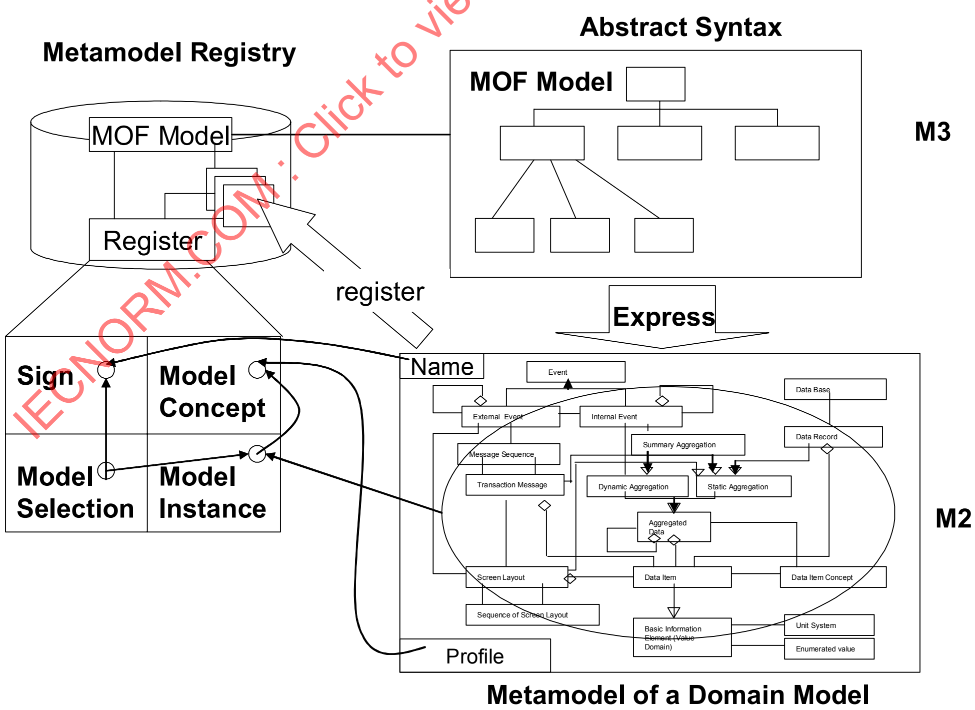

Figure 14 — Registration of metamodels as an upper model