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**Information Technology – Framework for Metamodel
Interoperability**

-- Part-1: Reference model

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. 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 part of ISO/IEC 19763 may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

International Standard ISO/IEC WD 19763-1 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 32, *Data management services*.

ISO/IEC WD 19763 consists of the following parts, under the general title *Information technology — Framework for Metamodel interoperability*:

- _ *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 and E-Commerce 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 those trends, most of the scopes of the standardization activities tend to be focused on the facilities or schema that could enable the collaborations among different organization.

That are,

- a) Modelling facilities or modelling architectures such as UML or MDA
- b) E-Business protocols and exchange formats such as ebXML , XMI or SOAP
- c) Description facilities of information resources such as XML, RDF or WSDL
- d) Business process integration facilities such as BPEL or BPMN
- e) Registry facilities such as ISO/IEC 11179 (MDR), ebXML R&R, or UDDI
- f) Meta-modeling facilities such as MOF
- g) Ontology descriptive facilities such as OWL, DAML+OIL
- h) Descriptive facilities for Logics such as CL, SCL, CG or DL.

Adding to those, the new activities which focus on the contents to be treated by facilities, were emerging and became major concerns of the standardization.

That are,

- a) Instances of common model for each business domain, such as GCI, CPFR or HL7
- b) Modelling profiles or the modelling patterns such as UML profile for EDOC or EAI
- c) Instances of registry metamodel such as ebXML RIM or HL7 RIM,
- d) Instances of metamodel such as CWM for data warehouse or ODM for Ontology,
- e) Instances of metadata, such as Dublin Core or ebXML Core Component
- f) Instances of ontology model such as SNOMED in the Healthcare, SUO in the engineering

Those contents could be stored in the registries in order to enable the effective sharing among different organization.

Then, a lot of registries or repositories were developed and put in the operations. However, due to the difference on their metamodels or the disharmony on their information element meanings, the effective collaborations among organizations or communities became difficult.

There are actual needs for new facilities that enable the harmonized federation among those registries.

To cope with those requirements, this Meta Model Framework for Interoperability family of standards provides the facilities for describing various types of registries or metamodels as a consolidated set of metamodel frameworks.

This consolidated metamodel framework will provide features as follows.

- a) Metamodel registering mechanisms for enabling the federation of registries.
- b) Description and registering mechanism of the various modelling constructs for reusing.
- c) Description and registering mechanisms of rules of model mapping and transformation to enable the harmonization of registry contents.

This part of Meta Model Framework family standards describes the basic concept of Meta Model Framework (MMF) which should be used in the development of other parts of MMF in this family. The Issues and requirements to be concerned in the development are also defined.

Information Technology–Framework for Metamodel interoperability –Part 1: Reference model

1 Scope

The metamodel framework family of standards consists of multiple parts which are to be used in the development of a harmonized metamodel to facilitate the interoperation of existing registries or metamodels.

Figure-1 illustrates the overall structure of the standards. However, this structure does not exclude the possibility of future extensions adding other useful metamodel frameworks, such as for model constructs or the registration procedure.

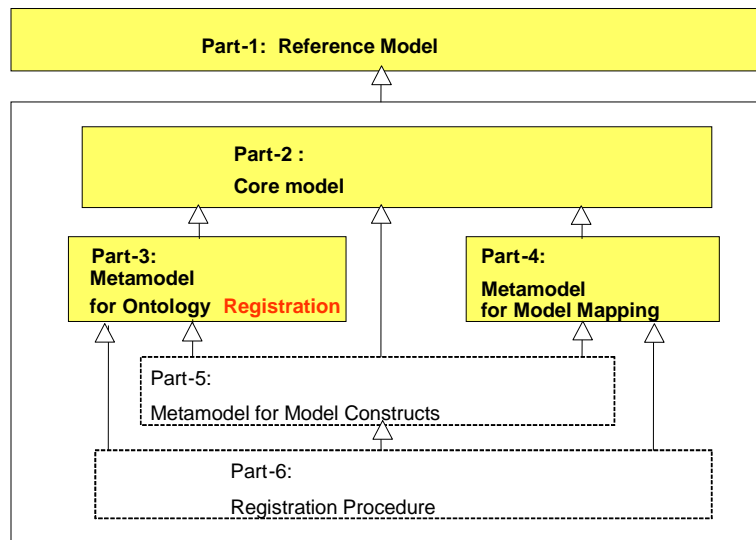


Figure-1 Overall structure of the metamodel framework standard

Part-1 Reference model

This part of the standard describes 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

This part of the standard describes 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

This part of the standard describes a metamodel framework for registering individual ontology schemas.

Part-4 Metamodel for model mapping

This part of the standard describes a metamodel framework for describing any sort of mapping between objects such as metamodels, model elements or data elements.

1.1 Scope - Metamodel Interoperability

The objectives of this 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.

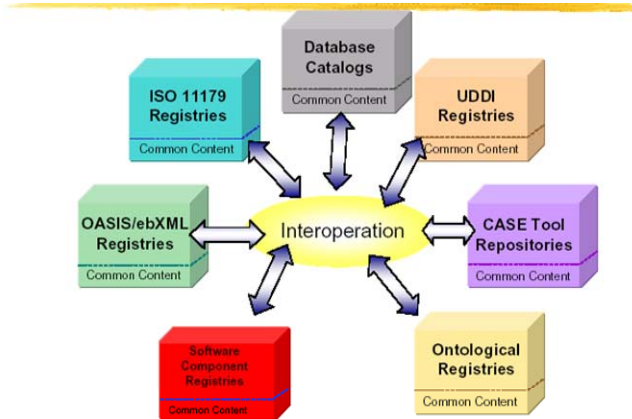


Figure-2 Registry federation with metamodel framework

Problems to be addressed

Many standards organizations, both in ISO and outside ISO, have developed registries to enable the sharing and exchanging of various types of business objects such as object contracts, transaction messages, or product information. Most of them use a particular modeling facility such as UML to represent business process models and transaction protocols to be shared.

In so doing, they developed metamodels in their registries for the effective sharing of those objects and for implementation.

Today, a lot of commercial registries are available in the market. However, one of the issues in metamodel implementation, especially in the business area, is a lack of harmony in the metamodel technologies and methodologies they use. For instance, ebXML (UN/CEFACT, OASIS) defined the ebXML registry with their own metamodel. Also, UDDI (Universal Destination and Discovery Integration) defined its own registry.

Even if they could use a common modeling facility, such as UML or MOF, the contents of the metamodel and model constructs that they use might be incompatible with one another. Then it might be difficult for registry users to find an appropriate target to collaborate with.

1.2 Scope - Metamodel Framework Architecture

This part provides an architectural view of a consolidated set of metamodel framework standards in order to obtain the goals and objectives of this family of standards (See Figure-3). This view is needed to guide of metamodel framework standard development efforts by showing the concept and relationships of metamodel frameworks.

In this family of standards, every metamodel framework is governed by the core model and inherits the concepts and constructs of the core model.

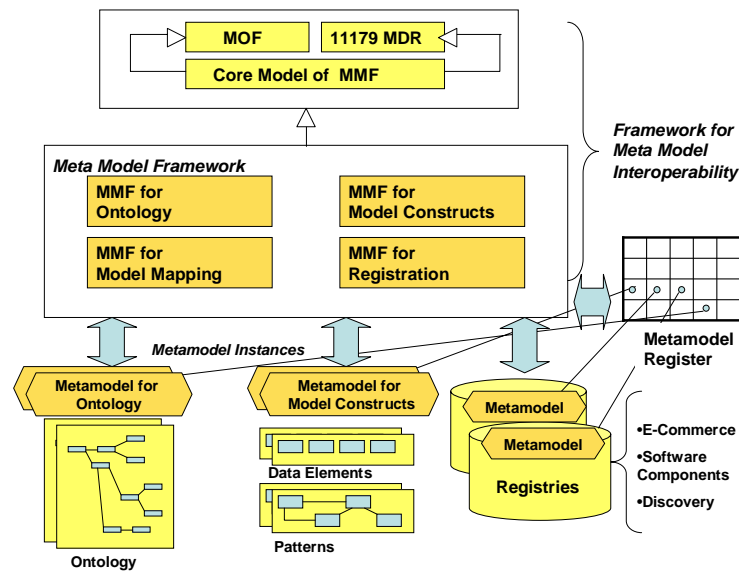


Figure-3 Conceptual View of Metamodel Framework Architecture

The core model of this family is formulated by inheriting both MOF metamodel and the MDR (ISO/IEC 11179-3) metamodel; accordingly all of the metamodel frameworks have to follow the metamodel concept and basic meta objects of MOF and MDR.

The more detailed structure of the architecture is discussed in clause 4 of this part.

1.3 Scope – Exclusions

The following are not covered in the scope of this 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

1.4 Scope – Area of Applicability

This standard is intended to be applied in the following areas.

1.4.1 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.

1.4.2 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.

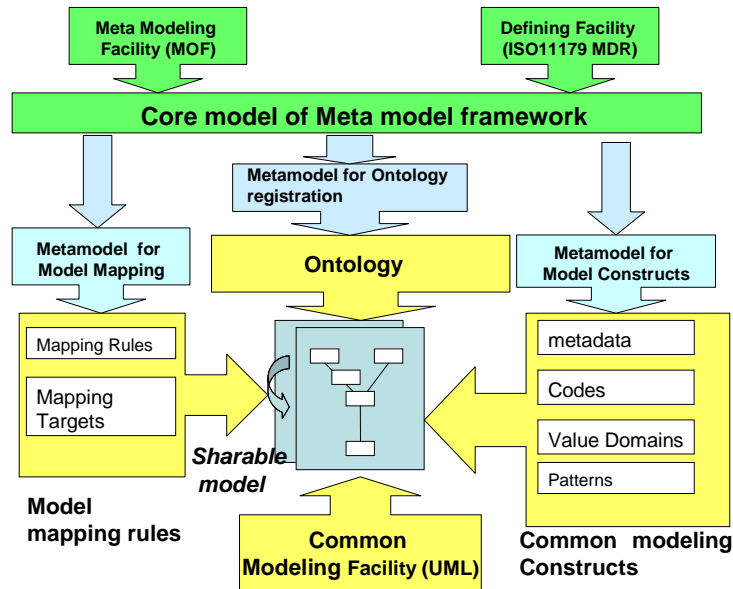


Figure-4 Metamodel Frameworks to support sharing of model constructs

1.4.3 Business collaboration through EC or EB

Today, E-business and E-commerce were 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.

The metamodel framework family of standards facilitates business collaborations through E-business or E-commerce by providing mechanisms to describing metamodel in each registry in order to be shared among different business domain.

Particularly, the core model of the metamodel framework provides a mechanism for describing each different metamodel in local registries and enables registration of those to the registry.

Also, the metamodel framework for model mapping provides a facility for registering mapping rules to enable the federation among different registries.

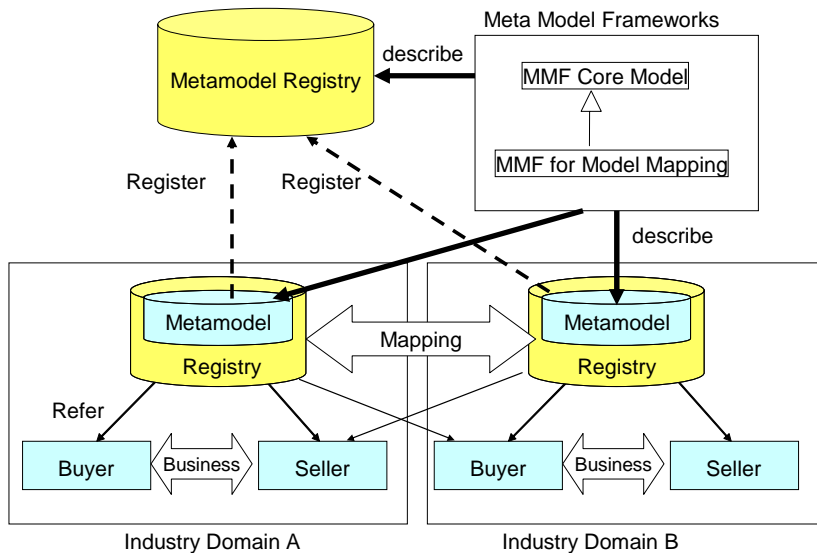


Figure-5 Registry Federation by the Metamodel Frameworks

2. Normative References

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

ISO 8601:2000, Data elements and interchange formats – Information exchange – Representation of dates and times

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

ISO/IEC 11179-2, Information technology – Metadata registries (MDR) - Part 2 : Classification

ISO/IEC 11179-3, Information technology – Metadata registries (MDR) - Part 3 : Metamodel

ISO/IEC 11179-4, Information technology – Metadata registries (MDR) - Part 4 : Formulation of data definitions

ISO/IEC 11179-5, Information technology – Metadata registries (MDR) - Part 5 : Naming and identification principles

ISO/IEC 11179-6, Information technology – Metadata registries (MDR) - Part 6 : Registration

ISO/IEC 11404:1996, Information technology – Programming languages, their environments and system software interfaces – Language-independent datatypes

ISO 12620:1999, Computer applications in terminology – Data categories

ISO/IEC 19501-1:2002, Information technology – Unified Modeling Language (UML) – Part 1: Specification (Not yet completed)

ISO/IEC 19502.:2004, Information technology – Meta Object Facility (MOF) (Not yet completed)

In the text that follows there are many references “See MOF”. There needs to be a normative reference here to MOF.

3. Definitions

3.1 Definition of Metamodel Concepts

3.1.1 business object

Object which represents business entities or business processes. Typical business objects are Customer, Products, and Ordering, etc. [OMG, 1995.]

3.1.2 defining facility

A facility or a mechanism which is used in the defining the nature of an object. In this document, this terminology is to be used to distinguish from the modeling facility. A typical one is the quadrant scheme used in the MDR (ISO/IEC11179).

3.1.3 domain model

A model which represents a particular domain

3.1.4 metadata

Data which describes other data.

See. ISO/IEC 11179-1 (MDR)

See. ISO/IEC DIS19502 (MOF)

3.1.5 metamodel

A model which governs other models.

3.1.6 metamodel construct

Model constructs which are used in meta models

See. Modeling constructs

3.1.7 meta-modeling facility

A modeling facility used for meta-modeling. MOF is an example of a meta-modeling facility.

See. ISO/IEC DIS19502 (MOF)

See. Modeling Facility

3.1.8 meta-object

An object which conform an metamodel.

See. ISO/IEC DIS19502 (MOF)

3.1.9 model

A representation of an universe of discourse (UOD) using a normative modeling facility

See. ISO/IEC DIS 19501 (UML)

See. ISO/IEC DIS19502 (MOF)

3.1.10 modeling constructs

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

3.1.11 modeling facility

A set of rules and notations for use when modeling. UML is a typical example.

See. ISO/IEC DIS 19501 (UML)

See. ISO/IEC DIS19502 (MOF)MOF

3.2 Broad Terms used in this part of ISO/IEC CD19763-1

3.1.12 model

3.1.13 object

3.1.14 ontology

3.1.15

Abbreviations

3.1.16 BPMN

Business Process Markup Language

3.1.17 BPEL

Business process Execution Language

3.1.18 CWM

Common Warehouse Metamodel

3.1.19 ebXML

electronics business XML

3.1.20 MDA

Model Driven Architecture

3.1.21 GCI

Global Commerce Initiative

3.1.22 CPFR

Continuous Planning forecasting & Replenishment

3.1.23 CL

Common Logic

3.1.24 ODM

Ontology Descriptive Language

3.1.25 HL7

Healthcare Level 7

3.1.26 OWL

Web Ontology Language

3.1.27 MOF

Meta Object Facility

See: ISO/IEC DIS 19502 (In Process)

3.1.28 RDF

Resource Definition Framework

3.1.29 SNOMED

Systematized Nomenclature of Medicine

3.1.30 SUO

IEEE P16001 Standard Upper Ontology

3.1.31 UDDI

Universal Destination, Discovery & Integration

3.1.37 UML

Unified Modeling Language

4 Metamodel Framework Architecture

4.1. Overall Structure of the Metamodel Framework Architecture

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

The metamodel framework architecture consists of a core model and several types of metamodel framework, such as a metamodel framework for ontology, a metamodel framework for mapping and a metamodel framework for model constructs. However, other useful metamodel frameworks are expected to be proposed. (See Figure-6).

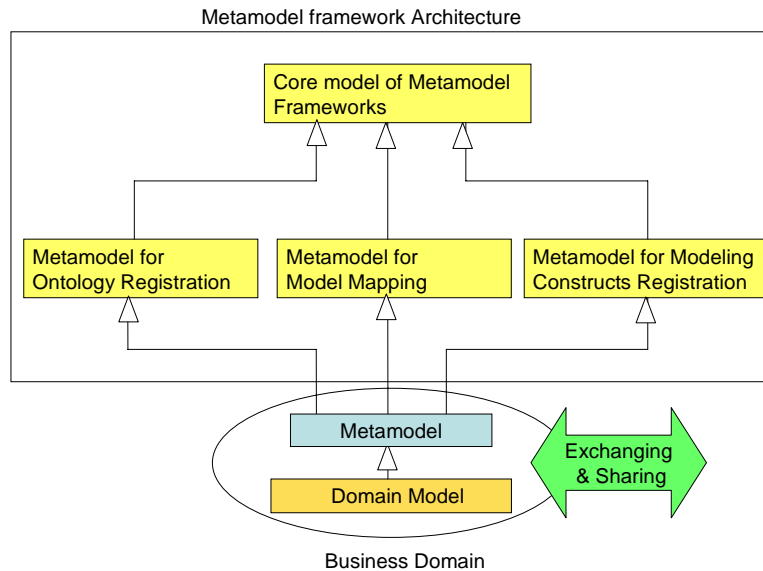


Figure- 6 Metamodel Framework Architecture

4.1.1 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 this family of standards. Figure-7 illustrates the relationship among those models. (M0, M1, denotes meta hierarchy levels used in MOF).

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 meta modeling efforts, some particular modeling aspects or modeling concerns regarding an Universe of Discourse (UOD) have to be captured by a modeler. Most of the difficulties in the sharing of models are caused by the inconsistency of the perspective of those aspect and concerns between modelers, 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 peoples 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;

- 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

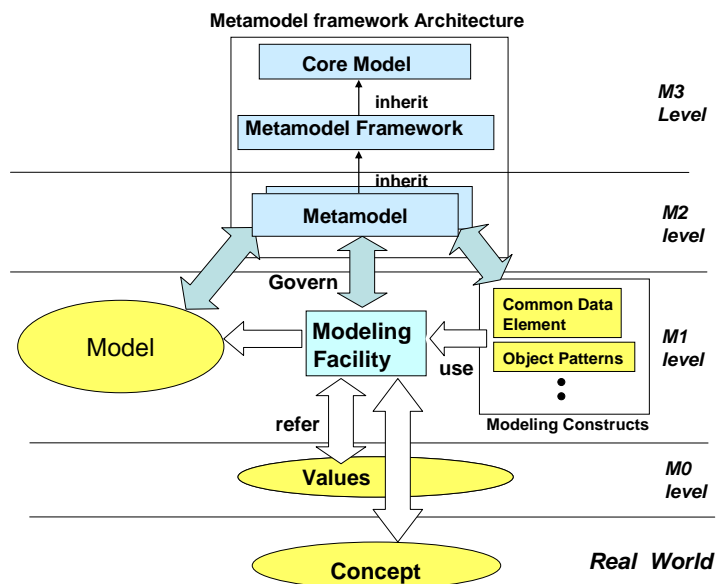


Figure- 7 Metamodel framework Architecture and overall structure of meta hierarchy

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

The metamodel framework architecture is a set of normative metamodel framework 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 business 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) a unified view of the functional classification of metamodels;
- c) a common infrastructure for different modeling facilities to establish interoperability between them.

4.1.2 Definition of a Metamodel Framework

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

The purpose of a metamodel framework is to provide:

- a) a normative use of meta objects defined in the core model to meet a particular metamodel concern;
- b) a normative use of meta-model constructs specified by the core model to meet a particular metamodel concern.

A metamodel framework is a set of normative meta objects and constructs to be used to represent a particular metamodel for a metamodel domain, such as selecting model constructs, mapping between models or model constructs.

4.1.3 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 DIS19502 not completed) and object descriptive concept which based upon the quadrant scheme of MDR (ISO/IEC 11179).

However, due to the nature of MOF, only abstract syntax of the metamodel constructs were provided by MOF, then, it is needed to define specialized own metamodel constructs to represent metamodel frameworks.

The core model of this family of standard is a consolidation of MOF and MDR scheme by describing the MDR's Quadrant scheme such as the concept, the conceptual domain, the value domain with the MOF meta object describing facility.

The detail mechanism on those is described at 4.2 Core Model.

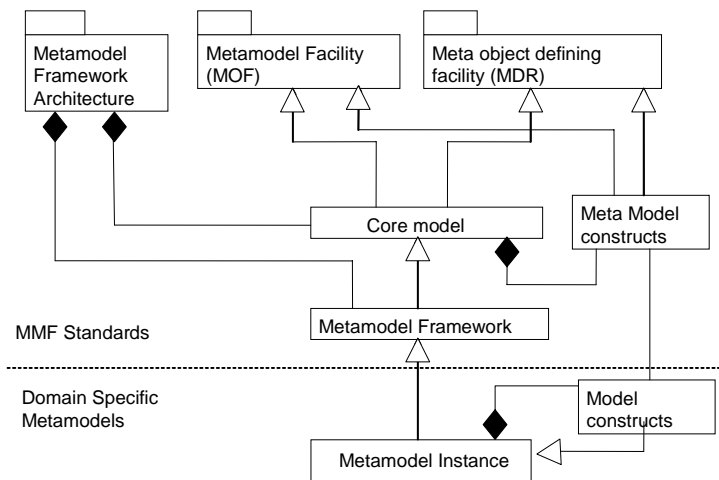


Figure-8 Structure of the Metamodel framework architecture

4.2 Core model (MMF Part-2)

The core model is a vital part of this family of standards as the MMF for Interoperability Part-2. The core model provides a common descriptive mechanism for each metamodel such as the MM for Ontology (Part-3), the MM for Model mapping (Part-4).

In the core model, the MOF (ISO/IEC DIS19502 not completed yet) is used as a meta modeling facility, and for an object defining facility, 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 representation concept of the Quadrant scheme with MOF.

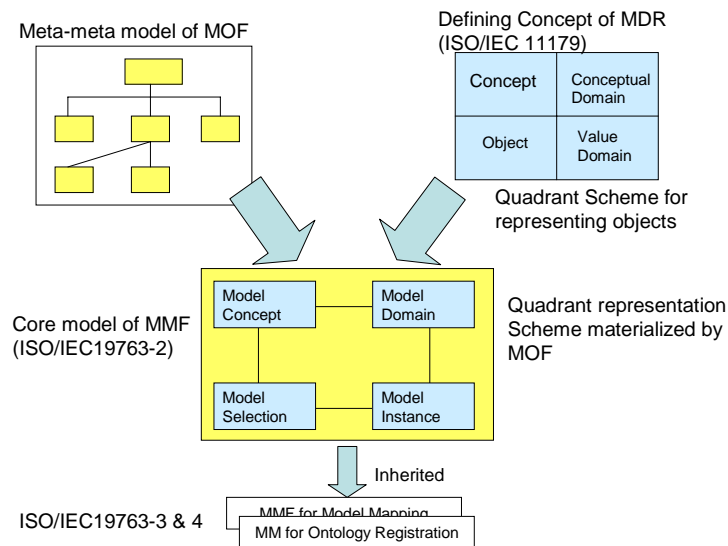


Figure-9 Core model as a successor of both MOF and MDR

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 its concept by name and possible variations correspond to the concept.

Following these manner, 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-10 illustrates an example. An object named "BCC" is specified as an instance of the "model concept" to select a proper model. In the "Model Domain", exact details as metamodel (in this case, "ebXML Core Component Metamodel") are shown. Then, it becomes possible to select a model or a part of model with the exact model concept and its underlying metamodel.

The Core model is used in the development of normative metamodel such as the Meta Model for Ontology Registration (Part-3) and the Metamodel for Model Mapping (Part-4).

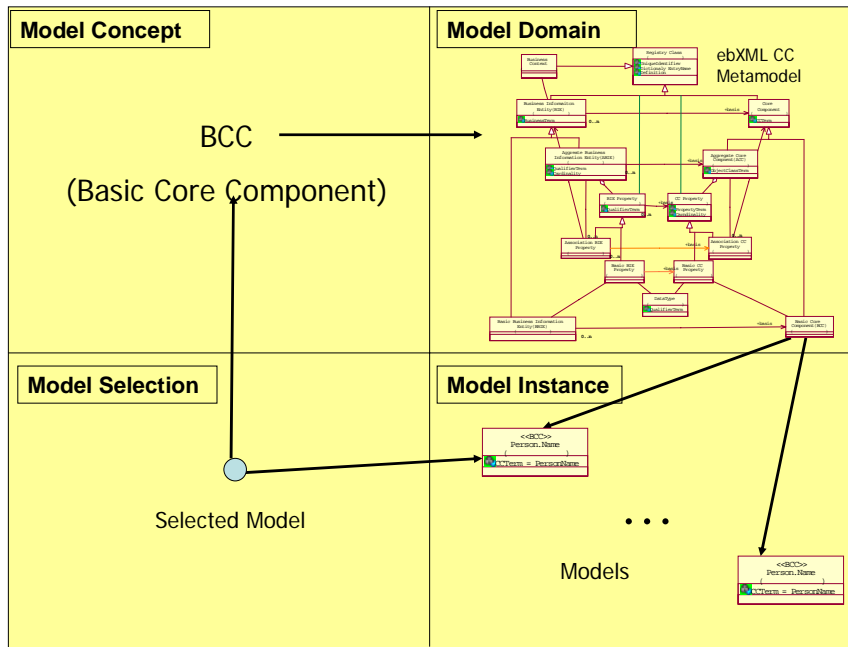


Figure- 11 Example of quadrant scheme for describing a metamodel

Figure-11 illustrates the meta-meta model which is materialized with the integration of both MDR and MOF facilities. For more detail see document ISO/IEC CD19763-2 (Core model).

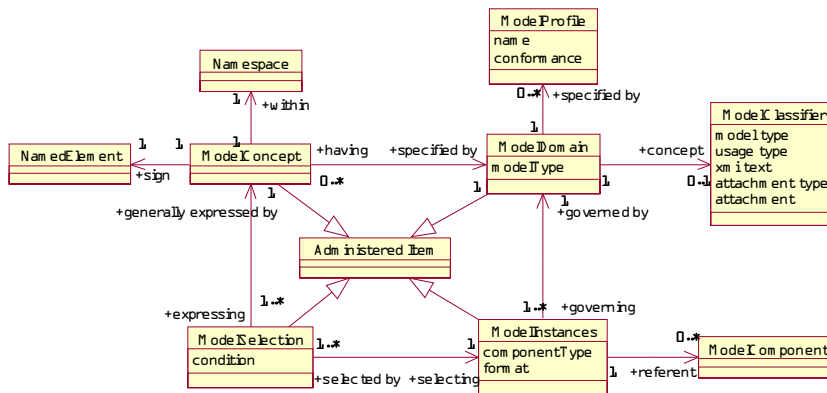


Figure-12 MDR scheme represented by MOF metamodel

4.3 Metamodel for Ontology Registration

This standard is a part (part-3) of the metamodel framework family of standards.

This part is a normative metamodel which is formulate by specializing the Core Model (Part-2) for the purpose of the registration of metamodels which describe ontology.

Today, a lot of consortia or organizations have defined their ontology such as SNOMED for the medical domain such as HL7 or SUO for the electronic engineering domain and they were widely accepted. However, the description methods which they used are not same.

Also, many organizations are in charge of the standardization of the ontology descriptive mechanism. In the ISO/IEC SC32, the Common Logic standardization was initiated. In the W3C, RDF (Resource Description Framework) and OWL (Web Ontology Language) are standardized. OMG is also discussing ODM (Ontology Descriptive Metamodel).

Then, this part of MMF standard (part-3) is a normative metamodel that enables the registration of a specialized metamodel which prepared for the purpose of the describing ontology such as ODM (Ontology Descriptive Metamodel) of OMG.

This could be useful in the materialization of a harmonized sharing of an ontology scheme within a business domain or among business domains.

In the development of this part of MMF standards, it should be inevitable to watch those activities and keep consistency with them. Then following issues are also considered.

- (1) MM for ontology registration should not provide any contents for ontology scheme
- (2) MM for ontology registration should provide a facility to register a particular ontology or a ontology metamodel in order to make them sharable and reusable.

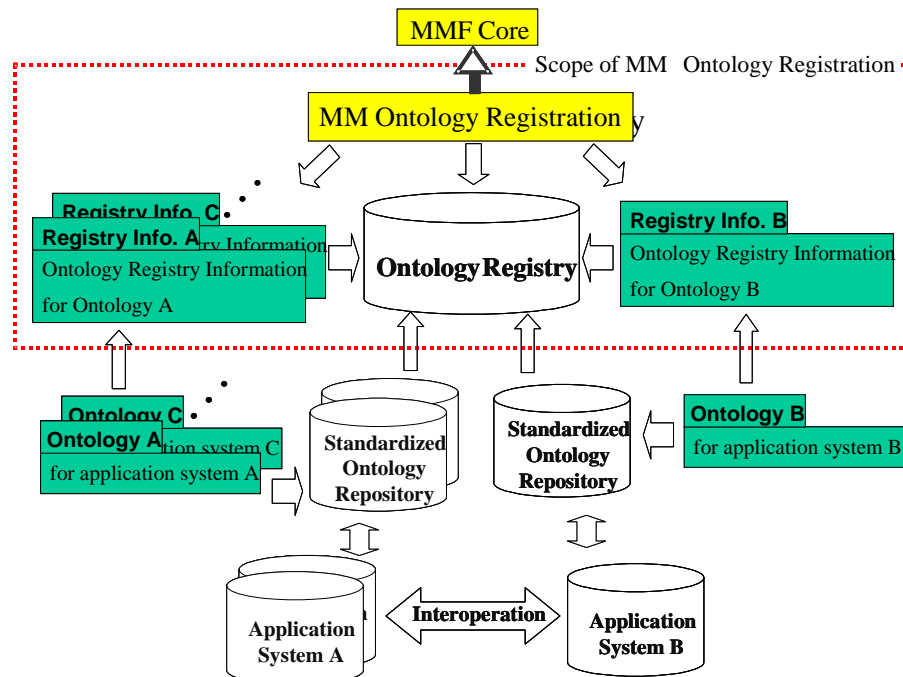
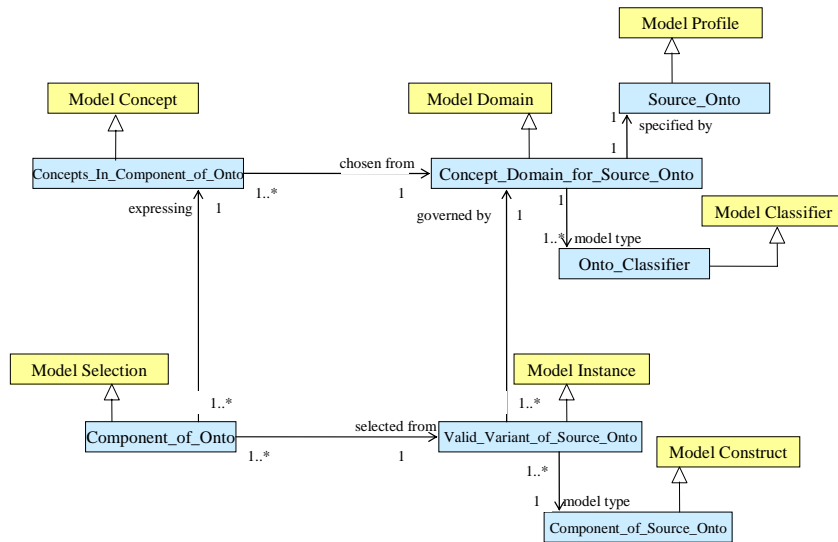


Figure-13 Metamodel for Ontology Registration

Figure-14 illustrates the part-3 metamodel of

Normative part of MMF-3 Standard (MMF4Ontology)



4.4 Metamodel for Model mapping

This standard is a part of the metamodel framework family of standards (Part-4). It is based on inheritance of the core model.

This standard provides solutions to resolve problems typically found in a heterogeneous environment which consists of different software platforms and middleware. Even in a single environment which consists of similar platforms, a business object might be implemented or installed in different formats or syntaxes.

The metamodel framework for model mapping provides a normative metamodel which allows the describing of differences regarding formats and types of objects to be exchanged or shared. This metamodel framework also provides a capability for describing transformation rules between different objects in term of a metamodel instance.

Figure-17 illustrates the basic structure of the MMF for Model mapping which could be minimal set of metamodel for representing both mapping targets and mapping rules.

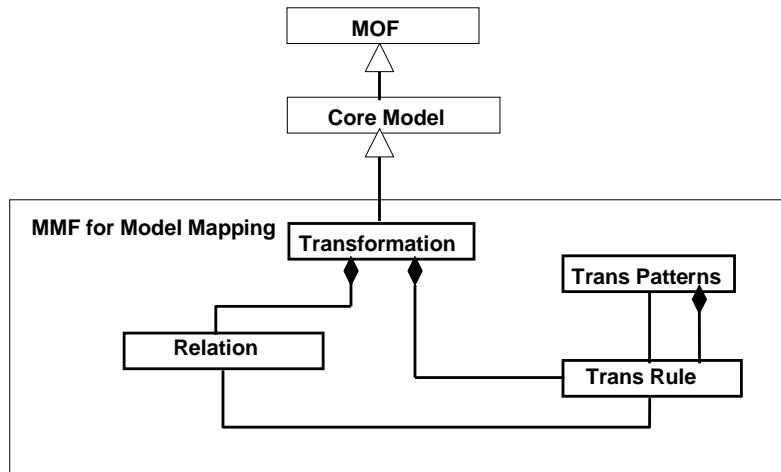


Figure-14 Metamodel for model mapping

In the development of MMF for model mapping, following issues should be concerned.

- (1) Discussions which are taking places in the standard organizations such as OMG, should be watched
- (2) Actual implementation of those scheme, i.e. CWM (Common Warehouse Metamodel) or some other commercial products for the data warehouse should be investigated
- (3) The mapping between models or model elements which were defined with different modeling facilities, such as UML or IDEF1X should be investigated and some sort of the transform metamodel framework should be provided in this standard.

[NOTE:]

The mapping rule between models defined by different modeling facilities might be a hard trial in the development of the MMF for model mapping. However, a place holder for this sort of framework should be prepared in the standard.

4.5 Metamodel for model constructs

This standard supports the registration of various types of model constructs and their reuse. Typical model constructs could be;

- a) Data elements
 - b) Data base records
 - c) Object patterns
 - d) Object definition templates
 - e) Message format
- etc.

[NOTE]

At the moment, no sub project to a metamodel framework for modeling constructs has been initiated.

6. Conformance

TBD

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TR 9007 provides information on conceptual modelling.

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ISO/IEC 10027 describes the concept of levels of modelling.

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TR 15452 describes the specification of value domains. It is expected to be replaced by ISO/IEC TR 20943-3.

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TR 20943-1, which is under development at the time of publication of ISO/IEC 11179-3, will provide guidelines for recording data elements in a 11179-3 metadata registry.

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