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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
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Foreword

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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: Framework

Part 3: Metamodel for ontology registration

Part 5: Metamodel for process model registration

Part 6: Registry summary

Part 7: Metamodel for service model registration

Part 8: Metamodel for role and goal model registration

Part 9: On demand model selection [Technical Report]

Part 10: Core model and basic mapping

Part 12: Metamodel for information model registration

Part 13: Metamodel for form design registration

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 and/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 could 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 so as 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 MFI specifications can be considered as an extension of those for a Metadata Registry (MDR) as defined in ISO/IEC 11179-3 because MFI and MDR share the same registration mechanism and procedures. In 2010 a special study project was initiated to consider the harmonisation of MDR and MFI and a key recommendation of that study project was that the common facilities should be identified and used for both MDR and MFI. It is anticipated that MDR and MFI could be more closely related and integrated, leading to benefits for the users who need more effective sharing of information and models, or more sophisticated interoperation of systems.

This new edition of Part 1 has been developed to provide a clear overview of MFI and to illustrate the overall architecture of the MFI family of standards to reflect the major changes described above.

Information technology – Metamodel framework for interoperability (MFI) – Part 1: Framework

1 Scope

1.1 Inclusions

This is a part of the ISO/IEC19763 (Metamodel framework for interoperability) (MFI) family of standards. As the first part of MFI, this part provides an overview of the whole of MFI. In particular, the purpose, the underlying concepts, the overall architecture and the requirements for the development of other standards within the MFI family are described.

MFI provides a set of normative metamodels to enable the registration of many different types of model. Each of these metamodels is expressed as a UML Class Diagram.

MFI is evolving. Currently, in addition to this part, the MFI family comprises:

- A core model and facilities for the basic mapping of models (Part 10)
- A metamodel for ontology registration (Part 3)
- A metamodel for process model registration (Part 5)
- A metamodel for service model registration (Part 7)
- A metamodel for role and goal model registration (Part 8)
- A Technical Report describing on demand model selection based on RGPS (Role, Goal, Process and Service) (Part 9)
- A metamodel for information model registration (Part 12)
- A metamodel for form design registration (Part 13)
- A metamodel for a registry summary (Part 6)

These parts are described in more detail in Annex A.

1.2 Exclusions

The MFI does not specify any physical structure of the registry where model information is to be recorded. MFI metamodels define standard views as models to be used in the registering of model instances in a model registry while actual instance documents could be stored in a model repository.

2 Conformance

This part of ISO/IEC 19763 specifies no conformance requirements. Other parts of the ISO/IEC 19763 family of standards 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 11179-3, Information technology – Metadata registries (MDR) – Part 3: Registry metamodel and basic attributes

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

ISO/IEC 19505-1:2012, Information technology -- Object Management Group Unified Modeling Language (OMG UML) -- Part 1: Infrastructure

ISO/IEC 19505-2:2012, Information technology -- Object Management Group Unified Modeling Language (OMG UML) -- Part 2: Superstructure

4 Terms, definitions and abbreviated terms

4.1 Terms and definitions

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

4.1.1
11179-3 Common Facilities
combination of the Registration package and the Basic package and the Identification Designation and Definition package on which the first package is dependent

4.1.2
concept
unit of knowledge created by a unique combination of characteristics

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

[ISO 1087-1:2000, 3.2.1]

4.1.3
cloud computing
paradigm for enabling network access to a scalable and elastic pool of shareable physical or virtual resources with self-service provisioning and administration on-demand

NOTE Examples of resources include servers, operating systems, networks, software, applications, and storage equipment.

[ISO/IEC 17788, 3.2.4]

4.1.4
framework
logical structure for classifying and organizing complex information

[ISO/TS 27790:2009, 3.27]

NOTE In MFI the framework is used to represent the architectural view of a set of metamodels for registration.

4.1.5
information model
graphical and textual representation of entities and the relationships between them

NOTE May 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

4.1.6
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

[ISO/IEC 2382-1]

4.1.7
metadata
data that defines and describes other data

[ISO/IEC 11179-3:2013, 3.2.74]

4.1.8
metadata item
instance of a **metadata object** (4.1.9)

[ISO/IEC 11179-3:2013, 3.2.75]

4.1.9
metadata object
object type defined by a **metamodel** (4.1.11)

[ISO/IEC 11179-3:2013, 3.2.76]

4.1.10
metadata registry
information system for registering **metadata** (4.1.7)

NOTE the associated information store or database is known as a metadata register

[ISO/IEC 11179-3:2013, 3.2.78]

4.1.11
metamodel
model (4.1.12) that explains a set of related **models** (4.1.12) by defining the language for expressing such **models** (4.1.12)

[ISO 14813-5:2010, B.1.84]

4.1.12
model
representation of some aspect of a domain of interest using a normative **modelling facility** (4.1.18) and **model constructs** (4.1.13)

NOTE models can be used to express a set of information requirements, processes, services, roles, goals or some other aspect of a domain of interest

4.1.13
model construct
unit of notation to represent a **model** (4.1.12)

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

4.1.14
model element
element or component in a **model** (4.1.12)

NOTE Examples of model elements are representation of an entity type in an information model, representation of an event in a process model, representation of a service operation in a service model, or representation of an actor in a role and goal model.

4.1.15
model information
information that describes characteristics of a **model** (4.1.12) to be registered

NOTE In MFI, the model information about a model will be registered using instances of Registered_Item as specified in ISO/IEC 11179-3

4.1.16
model registry
registry (4.1.24) where **models** (4.1.12) are registered

4.1.17
model repository
repository (4.1.25) where **models** (4.1.12) are stored

4.1.18
modelling facility
set of rules and notations for use when modelling

NOTE 1 UML is a typical example of a modelling facility

NOTE 2 May also be known as a modelling language

4.1.19
modelling language
language or notation that is used to model some aspect of a domain of interest

NOTE 1 UML is a typical example of a modelling language

NOTE 2 May also be known as a modelling facility

4.1.20
ontology
specification of concrete or abstract things, and the relationships among them, in a prescribed domain of knowledge

NOTE The specification should be computer processable

[ISO/IEC 19763-3:2010]

4.1.21
process
collection of related, structured activities or tasks that achieve a particular goal

4.1.22
process model
representation of a **process** (4.1.21), using a specific process **modelling language** (4.1.19)

4.1.23
registration
<generic> inclusion of a item in a **registry** (4.1.24)
<metadata registry> inclusion of a **metadata item** (4.1.8) in a **metadata registry** (4.1.10)

[ISO/IEC 11179-3:2013, 3.2.108]

NOTE 1 In ISO/IEC 19763 a metadata item is a model or a model element and a metadata registry is a model registry.

NOTE 2 Registration requires that a minimum set of administrative information about the metadata item (model) be specified, such that it becomes a registered item

4.1.24
registry
information system for **registration** (4.1.23)

[ISO/IEC 11179-3:2013, 3.2.113]

NOTE 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

4.1.25
repository
place where, or receptacle in which, things are or may be stored

NOTE In MFI and MDR, a repository is recognized as a database that stores actual instances to conform to a particular metamodel or a particular set of metadata.

4.1.26
service
kind of web based application, which encapsulates one or more computing modules and can be accessed through a specified interface

4.2 Abbreviated terms

BPEL
Business Process Execution Language

BPMN
Business Process Model and Notation

IDEF1X
Integration DEFinition for Information Modeling

IEC
International Electrotechnical Commission

ISO
International Organization for Standardization

LOD
Linked Open Data

MDR
Meta Data Registry

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

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

MFI
Metamodel framework for interoperability (this family of standards (ISO/IEC 19763))

MFI Core and mapping
ISO/IEC 19763-10, Information technology – Metamodel framework for interoperability – Part-10: Core model and basic mapping

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

UN
United Nations

W3C
World Wide Web Consortium

XML
eXtensible Markup Language

5 Purpose and objectives of MFI

5.1 Purpose of MFI

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 (ISO/IEC 2382-1:1993). The models that are registered may be ontologies, information models, process models, service models, models of roles and goals or any other type of model specified within MFI.

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 may 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 through to the complexity of Express-G, as a UML Class Diagram, or even as a set of SQL CREATE TABLE statements. Similarly, process models may be expressed as BPMN models, as UML Activity Diagrams, or as a set of BPEL statements.

The sharing of these models is essential if interoperability is to be achieved. If two systems are to exchange information then not only must 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 must 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 need to be unambiguously understood.

The underlying purpose of MFI is to allow the sharing of these models. Each of the main parts of MFI 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 in MFI is an information model that provides a conceptual view of the information that is recorded when a model is registered. Each of these metamodels is expressed as a UML Class Diagram.

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

5.2 Strengthening interoperability and integration capability

5.2.1 Introduction

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

- System interoperability
- Semantic interoperability

This is illustrated in Figure 1 below.

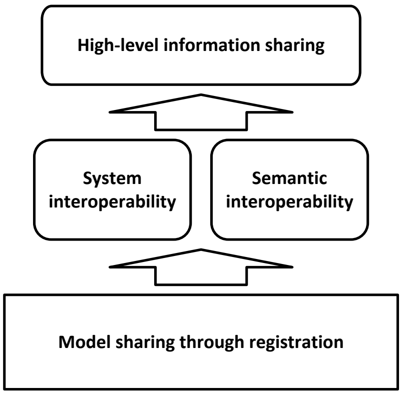

Figure 1 – Two types of interoperability

5.2.2 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 individually, 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.

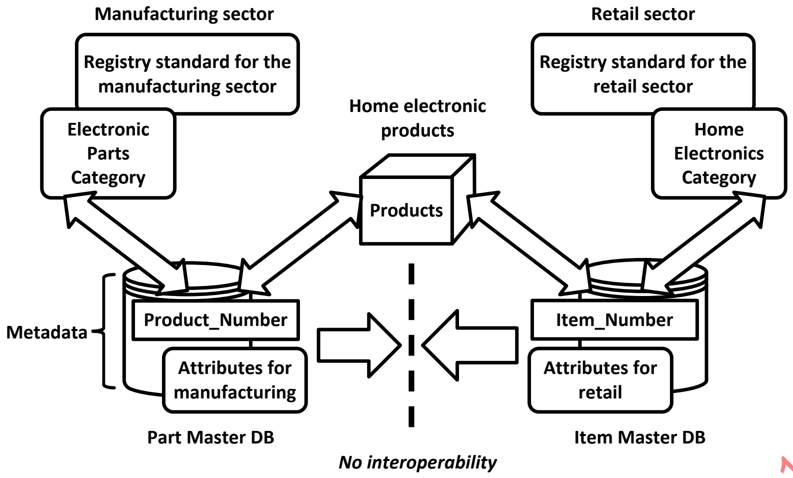

Figure 2 – Current problems with cross-industries interoperation

To overcome this problem there must 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 must be supported by a specific platform or infrastructure.

In the 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.

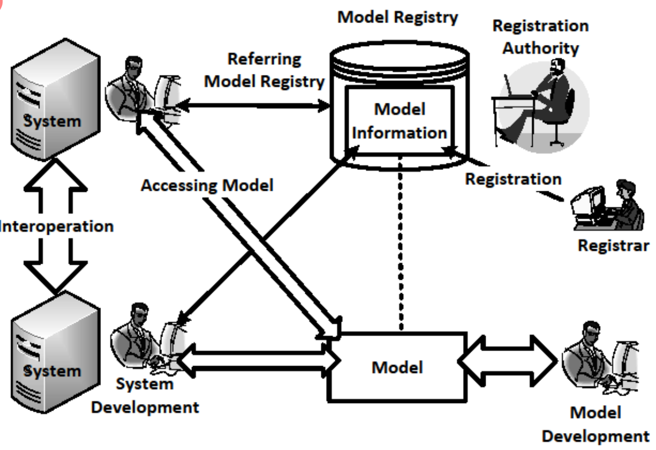

Figure 3 – Basic concept of model sharing through a model registry

5.2.3 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.

By enabling the registration of ontologies, where each ontology is a set of inter-related concept definitions within a specific domain of knowledge, MFI provides the ability to annotate each model construct so that data sharing and model sharing can be based on the semantic understanding of the model or the information represented by the model.

As well as aiding the understanding of the meaning of information, these facilities are also helpful in the definition of mapping rules between model constructs.

5.3 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), which will record the nature of the registry and its content and also provide technical information to enable accessing the registry. The intention is that the RS should be attached to each registry.

Figure 4 below illustrates a typical example of the use of Registry Summaries. Each registry in a particular domain can make their Registry Summary publically 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).

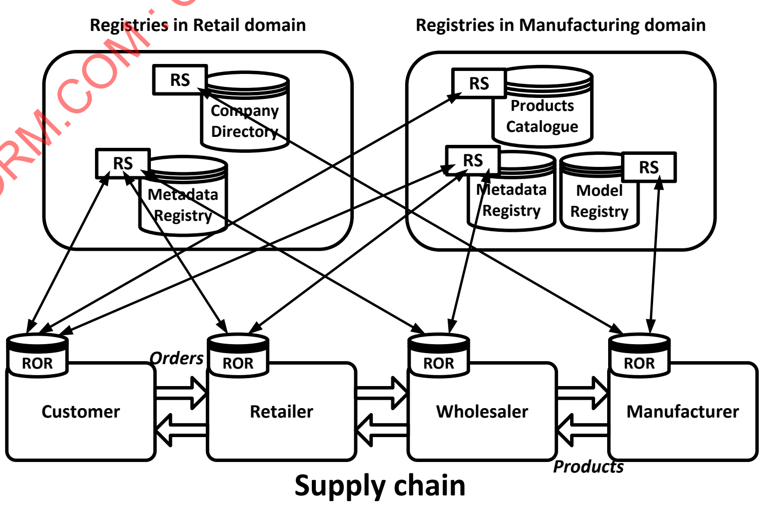

Figure 4 – Registry interoperability using RS and ROR

5.4 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 the Technical Report that explains the on demand model selection based on RGPS, as illustrated in Figure 5.

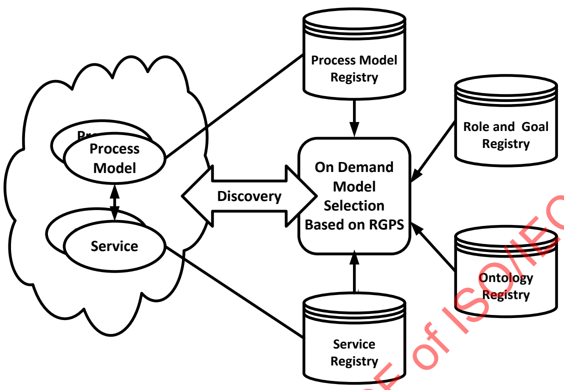

Figure 5 – Discovering services and processes based on RGPS

6 Model registration

6.1 Basic idea of the MFI metamodels

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 of 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 for business process modelling, are often used. All of 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).

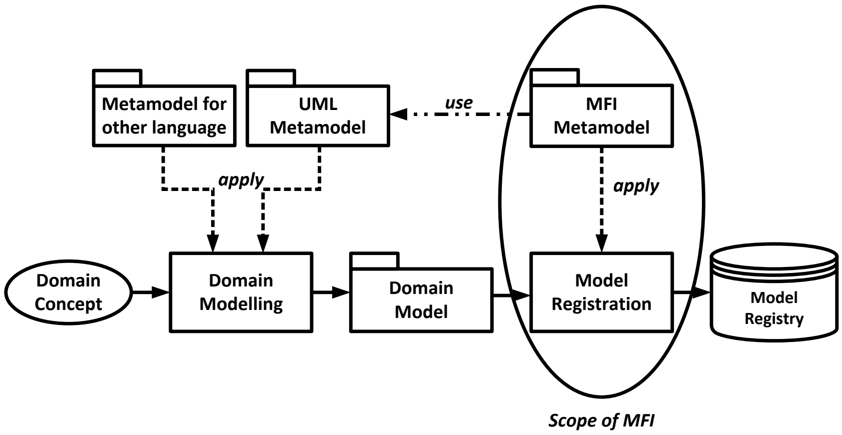

Figure 6 – MFI metamodels and the UML metamodel

6.2 Basic concept of model registration

MFI is a set of metamodels specifying the structure of registries that may 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.

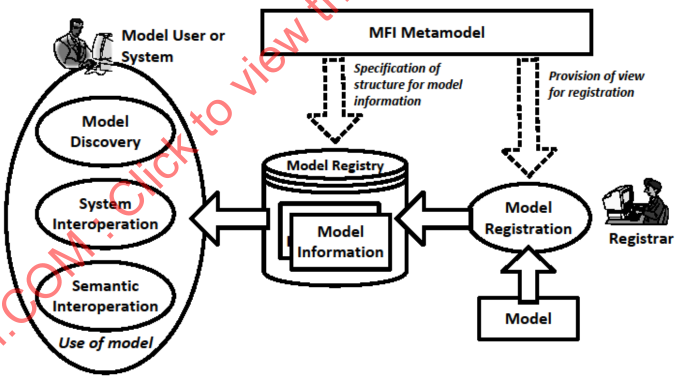

Figure 7 – Basic concept of MFI registration

One of the MFI metamodels 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:

- ontologies
- information models
- process models
- service models

- role and goal models
- form designs

MFI does not specify any implementation requirements for a registry. Each metamodel only specifies the information that may 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:

- where the model exists, who is the owner, and when it is registered,
- what model elements are included in the model, and
- what are relationships between these model elements.

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

An MFI registry uses the registration facilities that are specified in the MDR Metamodel. As such, for each model the following information may be recorded:

- details of the registration authority, including the registrar.
- the date of the registration.
- the submission status.
- the ownership of the model.
- the context of the model.
- the elements within the model.

In terms of the MDR Metamodel, the registered model becomes a registered item, as shown in Figure 8.

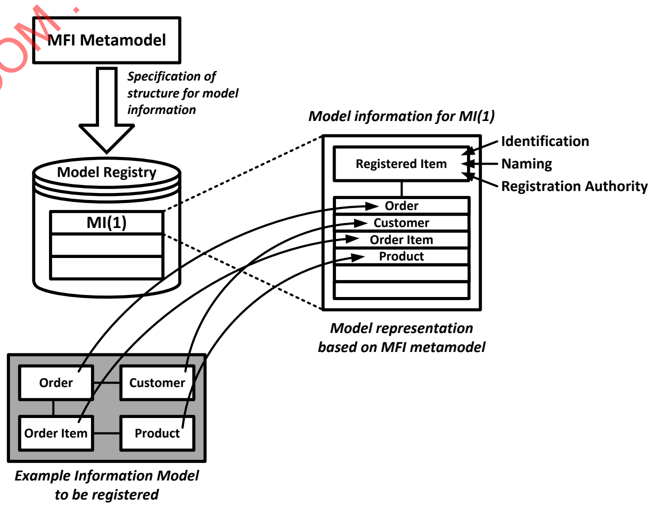

Figure 8 – Relationship between a model and its associated model information

7 MFI architecture

7.1 The overall structure of MFI

This section specifies the architecture of MFI. All future developments of extra parts of MFI must adopt this architecture.

The MFI family of standards consists of a number of parts, each of which (other than this part and any technical reports) specifies a metamodel. Most of these metamodels provide for the registration of a particular type of model. One part (Part 10) provides common facilities for the other parts: a core model and basic mapping facilities.

In order to achieve the purpose set out in Clause 5 the MFI family of standards needs to be tightly harmonised with the MDR family of standards. This is because metadata is needed to define the model information that is to be registered in the MFI registries. MFI uses the registration procedure specified in MDR Registration.

MFI can be considered to be an extension of MDR. Figure 9 shows the basic overall structure of the MFI standard, including its relationship to MDR and UML.

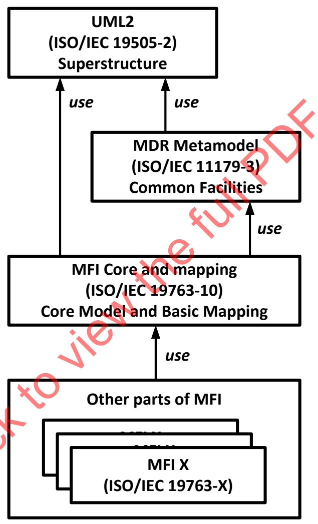

Figure 9 – Overall structure of MFI and its relationships to MDR and UML

7.2 A common modelling facility for MFI

To maintain consistency between the parts of the MFI family of standards, one of the parts (Part 10) provides common modelling facilities in addition to facilities to map models together.

Figure 10 shows the core model concept. Central to the core model are three metaclasses:

- Modelling_Language,
- Model, and
- Model_Element.

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

