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Preface

OMG

Founded in 1989, the Object Management Group, Inc. (OMG) is an open membership, not-for-profit computer industry standards consortium that produces and maintains computer industry specifications for interoperable, portable, and reusable enterprise applications in distributed, heterogeneous environments. Membership includes Information Technology vendors, end users, government agencies, and academia.

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More information on the OMG is available at https://www.omg.org/.

OMG Specifications

As noted, OMG specifications address middleware, modeling and vertical domain frameworks. All OMG Formal Specifications are available from this URL:

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Submission Background

This version of the FIBO specification replaces the set of specifications under FIBO version1. In place of several FIBO specifications (one for each of e.g. Foundations, Business entities etc.), these sets of subject matter are identified as Domains in FIBO v2 and are all provided as part of this single FIBO specification, as a set of normative Annexes B and following (Annex A details the machine readable deliverables that form part of this specification, as was the case in FIBO v1).

In general, new content will have previously been published by the EDM Council in a separate namespace, as spec.edmcouncil.org/fibo, will already have been vetted and in most cases will already have started to be used by the financial industry.

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1 Scope

1.1 Overview

FIBO is a modularized formal model of the concepts represented by finance industry terms as used in official financial organization documents such as contracts, product/service specifications and governance and regulatory compliance documents, as well as in finance industry data and messaging.

The scope of *finance industry* encompasses a broad range of organizations that manage money, including credit unions, banks, credit card companies, insurance companies, consumer finance companies, stock brokerages, investment funds and some government sponsored enterprises along with government itself.

The financial industry as defined for the scope of this specification includes wholesale (both buy-side and sell-side) and retail finance along with the regulatory apparatus that deals with activities in these sectors. Geographically the scope of this specification covers the financial markets globally including both Western and Islamic banking practices and process.

The information used in the financial industry is divided conceptually into referential information (foundational, instruments and business entities), temporally sensitive concepts (things with values that change over time such as prices and yields, known as market data) and process related concepts (corporate actions and further process related ontologies such as securities issuance).

Referential Concepts: In terms of referential information, in addition to concepts relating to business entities the scope of this specification covers the full range of financial instruments. Financial instruments are all contracts of one sort or another and are described semantically in terms of contracts and their terms, representing the commitments made in these contracts. These include contracts that may be bought or sold by different parties (negotiable securities), and contracts that are struck between parties. These include:

- Negotiable securities
    - Equity securities (shares, etc.) both publicly traded and privately held
    - Debt securities including mortgage, loan and asset backed securities
    - Rights instruments
    - Collective investment vehicles (funds and instruments traded in those funds)
    - Exchange traded derivatives
- Bilateral agreements (over the counter instruments)
    - Over the counter derivatives
    - Over the counter debt contracts (money market instruments, loan participation)
    - Loan contracts including mortgage loans, retail and corporate loans

Time-dependent concepts: Information that takes different values over time are considered separately from a conceptual point of view but are included in the scope of this specification. These comprise financial information with past, present and projected future values, such as prices, yields and analytics. These include:

- Publicly quoted indices and indicators
    - Indices relating to financial instruments such as stock indices
    - Indicators of factors relating to some economy (economic indicators)
    - Rates of exchange between currencies
    - Credit indices
    - Other publicly available or chargeable data relating to financial and economic matters

- Securities pricing (including exchange prices, transaction prices, etc.)
- Yields on debt
- Security analytics, including
    - Debt analytics – various measures of duration, convexity etc.
    - Yield curves and other analytical measures of movements in price or value
- Derivatives pricing
- Derivatives analytics, collectively known as ‘greeks’
- General debt analytics such as Net Present Value (NPV) on loans
- Fund measures and analytics
- Any other time-dependent values that provide some measure of an instrument, a collection of instruments or a market
- Phases and statuses of things that change their status over time, including
    - loan statuses
    - security trading statuses
    - credit ratings and credit statuses of instruments and of business entities
    - status and phase concepts for other stateful things in the finance domain

Process related concepts: the use of ontology is not limited to static or temporal information but is also able to represent representations of events, activities and processes, including lifecycles of securities, loans and other financial instruments, formal specifications of business process workflows, and the occurrences of events prescribed in process definitions. These include:

- Corporate actions and events
    - Events representing changes to the information or status of a business entity
    - Events representing changes to the information for a security (e.g., stock splits)
    - Corporate events requiring some action on the part of the holder
- Securities issuance
    - Process definitions for different forms of issuance for equity and debt securities, e.g., IPO, bond syndication, bond auction, municipal debt issuance
    - Processes for issuance of asset-backed and mortgage-backed securities, both agency and private label

Note that the bulk of the scope for corporate actions and events is represented in the ISO 15022 and ISO 20022 messaging standards for corporate actions.

Foundational Concepts: the nature of an ontology is that it frames specific concepts with reference to more general categories of ‘thing’ in order to provide disambiguation between these concepts. To support this, this Specification includes in its scope a number of high-level conceptual abstractions. These include:

- Concepts common to all of finance
    - Financial instruments common concepts
    - Concepts referenced in various security or fund concepts, such as baskets and pools
    - Debt concepts and common types of contractual terms (interest terms, repayment terms etc.)
    - Taxation, regulatory, compliance and other governance related concepts and the entities responsible for those

    - Information relating to financial industry participants and the global financial system, wholesale markets etc. (exchanges, clearing houses, custodian banks, etc.)
    - Retail banking and retail finance concepts including current accounts, lending, etc.
    - Accounting and reporting concepts
- Concepts not specific to finance; These include but are not limited to:
    - concepts defining dates, times, calendars, and schedules
    - legal, contractual, agreements and transactions
    - kinds of entity including people and organizations, legal entities
    - the concepts of things defined by roles or other contexts (functions etc.)
    - geographical and geopolitical and other location concepts
    - kinds of information: arrangements, codes and schemes, documents, messaging etc.
    - mathematical and analytics concepts for example relating to formulae, curves, quantities and measurement
    - other common business abstractions such as goals, objectives, strategy, policy, risk etc. that are of relevance to any business enterprise
    - events, activities, process definitions and the like (things that happen or prescriptions of things that are intended to happen)
    - relationships among business entities including ownership and control relations
    - general reusable relationships

The scope of FIBO does not include more fundamental conceptual building blocks, generally referred to as 'upper ontology' or 'top level ontology'. Rather, the focus of FIBO is to provide ontologies that can make use of the concepts defined in the above scope in a practical application concept.

1.2 Applications and Uses of FIBO

One of the key benefits of FIBO with respect to data, message or reasoning metamodels is that it can provide a semantic anchor firmly rooted in the concepts as understood and used by people in the finance industry. FIBO enables the creation of logical data models such that those logical models derive their formal semantics from FIBO.

FIBO provides ontologies to support semantic reasoning and querying applications.

FIBO allows disambiguation of new and existing regulation. To the extent that regulatory requirements may reference the formal concepts in FIBO, terms referred to in these regulatory requirements, or in reports that are mandated, would be semantically unambiguous.

One important goal of FIBO is for the formal business definitions to be used in legal documents such as contracts, terms and conditions of sales and payment, IP protection, compliance reports; and to underpin less formal language used in advertising and customer-facing websites.

The business terms and definitions in this specification may be used as a reference model to which firms would tie their own proprietary models (semantic models or ontologies); and also, as a catalog for all of the relevant data models.

1.3 FIBO Concepts Articulation

FIBO concepts are documented using two forms of definition:

1. A structured ontology specification of the concept, and its relationships to others, represented using the Web Ontology Language (OWL).
2. Natural language definitions which represent the concepts in natural language using the vocabulary of the finance industry.

This specification covers both the models and the underlying architecture employed for producing and presenting the models.

The FIBO specifications are divided into top level sections called 'domains' and these are given in Annexes B through J. The notion of a 'domain is explained in Clause 8.

1.3.1 Definitions

The human readable definitions have been constructed by and with the input of business subject matter experts.

Some definitions have been derived from definitions of data elements corresponding to those terms in industry data or messaging standards. These have been adapted where necessary to ensure that they are descriptive of the thing or fact itself and not of data elements for data about those things or facts, and have then been reviewed by industry subject matter experts to ensure that such adaptation accurately captures the sense of the business concept. In cases where the definition in a data or message standard was incomplete, context-specific or tautologous, a fresh definition was framed by the industry subject matter experts who participated in these reviews, or a third-party definition was proposed and adopted.

1.3.2 Definitions Policy

In some cases, definitions have been obtained from third party sources. The policy for arriving at definitions for the FIBO industry terms was as follows (and remains so for future iterations and extensions):

FIBO definition citations are only any ISO standard, any OMG standard, any other standards such as FpML, GLEIF, ISDA, CFTC, OFR, FINRA, any government document/site/law (for the US, ending in .gov), including European Union (4uropa.eu), academic sites allowing free citations. Existing definitions not cited to any of the above will be deprecated as FIBO is updated.

FIBO citations will be based on the IEEE citation format. Guidelines on reference citations for the IEEE are spelled out in:

https://ieee-dataport.org/sites/default/files/analysis/27/IEEE%20Citation%20Guidelines.pdf.

The IEEE citation format will be followed for online, print, personal, and all other references.

In all cases the source from which the definition was obtained, or from which it was adapted, is recorded in annotation metadata for that concept.

2 Conformance

2.1 Overview

This clause defines conformance points for the following types of artifacts:

- Extensions of FIBO
- Technical applications of FIBO such as logical data models, XML schemas, operational ontologies, code, and other technical artifacts
- Data Conformance

Conformance of technical applications of FIBO is the most important conformance point, because it addresses the core issue of what it means to conform to the ontologies that FIBO defines. In comparison, conformance of extensions and representations, while still important, are somewhat secondary concerns.

2.2 Conformant Technical Applications of Model Content

Technical applications of FIBO content are logical data models, XML schemas, operational ontologies, code artifacts, and other technical artifacts that purport to conform to FIBO.

2.2.1 Assessing FIBO Model Conformance

Given that a technical application includes a set of information elements some of which correspond to the concepts in FIBO, then the application is *FIBO Model Conformant* if and only if:

- At least one of those information elements corresponds to a concept in the FIBO ontology for which conformance is claimed.
- The application does not permit actual data to exist which would not be valid set of instances of those corresponding FIBO concepts: in other words, if the data is represented as a set of individuals of the corresponding FIBO concepts then they will constitute a valid FIBO model with no contradictions.

It is permissible for the information elements to have additional information or to be more constrained than those in FIBO.

2.2.1.1 Full FIBO Model Conformance

If a technical application is FIBO Model Conformant with the complete set of FIBO ontologies, then the application satisfies Full FIBO Model Conformance.

2.2.1.2 FIBO Ontology Model Conformance

If a technical application is FIBO Model Conformant with a particular FIBO ontology, then the application satisfies FIBO Ontology Conformance for that particular ontology. There is thus a separate compliance point for each Domain in Annex B and the following.

2.2.1.3 FIBO Domain Model Conformance

If a technical application is FIBO Model Conformant with a particular FIBO domain, then the application satisfies FIBO Ontology Conformance for all ontologies in that particular domain. There is thus a separate compliance point for each domain in Annex B and the following.

2.2.1.4 FIBO Module Model Conformance

If a technical application is FIBO Model Conformant with a particular FIBO module, then the application satisfies FIBO Ontology Conformance for all ontologies in that particular module. There is thus a separate compliance point for each module in each domain in Annex B and the following.

2.3 FIBO Extension Conformance

This definition of conformance points applies to extension of the model content for use locally. The following conformance point may be asserted for each ontology that extends FIBO itself:

- FIBO-Full Extension in OWL: Satisfies FIBO Extension Conformance (see below) and OWL2 Conformance

In turn, for technical applications to assert *FIBO Extension Conformance* these applications must also satisfy FIBO Model Conformance (see 2.2.1). An ontology asserting *FIBO Extension Conformance* must also satisfy the rules in the following three sub-clauses related to labeling, model consistency and relationship to subject matter.

2.3.1 Labeling

Business-facing labels shall be provided for all named model constructs. These labels must conform to the following formal requirements:

- Labels shall use normal English expression including spaces and punctuation, using lowercase except for proper nouns.
- Labels shall represent a plain English name (in US English spelling) which is that most commonly used by the finance industry for that concept.
- Labels do not need to be unique across the model but should be unique where this is realistically possible and shall always be unique within any individual ontology file.
- At least one business-facing label shall be present which is not in the form of, or contain, acronyms (including business acronyms).

2.3.2 Model Consistency

Reasoning is the mechanism by which the logical assertions made in an ontology and related knowledge base are evaluated by an inference engine. A logical assertion is simply an explicit statement that declares that a certain premise is true. Such assertions, taken together, form a logical theory, and a consistent theory is one that does not contain any logical contradictions. This means that there is at least one interpretation of the theory in which all of the axioms contained therein are provably true. The logical assertions expressed in the FIBO ontologies have been checked using multiple inference engines, designed specifically to support OWL 2, for internal logical consistency *(i.e.*, for consistency within that single ontology), and for logical consistency with imports closure (meaning, consistency including all axioms in any imported ontology in addition to those in the single ontology in question).

In order for any extension to FIBO to be conformant, it must be verified as being logically consistent (internally and with respect to imports) in addition to syntactically correct according to the OWL specifications. Examples of reasoning engines that can be used to verify logical consistency of an OWL 2 ontology are discussed in an article on Wikipedia[1]. Members of the OMG Ontology Special Interest Group (ontology@omg.org) can also make recommendations for tooling that might assist FIBO users in verifying their extensions.

In addition to being logically consistent, a conformant FIBO extension must be a conservative extension of each FIBO ontology that it imports i.e., the extension must not prove new logical assertions about the concepts defined in the imported ontologies. More formally, any logical assertion regarding concepts drawn exclusively from the vocabulary of an imported FIBO ontology is provable in a conformant extension if and only if it is provable within the imported ontology. This condition ensures that conformant FIBO extensions use the concepts defined in the imported FIBO ontologies without changing their meanings by narrowing or constraining them and supports composability of conformant FIBO extensions. As for logical consistency, reasoners can be used to verify that an OWL2 ontology is a conservative extension of an imported ontology but in general it is a

[1] http://en.wikipedia.org/wiki/Semantic_reasoner

more difficult problem so reasoners will take longer to determine this. Pragmatic guidelines like prohibiting restrictions on imported concepts can help ensure that extensions are conservative but in general it is possible to restrict imported concepts indirectly in subtle ways and so a reasoner should be used to verify conformance.

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3 References

3.1 Normative References

The following normative documents contain provisions which, through reference in this text, constitute provisions of this specification. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply.

Reference	Description
[Dublin Core]	DCMI Metadata Terms, Issued 2013-06-14 by the Dublin Core Metadata Initiative. Available at http://www.dublincore.org/documents/dcmi-terms/
[ISO 4217a]	ISO 4217 Codes for the representation of currencies and funds, Seventh edition, 2008-07-15
[ISO 4217b]	ISO 4217 Currency and funds code list, 2014-03-28
[LCC]	OMG Languages, Countries and Codes Specification formal/17-12-07. Available at https://www.omg.org/spec/LCC/
[MOF Core]	Meta Object Facility (MOF™) Core, v2.4.1. OMG Available Specification, formal/2011-08-07. Available at https://www.omg.org/spec/MOF/2.4.1/
[XMI]	XML Metadata Interchange Specification, v2.5.1. OMG Available Specification, formal/2015-06-07. Latest version available at https://www.omg.org/spec/XMI/
[ODM 1.1]	Ontology Definition Metamodel™ (ODM™). Available at http://www.omg.org/spec/ODM/
[OMG AB Specification Metadata]	OMG Architecture Board recommendations for specification of ontology metadata, Available at http://www.omg.org/techprocess/ab/SpecificationMetadata/
[OWL 2]	OWL 2 Web Ontology Language Quick Reference Guide (Second Edition), W3C Recommendation 11 December 2012. Available at http://www.w3.org/TR/2012/REC-owl2-quick-reference-20121211/.
[RDF 1.1]	RDF 1.1 Concepts and Abstract Syntax, W3C Last Call Working Draft. Latest version Available at http://www.w3.org/TR/2013/WD-rdf11-concepts-20130723/
[RDF Concepts]	Resource Description Framework (RDF): Concepts and Abstract Syntax. Graham Klyne and Jeremy J. Carroll, Editors. W3C Recommendation, 10 February 2004. Latest version is available at http://www.w3.org/TR/rdf-concepts/.
[RDF Schema]	RDF Vocabulary Description Language 1.0: RDF Schema. Dan Brickley and R.V. Guha, Editors. W3C Recommendation, 10 February 2004. Latest version is available at http:// www.w3.org/TR/rdf-schema/
[SKOS]	SKOS Simple Knowledge Organization System Reference, W3C Recommendation 18 August 2009. Available at http://www.w3.org/TR/2009/REC-skos-reference-20090818/
[UML2]	Unified Modeling Language™ (UML®). Available at https://www.omg.org/spec/UML
[Unicode]	*The Unicode Standard, Version 3*, The Unicode Consortium, Addison-Wesley, 2000. ISBN 0-201-61633-5, as updated from time to time by the publication of new versions. (See http:// www.unicode.org/unicode/standard/versions/ for the

Reference	Description
	latest version and additional information on versions of the standard and of the Unicode Character Database).
[UTF-8]	RFC 3629: UTF-8, a transformation format of ISO 10646. F. Yergeau. IETF, November 2003, http://www.ietf.org/rfc/rfc3629.txt
[W3C Datatypes in RDF and OWL]	XML Schema Datatypes in RDF and OWL, W3C Working Group Note 14 March 2006, Available at http://www.w3.org/TR/2006/NOTE-swbp-xsch-datatypes-20060314/
[XML Schema Datatypes]	XML Schema Part 2: Datatypes. W3C Recommendation 02 May 2000. Latest version is available at http://www.w3.org/TR/xmlschema-2/

3.2 Non-Normative References

The following informative documents are referenced throughout this text or in parts of the Annexes:

Reference	Description
[DL Handbook]	The description logic handbook: theory, implementation, and applications Cambridge University Press New York, NY, USA ©2003 Available at: https://dl.acm.org/citation.cfm?id=885746
[FpML]	Financial products Markup Language – www.fpml.org
[ISO 1087]	ISO 1087-1:2000 Terminology — Vocabulary — Part 1: Theory and application
[ISO 15022]	https://www.iso20022.org/15022/iso-15022-home
[ISO 20022]	www.iso20022.org
[SMIF RFP]	Semantic Information Modeling for Federation (SIMF) RFP. Object Management Group, ad/11-12-10. Available at: https://www.omg.org/cgi-bin/doc?ad/11-12-10
[SMIF]	Semantic Modeling for Information Federation. Object Management Group, adtf/2016-12-01. Available at http://smif.modeldriven.org/SMIFSubmissionMasterDocument.pdf All materials available at: http://smif.modeldriven.org/
[UMLCMP]	UML Concept Modeling Profile. Available at: http://spec.edmcouncil.org/UMLCMP/index.html

3.3 Changes to Adopted OMG Specifications

This specification does not change or replace any OMG specifications. This specification uses the Concept Modeling Profile [UMLCMP] derived from the [SMIF] draft submission specification.

4 Terms and Definitions

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

Content

Definition: Subject matter or meta-content.

Business subject matter

Definition: Subject matter that defines and describes the kinds of people (and the roles they play), organizations and other things that an enterprise has to deal with in the course of its operational business, regardless of how this content is presented to the people in the organization (e.g., in text documents, web pages, audio broadcasts).

Example: Business concepts, such as: *OTC derivative*, *business day.*

Example: Relationships between business concepts, such as: *swap transaction has ISDA confirmation.*

Example: Constraints, such as: Each ISDA confirmation is of exactly one swap transaction.

Example: Descriptions, such as: ISDA is the largest trade organization of participants in the OTC derivatives market.

Example: Business processes (defined in terms of the business concepts), such as:

If a Disputing Party reasonably disputes the Value of any transfer of Eligible Credit Support, then the Disputing Party will notify the other party not later than the close of business on the Local Business Day following.

Note: Business subject matter is mainly about kinds of thing, but may include individuals, in three roles: (1) as one-of-a-kind things referenced in the subject matter, such as *ISDA*, *Dodd-Frank Act*, *EC Treaty*; (2) As types defined by enumeration, such as the currencies in which a trading business maintains accounts; (3) in examples.

Note: Business subject matter is usually scoped by area of business jurisdiction (or something similar), such as, say, derivatives trading. The business subject matter is about the business of derivatives trading.

Other areas of responsibility in the enterprise have different subject matter. For example, the IS department's subject matter includes information models of things in the operational business (including derivatives trading). The finance department's subject matter includes financial models of things in the operational business.

Model-Theoretic Conformance

Definition: The specific manner in which some model conforms with some theory about what it is intended to model and how it is intended to model it.

Ontology

Definition: A formalization of a conceptualization. For the purposes of this specification the formalization is in OWL, using ODM as a means to render this, and the conceptualization is that of business subject matter.

Relationship Property

Definition: Property of some class of thing defined with reference to some other class of thing.

Simple Property

Definition: Property of some class defined with reference to some datatype.

Subject matter

Definition: Information about things in the universe of discourse; the essential facts, data, or ideas that constitute the basis of spoken, written, or artistic expression or representation; often, the substance as distinguished from the form especially of an artistic or literary production.

Vocabulary

Definition: A set of words, each giving one or more formal definitions which apply to a meaningful concept that is referred to by that word.

5 Symbols and Abbreviations

5.1 Symbols

There are no symbols introduced by this specification.

5.2 Abbreviations

The following abbreviations are used throughout this specification:

- OWL – Web Ontology Language
- ODM – Ontology Definition Metamodel
- RDF – Resource Definition Framework
- SME – Subject Matter Expert
- SMIF – Semantic Modeling for Information Federation
- UML – Unified Modeling Language
- URI – Uniform Resource Identifier
- URL – Uniform Resource Locator
- XMI – XML Metadata Interchange
- XML – eXtensible Markup Language

Additional symbols and abbreviations that are used only in annexes to this specification are given in those annexes.

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6 Additional Information

6.1 How to Read this Specification

6.1.1 Audiences

This specification has the following audiences:

- The standards community
- The finance industry business community
- The regulatory community
- Technical architects
- Semantic Modelers

Each clause opens with a statement identifying the intended audience for that clause. The language in that clause is then framed appropriately for readers from that audience. Where "Intended Audience" is not stated the material in that clause is intended to be comprehensible to all general readers.

6.1.1.1 Standards Community

This audience is intended to be able to follow and validate the way in which this specification sets out the arrangements for the production and maintenance of model content.

6.1.1.2 The Finance Industry Business Community

This specification includes descriptions of diagrams and reports that are intended for consumption by business subject matter experts. This and the clause on "Reading the Annexes" are the only material intended for business subject matter experts (Clause 6.6).

6.1.1.3 The Regulatory Community

As for Finance Industry Business Community.

6.1.1.4 Technical Architects

These include but are not limited to:

- Tooling vendors and developers
- Other content providers / enriched content providers
- Business Analysts – anyone who use the model on site, whether they are a modeler, a metadata analyst, etc.
- Technology Management

The bulk of the "Architecture" clause is intended to be read and understood by these audiences and by the 'Semantic Modelers' audience.

6.1.1.5 Semantic Modelers

Much of the material in this specification is intended to be read and understood by semantic modelers. This includes the 'Conformance' clause (2), and the 'Architecture' clause (8).

The Semantic modeler audience is not the same as the technical audience, although some individuals may possess skills in both. Clauses of this specification which are written for a semantic modeling audience do not require any training in any formal technology in order to understand and act upon their contents. These clauses do require a clear understanding of semantics and formal logic. It is not necessarily the case that technical readers are expected to be able to read and understand all aspects of the semantic modeling material. It should also be noted that some terms which have specific meanings in one or more technology environments, may have different (or often only subtly different) meanings to the semantic modeling audience. Where both semantics and technical audiences are intended to read a clause, care has been taken to try to use all of the applicable terms and qualify words which have multiple different usages to these audiences.

6.2 Acknowledgements

The following organization submitted this specification:

- Enterprise Data Management Council

The following companies have provided significant expertise and resources in the development of its content and architecture:

- Adaptive Inc.
- Australia and New Zealand Banking Group
- AVOX/DTCC
- Bank of America
- Barclays Capital
- BBH
- Bloomberg
- Business Semantics
- CIBC
- Citigroup Inc.
- Credit Suisse Group AG
- CUSIP
- The Federal National Mortgage Association (Fannie Mae)
- David Frankel Consulting
- FacetApp
- Fidelity
- GoldenSource Corporation
- HSBC Holdings plc
- Hypercube Ltd.
- JPMorgan Chase & Co.
- The Manufacturers Life Insurance Company
- Michigan State University
- Model Driven Solutions
- Model Systems
- Morgan Stanley
- MphasiS
- National Australia Bank
- No Magic

- Nomos Software
- Nordea Bank
- Oakland University
- OntoAge
- OpenFinance
- PricewaterhouseCoopers LLP
- Revelytix
- Sallie Mae
- SAP
- Semantic Arts
- State Street
- Sungard
- SWIFT
- Tahoe Blue
- Thematix Partners LLC
- Thomson Reuters
- UBS AG
- University of British Columbia
- University College Cork
- Wells Fargo
- Wizdom Systems, Inc.

6.3 Organization

Within the context of this specification a module is group of ontologies, organized as a component of a domain with respect to the domain namespace (e.g., FND), and as a folder from a file management perspective. One or more ontologies are contained in each of the modules in this specification. For each domain and module, there is a "metadata" ontology file, which provides metadata about the domain or module, specified as metadata of a named individual that is that domain or module. Each of the primary ontologies in a given module is defined as an OWL file, as are the "metadata" files.

6.4 Interpreting the Model Logic

Intended Audiences: *Business Subject Matter experts*

6.4.1 Introduction

The model is intended by read and understood by business domain experts with knowledge of the topics covered. It requires no knowledge of modeling theory, technical modeling languages, technology development, or data modeling.

The following knowledge is required to interpret the model content:

- Set theory
- Business (commerce, law, finance)

6.4.2 What the Model Contains

The model described in this specification contains elements called 'Classes' representing categories of thing in some real or possible world and 'Properties' about those things in the form of relationships between one class of thing and another, or between some class of thing and some kind of data (called 'datatypes'). Classes and properties all have as a minimum the definition for the term that they represent, plus additional information on usage, review history, sources of terms and definitions and the like.

The models represented in this kind of logic can be descried in Description Logic (DL) and can be represented in UML tooling using either the Concept Modeling Profile [UMLCMP] or the Ontology Definition Metamodel [ODM] and can be serialized textually using the Web Ontology Language [OWL].

These models depend for their interpretation on the 'Open World Assumption' (OWA). This is a consequence of using the Web Ontology Language (OWL) and is a common feature of ontology models, these being focused on the semantics of things in the world rather than the available data. This way of interpreting models says that the absence of any specific data about something does not imply that that thing or datum does not exist (absence of evidences does not constitute evidence of absence). This is in contrast to the closed world assumption (CWA) in which most data models are interpreted, where a complete set of data is assumed.

These concepts are described in the sub-clauses which follow.

6.4.3 Interpretation

The model conveys 'Classes' (categories of thing) and 'Properties'. Properties are in two forms:

- 'object properties': these are a statement about something which is framed in terms of something else, that other thing also being framed as a kind of 'Thing'.
- 'datatype properties': these are a statement about something which is framed in terms of some simple type of information, such as textual entries, yes/no answers, dates, numbers and selections of textual information.

In addition, there are relationships which represent additional set theory concepts, notably logical unions, logical intersections and mutual exclusivity.

Each class also has a 'sub class' relationship, with the sense of 'is a', typically shown as a closed upward pointing arrow on most diagrams. This relationship indicates that the thing from the non-arrowed end is "a kind of" the thing at the end with the arrow.

Most classes are defined in terms of logical statements called 'restriction'. A restriction sets out a condition (usually a necessary and sufficient condition, sometimes just a sufficient condition) for something in the world to be considered as being a member of that class. Restrictions are framed in terms of the possession by that class of some property, and the nature of that property as it applies to members of that class – for example, whether any member of a given class must necessarily have a certain property, must have it with values only coming from a given class or set of classes, must have within certain numeric bounds and so on. Each of these restrictions can be expressed in formal Description Logic (DL), can be reflected in OWL model syntax, and is able to be represented on diagrammatic views of the FIBO models. For example, in DL these are known variously as existential restrictions, universal restrictions and cardinality restrictions. Cardinality restrictions may be qualified with reference to some class or may be unqualified.

6.4.3.1 Classes

A class is a set theory construct. A class is defined as the set of individuals which are defined according the assertions (properties and property restrictions) given for that kind of thing. Membership of the set is defined in the sense that any individual in the world of which the stated facts are true or applicable, is a member of that set. In terms of logical theory, these sets are mostly defined intentionally. In some cases, FIBO defines a set explicitly as a list of its members (in logical theoretic terms, an extensional definition).

6.4.3.2 The sub-Class or 'is a' relationship

With few exceptions, each class in the model is a sub class of one or more classes. The relationship between the class and the class of which it is a sub-class may be interpreted as an 'is a' form of relationship, meaning that the thing of which the sub class relationship is shown is a kind of the thing to which the arrow in that relationship is pointing.

This relationship formally indicates that the class that owns the sub-class relationship inherits all of the facts about the related class. In addition, this relationship is transitive. For example, if a share is a security and a security is a transferable contract then a share is a transferable contract.

The relationships of this type create a formal inheritance structure called a Taxonomy. Taxonomies in this sense may be single inheritance (as is often seen in technical model designs) or multiple inheritance. In the FIBO models these are multiple inheritance, meaning that types of thing (such as types of contract) may be classified in more than one way. So, for example, an interest rate swap is both a swap and an interest rate derivative.

As an example of multiple inheritance, one might say that in terms of the Linnaeus Taxonomy of Species, a whale is a mammal, while one may also create a set of taxonomic classifications based on habitat, in terms of which a whale may also be a marine animal.

6.4.3.3 Object Properties

An Object Property is defined as a property which is framed in terms of a relationship to some other class of thing.

Object Properties fit into the form subject-predicate-object where the subject is the class of thing from which the relationship is drawn, the object is the thing to which the relationship points and the predicate is the property itself.

There are additional pieces of information about these Object Properties, such as whether they are symmetric, transitive and so on. The use and interpretation of these refinements to Object Properties are beyond the scope of this explanatory sub clause.

6.4.3.4 Datatype Properties

Datatype Properties are assertions about things in a class, which are framed in terms of some simple type of information.

Types of information about which Simple Properties are asserted are:

- String (Text)
- Decimal (Number)
- Integer (Whole number)
- Boolean (Yes/no)
- Enumerated data range (Selection of textual descriptors)

6.4.3.5 Logical Unions

Logical unions indicate that any individual which is a member of any one of the classes of thing of which the union is a union, is a member of that union.

Object Properties may refer to unions in the same way that they refer to other classes of Thing.

Unions have no names or definitions. In those cases where a business concept is necessarily a logical union, a named class is defined and given an equivalent class relationship to the corresponding union.

6.4.3.6 Mutually Exclusive (Disjoint) Classes

Given that each thing is a set of potential members defined by their properties, it is possible for any one thing in the world to be defined as being a member of more than one set, if the properties asserted for one set are not incompatible with the properties asserted for another set.

Where membership of one set necessarily precludes membership of another set (that is, where a set is defined such as to specifically exclude members of another set), this is represented by a logical relationship between the classes, called a 'disjoint with' relation.

Where classes are not indicated as being mutually exclusive (and their parents' classes are also not mutually exclusive), any individual may belong to both classes (that is, both sets of things).

6.4.3.7 Sub Property Relations between Properties

Properties are also disposed in a hierarchy similar to that given for the classes. Where a property is intended to represent a narrow but related relationship to some more general property, this is represented using a 'sub property of' relationship. The Property named in this relationship represents a more general meaning, of which the Property labeled in this way represents a narrower definition of the same meaning.

6.4.3.8 Inverse relationships

Properties in the model are all one-directional, by virtue of their being framed as 'subject-predicate-object' triples. In the business domain, meaningful terms and definitions may exist in either direction between one class of thing and another (for example, customer has an account versus an account is that of a customer).

Where properties are included in the model that have this kind of inverse relationship, this is modeled as an 'inverse of' assertion.

6.4.3.9 Selection Lists (textual)

In some cases, a property may take one of a set of possible literal values, such as textual values. While this is common in data models (where these are given as enumerations), most cases where an enumeration would be given in a data model is modeled either as a set of classes or as a set of individuals of the same class.

In the few cases where the model semantics requires a possible enumeration of literals, this is given as an enumerated data range.

6.4.3.10 Selections of Individuals

This is a class or set of things of which the members are explicitly listed (in theoretical terms, an extensional definition of the class).

An extensional set of things as described above (also known as an enumeration – not the same as a data enumeration) takes the form of a named class and a set of Individuals whose type is that class.

6.5 Logical Interpretation of the Model Notation

The diagrams included in this Specification are intended to conform to the Concept Modeling Profile [UMLCMP]. This includes the set of UML stereotypes and graphical notation used in the diagrams provided.

The textual notation used to represent description logic expressions (i.e., the expressions in the Class Expression columns in class tables containing ontology details) as described in the preceding clauses, are explained in Table 6-1 below with reference to the notation defined in the Description Logic Handbook [DL Handbook]. Note that this is not intended to be comprehensive but includes the primary patterns that are used in the FIBO specification, for property restrictions in particular.

Table 6-1 Description Logic Expressions Notation

Construct	Logical Interpretation	DL Notation
Boolean Connectives and Enumeration		
intersection	The intersection of two classes consists of exactly those individuals which are instances of both classes.	$C \cap D$
union	The union of two classes contains every individual which is contained in at least one of these classes.	$C \cup D$
enumeration	An enumeration defines a class by enumerating all its instances.	oneOf (i_1, i_2, i_3, … i_n)
Property Restrictions		
universal quantification In diagrams: {redefines} without name	Universal quantification is used to describe a class of individuals for which all related individuals must be instances of a given class (*i.e.*, allValuesFrom in OWL).	∀R.C, where R is the relation (property) and C is the class that constrains all values for related individuals
existential quantification In diagrams: {subsets} without name	Existential quantification is used to define a class as the set of all individuals that are connected via a particular property to at least one individual which is an instance of a certain class (*i.e.*, someValuesFrom in OWL).	∃R.C, where R is the relation (property) and C is the class that constrains some values of related individuals
individual value In diagrams: {redefines} with range of individual	Individual value restrictions are used to describe classes of individuals that are related to one particular individual (*i.e.*, hasValue in OWL).	∀R.I, where R is the relation (property) and I is the individual
exact cardinality In diagrams: multiplicity on end	Cardinality (number) restrictions define classes by restricting the cardinality on the sets of fillers for roles (relationships, or properties in OWL). Exact cardinality restrictions restrict the cardinality of possible fillers to exactly the number specified.	= n R (for unqualified restrictions) = n R.C (for qualified restrictions, i.e., including onClass or on DataRange)
maximum cardinality In diagrams: multiplicity on end	Maximum cardinality restrictions restrict the cardinality of possible fillers to at most the number specified (inclusive).	≤ n R (for unqualified restrictions) ≤ n R.C (for qualified restrictions)
minimum cardinality In diagrams: multiplicity on end	Minimum cardinality restrictions restrict the cardinality of possible fillers to at least the number specified (inclusive).	≥ n R (for unqualified restrictions) ≥ n R.C (for qualified restrictions)
Class Axioms		
equivalent classes	Two classes are considered equivalent if they contain exactly the same individuals.	≡ C
disjoint classes In diagrams: dashed arrow with a <<disjointWith>> label	Disjointness means that membership in one class specifically excludes membership in another.	¬ C

As described in the preceding clause, restrictions are shown as association elements (arrowed lines), where the association end has no name. Named associations that have the {subsets propertyName} indication are sub properties of the indicated property.

For the vast majority of the property restrictions specified in FIBO, the restrictions are defined as necessary conditions for class membership, rather than sufficient conditions. As a result, the tables assume that necessary conditions are the default and only in cases where a restriction imposes sufficient conditions will that be stated.

6.6 Reading the Annexes

This specification contains a number of annexes. The first of these (Annex A) describes the various normative and informative artifacts delivered with FIBO while Annex B and the following describe the model content in diagrams and in tabular reports. There is one such annex per FIBO domain. These are intended to be read by potential users of the FIBO specification and are therefore written for the technical architect and semantic modeler audiences. In the annexes with the exception of annex A, all material is normative, with the exception of the diagrams, which are informative.

6.6.1 Interpreting the Classes Tables

Class Expressions column:

In each ontology clause, the column titled 'Class Expressions' sets out the logical expressions for each class. These are presented in an approximation to 'natural language', generated directly from the model OWL. The natural language expressions represent the underlying OWL expressions as described below.

Property Name Splits for Natural Language

In some cases, a property's verb is split to give a more representative use of natural language, as in the example below where the word 'some' appearing between 'has' and 'capacity' reflects a property called 'hasCapacity' with the someValuesFrom restriction. The verbs 'has' and 'is' are used to make this kind of predicate name split.

```
has some capacity that is a signatory capacity
```

Sub-class relations: the RDF subClassOf relation is represented by the following wording:

```
A sub class of [Class].
```

Example:

```
A sub class of formal organization.
```

In OWL the statement represented by this is that the class described in that row of the table has the relation rdfs:subClassOf **[Class].**

Restrictions: These include **existential** (in OWL, someValuesFrom), **universal** (allValuesFrom) and **cardinality** restrictions. Where a cardinality restriction includes reference to a class or datatype these are qualified, otherwise they are unqualified restrictions.

Interpretation of the different restriction types is as follows:

Existential restrictions (someValuesFrom) are reflected in the following style of wording:

```
some [property] that is a [Class]
```

or if there is a split verb:

```
it has/is some [property] that is a [Class]
```

This corresponds to the following OWL relations:

> The OWL class so restricted is a member of the set of things that have the property [property] such that there must be some occurrence of that property whose range is taken from the class [Class].

This reflects the following statements in OWL:

Restriction onProperty **[property]** someValuesFrom **[Class]**

Example:

```
it has some objective that is a business objective
```

(Note that the predicate name in this example is hasObjective, using the property name split technique described above)

Universal restrictions (allValuesFrom) are reflected in the following style of wording:

```
only [property] a [Class]
```

or if there is a split verb:

```
it has/is only [property] a [Class]
```

This reflects the following statements in OWL:

Restriction onProperty **[property]** allValuesFrom **[Class]**

Example:

```
it is only conferred by of a court of law
```

(note again that the verb 'isConferredBy' is split in the above example)

Cardinality restrictions

Minimum cardinality restrictions are reflected by the following style of wording:

```
it [property] at least [n] [Class](s)
```

or if there is a split verb:

```
it has/is [property] at least [n] [Class](s)
```

This reflects the following statements in OWL:

Restriction onProperty **[property]** onClass **[Class]** minQualifiedCardinality=n

Or if unqualified:

Restriction onProperty **[property]** minCardinality=n

Example

```
it governs at least 2 federal state(s)
```

Maximum cardinality restrictions are reflected by the following style of wording:

```
it [property] at most [n] [Class](s)
```

or if there is a split verb:

```
it has/is [property] at most [n] [Class](s)
```

This has the effect of:

Restriction onProperty **[property]** onClass **[Class]** maxQualifiedCardinality=n

Or if unqualified:

Restriction onProperty **[property]** maxCardinality=n

Example

```
it has at most 1 legal form that is a entity legal form
```

Which reflects the following statements in OWL:

Restriction onProperty **hasLegalForm** onClass **EntityLegalForm** maxQualifiedCardinality=n

(Note that this example again uses the technique of splitting the property name 'has legal form' to reflect the natural language in which this axiom would be expressed)

Exact cardinality restrictions are reflected by the following style of wording:

```
exactly [n] [property] that is a [Class]
```

or if there is a split verb:

```
it has/is exactly [n] [property] that is a [Class]
```

This corresponds to an OWL cardinality restriction with a specific number.

This reflects the following statements in OWL:

Restriction onProperty **[property]** onClass **[Class]** qualifiedCardinality=n.

Or if unqualified:

Restriction onProperty **[property]** cardinality=n

Note that the word order may be split around the property verb to give a more natural language rendition, as indicated earlier and as given the following example where the property is 'hasIdentity'.

Example:

```
it has exactly 1 identity that is a natural person
```

(note that the property name hasIdentity is split in this example).

Minimum 0 cardinality restrictions

A special case of the use of cardinality restrictions applies when the cardinality is given as a minimum of zero (min 0), which has no logical effect in OWL. Where this occurs, the model should be interpreted to say that the class so restricted would normally have some occurrence of the given property but that this does not need to be present to define that class.

Example:

```
it holds at least 0 license(s)
```

means that the class in question would generally be expected to have the property 'holds' with a range of 'license' but that property is not always present for that class, and it would retain its same interpretation if that property were not present.

So-called 'cascading' restrictions

In some cases, the range defined for a restriction is itself another restriction, or some other blank node such as a logical union. The presence of a blank node is represented in the natural language by the use of the word 'something'. Where the range is another restriction it takes the following form:

```
it [property one] something that [restriction type wording] [property
two] that is a [class]
```

This reflects the following statements in OWL:

> Restriction onProperty **[propertyOne]** [restriction type] (Restriction onProperty **propertyTwo** [restriction type] onClass **[Class])**

Examples:

Existential:

```
it is played by something that has some capacity that is a signatory
capacity
```

In this example, the restricted class is some party in a role and the sequence (or 'cascade') of restrictions is saying that to be a member of this class of parties in roles, is to be that which is played by something that has the capacity in question, in this case a 'signatory capacity', this being the capacity to sign legal documents.

Universal:

```
it is played by something that is only member of of a government body
```

(note the double 'of' is an artifact of the natural language generation)

In this example, the kind of class defined, which again is some kind of a party in a role, is to be that whereby the role is played by something which has the 'member of' relation to indicate that it is a member of a government body.

Restrictions whose range is a logical union: this uses the word 'that' to introduce the blank node that is the range of the restriction, as follows:

```
it [property] [restriction type wording] thing that [class] OR
[class] …
```

This reflects the following statements in OWL:

> Restriction onProperty **[property]** onClass (unionOf (**Class**, **Class** …))

Example:

```
it identifies exactly 1 thing that legal person OR formal organiza-
tion
```

Which reflects the following statements in OWL:

> Restriction onProperty **identifies** onClass (unionOf (**LegalPerson**, **FormalOrganization**)) qualifiedCardinality=1

Mutual Exclusivity Relations:

These are reported directly from the OWL without use of further natural language, as follows:

```
This class is mutually exclusive with the class [Domain/Module/Ontol-
ogy/ClassName].
```

This reflects the following statement in OWL:

> disjointWith **[Class]**

Note that the namespace structure (Domain abbreviation, Module, Ontology, ClassName) is given for the referenced class.

Example:

```
This class is mutually exclusive with the class FND/AgentsAndPeo-
ple/People/IncapacitatedAdult.
```

Class equivalence relations:

These are reported directly from the OWL without use of further natural language, as follows:

```
This class is equivalent to
[Domain/Module/Ontology/ClassName]
```

Note that the namespace structure (Domain abbreviation, Module, Ontology, Class Name) is given for the referenced class.

This reflects the following statement in OWL:

equivalentClass **[Class]**

Example:

```
This class is equivalent to BE/SoleProprietorships/SoleProprietor-
ships/SoleProprietorship
```

Property Expressions:

In the Properties tables for each ontology that has properties, the 'Property Axioms' column gives the sub property relations, domain, range and inverse properties, where these exist.

For properties that have no domain and / or range, this is reflected by the use of the word 'Anything' as the domain or range respectively. In OWL, any property whose domain or range is unstated is taken to be the universal class of which everything is a member (Thing in OWL, or Top in some other systems). The Property Axioms column is therefore interpreted as follows:

Sub property of **[rdfs:subPropertyOf.property]**.

Domain **[rdfs:domain.Class / Anything]**

Range **[rdfs:range.Class / Anything / the union of ([Class] and [Class])]**.

Is inverse of **[owl:inverseOf.property].**

In each case the property or class referenced in the statement is given with its full path i.e., [Domain abbreviation/Module/Ontology/[propertyName or ClassName]]

Property Types:

In addition to property axioms, the Properties table has a separate column setting out the type of property, titled 'Property Type'. This column directly reflects the property type in the underlying OWL and gives no interpretative controlled natural language. Object properties are properties whose range is another class, while datatype properties are properties whose range is a datatype. Further specialized property types (such as transitive and functional properties) are also given where the property is of this kind. In these cases, it should be understood that the property is also an OWL object property (or OWL datatype property in the event that any of the given property types are applicable to datatype properties, which most are not).

6.6.2 Interpreting the Diagrams

The diagrams in this specification are rendering using a tool (Cameo Concept Modeler) that allows for FIBO ontologies to be modeled as 'Concept Models' under the Concept Modeling Profile specification [UMLCMP]. Graphical features in these diagrams correspond either to description logic assertions or in some cases to information about the disposition of the model content (for example showing where a class or a property is situated in a concept model other than the one in which that diagram resides).

The Description Logic assertions represented by the UML Concept Modeling Profile [UMLCMP] diagrams are readily able to be serialized in RDF/OWL. While the diagrams do not represent OWL syntax or triples directly, these correspond to OWL constructs when these models are generated. This section describes the relationship between the diagram features, the logic represented by each of those features and the generated OWL as reflected in the FIBO OWL machine readable files.

Graphical Features Reflecting Model Content Disposition

The following features of the diagrams do not reflect any model logic but are intended to indicate the disposition of model content.

Classes – shaded versus unshaded boxes: Shaded classes are situated within the concept model (ontology) reported on in the diagram. Unshaded classes are situated in some other concept model.

Properties – use of X indications on association ends: properties (association ends) that are situated in some concept model (ontology) other than one in which the class representing the domain of that property is situated, are shown with X symbols in place of any other indications such as an arrow or no arrow. These X symbols have no meaning in the model logic.

Graphical Features Reflecting Model Logic

The following features have the logical meaning described for them. The logic used in FIBO is Description Logic and can be understood (and is described here) in terms of set theory. The corresponding OWL serialization is also given here.

Classes: these are indicated by a rectangular box. A class is a set of things in some real or possible world. The rectangular box reflects the use of a UML Class element.

In most cases the UML class element partition for 'Attributes' is turned off. Depending on the level of detail shown on a given diagram, this may be turned on to indicate an alternative view of properties (principally datatype properties) whereby the property is shown as a line of text in that partition as described below. In all cases the UML partition for 'Operations' is suppressed.

Classes have lines between them indicating relationships in the model. The lines (modeled here as UML associations) do not reflect properties, rather their ends are the properties.

Labels: Class graphics (the boxes) are decorated with a textual label. This label is reflected by an RDFS label (rdfs:label) in the generated OWL. The proper name for the class (which is always in UpperCamelCase) is reflected in the URI for the element but is not shown on the diagram. The Classes tables show both the class name and the human readable label.

Generalizations: Where a class specializes some other class (its members are also members of that other class), this is shown using a UML Generalization relationship, rendered as an arrow with a triangular head. This points from the class of which it is an assertion, to the more general class. This corresponds to the RDFS statement rdfs:subClassOf, asserted for the class at the end of the arrow that does not have an arrowhead.

Note: some UML Generalization relationships are decorated by text giving a machine-generated label for a corresponding Generalization Set, e.g., "{incomplete, overlapping} set 1". This has no meaning in the model logic for FIBO and does not cause any RDF or OWL assertions to be generated. Generalization Sets are used more formally in the definition of logical unions (see below) where the class element for the union itself corresponds to something in OWL.

Disjoints: Where a class is disjoint with another class (that is, membership of one class is mutually exclusive with membership of the other(s)), this relationship is shown as a dashed arrow with a label showing the <<disjointWith>> stereotype.

Equivalent Classes: Where a class is equivalent to another class, or to a logical union or intersection, this relationship is indicated by means of a double-ended Generalization relationship between the two UML class elements (boxes), with the stereotype of <<Equivalent Class>> indicated against the element.

Logical unions: The logical union of two or more classes is shown as a box (a class element in UML) the same as for a class, but with no name. Depending on the level of information given in a particular diagram, this may show the CMP stereotype of <<Union>>.

Logical Intersections: The logical intersection of two or more classes is shown as a box (a class element in UML) the same as for a class, but with no name. Depending on the level of information given in a particular diagram, this may show the CMP stereotype of <<Intersection>>.

Datatypes: XML primitive datatypes are represented as a box, similar to the element for classes. As for classes, these are represented using the UML Class element. Depending on the level of details shown in the diagram, these may have a stereotype indication within the box to identify them as datatypes.

Properties: these are indicated by the named ends of lines or by textual material within the class elements.

Properties as association ends: UML Association elements are drawn as lines between class boxes, such that the ends of these association elements represent properties. The association element itself has no name or label and does not correspond to anything in the underlying logic or the generated OWL.

Where both ends of a line (UML association) have a name, these properties are the inverse of one another. In the OWL serialization for these, one of these properties will have an assertion that it is 'inverse of' (owl:inverseOf) the other. When both ends of a UML association represent a property, there is no arrow on either end.

When only one end of an association represents a property there is an arrow pointing to the class that is the range of that property.

As noted above, when the property is situated in a different concept model (ontology), these indications are suppressed in favor of the 'X' element that indicates the difference in location (ownership) of the element.

This representation is used both for what in OWL are identified as object properties and datatype properties. The CMP does not make the distinction between these kinds of properties and datatype properties are recognizable only by the fact that their range is one of the XML primitive datatypes.

Properties as textual material: An alternative means of representing properties is to show each property as a line of text within a partition in the class element. These give the property name, a colon and the target datatype or class name for that property. This notation uses the UML Attribute element.

Sub-property axioms: Where a property is a sub property of some other property, this is reflected by the word 'subsets' within curly braces along with the name of the parent property, as follows:

{subsets property}

This method of indicating sub property relationships is not available for properties that are indicated using the UML Attribute notation. The sub property relations will still exist in the model but would not be displayed for properties that are rendered in this format.

Restrictions

These include **existential** (in OWL, someValuesFrom), **universal** (allValuesFrom) and **cardinality** restrictions. Where a cardinality restriction includes reference to a class or datatype these are qualified, otherwise they are unqualified restrictions.

Restrictions are represented on the ends of the association lines. Unlike properties, they do not have a name. Interpretation of the different restriction types is as follows:

Existential Restrictions: these correspond to a 'some values from' restriction in OWL (owl:someValuesFrom) and have the meaning that there 'must be some' occurrences of the stated property with the stated class or datatype as its range. There may be other occurrences of the same property that do not meet this criterion.

On the model diagrams an existential restriction is identified as follows:

- The association end does not have a name (identifying it as a restriction not a property)

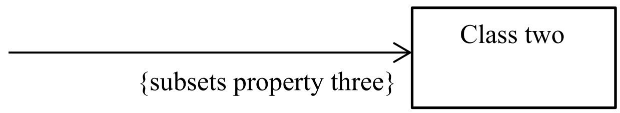
- The association end is accompanied by a {subsets} textual annotation.

The {subsets} annotation gives the name of the property restricted in this restriction.

The class to which the association end is connected gives the class to which the restriction refers.

Example:

Given an association at the far end of an association line from a Class One, such that the association end is adjacent to Class Two, and with the textual element {subsets propertyThree}, this represents an existential restriction on 'Class One', on the property 'property three' on the class 'ClassTwo'.



In OWL this is represented as:

Restriction onProperty **[propertyThree]** someValuesFrom **[ClassTwo]**

Universal Restrictions: these correspond to an 'all values from' restriction in OWL (owl:allValuesFrom) and have the meaning that any occurrences of the stated property 'may only be' with the stated class or datatype as its range. There may not be other occurrences of the same property that do not meet this criterion. There need not be any occurrences of this property.

On the model diagrams an existential restriction is identified as follows:

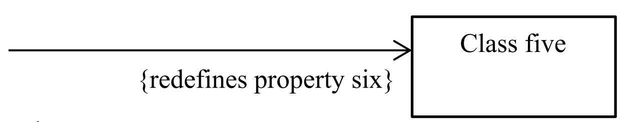
- The association end does not have a name (identifying it as a restriction not a property)
- The association end is accompanied by a {redefines} textual annotation.

The {redefines} annotation gives the name of the property restricted in this restriction.

The class to which the association end is connected gives the class to which the restriction refers.

Example:

Given an association at the far end of an association line from a Class Four, such that the association end is adjacent to Class Two, and with the textual element {redefines propertySix}, this represents an existential restriction on 'Class One', on the property 'property three' on the class 'ClassFive'.



In OWL this is represented as:

Restriction onProperty **[propertySix]** allValuesFrom **[ClassFive]**

Cardinality Restrictions

These are shown by the use of UML multiplicity indicators (m..n) adjacent to an association end. These may be adjacent to a {subsets} declaration indicating a restriction, or they may be given on an association end that represents a property. In the latter case, the property and a cardinality restriction of the stated value on that property are both generated in the OWL.

The UML association textual annotations generally have two figures m..n. In OWL the corresponding types of restriction are minimum cardinality, maximum cardinality and exact cardinality.

These may be interpreted as shown in Table 6-2.

Table 6-2 Cardinality Restrictions Interpretation as OWL cardinalities

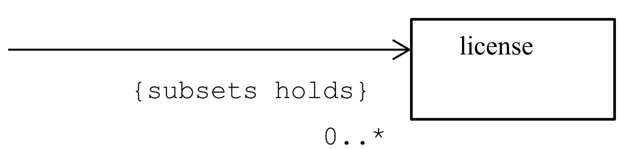
Diagram indication	Meaning	OWL
m..*	At least m	minCardinality = m minQualifiedCardinality = m
1..*	At least one	minCardinality = 1 minQualifiedCardinality = 1
0..n	At most n	maxCardinality = n maxQualifiedCardinality = n
0..1	At most 1	maxCardinality = 1 maxQualifiedCardinality = 1
n	Exactly n	Cardinality = n QualifiedCardinality = n
m..n	At least m and at most n	minCardinality = m + maxCardinality = n minQualifiedCardinality = m + maxQualifiedCardinality = n
0..*	See below	minCardinality = 0

If the association end that represents the restriction is associated with the class 'Thing' then this is an unqualified restriction. Otherwise it is a qualified cardinality restriction, qualified by the class.

Minimum 0 cardinality restrictions

A special case of the use of cardinality restrictions applies when the cardinality is given as a minimum of zero (min 0), which has no logical effect in OWL. Where this occurs, the model should be interpreted to say that the class so restricted would normally have some occurrence of the given property but that this does not need to be present to define that class.

Example:



This means that the class in question would generally be expected to have the property 'holds' with a range of 'license' but it would retain its same interpretation as a class if that property were not present.

7 Introduction

7.1 Audiences for this Clause

This clause is intended for a general readership and introduces the FIBO specification, its background and context, and some potential usages of this specification.

Technical audiences (in both conventional and semantic technology) are directed at the “Architecture” clause (8).

Business audiences (financial industry participants, regulators and others) are directed at the sub clause on interpreting model logic (6.4) and the model content itself in Annex B and the following.

7.2 FIBO Background

The Financial Industry Business Ontology (FIBO) is a repository of business concepts and their meanings, curated by the Enterprise Data Management Council and presented in the form of a series of ontologies in the Web Ontology Language [OWL] for use in a range of applications in which shared, unambiguous concepts are of benefit.

The FIBO ontologies are maintained in a single on-line source control repository (on GitHub) which is continually updated. The system of record for FIBO is the set of OWL files in that repository. Representations of the OWL content are made available in a number of formats both for human and machine readability and use. These are automatically updated to the EDM Council’s dedicated FIBO website at https://spec.edmcouncil.org/fibo for use by implementers and for reference by the financial industry. All content is continually updated in each of the published formats, each time the OWL files change in the underlying repository. In addition, material that has reached a suitable level of maturity and that has passed a number of quality tests is published quarterly and is identified as the ‘Production’ sub-set of that content. This quarterly Production release of FIBO forms the basis of this OMG FIBO specification. Going forward, each quarterly release of FIBO by the EDM Council will form the basis for a subsequent update to this specification.

The OWL machine readable files published as part of this specification at the Object Management Group are given at dereferenceable URIs in the omg.org domain as indicated in the coversheet of this specification and in the accompanying Inventory. The OMG URI structure follows that of the corresponding OWL files published by the EDM Council at the above EDM Council URI.

This FIBO Version 2 specification is intended to replace the earlier OMG FIBO specifications identified as Version 1 of FIBO Foundations, FIBO Business Entities, FIBO Indices and Indicators and FIBO Financial Business and Commerce. The same source material (that is, the same OWL ontology files) in the EDM Council’s GitHub repository that was used to originate the FIBO Version 1 specifications and the EDM Council publications, is now used as the point of origination for the content of this FIBO Version 2 specification. FIBO Version 2 differs from the FIBO Version 1 specifications in that the content of those earlier specifications is combined into this single FIBO specification. This specification also picks up changes and improvements made since the last publication date of each of the FIBO Version 1 specifications, as well as adding further subject areas. All changes to content in FIBO Version 2 are intended to be backwardly compatible with the earlier OMG FIBO Version 1 specifications.

This FIBO Version 2 specification is made available via the OMG in the ‘non-assert’ Intellectual Property mode as defined by the OMG, and under the terms of the MIT License, which allows for this content to be freely used, including in commercial applications, subject only to the requirement for attribution of this content to the Enterprise Data Management Council.

7.3 Usage Scenarios

Intended Audiences: *Technical implementers (conventional and semantic technology); technology management*

The uses envisaged for the model are as follows:

- Model driven development
    - Of database schemas
    - Of message schemas
    - Of common messaging across a business unit or organization
- Semantic Technology development
- Integration of systems and/or data feeds

In addition, the model may be extended locally to extend the scope of what is modeled, prior to using such local extensions in any of the above usage scenarios.

7.3.1 Model Driven Development

Model Driven Development refers to the top town development of technical artifacts starting with a high level, business view of the requirements (for programs) or the data semantics (for data).

The model defined in this specification is intended to be situated within any model driven development framework, as a conceptual model and potentially extended locally with additional concepts. This is the case whether the development is for databases, messages or a combination of the two.

Analysis of the model and metadata provided may enable the automation or partial automation of the production of logical data models, or at least of a candidate starting point for the development of a logical data model.

The model described and presented within this specification supports multiple inheritance between classes, whereas many logical data models would be developed using a single inheritance taxonomy (as this is often a constraint on the logical or physical models' development).

If this model is used within a UML tool, users may create formal mappings between logical data model constructs and the semantics corresponding to these in the FIBO model content. This simplifies the validation and verification of technical data model artifacts.

7.3.2 Semantic Technology Development

As part of this specification, model content is made available in the Web Ontology Language (OWL) format, which is the format most commonly used in semantic technology applications.

7.3.3 Integration of systems and/or data feeds

The simplest application of this model is to simply use the terms as a common point of reference when comparing terms within different logical or physical data models. This would be of value for example when integrating different systems.

Many systems may not have a formally stated ontology for the data elements that they use, or the database schema may be considered to be the only record of the meanings of the terms therein. Typically, whenever two or more systems need to be integrated, there is a time consuming and almost open ended "mapping" exercise in which the meanings of each of the terms in each of the databases or message schemas involved in the integration, are guessed and perhaps written down.

In reality, even when the intended meanings of the elements in each database and message schema are known, there is not an easy one-to-one mapping between one system and another. This is typically the result of good design: the more the designs have made use of reusable common data structures, the more efficient that design is, but correspondingly the less explicit is the semantics of the terms.

In an integration project that brings together data elements from more than two systems or data feeds, the number of mappings that need to be carried out between one system or feed and another is an exponential function of the number of such data sources and feeds. In order to have a mapping exercise which is only arithmetically related to the number of data sources and feeds, it is necessary to have a single "hub" of terms which are able to be used as a common point of reference between each of the data models.

While this can often be achieved using a single data model, in practice the limitations on data models (such as single inheritance taxonomies in many cases, though not all) mean that no one model can be found against which all terms in all data models and feeds may be cross referenced. The model presented as part of this specification, being a semantic model, contains full definitions of the meaningful concepts which may be referred to by any of the data elements in the data sources or feeds that need to be integrated, as long as this model may be extended locally to cover areas of scope which are not part of the current specification.

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8 Architecture

Intended Audience: *Technical, including Enterprise and Information Architects, Implementers.*

This clause provides an overview of the ontology architecture and modeling strategies used to develop the FIBO ontology.

8.1 Ontology Architecture and Namespaces

The ontology architecture for FIBO is designed to facilitate reuse and ontology evolution to the degree possible. It is also designed to facilitate mapping to other standards, in particular, to financial industry domain standards, such as FpML (Financial Products Mark-up Language) [FpML]. There are countless standards used for financial reporting, many of which are complex and lengthy, with overlap and jurisdiction-specific semantics. An approach to the foundational terminology that provides very high-level, abstract conceptual knowledge designed to facilitate mapping is an important design goal of FIBO Foundations.

Concepts for Country, Organization and others are derived directly by reference to applicable standards, such as the OMG standard for Language and Countries Codes [LCC].

8.2 Modular Structure

The Financial Industry Business Ontology is made up of a number of OWL ontology files. These are grouped into a modular structure to make up the overall FIBO Specification. These components are shown in Table 8-1.

Table 8-1: FIBO Modular Structure Components

Exemplar	Component Type
FIBO	Specification
FND	Domain
FND/Accounting	Module
EuropeanEntities	Sub Module
CurrencyAmount	Ontology

Each component of FIBO is nested within a broader component, with the exception of the FIBO Specification component in which all other components are contained. The FIBO Specification contains a number of Domains; each Domain contains a number of Modules, and each Module contains either Ontologies (where 'ontology' refers to an individual OWL file) or other Modules.

Some Modules contain ontology files containing OWL Individuals that are exemplars or jurisdiction specific instances of classes or properties in the ontologies in the same Module; these are known as Sub Modules and are nested within that package / namespace fragment, similar to a Module. Note that ordinary modules situated within another module (e.g., Bonds) are not identified as Sub Modules but as Modules.

Each component is represented both by a directory in the operating system directory structure and by a namespace fragment in the URI of the component (e.g., '/Accounting/').

Each component has a namespace abbreviation which is also divided into parts representing that component and the components above it in the containment structure. For example, the Accounting module in the Foundations (FND) domain in FIBO has the namespace abbreviation fibo-fnd-acc and this abbreviation forms the first three parts of the 4-part ontology abbreviations for each ontology in that module, for example fibo-fnd-acc-cur for the CurrencyAmount ontology.

These components are described below.

Domains: These combine topically related concepts, such as those for business entities, derivatives, securities and so on. A special domain-level element of FIBO is called FIBO Foundations and provides concepts that are foundational across all business domains. Similarly, a domain called Financial Business and Commerce is provided for concepts that are common across multiple other FIBO domains but are specific to finance, such as financial instrument and debt concepts.

The current and anticipated domains in FIBO are listed in Table 8-2 below. These are divided conceptually into referential information (foundational, instruments and business entities), temporally sensitive concepts (things with values that change over time such as prices and yields, known as market data) and process related concepts (corporate actions and further process related ontologies such as securities issuance).

Table 8-2: FIBO Domains

FIBO Domain	Status	Annex
Referential Concepts		
Business Entities	Included in this version	Annex B
Collective Investment Vehicles	Future completion	Annex C
Derivatives	Included in this version	Annex D
Financial Business and Commerce	Included in this version	Annex E
Foundations	Included in this version	Annex F
Indices and Indicators	Included in this version	Annex G
Loans	Future completion	Annex H
Securities	Included in this version	Annex J
Temporally Variable Concepts		
Market Data	Future completion	Annex K
Process Concepts		
Corporate Actions and Events	Future completion	Annex L
Business Process	Future completion	Annex M

Modules: Each domain is divided into a number of *modules*. For example, the Derivatives / Asset Derivatives module includes: a general ontology of AssetDerivatives.rdf for common asset derivative concepts, a BondOptions.rdf ontology, an EquityForward.rdf ontology and so on, that capture business concepts for each category of well-known asset derivative contract.

Via FIBO Foundations, the majority of FIBO modules will ultimately depend on (1) Basic Terminology and Ontology Metadata and (2) common FIBO Foundations ontologies for concepts defining dates, times, calendars, and schedules (FinancialDates.rdf) and others.

By design, FIBO avoids the use of circular dependencies, even though the OWL language supports this. Where real world subject matter is circular in nature, concepts are introduced in a piecewise fashion such as to retain a non-circular import graph. This is facilitated by being able to create additional assertions on a class in one ontology, in a separate ontology that is further downstream.

The FIBO standard reuses metadata definitions from:

- The Dublin Core Metadata Terms Standard
- The W3C Simple Knowledge Organization System (SKOS)
- The OMG Architecture Board's Specification Metadata Recommendation

SKOS and the OMG Specification Metadata are explicitly imported, while the Dublin Core is not, due to the fact it is an RDF Vocabulary and only OWL ontologies may be formally imported.

Table 8.3 lists the prefixes and namespaces considered external to FIBO.

Table 8-3: Prefix and Namespaces for referenced/external ontologies

Namespace Prefix	Namespace
rdf	http://www.w3.org/1999/02/22-rdf-syntax-ns#
rdfs	http://www.w3.org/2000/01/rdf-schema#
owl	http://www.w3.org/2002/07/owl#
xsd	http://www.w3.org/2001/XMLSchema#
dct	http://purl.org/dc/terms/
skos	http://www.w3.org/2004/02/skos/core#
sm	http://www.omg.org/techprocess/ab/SpecificationMetadata/
lcc-lr	http://www.omg.org/spec/LCC/Languages/LanguageRepresentation/
lcc-639-1	http://www.omg.org/spec/LCC/Languages/ISO639-1-LanguageCodes/
lcc-cr	http://www.omg.org/spec/LCC/Countries/CountryRepresentation/
lcc-3166-1	http://www.omg.org/spec/LCC/Countries/ISO3166-1-CountryCodes/

The namespace approach taken for FIBO is based on OMG guidelines and is constructed as follows:

- A standard prefix `https://www.omg.org/spec/`
- The specification name, EDMC-FIBO
- The abbreviation for the domain: for example FND or BE
- The module name
- The ontology name

Note that the URI/IRI strategy for the ontologies in FIBO takes a "slash" rather than "hash" approach, in order to accommodate server-side applications.

Though not technically necessary, this specification does mandate namespace prefixes to be used. These are constructed as follows with the components separate by "-":

- The specification name `fibo`
- The domain abbreviation: e.g. `fnd`

- An abbreviation for the module name
    - Where modules contain further modules, an abbreviation for the contained module
- An abbreviation for the ontology name

The namespaces and prefixes corresponding to FIBO ontologies are given in Annex B and onwards, for each ontology in each domain.

9 Additional Metadata

9.1 Introduction

Two kinds of ancillary OWL file are provided with this specification. One kind of ancillary file provides the means for users to import all of FIBO or all of a given domain, and is known as an 'All' file (having the filename 'All[DomainName]'. The other type of ancillary OWL file documents the metadata for each domain and module and for the FIBO Specification itself. These ancillary files are listed in Table 2 below. This table gives examples for a domain (Foundations, abbreviated FND) and for a module within that domain (Accounting) by way of illustration.

The metadata described in this Clause is specific to the OMG FIBO Version 2 Specification and is derived from similar metadata maintained by the EDM Council in its publication of FIBO content, with minor variations for matters specific to the OMG and with EDM Council URIs replaced by the corresponding OMG URIs.

Table 9-1: Metadata and All Files Types and Examples

Function	Example Filename (.rdf)	Example Named Individual
Modular Structure		
Domain	AllFND	N/A
Metadata		
FIBO as a whole	MetadataFIBO	FIBOSpecification
Domain	MetadataFND	FNDDomain
Module	MetadataFNDAccounting	AccountingModule
Sub Module	Not required	Not required
Ontology	CurrencyAmount	N/A

Metadata about FIBO components (domains, modules etc.) are maintained as annotations to a named individual (owl:NamedIndividual) representing the domain or module within these metadata ontology files. An example of each of these is included in Table 2. There are no named individuals in the Modular Structure ('All') files. There are no named individuals in the OWL ontologies files, the metadata for those being maintained as metadata annotations within the OWL file 'ontology' element itself.

Given that the Metadata and All files take the form of OWL ontology files, these have their own file metadata as well, giving basic annotations relating to the metadata file itself. These are separate to the metadata for the FIBO component (domain, module etc.) and are specified separately.

Each Metadata ontology has its own namespace abbreviation for the metadata ontology file ending in -mod so that it is distinct from the abbreviation for the FIBO component that it documents, for example fibo-fnd-acc-mod documenting the module fibo-fnd-acc, and fibo-fnd-mod documenting the domain fibo-fnd. Similarly, the FIBO Specification itself has the abbreviation fibo and its metadata ontology file has the abbreviation fibo-spec.

9.1.1 Use of Metadata Standards

As discussed in Clause 8, the FIBO specifications reuse existing metadata standards, including:

- The Dublin Core Metadata Terms Standard
- The W3C Simple Knowledge Organization System (SKOS)
- The OMG Architecture Board's Specification Metadata Recommendation

These metadata definitions are not inherent elements of RDF Schema or OWL, although the standard makes extensive use of `rdfs:label` in particular. This clause of the specification describes the metadata used throughout the standard and provides examples where appropriate for clarification purposes.

The use of the “sm” namespace prefix in the abbreviated IRI for the metadata term refers to the OMG Specification Metadata ontology, as identified in Table 8.1, in Clause 8.

9.2 The ‘Metadata’ and Imports Files

9.2.1 Modular Structure Imports Files

A set of files is provided with which to import all the ontologies in FIBO, in a given FIBO Domain and in each FIBO Module. These are called ‘All’ files and take the form of RDF/OWL ontologies.

9.2.1.1 Overall FIBO All Files

The ‘All’ files for all of FIBO are automatically generated during the EDM Council’s publication process but no corresponding ‘All’ file is generated for the OMG FIBO Version 2 Specification. These are therefore not included in this Specification and are not specified in this Clause.

9.2.1.2 Domain All Files

The Domain ‘All’ files contain imports of all the ontologies in a given Domain.

9.2.1.3 All Files Metadata

The ‘All’ files also have metadata for the ‘All’ ontology file itself. These are maintained in the ontology declaration part of the ontology file. The metadata elements used are shown in Table 9-2.

Table 9-2: Metadata Elements in ‘All’ Files

Metadata Element	Required contents (description)
rdfs:label	‘All imports ontology for the [name of Domain or Module]’
sm:copyright	Copyright assertion for EDM Council Copyright assertion for Object Management Group
dct:license	MIT License link
sm:filename	Name of the All file
sm:fileAbbreviation	fibo-[domain or module]-all
versionIRI	The OWL versionIRI for the All file
dct:abstract	Describes the nature and role of the All file
dct:issued	Date of the formal release (Quarterly release date) plus arbitrary time of day (6pm) as this is a complete date/time datum.
sm:contentLanguage	OWL (URI for W3C OWL reference)

The MIT License link dereferences to an on-line resource giving the terms of the MIT license under which the FIBO content is made available.

9.2.2 Metadata Files

Each metadata file contains a single ‘Named Individual’ (owl:NamedIndividual) representing the FIBO component, for example for the domain or the module. Metadata relating to each FIBO component is maintained as annotations on that named individual, in a metadata file located in the file system directory corresponding to that component.

For FIBO as a whole, the named individual represents the FIBO Specification.

Note that ‘Domain’ is recognized as a distinct concept in the FIBO structure but uses metadata for the concept of ‘Module’ in its more general sense, using OMG Specification Metadata module annotations. Similarly, sub-Modules use the Module Specification Metadata annotations where applicable but do not have the same metadata requirements as a Module.

Metadata files are named according to the combination of the domain abbreviation (e.g., MetadataFND) and for module metadata files, the module name appended onto the domain abbreviation (e.g., MetadataFNDAccounting).

These files also have their own metadata, since they are OWL ontology files. This metadata is described separately and is maintained within the ontology declaration of the metadata ontology file.

9.2.2.1 Namespace Abbreviations Used

The namespaces given in the Named Individual metadata and the Ontology metadata in the two sub-sections that follow, are shown in Table 8-3 in Clause 8.

9.2.3 FIBO Components Metadata

The metadata for the FIBO components (domains, modules etc.) are given as metadata annotations on named individuals (owl:NamedIndividual) in the metadata files, as described in Table 9-3.

Table 9.3: FIBO Component Metadata

1: FIBO Specification Metadata
Component Type: Specification
Filename: MetadataFIBO
Named Individual: FIBOSpecification

Metadata	Content and Notes	Example
rdf:type	sm:Specification	
rdfs:label	Short name	Financial Industry Business Ontology
skos:definition	Describes the individual	individual representing metadata about the FIBO specification
sm:specificationTitle	Formal title	Financial Industry Business Ontology (FIBO)
sm:specificationAbbreviation	FIBO	
dct:issued	EDMC Quarterly release date	2018-06-30T18:00:00
sm:specificationURL	Formal URL for the specification	https://www.omg.org/spec/EDMC-FIBO/
dct:abstract	Abstract for all FIBO	
sm:technologyArea	Technology covered by the spec	‘formal semantics’
sm:topicArea	Industry topic(s)	‘finance’
sm:copyright	EDM Council OMG	Copyright (c) 2013-2018 EDM Council, Inc. Copyright (c) 2015 - 2018 Object Management Group, Inc.
dct:license	Link to MIT License	http://opensource.org/licenses/MIT
sm:dependsOn	Dependencies if any	None given
sm:keyword	Various keywords	FIBO, Financial Industry Business Ontology
rdfs:seeAlso	Other relevant URIs	www.edmcouncil.org
dct:hasPart	List all the Named Individuals representing the domains that are part of this specification	&fibo-be-mod;BEDomain[2]

[2] Note that the content of the hasPart relation is given in and RDF Resource declaration; these take the form of a namespace abbreviation that is preceded by an ampersand and followed by a semi-colon.

2: Domain Metadata
Component Type: Domain
Example Filename: MetadataFND
Example Named Individual: FNDDomain

Metadata	Content and Notes	Example
rdf:type	sm:Module	
rdfs:label	Short name of domain (for FIBOPedia[3])	Foundations
dct:title	Full title of domain (for specification annex heading)	EDMC Financial Industry Business Ontology (FIBO) Foundations (FND) Domain
sm:moduleAbbreviation	Module abbreviation (lowercase)	fibo-fnd
dct:abstract	Domain abstract	
sm:copyright	EDM Council OMG	Copyright (c) 2013[4]-2018 EDM Council, Inc. Copyright (c) 2013-2018 Object Management Group, Inc.
dct:license	Link to MIT License	http://opensource.org/licenses/MIT
dct:creator	Public landing URI of the FCT	https://spec.edmcouncil.org/fibo/fct/Foundations
sm:keyword	One or more keywords of phrases describing the domain	foundational vocabulary
rdfs:seeAlso	Link to the FIBO spec web page	https://spec.edmcouncil.org/fibo/
dct:hasPart	List all the Named Individuals that represent modules that are part of this domain. NOTE: this must include all modules regardless of the status of their ontologies.	&fibo-fnd-acc-mod; AccountingModule
sm:contributor	Optional list of contributors as separate contributor elements	Company Name, Inc.

3: Module Metadata
Component Type: Module
Filename: MetadataFNDAccounting
Example Named Individual: AccountingModule

Metadata	Content and Notes	Example
rdf:type	sm:Module	
rdfs:label	Module short name	Accounting
dct:title	Module long name	FIBO FND Accounting Module
sm:moduleAbbreviation	Module abbreviation (lowercase)	fibo-fnd-acc
dct:abstract	Module abstract	This module contains ontologies of general accounting concepts including debt, equity, interest and so on, as well as currency amounts.
sm:copyright	EDM Council	Copyright (c) 2013-2018 EDM Council, Inc.

[3] FIBOPedia is one of the EDM Council deliverable formats that are generated from the OWL.

[4] The first year in each of the EDM Council and OMG Copyright statements will vary according to the date that the artifact in question was first created by the EDM council and / or submitted to the OMG.

Metadata	Content and Notes	Example
	OMG	Copyright (c) 2013-2018 Object Management Group, Inc.
rdfs:seeAlso	Reference to URI of FIBO itself	https://spec.edmcouncil.org/fibo/
dct:hasPart	List all the IRIs for ontologies that are part of this module NOTE: this must include all ontologies regardless of their status.	https://spec.edmcouncil.org/fibo/ontology/FND/Accounting/AccountingEquity/
sm:contributor	Optional list of contributors as separate contributor elements	Company Name, Inc.

9.2.4 Metadata Ontology File Metadata

The metadata ontology files containing the named individuals described above, are themselves OWL ontology files and therefore contain metadata describing that file. The metadata used for these files is described in Table 9-4.

Note that this metadata varies between specification, domain and ontology metadata files as identified in this table.

Table 9-4: Ontology File Metadata for the Metadata Ontology Files

Metadata Element	Required contents (description)
rdfs:label	'Metadata ontology for the [name of Domain or Module]'
sm:copyright	Copyright assertion for EDM Council Copyright assertion for Object Management Group
dct:license	MIT License link
sm:filename	Name of the Metadata file e.g., MetadataFNDAccounting.rdf
sm:fileAbbreviation	fibo-[domain or module]-mod fibo-spec (for Specification metadata file only)
versionIRI	The OWL versionIRI for the Metadata file
dct:abstract	Describes the nature and role of the Metadata file
sm:contentLanguage	OWL (URI for W3C OWL reference)
owl:imports	Should be sm, av plus the metadata ontology files for the components of this element e.g., MetadataFNDAccounting for the FND Domain; ontologies that are part of the Module.
dct:issued	Date the file was issued as part of the EDM Council publication process (a separate element, sm:publicationDate, exists for the date a file was published into the OMG submission process, for OMG files).

9.2.5 Ontology File Metadata

In addition to the stand-alone metadata files listed above, metadata is maintained for the FIBO content ontologies. The metadata for each ontology is asserted within the 'ontology' element of the ontology file itself. There is no OWL named individual corresponding to each of these ontology files.

Table 9-5: Ontology File Metadata

Component Type: Ontology
Example Filename: CurrencyAmount
There is no Named Individual for these

Metadata	Content and Notes	Example
rdfs:label	Ontology name + 'Ontology'	Currency Amount Ontology
dct:abstract	Ontology abstract	
dct:license	MIT license link	http://opensource.org/licenses/MIT
sm:contentLanguage	OWL URI	http://www.w3.org/standards/techs/owl#w3c_all
sm:copyright	EDM Council Copyright statement OMG Copyright statement	Copyright (c) 2013-2018 EDM Council, Inc. Copyright (c) 2013-2018 Object Management Group, Inc.
sm:dependsOn	List of direct dependencies URIs	
sm:directSource	Where applicable e.g., ISO 4217	
sm:fileAbbreviation	Namespace abbreviation for the ontology	fibo-fnd-acc-cur
sm:filename	Filename of the ontology file	CurrencyAmount.rdf
rdfs:seeAlso	Domain, Module, FIBO Metadata URIs	
owl:versionIRI	Full version IRI with e.g., /2018Q2/	
skos:editorialNote	Editorial notes where applicable (typically Provisional)	
hasMaturityLevel	Text from a controlled list of maturity levels	'Release', 'Provisional' or 'Informative'

9.3 Metadata Content

This sub-Clause describes the actual content of the metadata specified above.

9.3.1 Specification-Level Metadata

The metadata for the FIBO specification itself is defined in a single metadata file as described in the preceding sub-Clause. Unlike the metadata for domains and modules this is not reported in any of the Annexes to this specification but instead is given in Table 9-6 below.

Table 9-6: FIBO Specification Metadata

Metadata Term	Value
rdf:type	sm:Specification
rdfs:label	Financial Industry Business Ontology
dct:abstract	The Financial Industry Business Ontology (FIBO) is a collaborative effort among industry practitioners, semantic technology experts and information scientists to standardize the language used to precisely define the terms, conditions, and characteristics of financial instruments; the legal and relationship structure of business entities; the content and time dimensions of market data; and the legal obligations and process aspects of corporate actions. The definitions and relationships that comprise the FIBO specification have been modularized into a number of domains, which in turn include a number of modules, each of which is further modularized into one or more constituent ontologies.

Metadata Term	Value
	The FIBO ontologies are available as OWL 2 ontologies from the EDM Council site, and as UML models that are compliant with the Semantics for Information Modeling and Federation (SMIF) draft specification, and are linked at https://www.omg.org/spec/EDMC-FIBO/ .
dct:hasPart	&fibo-be-mod;BEDomain
dct:hasPart	&fibo-der-mod;DERDomain
dct:hasPart	&fibo-fbc-mod;FBCDomain
dct:hasPart	&fibo-fnd-mod;FNDDomain
dct:hasPart	&fibo-ind-mod;INDDomain
dct:hasPart	&fibo-sec-mod;SECDomain
dct:issued	2018-08-27T18:00:00
dct:license	http://opensource.org/licenses/MIT
dct:title	Financial Industry Business Ontology (FIBO)
sm:copyright	Copyright (c) 2013-2018 EDM Council, Inc.
sm:copyright	Copyright (c) 2015-2018 Object Management Group, Inc.
sm:dependsOn	http://www.omg.org/spec/LCC/
sm:dependsOn	http://www.omg.org/techprocess/ab/SpecificationMetadata/
sm:keyword	FIBO
sm:keyword	Financial Industry Business Ontology
sm:specificationAbbreviation	FIBO
sm:specificationURL	https://www.omg.org/spec/EDMC-FIBO/
sm:technologyArea	formal semantics
sm:topicArea	finance
rdfs:seeAlso	http://www.edmcouncil.org/

9.3.2 Domain, Module and Ontology-Level Metadata

Every domain and module will have unique metadata specific to that domain or module, as given in the metadata tables in Annexes B onward. Additionally, every ontology will include curation and other metadata. The domain and module metadata is given in the module "Metadata" ontology as described in the preceding sub-clauses while the ontology metadata is included within the ontology itself.

Explicit use of the MIT License[5] for software (including OWL ontologies, CMP/UML models, XMI) is intended to assure users of the ontologies that the ontologies are freely available, for use with attribution, and without warranty.

These details are provided in the tables for the individual domains, modules and ontologies in Annex B and onward.

[5] See http://opensource.org/licenses/mit-license.php

9.4 Ontology Entity-Level Metadata

This sub clause describes the metadata that are applied to each named concept (Class and Property) in the ontologies.

9.4.1 Definitions, Notes, and Labels

Table 9-7: Definitions, Labeling, and Notes

Term Requirement	Term Type	Annotation	Usage Notes
Definition	Definition	`skos:definition`	Main formal definition of term. Must always be present
Change history	Note	`skos:changeNote`	Notes indicating why something was modified
General note, editorial comment	Note	`skos:editorialNote`	The bulk of the "Further Notes" narrative is expressed this way
Examples	Note	`skos:example`	Examples
Explanatory note	Note	`fibo-utl-av:explanatoryNote`	Notes providing additional explanation about the concept
Historical note	Note	`skos:historyNote`	Notes regarding the history of the concept
Note	Note	`skos:note`	Used when no specific note annotation is appropriate
Scope note	Note	`skos:scopeNote`	Clarifying information about the scope of the term or concept
Usage note	Note	`fibo-utl-av:usageNote`	Used to suggest how a particular concept is intended to be used
Preferred Label	Label	`skos:prefLabel`	Replaces rdfs:label if there is a preferred label for the concept
Alternate Label	Label	`skos:altLabel`	Alternate label additional to prefLabel. Should be used instead of rdfs:label for alternatives

9.4.2 Synonymous Terms

Synonyms are fundamental to FIBO ontology, both in its usage (for example in natural language processing applications) and in the maintenance of FIBO itself, where it is reflected in the reporting required for business domain view and review of the ontologies. At a basic level, business review reporting may require as little as just the concept, a label, its formal definition in text form, and any synonyms.

Fundamentally, an ontology, and any extensions derived from it, should contain only a single element defining a given concept, with synonyms captured using the `fibo-utl-av:synonym` annotation property. Within a given ontology, use of separate classes with the same meaning, together with the OWL construct for class equivalence (equivalentClass) is not considered best practice. Such an approach may be necessary to align or map ontologies to one another, however, where the same concepts exist in different namespaces. `fibo-utl-av:abbreviation` may be used to specify abbreviations and acronyms associated with concepts as appropriate.

9.4.3 Provenance and Cross-reference Annotation

Where possible, every effort is made in the FIBO ontologies to provide references for the origin of terms and their definitions, including cases where those definitions have been adapted for FIBO usage. Any FIBO ontology that includes terminology from a particular standard, such as FpML, ISO 20022, any regulatory publication, and so forth should note it as the source for a given concept or its definition.

Four annotation properties are provided in the FIBO AnnotationVocabulary to facilitate provenance documentation for the terminology and definitions specified in the standard. These are:

- `fibo-fnd-utl-av:adaptedFrom` – used where the text in the `skos:definition` is adapted from the definition of the term defined in the range of this property (range can be a string, URI, or BibliographicCitation).
- `fibo-fnd-utl-av:definitionOrigin` – used where the text in the `skos:definition` is a direct copy of the definition of the term defined in the range of this property (range can be a string, URI, or BibliographicCitation).
- `fibo-fnd-utl-av:termOrigin` – which provides the means to document the source of a term, in a standard, in some other document, or by some organization. The range of this property is the document and / or organization from which the term was derived (range can be a string, URI, or BibliographicCitation).
- `fibo-fnd-utl-av:nameOrigin` – which provides the means to document the name of the original term in the standard, other document or organization referenced via the annotation fibo-utl-av:termOrigin.

Note that FIBO does not recommend a specific standard for citations. There are a number of ontologies that might be considered for this purpose, and the OMG Specification Metadata provides a class called BibliographicCitation that can be used as the range of this annotation and can be mapped to the preferred citation definition for a given application, organization, or repository.

9.4.4 Change Management Annotation

In addition to the version information provided at the specification and domain level for a given FIBO ontology, additional annotations for change management purposes may be appropriate at the concept level. These may include:

- `skos:changeNote`
- `fibo-fnd-utl-av:modifiedBy` – identifying the person and/or organization responsible for the change
- `fibo-fnd-utl-av:modifiedOn` – identifying the date and time of the change
- `skos:isDeprecated`

In order to maintain backward compatibility, elements that are deleted are retained in the model while being annotation as ‘deprecated’, while for elements that are renamed or moved to another namespace, the existing element is retained and marked as deprecated and a new element introduced at the new location.

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Annex A: Machine Readable Files Part of This Specification (normative)

The FIBO ontologies are delivered as (1) RDF/XML serialized OWL (normative and definitive), (2) Additional RDF/XML serialized OWL for metadata ontologies and for domain-level imports ontologies (informative), and (3) UML XMI, serialized from UML with the UML Concept Modeling Profile [UMLCMP] profiles for RDF and OWL applied (informative). If there are differences between the OWL files and UMLCMP XMI, the OWL files take precedence.

Regardless of their form, each of the ontologies included in FIBO makes normative reference to the DCMI Dublin Core Metadata Terms [Dublin Core], W3C Simple Knowledge Organization System (SKOS) Recommendation [SKOS], and the OMG Architecture Board's Specification Metadata Recommendation [OMG AB Specification Metadata], which are not part of this specification.

The individual RDF/XML files are organized by module (directory), and within a given module, alphabetically by name, as shown in the URI structure for each individual OWL file. These files are UTF-8 conformant XML Schema files that are also OWL 2 compliant, and may be examined using any text editor, XML editor, or RDF or OWL editor. They have been verified for syntactic correctness via the W3C RDF Validator and University of Manchester OWL 2 Validator. They have also been checked for logical consistency using the Pellet OWL 2 reasoner from StarDog Union as well as the HermiT OWL 2 reasoner from Oxford University. The OWL ontologies will be dereference-able, together with technical documentation (HTML) from the OMG site once the specification is adopted.

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Annex B: Business Entities

Please refer to the separate document finance/2018-09-24 which is intended to be inserted here.

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Annex C: Collective Investment Vehicles

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Annex D: Derivatives

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Annex E: Financial Business and Commerce

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Annex F: Foundations

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Annex G: Indices and Indicators

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Annex H: Loans

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Annex J: Securities

Please refer to the separate document finance/2018-09-29 which is intended to be inserted here.