

Analytical Data Management
Reference Architecture Model

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Introduction

Analytical Data Management covers the data and metadata life-cycle objects and processes for systems which support, directly or indirectly, the specification, collection, aggregation and dissemination of data for further analysis in subject-matter areas. The subject-matter areas include, but are not limited to:

- *Economic and social statistics*
- *Marketing Support Systems*
- *Life-Sciences Information Systems*
- *Simulation Support Applications*
- *Transport & Logistics Planning*
- *Health Care*

This document provides a reference framework for architectural issues related to Analytical Data Management in the context of future submissions to the OMG, and comparisons with existing work in this area.

Overview

Problems of analytical data collection and dissemination

The “production” of analytical data actually involves three major processes: collection, production, and dissemination.

On the **collection** side it takes a long time to collect good quality data from the sources. There are many reasons for this, but the general lack of automation is a key factor:

- Obtaining the raw data for one survey or collection exercise often means extracting the data from more than one system. *Usually there is no automated support for this;*
- Data reporting codes required by the analytical data management system are not the same as the identification systems used in the data source. *Usually there is no automated way of correlating the two coding systems*

For example, when collecting data from national statistical administrations, the nomenclatures used at the national level are often different from those used at the European or international level. *Again, usually there is no automated way to translate from one to the other.*

On the **production** side there is often little or no inter-operability between the collection system and the production system. In many organisations, different production systems are built for different subject-matter domains with no real inter-operability between the production systems and the dissemination systems, especially where commercial products are used to analyse or otherwise manipulate the hypercube data.

This is true of both the national level and the international level (e.g. Eurostat, OECD, EMI, IMF etc.). This often leads to the development of non-commercial software by the organisation which is costly and which must be maintained over a long period.

On the **dissemination** side there is a general lack of demand for analytical data by potential clients or users because:

- *It is either out of date (due to the long gestation period in raw data collection);*
- *It is not easy to find or access, or even to understand, the information available due to a lack of support for metadata in both the dissemination database and the products that are used to access and view the statistics.*

In general, all organisations are developing and maintaining high cost systems to support the collection, production, and dissemination phases.

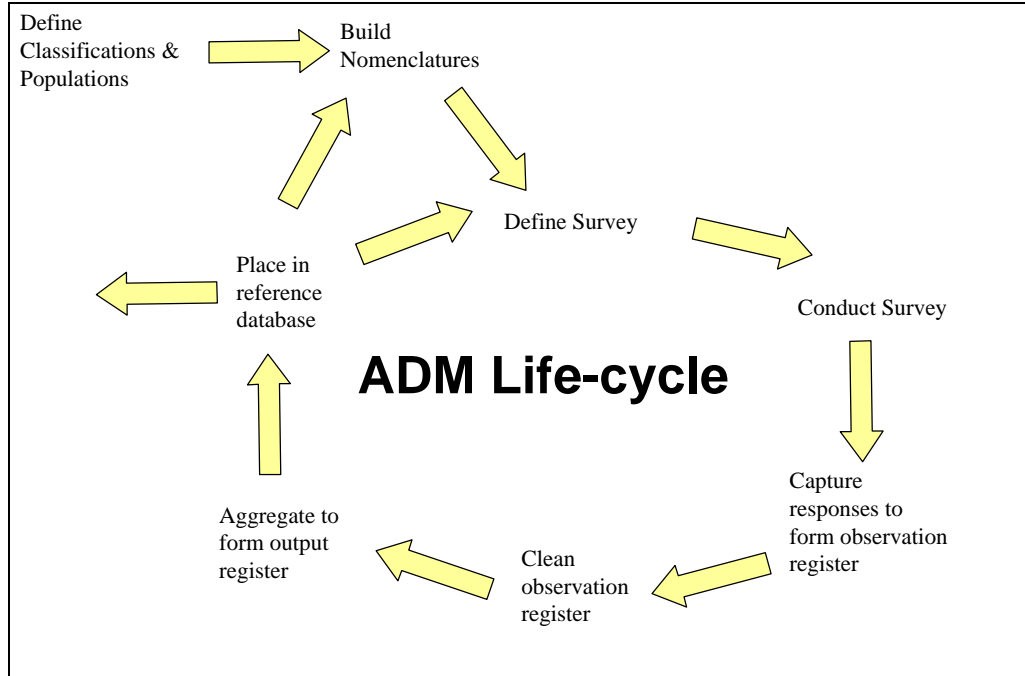
Goals

The goals for the Analytical Data Management are to enable:

- speedy collection of high quality raw data from disparate sources, both automated and non-automated;
- dissemination of relevant, high quality analytical to a wide audience (i.e. to anyone that wants them and is allowed access to them);
- automated flow of data and metadata between all stages of collection, production, and dissemination of information;
- wide availability of low cost software

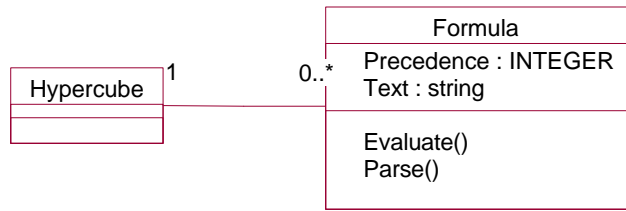
ADM Lifecycle

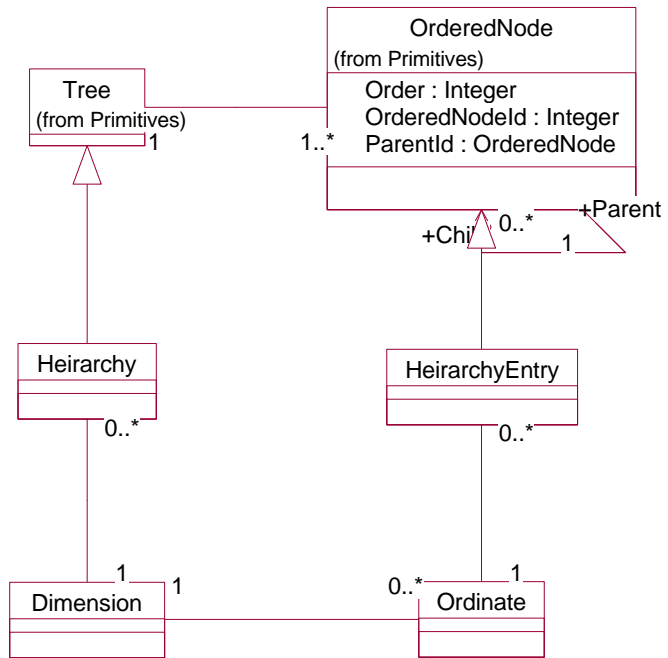
The ADM lifecycle is shown in the following diagram.

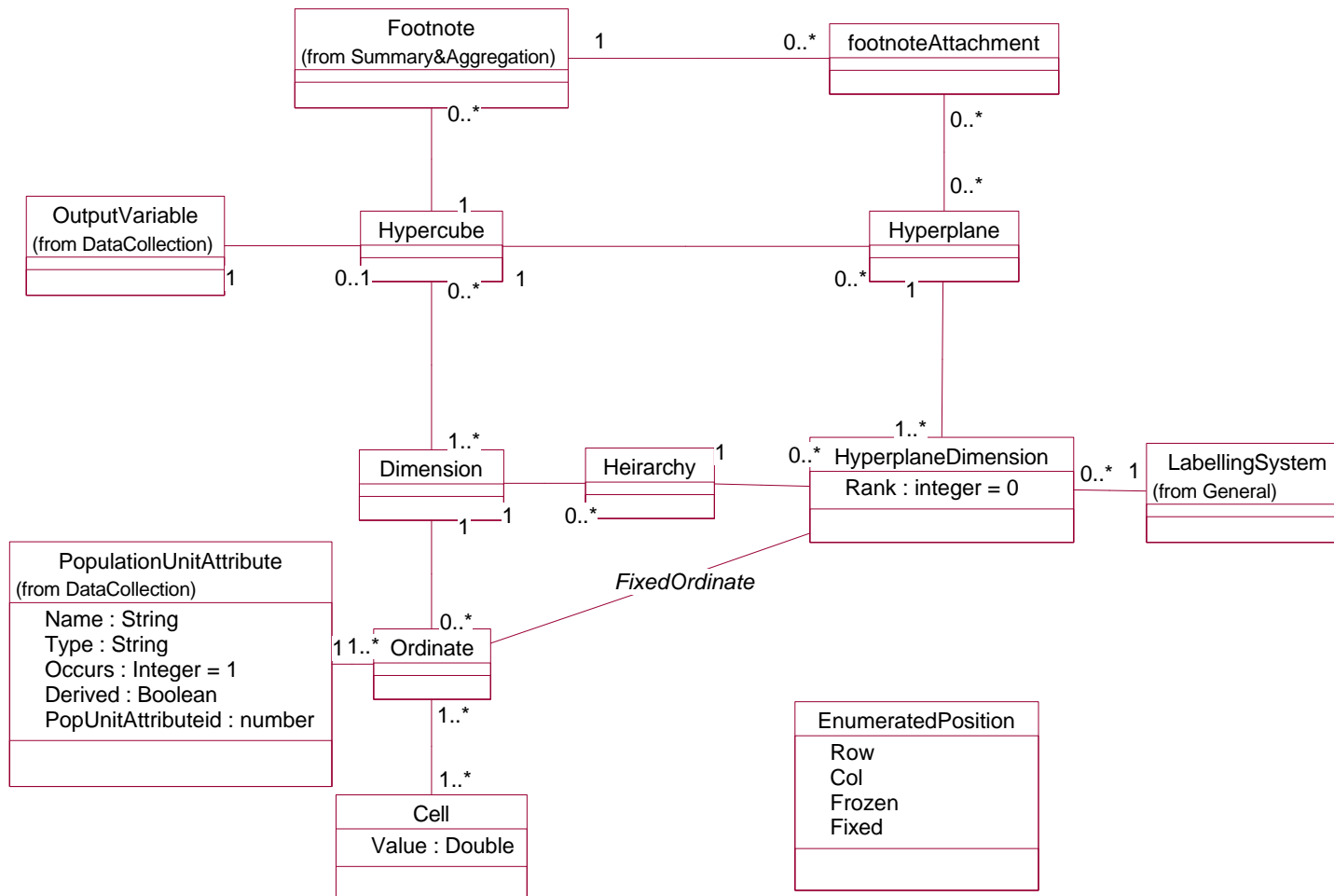


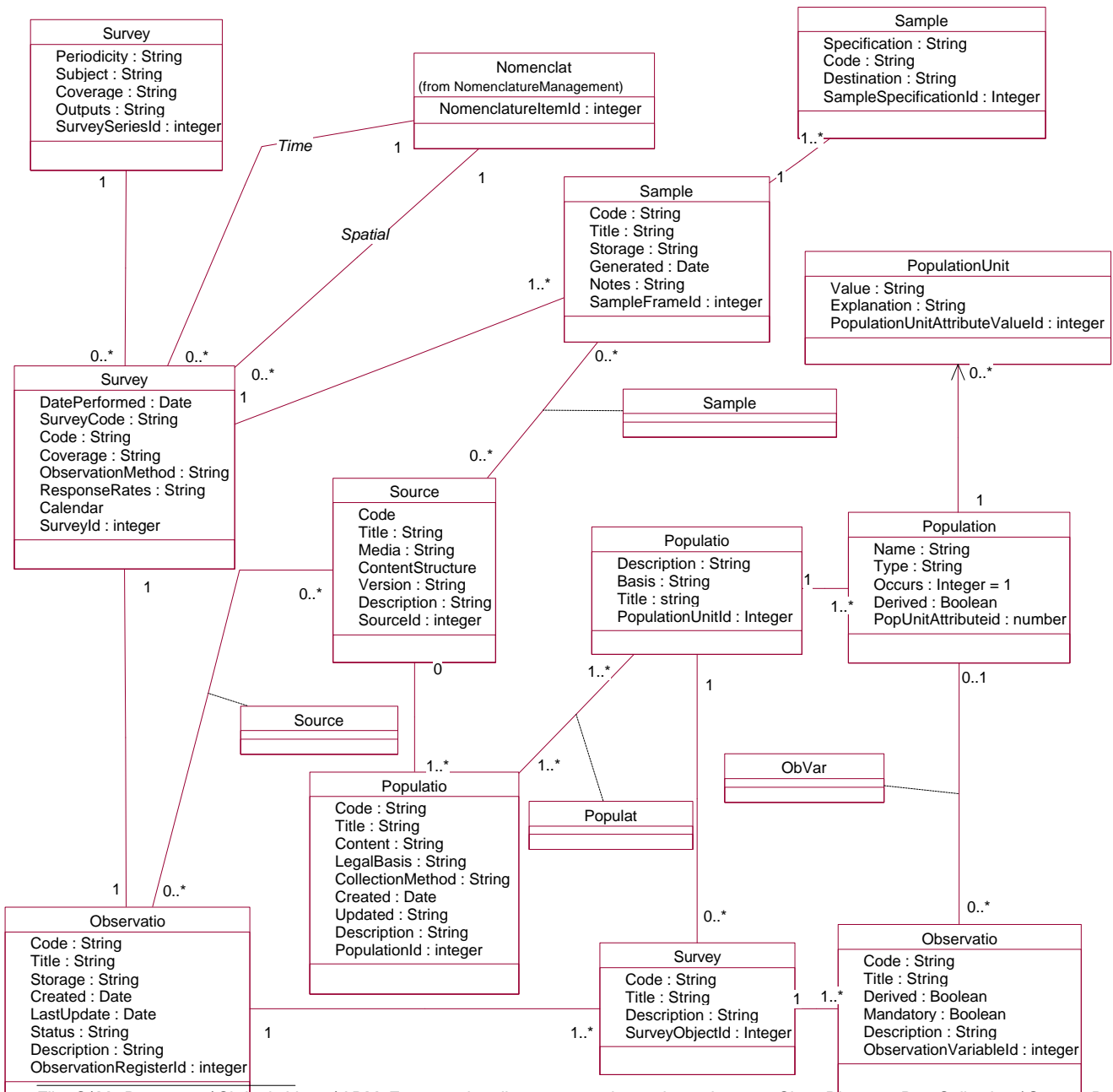
ADM Framework

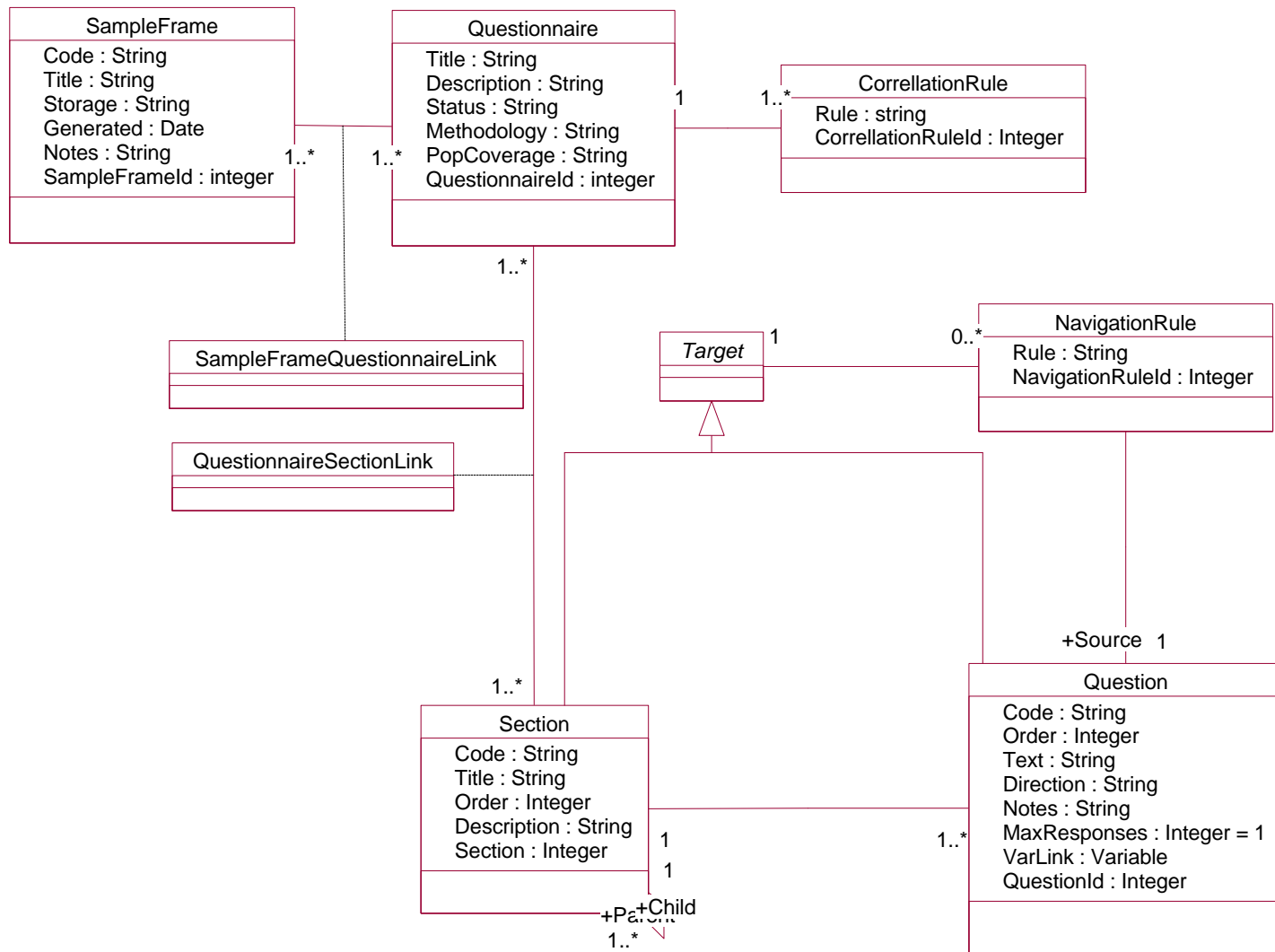
Annex 1 – Class Diagrams

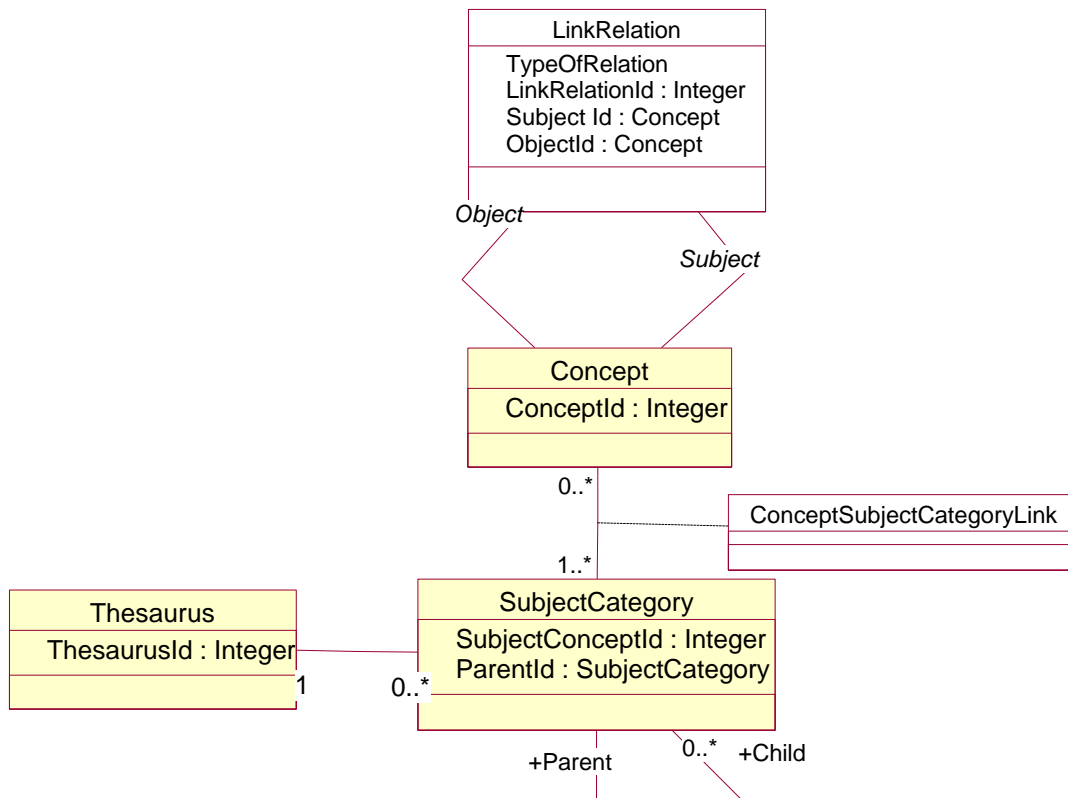


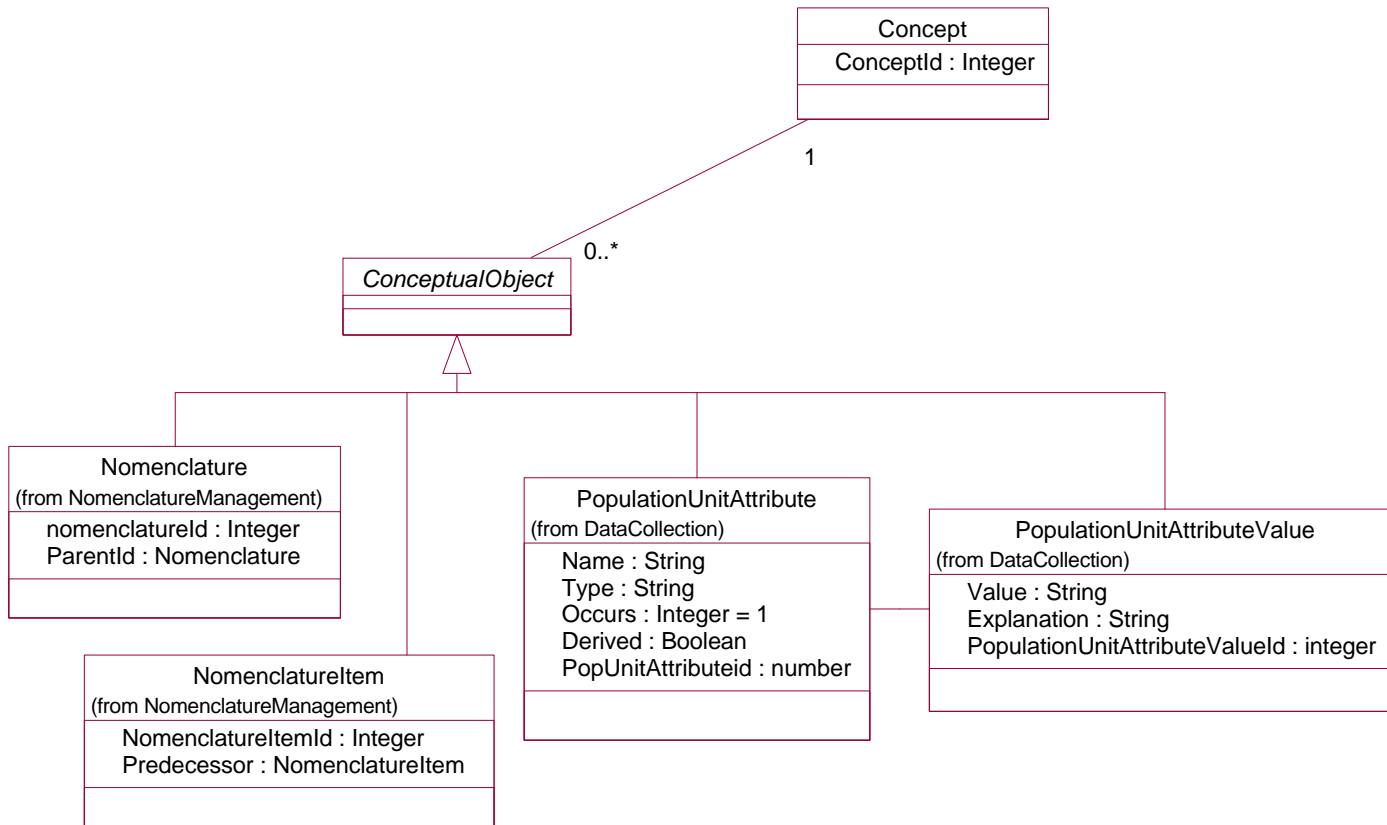


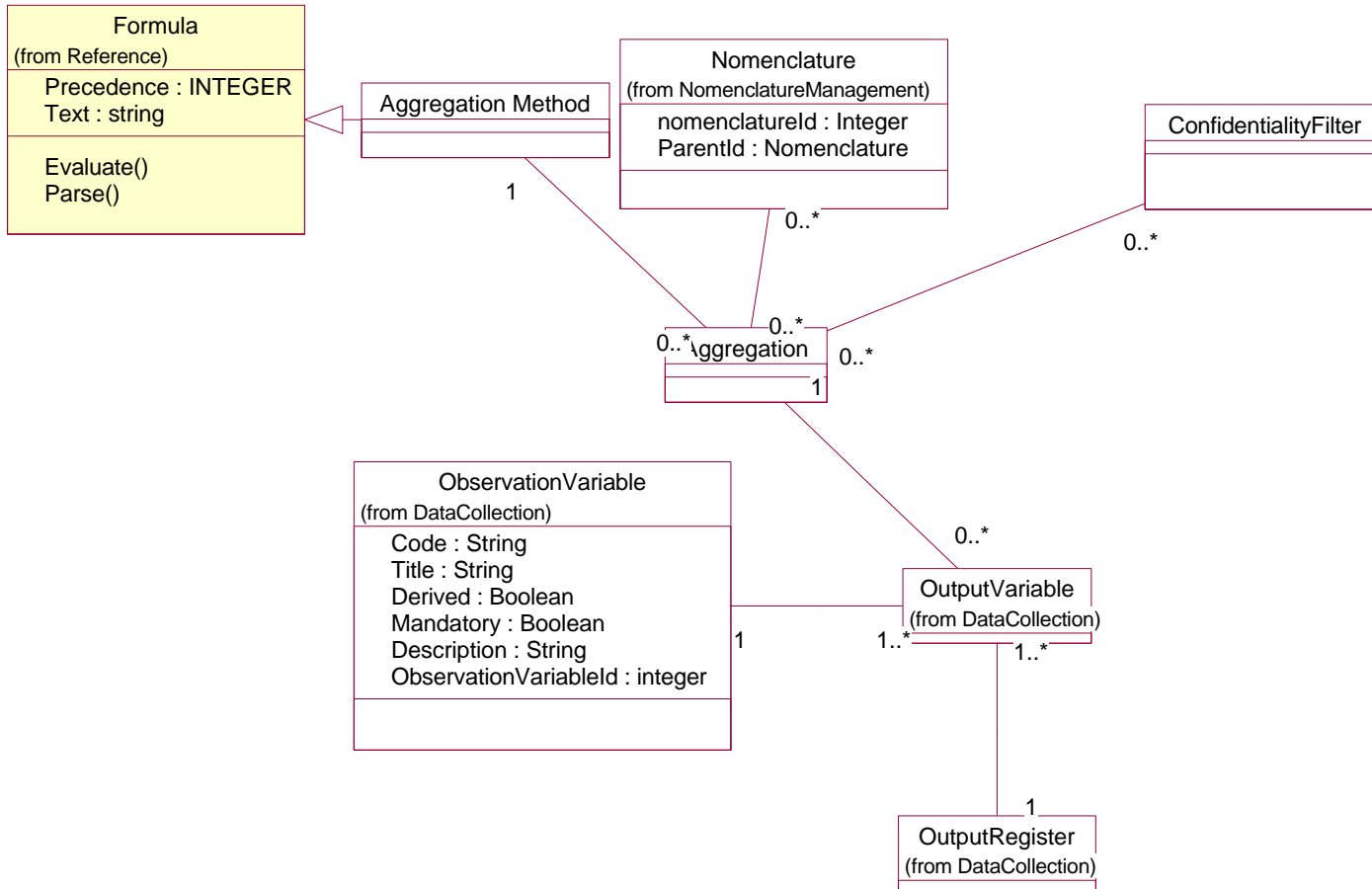


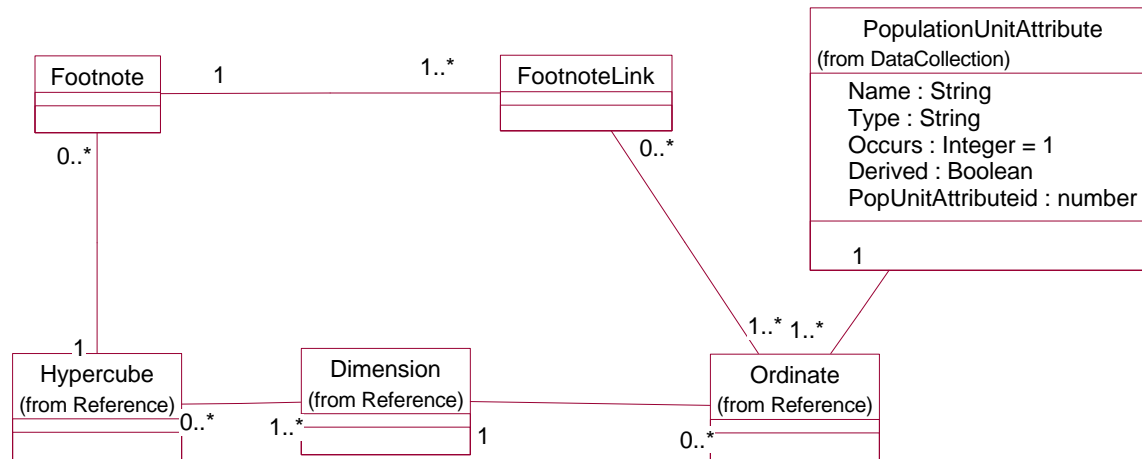


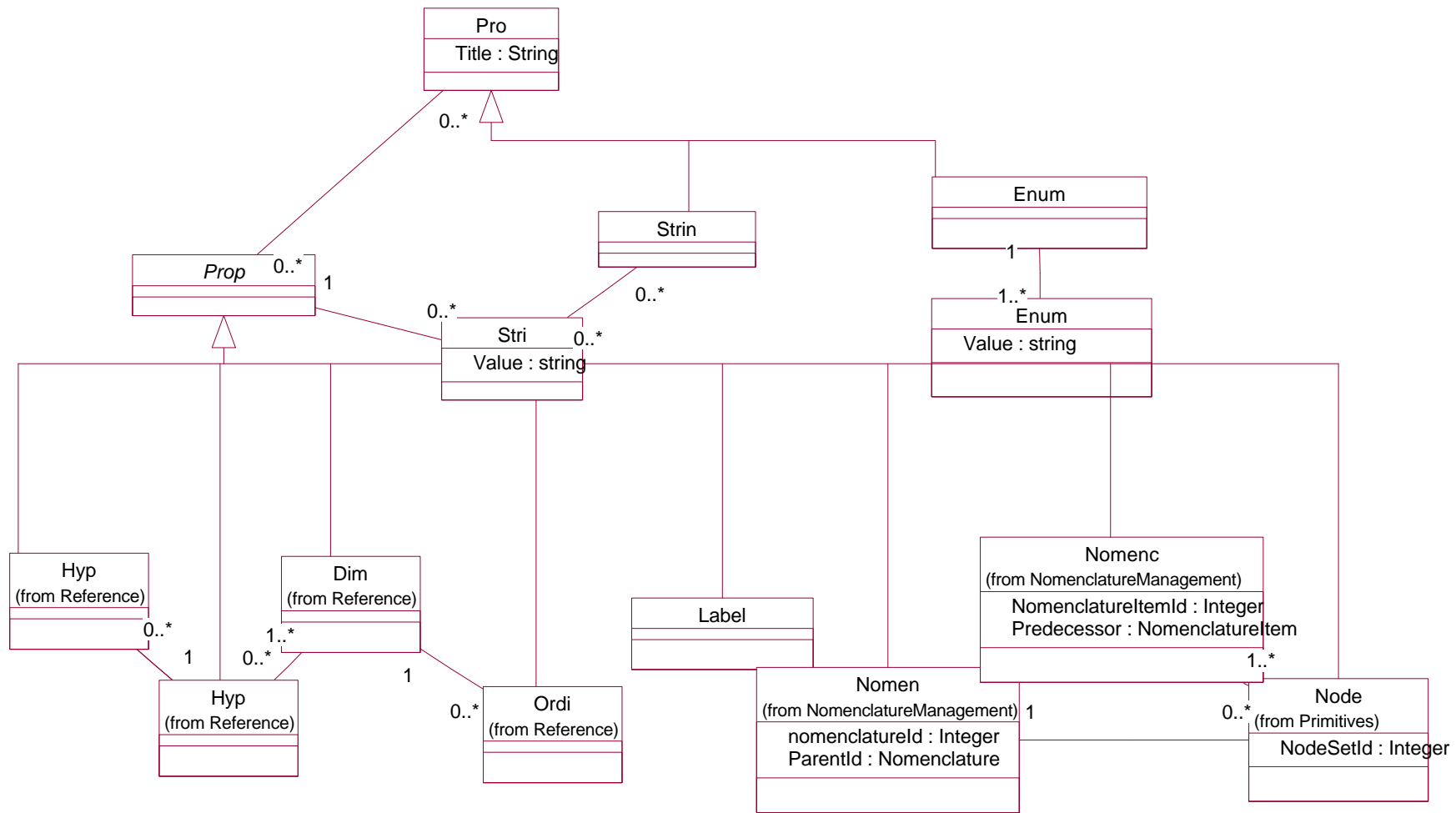


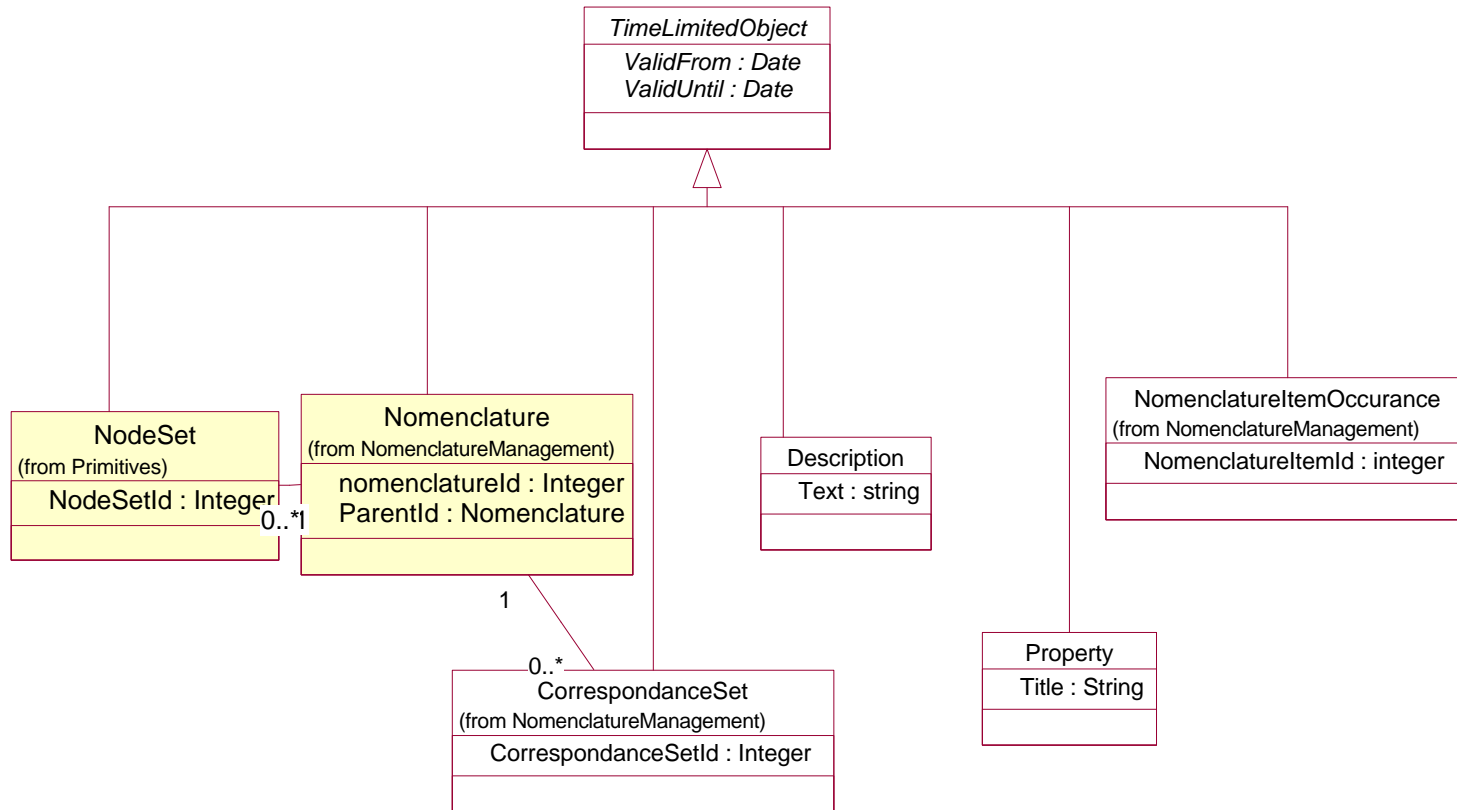


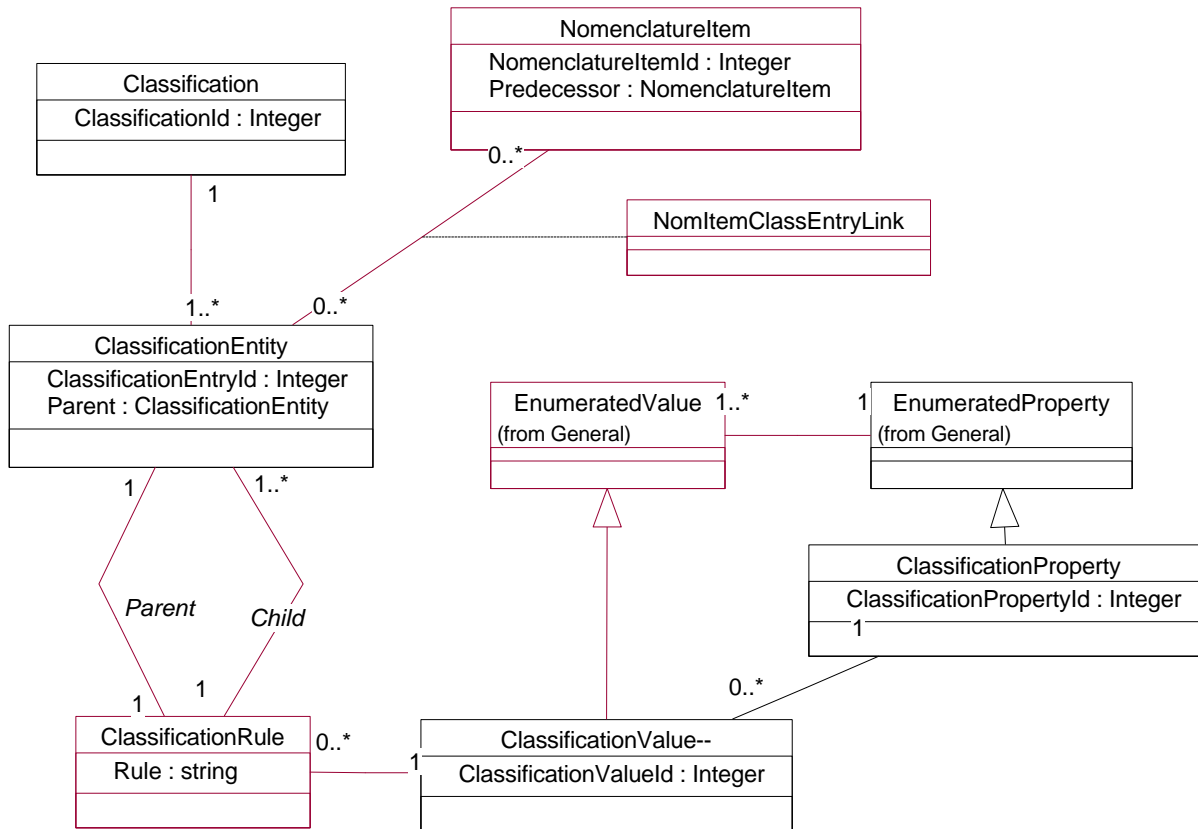


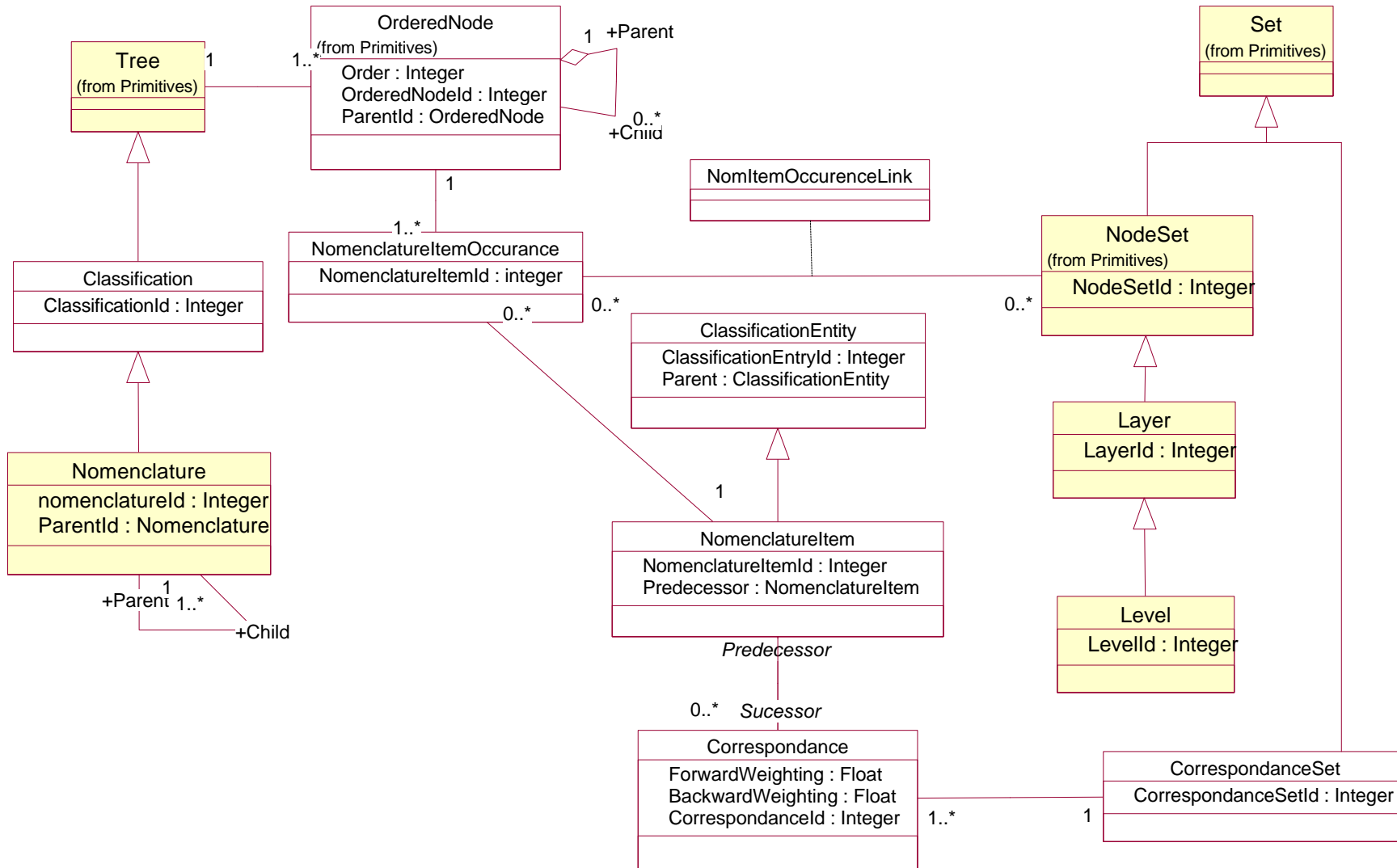












ADM Framework

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LOGICAL VIEW REPORT

Logical View

DataCollection

CorrellationRule

This class represents a rule for correlating the response from a single respondent, i.e. If a person is not employed, there should be a response to a question on the amount of unemployment benefit recieved.

Private Attributes:

Rule : string

CorrellationRuleId : Integer

Derived

This class represents a derived characteristic or attribute of a population unit; for example, given a population unit "Business", an derived attribute might be "net profit". Population unit attributes are used in sample specifications, and in variable definitions.

Derived from PopulationUnitAttribute

Private Attributes:

Formula : String

Formula for calculation of the derivation. The variables of this formula are other attributes of the population unit.

NavigationRule

This class represents an instruction to move between sections of a questionnaire, based on the respondent answers or other criteria.

Derived from MultiLingualObject

Private Attributes:

Rule : String

Condition/Branch statement for the rule.

NavigationRuleId : Integer

Nominal

Derived from PopulationUnitAttribute

Private Attributes:

Size : Integer
Number of characters (maximum) for nominal values.
AsIdentifier : Boolean
Flag to indicate if this value is an identifier for the population unit.
Default : String
Default value

ObservationRegister

This class describes the collection framework for the base data from a survey or enquiry.

Derived from AdministeredObject, DescribedObject

Private Attributes:

Code : String
Title : String
Storage : String
Created : Date
LastUpdate : Date
Status : String
Description : String
ObservationRegisterId : integer

ObservationVariable

This class represents a variable to be collected in the scope of the survey. A variable may be identificatory (i.e. Name of respondent), Classificatory or enumerated (i.e. Car color is one of "Blue", "Red", "Green"), or a collected observation (i.e. Income before tax) . A variable may also be defined as a calculation over other variables, i.e. Revenue = Income - Expenditure.

Derived from LabelledObject, ConceptualObject, AdministeredObject, DescribedObject

Private Attributes:

Code : String
Title : String
Derived : Boolean
Mandatory : Boolean
Description : String
ObservationVariableId : integer

Observed

Derived from PopulationUnitAttribute

OutputRegister

This class represents the repository for outputs from the aggregation process as applied to the contents of observation registers.

Derived from DescribedObject

OutputVariable

This class describes a value derived from the application of an aggregation procedure to variables in an observation register.

[Derived from AdministeredObject, DescribedObject](#)

Population

The definition of a potential population to be covered by a survey, where a population is a collection of population units to be observed in the scope of a survey.

This is essentially a specification of a collection of population unit instances, corresponding to a single population unit, over which the survey is to be conducted. A survey may cover different populations, optionally based on the same population unit. The collection may be complete, i.e. 100% coverage of the population (CENSUS), or a sample of the total population, specified in terms of stratification.

[Derived from DescribedObject](#)

Private Attributes:

Code : String

Organisation-specific

Title : String

Name of the population

Content : String

LegalBasis : String

CollectionMethod : String

Explanation of the method by which the population register contents are enumerated.

Created : Date

Date at which the population became effective

Updated : String

Frequency of register update

Description : String

PopulationId : integer

Population Unit

This class describes an object which is a subject of observation in the context of a statistical survey or enquiry. A population unit is described in terms of one or more attributes, which are directly or indirectly to be covered in the conduct of the survey.

Population units are collected together to form Populations, which are the specified collections of population unit instances.

[Derived from AdministeredObject, DescribedObject](#)

Private Attributes:

Description : String

Description of the population unit

Basis : String

Legal, statistical or other base for the population unit definition.

Title : string

PopulationUnitId : Integer

PopulationUnitAttribute

This class represents a characteristic or attribute of a population unit; for example, given a population unit "Business", an attribute would be "Number of Employees". Population unit attributes are used in sample specifications, and in variable definitions.

[Derived from ConceptualObject, DescribedObject](#)

Private Attributes:

Name : String

Name or title of the attribute

Type : String

The attribute type, as one of Nominal, Qualitative or Quantitative.

Occurs : Integer = 1

The number of values that can accrue to a population unit for this attribute. If Occurs = 1, then it is SCALAR, otherwise it's a VECTOR (a.k.a ARRAY)

Derived : Boolean

PopUnitAttributeid : number

PopulationUnitAttributeValue

This class contains a possible value for a population unit attribute, i.e. a member of the set of all possible values.

[Derived from ConceptualObject](#)

Protected Attributes:

PopulationUnitAttributeValueId : integer

Private Attributes:

Value : String

Value which a PUA can assume, as an enumerated data type entry.

Explanation : String

Qualitative

This class describes the qualitative aspects of a variable.

[Derived from PopulationUnitAttribute](#)

Private Attributes:

Enumerated : Boolean

Flag to indicate if the PUA is an enumerated type, i.e. it's possible values are defined in Property Unit Attribute Value records.

Quantitative

This class holds the quantitative characteristics of a variable.

[Derived from PopulationUnitAttribute](#)

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Private Attributes:

- MinValue : Number**
Minimum value that can be assumed by the attribute
- MaxValue : Number**
Maximum value that can be assumed by the attribute
- Default Value : Number**
Default value (within the min..max range)

Question

This class represents a question which may be asked in the scope of the survey for the purpose of collecting data for one or more variables from each respondent.

Derived from [Target](#), [MultiLingualObject](#)

Public Attributes:

- QuestionId : Integer**

Private Attributes:

- Code : String**
Organisation-specific identifier of the question.
- Order : Integer**
The order of the question within the section.
- Text : String**
Text of the question for respondents
- Direction : String**
Instructions on how to respond to the question (for users).
- Notes : String**
Methodological notes on the question.
- MaxResponses : Integer = 1**
Maximum number of responses for the question, where more than 1 is permissible.
- VarLink : Variable**
Variable under which the question response is stored.

Questionnaire

This class represents a questionnaire used in the conduct of a survey. Each survey may use one or more questionnaires, depending on the population structure(s) for the observations. For example, a business census will have one questionnaire for small and medium enterprises (SME's), and another for large businesses.

Derived from [DescribedObject](#), [MultiLingualObject](#)

Private Attributes:

- Title : String**
Name of the questionnaire
- Description : String**
- Status : String**
Status of the questionnaire specification (Pilot, Draft, Final)
- Methodology : String**
Methodology for the observation based on this questionnaire, including interpretation notes.
- PopCoverage : String**
Statistical description of the population coverage on which this questionnaire is based.

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QuestionnaireId : integer

Sample

This class represents a subset of the population which is covered by all or part of the survey instance.

[Derived from AdministeredObject](#)

SampleFrame

This class represents the actual units covered by a specified population. The information in the frame identifies each unit which is a (potential) respondent to the survey.

[Derived from AdministeredObject, DescribedObject](#)

Private Attributes:

Code : String

Organisation-specific unique identifier for the sample frame.

Title : String

Name of the sample frame.

Storage : String

Database or file location where the unit information extracted on the basis of the specification are stored.

Generated : Date

Date at which the sample frame was generated/extracted.

Notes : String

Notes on the frame contents.

SampleFrameId : integer

SampleSpecification

The definition of the selection or extraction criteria for the population units forming a sample frame for the survey.

[Derived from AdministeredObject, DescribedObject](#)

Private Attributes:

Specification : String

The selection criteria for the population units, expressed in the extraction language.

Code : String

Organisation-specific identifier of the sample frame

Destination : String

File or database identifier in which the population unit identifiers are stored following extraction.

SampleSpecificationId : Integer

Section

This class maintains a sub-structure within a questionnaire, corresponding to a chapter or section containing one or more questions. Sections are used in the specification of questionnaire documents and/or data editing programs, and in navigation rules.

Derived from Target

Private Attributes:

Code : String

Title : String

Order : Integer

The order of the section in the questionnaire, for layout and response sequencing.

Description : String

Section : Integer

Source

This class defines a register or other source for the enumeration of population units.

Derived from DescribedObject

Private Attributes:

Code :

Title : String

Media : String

ContentStructure :

Version : String

Description : String

SourceId : integer

SurveySeries

A SURVEY SERIES is an investigation and data collection activity performed by a statistical institution on a regular basis.

Derived from DescribedObject, MultiLingualObject

Private Attributes:

Periodicity : String

Subject : String

The subject-matter identifier for the survey

Coverage : String

The coverage of the survey, in terms of the population, regional base, sampling etc.

Outputs : String

Text describing the major outputs of the survey

SurveySeriesId : integer

Survey

This class represents the performance of a survey at a given time. Surveys are performed either on an ad-hoc basis, or have a fixed periodicity for performance (Annual, quarterly, etc.)

Derived from AdministeredObject, DescribedObject

Private Attributes:

DatePerformed : Date

SurveyCode : String

Identifier of the parent survey

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Code : String

Identifier of the survey instance (statistical office specific)

Coverage : String

Coverage specific to the survey instance, including changes to previous instances of the survey.

ObservationMethod : String

Note on the observation methods used for the conduct of the survey, i.e. by questionnaire, telephone interview, etc.

ResponseRates : String

Calendar :

The calendar of events in the conduct of the survey.

SurveyId : integer

SurveyObject

This class describes a logical object collected in the scope of a survey operation.

[Derived from AdministeredObject, DescribedObject](#)

[Private Attributes:](#)

Code : String

Title : String

Description : String

SurveyObjectId : Integer

UnitOfMeasure

This class describes a unit of measurement used in the observation of variables.

[Derived from DescribedObject](#)

[Private Attributes:](#)

name :

UnitOfMeasureId : integer

Target

This class describes a target object for navigation rules in terms of locating sections and questionnaires.

[Derived from MultiLingualObject](#)

ObVarPopUnitLink

link class

SampleFrameSourceLink

PopulationUnitLink

SourceObRegLink

SurveySampleFrameLink

SampleFrameQuestionnaireLink

QuestionnaireSectionLink

ConceptManagement

Concept

A concept has a meaning that does not change over time. The representation of the concept (either by title or by textual explanation) may change over time. A concept may be enumerated or measurable.

i.e. a concept is an object which possesses a single atomic meaning: any subdivision creates a new concept.

Derived from DescribedObject, MultiLingualObject

Public Attributes:

ConceptId : Integer

LinkRelation

This class creates an object/subject link between concepts.

Private Attributes:

TypeOfRelation :

LinkRelationId : Integer

Subject Id : Concept

ObjectId : Concept

SubjectCategory

This class describes a subject category for the organisation of concepts in subject-matter areas.

Derived from DescribedObject

Public Attributes:

SubjectConceptId : Integer

Private Attributes:

ParentId : SubjectCategory

Thesaurus

This class represents an organisation of concepts according to subject conceptual dependencies.

Derived from DescribedObject

Private Attributes:

ThesaurusId : Integer

ConceptualObject

This is the base class for the establishment of relationships between other metadata objects and

ConceptSubjectCategoryLink

Summary & Aggregation

Aggregation

This class defines an aggregation of data from an observation register, for export to an output register.

[Derived from DescribedObject](#)

Aggregation Method

This class describes a baseline methodology for aggregation, either:

- By formula
- By heirarchy navigation
- By a combination of the above

[Derived from Formula](#)

ConfidentialityFilter

[Derived from AdministeredObject](#)

Footnote

This class identifies a footnote, for attachment to cells and dimensions in hypercubes.

[Derived from DescribedObject, AdministeredObject](#)

FootnoteLink

Reference

Cell

This class is the implementation of the element of the multi-dimensional array.

[Derived from PropertiedObject](#)

Private Attributes:

Value : Double

EnumeratedPosition

Private Attributes:

Row :
Col :
Frozen :
Fixed :

Dimension

This class represents a single dimension of a multidimensional structure, where the dimension consists of a set of ordinates (a.k.a positions OR index values) which are indexing positions for the cells.

Derived from DescribedObject, PropertiedObject, LabelledObject, AdministeredObject

Fixed Formula

This class maintains a formula for application against a hypercube entity.

Derived from AdministeredObject

Private Attributes:

Precedence : INTEGER
Text : string

Public Operations:

Evaluate () : Error
Parse () :

Frozen Heirarchy

This class represents a mapping of items from a nomenclature structured into an ordered heirarchy.

Derived from Tree, MultiLingualObject, DescribedObject

HeirarchyEntry

An entry in a classification can be associated with only one ordinate. This is the difference between classifications and nomenclatures.

Derived from OrderedNode

Hypercube

This class represents a multi-dimensional dataset, structured according to dimensions and their positions, and containing data values in Cell instances.

Derived from DescribedObject, PropertiedObject, LabelledObject, AdministeredObject

Hyperplane

This class represents a structured view into a hypercube, consisting of a subset of the parent hypercube's dimensions and/or ordinates.

Derived from [DescribedObject](#), [PropertiedObject](#), [MultiLingualObject](#), [AdministeredObject](#)

HyperplaneDimension

This class represents the orientation of a hypercube dimension within a hyperplane. For every dimension in the hypercube, there exists a hyperplane dimension, which may be oriented as Row, Column, Fixed or Frozen.

In the case of a row or column, the hyperplane dimension records its rank. In the case of a fixed or frozen state, the hyperplane dimension records the ordinate.

The hyperplane dimension also records the hierarchy into which the ordinates are organised and the labelling system used to represent the ordinates.

Private Attributes:

Rank : integer = 0

Ordinate

An ordinate is the occurrence of a value in a dimension. For example if (x,y,z) are the coordinates of a cell in a 3 dimensional hypercube, x is an ordinate, y is an ordinate and z is an ordinate.

Derived from [DescribedObject](#), [PropertiedObject](#), [LabelledObject](#), [AdministeredObject](#)

Row footnoteAttachment

Dissemination

NomenclatureManagement

Classification

A classification is a hierarchically structured set of concepts such that each parent-child relationship of the hierarchy is based on a set of properties, which are enumerated values. A classification differs from a nomenclature in that the cross-product of all possible property values are represented as children of a parent.

Derived from [Tree](#), [DescribedObject](#)

Private Attributes:

ClassificationId : Integer

ClassificationEntity

A classification-entity is a sub-division either of the main classification or of another classification entity. A subdivision is according to one or more properties

Derived from Node, DescribedObject, ConceptualObject

Private Attributes:

ClassificationEntryId : Integer

Parent : ClassificationEntity

ClassificationProperty

A classification property distinguishes between sub-entities of a classification entity.

e.g. Colour and Manufacturer may be properties of car.

Derived from EnumeratedProperty, Property, LabelledObject, ConceptualObject

Private Attributes:

ClassificationPropertyId : Integer

ClassificationRule

A classification rule is a formal statement to be applied in including or excluding entries from a nomenclature based on the classification structure. For example, a rule for a vehicle classification could be:

```
IF Passenger_Capacity > 2 and <= 6
THEN Veh_Type = "CAR"
ELSE Veh_Type = "BUS"
```

The collection of rules for a classification is also known as the "Decision Theory".

Derived from MultiLingualObject

Public Attributes:

ClassificationRuleId : Integer

Private Attributes:

Rule : string

ClassificationValue--

A classification value is an enumerated value of a classification property.

[Derived from EnumeratedValue, ConceptualObject](#)

Private Attributes:

ClassificationValueId : Integer

Correspondance

This class describes a correspondance between two classifications, as a set of relations between items.

[Derived from AdministeredObject](#)

Private Attributes:

ForwardWeighting : Float

BackwardWeighting : Float

CorrespondanceId : Integer

CorrespondanceSet

A correspondance set is normally used to record the changes that occur when a nomenclature changes its version. (see transform)

[Derived from TimeLimitedObject, DescribedObject, AdministeredObject, Set](#)

Private Attributes:

CorrespondanceSetId : Integer

Layer

A Layer is a NodeSet such that no member of the set is the parent of another and the siblings of members are also members

[Derived from TimeLimitedObject, PropertiedObject, NodeSet](#)

Private Attributes:

LayerId : Integer

Level

A Level is a Layer where every node in the Level is equidistant from the root.

[Derived from Layer, PropertiedObject, TimeLimitedObject](#)

Private Attributes:

LevelId : Integer

Nomenclature

A Nomenclature is a heirarchically structured collection of concepts that relate to one or more hypercubes, dimensions and/or ordinates.

Derived from TimeLimitedObject, DescribedObject, PropertiedObject, LabelledObject, AdministeredObject, Node, Classification, ConceptualObject

Private Attributes:

nomenclatureId : Integer
ParentId : Nomenclature

NomenclatureItem

An item in a nomenclature can be associated with more than one ordinate in different dimensions - for example Blue Ford Cars.

Derived from TimeLimitedObject, PropertiedObject, AdministeredObject, ConceptualObject, ClassificationEntity

Private Attributes:

NomenclatureItemId : Integer
Predecessor : NomenclatureItem

NomenclatureItemOccurance

Derived from TimeLimitedObject

Private Attributes:

NomenclatureItemId : integer

NomItemClassEntryLink NomItemOccurenceLink

General

AdministeredObject

Protected Attributes:

Created : date
CreatedBy : string
CreatedAtNode : string
Updated : date
UpdatedBy : string
UpdatedAtNode : string
Owner : string
OwnedAtNode : string
Code : String
 Organisation-specific identifier of the object for reference purposes

Private Attributes:

adminId : Integer;

Code

Identifier of a classification item.

Derived from StringProperty

Definition

DescribedObject

Derived from AdministeredObject

Description

Derived from TimeLimitedObject, AdministeredObject

Private Attributes:

Text : string

EnumeratedProperty

Derived from Property

EnumeratedValue

Derived from DescribedObject

EnumeratedValueSet

Private Attributes:

Value : string

Label

Derived from Property

Private Attributes:

Text : string

LabelledObject

LabellingSystem

A labelling system is a system of labelling. i.e . a labelled object may be represented or referred to in differing ways according to language, organisation and./or the statistical domain constituting the context in which it is represented.

e.g. In the environment domain the OECD may refer to something as "Aromatic Hydrocarbon" in English, "Hydrocarbon Aromatique" in French while Eurostat refers to exactly the same thing as "Volatile Organic Compound" in English, and "Compound Organique Volatile" in French,

In the trade domain exactly the same thing might be referred to as "Petroleum products", "Products de Petroleum", "Oil refinery output", and "output de refinery de huile" by OECD and Eurostat in English and French respectively.

Derived from PropertyObject, DescribedObject, LabelledObject, AdministeredObject

Language

Derived from AdministeredObject

Private Attributes:

Name : string

MeasurableProperty

Derived from ClassificationProperty

MultiLingualObject

PropertyObject

This is an abstract class for a number of other classes which may require property management

Property

An attribute which gives some semantic value, related to a property object. The property contains the type and value information related to the item.

Derived from TimeLimitedObject, DescribedObject, AdministeredObject

Protected Attributes:

Title : String

StringProperty

Derived from Property

StringValue

Private Attributes:

Value : string

TextualRepresentation

TimeLimitedObject

The interval of validity of an entity. It consists of the begin and end date.

Derived from AdministeredObject

Protected Attributes:

ValidFrom : Date

ValidUntil : Date

Primitives

Node

A node is point in a hierarchy.

NodeSet

A NodeSet is any set of nodes having the same root. It may represent a complete or subset of the items in a nomenclature.

Derived from TimeLimitedObject, PropertiedObject, Set, DescribedObject, LabelledObject, AdministeredObject

Private Attributes:

NodeSetId : Integer

OrderedNode

An ordered node is a point in a hierarchy which is ordered.

Derived from TimeLimitedObject

Protected Attributes:

Order : Integer

LOGICAL VIEW REPORT

Private Attributes:

OrderedNodeId : Integer
ParentId : OrderedNode

Set
Tree

LOGICAL VIEW REPORT

TOTALS:

10 Logical Packages
98 Classes

LOGICAL PACKAGE STRUCTURE

Logical View
 DataCollection
 ConceptManagement
 Summary&Aggregation
 Reference
 Dissemination
 NomenclatureManagement
 General
 Primitives