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| |  |  |  | | --- | --- | --- | | 75 | Date: | $date.get(‘MMMM YYYY’) | |
| Archetype Modeling Language (AML)  #set ($thisversion = “1.0”) #set ($thisdoc = “Archetype Modeling Language (AML)”)  #set($documentNo = “health/2014-10-01”)  Version: $thisversion  **OMG Document Number: $documentNo**  **Standard document URL: http://www.omg.org/spec/AML/1.0**  Original File: N/A |

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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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• CWM  
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• Specialized CORBA specifications  
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The type styles shown below are used in this document to distinguish programming statements from ordinary English. However, these conventions are not used in tables or section headings where no distinction is necessary.

Times/Times New Roman - 10 pt.: Standard body text

**Helvetica/Arial - 10 pt. Bold: OMG Interface Definition Language (OMG IDL) and syntax elements.**

Courier - 10 pt. Bold: Programming language elements.

Helvetica/Arial - 10 pt : Exceptions

NOTE: Terms that appear in italics are defined in the glossary. Italic text also represents the name of a document, specification, or other publication.

# Scope

## Archetype Modeling Language (AML) Background

This specification defines the Archetype Modeling Language (AML). The AML defines a standard means for modeling Archetype Models (AMs) to support the representation of Clinical Information Modeling Initiative (CIMI) artifacts using modeling profiles as defined in the UML. Archetype Models are Platform Independent Models (PIMs) and are developed as a set of constraints on a specific Reference Model (RM).

The CIMI RM is the underlying RM on which CIMI’s clinical information models are defined. The reference model defines a rigorous and stable set of modeling patterns that include a set of structural patterns, complex data types, and demographic classes. All CIMI clinical models will be defined by constraining the CIMI reference model. Each instance of a CIMI Clinical Model will be a constrained instance of the CIMI reference model conforming to the constraints defined by the associated clinical model.

The motivation for including a reference model in the CIMI clinical modeling architecture is to provide a consistent computational framework upon which model authoring and translation tools can be based. The reference model is the ‘common language’ used to describe all clinical models. It provides a single information model that can be used to represent instances of all clinical models and upon which further constraints can be applied to represent the specific information requirements of all clinical model. This information model represents the core artifact implemented in software; it provides the physical structure of the clinical models and its example instances. Existing implementation experience has shown this increases the computational capabilities of the resulting modeling and translation tools.

Development of the AML specification was guided by:

1. The need for a means to accurately and usefully represent AMs in accordance with the openEHR Foundation’s Archetype Definition Language (ADL) and Archetype Object Model (AOM) version 2.0 specifications;
2. Compatibility with the Object Management Group (OMG) *Common Terminology Service 2 (CTS2)* specification; and
3. Where possible, being informed by and faithful to the *ISO/IEC 11179, Information Technology, -- Metadata registries*, specification.

In the AML RFP, the version of the openEHR Foundation’s ADL and AOM specifications cited for coverage by the OMG AML specification was version 1.5. In the process of producing the AML specification, however, a number of inconsistencies were discovered in the openEHR specifications, as well as opportunities for improvements. These were reported to the openEHR Foundation. In response, the openEHR Foundation revised the specifications. This resulted in a set of changes to the specifications that were not backward compatible with version 1.5. As a consequence, the revised specifications were released as version 2.0, subsuming the requirements found in version 1.5, now made consistent in version 2.0, and forming the updated requirements basis for AML coverage.

## AML Intended Users

The AML is primarily intended to support two clinical modeling communities of users:

* Those having subject matter expertise regarding clinical model domains and currently using ADL-based tools to develop such models, and
* Those familiar with modeling using the UML, though not necessarily familiar with clinical modeling domains or current methods employed to represent them.

Clause 7 of this specification, *AML Meta Model*, provides an informational meta model of the openEHR AOM as an aid to bridging between these communities.

While the AML specification targets CIMI clinical modeling practitioners, the modeling approach defined in the profiles is intended to be generalizable for use with other reference models and application in other domain areas.

## AML Profiles

The AML is specified by three UML profilescollectively meeting the requirements of archetype modeling. These are the:

* *Reference Model Profile (RMP)*: Enables the specification of reference models upon which archetypes can be based;
* *Constraint Model Profile (CMP)*: Supports the specification of constraints on a given reference model to enable the development of archetypes including Clinical Information Models (CIMs); and
* *Terminology Binding Profile (TBP)*: Supports the binding of information models to terminology. Terminology bindings include:
  1. *Value Bindings*: Support linking the data model to value domains that restrict the valid value of an attribute to a set of values corresponding to a set of meanings recorded in an external terminology;
  2. *Semantic Bindings:* Define the meaning of model elements using concepts in an external terminology; and
  3. *Constraint Bindings:* Specify constraints on the information model using concepts and relationships defined in an external terminology.

This set of UML profiles enables the specification of CIMI clinical model content (using the CIMI Reference Model) and the generation of CIMI clinical model artifacts, such as ones represented by the openEHR Foundation’s ADL. (The ADL is a serialization of the openEHR Foundation’s AOM.) While the transformation of AML models to an instance of the AOM was an optional requirement for the AML specification, the AML profile supports the representation of sufficient information in an AM to enable such a transformation.

# Conformance

## Conformance Points

This specification defines the following conformance points (also referred to as conformance targets):

* AML Reference Model Profile
* AML Terminology Binding Profile
* AML Constraint Model Profile

## AML Reference Model Profile

Sub clause 8.1 of this specification defines the AML Reference Model Profile.

## AML Terminology Binding Profile

Sub clause 8.2 of this specification defines the AML Terminology Binding Profile. The Terminology Binding Profile imports the Reference Model Profile.

## AML Constraint Model Profile

Sub clause 8.3 of this specification defines the AML Constraint Model Profile. The Constraint Model Profile imports both the Reference Model Profile and Terminology Binding Profile.

# Normative References

The following normative documents contain provisions that, 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.

[ADL] openEHR *Archetype Definition Language: ADL2*, <http://www.openehr.org/releases/trunk/architecture/am/adl2.pdf>

[AOM] *openEHR Archetype Object Model* (AOM), <http://www.openehr.org/releases/trunk/architecture/am/aom2.pdf>

[AOMT] openEHR *openEHR Templates* (supersedes *openEHR Archetype Templates*), <http://www.openehr.org/releases/trunk/architecture/am/tom.pdf>

[ARCH] *openEHR Archetypes: Constraint-based Domain Models for Future-proof Information Systems*, <http://www.openehr.org/publications/archetypes/archetypes_beale_oopsla_2002.pdf>

[CIMI] CIMI Reference Model Requirements, <http://informatics.mayo.edu/CIMI/index.php/CIMI_Reference_Model_Requirements>

[CTS2] OMG *Common Terminology Service 2 (CTS2)*, [http://www.omg.org/spec/CTS2/1.1/](http://www.omg.org/spec/CTS2/1.1/" \o "http://www.omg.org/spec/CTS2/1.1/)

[HLV7v3] *HL7 Version 3 Standard: Core Principles and Properties of Version 3 Models*, <http://www.hl7.org/implement/standards/product_brief.cfm?product_id=58>

[MDMI] OMG *Model Driven Message Interoperability (MDMI), Version 1.0*, <http://www.omg.org/spec/MDMI/1.0/>

[MDR] *ISO/IEC 11179, Information Technology, -- Metadata registries*, [http://metadata-standards.org/11179/](http://metadata-standards.org/11179/" \o "http://metadata-standards.org/11179/)

[NIEM] OMG *UML Profile for NIEM Version 1.0*, [http://www.omg.org/spec/NIEM-UML/1.0/](http://www.omg.org/spec/NIEM-UML/1.0/" \o "http://www.omg.org/spec/NIEM-UML/1.0/)

[OCL] OMG *Object Constraint Language (OCL), Version 2.4*, <http://www.omg.org/spec/OCL/2.4/>

[ODM] OMG *Ontology Definition Metamodel (ODM) Version 1.1*, <http://www.omg.org/spec/ODM/1.1/>

[QVT] OMG *Meta Object Facility (MOF) 2.0 Query/View/Transformation, V1.2 (Beta)*, <http://www.omg.org/spec/QVT/1.2/Beta/>

[UML] OMG *Unified Modeling Language (UML) Version 2.5 – Beta 2*, <http://www.omg.org/spec/UML/2.5/Beta2/>

# Terms and Definitions

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

Archetype

An archetype is a re-usable formal definition of domain level information defined in terms of constraints on an information model. The key feature of the archetype approach to computing is a complete separation of information models (such as object models of software or models of database schemas) from domain models.

Archetype Definition Language (ADL)

ADL is a formal language for expressing archetypes. It provides a formal, textual syntax for describing constraints on any domain entity whose data is described by an information model (also known as the 'underlying reference model'). The ADL syntax is semantically equivalent to the AOM and represents one possible serialization of the AOM. The current version of ADL is known as 'ADL 2'.

Archetype Instance

An archetype instance is a single instantiation of data conforming to a specific archetype. In the context of CIMI this data will typically be clinical.

Archetype Model (AM)

An AM is a re-usable, formal model of an archetype expressed as a computable set of constraint statements on an underlying reference model (URM). Concepts that can be modeled using archetypes include weight measurement, blood pressure, microbiology results, discharge referral, prescription, or diagnosis. CIMI archetypes will be represented as an instance of the ‘Archetype Object Model’.

Archetype Object Model (AOM)

The AOM is the definitive expression of archetype semantics and is independent of any particular syntax. It is defined as an object model using a UML class diagram. It is a generic model, meaning it can be used to express archetypes for any reference model in a standard way. Version 1.4 of the AOM was standardized in ISO-13606:2. The current version is known as 'AOM 2'.

Archetype Query Language (AQL)

The AQL is a declarative query language developed specifically for expressing queries used for searching and retrieving the clinical data found in archetype-based EHRs. AQL expresses queries at the archetype level, i.e. semantic level, and not at the data instance level. This is key to achieving shared queries across system or enterprise boundaries.

Clinical Data Repository (CDR)

A CDR is a data store holding and managing clinical data collected from service encounters at the point-of-service locations such as hospitals, clinics, etc.

Clinical Document Architecture (CDA)

A CDA is an HL7 XML-based markup standard intended to specify the encoding, structure, and semantics of clinical documents for exchange.

Clinical Information Model (CIM)

A CIM is a representation of the structured clinical information (including relationships, constraints and terminology) describing a specific clinical concept - e.g. a blood pressure observation, a Discharge Summary, or a Medication Order.

Clinical Information Modeling Initiative (CIMI)

CIMI is an initiative established to “improve the interoperability of healthcare information systems through shared implementable clinical information models.”

Clinical Information Modeling Initiative (CIMI) Reference Model (RM)

The CIMI RM is the underlying Reference Model on which CIMI's clinical models (i.e. archetypes) are defined. This reference model defines a rigorous and stable set of modeling patterns, including a set of complex data types, information patterns (e.g. data, qualifier, state), and structural patterns (e.g. composition, entry, tree). All CIMI clinical models (i.e. archetypes) will be defined by constraining the CIMI RM. The RM is intended to be instantiated with patient data which conforms to the constraints defined by the associated clinical model.

Clinical Model Governance

Clinical Model Governance is a set of policies and processes through which the high clinical quality of all clinical artifacts (including clinical models and-or archetypes) is maintained during creation, storage, verification, maintenance, and distribution, by, for, and on behalf of CIMI.

Clinical Model Repository

The Clinical Model Repository is a data store holding clinical information models and associated artifacts in an agreed sharable format.

Clinical Model Verification

Clinical Model Verification is the act of reviewing, inspecting, or testing in order to establish a clinical model specification meets appropriate clinical safety and quality standards.

Clinical Modeling Language

A Clinical Modeling Language is a modeling language defining clinical information models.

Clinical Requirement

Clinical Requirements are requirements articulating clinical needs including clinical practices, standards, guidelines, principles, and other clinical concepts.

Code System

A Code System is a managed collection of uniquely identifiable concepts with associated representations. A code system may also form an ontological system for representing a set of concepts, e.g. SNOMED-CT, LOINC, ICD-10, etc.

Common Terminology Services 2 (CTS2)

CTS2 is an OMG specification providing a standard interface to disparate terminology sources. The Information Model specifies the structural definition, attributes, and associations of resources common to structured terminologies such as Code Systems, Binding Domains, and Value Sets. The Computational Model specifies the service descriptions and interfaces needed to access and maintain structured terminologies.

Concept

In information modeling, a concept represents an “idea” as a word or phrase in order to support human understanding, but may also be represented with a concept identifier in order to bind it to a controlled terminology or ontology.

Concept Domain

A Concept Domain is a named category of like concepts bound to one or more coded elements in an information model. Concept Domains exist to constrain the intent of the coded element and are independent of any specific vocabulary, code system, or Realm. A Concept Domain provides a high level grouping for all things possible in a given domain from which value sets will be constructed.

Concept Domain Binding

A Concept Domain Binding is the association of a value set with a concept domain in a given context.

Conceptual Information Model

A Conceptual Information Model is a representation of real-world objects and their relationships and constraints as understood by domain experts. A conceptual model should include no implementation-specific details.

Conformance

Conformance is the requirement that those who participate in CIMI by contributing data components or creating and sharing ADL artifacts are following the agreed-upon procedures for doing so and that all documentation meets minimum criteria and the CIMI Naming and Design Rules where applicable.

Constraint Model

A Constraint Model is a formal specification used for describing constraints on an Underlying Reference Model. The Constraint Model is used to express clinical information models (i.e. archetypes), not to be confused with the clinical information models that are instances of the constraint model.

Detailed Clinical Model

A Detailed Clinical Model is a relatively small standalone information model designed to express a precise clinical concept in a standardized and reusable manner.

Fully Defined Concept

A Fully Defined Concept is a concept uniquely defined by a set of defining relationships.

Information Model

An Information Model is a structured representation of the information requirements of a domain including the classes of information required and their attributes, relationships, and constraints.

Node

A Node is a named part of an information model.

Ontology

An Ontology is a formal representation of knowledge as a set of concept identifiers, terms describing the concepts so identified, and the relationships among them.

Reference Model

A Reference Model is an information model defining a set of modeling patterns upon which clinical models are defined.

Reference Terminology

A Reference Terminology is a terminology designed to provide common semantics for diverse implementations.

Semantic Binding

Semantic Binding is the association of a node in an information model with a concept from a controlled terminology representing its meaning.

Terminology

A Terminology is a vocabulary of technical terms used in a particular field, subject, science, or art.

Terminology Binding

Terminology Binding is the assertion of a relationship between an information model and a terminology.

Value Binding

Value Binding is the association of a given node in a clinical model with the set of valid concepts that may populate it.

Value Set

A Value Set is a set of concept identifiers deemed valid for use in a specific context, especially to define the domain of a data element.

# Symbols

## Graphical Symbols

No AML-specific graphical symbols are defined in this specification.

## Abbreviations

ADL Archetype Definition Language

AM Archetype Model

AML Archetype Modeling Language

AOM Archetype Object Model

AQL Archetype Query Language

CDA Clinical Document Architecture

CDL Clinical Document Language

CDR Clinical Data Repository

CIM Clinical Information Model

CIMI Clinical Information Modeling Initiative

CMP Constraint Model Profile

CRM Clinical Reference Model

CTS2 Common Terminology Services 2

EHR Electronic Health Record

HL7 Health Level Seven

ICD-10 International Statistical Classification of Diseases and Related Health Problems, 10th Edition

LOINC Logical Observation Identifiers Names and Codes

MDA Model Driven Architecture

OCL Object Constraint Language

OMG Object Management Group

OpenEHR Open Electronic Health Record

PIM Platform Independent Model

PSM Platform Specific Model

RM Reference Model

RMP Reference Model Profile

SNOMED CT Systematized Nomenclature of Medicine – Clinical Terms

TBP Terminology Binding Profile

UML Unified Modeling Language

URI Uniform Resource Identifier

URM Underlying Reference Model

# Additional Information

## Changes to Adopted OMG Specifications

No changes to adopted OMG specifications are required to adopt this specification.

## Acknowledgements

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1. Mayo Clinic
2. Visumpoint, LLC

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1. Escape Velocity, LLC

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# The AOM and the AML Metamodel

This section describes the purpose behind the AML Metamodel and how it relates to the AOM. The actual AML Metamodel can be found in Appendix A

##

## Entry point for processing

#import('js', 'com.nomagic.reportwizard.tools.script.JavaScriptTool')

#import("query", "com.nomagic.reportwizard.tools.QueryTool")

#import('text', 'com.nomagic.reportwizard.tools.TextTool')

#set($printedEnums = $array.createArray())

#set($printedInterfaces = $array.createArray())

#set($printedClasses = $array.createArray())

#set($printedDataTypes = $array.createArray())

#set($printedStereoTypes = $array.createArray())

#set($printedPrimitiveTypes = $array.createArray())

#set($elemList = $array.createArray())

## hard coded work around for lack of meta-data ☹

#set($profileNames = $array.createArray())

$profileNames.add(“Reference Model Profile”)

$profileNames.add(“Terminology Profile”)

$profileNames.add(“Constraint Profile”)

#set($level = 0)

#foreach ($pkg in $packageScope)

#packageList($pkg, 1)

#end

##foreach($elem in $elemList)

##$elem [ref-$elemList.indexOf($elem)]

##end

##

## MACRO writeText – output the HTML representation of $txt

#macro (writeText $txt)

#set($txt1 = $text.html($txt))$txt1#end

## MACRO writeBookmark1 – write a numbered or unnumbered level 1 bookmark

#macro (writeBookmark1 $obj1 $dp1 $withNum)

#if($withNum == “true”)

# $bookmark.create($obj1.ID.substring($obj1.ID.indexOf(“ “)), $dp1)

#else

# $bookmark.create($obj1.ID.substring($obj1.ID.indexOf(“ “)), $dp1)

#end

#end

## MACRO writeHeader

#macro (writeHeader1 $dp2 $withNum)

#if($withNum == “true”)

# $dp2

#else

# $dp2

#end

#end

## MACRO writeBookmark2 --

#macro (writeBookmark2 $obj2 $dp3 $withNum)

#if($withNum == “true”)

## $bookmark.create($obj2.ID, $dp3)

#else

## $bookmark.create($obj2.ID, $dp3)

#end

#end

## MACRO writeHeader2 --

#macro (writeHeader2 $dp4 $withNum)

#if($withNum == “true”)

## $dp4

#else

## $dp4

#end

#end

#macro (writeBookmark3 $obj3 $dp5 $withNum)#if($withNum == “true”)

### $bookmark.create($obj3.ID, $dp5)

#else

### $bookmark.create($obj3.ID, $dp5)

#end#end#macro (writeHeader3 $dp6 $withNum)#if($withNum == “true”)

### $dp6

#else

### $dp6

#end#end#macro (writeBookmark4 $obj4 $dp7 $withNum)#if($withNum == “true”)

#### $bookmark.create($obj4.ID, $dp7)

#else

#### $bookmark.create($obj4.ID, $dp7)

#end#end#macro (writeHeader4 $dp8 $withNum)#if($withNum == “true”)

#### $dp8

#else

#### $dp8

#end#end#macro (writeBookmark5 $obj45 $dp75 $withNum)#if($withNum == “true”)

##### $bookmark.create($obj45.ID, $dp75)

#else

#### $bookmark.create($obj45.ID, $dp75)

#end#end#macro (writeHeader5 $dp55 $withNum)#if($withNum == “true”)

##### $dp55

#else

#### $dp55

#end#end#macro (writeBookmark $obj4 $dp7 $withNum)#if($withNum == “true”)

1. **$bookmark.create($obj4.ID, $dp7)**

#else

**$bookmark.create($obj4.ID, $dp7)**

#end#end#macro (writeHeader $dp8 $withNum)#if($withNum == “true”)

1. **$dp8**

#else

**$dp8**#end#end#macro (writeListItem $dp9)

* **$dp9**#end

##

## writeCode

#**macro** (writeCode $code)

$code#end

##

## StripPrefix

#macro(stripPrefix $txt)$js.eval(‘e.replace(/[0-9\.]\s\*/, “”)’, ‘e’, $txt))#end

##

## printAttr

#**macro**(printAttr $att)

#set($vis = “~”)

#if($att.visibility == “public”)

#set($vis= “+”)

#elseif($att.visibility == “private”)

#set($vis = “-”)

#elseif($att.visibility == “protected”)

#set($vis = “#”)

#end

#set($mult = $att.multiplicity)

**•** <property> $att.name : $att.type.qualifiedName #if($mult.length() > 0)[$mult]#end

#\*$att.visibility $att.name#if($att.type) : #if($js.eval(‘(typeQN.indexOf(“UML Standard Profile”) != -1)’, ‘typeQN’, $att.type.qualifiedName))$att.type.name#else$bookmark.open($att.type.ID, $att.type.name)#end #end#if($att.multiplicity != “”) [$att.multiplicity]#end#if($att.defaultValue) = $att.defaultValue.text#end\*#

#if($att.documentation != “”)

#writeText($att.documentation)

#end

#end

#\*

<property> ::= [<visibility>] [‘/’] <name> [‘:’ <prop-type>] [‘[‘ <multiplicity-range> ‘]’] [‘=’ <default>] [‘{‘ <prop-modifier > [‘,’ <prop-modifier >]\* ’}’]

\*#

#macro(formatAttr $attr)

#end

#macro(getVisibility $vis)

#end

##

## MACRO printOper

#**macro**(printOper $oper)

#set($paramLists = $oper.ownedParameter)

#set($size = 0)

#foreach($p in $paramLists)

#if($p.direction != “return”)

#set($size = $size +1)

#end

#end

#set($i = 1)

**• $oper.visibility $oper.name (#foreach($param in $paramLists)**

**#if($param.direction != “return”)$param.name**

**#if($param.type) : #if($js.eval(‘(typeQN.indexOf(“UML Standard Profile”) != -1)’, ‘typeQN’, $param.type.qualifiedName))$param.type.name#else $bookmark.open($param.type.ID, $param.type.name)#end#end#if($param.multiplicity != “”) [$param.multiplicity]#end#if($param.defaultValue) = $param.defaultValue.text#end#if($size != $i), #end#set($i = $i + 1)#end#end)#if($oper.type) : #if($js.eval(‘(typeQN.indexOf(“UML Standard Profile”) != -1)’, ‘typeQN’, $oper.type.qualifiedName))$oper.type.name#else $bookmark.open($oper.type.ID, $oper.type.name)#end#end#if($oper.hasTypeModifier() && $oper.typeModifier != “”)$oper.typeModifier#end**

#if($oper.documentation != “”)

#writeText($oper.documentation)

#end

#end

**##**

**## printAsso**

#**macro**(printAsso $attribute $association $object)

#foreach($member in $association.memberEnd)

#if($member.type != $object)

#set($memberEnd = $member)

#end

#end

**• $memberEnd.visibility#if($attribute.name != “”) $attribute.name#end#if($memberEnd.type) : #if($js.eval(‘(typeQN.indexOf(“UML Standard Profile”) != -1)’, ‘typeQN’,$memberEnd.type.qualifiedName))$memberEnd.type.name#else$bookmark.open($memberEnd.type.ID,$memberEnd.type.name)#end#end#if($memberEnd.multiplicity !=“”)[$memberEnd.multiplicity]#end#if($memberEnd.defaultValue) = $memberEnd.defaultValue.text#end**

#if($association.documentation)

#writeText($association.documentation)

#end

#if($memberEnd.documentation != “”)

#writeText($memberEnd.documentation)

#end

#end

**##**

**## writeHeading**

#macro (writeHeading $object $disp $isBookmark $headingLevel $headType $withNumbering)

#if($headType != “”)

#set($disp = “$disp [$headType]”)

#end

#if($profileNames.contains($disp))

#set($disp = “$disp [Profile]”)

#end

#if($headingLevel == 1)

#if($isBookmark == “true”)

#writeBookmark1($object $disp $withNumbering)

#else

#writeHeader1($disp $withNumbering)

#end

#elseif($headingLevel == 2)

#if($isBookmark == “true”)

#writeBookmark2($object $disp $withNumbering)

#else

#writeHeader2($disp $withNumbering)

#end

#elseif($headingLevel == 3)

#if($isBookmark == “true”)

#writeBookmark3($object $disp $withNumbering)

#else

#writeHeader3($disp $withNumbering)

#end

#elseif($headingLevel == 4)

#if($isBookmark == “true”)

#writeBookmark4($object $disp $withNumbering)

#else

#writeHeader4($disp $withNumbering)

#end

#elseif($headingLevel == 5)

#if($isBookmark == “true”)

#writeBookmark5($object $disp $withNumbering)

#else

#writeHeader5($disp $withNumbering)

#end

#elseif($headingLevel == 6)

#if($isBookmark == “true”)

#writeBookmark($object $disp “false”)

#else

#writeHeader($disp “false”)

#end

#else

#if($isBookmark == “true”)

#writeBookmark($object $disp $withNumbering)

#else

#writeHeader($disp $withNumbering)

#end

#end

#end

**##**

**## findNestedElement**

#macro(findNestedElement $object)

#set($innerElement = $report.getInnerElement($object))

#foreach($nested in $innerElement)

#if($nested.elementType != “package” && $nested.elementType != “model” && $nested.elementType != “profile” )

#if($nested.elementType == “interface”)

#set($tmp = $nestedInterface.add($nested))

#elseif($nested.elementType == “class”)

#set($tmp = $nestedClass.add($nested))

#elseif($nested.elementType == “enumeration”)

#set($tmp = $nestedEnum.add($nested))

#elseif($nested.elementType == “datatype”)

#set($tmp = $nestedDataTypes.add($nested))

#elseif($nested.elementType == “stereotype”)

#set($tmp = $nestedStereoTypes.add($nested))

#elseif($nested.elementType == “primitivetype”)

#if($js.eval(‘(primtypename.indexOf(“AML”) != -1)’, ‘primtypename’, $nested.name))

#set($tmp = $nestedPrimitiveTypes.add($nested))

#end

#end

#set($in = $report.getInnerElement($nested))

#if($in.size() > 0)

#findNestedElement($nested)

#end

#end

#end

#end

**##**

**#macro(updateElemList $obj)**

**#if(!$elemList.contains($obj))**

**$elemList.add($obj.qualifiedName)**

**#end**

**#end**

**##**

**## packageList - entry point**

#macro (packageList, $parentPackage, $plevel)

#set($packageInterface = $array.createArray())

#set($packageClass = $array.createArray())

#set($packageEnum = $array.createArray())

#set($packageDataTypes = $array.createArray())

#set($packageStereoTypes = $array.createArray())

#set($packagePrimitiveTypes = $array.createArray())

#set($nestedInterface = $array.createArray())

#set($nestedClass = $array.createArray())

#set($nestedEnum = $array.createArray())

#set($nestedDataTypes = $array.createArray())

#set($nestedStereoTypes = $array.createArray())

#set($nestedPrimitiveTypes = $array.createArray())

#if(($parentPackage.elementType ==“package”)||($parentPackage.elementType == “profile”))

#foreach($element in $parentPackage.importedMember)

#if($js.eval(‘(n.indexOf(“UML Standard Profile”) == -1)’, ‘n’, $element.qualifiedName))

##TYPE: $element.elementType

#if($element.elementType == “interface”)

##INTERFACE: $element.name

#set($tmp = $packageInterface.add($element))

#set($inner = $report.getInnerElement($element))

#if($inner.size() > 0)

#findNestedElement($element)

#end

#elseif($element.elementType == “class”)

##CLASS: $element.name

#set($tmp = $packageClass.add($element))

#set($inner = $report.getInnerElement($element))

#if($inner.size() > 0)

#findNestedElement($element)

#end

##INSIDE: #if($packageClass.size() > 0) TRUE #end

#elseif($element.elementType == “enumeration”)

##ENUM: $element.name

#set($tmp = $packageEnum.add($element))

#set($inner = $report.getInnerElement($element))

#if($inner.size() > 0)

#findNestedElement($element)

#end

#elseif($element.elementType == “datatype”)

##DATATYPE: $element.name

#set($tmp = $packageDataTypes.add($element))

#set($inner = $report.getInnerElement($element))

#if($inner.size() > 0)

#findNestedElement($element)

#end

#elseif($element.elementType == “primitivetype”)

##PRIMITIVE: $element.name

#if($js.eval(‘(primtypename.indexOf(“AML”) != -1)’, ‘primtypename’, $element.name))

#set($tmp = $packagePrimitiveTypes.add($element))

#set($inner = $report.getInnerElement($element))

#if($inner.size() > 0)

#findNestedElement($element)

#end

#end

##INSIDE: #if($packagePrimitiveTypes.size() > 0) TRUE #end

#elseif($element.elementType == “stereotype”)

##STEREOTYPE: $element.name

#set($tmp = $packageStereoTypes.add($element))

#set($inner = $report.getInnerElement($element))

#if($inner.size() > 0)

#findNestedElement($element)

#end

##INSIDE: #if($packageStereoTypes.size() > 0) TRUE #end

#end

#end

#end

#end

#set($tmp = $array.addCollection($packageInterface, $nestedInterface))

#set($tmp = $array.addCollection($packageClass, $nestedClass))

#set($tmp = $array.addCollection($packageEnum, $nestedEnum))

#set($tmp = $array.addCollection($packageDataTypes, $nestedDataTypes))

#set($tmp = $array.addCollection($packageStereoTypes, $nestedStereoTypes))

#set($tmp = $array.addCollection($packagePrimitiveTypes, $nestedPrimitiveTypes))

#set($diagramList = $array.createArray())

#if($elemList.contains($parentPackage.qualifiedName))

#writeHeading($displayTitle, $displayTitle, “false”, $plevel, “”, “true”) [ref-$elemList.indexOf($parentPackage)]

#else

#foreach($d in $sorter.humanSort($parentPackage.ownedDiagram))

#if(($d.diagramType == “Class Diagram”)|| ($d.diagramType == “Profile Diagram”) ||($d.diagramType == “Package Diagram”))

#set($tmp = $diagramList.add($d))

#end

#end

#if($parentPackage != $project.model)

#set($displayTitle = $js.eval(‘e.replace(/[0-9\.]+\s\*/, “”)’, ‘e’, $parentPackage.name))

#writeHeading($displayTitle, $displayTitle, “false”, $plevel, “”, “true”)

#if($parentPackage.documentation != “”)

#writeText($parentPackage.documentation)

#end

#printDiagrams($diagramList $plevel)

#end

#set ($subPackages = $parentPackage.nestedPackage)

##

## Data Types

#set ($diagIndent = $plevel)

#if($packageDataTypes.size() > 0)

#foreach($dtp in $sorter.humanSort($packageDataTypes))

#createCommonContent ($dtp, “DataType” , $diagIndent)

#end

#end

##

## Interfaces

#if($packageInterface.size() > 0)

#foreach($interface in $sorter.humanSort($packageInterface))

#createCommonContent($interface, “Interface” , $diagIndent)

#end

#end

##

## classes

#if($packageClass.size() > 0)

#foreach($class in $sorter.humanSort($packageClass))

#createCommonContent($class, “Class” , $diagIndent)

#end

#end

##

## enumerations

#if($packageEnum.size() > 0)

#foreach($enum in $sorter.humanSort($packageEnum))

#createEnumerationContent ($enum , $diagIndent)

#end

#end

##

## primitive types

#if($packagePrimitiveTypes.size() > 0)

#foreach($ptp in $sorter.humanSort($packagePrimitiveTypes))

#createCommonContent ($ptp, “Primitive Type”, $diagIndent)

#end

#end

##

## stereotypes

#if($packageStereoTypes.size() > 0)

#foreach($stp in $sorter.humanSort($packageStereoTypes))

#createCommonContent ($stp, “Stereotype”, $diagIndent)

#end

#end

#end

##

#foreach ($pkg in $sorter.humanSort($subPackages))

#if ($plevel == 1)

#packageList($pkg, 2)

#elseif($plevel == 2)

#packageList($pkg, 3)

#elseif($plevel == 3)

#packageList($pkg, 4)

#else

#packageList($pkg, 5)

#end

#end

#end

##

##

##MACRO printDiagrams

#macro (printDiagrams $pkgdiagrams $diagIndent)

#if($pkgdiagrams)

#if($pkgdiagrams.size() > 0)

#foreach($diag in $sorter.humanSort($pkgdiagrams))$image.setWidth($diag.image, -2)

**$bookmark.create($diag.ID,** $js.eval(‘e.replace(/[0-9\.]+\s\*/, “”)’, ‘e’, $**diag.name))**

#if($diag.documentation != “”)

#writeText($diag.documentation)

#end

#end

#end

#end

#end

##

##MACRO createEnumerationContent

#macro(createEnumerationContent $enum $ind)

#set($indent = $ind + 1)

#writeHeading($enum, $enum.name, “true”, $indent, “Enumeration”, “true”)

#if($enum.documentation != “”)

#writeHeading($enum, “Description”, “false”, 7, “”, “false”)

#writeText($enum.documentation)

#end

#set($allDiagrams = $project.getDiagrams())

#set($pas = $enum.presentationElement)

#set($size = $pas.size())#if($pas.size() > 0)

#set($diagramList = $array.createArray())

#foreach($pa in $pas)

#set($entry = $pa.diagramPresentationElement.name)

#if(!$diagramList.contains($entry))

#set($tmp = $diagramList.add($entry))

#end

#end

#end

#if($diagramList.size() > 0)

#writeHeading($diagramList, “Diagrams”, “false”, 7, “”, “false”)

#foreach($diag1 in $diagramList)

#set($targetDiag = $report.findElementByName($allDiagrams, $diag1))

#if ($targetDiag.size() > 0)$bookmark.open($targetDiag.get(0).ID, $js.eval(‘e.replace(/[0-9\.]+\s\*/, “”)’, ‘e’, $diag1))#end#if($size != $velocityCount), #end

#end

#end

#set($enumLiterals = $enum.ownedLiteral)

#if($enumLiterals.size() > 0)

#writeHeading($implementInterface “Enumeration Literals”, “false”, 7, “”, “false”)

#foreach($enumLit in $sorter.humanSort($enumLiterals))

#writeListItem($enumLit.name)

#if($enumLit.documentation != “”)

#writeText($enumLit.documentation)

#end

#end

#end

#end

##

##

## MACRO createCommonContent

#macro(createCommonContent $umlType $typeName $ind)

#set($indent = $ind + 1)

#if(!$elemList.contains($umlType.qualifiedName))

##[include a reference to ref-$elemList.indexOf($umlType.qualifiedName)]

##else

#updateElemList($umlType)

#set($title = $umlType.qualifiedName)

#if($profileNames.contains($umlType.name))

#set($title = $umlType.name + “ [Profile]”)

#end

#writeHeading($umlType, $title, “true”, $indent, $typeName, “true”)

#if($umlType.documentation != “”)

#writeHeading($umlType, “Description”, “false”, 7, “”,“false”)

#writeText($umlType.documentation)

#end

#set($allDiagrams = $project.getDiagrams())

#set($pas = $umlType.presentationElement)

#set($size = $pas.size())

#if($pas.size() > 0)

#set($diagramList = $array.createArray())

#foreach($pa in $pas)

#set($entry =$pa.diagramPresentationElement.name)

#if(!$diagramList.contains($entry))

#set($tmp = $diagramList.add($entry))

#end

#end

#end

#if($diagramList.size() > 0)

#writeHeading($diagramList “Diagrams”, “false”, 7, “”, “false”)

#foreach($diag1 in $sorter.humanSort($diagramList))

#set($targetDiag = $report.findElementByName($allDiagrams, $diag1))

#if ($targetDiag.size() > 0)$bookmark.open($targetDiag.get(0).ID, $js.eval(‘e.replace(/[0-9\.]+\s\*/, “”)’, ‘e’, $diag1))#end#if($size != $velocityCount), #end#end

#end

#if (($typeName != “DataType”)&&($typeName != “Interface”)&&($typeName != “Primitive Type”))

#set($implementInterface = $umlType.realizedInterface)

#set($size = $implementInterface.size())

#if($implementInterface.size() > 0)

#writeHeading($implementInterface “Implemented Interface”, “false”, 7, “”, “false”)

#foreach($interface in $sorter.humanSort($implementInterface))$bookmark.open($interface.ID,$interface.name)#if($size != $velocityCount), #end#end#end

#end

#set($baseClassifier = $umlType.baseClassifier)

#set($size = $baseClassifier.size())

#if($baseClassifier.size() > 0)

#writeHeading($baseClassifier, “Direct Superclasses (Generalization)”, “false”, 7, “”, “false”)

#foreach($bclass in $sorter.humanSort($baseClassifier))

#if($js.eval(‘(primtypename1.indexOf(“UML Standard Profile”) == -1)’, ‘primtypename1’, $bclass.qualifiedName))$bookmark.open($bclass.ID, $bclass.name)#else$bclass.name#end#if($size !=$velocityCount), #end#end

#end

#set($specClassifier = $umlType.specificClassifier)

#set($size = $specClassifier.size())

#if($specClassifier.size() > 0)

#writeHeading($specClassifier, “Direct Subclasses (Specialization)”, “false”, 7, “”, “false”)

#foreach($sclass in $sorter.humanSort($specClassifier))

#if($js.eval(‘(primtypename2.indexOf(“UML Standard Profile”) == -1)’, ‘primtypename2’, $sclass.qualifiedName))$bookmark.open($sclass.ID, $sclass.name)#else $sclass.name #end#if($size !=$velocityCount), #end#end

#end

#set($allAtt= $array.createArray())

#foreach($a in $umlType.ownedAttribute)

#if(!$a.association)

#set($tmp = $allAtt.add($a))

#end

#end

#if($allAtt.size() > 0)

#writeHeading($allAtt, “Attributes”, “false”, 7, “”, “false”)

#foreach($att in $allAtt)

#if(!$att.association)

#printAttr($att)

#end

#end

#end

#set($allOper = $umlType.ownedOperation)

#if($allOper.size() > 0)

#writeHeading($allOper, “Operations”, “false”, 7, “”, “false”)

#foreach($oper in $allOper)

#printOper($oper)

#end

#end

#set($associationLists = $array.createArray())

#foreach($attribute in $umlType.ownedAttribute)

#if($attribute.association)

#if($js.eval(‘(assocnm.indexOf(“base\_”) == -1)’, ‘assocnm’, $attribute.name))

#set($tmp=$associationLists.add($attribute.association))

#end

#end

#end

#if($associationLists.size() > 0)

#writeHeading($associationLists, “Associations”, “false”, 7, “”, “false”)

#foreach($attribute in $umlType.ownedAttribute)

#if($attribute.association)

#if($js.eval(‘(assocnm.indexOf(“base\_”) == -1)’, ‘assocnm’, $attribute.name))

#set($association = $attribute.association)

#printAsso($attribute, $association, $umlType)

#end

#end

#end

#end

#set($rules = $array.createArray())

#foreach($rule in $umlType.ownedRule)

#set($tmp = $rules.add($rule))

#end

#if($rules.size() > 0)

#writeHeading($rules, “Constraints”, “false”, 7, “”, “false”)

#foreach ($rulei in $rules)

#writeListItem($rulei.name)

#if ($rulei.specification)

#if(($rulei.documentation)&&($rulei.documentation !=“”))

#writeText($rulei.documentation)#end#if($rulei.specification.text != “”)

#if($rulei.specification.language)

$js.eval(‘lname.replace(“OCL2\.0”, “OCL”)’, ‘lname’, $rulei.specification.language.toString())

#end

#writeCode($rulei.specification.text)

#end

#end

#end

#end

#end

#end

# Appendix A: AML MetaModel