|  |
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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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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/>

[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/>

[NIEM] OMG *UML Profile for NIEM Version 1.0*, <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 ☹

## NOTE: set $tmp since the add method of a list outputs true

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

#set($tmp = $profileNames.add(“Reference Model Profile”))

#set($tmp = $profileNames.add(“Terminology Profile”) )

#set($tmp = $profileNames.add(“Constraint Profile”))

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

#set($tmp = $ignoreList.add(“Sample Data Binding”))

#set($tmp = $ignoreList.add(“MappedDate”))

#set($tmp = $ignoreList.add(“MappedTime”))

#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)

**•** $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 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.replace(“ “, “”) + “ [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))

#set($tmp = $elemList.add($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.name)

#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 ($targetDiag.size() > 0 && !$ignoreList.contains($diag1))$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, $bclass.qualifiedName)#else$bclass.qualifiedName #end#if($size !=$velocityCount), #end#end

#end

#set($metaclasses = $umlType.metaclass)

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

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

#writeHeading($metaclasses, “Meta-classes”, “false”, 7, “”, “false”)

#foreach($mclass in $sorter.humanSort($metaclasses))

$mclass.qualifiedName

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

# AML-UML Transformation Reference (Informative)

## Introduction

This clause provides component, structural and abstract orientation to the transformations between the UML Profile for AML and the AOM 2.0 Meta-model, as specified in [AOM]. The transformations are expressed in terms of OMG QVT [QVT]. The QVT and related metamodels and profiles are provided as machine-readable artifacts associated with this specification (see **Error! Reference source not found.**). This clause, and its associated QVT, are presented from a transformation engineering perspective and illustrate abstract model manipulation. Other clauses in this specification and/or informative artifacts associated with this specification provide illustrations of concrete target artifact syntax. The associated QVT are the normative expression for the mapping (in the sense defined in Clause **Error! Reference source not found.**). In case of apparent conflict between the informative orientation provided in this clause and the QVT, the QVT takes precedence.

### AML Provisioning Context

The transformations referenced in this clause are intended to constitute a provisioning process that enables representation of AOM 2.0 artifacts as AML-UML Models or in one of the native AOM-conformant formats, including XML. The overall provisioning process is illustrated in Figure 10‑1. The focus of this clause is to illustrate the transformation between AML-UML Models and AOM 2.0. The AOM 2.0 concrete artifacts addressed by these transformations are XML Documents conformant with the AOM 2.0 Archetype Schemas. The AOM architecture and tooling defines rendering of an AOM Model in multiple formats, including ADL and XML. A meta-model for Schemas is specified in Clause 10 (XML Schema InfosetModel) of the OMG MOF 2 XMI Mapping Specification [XMI]. A meta-model based on the AOM 2.0 Archetype Schemas is included in the machine-readable artifacts for this specification (see **Error! Reference source not found.**). AOM Artifacts provisioned by the transformations are represented (serialized) in their native XML form.

The Archetypes in a Library constrain a Reference Model. The AML-UML Profile does not specify any specific Reference Model. During transformation, the Archetypes are wired into UML representations of Reference Models. Examples of Reference Models include:

* *CIMI Reference Model.* The Reference Model whose target namespace is “*http://release.niem.gov/niem/structures/3.0/*”. A Reference Model used by the Clinical Information Modeling Initiative.
* *openEHR.* The NIEM NDR Schema whose target namespace is “*http://release.niem.gov/niem/proxy/xsd/3.0/*”. A Reference Model used by the openEHR community whose main focus is electronic patient records and systems.

The transformations use a set of shared, reusable libraries for:

* *PrimitiveTypes*. The UML Primitive Types library includes definitions for some of the Primitive Types supported by the AOM 2.0 meta-model: Boolean, String, Integer, and Real.
* *XML Primitive Types.* The UML XML Primitive Types library represents the data types defined in the XML Schema for Schemas. There is an isomorphic mapping between the types in the UML XML Primitive Type library and the explicitly defined SimpleTypeDefinitions in the Schema for Schemas. This type library is defined by the NIEM-UML Specification. The primary types referenced by AML-UML are the temporal types.

The AML-UML model which serves as source or target of a transformation is a «ArchetypeLibrary» Package.

* The AML Profiles are applied to the «ArchetypeLibrary» Package.
* The AML Profiles may import other Profiles and/or model libraries such as the XMLPrimitiveTypes.
* Some «ReferenceModel» is imported into the «ArchetypeLibrary». The Classifiers which are transitively owned by the «ReferenceModel» are constrained by Classifiers owned by the «Archetype»s within the «ArchetypeLibrary».

An AOM Model is an instance of an AOM 2.0 MOF Meta-model.

* The AOM Model is parsed-from/serialized-to an XML Document conformant with the AOM XML Schema.
* The AOM Architecture externalizes an Archetype Object Model in one of several forms. Based on AOM tools and specifications, an AOM XML Document may be translated to/from an ADL Specification.

There are two QVT «OperationalTransformation»s between an AML-UML Model and the AOM Model:

* adl2uml. Transforms a set of AOM XML Documents to an AML-UML «ArchetypeLibrary».
* uml2adl. Transforms an AML-UML «ArchetypeLibrary» to a set of AOM XML Documents.



Figure 10‑1 AML Provisioning Context

### QVT Packaging

The transformations referenced in this clause include:

* *adl2uml.* Transforms a library of AOM Archetype Documents to AML-UML.
* *uml2adl.* Transforms an AML-UML model to a library of AOM Archetype Documents.

Additionally, there are inherited common transformations:

* *AMLplatformBinding.* A set of platform-specific operations. For the purposes of this specification, these are defined as abstract operations.
* *AMLglobals.* A set of variables initialized at the beginning of the transformation, including references to Profiles and Stereotypes from AML-UML, and various constants referenced in the AOM 2.0 Specification.



Figure 10‑2 AML Transformations

### Transformation Reuse and Composition

Reuse and composition facilities are associated with QVT mapping operations. Disjunction enables selecting, among the set of disjunctive mappings, the first that satisfies the when clause and then invoking it. For the AML transformations, disjunction is used to identify a concrete MappingOperation to be selected from a given disjunctive MappingOperation. The disjunction hierarchy generally follows the AOM meta-model inheritance hierarchy and/or the UML meta-model inheritance hierarchy. Another reuse and composition facility associated with QVT mapping operations is inheritance. Inheritance enables reuse of the execution logic of an inherited mapping. Thus, disjunction is used to initially select a leaf mapping operation and inheritance is used to share common execution logic. For the AML transformations, inheritance is used to identify the hierarchy of execution logic required to populate target Elements from a source Element. The mapping inheritance generally follows the AOM meta-model inheritance hierarchy and/or the UML meta-model inheritance hierarchy. Figure 10‑3 illustrates the pattern of disjunction and inheritance used for the transformations.

* The notation «mapping» represents a QVT mapping operation.
* The notation «inherits» represents a QVT mapping inheritance.
* The notation «disjuncts» represents a QVT mapping disjunction.
* Only «mapping» operations with either inherits or disjuncts are included in the figure.
* The figure depicts «mapping» operations for the adl2uml transformation. The uml2adl transformation has a similar pattern of disjunction and inheritance.



Figure 10‑3 AML Transformation Disjunction and Inheritance

### Transformation Notation

Figure 10‑4 provides an example of how mappings are described for the transformations.

* Each figure depicts a related set of model concepts. Since the model mappings are largely isomorphic, a single figure is used to illustrate an AOM to AML transformation as well as an AML to AOM transformation.
* Each mapping figure has at least two models depicted, one being the AOM meta-model and the other being a representation of an AML-UML Model Instance. An AML-UML Model Instance is depicted as an actual AML-UML model fragment, when the UML graphical notation is appropriate. An AML-UML Model Instance may alternatively be depicted using UML Instance Specification notation, when there is no suitable UML graphical notation (as in the case of Value Specifications, Expressions, etc.). A Reference Model fragments is sometimes depicted as the third model.
* Each model is adorned with sample model notation used to depict concepts associated with that model.
* A QVT «mapping» is depicted as a Stereotyped Realization from the AOM meta-model to an instance of an AML-UML model. In cases where a Realization cannot be depicted, a Comment is shown annotating one or more model elements from the AOM meta-model and one or more instance model elements from the AML-UML model.
* Each QVT «mapping» is shown with the QVT mapping operation name. Details of the operation can be found in the associated QVT Files for this specification.
* Note that the figures in this clause are primarily intended as a high-level orientation to key «mapping»s of the QVTs. Neither the figures nor the accompanying narrative provide all detail associated with a mapping operation. For definitive information about fine-grained aspects of the mapping, please consult the associated QVT Files for this specification.



Figure 10‑4 AML Transformation Mapping Notation Overview

### Platform Binding

There are variations in UML Platform implementations, particularly with respect to management of Profile/Stereotype/tag values. Some platforms implement Profiles via MOF, others provide implementation of applied Stereotypes via UML InstanceSpecifications. Transformation Operations which have variant implementations across platforms have been isolated from the specified transformations, enabling the core transformation to be applied to different platforms via a platform binding layer. In most cases, the variations can be specified directly in QVT. Examples of core UML utility functions which have platform variations include:

* *abstract query UML::Profile::getOwnedStereotype(stereotypeName:String):UML::Stereotype;*

Retrieves the first Stereotype with the specified “Name” from the “Owned Stereotype” reference list.

* *abstract query UML::Element::getNearestPackage():UML::Package;*

Retrieves the nearest package that owns (either directly or indirectly) this element, or the element itself (if it is a package).

* *abstract query UML::Element::isStereotypeApplied(stereotype:UML::Stereotype):Boolean;*

Determines whether the specified stereotype is applied to this element.

* *abstract query UML::Element::getStereotypeApplication(stereotype:UML::Stereotype):Stdlib::Element;*

Retrieves the application of the specified stereotype for this element, or null if no such stereotype application exists. The result is a Stdlib::Element, which may be implemented as a MOF instance or a UML <InstanceSpecification>, depending upon platform.

* *abstract helper Stdlib::Element::get<Classifier.name><Property.name>():<result>;*

A basic getter for tag values. The context (Stdlib::Element) is an instance of a Classifier defined in the profile. <Classifier.name> is the name of the Classifier (without the XSD prefix). <Property.name> (first character capitalized) is the property to be retrieved.

<result> may be : an OCL Primitive type or Stdlib::Element (if it represents an instance of a Classifier in the Profile) or some form of OCL Collection of OCL Primitive types or Stdlib::Elements.

* *abstract helper Stdlib::Element::set<Classifier.name><Property.name>(value:<valueType>);*

A setter for tag values. The context (Stdlib::Element) is an instance of a Classifier defined in the profile. <Classifier.name> is the name of the Classifier (without the prefix). <Property.name> (first character capitalized) is the property to be set. The value argument may be : an OCL Primitive type or some form of Enumeration defined within the Profile.

* *abstract helper Stdlib::Element::get<Classifier.name><Property.name>List():Stdlib::Element;*

The context is an instance of a Classifier from the Profile. <Classifier.name> is the name of the Classifier (without the prefix). <Property.name> (first character capitalized) is the property to be retrieved. The value returned represents a logical “Slot” for a list of objects.

* *abstract helper Stdlib::Element::create<Classifier.name>Instance():Stdlib::Element;*

The context is a logical “Slot”. The operation creates an instance of the Classifier named <Classifier.name> from the Profile and adds it to the context..

* *abstract helper UML::MultiplicityElement::setLower(lower:Integer);*

Context is a UML Multiplicity Element. The platform-specific operation sets the lower bound of the multiplicity interval.

* *abstract helper UML::MultiplicityElement::setUpper(upper:Integer);*

Context is a UML Multiplicity Element. The platform-specific operation sets the upper bound of the multiplicity interval.

* *abstract helper UML::Package::applyProfile(profile : UML::Profile);*

Context is a UML Package. Applies the current definition of the specified profile to this package and automatically applies required stereotypes in the profile to elements within this package's namespace hierarchy. If a different definition is already applied, automatically migrates any associated stereotype values on a “best effort” basis (matching classifiers and structural features by name).

* *abstract helper UML::Element::applyStereotype(stereotype:UML::Stereotype):Stdlib::Element;*

Context is any UML Element. The operation applies the specified stereotype to this element and returns an instance of the applied stereotype.

### Global Properties

Property names are shared between the transformations. Properties may be one of the following kinds, depending upon the name syntax:

* *<name>Profile*The value is a UML Profile initialized during transformation startup.
* *<name>Stereotype*The value is a UML Stereotype initialized during transformation startup.
* *Other.* All other properties are string constants statically initialized.

## Archetype Library

The AML transformations are defined as a set of mappings between AOM Archetypes and AML-UML model elements. In general, there is a one-to-one correspondence between Elements in the AML-UML model and Elements in the AOM meta-model. At the highest compositional level defined within the AOM architecture, an archetype library is a container for a set of AUTHORED\_ARCHETYPEs. Figure 10‑5 illustrates the high-level packaging map between an AOM Archetype Library and an AML-UML model in the context of a UML Reference Model.

* A mapping is defined between a file system folder and an «ArchetypeLibrary» Package. Each AOM AUTHORED\_ARCHETYPE corresponds to a document within the file system folder and maps to an «Archetype» Package. Based on the rmPublisher and rmVersion, the «ArchetypeLibrary» is bound (via import) to some «ReferenceModel». The «ArchetypeLibrary» has the AML Profiles applied. The «Archetype»s within an «ArchetypeLibrary» must have the same rmPublisher and rmPackage. While the rmPublisher is specified in the «ReferenceModel», the logical notion of rmPackage is recorded in an «ArchetypeLibrary» tag.
* A mapping is defined between each AUTHORED\_ARCHETYPE document and an «Archetype» Package. 

Figure 10‑5 «ArchetypeLibrary» Mapping Overview

## Archetype

Figure 10‑6 illustrates mappings between AOM and AML related to an «Archetype» Package.

* An AML «Archetype» has tag definitions to capture information from an AOM AUTHORED\_ARCHETYPE. «Archetype» tags include attributes inherited by AUTHORED\_ARCHETYPE as well as those contained by some associated Classifiers.
* The AOM ARCHETYPE parent\_archetype\_id is represented as an import from one «Archetype» to another «Archetype» within the same «ArchetypeLibrary».
* The name of the «Archetype» corresponds to a concept\_id in the AOM meta-model. The AOM AUTHORED\_ARCHETYPE attributes rmPublisher and rmPackage are derivable from «ReferenceModel» and «ArchetypeLibrary», respectively. The rmClass attribute defined in AOM is derivable from the top level «ArchetypeDefinition» Usage. The remaining components of the physicalId attribute in AOM are captured as tags in the «Archetype».



Figure 10‑6 «Archetype» Mapping Overview

## Terminology Definition

Figure 10‑7 illustrates mappings related to Terminology Definitions.

* For an ARCHETYPE in AOM, there is exactly one terminology. The type of the terminology is ARCHETYPE\_TERMINOLOGY. That singleton ARCHETYPE\_TERMINOLOGY is represented in AML-UML as a package named “ontology”, nested within the «Archetype» Package.
* For an ARCHETYPE in AOM, natural languages have meta-data defined in TRANSLATION\_DETAILS and RESOURCE\_DESCRIPTION\_ITEM. The natural language is specified in a TERMINOLOGY\_CODE, which contains a combination of terminology\_id and a language code. In AML-UML, the terminology\_id is modeled as a Package containing a «ResourceTranslation» corresponding to each language code. In the example below, the terminology\_id is ISO\_639-1. The mapping from TERMINOLOGY\_CODE to Package is performed by the QVT «mapping» LanguagePackage.
* The language code of an AOM TERMINOLOGY\_CODE is mapped to a «ResourceTranslation» via the QVT «mapping» LanguageEnumeration. The mapping merges information from RESOURCE\_DESCRIPTION\_ITEM and TRANSLATION\_DETAILS. Thus, a «ResourceTranslation» contains tag definitions which encompass the language-specific AOM meta-information contained in both RESOURCE\_DESCRIPTION\_ITEM and TRANSLATION\_DETAILS.
* The terminology\_id Package (e.g., ISO\_639-1) contains an «EnumeratedValueDomain» Enumeration named IdentifierDefinition. The contents of the IdentifierDefinition are a set of node identifiers corresponding to the ids in an AOM Terminology Definition. These identifiers are used to associate Archetype Classifiers to multiple natural Languages, terminology bindings, and value sets. The EnumerationLiterals in this Enumeration are referenced as the “id” for Archetype Classifiers and other «IdentifiedItem»s, including the EnumerationLiterals within a «ResourceTranslation».
* The AOM AUTHORED\_RESOURCE attribute “original\_language” has a QVT «mapping» to a Usage named “original\_language” between an «Archetype» and the «ResourceTranslation » corresponding to that original\_language.
* Similarly, the AOM ARCHETYPE\_TERMINOLOGY attribute “original\_language” has a QVT «mapping» to a Usage named “terminology\_original\_language” between an «Archetype» and the «ResourceTranslation » corresponding to that original\_language.



Figure 10‑7 Terminology Definition Mapping Overview

## Terminology Binding

The ARCHETYPE\_TERMINOLOGY component of the AOM Model provides for multi-lingual terminology definitions, bindings of terminology to technology, and local value set constraints.

* The AOM ARCHETYPE\_TERMINOLOGY (of which there is one per «Archetype») has a term\_bindings «mapping» to a Package named “term\_bindings”. The term\_bindings Package owns all the «ValueSetDefinitionReference»s used to define terminology bindings.
* The AOM ARCHETYPE\_TERMINOLOGY attribute named “term\_definitions” is a set of tables keyed by language. Each entry in the term\_definitions set has a QVT CodeDefinitionSet «mapping» to a «ResourceDefinition» whose name is the language key.
* The columns of the table keyed by language are “id”, “text”, and a “description”. Each row of the table has an ARCHETYPE\_TERM «mapping» to an «IdentifiedItem» within the language’s «ResourceDefinition». The AOM “text” is mapped to the «IdentifiedItem» name and the “description” is mapped to the body of the ownedComment.
* The «IdentifiedItem» has an “id” tag whose value is the corresponding «IdentifiedItem» identifier within the IdentifierDefinition. AOM rules require that each language include text/description for all identifiers, so each language will have a term/definition for each «ARCHETYPE\_TERM» in the IdentifierDefinition.
* The AOM ARCHETYPE\_TERMINOLOGY attribute named “term\_bindings” is a set of tables keyed by a technology identifier. Each entry in the term\_bindings set has a QVT TermBindingSet «mapping» to a «ValueSetDefinitionReference» whose name is the technology identifier.
* The columns of the table keyed by terminology identifier are “id” and “uri”. Each row of the table has a TERM\_BINDING\_ITEM «mapping» to a «ConceptReference» within the terminology’s «ValueSetDefinitionReference». The AOM “id” is mapped to the «ConceptReference » name and the “uri” is mapped to the “uri” tag.
* The “id” tag from the AOM model corresponds to an «ARCHETYPE\_TERM» owned by the IdentifierDefinition. The «ARCHETYPE\_TERM» tag named “term\_bindings” references the term binding «ConceptReference».



Figure 10‑8 Terminology Binding Mapping Overview

## Local Value-Sets

The ARCHETYPE\_TERMINOLOGY component of the AOM Model provides for definition of local value set constraints in terms of «ARCHETYPE\_TERM» identifiers.

* The AOM ARCHETYPE\_TERMINOLOGY attribute named “value\_sets” is a set of “at” lists keyed by an “ac” identifier. Each entry in the value\_sets set is used to populate the “value\_set\_members” tag of an «ARCHETYPE\_TERM» within the IdentifierDefinition. The «ARCHETYPE\_TERM» whose name corresponds to the “ac” key of a value set is located. Each “at” identifier also has an «ARCHETYPE\_TERM» with a matching name. The value\_set\_members tag of the “ac” «ARCHETYPE\_TERM» is set to the list of “at” «ARCHETYPE\_TERM»s.



Figure 10‑9 Local Value-Sets

## Archetype Definition

An AOM ARCHETYPE has a distinguished C\_COMPLEX\_OBJECT which is the “definition” of an ARCHETYPE. The overall structure of an Archetype in AOM is basically a structure where objects contain attributes which contain objects, etc. Each Complex Object is a constraint of a Reference Model Classifier, and each attribute is a constraint on a Reference Model attribute.

* The AOM ARCHETYPE attribute named “definition” is a C\_COMPLEX\_OBJECT which is the root of a logical containment structure. The “definition” attribute itself has an ArchetypeDefinition «mapping» to an «ArchetypeDefinition » Usage from the «Archetype» Package to a «ComplexObjectConstraint» Classifier. Part of the AOM physical\_id attribute is the rm\_class, which is derived from the «Constrains» Classifier of the Classifier identified by the «ArchetypeDefinition » Usage.
* The «ComplexObjectConstraint» Classifier is mapped from an AOM C\_COMPLEX\_OBJECT via the C\_COMPLEX\_OBJECTAbstract «mapping». The «Constrains» Generalization is mapped from the rm\_type\_name of the AOM C\_OBJECT. The name of the «ComplexObjectConstraint» Classifier will be set to the term name associated with the node\_id in C\_OBJECT, if possible. The AOM C\_DEFINED\_OBJECT is\_frozen attribute is mapped to the UML Classifier isLeaf attribute. The AOM node\_id attribute of C\_OBJECT is mapped to the “id” tag of «ComplexObjectConstraint», which will have a value of the corresponding «ARCHETYPE\_TERM» in IdentifierDefinition.
* A Property is mapped from a C\_ATTRIBUTE via the P\_C\_ATTRIBUTE «mapping». The mapping will subset or redefine the Reference Model Property identified by rm\_attribute\_name of the AOM C\_ATTRIBUTE. The AOM C\_ATTRIBUTE will be mapped to multiple UML Properties, one for each of the defined children of \_C\_ATTRIBUTE. Cardinality of each such UML Property is determined by occurrences information in the child C\_OBJECT. A Property will nominally have composite Aggregation, unless it is a Proxy (in which case Aggregation is “none”). The Property is an Association End of a newly created Association. The type of the new Property is defined by the children, and is nominally a Classifier within the «Archetype». If the child itself does not have any constraining attributes, then the type of the Property is the same as that specified in the Reference Model.



Figure 10‑10 Archetype Definition Mapping Overview

## Object References

An AOM C\_OBJECT has specializations which provide for some variances in how objects may be referenced, reused, or constrained.

* The AOM ARCHETYPE\_SLOT is mapped to an «ArchetypeSlot » Classifier via the ARCHETYPE\_SLOT «mapping ». The «Constrains » Generalization may optionally be to a Classifier in a parent Archetype (however, the example below does not override a parent definition). The includes, excludes attributes of the AOM ARCHETYPE\_SLOT are mapped to a Constraint . The element constrained is the Property whose type is the «ArchetypeSlot » Classifier. In the example below, the Constrained element is the Property named “id97” within the Classifier named “Discharge delayed”.
* An AOM C\_COMPLEX\_OBJECT\_PROXY is essentially a reference to a Complex Object within the same Archetype. A C\_COMPLEX\_OBJECT\_PROXY effects the mapping of a Property. There is no Classifier created for a C\_COMPLEX\_OBJECT\_PROXY. Instead, the type of a Property is set to the target specified by the target\_path attribute of C\_COMPLEX\_OBJECT\_PROXY and the aggregation of the Property is set to “none”. In the example below, there is a «ComplexObjectConstraint » with id108 which was referenced via containment from id105. There is a Property on id120 which references id108 with no aggregation, corresponding to the AOM C\_COMPLEX\_OBJECT\_PROXY with a target\_path of id108. The original id of C\_COMPLEX\_OBJECT\_PROXY is retained in the «ObjectConstraint » placed on the Property with no aggregation.



Figure 10‑11 Object Reference Mapping

## Primitive Constraints

Constraints on an AOM C\_PRIMITIVE\_OBJECT are mapped to a UML Constraint on the Property whose type maps to a C\_PRIMITVE\_OBJECT.

* A C\_PRIMITVE\_OBJECT maps to a Constraint. A Property whose type maps to the C\_PRIMITIVE\_OBJECT is the constrainedElement of a Constraint. The Constraint is an ownedRule of the Classifier owning the Property.
* The Constraint has a specification which is an Expression. The symbol for these primitive expressions is normally “or” and the operands are either discrete literal values or Intervals.
* The assumed\_value of a C\_PRIMITIVE\_OBJECT maps to some Literal ValueSpecification which is the defaultValue for the Property.
* The AOM concept of an Interval constraint on a C\_ORDERED Primitive is mapped to a UML Interval, with Literal ValueSpecifications for the min and max of the Interval.
* A C\_STRING mapping has Expression operands and a defaultValue which are LiteralString.
* A C\_BOOLEAN mapping has Expression operands and a defaultValue which are LiteralBoolean.
* A C\_REAL mapping has Expression operands which are Intervals, where the min and max are LiteralReal.
* A C\_INTEGER mapping has Expression operands which are Intervals, where the min and max are LiteralInteger.



Figure 10‑12 Primitive Constraints

## Temporal Constraints

AOM Constraints on Temporal Primitives are specializations of constraints on ordered Primitives. As such, the AOM Temporal Primitive map to UML Constraints on a Property. The Constraint will have an “or” Expression with operands. The operands, in this case, will be TimeIntervals. The min/max will be TimeExpressions, with the exception of Duration, where the ValueSpecification is specified as min/max Duration.



Figure 10‑13 Temporal Constraints Mapping Overview

## Code Constraints

AOM Constraints on Codes are specializations of constraints on Primitives. As such, the AOM Code Constraint maps to UML Constraints on a Property. The Constraint will have an “or” Expression with operands. The operands and/or default Values, in this case, will be InstanceValues where the instance is an EnumerationLiteral.



Figure 10‑14 Code Constraint Mapping Overview

## Assertions

AOM Assertions may be placed on an Archetype as a whole or as the includes/excludes lists of an ARCHETYPE\_SLOT. The Assertions are mapped to UML Expression trees and become part of the Constraint specification for an «ArchetypeSlot » or «Archetype ».

* An AOM ASSERTION has one EXPR\_ITEM. The AOM EXPR\_ITEM is mapped via EXPR\_ITEM «mapping » to a UML Expression. The name of the Expression is from the AOM ASSERTION tag. The type of the Expression is derived from the AOM EXPR\_ITEM type.
* An AOM EXPR\_OPERATOR is mapped to a UML Expression via EXPR\_OPERATOR «mapping » (which inherits EXPR\_ITEM «mapping » ). The UML Expression symbol (i.e., operator) is derived from the kind of EXPR\_OPERATOR operator. An AOM EXPR\_OPERATOR is specialized into EXPR\_UNARY\_OPERATOR and EXP\_BINARY\_OPERATOR (with corresponding specializations of the QVT mappings).
* An AOM EXPR\_UNARY\_OPERATOR is mapped to an Expression with a single operand using the QVT «mapping » EXPR\_UNARY\_OPERATOR.
* An AOM EXPR\_BINARY\_OPERATOR is mapped to an Expression with a left operand and a right operand using the QVT «mapping » EXPR\_BINARY\_OPERATOR.
* An AOM EXPR\_LEAF is a specialization of EXPR\_ITEM. The type of the Expression is derived from the AOM EXPR\_ITEM type. The symbol (e.g., operator) is derived from EXPR\_LEAF.reference\_type.



Figure 10‑15 Assertions Mapping Overview