* SBVR’s Use of MOF and XMI

## General

This clause defines a transformation:

* from the *business* vocabulary text in the terminological entries in SBVR Clauses 7-21 which is created for use by the business people operating an organization
* to a *data model*, i.e. the SBVR XMI Metamodel XML Schema *(see Clause 25.3)* for SBVR Content Model Exchange Documents *(see Clause 2)*.

The SBVR XMI Metamodel *(see Clause 25.2)* is a MOF-based metamodel that specifies a CMOF representation of SBVR semantics in the SBVR XMI Metamodel XML Schema data model for exchanging the content of SBVR Terminological Dictionaries and Rulebooks in SBVR Content Model Exchange XML Documents *(see Clause 2)*.

SBVR’s use of MOF and how the SBVR XMI Metamodel handles certain semantic modeling challenges using MOF 2.0 are described below. The SBVR XMI Metamodel is available as an XML document *(see Clause 25.2)*. It is generated by the transformation specified in this Clause from the text of the Clauses 7 through 21 terminological entries. An example model that instantiates the SBVR XMI Metamodel is then shown and explained. Finally, the SBVR Content Model for SBVR (see Clause 25.4) is explained.

Models of business concepts, business vocabularies and business guidance can be communicated in terms of SBVR semantics using XML documents, i.e. “SBVR Content Model Exchange Documents”, *(see Clause 2)* that conform to the “SBVR XMI Metamodel XML Schema” (see Clause 25.3) created from the “SBVR XMI Metamodel” (see Clause 25.2). The Clause 25.4 “SBVR Content Model for SBVR” XML document is an example of an “SBVR Content Model Exchange Document” containing the terminological entry content of SBVR Clauses 7-21.

## SBVR's Use of MOF

The following terms used in this clause are not words defined by SBVR. Their meanings come from MOF 2.0.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| metamodel | package | association | association end | class | attribute | data type |
| model |  | link |  | element |  | data value |

How each of these is used with respect to SBVR is explained below.

The MOF diagram patterns shown in the Figures in Clause 23.3 are the target patterns for the CMOF content in the SBVR XMI Metamodel *(see 25.2)* that is generated from the terminological entry text in Clauses 7-21 according to the transformations specified in Clause 23 (this clause).

### Metamodels

A model is a representation of facts. A model instantiates a metamodel which describes the structure and language by which facts are represented in models. A metamodel is itself a model which instantiates the MOF model (the meta-metamodel). The diagram below illustrates how SBVR fits into the MOF metamodeling architecture.

* SBVR Machine-Readable File Relationships

The SBVR XMI Metamodel (see sub clause 25.2) instantiates the MOF model. It describes SBVR Content models, which represent facts built on SBVR concepts represented in the SBVR Vocabulary.

The SBVR XMI Metamodel does not include definitions, rules, notes, examples or semantic formulations. Rather, it mirrors the SBVR namespaces for those vocabularies. It provides a MOF means of expression (classes and associations) where the SBVR vocabulary namespaces identify an English language means of expression (designations and verb concept wordings). Both use the same signifiers. A result of this alignment of the SBVR XMI Metamodel with the SBVR vocabulary is that knowledge of the vocabulary implies knowledge of the Metamodel and vice versa. The SBVR XMI Metamodel is serialized as an XML document (see 25.2).

### SBVR Content Models

SBVR Content models represent facts that are about or within a body of shared meanings. For example, facts about EU-Rent’s concepts, rules, their representations and their semantic formulations can be represented in a SBVR Content model. A thing represented in a model is identified by facts about the thing that satisfy a reference scheme. An example SBVR Content model is shown in Using MOF to Represent Semantics below. SBVR Content models are often incomplete representations of a body of shared meanings. The size of a model depends on what facts are being represented, which can be as little as a single fact.

One particular SBVR Content model is the SBVR Content Model for SBVR (see sub clause 25.4), which is a model of SBVR in terms of itself. It is described in sub clause Example SBVR Content Model below.

An SBVR Content Model instantiates the SBVR XMI Metamodel. It represents a fact model, which combines a conceptual schema and a set of facts. The conceptual schema is described by the SBVR model of SBVR. The facts are expressed in terms of the concepts in the conceptual schema and are limited to what is possible according to the conceptual schema.

All uses of the terms “conceptual schema” and “fact model” in this clause are as defined in sub clause 24.2.2.1.

## MOF Model Elements for SBVR

The SBVR Vocabulary is mapped to MOF elements that make up the SBVR XMI Metamodel. It should not be construed from this one-way mapping that a MOF class is the same thing as an SBVR concept or that there is any semantic equivalence between MOF and SBVR.

SBVR model content is represented in SBVR Content models according to the SBVR XMI Metamodel. SBVR Content models instantiate the SBVR XMI Metamodel, not the UML Metamodel. Another transform would be needed to represent SBVR model content using UML.

Both the mapping of the SBVR Vocabulary to MOF and the representation of SBVR model content using MOF are described below, divided using the following headings.

|  |  |
| --- | --- |
| Heading | Purpose |
| *MOF Elements of the SBVR XMI Metamodel* | Prescriptive description of the mapping of the SBVR Vocabulary into a MOF-based metamodel |
| *Elements of SBVR Content Models* | Prescriptive description of how facts are represented within an SBVR Content model |
| *Rationale* | Design rationale explaining aspects of SBVR or MOF that led to the MOF representations described here |

### MOF Packages for SBVR Vocabulary Namespaces

###### MOF Elements of the SBVR XMI Metamodel

The SBVR Vocabulary is mapped to the SBVR XMI Metamodel, which is made up of one package, which is a MOF-based reflection of the SBVR vocabulary namespace.

###### Elements of SBVR Content Models

The package that makes up the SBVR XMI Metamodel contain classes and associations.

###### Rationale

The SBVR XMI Metamodel package can be imported or merged into other MOF-based metamodels. For example, a metamodel of organizational structure can import the SBVR XMI Metamodel package as a starting point for modeling organization types and organizational roles. Similarly, a metamodel of business process can import the SBVR XMI Metamodel package in order to relate processes to rules, or for modeling semantic formulations of rules that govern processes.

### MOF Classes for SBVR Noun Concepts

###### MOF Elements of the SBVR XMI Metamodel

Each designation in a vocabulary namespace for a noun concept that is not a role is mirrored in the SBVR XMI Metamodel as a class. The signifier of the designation is the name of the class. The signifier of each synonym of the designation is an alias for the class.

The metamodel includes generalizations between classes reflecting generalizations between the represented noun concepts. Each SBVR concept besides ‘thing’ specializes ‘thing’, so the classes have the class ‘**thing**’ as a superclass either directly or indirectly.

The classes in the metamodel that mirror the following concepts are abstract (isAbstract = true):

actuality

binary logical operation

bindable target

closed semantic formulation

community

concept

expression

fact

logical formulation

logical operation

meaning

modal formulation

projecting formulation

quantification

res

semantic formulation

set

situation

state of affairs

thing

Example Vocabulary:

 **characteristic**

 General Concept: verb concept

 Synonym: unary verb concept

Figure:

SBVR XMI Metamodel:


###### Elements of SBVR Content Models

Where a class represents a noun concept, an element (in an SBVR Content model) that instantiates the class represents a fact that an instance of the noun concept exists. References to the element within the SBVR Content model indicate references to the instance of the noun concept. Note that it is possible that two elements in an SBVR Content model represent the same actual thing (MOF Packages for SBVR Vocabulary Namespaces explains situations where this is likely and tells how to relate the two elements within the SBVR Content model). Also, a lack of an element in an SBVR Content model implies nothing - it does not imply that something does not exist.

An element of an abstract class exists in a MOF-based model only by instantiating a nonabstract subclass of that abstract class.

###### Rationale

Use of aliasing, though not common in MOF-based metamodels, keeps a strong alignment of the SBVR XMI Metamodel with the SBVR vocabulary.

The SBVR XMI metamodel is intended to provide for representing meanings and their representations. It is not intended for representing things in general. Making some classes abstract simplifies interpretation of SBVR Content models by limiting them to SBVR’s scope.

. Each case of an objectification involves the verb concept objectified, the noun concept objectifying it along with terminological content that specifies the connection. Each of the two concepts is represented separately in the SBVR XMI Metamodel.

### MOF Boolean Attributes for SBVR Characteristics

###### MOF Elements of the SBVR XMI Metamodel

A characteristic is represented in MOF as an optional Boolean attribute as shown below.

Example Vocabulary:

 variable is unitary

Figure:

SBVR XMI Metamodel:


###### Elements of SBVR Content Models

For an element in an SBVR Content model, the meaning of the value TRUE is that the characteristic is attributed to the thing represented by the element. A meaning of FALSE is that the thing represented by the element does not have the characteristic. A meaning of the attribute being null is the same as the attribute being unspecified for the element.

###### Rationale

The attribute is optional in support of the Open World Assumption, explained in Open World Assumption below.

### MOF Associations for SBVR Binary Verb Concepts

###### MOF Elements of the SBVR XMI Metamodel

Each binary verb concept is represented in MOF terms as an association. Association names match verb concept wordings. If a verb concept has only one verb concept wording, the association's name is the expression of that verb concept wording, but with subscripts raised to normal text. The names of the association's ends are the placeholder expressions from the verb concept wording. The ends are owned by the association so that individual links can be serialized using XMI.

In cases of more than one verb concept wording (synonymous forms), one is chosen to name the association that does not imply a designation in an attributive namespace. Then there is an alias for the association for each other verb concept wording that has matching placeholder expressions (which implies matching association end names).

Including the names of an association's ends in the association’s name makes the association's name unique within a package, as required by MOF.

In cases where an association’s ends both connect to the same class, subscripts are used on placeholders to distinguish them. In the association name and its ends’ names the subscripts are raised to normal text and serve to distinguish the ends.

Example Vocabulary:

 concept1 specializes concept2

 Synonymous Form: concept2 generalizes concept1

Figure:

SBVR XMI Metamodel:

Some definitional rules impose multiplicity constraints for binary verb concepts. These are formally-stated restrictions on multiplicity in a definition or a definitional rule in the SBVR terminological entries (Clauses 7-21) and are included in the SBVR XMI Metamodel. If no multiplicity restriction is specified in the SBVR terminological entries, the implied multiplicity of “no minimum and/or maximum restriction” in the SBVR terminological entries is made explicit in the SBVR XMI Metamodel using the multiplicity “0..\*” .

 Annex A.2.1.1 documents the SBVR Structured English keywords that are used for the expression of multiplicities in SBVR terminological entries. The following table shows those keywords along with the corresponding multiplicity in the SBVR XMI Metamodel.

|  |  |  |
| --- | --- | --- |
| ***SBVR Structured English Keyword*** | ***Kind of Logical Formulation*** | ***UML Multiplicity*** |
|  at least one | existential quantification  | 1..\* |
|  at least *n* | at-least-n quantification  | *n..\** |
|  at most one | at-most-one quantification  | 0..1 |
|  at most *n* | at-most-n quantification  | 0..*n* |
|  exactly one | exactly-one quantification  | 1..1 |
|  exactly *n* | exactly-n quantification  | *n..n* |
|  at least *n* and at most *m* | numeric range quantification  | *n..m* |
|  more than one | at-least-n quantification with *n* = 2  | 2..\* |

###### Elements of SBVR Content Models

Where an association represents a binary verb concept, a link of the association within an SBVR Content model represents a fact of that binary verb concept. The absence of a link implies nothing. There are no defaults.

###### Rationale

All association ends in the SBVR XMI metamodel are noncomposite.

### MOF Attributes for SBVR Roles of Verb Concepts

###### MOF Elements of the SBVR XMI Metamodel

A role of a binary verb concept that has a designation in an attributive namespace is understood in MOF terms as an attribute owned by the subject class. Such designations appear as names on association ends. In the example below, ‘element’ is in an attributive namespace for the concept ‘set,’ so it is mirrored in the SBVR XMI Metamodel as an attribute.

Example Vocabulary:

 thing is in set

 Synonymous Form: set includes thing

 Synonymous Form: set has element

Figure:

SBVR XMI Metamodel:

In each case where an attribute and an association end represent the same role, the SBVR XMI Metamodel includes a tag that tags both the attribute and the association end. The tag connects them to show their correlation. The tag’s name is “org.omg.sbvr.sameRole,” its value is "" (the empty string), and its elements are the attribute and the association end.

Where structural rules impose multiplicity constraints, they are included in the SBVR XMI Metamodel for association ends and for attributes.

###### Elements of SBVR Content Models

Where a role of a binary verb concept is understood in MOF terms as an attribute, specification of the attribute for an element in an SBVR Content model represents the entire extension of that verb concept for the element. There are no defaults. If the attribute is unspecified for an element, it is simply unspecified; it is not presumed by default to have no value. If anything is specified, all values of the attribute are specified. Specification that the attribute is null means there is no instance of the verb concept for the element.

###### Rationale

The attributes described in the sub clause are in addition to the associations that represent the binary verb concepts - the reason for the distinction is explained below.

To preserve ‘set’ semantics, any two values of the same attribute of the same element in an SBVR Content Model represent two different things. Where an attribute has two or more values, it can be concluded that each of the values represents a thing that is distinct from the others.

### MOF Classes for SBVR Ternary Verb Concepts

###### MOF Elements of the SBVR XMI Metamodel

MOF 2.0 does not support ternary associations. Therefore, a ternary verb concept is represented in MOF terms as a class with one single-valued, required attribute for each role of the verb concept. The class’s name takes the same form as the name of an association for a binary verb concept. If there are multiple verb concept wordings for a ternary verb concept, aliases are used.

Example Vocabulary:

 **state of affairs involves thing in role**

Figure:

SBVR XMI Metamodel:


###### Elements of SBVR Content Models

In an SBVR Content model, an element of such a class represents a fact of the ternary verb concept.

### Data Values

###### MOF Elements of the SBVR XMI Metamodel

The classes ‘text’ and ‘integer,’ representing ‘text’ and ‘integer,’ have data attributes shown below.

SBVR XMI Metamodel:


###### Elements of SBVR Content Models

If one of these attributes is specified in an SBVR Content model, the represented text or integer is the specified value. Specification of null is equivalent to not specifying anything. There are no defaults.

The concepts ‘text’, ‘integer’, and ‘number’ are SBVR noun concepts, so their instances can be represented like instances of other noun concepts (see 23.2.2 MOF classes for SBVR Noun Concepts) without using the ‘value’ attributes shown above. A specific number can be identified by a designation. The ISO 6093 Number Namespace includes designations of all integers and of numbers with decimal places. Each designation in the ISO 6093 Number Namespace shall be interpreted according to [ISO 6093].

Each text value is a Unicode string of undefined length and is considered without regard to markup.

###### Rationale

The attributes are optional because SBVR allows that texts and integers, like other kinds of things, can be described by facts without necessarily being identified. Also, the data types ‘String’ and ‘Integer’ in MOF have size limitations, so the attributes cannot be used for all cases. To refer to a string or integer that is beyond the MOF limitations, a model can identify the string or integer using facts about it that satisfy a reference scheme. For example, the number 999999999999 can be identified as having a designation in the ISO 6093 Number Namespace with the signifier “999999999999”.

### XMI Names

###### MOF Elements of the SBVR XMI Metamodel

A named element is tagged with an ‘org.omg.xmi.xmiName’ tag if its XMI name differs from its MOF name. XMI names are determined from MOF names by upcasing each character that follows a blank and then removing the blank. The names, because they come from the SBVR vocabularies, do not contain any characters that are invalid in XML identifiers.