MapleMBSE Virtual Features Guide

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Preface

MapleMBSE Overview

MapleMBSE™ gives an intuitive, spreadsheet based user interface for entering detailed system design definitions, which include structures, behaviors, requirements, and parametric constraints.

Related Products

MapleMBSE 2019 requires the following products.

- Microsoft® Excel® 2010 Service Pack 2, Excel 2013 (updated to most recent version, for details please see the Release Notes) or Excel 2016.
- Oracle® Java® SE Runtime Environment 8.

Note: MapleMBSE looks for a Java Runtime Environment in the following order:

1) If you use the -vm option specified in **OSGiBridge.init** (not specified by default), MapleMBSE will use it.

2) If your environment has a system JRE (meaning either: JREs specifed by the environment variables JRE_HOME and JAVA_HOME in this order, or a JRE specified by the Windows Registry (created by JRE installer)), MapleMBSE will use it.

3) The JRE installed in the MapleMBSE installation directory.

If you are using IBM® Rational® Rhapsody® with MapleMBSE, the following versions are supported:

- Rational Rhapsody Version 8.1.2 or Version 8.1.3
- Teamwork Cloud™ server 18.5

Note that the architecture of the supported non-server products (that is, 32-bit or 64-bit) must match the architecture of your MapleMBSE architecture.

Related Resources

Resource	Description
MapleMBSE Installation Guide	System requirements and installation instructions for MapleMBSE. The **MapleMBSE Installation Guide** is available in the **Install.html** file located either on your MapleMBSE installation DVD or the folder where you installed MapleMBSE.
MapleMBSE Applications	Applications in this directory provide a hands on demonstration of how to edit and construct models using MapleMBSE. They, along with an accompanying guide, are located in the Application subdirectory of your MapleMBSE installation.
MapleMBSE Configuration Guide	This guide provides detailed instructions on working with configuration files and the configuration file language.
MapleMBSE User Guide	Instructions for using MapleMBSE software. The **MapleMBSE User Guide** is available in the folder where you installed MapleMBSE.

For additional resources, visit **http://www.maplesoft.com/site_resources**.

Getting Help

To request customer support or technical support, visit **http://www.maplesoft.com/support**.

Customer Feedback

Maplesoft welcomes your feedback. For comments related to the MapleMBSE product documentation, contact doc@maplesoft.com.

1 Introduction

1.1 Scope and Purpose of this Document

The purpose of the MapleMBSE Virtual Features Guide is to describe MapleMBSE virtual features and explain how to use them.

The intended audience for this document are users who are familar with UML, SysML and Model-based Systems Engineering concepts and who intend to create their own MapleMBSE configuration files.

1.2 Prequisite Knowledge

To fully understand the information presented in this document the reader should be familiar with the following concepts:

- The Eclipse Modeling Framework `ecore` serialization. In particular, knowing how to use any tool of your choice to track all the *eReferences* independently of the *eSuperTypes* .
- Thus, some basic concepts of Meta Object Facilty like *eClassifiers* and *eStructuralFeatures*. A correct mse configuration file has within each qualifier a concrete UML *eClassifiers* and each dimension should be accessed using a non-derived *StructuralFeature* defined in the `UML.ecore` or a virtual one inside this guide.
- MapleMBSE Configuration Language elements, (especially dimension and qualifiers, and the syntax for importing the MapleMBSE ecore). For more information on the MapleMBSE Configuration language, see the **MapleMBSE Configuration Guide**.

1.3 Motivation for Using MapleMBSE Virtual Features

SysML provides a high level of abstraction to cover as many modeling scenarios as possible with the diagrams offered. It is a powerful and complex language that is extremely difficult to master because of its complexity (there are hundreds of pages of technical specifications for SysML).

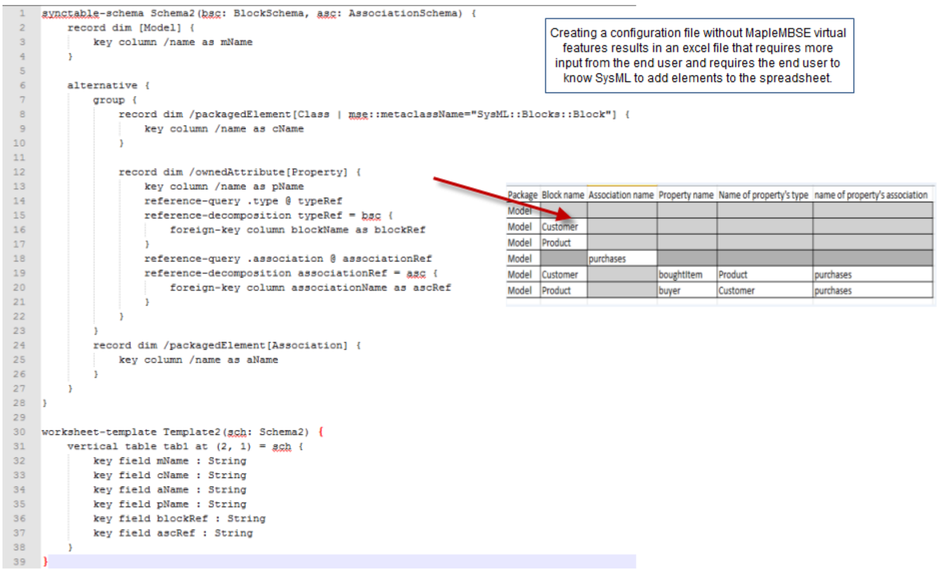
Many different concrete and abstract *Classifiers*, with very specific semantics, are part of the SysML technical specifications. These *Classifiers* should not be used interchangeably. Even "linking" elements changes depending on the "linked" elements. For example, SysML *Associations* are to *Classes* as *Connectors* are to Ports, or, what *ControlFlows* can be for *ActivityNodes*. However, these elements are not interchangeable.

An end user, defined as a user who will be updating model information using the MapleMBSE spreadsheet interface but likely will not be involved in creating or editing configuration files, who interested in taking advantage of the modeling capabilities of SysML, should not need to know its complexities. MapleMBSE helps to hide this complexity from the end user, through virtual features. They are called virtual features because, although they extend the capabilities of native SysML, they themselves are not part of SysML.

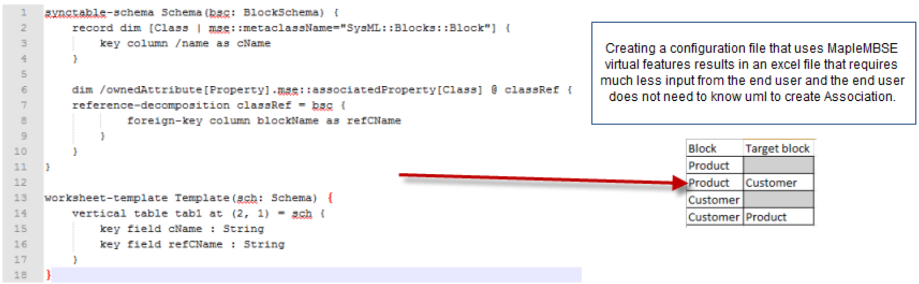
With the right choice of labels within an Excel template and a well designed configuration (.mse) file that implements MapleMBSE virtual features, an end user can enter a couple of inputs in a spreadsheet and create *Blocks* and the Associations linking them, or Ports and Connectors, or other combinations of elements.

For example, consider the following code snippet from a MapleMBSE configuration file in the figure below. This figure illustrates the scenario where a configuration file is designed without the use of virtual features to represent SysML *Associations* between *Blocks*.

Notice in the generated Excel worksheet, the number of inputs required of the end user to represent the *Assocation* between **Customer** and **Product**. This requires knowledge of SysML on the part of the end user.



Now consider an example that represents the same Association between Customer and Product, as shown in the figure below. This time, the configuration file is designed using the MapleMBSE virtual features, specifically, the associatedProperty virtual feature. Notice, the only inputs required of the end user are the two SysML *Blocks*, **Customer** and **Product**. The cross-references need for the Association are completed automatically.



1.4 Importing the MapleMBSE Ecore

Loading MapleMBSE virtual features is analogous to the way you would load UML Structural Features using UML Ecore. The corresponding MapleMBSE Configuration language uses `import-ecore`.

The general syntax is

import-ecore "URI"

For example, to specify the NoMagic ecore:

"http://www.nomagic.com/magicdraw/UML/2.5"

To specify the MapleMBSE ecore:

```
"http://maplembse.maplesoft.com/common/1.0"
```

You must create an alias for the `ecore` using the syntax:

import-ecore "URI" as Alias

For example, to specify an alias for the MapleMBSE `ecore`:

```
import-ecore "http://maplembse.maplesoft.com/common/1.0" as
mse
```

This allows you to use the short form, `mse`, instead of the whole syntax.

1.5 General Syntax for the MapleMBSE Virtual Features

The general syntax for the virtual features is

```
[./]?alias::virtualfeature
```

The first character can be a dot, a forward slash, or a blank. There is no strict rule of thumb for this. For specific syntax, see the Syntax subsection for each virtual feature.

`alias` – This is the alias for the ecore import

`virtualfeature` - This is the virtual feature name you want to use, for example, `associatedProperty`.

1.6 List of Virtual Features

The MapleMBSE virtual features can be grouped into five categories:

Stereotypes (page 5). This group includes the `metaclassName` and `featureName` virtual features.
Associations (page 11) This group includes the `associatedProperty`, `directAssociatedProperty`, and `otherAssociatedEnd` virtual features.
*Connectors (page 21)*This group includes the `connectedPropertyOrPort` and `otherConnectorEnd` virtual features.
*Dependencies (page 25)*This group includes the `clientDependencies` and `supplierDependencies` virtual features.
*Util (page 29)*This group includes the `multiplicityProperty` virtual feature.

2 Stereotypes

SysML can be explained as a subset of elements defined in the UML specifications plus some additional features not included in UML. One of these features is a *Stereotype*. *Stereotypes* are applied to those elements adding extra meaning or modeling semantics. MapleMBSE offers several virtual features to apply *Stereotypes* and navigate their extended modeling capacities.

2.1 metaclassName

Description

Use the **metaclassName** virtual feature to apply *Stereotypes* while creating elements using MapleMBSE. To use this virtual feature you need to identify the qualified name of the *Stereotype* that you want to apply and whether the element is compatible with that stereotype.

Syntax

Any *Element* of the *Model* can have a list of *appliedStereotype* but only certain *Stereotypes* should be applied to certain *Element*. This is one of the few virtual features that is used as a filter inside the qualifier and it does not require a dot or slash notation prior to the alias. The **metaclassName** virtual feature must be followed by an equals simbol and the qualified name of the *Stereotype* between quotation mark.

alias::metaclassName="qualified::name"

It is important to note that this qualified name is basically a path and the name that identifies uniquely each *Stereotype*, and each substring is concatenated with a double colon notation.

Using the metaclassName Virtual Feature

The following steps lllustrate what you need to do to use AssociatedProperty virtual feature:

1. The MapleMBSE ecore is imported and its alias is mse.
2. Two data-sources are used for this example with `metaclassName` to filter *Blocks* and *Requirements*. **Note**: both of those SysML concept are UML Classes but with different Stereotypes.
3. Defining `synctable-schemas`, one for *Blocks* and another for *Requirements*. **Note**: To avoid problems with MapleMBSE it is a good practice to use the same qualifier and *Stereotype* filter in the `data-source` and the first `dimension` of the schema.
4. Complete the rest of the configuration as usual: `worksheet-templates`, `synctable` and `workbook`.

Example

The following example showcases how to use `metaclassName` to create *Classes* applying 2 different *Stereotypes*.

```
import-ecore "http://www.nomagic.com/magicdraw/UML/2.5"
import-ecore "http://maplembse.maplesoft.com/common/1.0" as mse

data-source Root[Model]
data-source blocks = Root/packagedElement[Class | mse::metaclassName="SysML::Blocks::Block"]
data-source requirements = Root/packagedElement[Class | mse::metaclassName="SysML::Requirements::Requirement"]

synctable-schema BlockSchema {
    record dim [Class | mse::metaclassName="SysML::Blocks::Block"] {
        key column /name as bName
    }
}

synctable-schema RequirementSchema {
    record dim [Class | mse::metaclassName="SysML::Requirements::Requirement"] {
        key column /name as rName
    }
}

worksheet-template BlockTemplate (bsc: BlockSchema) {
    vertical table tab1 at (1, 1) = bsc {
        key field bName: String
    }
}

worksheet-template RequirementTemplate(rsc: RequirementSchema) {
    vertical table tab1 at (1, 1) = rsc {
        key field rName: String
    }
}

synctable blockTable = BlockSchema<blocks>
synctable requirementTable = RequirementSchema<requirements>

workbook {
    worksheet BlockTemplate(blockTable)
    worksheet RequirementTemplate(requirementTable)
}
```

Figure 2.1: metaclassName Example

2.2 featureName

Description

As mentioned in the introduction of this section, once you applied a *Stereotype* to any *Element*, you are changing its semantics and extending it. Use `featureName` to access those extended properties stored in *Slots* using their qualified names.

The class diagram in *Figure 2.2 (page 7)* shows the different *EClasses* that need to be queried in order to access those *Slots*, remember that *Element* is an abstract *EClass* and it should not be used as the qualifier. Basically all elements in a *Model* implement *Element*, thus *EClasses* like *Class* have the structural feature *appliedStereotypeInstance* to query *InstanceSpecification*.

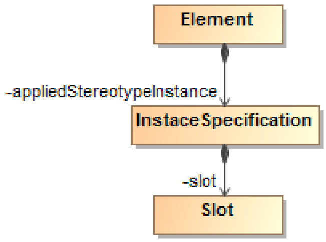


Figure 2.2: A The appliedStereotypeInstance Structure

Syntax

Use `featureName` the same way `metaclassName` is used within a qualifier as a filter, meaning that no dot or slash notations are needed before the alias. It expected, follwing the virtual feature, an equal symbol and a string between quotation marks; this string is the qualified name of the property to access.

```
alias::featureName="qualified::name"
```

This qualified name is similar to the one used to identify the *Stereotype* but it differs slightly at the end with an extra information concatenated to identity a single extension. As mentioned before this virtual feature is usable while querying a *Slot* inside a *InstanceSpecification* inside an concrete *Element*, but you must also know that this *Element* must be filtered by `metaclassName` with the qualified name that identifies the *Stereotype*.

Using the featureName Virtual Feature

To access extra Properties added after applying a Stereotype:

1. Import the MapleMBSE ecore.
2. Inside a syntable-schema navigate to a *MultiplicityElement*, in this case, `/ownedAttribute[Property]` within a Class.
3. Within that dimension, define a regular column using `/mse::multiplicityProperty.`
4. Complete the rest of the configuration as usual: worksheet-templates, synctable and workbook.

Example

The following example illustrates how to access extra *Properties* added after applying a *Stereotype*.

1. Import MapleMBSE ecore, for this example use `mse` as the alias.
2. Create a data-source using the `metaclassName` virtual feature mentioned before to filter *Requirements*.
3. Define a synctable-schema for *Requirements*. **Note**: use the same qualifier and *Stereotype* for the first `dimension` that for the `data-source`.
4. To access the `SysML::Requirements::Requirement::Text` *Property* added to a *Class* after applying the Requirement Stereotype you must:
   1. Navigate *appliedStereotypeInstance* to get an *InstanceSpecification*.
   2. Then *slot* to recover all the *Slots* within the *InstanceSpecification*
   3. Use `featureName` with the *Slot* qualifier to filter the *Property* that you want to access

   Note: The qualified name of that *Property* is the name of the qualified *Stereotype* plus 2 colons and the name of the *Property*.
   Stereotype: `SysML::Requirements::Requirement`
   Property: `SysML::Requirements::Requirement::Text`
4. Complete the rest of the configuration as usual: `worksheet-templates`, `synctable` and `workbook`.

```
import-ecore "http://www.nomagic.com/magicdraw/UML/2.5"
import-ecore "http://maplembse.maplesoft.com/common/1.0" as mse

data-source Root[Model]
data-source requirements = Root/packagedElement[Class | mse::metaclassName="SysML::Requirements::Requirement"]


synctable-schema RequirementSchema {
    record dim [Class | mse::metaclassName="SysML::Requirements::Requirement"] {
        key column /name as rName
        column /appliedStereotypeInstance[InstanceSpecification]/slot[Slot|mse::featureName=
          "SysML::Requirements::Requirement::Text"]/value[LiteralString]/value
            as spec
    }
}

worksheet-template RequirementTemplate(rsc: RequirementSchema) {
    vertical table tab1 at (1, 1) = rsc {
        key field rName: String
        field spec: String
    }
}

synctable requirementTable = RequirementSchema<requirements>

workbook {
    worksheet RequirementTemplate(requirementTable)
}
```

Figure 2.3: featureName Example

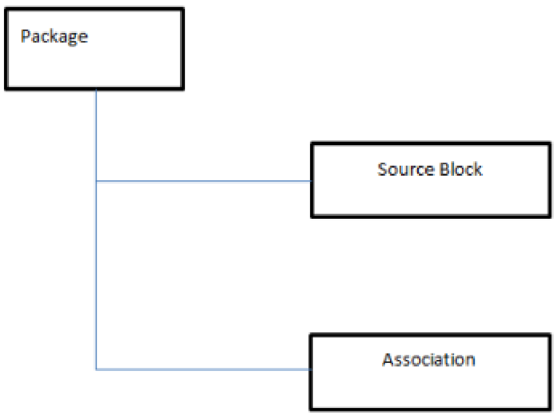
3 Associations

An *Association* between two *Blocks* creates cross references for two UML *Classes* with SysML *Block Stereotypes* (`<<block>>`) to one *Association* using two properties and also makes some cross references, like *Type* and *Association*, within those properties .

3.1 associatedProperty

Description

In MagicDraw, with a couple clicks from one block to another, all of these elements are correctly created. Similarly in MapleMBSE, the `associatedProperty` virtual feature provides the ability to connect two SysML *Blocks*, creating a bidirectional *Association* at the same hierarchicallevel in the diagram as the source *Block*.



When MapleMBSE queries the model, the `associatedProperty` returns the target *Block* (the *Block* that is related to a *Property* through an *Association*).

Syntax

The general syntax for using the `associatedProperty` virtual feature is as follows:

```
.alias::associatedProperty
```

Where `alias` is the alias you assigned to the MapleMBSE ecore. For more information on assigning aliases, see *Importing the MapleMBSE Ecore (page 3)*.

The `associatedProperty` virtual feature must be used when querying the *Property* of a *Block*.

Using the associatedProperty Virtual Feature

The following example lllustrates what you need to do to use AssociatedProperty virtual feature.

1. In line two, the **maplembse ecore** is imported with an alias.
2. Use an `ownedAttribute[Property]` as the queried dimension.
3. Make a reference-query to a class using mse::`associatedProperty`.
4. Complete the `reference-decomposition`.

Example

```
import-ecore "http://www.nomagic.com/magicdraw/UML/2.5"
import-ecore "http://maplembse.maplesoft.com/common/1.0" as mse

data-source Root[Model]
data-source structurePkg = Root/packagedElement[Package]
data-source clss = structurePkg/packagedElement[Class]

synctable-schema ClassTableSchema {
    dim [Class] {
        key column /name as ClassName
    }
}

synctable-schema ClassTreeTableSchema(blocks: ClassTableSchema) {
    record dim [Class] {
        key column /name as className1
    }
    dim /ownedAttribute[Property].mse::associatedProperty[Class] @ cls {
        reference-decomposition cls = cts {
        foreign-key column ClassName as referredClassName
        }
    }
}

synctable classTableSchema = ClassTableSchema<clss>
synctable classTreeTableSchema = ClassTreeTableSchema<clss>(classTableSchema)

worksheet-template ClassTable(cts: ClassTableSchema) {
    vertical table tab1 at (6, 2) = cts {
        key field ClassName : String
        key field Name4 : String
    }
}

worksheet-template ClassTreeTable(ctt: ClassTreeTableSchema) {
    vertical table tab1 at (6, 2) = ctt {
        key field ClassName1 : String
        key field referredClassName : String
    }
}

workbook{
    worksheet ClassTable(classTableSchema)
    worksheet ClassTreeTable(classTreeTableSchema)
}
```

Figure 3.1: associatedProperty Example

3.2 directedAssociatedProperty

Description

To create *Associations* with navigability in one direction MapleMBSE uses *directedAssociatedProperty*, using this virtual feature links two *Classes* and adds a *Property* to the source *Block* and other *Property* to an *Association*.
Based on the a*ggregation* value we can use this virtual feature to create *Association*, *Aggregation* and *Composition* with direction.

Syntax

The general syntax for using the `directedAssociatedProperty` virtual feature is as follows:

```
.alias::directedAssociatedProperty
```

Where `alias` is the alias you assigned to the MapleMBSE ecore (hyperlink to above).

The `directedAssociatedProperty` virtual feature must be used when querying the *Property* of a *Block*.

Using the directAssociatedProperty Virtual Feature

The following example lllustrates what you need to do to use `directedAssociated-Property`.

1. In line two, the **maplembse ecore** is imported with an alias.
2. Use an `ownedAttribute[Property]` as the queried dimension.
3. Make a reference-query to a class using `mse::directedAssociatedProperty`.
4. Complete the `reference-decomposition`.

Example

```
import-ecore "http://www.nomagic.com/magicdraw/UML/2.5"
import-ecore "http://maplembse.maplesoft.com/common/1.0" as mse

data-source Root[Model]
data-source structurePkg = Root/packagedElement[Package]
data-source clss = structurePkg/packagedElement[Class]

synctable-schema ClassTableSchema {
    dim [Class] {
        key column /name as ClassName
    }
}

synctable-schema ClassTreeTableSchema(blocks: ClassTableSchema) {
    record dim [Class] {
        key column /name as className1
    }
    dim /ownedAttribute[Property].mse::directedAssociatedProperty[Class] @ cls {
        reference-decomposition cls = cts {
        foreign-key column ClassName as referredClassName
        }
    }
}

synctable classTableSchema = ClassTableSchema<clss>
synctable classTreeTableSchema = ClassTreeTableSchema<clss>(classTableSchema)

worksheet-template ClassTable(cts: ClassTableSchema) {
    vertical table tab1 at (6, 2) = cts {
        key field ClassName : String
        key field Name4 : String
    }
}

worksheet-template ClassTreeTable(ctt: ClassTreeTableSchema) {
    vertical table tab1 at (6, 2) = ctt {
        key field ClassName1 : String
        key field referredClassName : String
    }
}

workbook{
    worksheet ClassTable(classTableSchema)
    worksheet ClassTreeTable(classTreeTableSchema)
```

Figure 3.2: directAssociatedProperty Example

3.3 otherAssociatedEnd

Description

otherAssociationEnd is used in the case when two classifiers has to be linked and the information about the properties of these classifiers are owned by the association and not the classifiers themselves, such as in the case of UseCase diagram where assocaition exist between an actor and usecase and these two classifiers does not own any property that defines the other classifier.

Syntax

The general syntax for using the `otherAssociationEnd` virtual feature is as follows:

```
.alias::otherAssociationEnd
```

Where `alias` is the alias you assigned to the MapleMBSE ecore (hyperlink to above).

The `otherAssociationEnd` virtual feature must always be used when querying a Class
.

Using the otherAssociatedEnd Virtual Feature

The following example lllustrates what you need to do to use `otherAssociationEnd`.

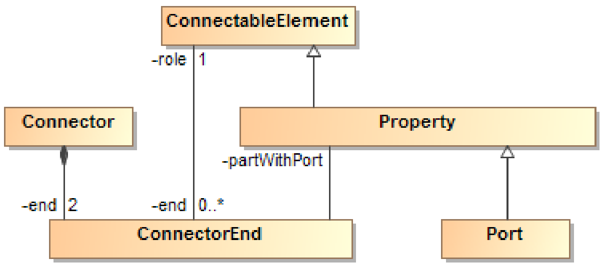
1. In line two, the **maplembse ecore** is imported with an alias.
2. Use when a `Class` as the queried dimension.
3. Make a reference-query to a class using `mse::otherAssociationEnd`, unlike other virtual features in this section otherAssociationEnd should not be used when a property is querried.
4. Complete the `reference-decomposition`.

Example

```
import-ecore "http://www.nomagic.com/magicdraw/UML/2.5"
import-ecore "http://maplembse.maplesoft.com/common/1.0" as mse

data-source Root[Model]
data-source useCasePkg = Root/packagedElement[Package]
data-source actors = useCasePkg/packagedElement[Actor]
data-source useCases = useCasePkg/packagedElement[UseCase]

synctable-schema ActorsTable {
    record dim [Actor] {
        key column /name as Actor
    }
}

synctable-schema UseCasesTable(ac:ActorsTable) {
    record dim [UseCase] {
        key column /name as Name
        reference-query .mse::otherAssociationEnd[Actor] @ actor
        reference-decomposition actor = ac {
        foreign-key column Actor as Actor
        }
    }
}


synctable actorsTable = ActorsTable<actors>
synctable useCasesTable = UseCasesTable<useCases>(actorsTable)

worksheet-template Actors(ac: ActorsTable) {
    vertical table tab1 at (5, 3) = ac {
        key field Actor : String
    }
}

worksheet-template UseCases(auct: AssociatedUseCasesTable) {
    vertical table tab1 at (5, 3) = auct {
        key field Name : String
        key field Actor : String
    }
}

workbook {
    worksheet Actors(actorsTable)
    worksheet UseCases(useCasesTable)
}
```

Figure 3.3: otherAssociatedEnd Example

4 Connectors



A *Connector* is used to link *ConnectableElements* (for example, *Ports* or *Properties)* of a *Class* through a *ConnectorEnd.* A *Connector* has two *ConnectorEnds*.

Based on the connection between *Properties* of a *Class* the connection can be of two types: *Delegation* (connecting *Ports* or *Properties* from the system to *Ports* or *Properties* inside a *Class*) or *Assembly* (connecting *Ports* or *Properties* within a *Class*).

4.1 connectedPropertyOrPort

Description

To achieve this connection MapleMBSE uses `connectedPropertyOrPort` virtual feature.
The `connectorPropertyOrPort` virtual feature connects *Ports* or *Properties* of a *Class.* It automatically detects the kind of relation required between the *Properties* being connected and creates the appropriate connection.

When MapleMBSE queries the model, the `connectedPropertyOrProt` return the list of target properties.

Syntax

The general syntax for using the `connectedPropertyOrPort` virtual feature is as follows:

```
.alias::connectedPropertyOrPort
```

Where the `alias` is alias you assigned to MapleMBSE ecore.

When the connection is created through `connectedPropertyOrPort`, the owner of the connected *Property* is determined automatically by MapleMBSE, regardless of whether this is a *Delegation* or *Assembly* type connection.

Using the connectedPropertyOrPort virtual feature

In general, to use the `connectedPropertyOrPort` virtual feature:

1. First, import the MapleMBSE ecore with `alias`
2. Use an `ownedAttribute[Property]` as the queried dimension.
3. Make a reference-query to a property using `mse::connectedPropertyOrPort`.
4. Complete the `reference-decomposition`.

Example

A specific example of how to use the `ConnectedPropertyOrPort` virtual feature is shown below.

```
import-ecore "http://www.nomagic.com/magicdraw/UML/2.5"
import-ecore "http://maplembse.maplesoft.com/common/1.0" as mse

synctable-schema BlocksTable {
        record dim [Class|mse::metaclassName="SysML::Blocks::Block"] {
                key column /name as BlockName
        }
        dim /ownedAttribute[Property] {
                key column /name as PropertyName
        }
}
synctable-schema ConnectedPropertyOrPortTable(bT: BlocksTable) {
        record dim [Class|mse::metaclassName="SysML::Blocks::Block"] {
                key column /name as className
        }
        record dim /ownedAttribute[Property] {
                key column /name as ParentPort
        }
        record dim .mse::connectedPropertyOrPort @ cls {
                reference-decomposition cls = bT {
                foreign-key column BlockName as referredClassName
                foreign-key column PortName as referredPortName
                }
        }
}
```

Figure 4.1: connectedPropertyOrPort Example

4.2 otherConnectorEnd

Description

To achieve this connection MapleMBSE also use `otherConnectorEnd` virtual feature. This virtual feature can connect between ports or properties of a class, `otherConnectorEnd` automatically create the relation required between the properties being connected and creates appropriate connection.

When MapleMBSE queries the model, the `otherConnectorEnd` return the list of connectorEnds which is associated with the property.

Syntax

The general syntax for using the `otherConnectorEnd` virtual feature is as follows:

```
.alias::otherConnectorEnd
```

Where the `alias` is the alias you assigned to the MapleMBSE ecore.

When the connection is created using `otherConnectorEnd`, the owner of the connected *Property* is determined automatically by MapleMBSE, regardless of whether this is a *Delegation* or *Assembly* type connection.

Using the otherConnectorEnd Virtual Feature

How to use the `otherConnectorEnd` virtual feature is shown in the example below:

1. First, import the MapleMBSE ecore with an appropriate alias
2. Use an `ownedAttribute[Property]` as the queried dimension.
3. Make a reference-query to a property using `mse::`otherConnectorEnd.
4. Complete the `reference-decomposition`.

Example

A specific example of how to use the `otherConnectorEnd` virtual feature is shown below.

```
import-ecore "http://www.nomagic.com/magicdraw/UML/2.5"
import-ecore "http://maplembse.maplesoft.com/common/1.0" as mse
synctable-schema BlocksTable {
        record dim [Class|mse::metaclassName="SysML::Blocks::Block"] {
                key column /name as blockName
        }
        dim /ownedAttribute[Property] {
                key column /name as propertyName
        }
}
synctable-schema OtherConenctorEndTable(bt:BlocksTable){
        record dim[Class|mse::metaclassName="SysML::Blocks::Block"]{
                key column /name as ownerBlockName
        }

        record dim /ownedAttribute[Property]{
                key column /name as pname
        }
        record dim .mse::otherConnectorEnd[ConnectorEnd] {
                key reference-query .role @  cls
                 reference-decomposition cls = bt {
                         foreign-key column BlockName as refRoleBlock
                         foreign-key column PropertyName as refportName
                 }
                 reference-query .partWithPort @ pwp
                 reference-decomposition pwp = bt {
                         foreign-key column BlockName as refPropertyBlock
                         foreign-key column PropertyName as refPropertName
                 }
        }
}
```

Figure 4.2: otherConnectorEnd Example

5 Dependencies

A *Dependency* is used between two model elements to represent a relationship where a change in one element (the supplier element) results in a change to the other element (client element).

A *Dependency* relation can be created between any *namedElement*. Different kinds of *Dependencies* can be created between the model elements such as *Refine*, *Realization*, *Trace*,*Abstraction* etc.,

5.1 clientDependencies

Description

The `clientDependencies` virtual feature creates a relation between the client being the dependent and supplier who provides further definition for the dependent.

Syntax

The general syntax for using the `clientDependencies` virtual feature is as follows:

```
/mse::clientDependencies
```

This virtual feature is used while querying a Class that has to be assiged as client to the dependency that is being created and is used in a following dimension the class that is being querried.

Where `alias` is the alias you assigned to the MapleMBSE ecore.

Using the clientDependencies Virtual Feature

In general, the following steps outline how to use `clientDependencies`:

1. It should be used when a named element is queried
2. Information about the type of relationship is specified as `[Dependency]`, `[Abstraction]` etc.,
3. When querying the model element with `mse::clientDependencies`, the reference decomposition should be to a supplier element.

Example

The example below is an illustration of how to use the `clientDependencies` virtual feature.

```
import-ecore "http://www.nomagic.com/magicdraw/UML/2.5"
import-ecore "http://maplembse.maplesoft.com/common/1.0" as mse

data-source Root[Model]
data-source package = Root/packagedElement[Package|name="Package"]
data-source act = package/packagedElement[Activity]
data-source cls = package/packagedElement[Class]

synctable-schema ActivityTableSchema {
    record dim [Activity] {
        key column /name as ActName
    }
}

synctable-schema ClassAbstractionTableSchema(acts:ActivityTable) {
    record dim [Class] {
        key column /name as ActName1
    }
    record dim /mse::clientDependencies[Dependency] {
        key reference-query .supplier @ refDecomp
            reference-decomposition refDecomp = reqs {
            foreign-key column ActName as AbsName
            }
    }
}

synctable activityTableSchema = ActivityTableSchema<act>
synctable classAbstractionTableSchema = ClassAbstractionTableSchema<cls>(ActivityTable)

worksheet-template ActivityTable(cts:ActivityTableSchema){
    vertical table tab1 at (4,5) = cts{
        key field ActName : String
    }
}

worksheet-template ClassAbstractionTable(cds:ClassAbstractionTableSchema){
    vertical table tab1 at (4,5) = cds{
        key field ActName1 : String
        key field AbsName : String
    }
}
workbook{
    worksheet ActivitiesTable(ActivityTable)
    worksheet ClassAbstractionTable(classAbstractionTableSchema)
}

```

Figure 5.1: clientDependencies Example

5.2 supplierDependencies

Description

Similar to `clientDependencies`, `supplierDependencies` is used to create a relation between two named elements. The only difference between the two virtual features is `supplierDependencies` is used when the relationship has to be made from supplier to client instead of client to supplier, as in the case of `clientDependencies`.

Syntax

The general syntax for using the `supplierDependencies` virtual feature is as follows:

```
/mse::supplierDependencies
```

This virtual feature is used while querying a Class that has to be assiged as supplier to the dependency that is being created and is used in a dimension following the class that is being querried.

Where `alias` is the alias you assigned to the MapleMBSE ecore.

Using the supplierDependencies Virtual Feature

The following example lllustrates what you need to do to use supplierDependencies

1. It should be used when a named element is being queried.
2. Information about the type of relationship is specified as [Dependency], [Abstraction] etc.,
3. When querrying the model element with mse::supplierDependencies the reference decomposition should be to a client element.

Example

```
import-ecore "http://www.nomagic.com/magicdraw/UML/2.5"
import-ecore "http://maplembse.maplesoft.com/common/1.0" as mse

data-source Root[Model]
data-source package = Root/packagedElement[Package|name="Package"]
data-source cls = package/packagedElement[Class|mse::metaclassName="SysML::Requirements::Requirement"]

synctable-schema RequirementsTableSchema {
    record dim [Class|mse::metaclassName="SysML::Requirements::Requirement"] {
        key column /name as ReqName
    }
}

synctable-schema RequirementsDerivesTableSchema(reqs:RequirementsTable) {
    record dim [Class|mse::metaclassName="SysML::Requirements::Requirement"]    {
        key column /name as ReqName1
    }
    record dim /mse::supplierDependencies[Abstraction|mse::metaclassName="SysML::Requirements::DeriveReqt"] {
        key reference-query .client @ reqDecomp
        reference-decomposition reqDecomp = reqs {
            foreign-key column ReqName as DeriveName
        }
    }
}

synctable requirementsTableSchema = RequirementsTableSchema<cls>
synctable requirementsDerivesTableSchema = RequirementsDerivesTableSchema<cls>(requirementsTable)

worksheet-template ReqClassTable(cts:RequirementsTableSchema){
    vertical table tab1 at (4,5) = cts{
        key field Name : String
    }
}

worksheet-template ReqClassDependency(cds:RequirementsDerivesTableSchema){
    vertical table tab1 at (4,5) = cds{
        key field Name1 : String
        key field DeriveName : String
    }
}

workbook{
    worksheet ReqClassTable(requirementsTableSchema)
    worksheet ReqClassDependency(requirementsDerivesTableSchema)
}
```

Figure 5.2: supplierDependencies Example

6 Util

This section contains all other virtual features that do not create elements but offer a better alternative to access and map model information.

6.1 multiplicityProperty

Description

The UML specification contains several *MultiplicityElements* like *Properties* that have *upper* and *lower* features to describe their multiplicity. Use the **`multiplicityProperty`** virtual feature to make a configuration that translates a string into those *upper* and *lower* values and the other way around.
This virtual feature recognizes the UML commonly used notation for multiplicity (e.g. 0..*). Supporting this notation makes MapleMBSE much easier to use without adding complexity and thus the final user has less to input into Excel.

Syntax

The general syntax for using the `multiplicityProperty` virtual feature is as follows:

`/alias::multiplicityProperty`

Where the `alias` is the alias you assigned to the MapleMBSE ecore.

This virtual feature can only be used while querying a concrete *EClass* implementing a *MultiplicityElement* like a *Property* or a *Pin*. A slash notation is needed prior to the alias, the 2 colons, and **`multiplicityProperty`**.

As mention previously `multiplicityProperty` uses a string to represent the multiplicity, meaning that this particular virtual feature cannot being used as a dimension with a qualifier. It is intended to be used only at a column declaration.

Using the multiplicityProperty Virtual Feature

The following example shows you how to map the multiplicity of a concrete *MultiplicityElement* like *Property* and a string.

1. Import the MapleMBSE ecore, as usual the alias used is `mse`
2. Inside a syntable-schema navigate to a *MultiplicityElement*, in this case */ownedAttribute[Property]* within a *Class*
3. Within that dimension, define a regular column using `/mse::multiplicityProperty`

4. Complete the rest of the configuration as usual: `worksheet-templates`, `synctable` and `workbook`

Example

```
import-ecore "http://www.nomagic.com/magicdraw/UML/2.5"
import-ecore "http://maplembse.maplesoft.com/common/1.0" as mse

data-source Root[Model]
data-source classes = Root/packagedElement[Class]

synctable-schema Schema {
    record dim [Class] {
        key column /name as cName
    }

    record dim /ownedAttribute[Property] {
        key column /name as pName
        column /mse::multiplicityProperty as multiplicity
    }
}

worksheet-template Template(sch: Schema) {
    vertical table tab1 at (2, 2) = sch {
        key field cName : String
        key field pName : String
        field multiplicity : String
        sort-keys cName, pName
    }
}

synctable tableProperty = Schema<classes>

workbook {
    worksheet Template(tableProperty)
}
```

Figure 6.1: multiplicityProperty Example

7 Activity Diagrams

An Activity Diagram is a diagram with a direct connection, ActivityEdge that connects a node, ActivityNode to another ActivityNode. An Activity Diagram is useful to abstract behavioral information within a system. In order to improve MSE configurations, MapleMBSE supports control and object flow, the 2 kind of ActivityEdges, with 2 distinct virtual features.

7.1 ActivityControlFlow

Description

A *ControlFlow* is an *ActivityEdge* that is used to control the execution of *ActivityNodes* within an Activity. Note that MapleMBSE will fail to instantiate abstract classes like ActivityNode and it will be required to instantiate instead concrete classes like *CallAction-Behavior*, *ActivityParameterNode* or *InitialNode*. Nonetheless, *ActivityNodes* can be used as a reference to create *ControlFlows. S*ee the example section for further details.

Syntax

The general syntax for using the `activityControlFlow` virtual feature is as follows:
`.alias:: activityControlFlow`
Where `alias` is the alias you assigned to the MapleMBSE ecore. For more information on assigning aliases, see Introduction#LoadingVF

The `activityControlFlow` virtual feature must be used when querying the *ActivityNode* of Activity.

Using the ActivityControlFlow Virtual Feature

The following example illustrates what you need to do to use `activityControlFlow` virtual feature:

1. Import the `maplembse ecore` with an alias.
2. Create an schema that navigates till an *ActivityNode* or which first dimension is an *ActivityNode*.
3. Make a dimension `reference-query` to another *ActivityNode* using `.mse::activityControlFlow.`
4. Complete the `reference-decomposition`.

This example has extra schema, `CallBehaviorActionSchema` used to create concrete *ActivityNodes*. The other schemas in this example will fail to instantiate *Element* because *ActivityNode* is an abstract class.

Note: Some data sources specific to a fictional project were created to simplify the `reference-decomposition`. In a real life scenario you might need to identify the *Package*, the *Activity* and the *ActivityNode* that you want to connect to.

Example

```
import-ecore "http://www.nomagic.com/magicdraw/UML/2.5"
import-ecore "http://maplembse.maplesoft.com/common/1.0" as mse

data-source Root[Model]
data-source pkg = Root/packagedElement[Package|name = "controlflow"]
data-source activities = pkg/packagedElement[Activity|name="activity"]
data-source nodes = activities/node[ActivityNode]
data-source cba = activities/node[CallBehaviorAction]

synctable-schema NodeSchema {
    dim [ActivityNode] {
        key column /name as nName
    }
}

synctable-schema CallBehaviorActionSchema {
    dim [CallBehaviorAction] {
        key column /name as nName
    }
}

worksheet-template CallBehaviorActionTemplate (cbasc: CallBehaviorActionSchema) {
    vertical table tab1 at (2, 1) = cbasc {
        key field nName
    }
}

synctable-schema Schema(nsc: NodeSchema) {
    dim [ActivityNode] {
        key column /name as nName
    }

    dim .mse::activityControlFlow[ActivityNode] @ tgtNode {
        reference-decomposition tgtNode = nsc {
            foreign-key column nName as tgtNode
        }
    }
}
```

Figure 7.1: ActivityControlFlow Example

7.2 ActivityObjectFlow

Description

An *ObjectFlow* is an *ActivityEdge* that is used to represent the flow of an object between *ActivityNodes* within an *Activity*. Due to some UML specifications, some *ActivityNodes* cannot be connected directly with an *ObjectFlow;* they required *Pins*. In parallel to those *Pins*, if one of those *ActivityNodes* is a *CallBehaviorAction* further detailed using another *Activity*, and then the following Objects must be synchronized in number and direction: Pins, ActivityParameterNode and Parameters. This synchronization is automatically supported by MapleMBSE so be aware of the creation of those Elements.

Syntax

The general syntax for using the `activityObjectFlow` virtual feature is as follows:
`.alias:: activityObjectFlow`
Where alias is the alias you assigned to the MapleMBSE ecore. For more information on assigning aliases, see *Introduction (page 1)*.
The `activityObjectFlow` virtual feature must be used when querying the *ActivityNode* of *Activity*.

Using the ActivityObjectFlow Virtual Feature

The following example illustrates what you need to do to use `activityObjectFlow` virtual feature:

1. Import the `maplembse ecore` with an alias.
2. Create a schema that navigates till an *ActivityNode* or which first dimension is an ActivityNode.
3. Make a dimension `reference-query` to another *ActivityNode* using `.mse:: activityObjectFlow`.
4. Complete the reference-decomposition.

Example

```
import-ecore "http://www.nomagic.com/magicdraw/UML/2.5"
import-ecore "http://maplembse.maplesoft.com/common/1.0" as mse

data-source Root[Model]
data-source pkg = Root/packagedElement[Package|name = "objectflow"]
data-source activities = pkg/packagedElement[Activity|name="activity"]
data-source nodes = activities/node[ActivityNode]

synctable-schema NodeSchema {
    dim [ActivityNode] {
        key column /name as nName
    }
}

synctable-schema Schema(nsc: NodeSchema) {
    dim [ActivityNode] {
        key column /name as nName
    }

    dim .mse::activityObjectFlow[ActivityNode] @ tgtNode {
        reference-decomposition tgtNode = nsc {
            foreign-key column nName as tgtNode
        }
    }
}

worksheet-template Template (sc: Schema) {
    vertical table tab1 at (2, 1) = sc {
        key field nName
        key field tgtNode
    }
}

synctable nodeTable = NodeSchema<nodes>
synctable controlFlowTable = Schema<nodes>(nodeTable)

workbook {
    worksheet Template(controlFlowTable)
}
```

Figure 7.2: ActivityObjectFlow Example

8 StateMachines

StateMachine diagrams are used to define the different states that a system will exist in. This kind of diagram helps modelers to describe discrete, event-driven behaviors of the whole system or its parts.

8.1 VertexTransition

Description

MapleMBSE, in order to simplify *Transition* between *Vertexes,* supports a `vertexTransition` virtual feature that allows a better end user experience while inputting data.Note that MapleMBSE will fail to instantiate abstract classes like *Vertex* and it will be required to instantiate instead concrete classes like *Pseudostate*, *State* or *FinalState*. Nonetheless, *Vertex* can be used as reference to create *Transitions.* See the example section for further details.

Syntax

The general syntax for using the `vertexTransition` virtual feature is as follows:
`.alias:: vertexTransition`
Where `alias` is the alias you assigned to the MapleMBSE ecore. For more information on assigning aliases, see *Importing the MapleMBSE Ecore (page 3)*.
The `vertexTransition` virtual feature must be used when querying the any kind of *Vertex* within a given *Region* of a *StateMachine*.

Using the VertexTransition Virtual Feature

The following example illustrates what you need to do to use the `vertexTransition` virtual feature:

1. Import the maplembse ecore with an alias.
2. Create an schema that navigates till an Vertex or which first dimension is an Vertex.
3. Make a dimension reference-query to another Vertex using .mse:: vertexTransition.
4. Complete the reference-decomposition.

This example has some extra schema, called `StateSchema`, used to create concrete *States*. The other schemas in this example will fail to instantiate *Element* because *Vertex* is an abstract class.
Note: some data sources specific to a fictional project were create in order to simplify the `reference-decomposition`, in a real life scenario you might need to identify the *Package*, the *StateMachine*, the *Region* and the *Vertex* that you want to connect to.

Example

```
import-ecore "http://www.nomagic.com/magicdraw/UML/2.5"
import-ecore "http://maplembse.maplesoft.com/common/1.0" as mse

data-source Root[Model]
data-source pkg = Root/packagedElement[Package|name="statemachine"]
data-source stm = pkg/packagedElement[StateMachine|name="stm"]
data-source rg = stm/region[Region|name="rg"]
data-source vertexes = rg/subvertex[Vertex]
data-source states = rg/subvertex[State]

synctable-schema VertexSchema {
    dim [Vertex] {
        key column /name as vName
    }
}

synctable-schema StateSchema {
    dim [State] {
        key column /name as sName
    }
}

worksheet-template StateTemplate(ssc: StateSchema) {
    vertical table tab1 at (2, 1) = ssc {
            key field sName
    }
}

synctable-schema Schema(vsc: VertexSchema) {
    dim [Vertex] {
        key column /name as vName
    }

    dim .mse::vertexTransition[Vertex] @ tgtRef {
        reference-decomposition tgtRef = vsc {
            foreign-key column vName as tgtVertex
        }
    }
}

worksheet-template Template(sc: Schema) {
    vertical table tab1 at (2, 1) = sc {
            key field vName
            key field tgtVertex
    }
}

synctable vertexTable = VertexSchema<vertexes>
synctable stateTable = StateSchema<states>
synctable transitionTable = Schema<vertexes>(vertexTable)

workbook {
    worksheet StateTemplate(stateTable)
    worksheet Template(transitionTable)
}
```

Figure 8.1: VertexTransition Example