SYSML PLUGIN

version 17.0.1

user guide

No Magic, Inc.

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CONTENTS

CONTENTS

CONTENTS

SYSML PLUGIN FOR MAGICDRAW

1. Introduction

Systems Modeling Language (SysML) is designed to unify the diverse modeling languages currently used by system engineers, the same way Unified Modeling Language (UML) is used in the software industry to unify the modeling languages used by software engineers.

SysML supports the specifications, analysis, designs, verifications, and validations of a broad range of complex systems.

In addition to supporting all SysML diagrams (Block Definition, Internal Block, Package, Parametric, Requirement, Activity, and Use Case diagrams), SysML Plugin also makes it possible for MagicDraw to support additional specifications, analysis, designs, and validations on a broader range of systems and system integrations.

SysML sample projects are available in the ***<md.install.dir>/samples/SysML*** directory.

2. Installation

To install SysML Plugin, either (i) follow the manual installation instructions if you have already downloaded the plugin, or (ii) use Resource/Plugin Manager in MagicDraw to download and install the plugin.

(i) To install SysML Plugin following the manual installation instructions on all platforms:

1. Download the **SysML_Plugin_<version number>.zip** file.
2. Exit the MagicDraw application currently running.
3. Extract the content of **SysML_Plugin_<version number>.zip** file to the directory where your MagicDraw is installed, i.e. ***<md.install.dir>***.
4. Restart the MagicDraw application.

(ii) To install SysML Plugin using Resource/Plugin Manager:

1. Click **Help** > **Resource/Plugin Manager** on the MagicDraw main menu. The **Resource/Plugin Manager** will appear and prompt you to check for available updates and new resources. Click **Check for Updates** > **Check**.

NOTE	Specify HTTP Proxy Settings for connection to start MagicDraw updates and resources.

2. Select the **SysML Plugin** check box and click **Download/Install**.
3. Restart the MagicDraw application.

3. System Engineer Perspective

In keeping with SysML unifying purpose, the System Engineer perspective was created to unify the diverse modeling languages currently used by system engineers. All the features dedicated to SysML are accessible.

What you will have to do to access the System Engineer perspective depends on whether you are:

(i) launching MagicDraw for the first time after SysML Plugin has been installed or,

(ii) switching to the System Engineer perspective from any other perspectives.

(i) If you are launching MagicDraw for the first time:

1. The following message dialog will open (Figure 1).
2. Click **Yes** to switch to the System Engineer perspective supporting SysML diagrams.

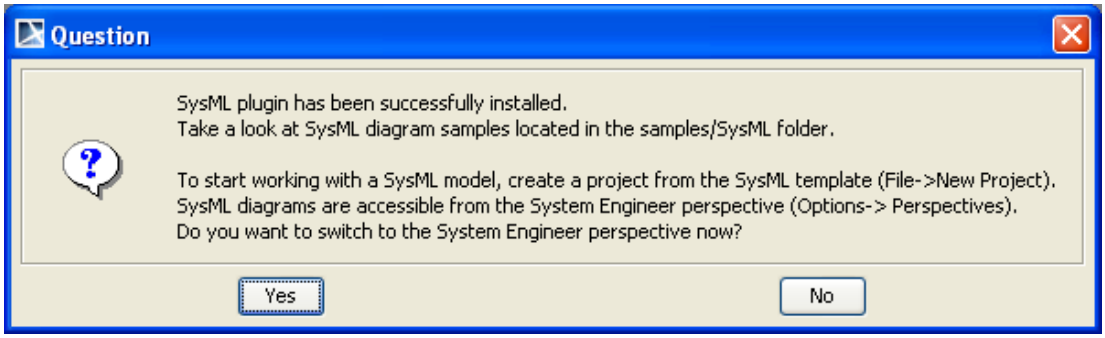


Figure 1 -- Launching MagicDraw with SysML Plugin Message Dialog

(ii) To switch to the System Engineer perspective from any other perspectives:

1. Click **Options** > **Perspectives > Perspectives** on the MagicDraw main menu.
2. Select **System Engineer** from the **Select Perspectives** dialog and click **Apply** (Figure 2).

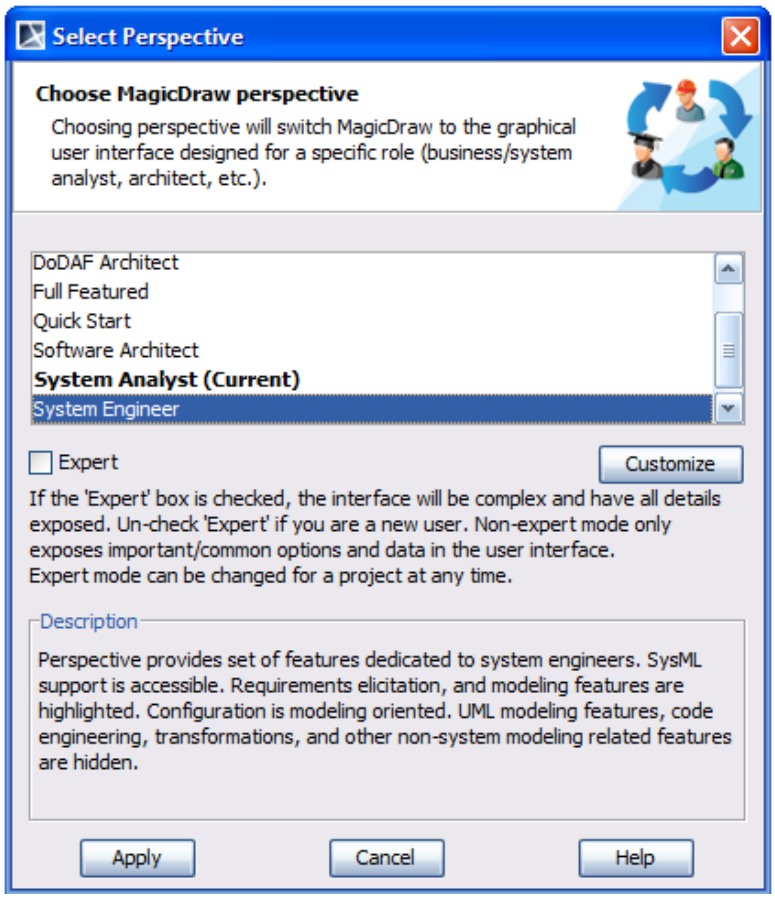


Figure 2 -- Select Perspectives Dialog

For more information on how to work with perspectives, see *Perspectives Selection and Customization* in the 'Getting Started' section in the MagicDraw User Manual.

4. Working with SysML Projects

Depending on whether you want to:

(4.1) Creating Blank SysML Project;

(4.2) Creating New SysML Project from Specified Template;

(4.3) Using OMG SysML Style

(4.4) Using QUDV Model Library; or

(4.5) Using Quick Search Dialog,

you will have to follow different procedures.

4.1 Creating Blank SysML Project

To create a new workspace for a blank project:

1. You can;
   (i) click **File** > **New Project** on the MagicDraw menu,
   (ii) click the **New Project** button on the main toolbar, or
   (iii) press **CTRL+N** (keyboard shortcut).
   The **New Project** dialog will open (Figure 3).
2. Click the **SysML Project** icon (Figure 3).
3. Enter the file name in the **Name** box.
4. Click the "**...**" button to locate where to store the newly-created project.
5. Click **OK**.
   If the current perspective is not set to 'System Engineer' perspective, the Open Associated Perspective dialog will open (Figure 4). Select **Yes** to set the current perspective to System Engineer to start model SysML.

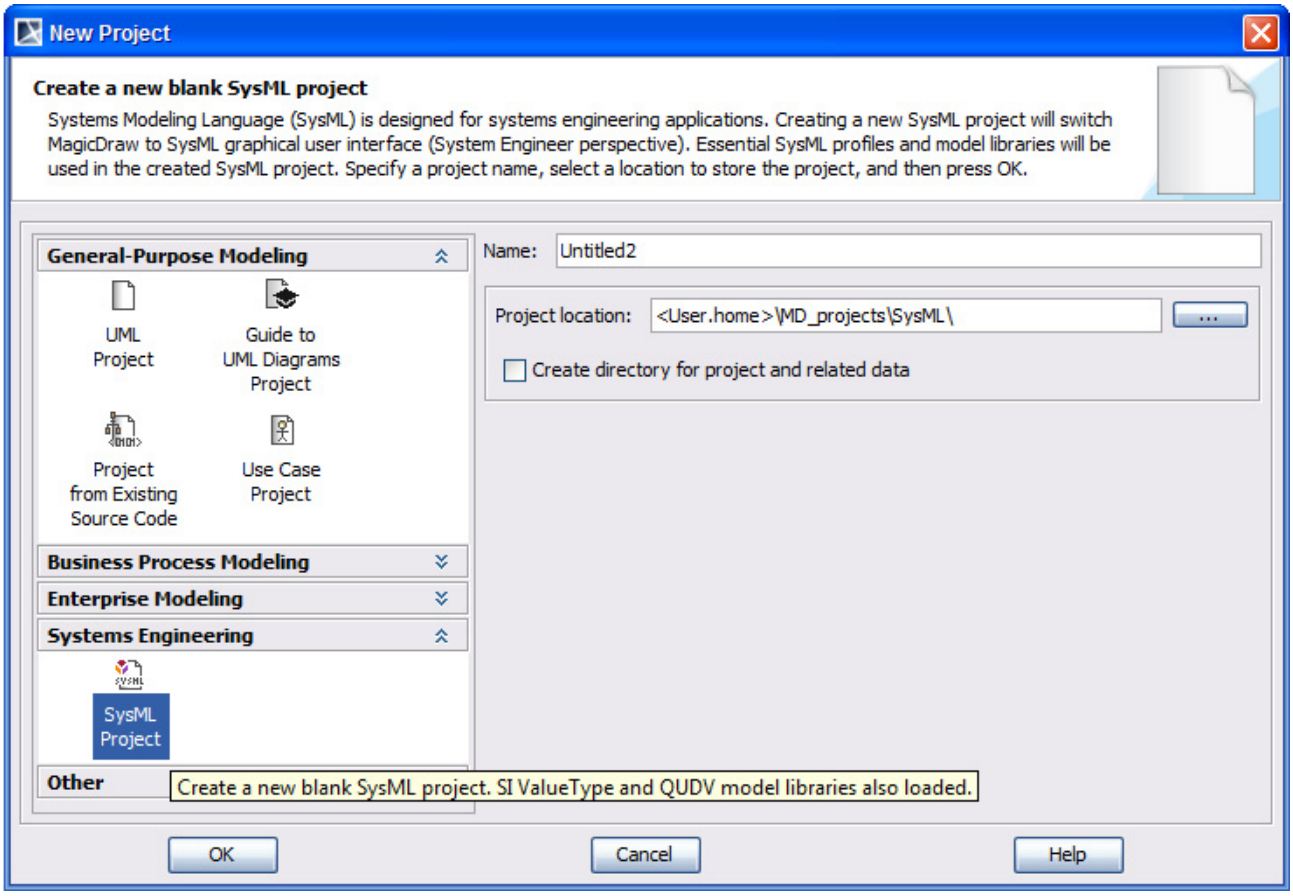


Figure 3 -- New Project Dialog

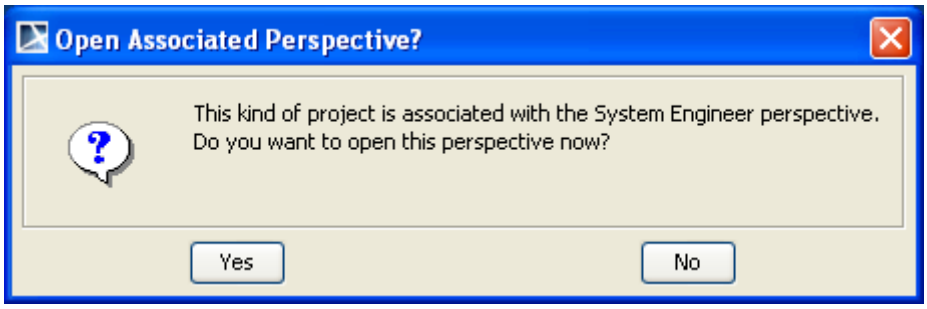


Figure 4 -- Open Associated Perspective dialog

4.2 Creating New SysML Project from Specified Template

To create a new SysML project from a specified template:

1. You can:
   (i) click **File** > **New Project** on the MagicDraw menu,
   (ii) click the **New Project** button on the main toolbar, or
   (iii) press **CTRL+N**.
   The **New Project** dialog will open (Figure 5).
2. Click the **Project from Template** icon (Figure 5).
3. Enter the file name in the **Name** box.

4. Click the "**...**" button to locate where to store the newly created project.
5. Select the **SysML** template from the **Select template** tree and click **OK** (Figure 5).

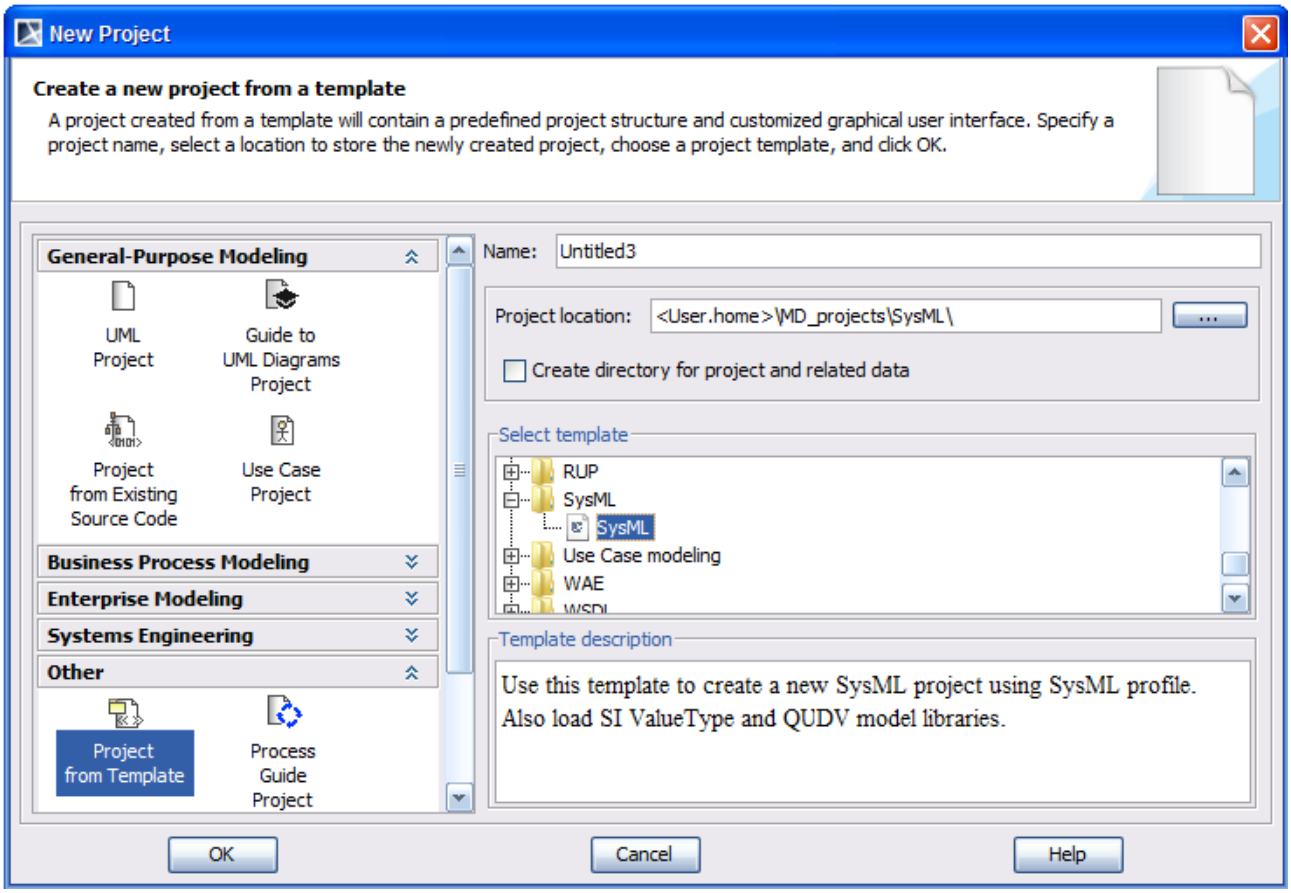


Figure 5 -- Selecting SysML Template

For more information on how to work with a new project, see the 'Working with Projects' section in the MagicDraw User Manual.

4.3 Using OMG SysML Style

SysML plugin provides the visual style of OMG SysML specifications (OMG SysML style) for using with your SysML model. Such style is available with every new SysML project created by SysML 16.8 or newer.

To use OMG SysML style in a new SysML project:

1. Create a new SysML project (see 4.1 Creating Blank SysML Project or 4.2 Creating New SysML Project from Specified Template).
2. On the main menu, select **Options > Project**.
3. The **Project Options** dialog will then display.
4. Select **Symbols properties styles** node (on the left), and then select the **OMG SysML style** in the **Symbols properties styles** panel (on the right), as displayed in Figure 6.
5. Press **Make Default** button, and then press **OK**.
6. The OMG SysML style is now used as default in your SysML project.

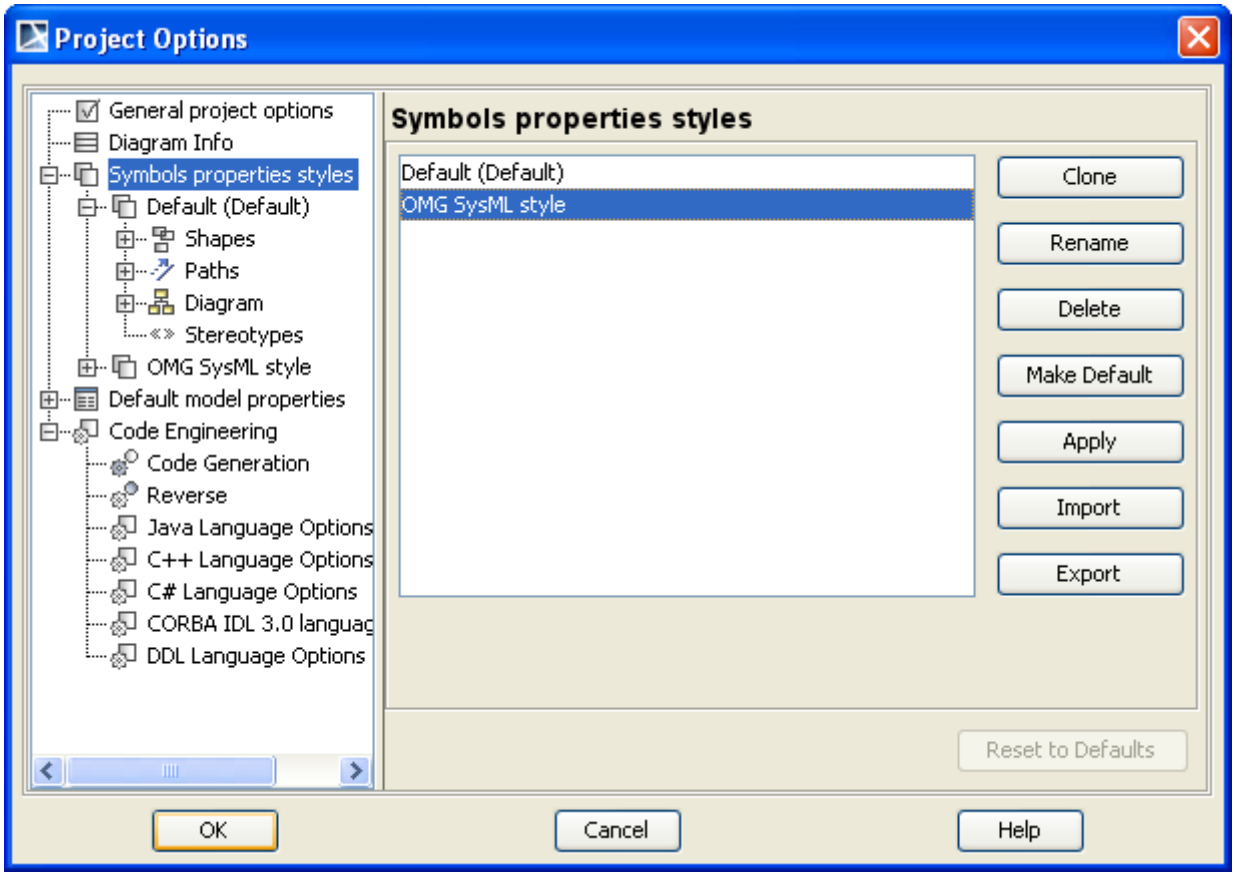


Figure 6 -- Project Options Dialog - Set Symbol Properties Style

To apply OMG SysML style to an existing SysML project:

1. Open the SysML project.
2. On the main menu, select **Options > Project**.
3. The **Project Options** dialog will then display.
4. Select **Symbols properties styles** node (on the left), as displayed in Figure 6.
5. In the **Symbols properties styles** panel (on the right), if the **OMG SysML style** is not available, press **Import** button. The **Open** dialog will then open (Figure 7). In the dialog, select **OMG SysML style.stl** located in ***<md.install.dir>/templates/SysML*** directory, and then press **Open**. Select the style in the **Symbols properties styles** panel.

   OR

   If the **OMG SysML style** is available in the **Symbols properties styles** panel (Figure 6), just select it.

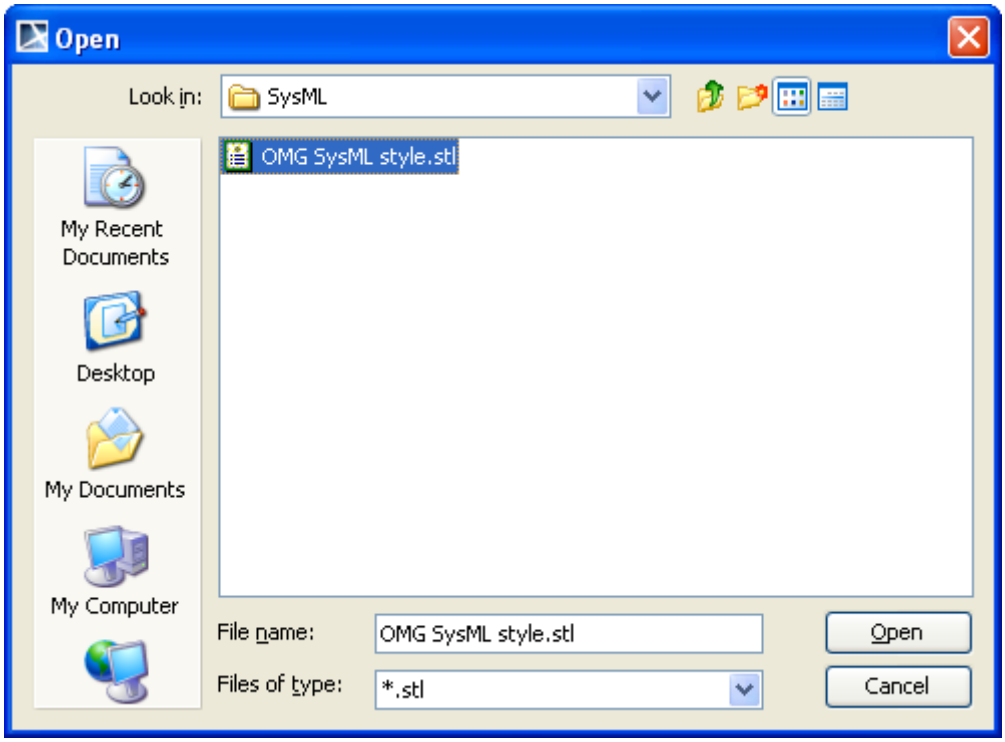


Figure 7 -- Open Dialog - Importing OMG SysML Style

6. Press **Make Default** button, and then press **OK**.
7. The OMG SysML style is now used as default in your SysML project. However, such style will be applied only to new SysML diagrams yet to be created.
8. If you would like to also apply such style to existing SysML diagram(s), open the **Project Options** dialog (Figure 6) again, select the style in the **Symbols properties styles** panel, and then press **Apply** button. The **Select Diagrams** dialog will then display (Figure 8).

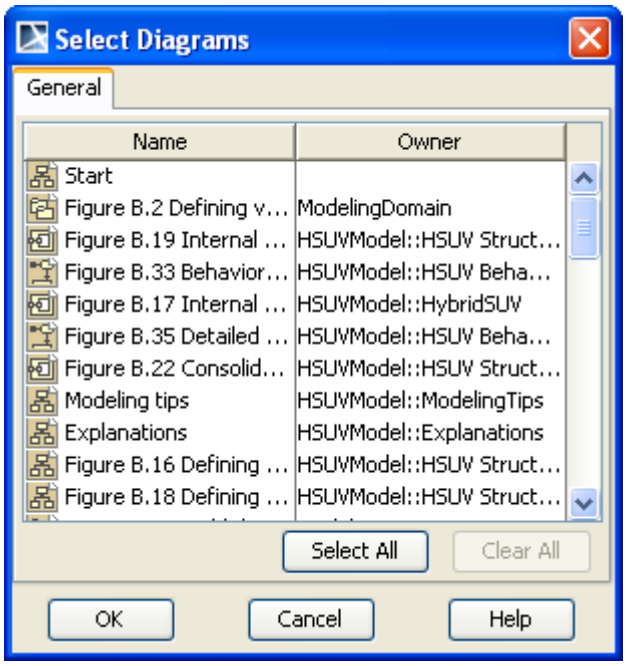


Figure 8 -- Select Diagrams Dialog - Applying OMG SysML Style to Diagrams

9. Select the SysML diagram(s) the OMG SysML style will be applied to, and then press **OK**. In the **Project Options** dialog, press **OK**.

NOTE	Applying OMG SysML style to existing SysML diagrams might distort the look of those diagrams. For quick diagram look modification, use the **Layout** feature in MagicDraw, available in the main menu.

4.4 Using QUDV Model Library

QUDV model library is introduced in Annex C: Non-normative Extensions, OMG SysML Specifications 1.2. This model library is designed in such a way that extensions to the ISQ and SI can be represented, as well as any alternative systems of quantities and units.

See 13. Model Library for Quantities, Units, Dimensions and Values (QUDV) for more detail on the model library in SysML plugin.

4.5 Using Quick Search Dialog

To open the Quick Search dialog using a keyboard shortcut:

1. Press **Crtl** + **Alt** + **F** to open the **Quick Search** dialog (Figure 9).

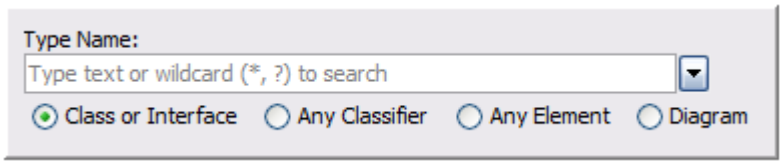


Figure 9 -- Quick Search Dialog

2. Either (i) enter the name of the element or diagram sought or (ii) select the element or diagram from the drop-down list box.
3. The diagram will open or the corresponding element will open in the Containment Tree.

5. SysML Diagrams

SysML Plugin supports the following SysML diagrams:

- SysML Block Definition Diagrams (BDD)
- SysML Internal Block Diagrams (IBD)
- SysML Package Diagrams
- SysML Parametric Diagrams
- SysML Requirement Diagrams
- SysML Activity Diagrams
- SysML Use Case Diagrams

- SysML Sequence Diagrams (similar to UML's one)
- SysML StateMachine Diagrams (similar to UML's one)

For more information on how to work with SysML diagrams, see the 'Working with Diagrams' section in the MagicDraw User Manual.

5.1 SysML Block Definition Diagrams (BDD)

A Block Definition Diagram defines the features of a block and any relationships between blocks such as associations, generalizations, and dependencies, in terms of properties, operations, and relationships (for example, a system hierarchy or a system classification tree).

Block Definition Diagrams are based on UML class diagrams and include restrictions and extensions as defined by SysML. They are generally used to display systems of blocks or show a system dictionary and/or extensions.

5.1.1 SysML BDD Metamodel and Elements

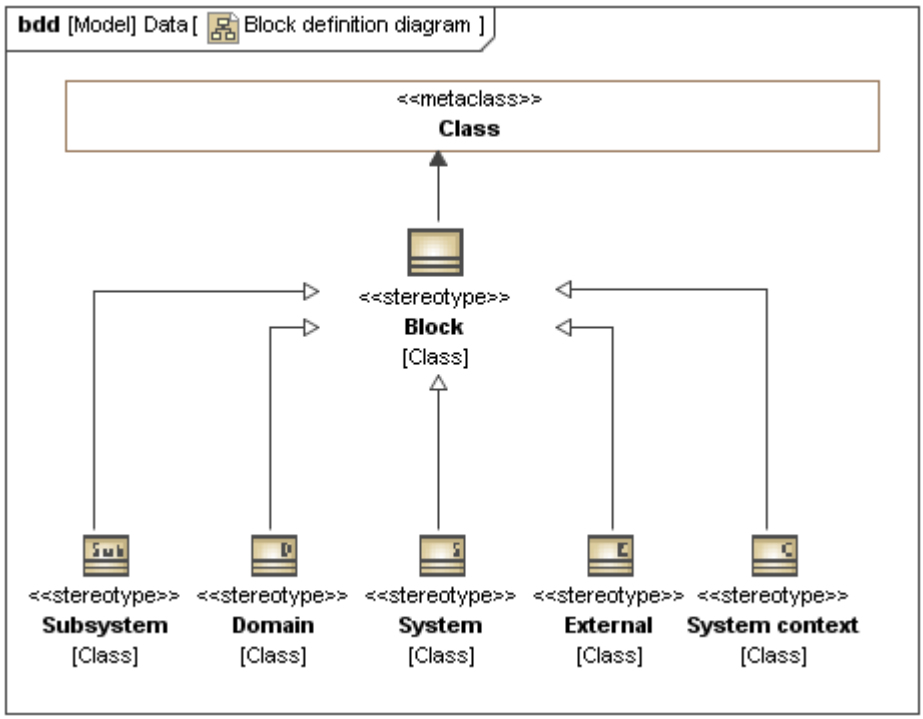


Figure 10 -- Block Element and MagicDraw SysML Block Subtypes Metamodel

Icon	Description
	**Block [SysML]:** Blocks provide a general purpose capability to describe the architecture of a system, and represent the system hierarchy in terms of systems and subsystems. Blocks describe not only the connectivity relationships within / between a system and its subsystems, but also quantitative values as well as other information about that system (for example, documentation).

Icon	Description
	Domain: A Domain block represents an entity, a concept, a location, or a person from the real-world domain. A domain block is part of the system knowledge [1].
	External: An External block is a block that represents an actor. It facilitates a more detailed modeling of actors like ports or internal structures [1].
	System: A System is an artificial artifact consisting of blocks that pursue a common goal which cannot be achieved by the system's individual elements. A block can be a software, hardware, a person, or an arbitrary unit [1].
	Subsystem: A Subsystem is a typically large, encapsulated block within a larger system [1].
	System Context: A System context element is a virtual container that includes the entire system and its actors [1].

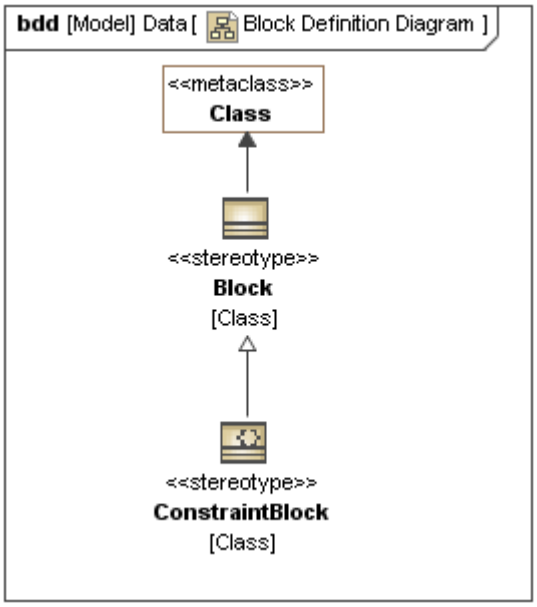


Figure 11 -- Constraint Block Metamodel

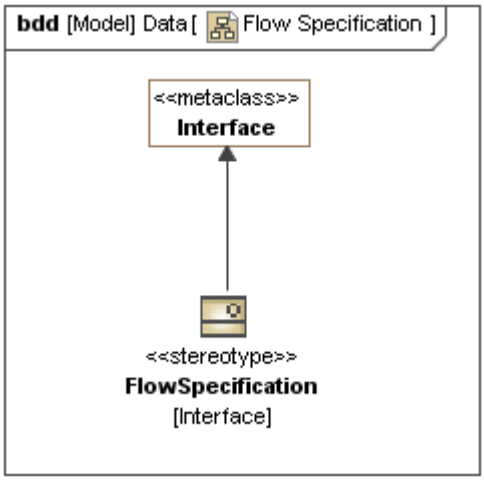


Figure 12 -- Flow Specification Metamodel

Icon	Description
	Constraint Block [SysML]: Constraint Blocks provide a mechanism to integrate engineering analysis, such as performance and reliability models, with other SysML models. Constraint Blocks can be used to specify a network of constraints representing mathematical expressions, which constrain the physical properties of a system. Constraint Blocks are generally defined in Block Definition Diagrams, and then used in Parametric diagrams.

Icon	Description
	**Flow Specification [SysML]:** A Flow Specification specifies inputs and outputs that can flow through a port in terms of Flow properties. Flow Specifications are used by Flow Ports to specify what items can flow via those ports.
	**Interface [UML]:** An Interface specifies operations or signals. If an Interface is provided to a port, the external parts may call operations or send signals to the Block owning the port via that port. If an Interface is required for a port, the Block owning the port may call operations or send signals to its environment via that port.

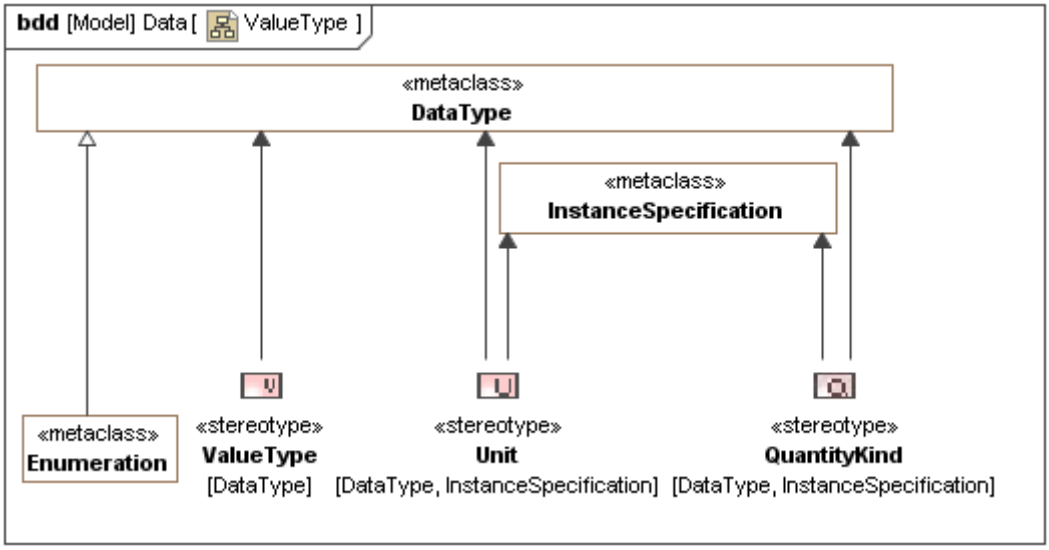


Figure 13 -- Value Type, Unit, and Quantity Kind Metamodels

Icon	Description
	**Value Type [SysML]:** A Value Type is a type which defines values that can be used to provide information on a system, but cannot be identified as the target of any reference. These values may be used to type properties, operation parameters, or, potentially, other elements within SysML.
	**Quantity Kind [SysML]:** A Quantity Kind (in SysML 1.0 and 1.1, called 'Dimension') is a kind of quantity that can be measured using defined and unrestricted units of measurement. For example, length, a quantity kind, may be measured by meter, kilometer, or foot units.
	**Unit [SysML]:** A Unit is a particular value that can be used to specify a quantity of a dimension. A unit often relies on precise and reproducible measuring techniques. For example, a unit of length such as meter may be specified as a multiple of a particular wavelength of light. A unit can also use less stable or precise ways to express some values, such as costs expressed in some currencies, or a severity rating measured by a numerical scale.

Icon	Description
	**Data Type [UML]:** A Data Type is a type whose instances are identified only by their values. A typical use of Data Types would be to represent the primitive types of the programming language used. For example, integer and string types are often treated as data types.
	**Enumeration [UML]:** An Enumeration is a kind of Data Type whose instances may be any of the user-pre-defined enumeration literals. It is possible to extend the set of applicable enumeration literals to other packages or profiles.

5.1.2 SysML BDD Toolbar

Element	Button (hot key)
Block: See Section 5.1.1 for description.	 (B)
Structured Block [SysML]: A Structured block is a Block element that contains an Internal Block Diagram and a hyperlink to it.	 (SHIFT + B)
Constraint Block: See Section 5.1.1 for description.	
Domain: See Section 5.1.1 for description.	
External: See Section 5.1.1 for description.	
Subsystem: See Section 5.1.1 for description.	
System: See Section 5.1.1 for description.	
System Context: See Section 5.1.1 for description.	
Value Type: See Section 5.1.1 for description.	
Data Type: See Section 5.1.1 for description.	
Quantity Kind: See Section 5.1.1 for description.	

Element	Button (hot key)
Unit: See Section 5.1.1 for description.	
Enumeration: See Section 5.1.1 for description.	 (K)
Instance [UML]: To create an instance specification of a classifier.	 (SHIFT + O)
Interface: See Section 5.1.1 for description.	 (I)
Flow Specification: See Section 5.1.1 for description.	
Port [UML]: A Port defines an interaction point on a Block or a part, allowing you to specify what can flow in/out of the Block/part or what services the block/part requires (expects) from or provides (offers) to its environment. Ports are connected by connectors to other parts or other ports.	
Flow Port [SysML]: A Flow Port is a port that specifies the input and output items that can flow between a Block and its environment. Flow Ports are interaction points through which data, material, or energy “can” enter or leave the owning Block. The specification of what can flow is achieved by typing the Flow Port with a specification of things that flow. This can include typing an atomic Flow Port with a single type (Block, Value Type, or Signal) representing the items that flow in or out, or typing a non-atomic Flow Port with a Flow Specification which lists multiple items that can flow. In general, Flow Ports are intended to be used for asynchronous, broadcast, or send-and-forget interactions. Note that only non-atomic Flow Ports can be conjugated. Once conjugated, all the directions of the typing Flow Specification's items will be negated.	
Interface Realization [UML]: An Interface Realization is a specialized Realization relationship between a Classifier and an Interface. This relationship signifies that the realizing classifier conforms to the contract specified by the Interface.	 (R)
Link [UML]: A Link is a connection between two objects.	 (SHIFT + L)
Association Block [SysML]: An Association Block is an Association Class (a kind of Association) stereotyped by «Block». Like any other Block, an Association Block can own properties and connectors.	

Element	Button (hot key)
Association [UML]: An Association represents a semantic relationship between two classifiers. It is used for referencing two Blocks with one another, thus creating two Reference Properties at both ends. The aggregation values of the both ends of an Association are 'none'.	 (S)
Directed Association [UML]: A Directed Association is a one-direction Association which references from a Block to another Block, thus creating one Reference Property, typed by the target Block, in the source end. The aggregation value of the target end of a Directed Association is 'none'.	
Aggregation [UML]: An Aggregation is a special form of Association that specifies a part-whole relationship from an ‘aggregate’ (whole / source) to a ‘component part’ (target). Creating an Aggregation will also create a Shared Property, typed by the ‘component part’, in the ‘aggregate’ and a Reference Property, typed by the ‘aggregate’, in the ‘component part’. The aggregation values of the target and source ends are 'shared' and 'none', respectively.	 (A)
Directed Aggregation [UML]: A Directed Aggregation is a one-direction Aggregation relationship which references from a Block ('aggregate') to another Block ('component part'), thus creating one Shared Property, typed by the 'component part', in the 'aggregate'. The aggregation value of the target end of a Directed Aggregation is 'shared'.	
Composition [UML]: A Composition is a special form of Aggregation which requires that a part of a Block instance be included in, at most, one composite object at a time. The composite object is responsible for the creation and destruction of its parts. In other words, a Composition specifies a 'strong' part-whole relationship from a ‘composite’ (whole / source) to a ‘composite part’ (target). Creating a Composition will also create a Part Property, typed by the ‘composite part’, in the ‘composite’ and a Reference Property, typed by the ‘composite’, in the ‘composite part’. The aggregation values of the target and source ends are 'composite' and 'none', respectively.	 (F)
Directed Composition [UML]: A Directed Composition is a one-direction Composition relationship which references from a Block ('composite') to another Block ('composite part'), thus creating one Part Property, typed by the 'composite part', in the 'composite'. The aggregation value of the target end of a Directed Composition is 'composite'.	
Generalization [UML]: A Generalization is a taxonomic relationship between a more general classifier and a more specific one. Each instance of the specific classifier is also an indirect instance of the general classifier. Thus, the specific classifier indirectly has the features of the general classifier.	 (G)
Usage [UML]: A Usage is a dependency in which one element (the client) requires the presence of another element (the supplier) for its correct functioning or implementation.	 (U)

[1] Stereotypes taken from the SYSMOD process: `http://www.sysmod.de` by Tim Weilkiens, OOSE

5.1.3 SysML BDD Specific Features

SysML BDD specific features includes:

(i) Inserting a New SysML Property Using One of the Block Menus
(ii) Inserting a New SysML Diagram Using the Block Shortcut Menu
(iii) SysML-Style Compartments
(iv) Creating an Association Block
(v) Creating a SysML Internal Block Diagram Using the Smart Manipulator Button

(i) Inserting a New SysML Property Using One of the Block Menus

You can create a new SysML property from the:

(a) Block shortcut menu (Figure 14)
(b) Block Smart Manipulator menu (Figure 15 and 16)

(a) To create a new SysML property using the Block shortcut menu:

1. Right-click a block and select **Insert New SysML Property** from the shortcut menu (Figure 14).
2. Select a SysML property that will be created.
3. Enter the name of the newly-created property.

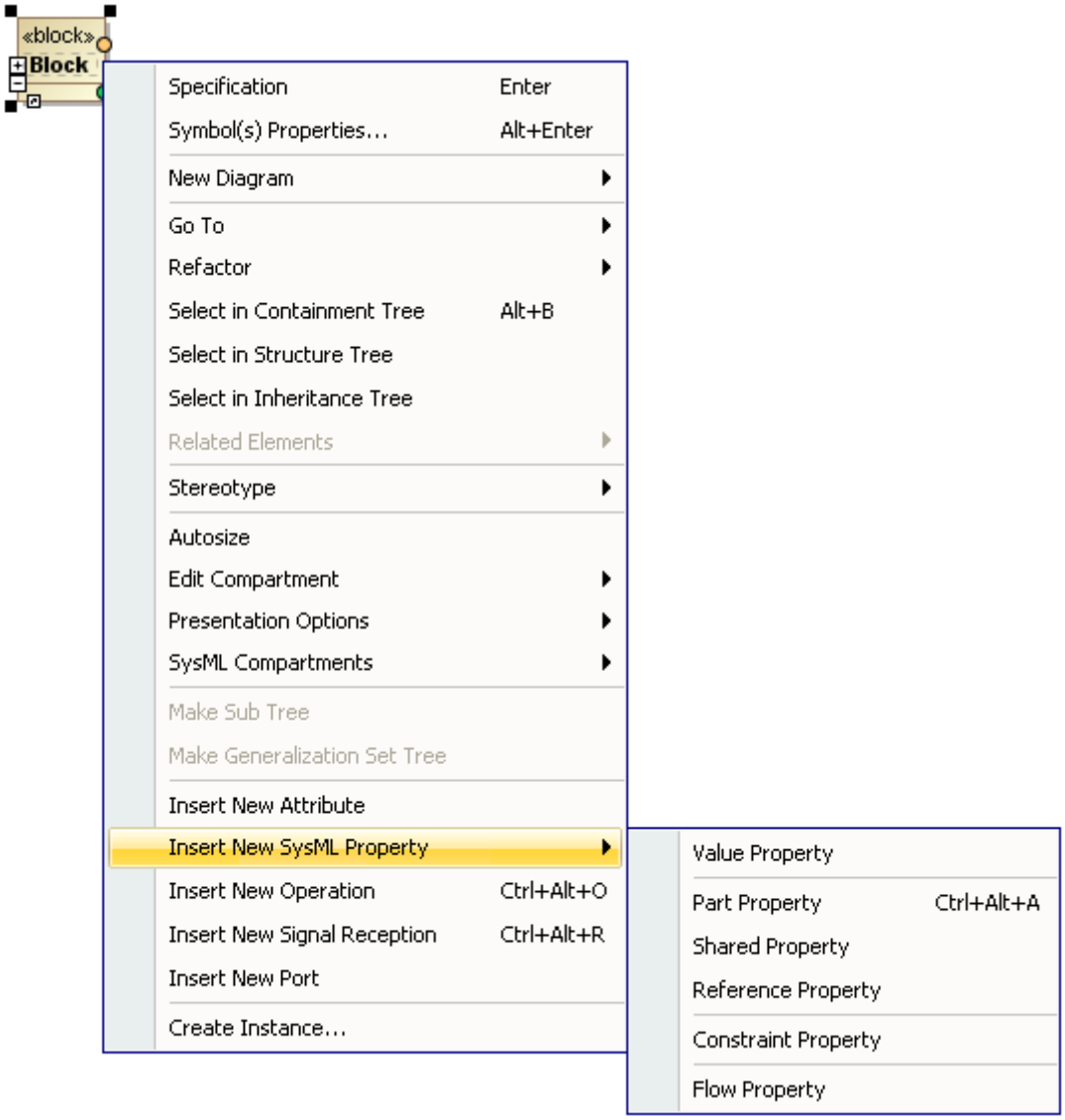


Figure 14 -- Shortcut Menu for Property and Operation Insertion

(b) To create a new SysML property using the Block Smart Manipulator menu, either:

1. Click the small orange circle on a Block. The sub-menu will open (Figure 15).
2. Select a property type, for example, Part Property.

or

1. Bring your pointer to a Block. The **Smart Manipulator** menu will open (Figure 16).
2. Select one of the very last six icons (yellow rectangle) on the menu to create a SysML property. In order for those icons to be displayed on the menu, you must be in the 'Expert' mode.

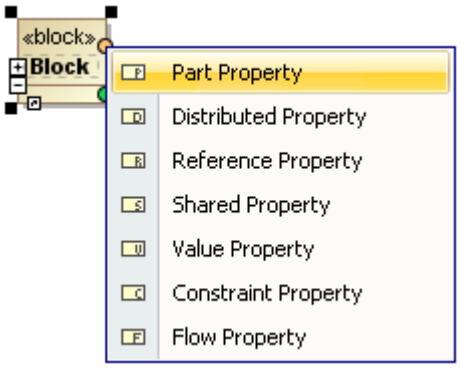


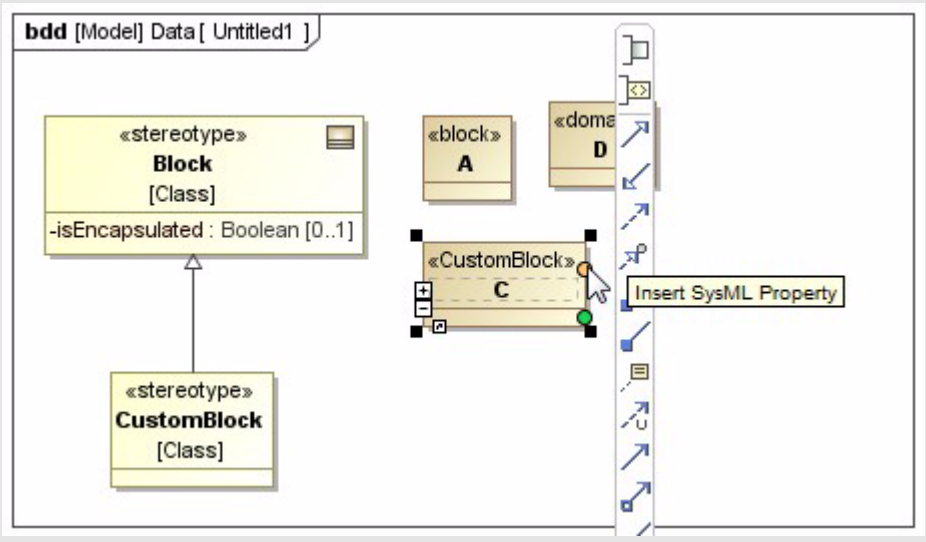
Figure 15 -- Block Smart Manipulator I for SysML Property

Figure 16 -- Block Smart Manipulator II for SysML Property

For further information on SysML properties, see the SysML Internal Block Diagrams (IBD) section.

You can also use the Block shortcut menu to create a new UML property or UML operation. For more information see MagicDraw User Manual.

NOTE	If you just create a new stereotype as a subtype of Block (e.g., CustomBlock), and use it in your model (e.g., "C"). When clicking the small orange button, the block smartmanipulator menu I (Figure 15) will not be displayed *unless you save and restart your project first*.



(ii) Inserting a New SysML Diagram Using the Block Shortcut Menu

To create a SysML diagram to be owned by a Block:

1. Right-click a block and select **New Diagram** from the shortcut menu.
2. Select one of the diagrams in the expanded sub-menu (Figure 17).

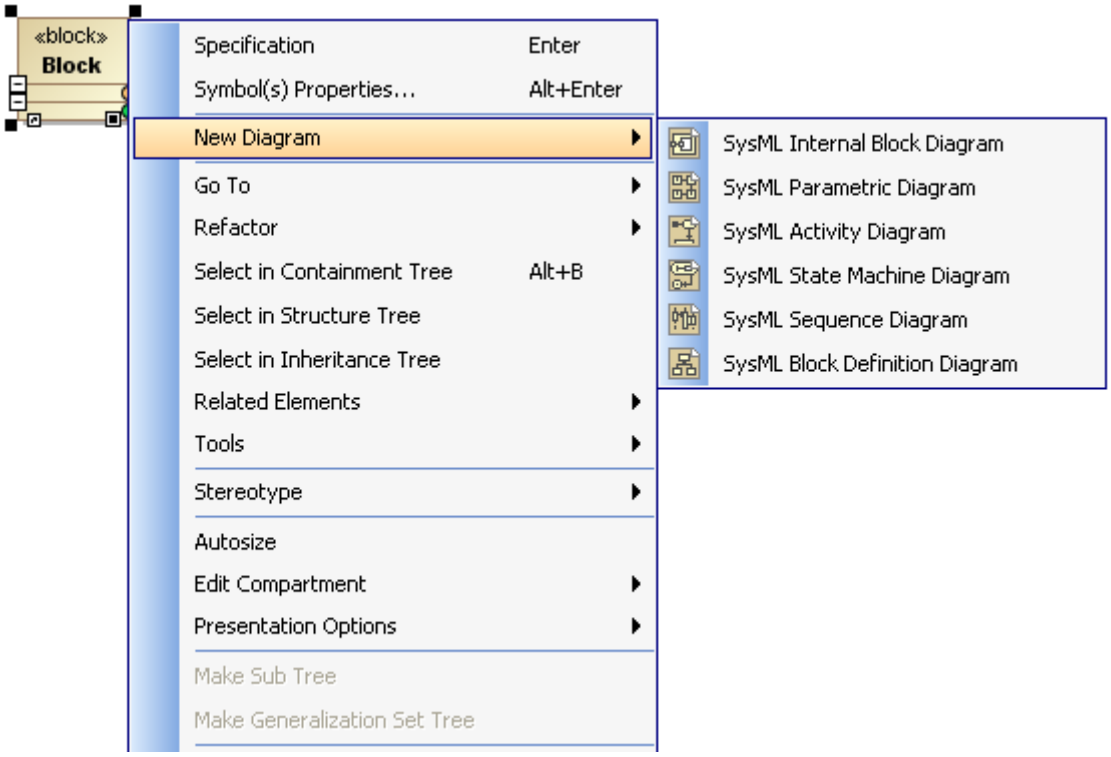


Figure 17 -- Inserting SysML Diagram from the Shortcut Menu

(iii) SysML-Style Compartments

SysML specifications allow Blocks to have multiple compartments. SysML plugin provides five independent, collpasible block compartments, i.e. ‘parts’, ‘references’, ‘values’, ‘constraints’ and ‘properties’ compartments (Figure 18).

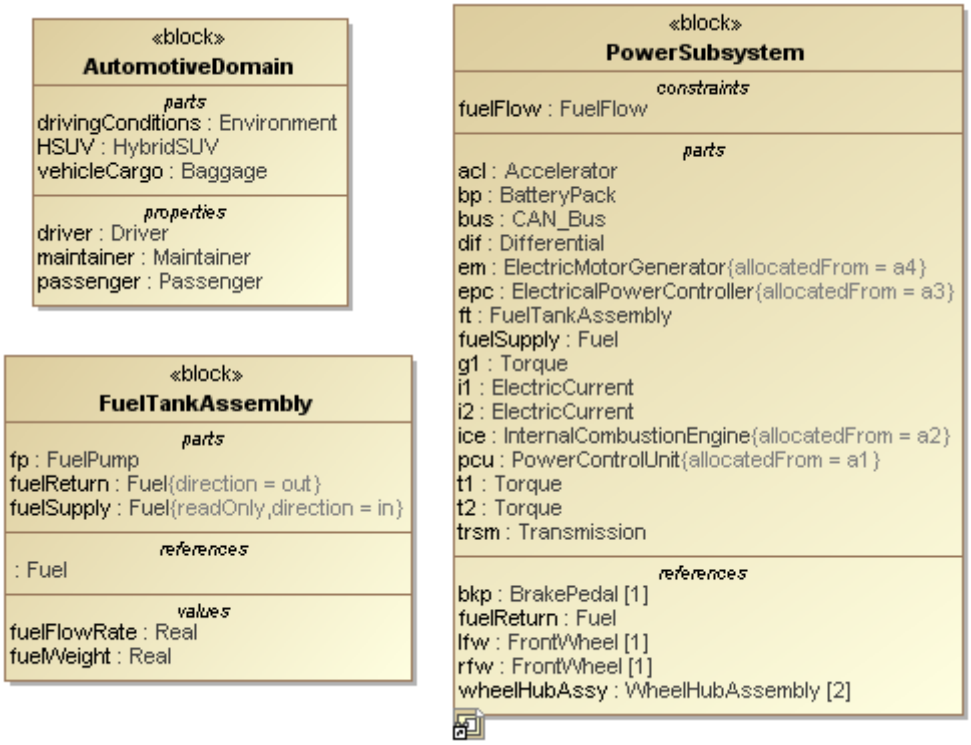


Figure 18 -- SysML Block Compartments

Table 1 -- SysML Block Compartments

SysML Compartments	Displayed Elements
parts	Part Properties: properties which are typed by Blocks or subtypes of Block, except Constraint Block, having ‘composite’ aggregation kind.
references	Shared Properties and Reference Properties: properties which are typed by Blocks or subtypes of Block, except Constraint Block, having ‘shared’ and ‘none’ aggregation kind, respectively.
values	Value Properties: properties which are typed by Value Types or subtypes of Value Type, always having ‘composite’ aggregation kind.
constraints	Constraints and Constraint Properties. Constraint Properties: properties which are typed by Constraint Blocks, or subtypes of Constraint Block, always having ‘composite’ aggregation kind.
properties	All other properties which cannot be classified into the previous compartments.

In addition, three SysML compartments are provided for displaying the Constraint Blocks’ properties, i.e. ‘constraints’, ‘others’ and ‘parameters’ compartments (Figure 19).

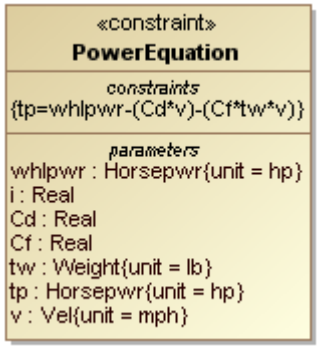


Figure 19 -- SysML Constraint Block Compartments

Table 2 -- SysML Constraint Block Compartments

SysML Compartments	Displayed Elements
constraints	Constraints and Constraint Properties. Constraint Properties: properties which are typed by Constraint Blocks, or subtypes of Constraint Block, always having 'composite' aggregation kind.
others	All other properties which cannot be classified into the previous compartments.
parameters	Constraint Parameters (reusing the 'ports' compartment of Class).

To suppress or expand SysML Block / Contraint Block compartment(s) of a Block / Constraint Block :

1. Right-click on the Block / Constraint Block symbol, and select **SysML Compartments** group.
2. To suppress or expand all SysML compartments at once, you can click on **Suppress All** or **Expand All**, respectively.
3. You can suppress or expand single SysML compartment by check or uncheck, respectively, the context menu item whose label is starting with "Suppress", followed by the compartment name (e.g. **Suppress Parts** for suppress/expand the 'parts' compartment (Figure 20)).

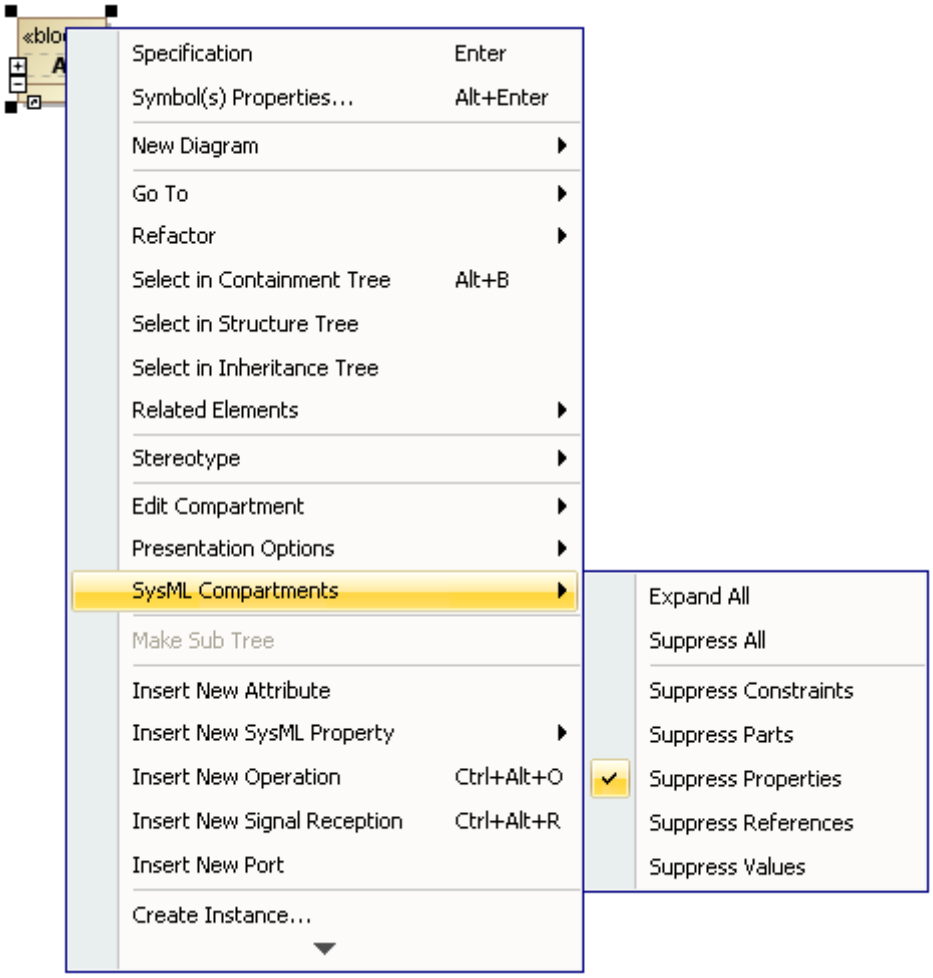


Figure 20 -- Context menu for suppression/expansion of SysML compartments

NOTE	• Each expanded compartment will be shown when it contains at least one properties. If the compartment contains no property, it will not be displayed even already expanded. • The 'parameters' compartment of each Constraint Block re-uses the 'ports' compartment of Class. Consequently, you can suppress or expand the 'parameters' compartment by using the symbol property for suppress 'ports' compartment.

(iv) Creating an Association Block

To create an Association Block on a Block Definition Diagram, either:

1. Select **Association Block** on the diagram toolbar (Figure 21).
2. Select a Block on the diagram to be used as the source of the Association Block to be created.
3. To select the target of the Association Block, either select an existing Block on the diagram to be used, or click on empty space on the diagram to create such target Block.
4. An Association Block will then be created between the source and target Blocks.

or

1. Select the **Association Block** icon in the **Smart Manipulator** menu of a Block to be used as the source of the Association Block (Figure 22).
2. To select the target of the Association Block, either select another Block or click on an empty space on the diagram to create such a target Block.
3. An Association Block will then be created between the source and target Blocks.

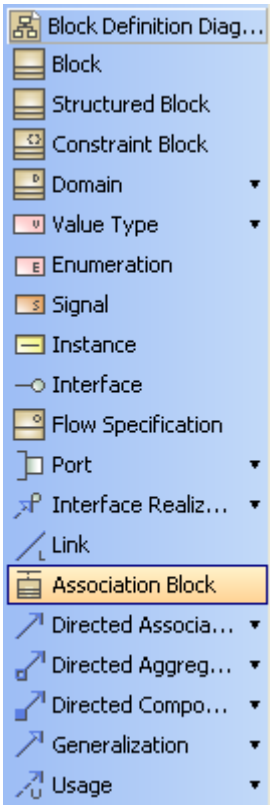


Figure 21 -- Association Block Button in BDD Diagram Toolbar

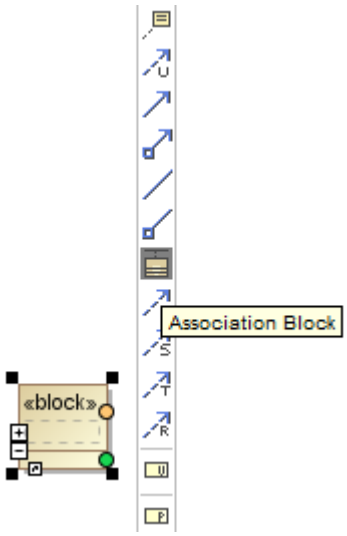


Figure 22 -- Block Smart Manipulator to Create an Association Block

(v) Creating a SysML Internal Block Diagram Using the Smart Manipulator Button

To create a SysML Internal Block diagram for a Block:

1. Select the Block symbol. The smart manipulator menu will appear (Figure 23).
2. Click the SysML Internal Block diagram button. The SysML Internal Block diagram will then be created to be owned by the selected block.
3. The name of created SysML Internal Block diagram will be the same as the owner block. The hyperlink to the created diagram will be added to the selected block.

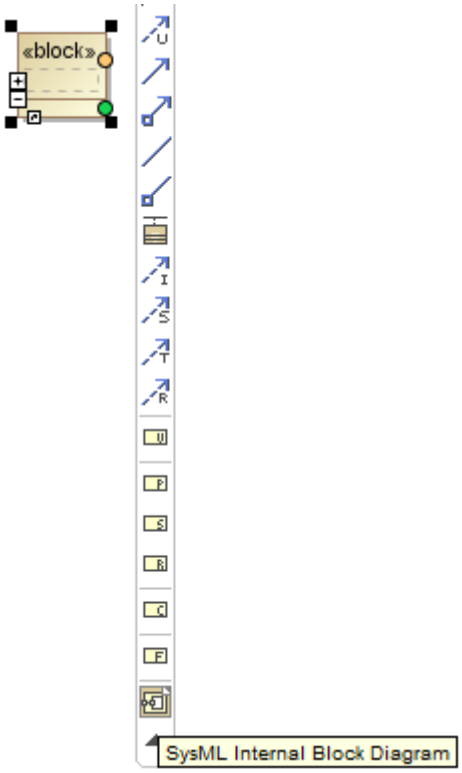


Figure 23 -- Smart Manipulator Menu for Creating IBD

5.1.4 Creating Instances of Blocks with Complex Structure

Creating instances for a complex model can be quite difficult, especially, since instances are frequently used in SysML (unlike in UML), in particular when assembling systems. Starting with version 16.5, a new feature has been included: Automatic Instantiation.

The purpose of this feature is to provide a wizard for automatic instantiation of the composite structures of a system or system parts. Instances are widely used in simulation environments, for example, Paramagic, and also for defining different system configurations and test cases.

The following two samples will describe how to use the Automatic Instantiation feature.

(i) To automatically instantiate a Block:

1. Right-click a Block and select **Create Instance...** on the shortcut menu (Figure 24). The **Automatic Instantiation Wizard** dialog will open (Figure 25). Note that SysML sample projects are available in the ***<md.install.dir>/samples/SysML*** directory. The **hybrid sport utility vehicle.mdzip** sample is used to demonstrate how this feature works.

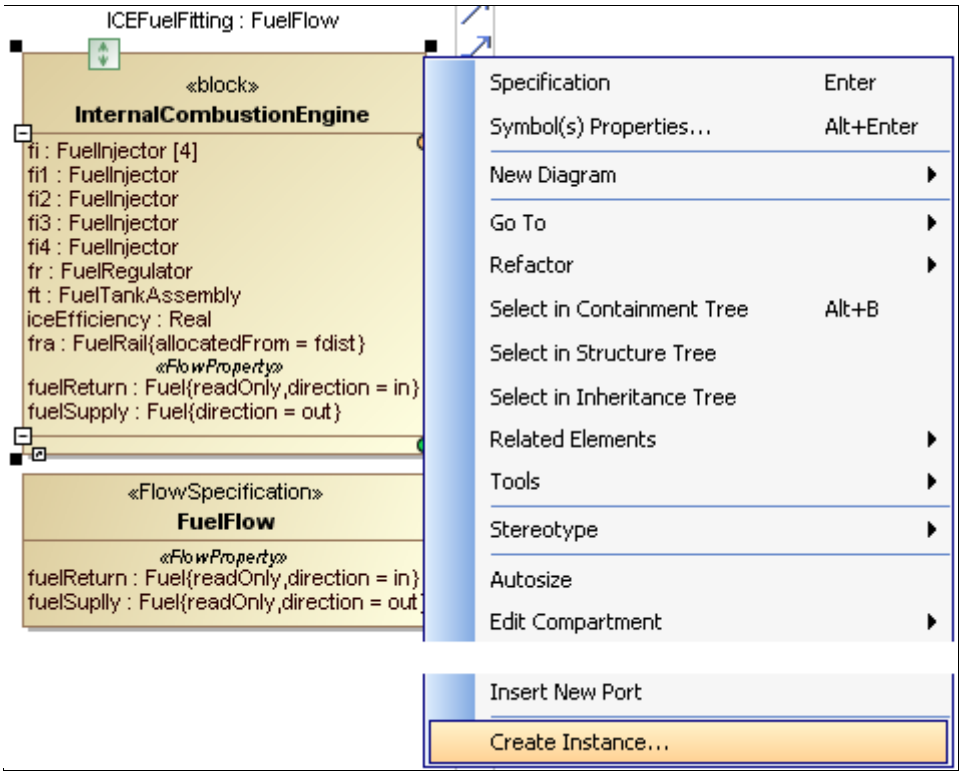


Figure 24 -- Create Instance... Shortcut Menu

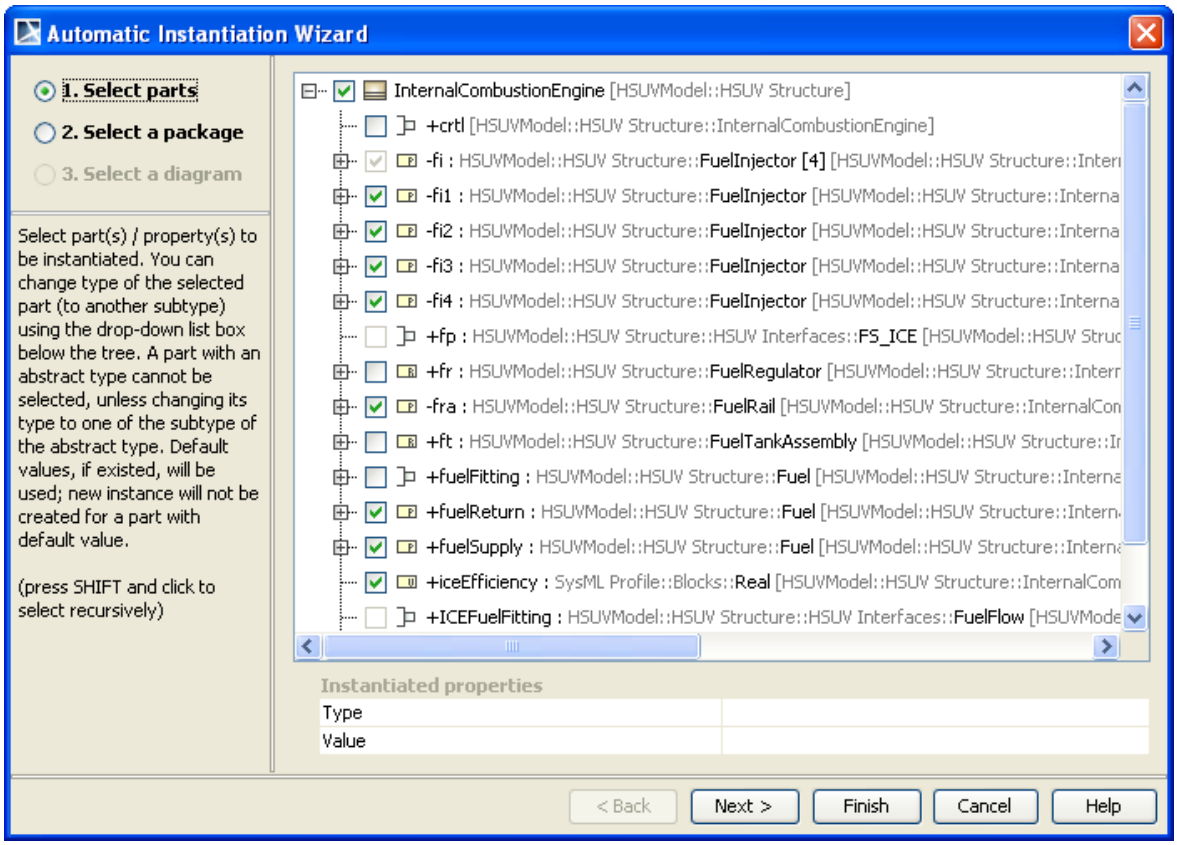


Figure 25 -- Automatic Instantiation Wizard - Step 1.Select Parts

NOTE	The **Automatic Instantiation Wizard** dialog contains three steps: (i) Select parts, (ii) Select a package, and (iii) Select a diagram (Figure 25).

2. In **Step 1 (Select parts)**, select a check box in front of a property to assign the value of the slot representing the property with instance specifications or values. In other words, if the property has no default value and has a type assigned, an instance specification of the assigned type will be created and assigned as the value of the slot representing the property.
3. The slot for the property with multiplicity greater than 1 ([0..*], [4], [1..5]), can contain more than one instance value. You can add more instance values to the slot of this property by right-clicking the property and select **Add parallel part** (Figure 26). A new node with the index of the instance value to be created will be listed under the selected property. You can also remove the instance value by right-clicking the node of the instance value and select **Remove parallel part** (Figure 27).

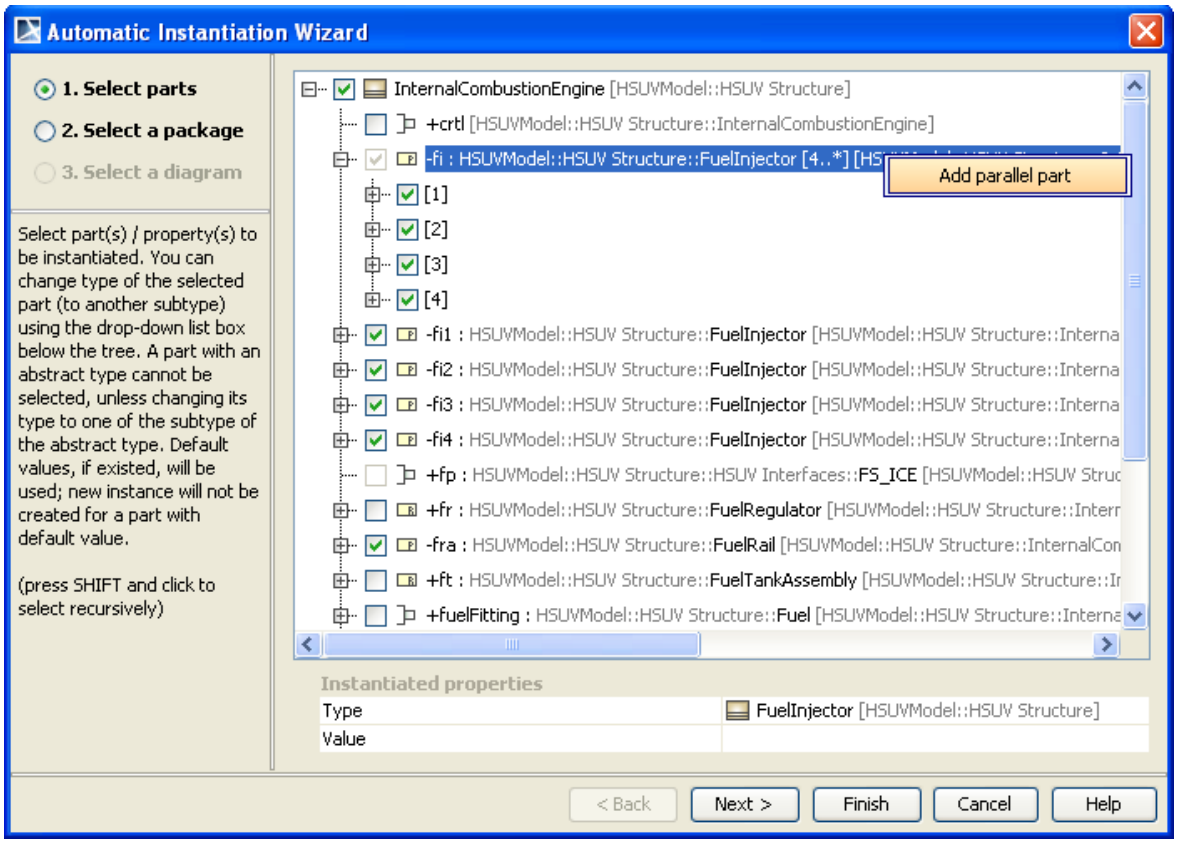


Figure 26 -- Adding More Instance Values

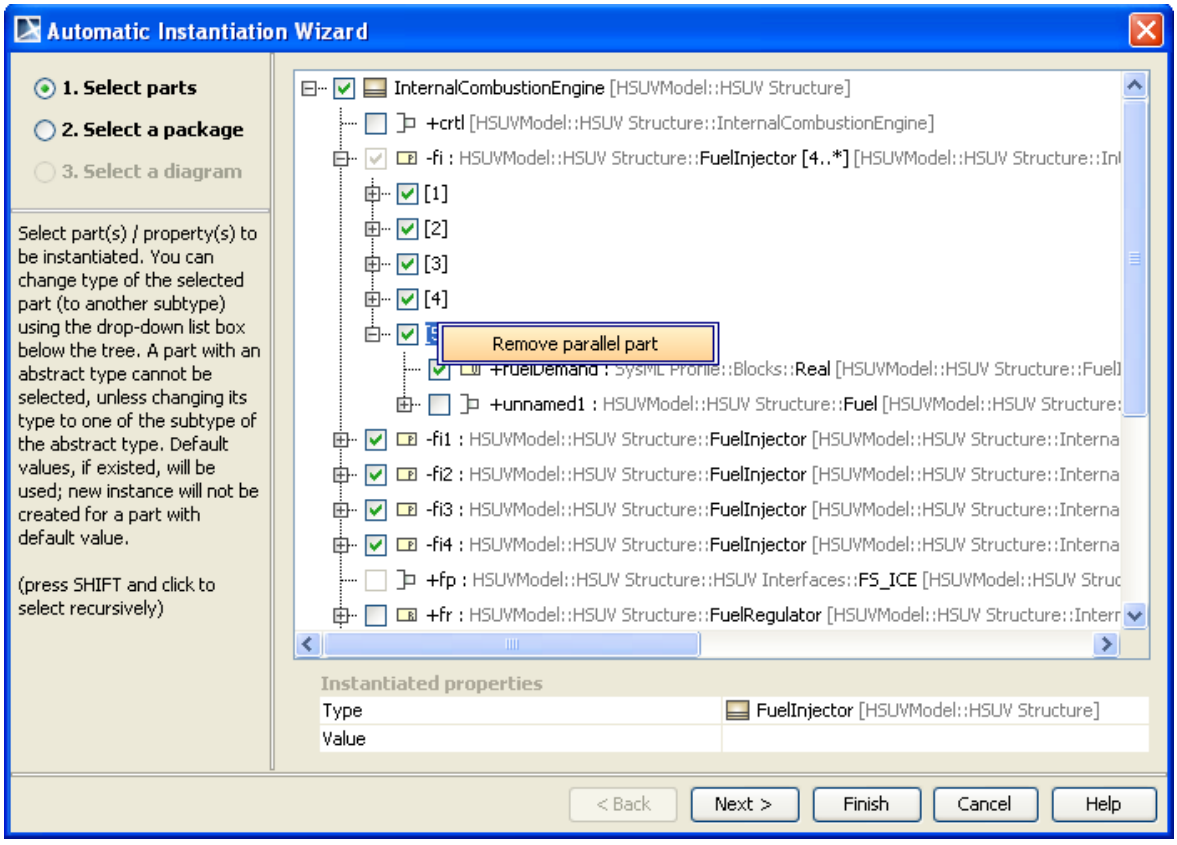


Figure 27 -- Removing Instance Value

4. You can change the instance specification type to be created for any selected property by changing the Type property in the Instantiated properties table. Generally, the possible classifiers are subtypes of the type of that particular property, unless the type is an Interface. If the type is an Interface, the options in the drop-down list will be elements which realize the Interface (Figure 28).

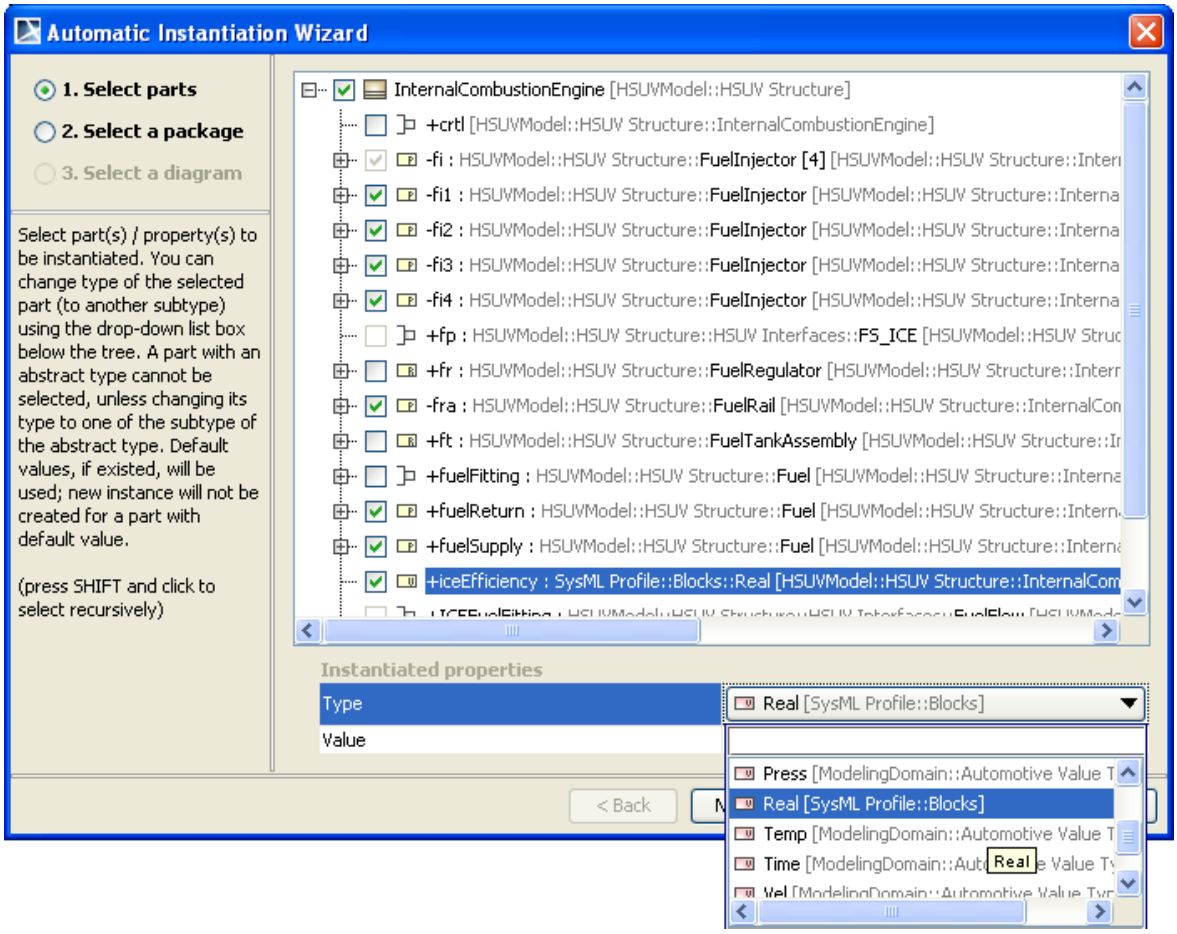


Figure 28 -- Selecting Type to Instantiate

NOTE	You cannot select any property typed by an Abstract Class or an Interface. You must first use the drop-down list to change the type of the instance specification to be created for that property.

5. For any selected property, you can also directly assign the value to the slot by using Value property in the Instantiated properties table. For the value properties, you can type the value into table directly (Figure 29). For the complex structure, you can selected the existing instance specification to be the instance value. Moreover, any value specification can be created and assigned to be slot value of selected property by right click on the cell Value in the table then the context menu for edit, delete and create a various type of value specification will be popped up (Figure 30).

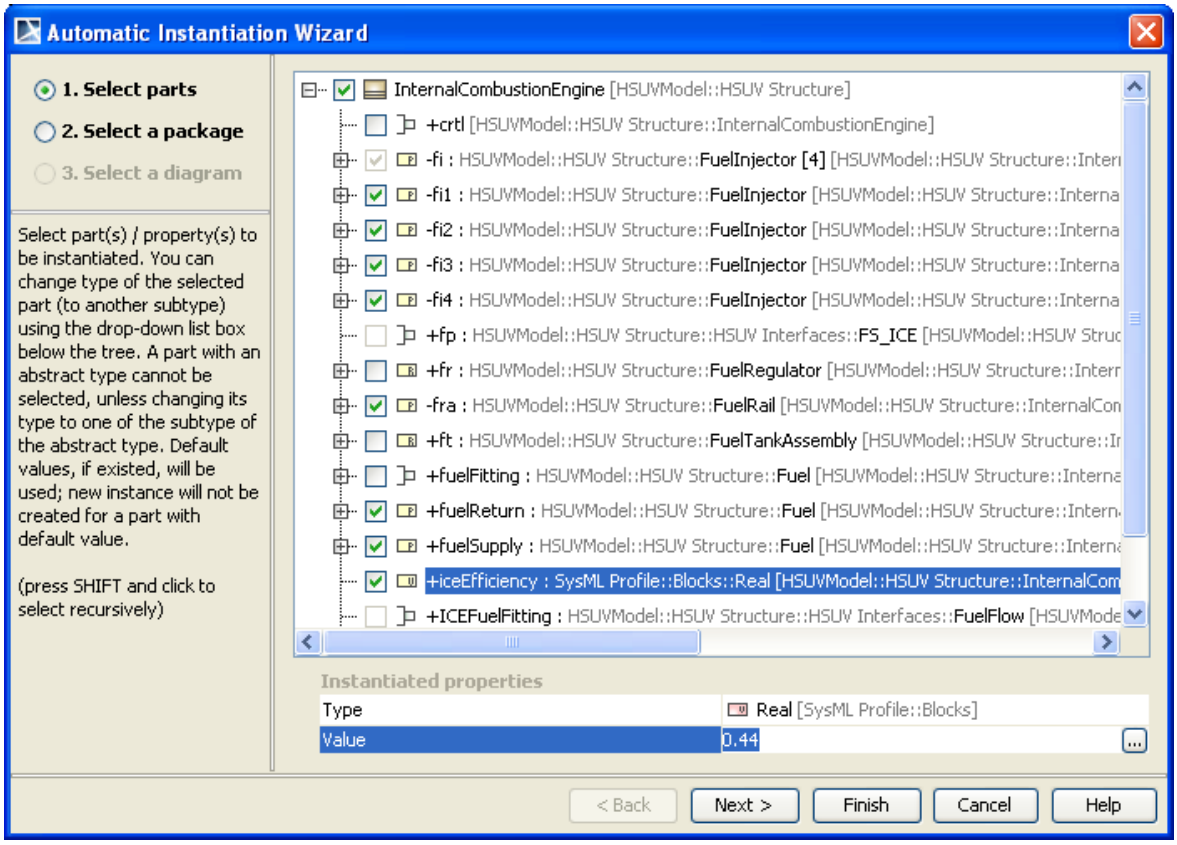


Figure 29 -- Assigning Value Property

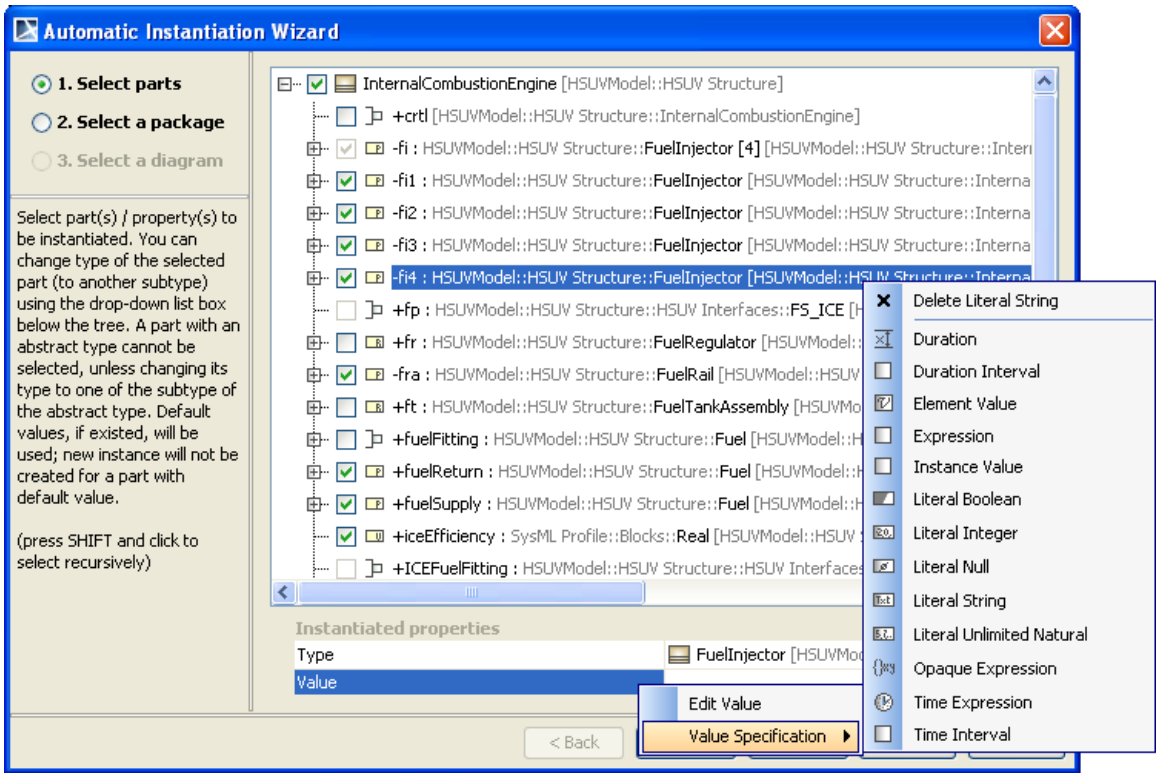


Figure 30 -- Changing Value Specificaotion Type for Slot Value

6. Click **Next** to proceed to the next step once all the required properties have been selected.
7. In **step 2 (Select a package)**, either select an existing package or create a new package to be used to hold instance specifications, which will be created after you click the **Finish** button. Click **Next**.

- To select an existing package, click on the package.
- To create a new package, select the package owner in the tree and click the **Create** button. A list of packages will open. Choose a package (**Package**, **Profile**, or **Model**) from that list. A package will be created and its specification dialog will open for you to customize, for example, assigning the package name (Figure 31).

.

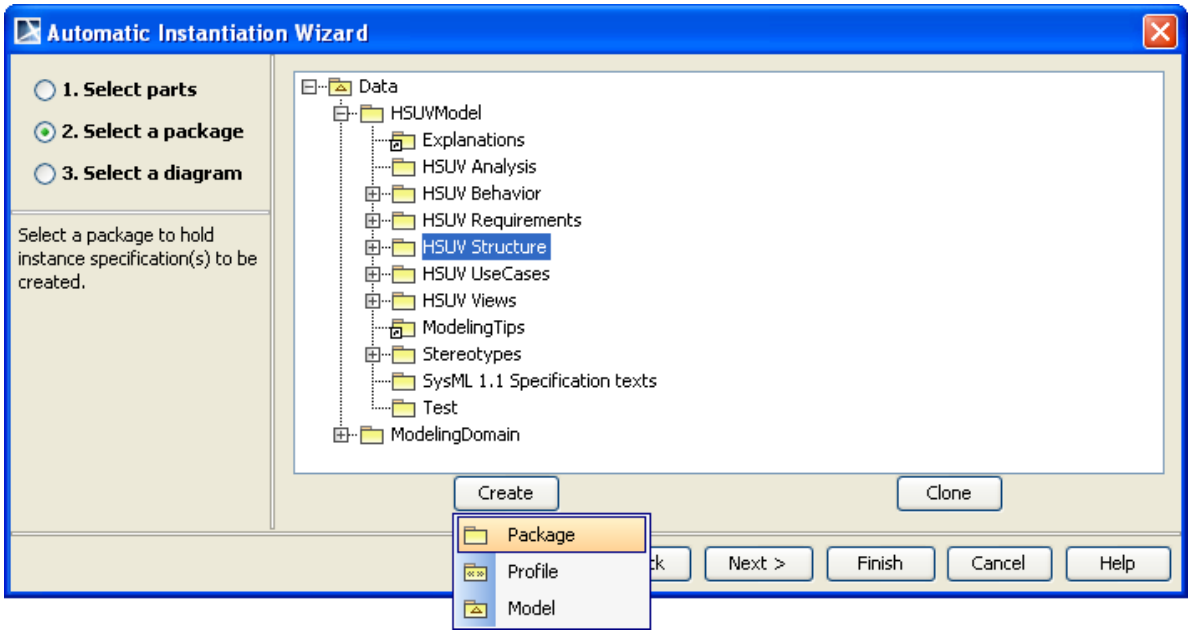


Figure 31 -- Automatic Instantiation Wizard - Step 2.Select a package

For example, to create the package named "ICE Type A" owned by **HSUV Structure**; you need to:

- Select the **HSUV Structure** package in the tree and click the **Create** button. A list of packages will open.
- Choose a package from the list. The package specification dialog will open.
- Type: **ICE Type A** in the name attribute and click the **Close** button. The **ICE Type A** package will be available in the tree.
- Select the package and click the **Next** button to proceed to Step 3 (Figure 32).

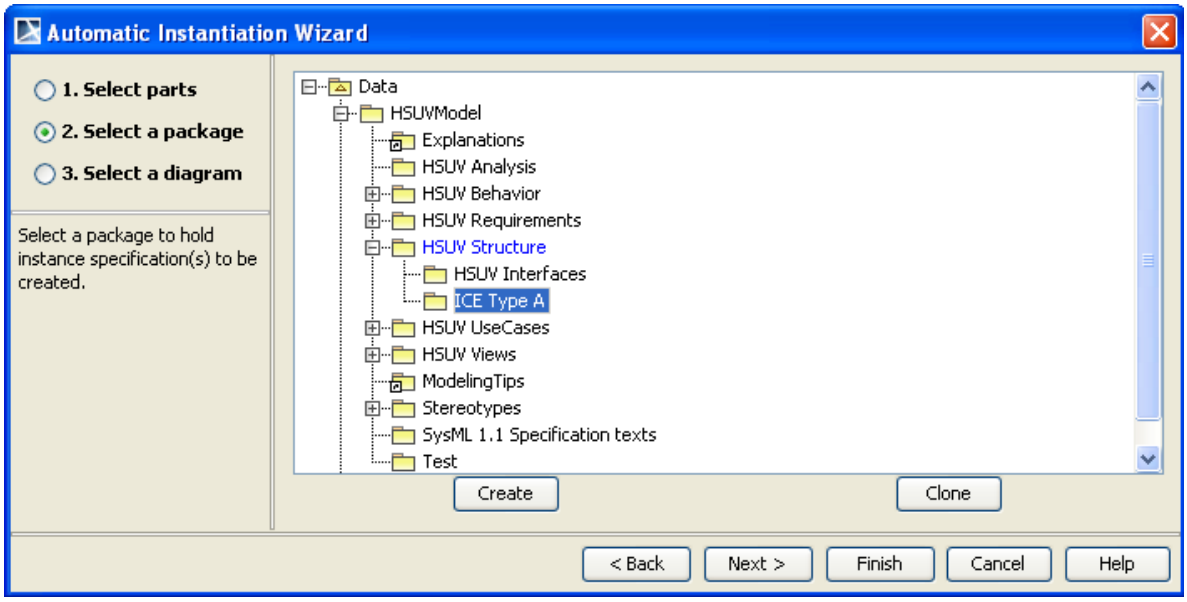


Figure 32 -- Automatic Instantiation Wizard - Step 2.Select a Package

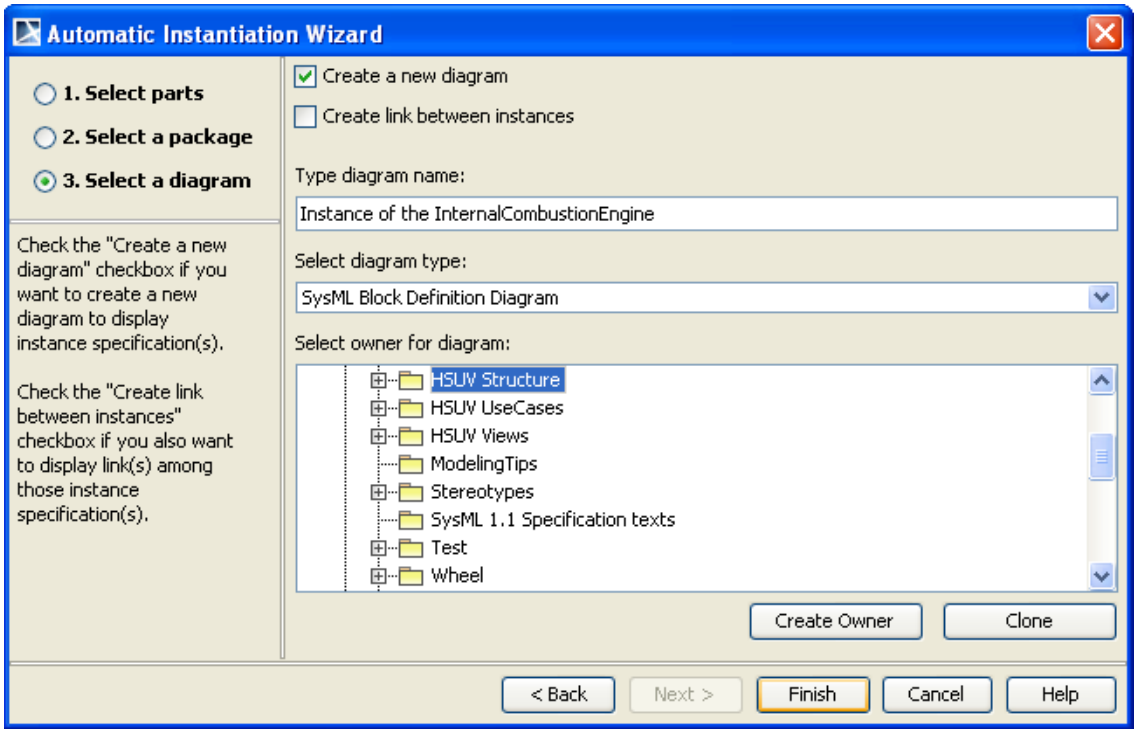


Figure 33 -- Automatic Instantiation Wizard - Step 3.Select a Diagram

8. In **Step 3 (Select a diagram)**, select the **Create shape on new diagram** check box to create a new diagram to display instance specifications (Figure 33).

NOTE	Select the **Create link between instances** check box to also create links among instances.

9. Type the diagram name and select the type (only static diagrams are allowed to hold instance specifications), and owner (select one from the tree).
10. Click **Finish** to create the instance specifications and diagram (Figure 33). The Instance specifications will be created and displayed in the chosen diagram (Figure 34).

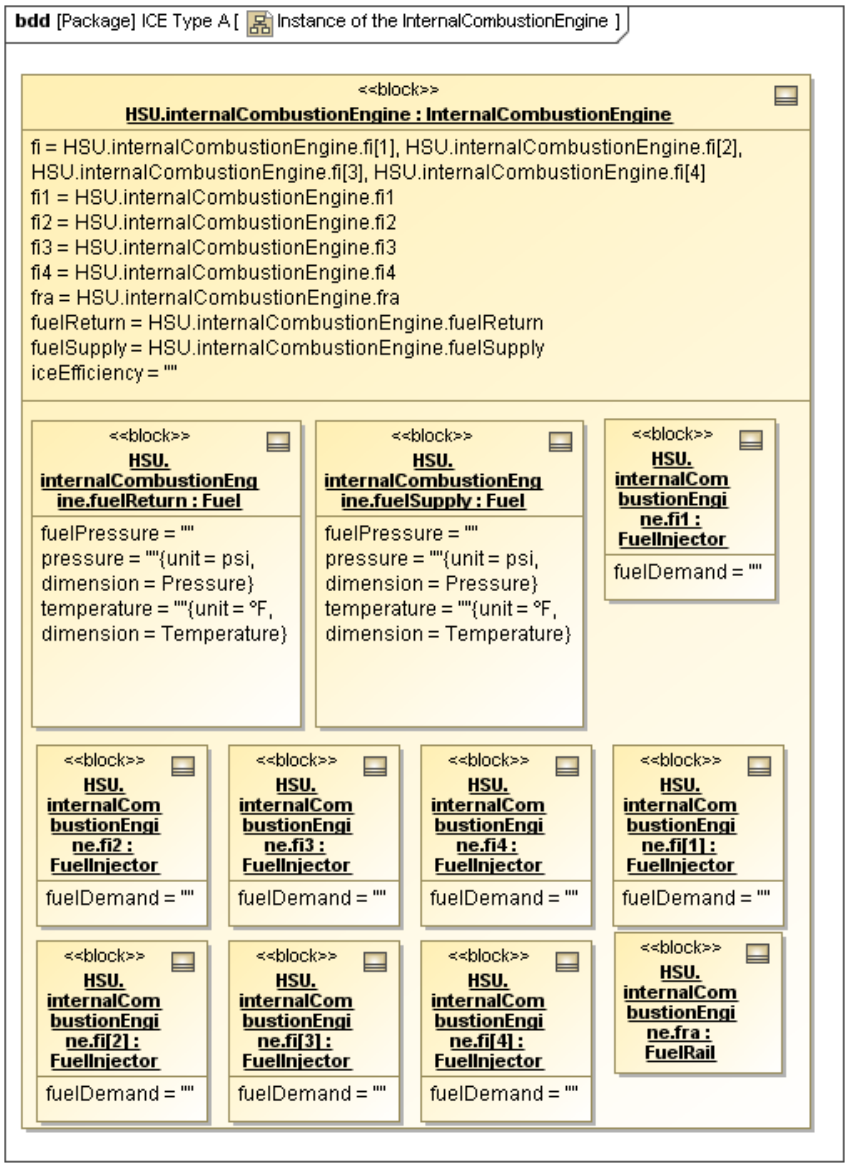


Figure 34 -- Example of Instance Created by Automatic Instantiation Wizard

11. You can reassign some values, for example, if you like to use “SuperFuel” for “fuelReturn” instead, then reassign the **fuelReturn** slot in the HSU.internalCombustionEngine : Internal-CombustionEngine instance specification (Figure 34) to **SuperFuel**, a Fuel kind with a specific fuelPressure (Figure 35). The newly-created diagram will look like the one in Figure 36.

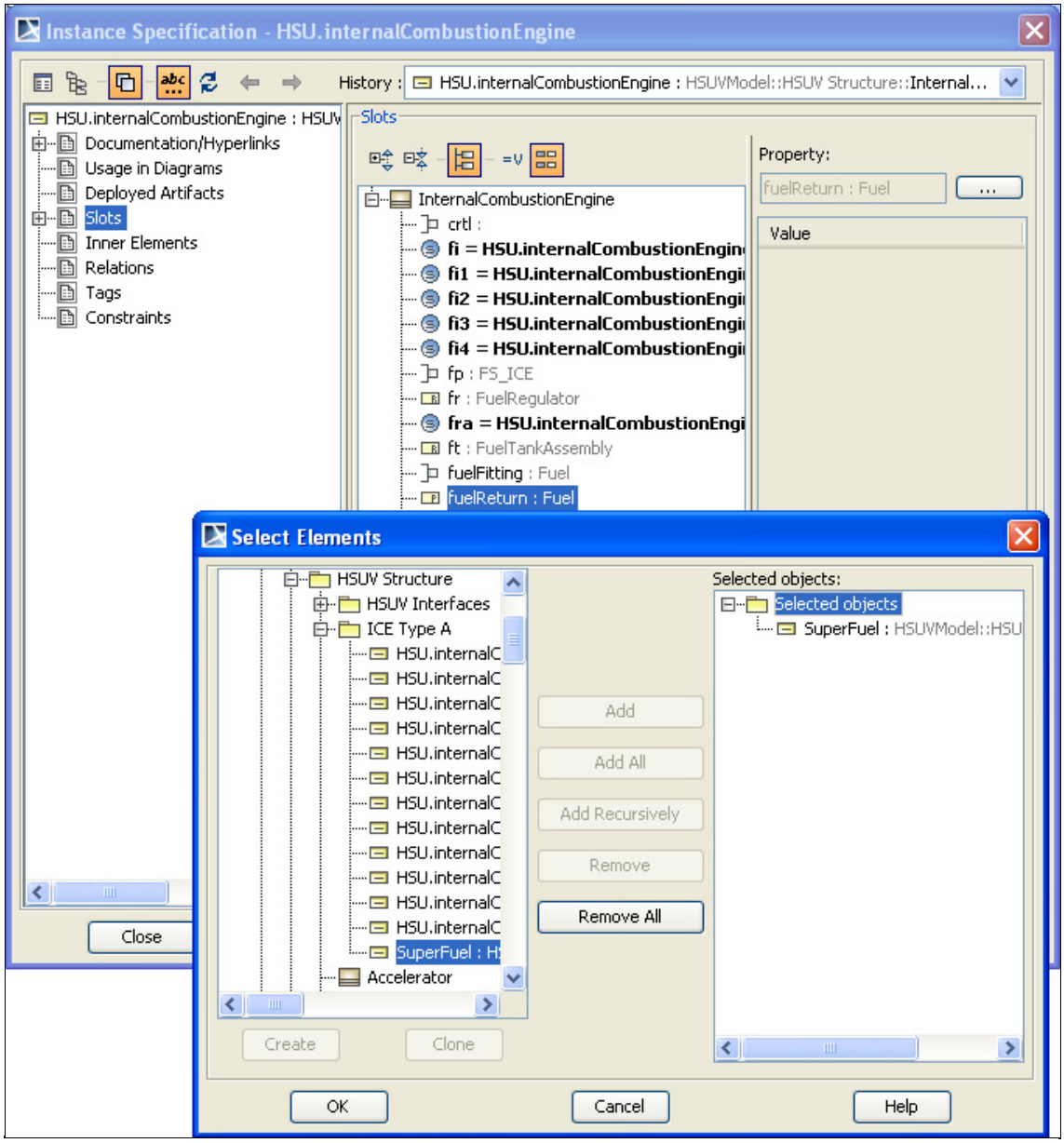


Figure 35 -- Changing Slot Value of "fuelReturn" Property

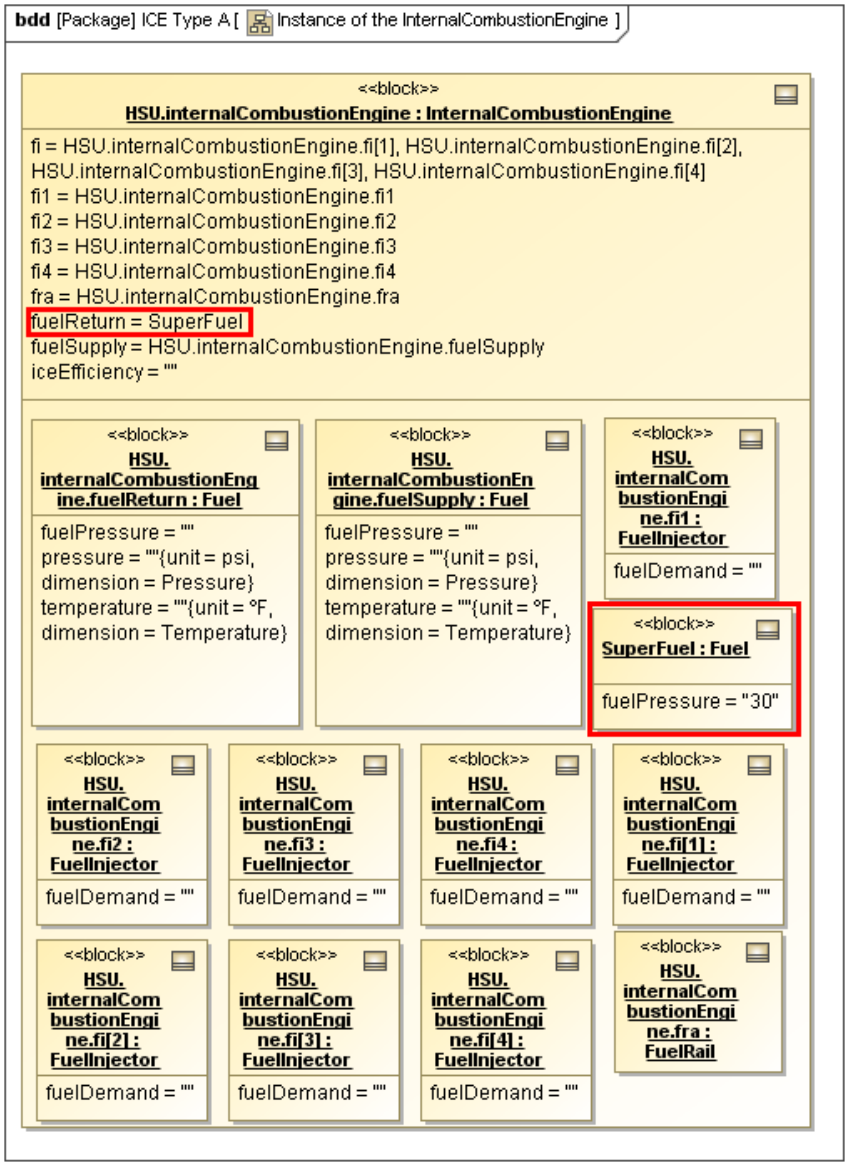


Figure 36 -- Resulting Instances After Changing Slot Value of "fuelReturn" Property

(ii) To automatically instantiate a Block to be used with Paramagic Plugin:

1. Right-click a block and select **Create Instance...** on the shortcut menu (Figure 37). The **Automatic Instantiation Wizard** dialog will open (Figure 38). Note that Paramagic sample projects are available in the ***<md.install.dir>/samples/ParaMagic*** directory after you installed Paramagic Plugin. The **Satellite.mdzip** sample is used to demonstrate how this feature works.

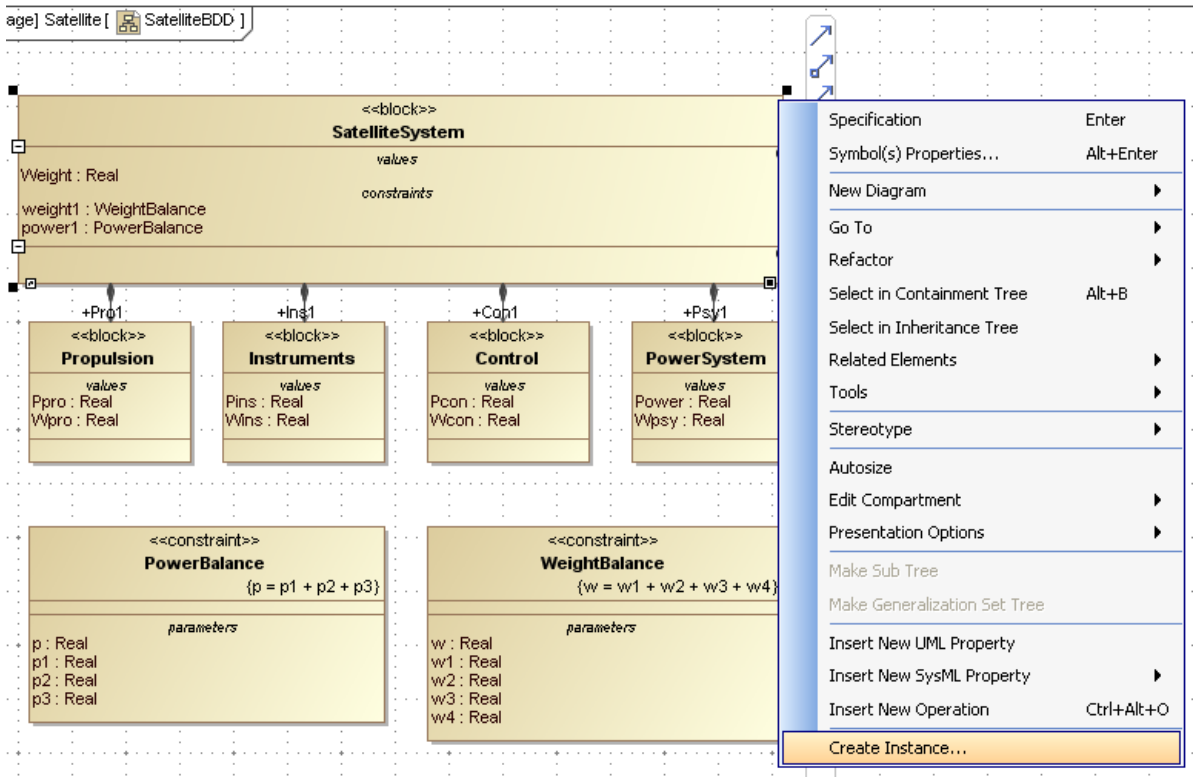


Figure 37 -- Create Instance... Shortcut Menu

2. In **Step 1 (Select parts)**, select the required properties as shown in Figure 38 and set the value for each value property of the instantiate classifier. Click **Next**.

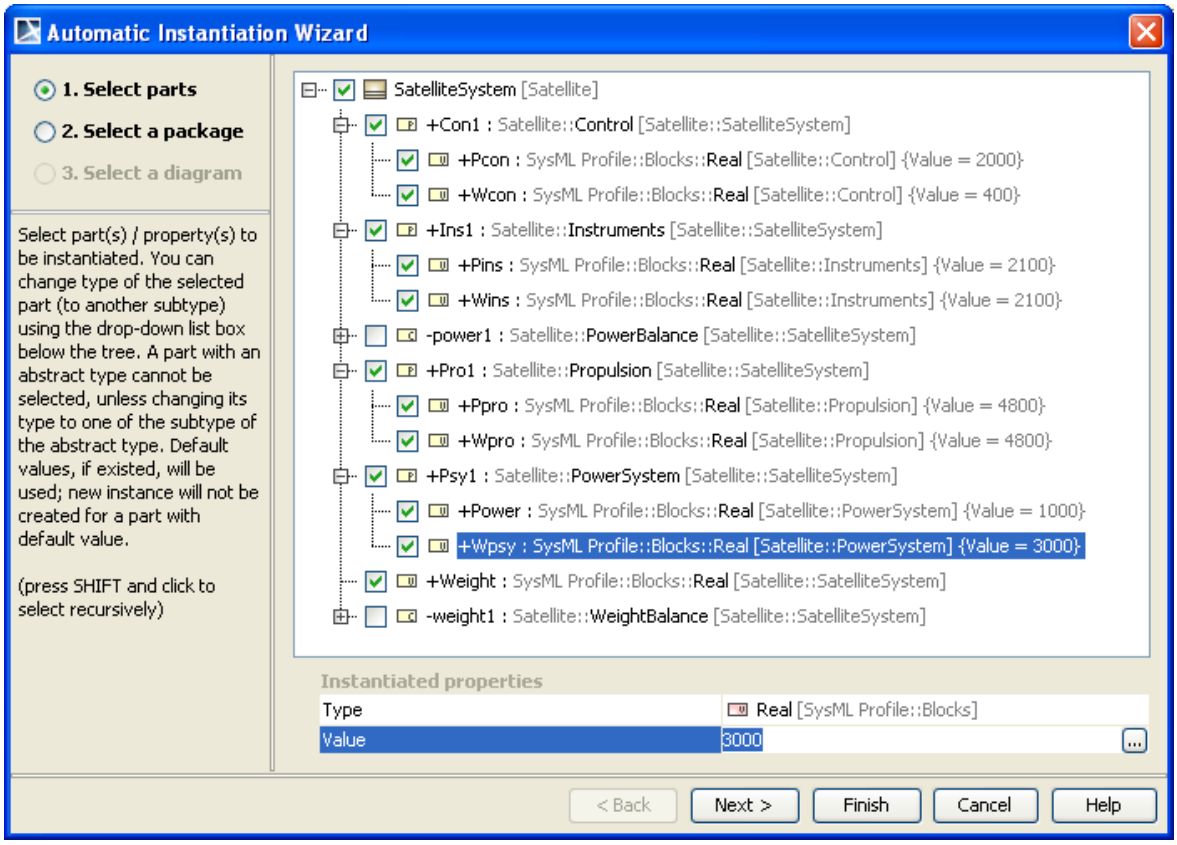


Figure 38 -- Automatic Instantiation Wizard - Step 1.Select parts

3. In **Step 2 (Select a package)**, create a new package named **SatelliteInstance02** (Figure 39) and click **Next**.

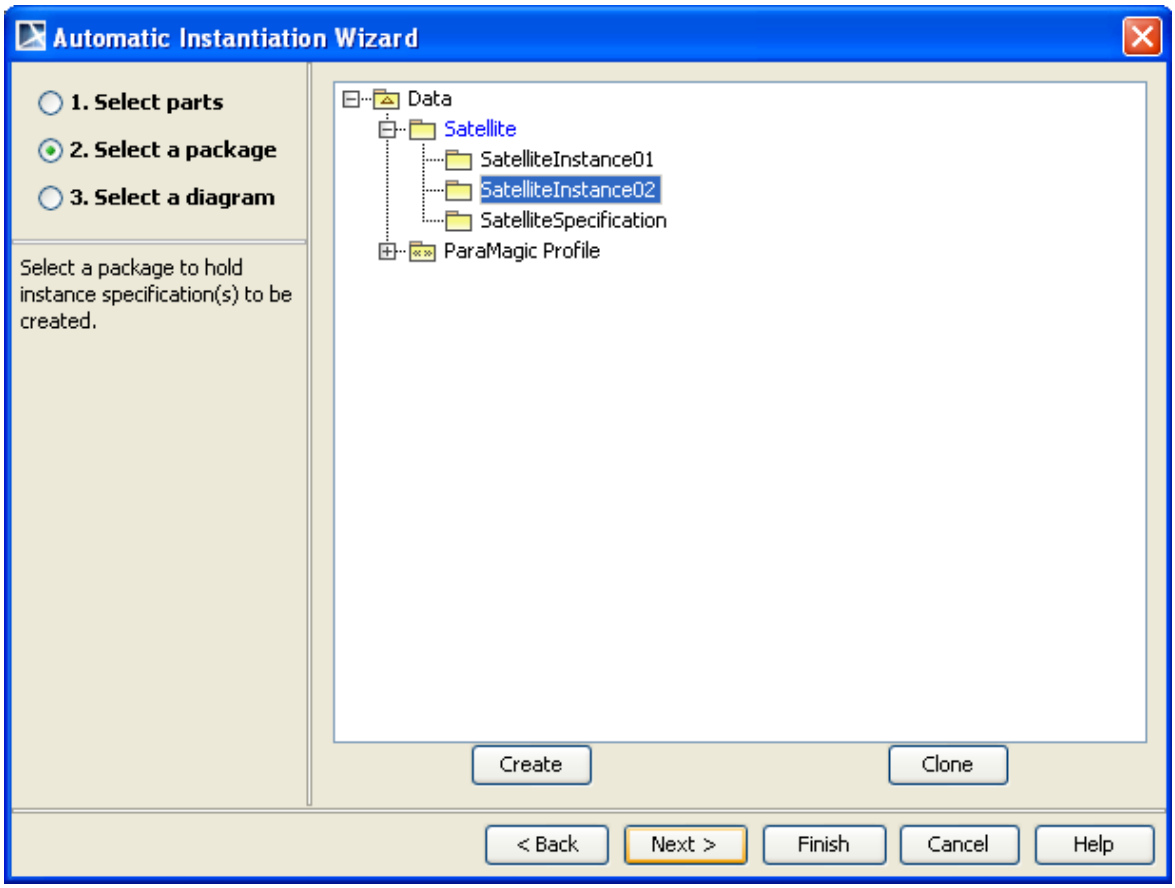


Figure 39 -- Automatic Instantiation Wizard - Step 2.Select a package

4. In **Step 3 (Select a diagram)**, type: **SatInstance02BDD** in the **Type diagram name** box, and select **BDD** as the diagram type (Figure 40).

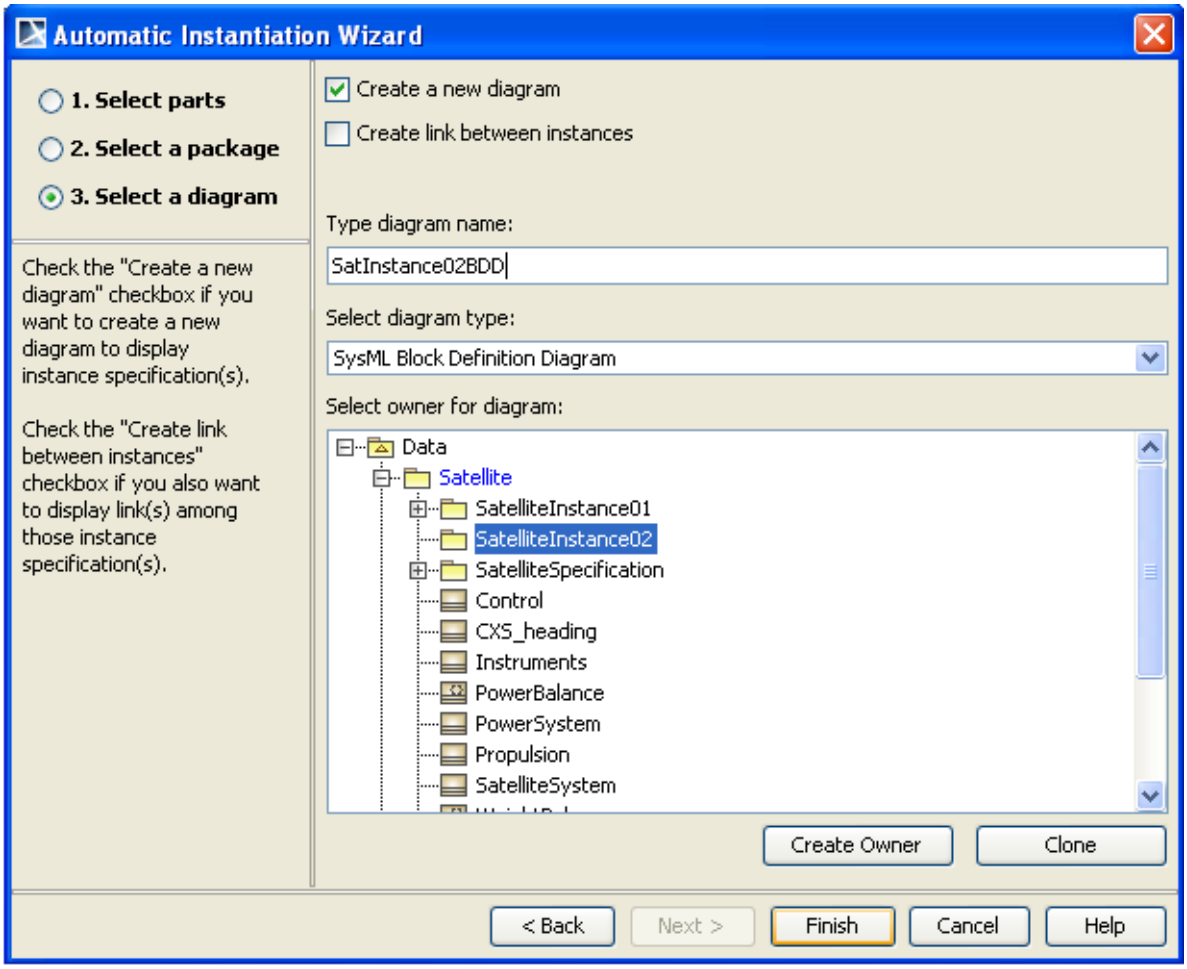


Figure 40 -- Automatic Instantiation Wizard - Step 3.Select a diagram

5. Click **Finish**. The **SatInstance02BDD** diagram will be created (Figure 41).

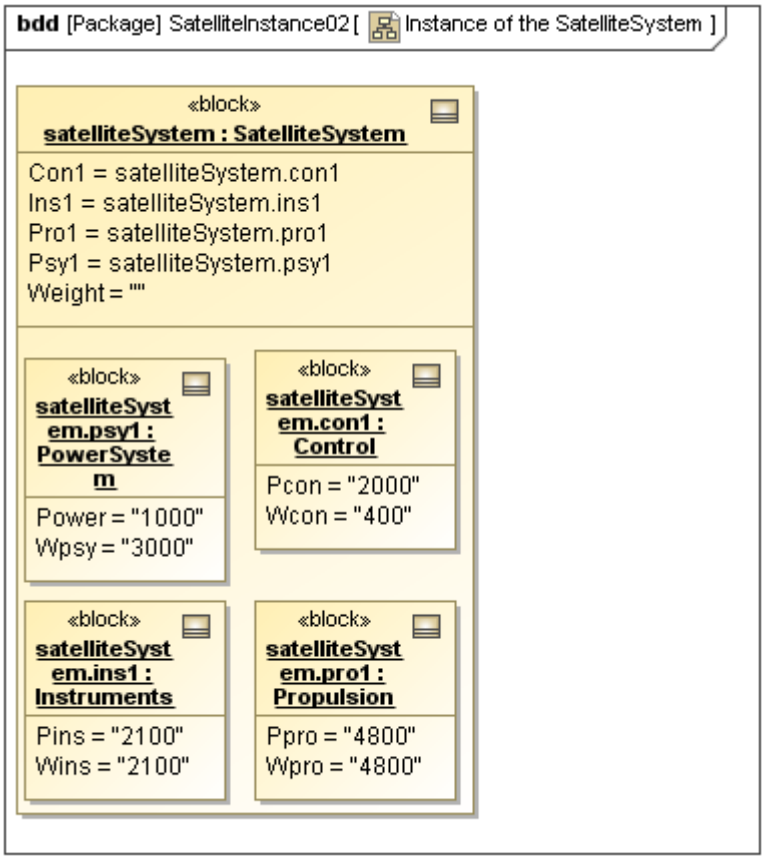


Figure 41 -- Example of Instance Created by Automatic Instantiation Wizard with Initialized Slots

6. Right-click the **SatelliteInstance02** package in the browser and select **ParaMagic** > **Util** > **Create CXI_heading** (Figure 42).
7. Right-click again and select **ParaMagic** > **Util** > **Add default causalities**. The package will then be ready for ParaMagic Plugin.

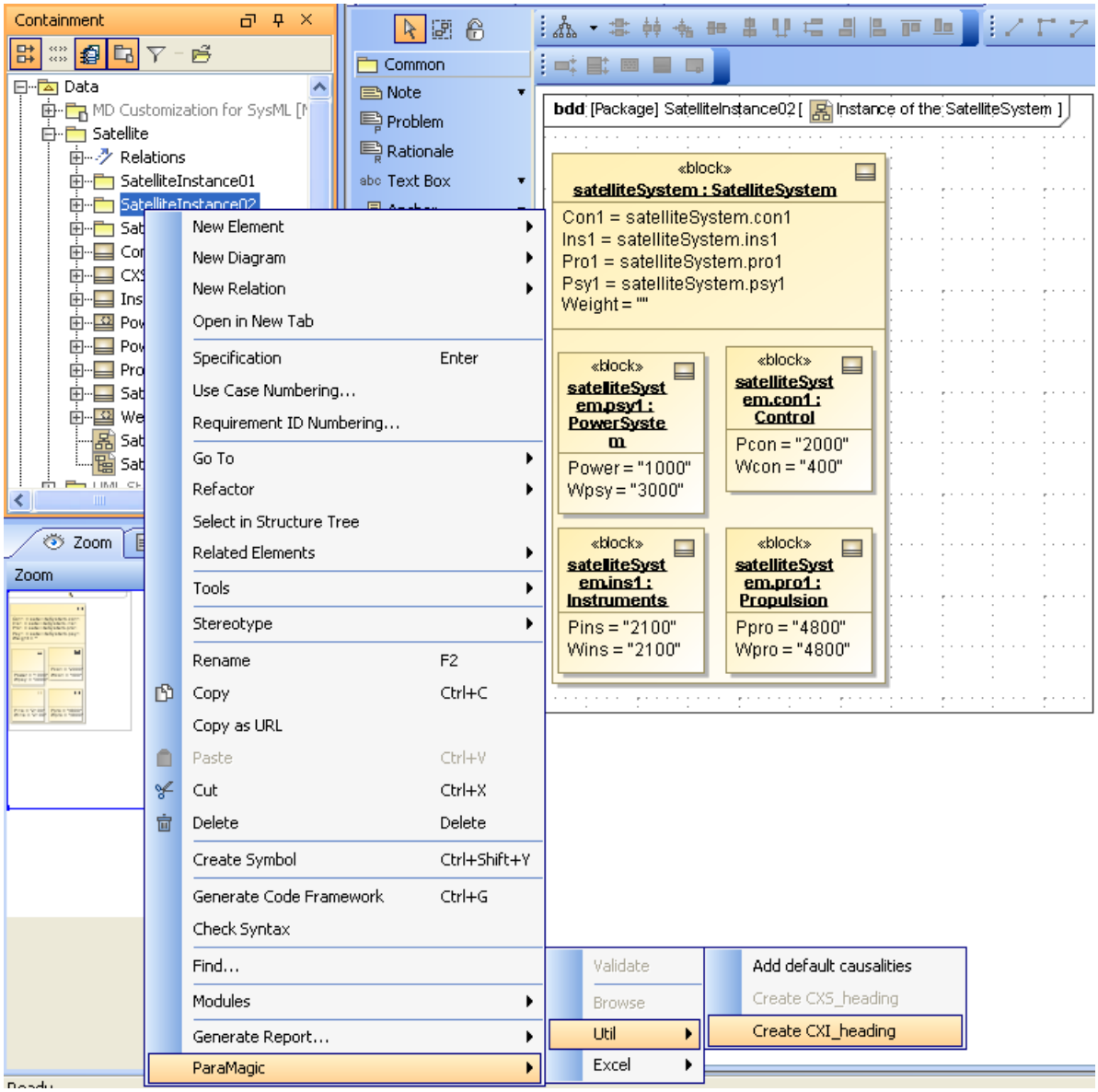


Figure 42 -- ParaMagic Shortcut Menu - Util

8. Right-click the **SatelliteInstance02** package in the browser and select **ParaMagic** > **Browse** to open the ParaMagic browser (Figure 43).

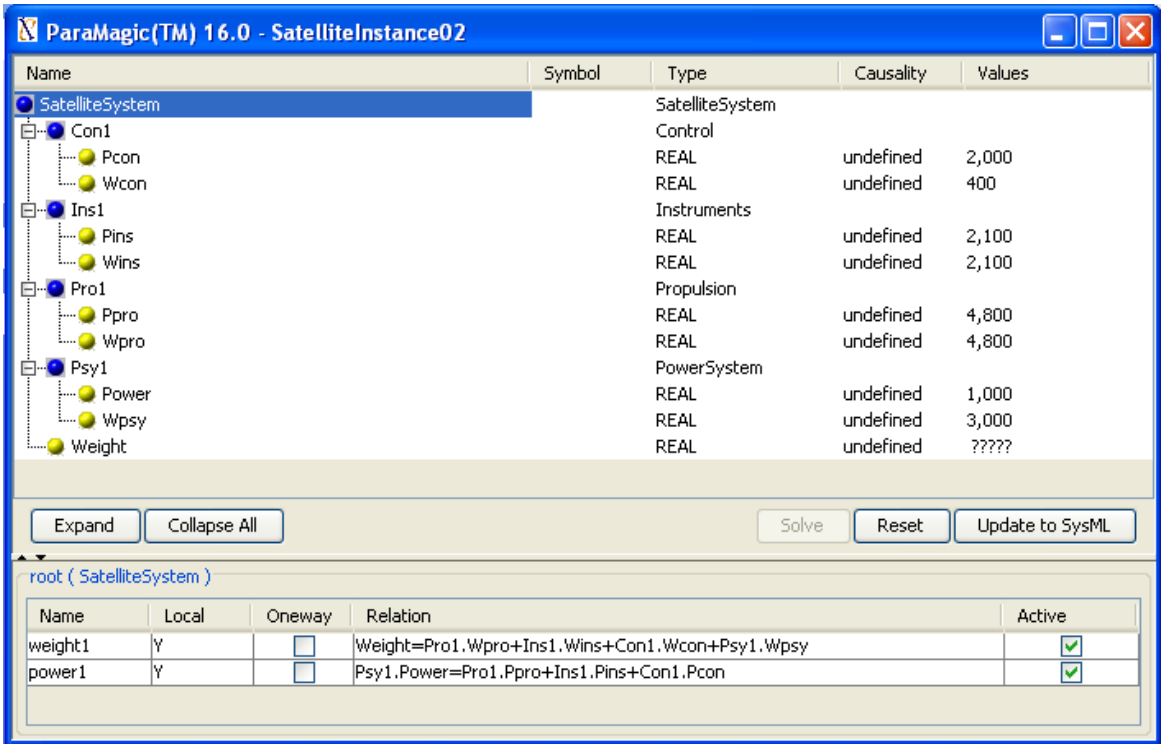


Figure 43 -- ParaMagic Browser

9. You can then use this browser to calculate the values of the properties. For more information on how to use this browser, see Paramagic User Manual.

5.1.5 Using SysML BDD Elements

Block

SysML blocks can be used throughout all phases of system specification and design, and can be applied to many different kinds of systems. These include modeling either the logical or physical decomposition of a system, and the specification of software, hardware, or human elements.

A Block is a modular unit that describes the structure of a system or an element. It may include both structural and behavioral features, such as properties and operations, that represent the state of the system and behavior that the system may exhibit. Some of these properties may hold parts of a system, which can also be described by blocks. A block may include a structure of connectors between its properties to indicate how its parts or other properties relate to one another.

Any reusable form of description that may be applied to a system or a set of system characteristics can be described by a block. Such reusable descriptions, for example, may be applied to purely conceptual aspects of a system design, such as relationships that hold between parts or properties of a system. Parts (properties) in these systems can interact by many different means, such as software operations, discrete state transitions, flows of inputs and outputs, or continuous interactions. Connectors owned by SysML blocks can be used to define relationships between parts or other properties of the same containing block.

Non-Normative Blocks

MagicDraw SysML proposes five block subtypes:

Domain
A Domain is a set of objects with a specific context and specific elements containing resources that are relevant to the objects. A domain should be used to manage those resources.

External 
An External is a block that interacts directly with the system to be modeled. It helps the system modeler identify the system of interest relative to its environment.

System 
A System is an artifact created by humans and consisting of blocks that pursue a common goal that cannot be achieved by the system's individual elements [1]. SysML supports the specifications, analysis, designs, verifications, and validations of a broad range of complex systems. These systems may include hardware, software, information, processes, personnel, and facilities.

Subsystem 
A Subsystem is a system block that, in turn, represents an independent system. This is often the case in a large system (Systems of Systems, SoS) [1]. A subsystem is typically represented by a set of logical or physical parts in a Block Definition Diagram. These parts realize one or more system operations.

System Context 
A System Context is a virtual wrapper around the entire system and its actors [1]. A system context refers to a defined usage of a block. It describes some of the top-level entities in the overall enterprise and their relationships by establishing system boundaries and top level use cases. It depicts each of the constraint blocks or equations that will be used for the analysis and the key relationships between them. A system context can be seen as an interface between systems and their external environments.

These block subtypes are generally used to provide more information on the block usage and/or block context.

Constraint Block 

Constraint blocks provide a mechanism for integrating engineering analysis such as performance and reliability models with other SysML models. Constraint blocks can be used to specify a network of constraints that represent mathematical expressions such as {F=m*a} and {a=dv/dt}, which constrain the physical properties of a system. Such constraints can also be used to identify critical performance parameters and their relationships to other parameters, which can be tracked throughout the system life cycle. A constraint block includes constraints (such as {F=m*a}) and their parameters (such as F, m, and a). Constraint blocks define generic forms of constraints that can be used in multiple contexts.

Reusable constraint definitions can be specified on Block Definition Diagrams and packaged into general-purpose or domain-specific model libraries. Such constraints can be arbitrarily complex mathematical or logical expressions. The constraints can be nested to enable a constraint to be defined in terms of more basic constraints such as primitive mathematical operators.

In general, you should define constraints in constraint blocks in a Block Definition Diagram first, and then use a Parametric Diagram to bind constraint parameters to properties.

Quantity Kind 

A Quantity Kind (formerly 'Dimension' in SysML 1.0 and 1.1 specifications) is a kind of quantity that may be stated by means of defined units. For example, the quantity kind of length can be measured by units of meters, kilometers, or feet.

 The only valid use of a Quantity Kind instance is to be referenced by the "quantity kind" property of a Value Type or Unit stereotype.

Unit 

A Unit is a quantity in terms of which the magnitudes of other quantities that have the same quantity kind can be stated. A unit often relies on precise and reproducible ways of measuring the unit. For example, a unit of length such as meter may be specified as a multiple of a particular wavelength of light. A unit may also specify less

stable or precise ways to express some value, such as a cost expressed in some currency, or a severity rating measured by a numerical scale.

The only valid use of a Unit instance is to be referenced by the “unit” property of a Value Type stereotype.

Value Type

A Value Type is defined as a stereotype of UML Data Type to establish a more neutral term for system values that may never be given a concrete data representation. A Value Type adds an ability to carry a unit of measure of a quantity kind associated with the value. If these additional characteristics are not required, then UML Data Type may be used (it is, however, not recommended by SysML 1.2 specification).

In general, define quantity kinds first, followed by units and their quantity kinds. After that, define value types and their units (and quantity kinds). However, users often forget to enter the corresponding quantity kind of a value type with unit. SysML Plugin provides an active validation constraint for filling the correct quantity kind to a value type with unspecified quantity kind, by selecting the **Apply valid quantity kind to the Value Type** option. See the ‘Validation’ section below for more details.

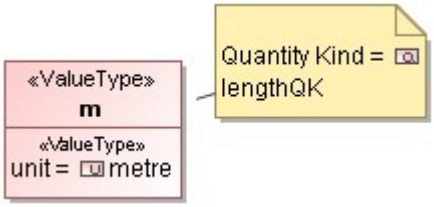


Figure 44 -- Value Type Example

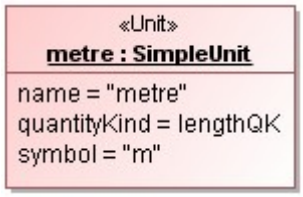


Figure 45 -- Unit Example

NOTE	SysML Plugin contains a model library that holds more than 80 units and quantity kinds of SI system, to be used as references of Value Type elements.

Flow Specification

A Flow Specification specifies inputs and outputs as a set of flow properties. It has a “flowProperties” compartment that lists the flow properties. A flow specification is used to type Flow Ports, in order to specify items which can flow via the ports.

The only valid attribute of a Flow Specification element is a Flow Property.

For more information on the flow port and the flow properties, please refer to the ‘SysML Internal Block Diagrams (IBD)’ section below.

5.1.6 Converting Data Types to SysML Value Types

SysML specification 1.2 suggests to use Value Type as the type of every value property. Therefore, every Data Type typing a Value Property should be either (i) replaced by another Value Type or (ii) converted to be a Value Type.

(i) Replacing UML Primitive Data Type with SysML Value Type

Every Value Property typed by a Primitive Data Type, e.g., Integer, String, Boolean, etc., will break a validation constraint (Figure 46). You can replace such Primitive Data Type usage with a corresponding Value Type easily using the suggested solution “Replace primitive DataType with equivalent ValueType”, when available.

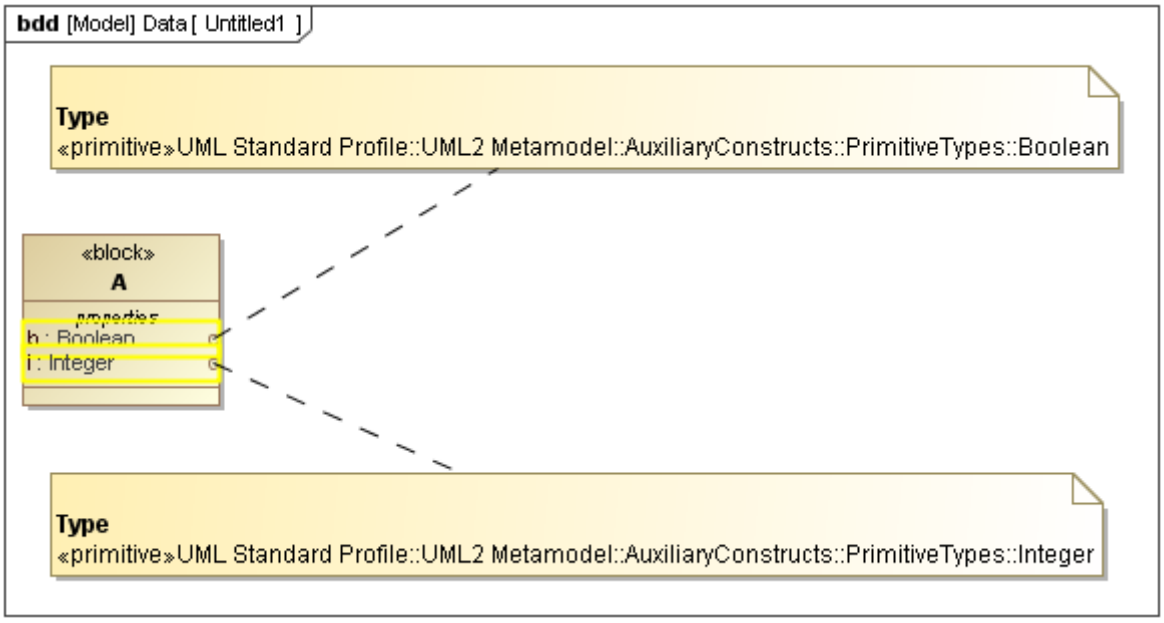


Figure 46 -- Invalid Value Properties

To replace Primitive Data Type with equivalent Value Type:

- In **Active Validation Results** window, select the property(ies) which is(are) typed by Primitive Data Type(s). See 6.1 Active Validation for more detail on such window.
- Right-click on the selected element(s).
- The shortcut menu will display.
- In the menu, select “Replace primitive DataType with equivalent ValueType” (Figure 47).

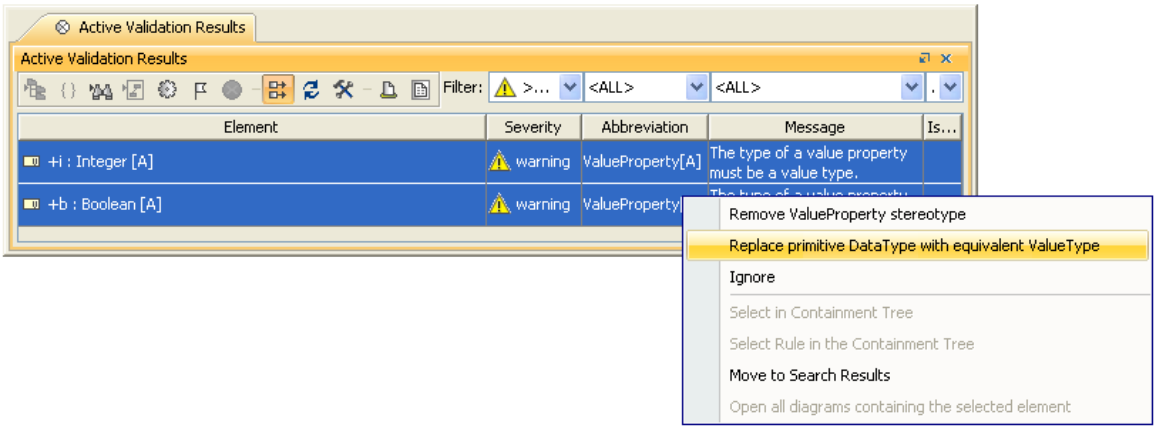


Figure 47 -- Active Validation Results Window Showing Invalid Value Properties

- The the selected property(ies) will then be typed by the equivalent SysML Value Types (Figure 48).

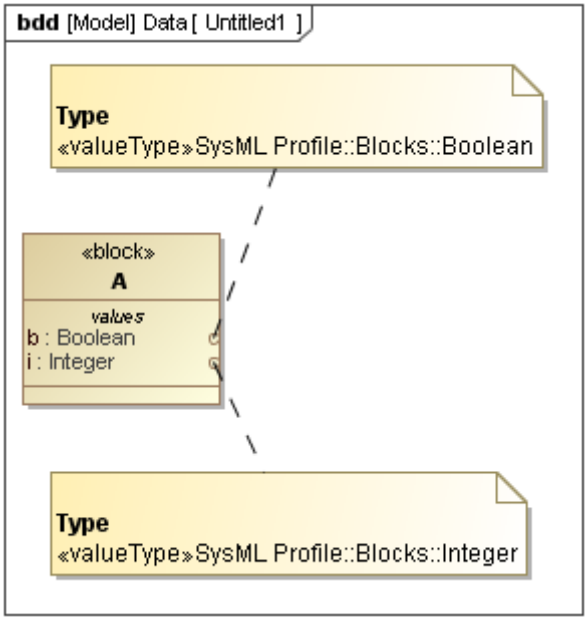


Figure 48 -- Valid Value Properties

(ii) Convert Data Type To Value Type

Simply apply the «ValueType» stereotype to the Data Types which type Value Properties in your SysML project.

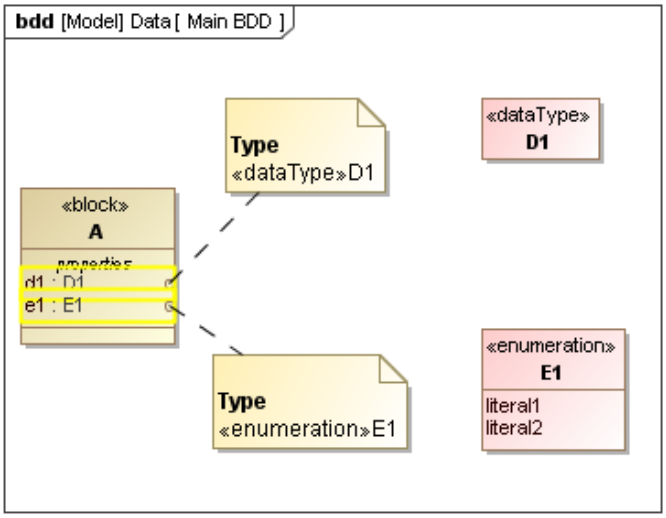


Figure 49 -- Value Properties Typed By Data Types.

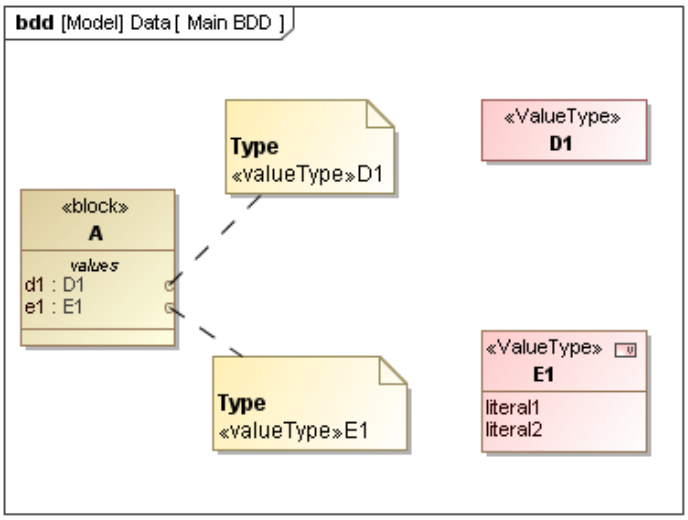


Figure 50 -- Converted Value Properties

You can specify each Value Type's Unit and Quantity Kind later, if necessary.

5.1.7 SysML Callout Box

To create a callout box showing the attributes, constraints and tag values of an element:

1. Either:
   - Created an the anchored Note to the symbol of element on the diagram using the anchor button in smart manipulator or
   - Create **Note** by using the diagram toolbar and create anchor line to the symbol of element.
2. Either :
   - Click **Edit compartment** of anchored Note using the smart manipulator button on **Note** (Figure 51) or
   - Select the context menu items in Edit Compartment menu group (Figure 52).

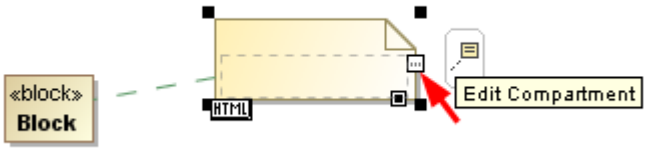


Figure 51 -- Edit Compartment Manipulator Button

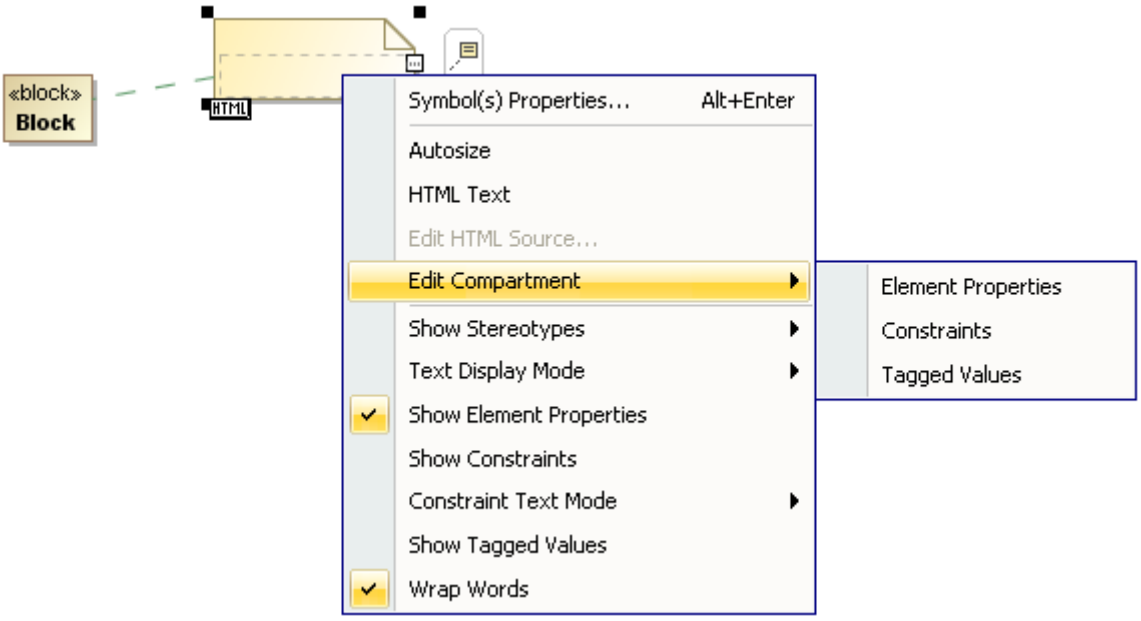


Figure 52 -- Edit Compartment Context Menu Group

3. The Compartment Edit dialog will pop up (Figure 53)

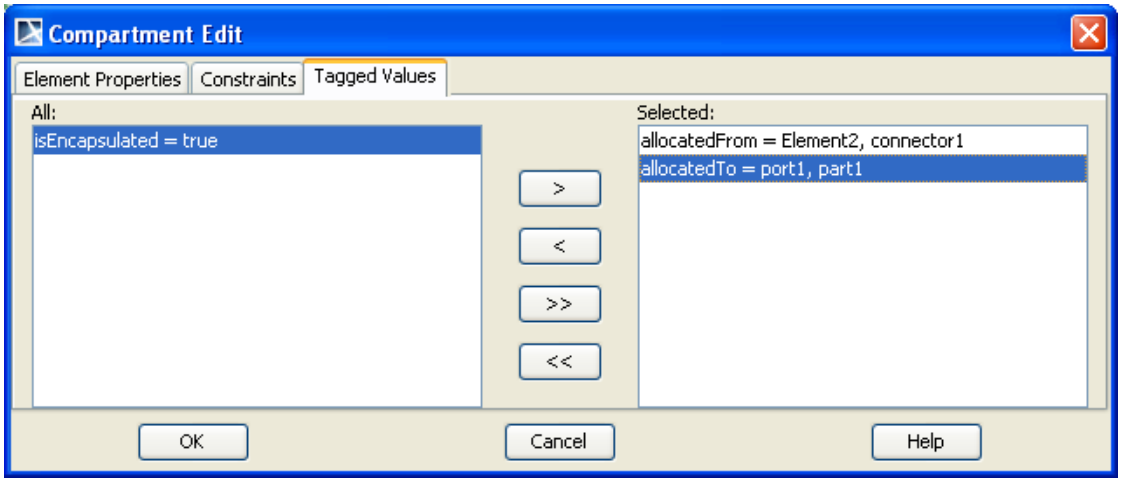


Figure 53 -- Compartment Edit dialog

4. Select the element properties, Constraints and tagged values which you want to show in the callout box. Then click OK to close the dialog.
5. Select **Show Tagged Values** in the context menu of Note symbol to show the selected tagged values in callout box (Figure 54).

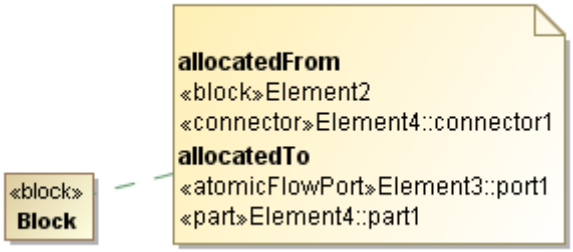


Figure 54 -- Callout Box with the SysML Callout Style

6. You can customize the display of the callout box using Symbol(s) Properties dialog of Note symbol (Figure 55).
    - **SysML Callout Style** symbol property can be used to switch between MagicDraw standard callout style and the SysML callout style. By default, this property is set to true for the SysML project. With SysML callout style, the element types (e.g. «block», «connector», «atomicFlowPort», «part») will be shown instead of the icon of the tagged values which are the model elements.
    - **SysML Element Type** symbol property can be used to show or hide the element types in the callout box when it is displayed with SysML callout style.

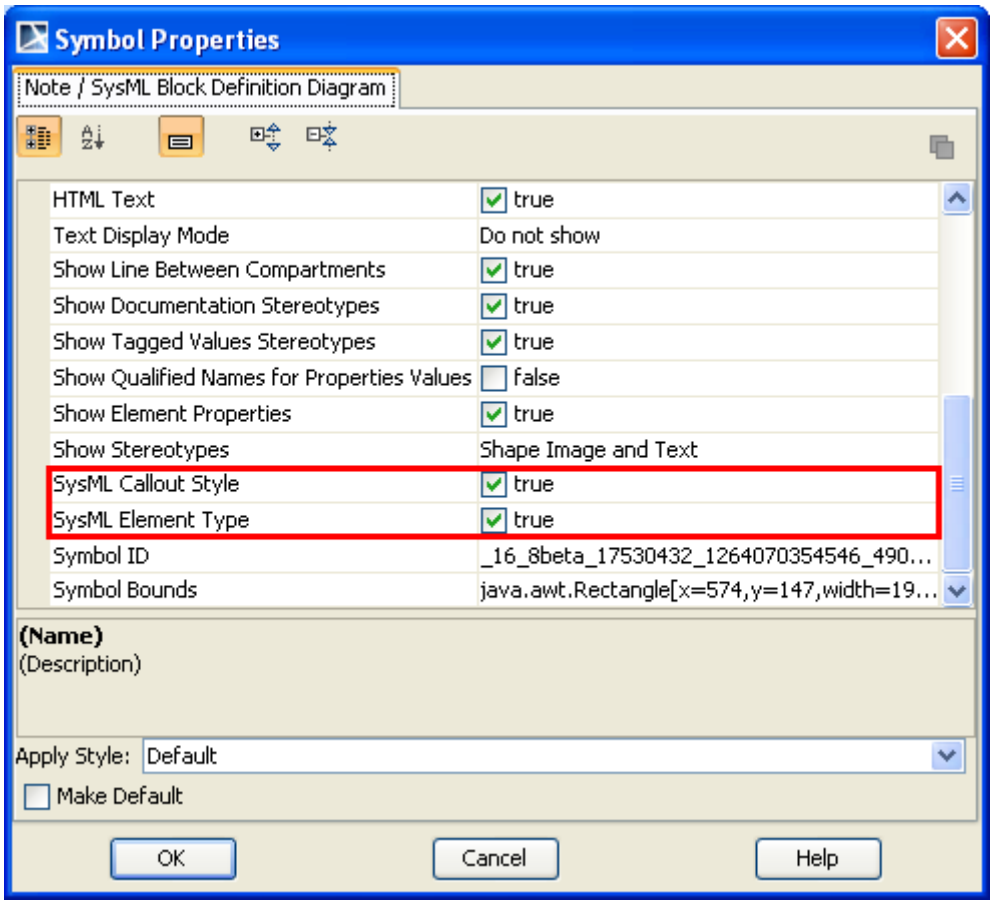


Figure 55 -- Symbol Properties Dialog of Callout Box

NOTE	The new callout notation applies to all types of SysML diagrams.

5.2 SysML Internal Block Diagrams (IBD)

Internal Block Diagrams are based on UML composite structure diagrams and include restrictions and extensions as defined by SysML. An Internal Block Diagram captures the internal structure of a Block in terms of properties and connections among properties. A Block includes properties so that its values, parts, and references to other blocks can be specified. However, whereas an Internal Block Diagram created for a Block (as an inner element) will only display the inner elements of a classifier (parts, ports, and connectors), an Internal Block Diagram created for a package will display additional elements (shapes, notes, and comments).

All properties and connectors that appear inside an Internal Block Diagram belong to (are owned by) a Block whose name is written in the diagram heading. That particular Block is the context of the diagram. SysML permits any property (part) shown in an Internal Block Diagram to display compartments within the property (or part) symbol.

5.2.1 SysML IBD Metamodel and Elements

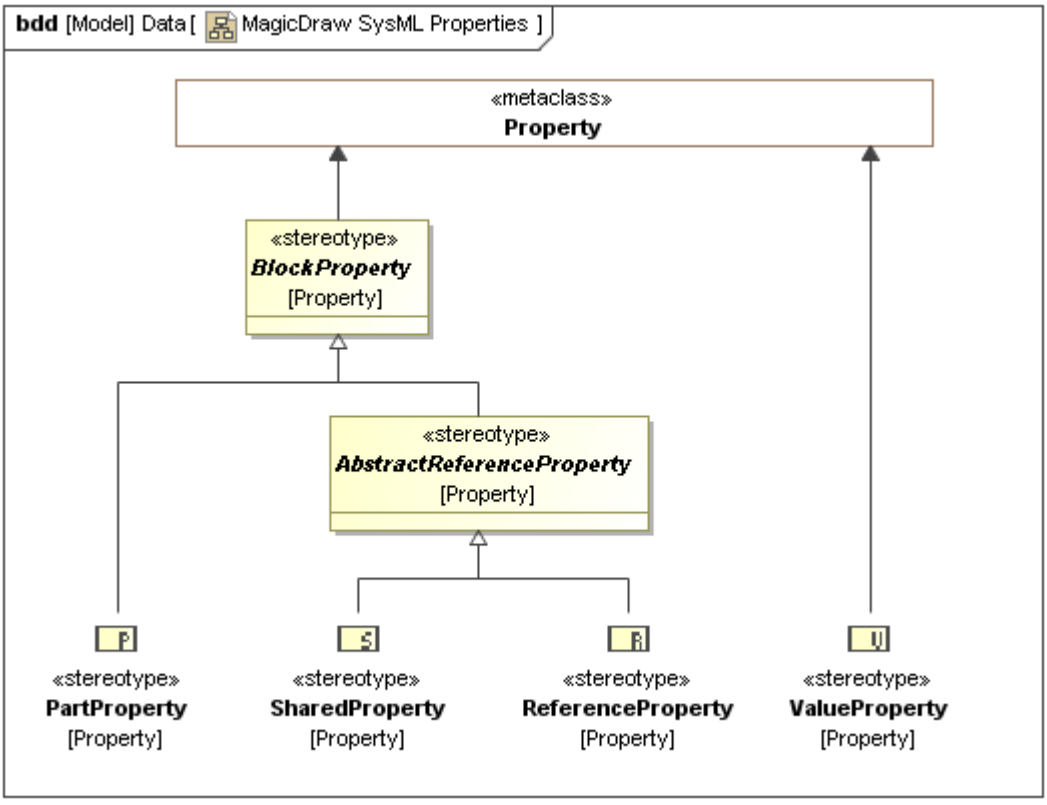


Figure 56 -- MagicDraw SysML Properties Metamodel

Icon	Description
	Part Property [MDSysML]: A Part Property is a property that specifies a part with strong ownership and coincidental lifetime of its containing Block. It describes a local usage or a role of the typing Block in the context of the containing Block. Every Part Property has **'composite' AggregationKind** and is typed by a Block. Part Properties are displayed in the 'parts' compartment.
	Shared Property [MDSysML]: A Shared Property is a property that specifies a shared part of its containing block. Every Shared Property has **'shared' Aggregationkind** and is typed by a block. Shared Properties are displayed in the 'references' compartment.
	Reference Property [MDSysML]: A Reference Property is a property that specifies a reference of its containing Block to another Block. Every Reference Property has **'none' AggregationKind** and is typed by a block. Reference Properties are displayed in the 'references' compartment.
	Value Property [MDSysML]: A Value Property is a property that specifies the quantitative property of its containing Block. Every Value Property has **'composite' AggregationKind** and is typed by a SysML Value Type. Value Properties are displayed in the 'values' compartment.

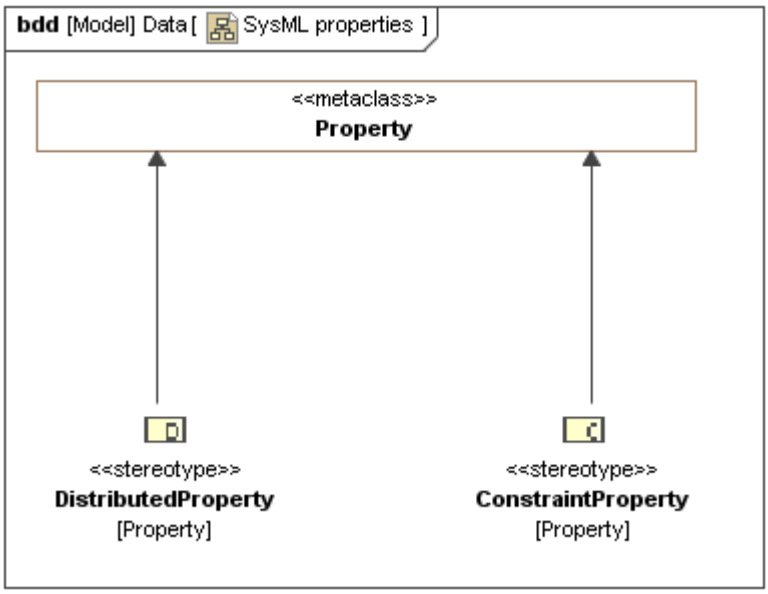


Figure 57 -- SysML Properties Metamodel

Icon	Description
	Constraint Property [SysML]: A Constraint Property is a property that specifies the constraints of other properties in its containing Block. Every Constraint Property has **'composite' AggregationKind** and is typed by a Constraint Block. Constraint Properties are displayed in the 'constraints' compartment.

Icon	Description
	**Distributed Property [SysML]:** A Distributed Property is a property of a Block or a Value Type, used to apply a probability distribution to the values of the property. Specific distributions can be defined by applying a subclass of the DistributedProperty stereotype to the property.

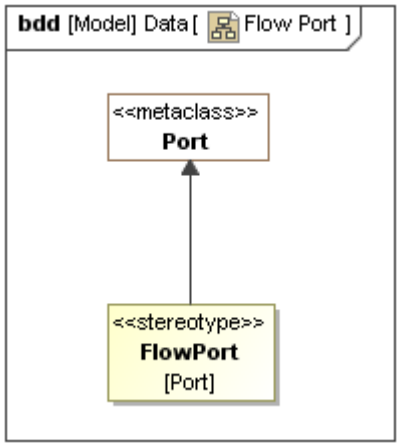


Figure 58 -- Flow Port Metamodel

Icon	Description
	**Flow Port [SysML]:** A Flow Port is a port that specifies the input and output items that can flow between a Block and its environment. Flow Ports are interactions points through which data, material, or energy “can” enter or leave the owning Block. The specification of what can flow is achieved by typing the Flow Port with a specification of things that flow. This can include typing an atomic Flow Port with a single type (Block, Value Type, or Signal) representing the items that flow in or out, or typing a non-atomic Flow Port with a Flow Specification which lists multiple items that can flow. In general, Flow Ports are intended to be used for asynchronous, broadcast, or send-and-forget interactions. Note that only non-atomic Flow Ports can be conjugated. Once conjugated, all the directions of the typing Flow Specification's items are negated.

5.2.2 SysML IBD Toolbar

Element	Button (hot key)
Value Property: See Section 5.2.1 for description.	
Part Property: See Section 5.2.1 for description.	

Element	Button (hot key)
Shared Property: See Section 5.2.1 for description.	
Reference Property: See Section 5.2.1 for description.	
Constraint Property: See Section 5.2.1 for description.	
Distributed Property: See Section 5.2.1 for description.	
Select Nested Part: Click this button to display a nested part inside a given context. For more information, see Section 5.2.3 SysML IBD Specific Features: (vii) Select Nested Part.	
Flow Property [SysML]: A FlowProperty signifies a single flow element that can flow to/from a block. Flow properties are defined directly on blocks or flow specifications that are those specifications which type the flow ports. Flow properties enable item flows across connectors connecting parts of the corresponding block types, either directly (in case of the property is defined on the block) or via flowPorts. A flow property's values are either received from or transmitted to an external block.	
Port [UML]: A Port defines an interaction point on a Block or a part, allowing you to specify what can flow in/out of the Block/part or what services the Block/part requires (expects) from or provides (offers) to its environment. Ports are connected by connectors to other parts or ports.	 (SHIFT + R)
Flow Port [SysML]: See Section 5.2.1 for description.	
Connector [UML]: A connector is used to bind two ports together, representing a relationship between those ports. A connector can be typed by an association. A logical connector can be allocated to a more complex physical path depicting a set of parts, ports, and connectors (refer to allocation).	 (C)
Item Property [SysML]: An optional property that relates the flowing item to the instances of the connector's enclosing block. This property is applicable only for item flows assigned to connectors. The multiplicity is zero if the item flow is assigned to an Association.	

5.2.3 SysML IBD Specific Features

The SysML IBD specific features include:

(i) Display Parts (Diagram shortcut menu)

(ii) Display Ports (Property shortcut menu)

(iii) Edit Compartment (Property shortcut menu)

(iv) Show Default Value and Show Slot Type (Property shortcut menus)

(v) Provided/Required Interfaces (Port shortcut / smart manipulator menu)

(vi) Display/Suppress Structure Compartment (Property shortcut menu)

(vii) Select Nested Part

(i) Display Parts (Diagram shortcut menu)

If you have already defined the part(s) (property(ies)) of a Block, you can then display the part(s) on any IBD, having the Block as its context.

To display parts in an IBD:

1. Right-click an IBD and select **Related Elements** > **Display Parts** (Figure 59). All the parts selected will be listed in the **Select Parts** dialog (Figure 60).

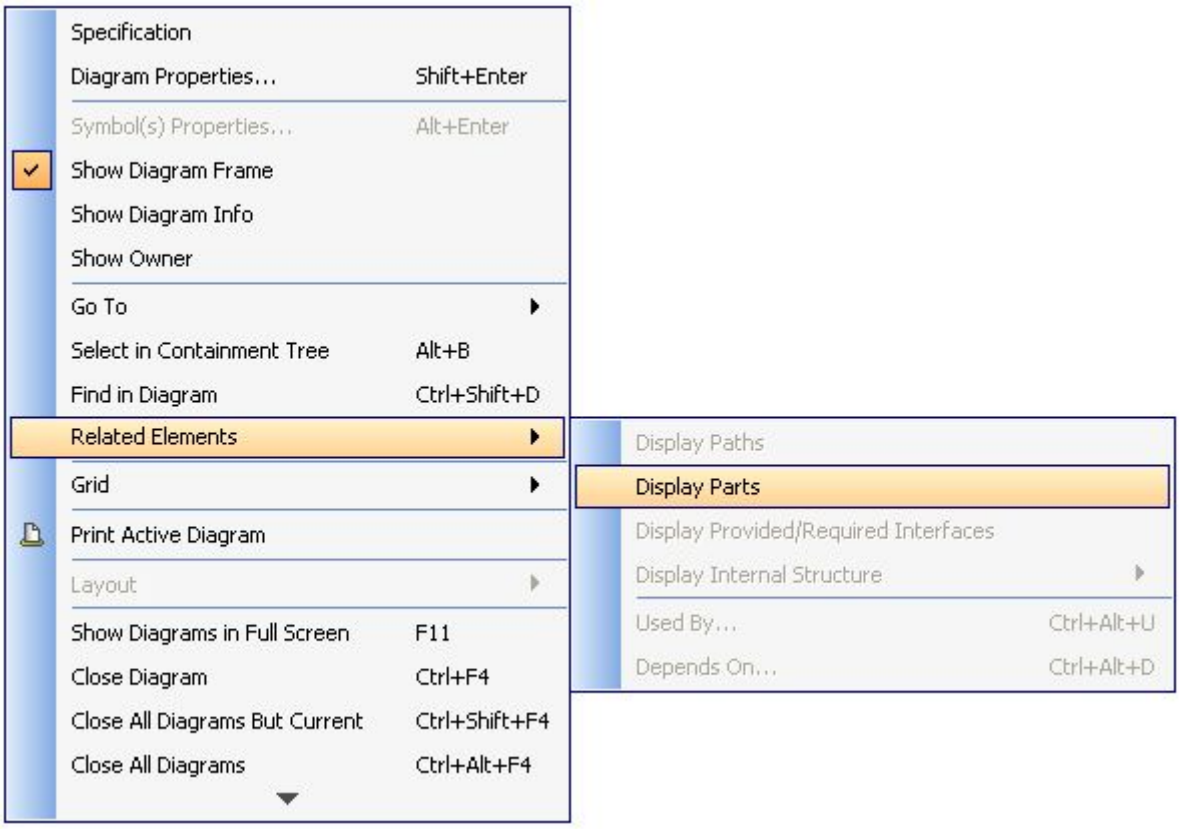


Figure 59 -- Diagram Shortcut Menu to Display Parts (Properties) of the Context of IBD

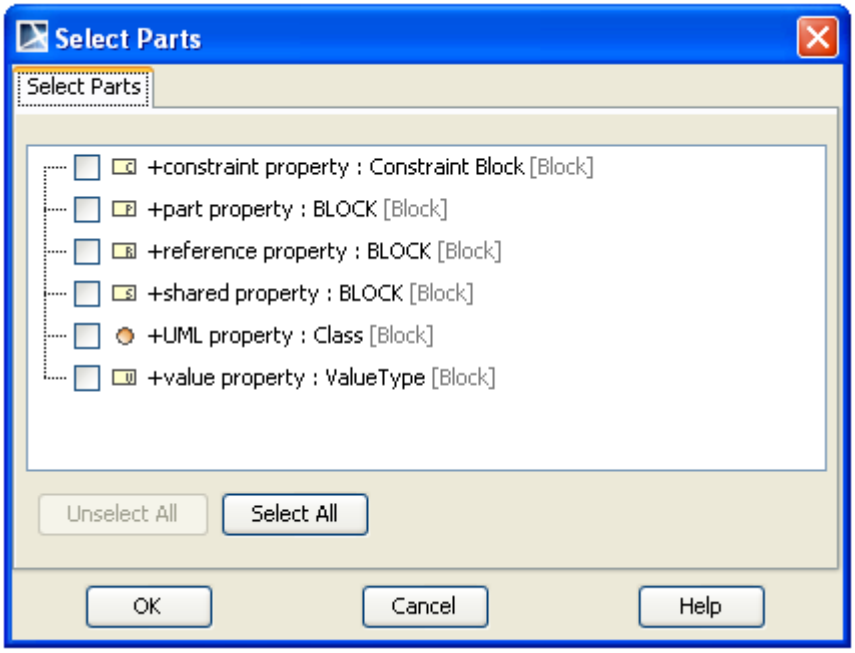


Figure 60 -- Select Parts Dialog

2. Select parts and click **OK** to show the selected parts in the IBD (Figure 60).

(ii) Display Ports (Property shortcut menu)

If you have already defined the port(s) / flow port(s) of a Block, you can then display the port(s) / flow port(s) on any part typed by the Block.

To display ports / flow ports on a part on an IBD:

1. You can either (i) select **Related Elements**. If the type (classifier) of the part owns at least one port/flow port, the **Display Ports** option will be enabled for you to select. Select this option (Figure 61).
   or (ii) click the icon on the **Smart Manipulator** menu of the part, as shown in Figure 62.

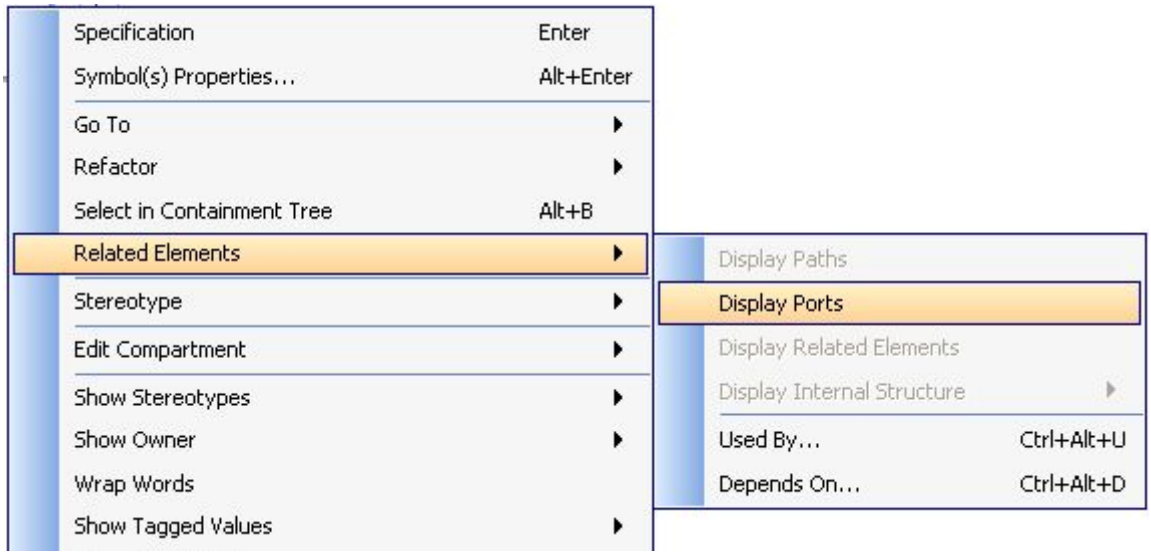


Figure 61 -- Property Shortcut Menu to Display Ports

Figure 62 -- Property Smart Manipulator Menu to Display Ports

2. All ports (including flow ports) will then be listed in the **Select Ports** dialog (Figure 63).
3. Click **OK** (Figure 63) to view the selected (checked) port(s) on the part symbol.

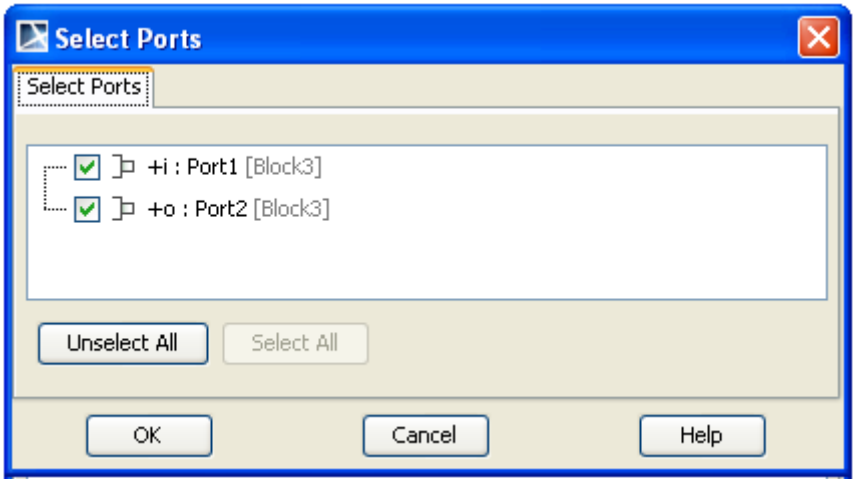


Figure 63 -- Select Ports Dialog

4. The selected ports will then be displayed on the part symbol (Figure 64).

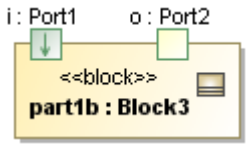


Figure 64 -- Example of Ports Displayed

(iii) Edit Compartment (Property shortcut menu)

You can customize element(s) to be displayed in the various compartments of a part. Such compartments include Constraints, Tagged Values, Default Value, Structure, etc.

To customize a compartment of a part:

1. Right-click a part and select **Edit Compartment** on the shortcut menu.
2. Select a compartment to be customized (Figure 65). The **Compartment Edit** dialog will open (Figure 66).

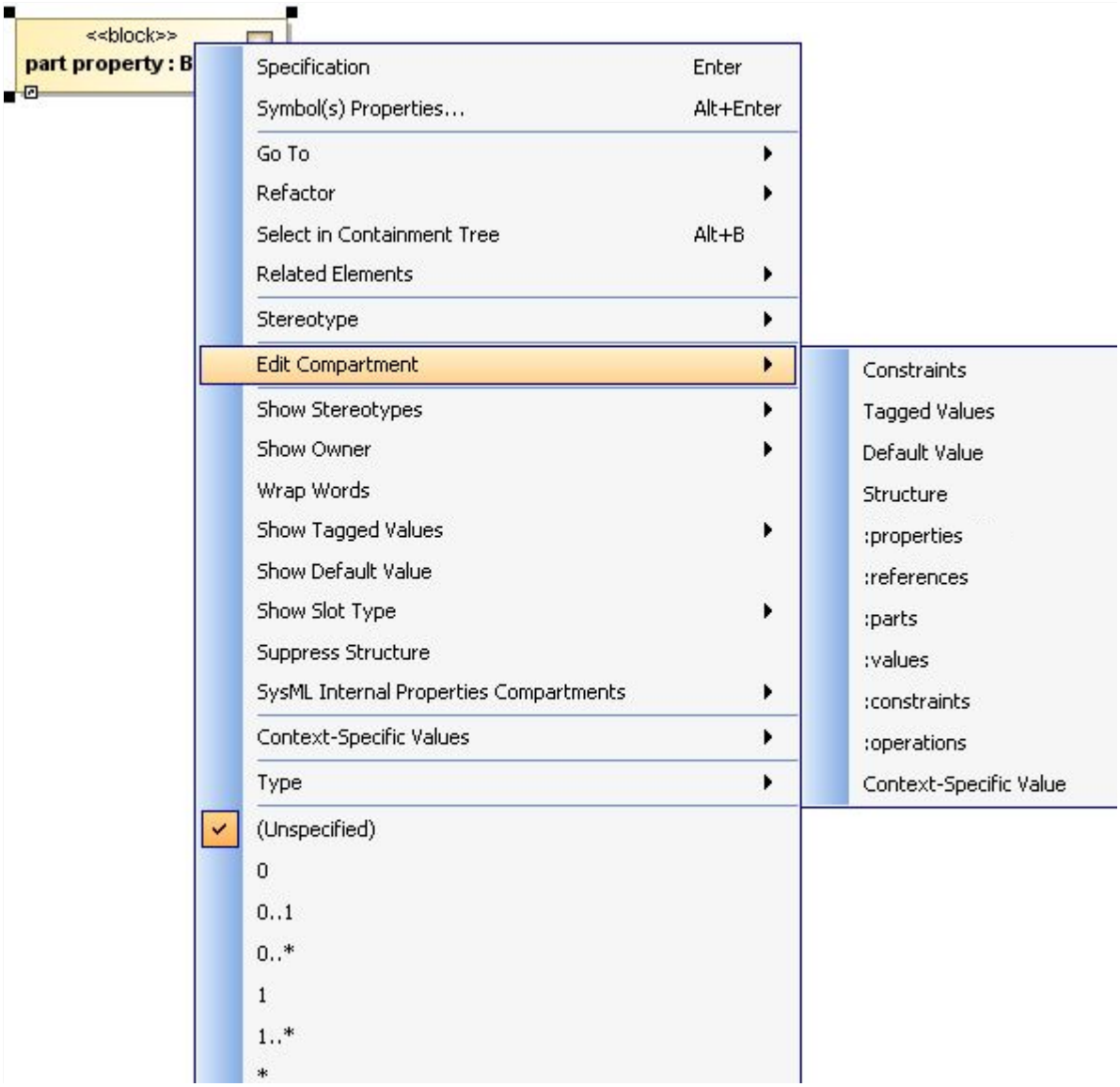


Figure 65 -- Property Shortcut Menu to Customize Part Compartments

3. In the **Compartment Edit** dialog, move an element from the **All:** to the **Selected:** box to display the element (Figure 66). Click **OK** when done.

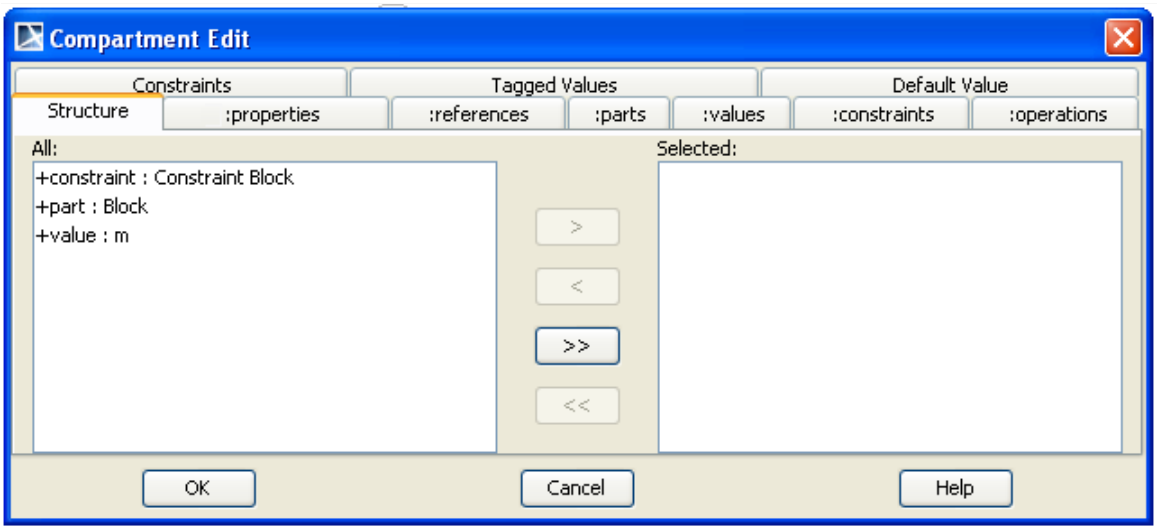


Figure 66 -- Compartment Edit Dialog

(iv) Show Default Value and Show Slot Type (Property shortcut menus)

Use (a) **Show Default Value** to display the default value of a part. If the default value is an Instance Specification, the **defaultValue** compartment containing the Instance Specification slot(s) will be displayed on the part instead. In this case, you can use (b) **Show Slot Type** to display the type(s) of the slot(s) in the compartment.

(a) Show Default Value

To display the default value of a part (property):

1. Right-click a part or property and select **Show Default Value** (if it already has a default value) on the shortcut menu (Figure 67).

NOTE	If the property has no default value, drag an instance with slot(s) to the property symbol. The instance will then be assigned as the default value for this property, and its slots with values will be displayed inside the property symbol (Figure 68).

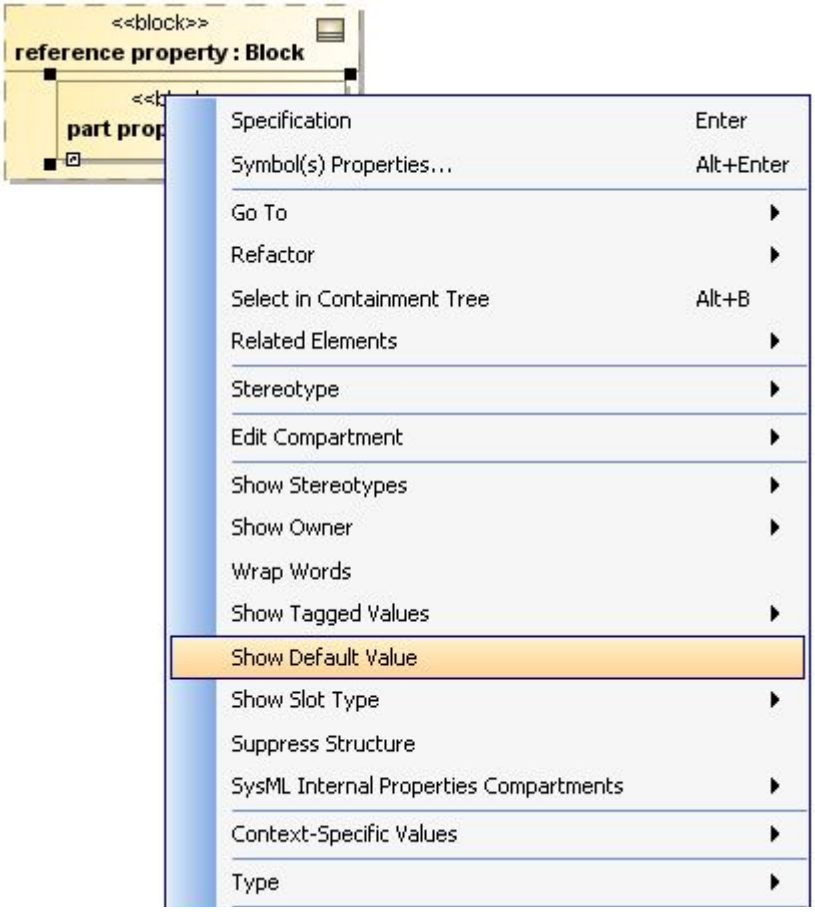


Figure 67 -- Property Shortcut Menu to Show Default Value

2. The default value of the property will be displayed. If the default value is an Instance Specification, the **defaultValue** compartment containing the Instance Specification slot(s) will be displayed instead (Figure 68).

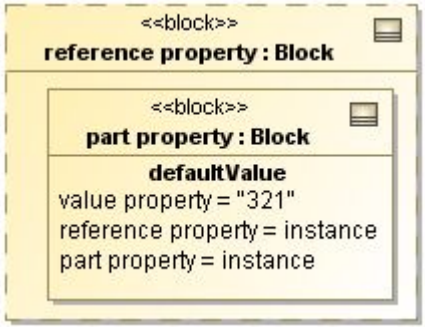


Figure 68 -- defaultValue Compartment

(b) Show Slot Type

Use the Show Slot Type shortcut menu to display the slot types in the defaultValue compartment of a property, having an Instance Specification as its default value:

To display the slot types of a part:

1. Right-click a property and select **Show Slot Type** on the shortcut menu. Three **Show Slot Type** options will be available on the shortcut menu (Figure 69): (i) None (no type slot will be displayed), (ii) Name, and (iii) Qualified Name.

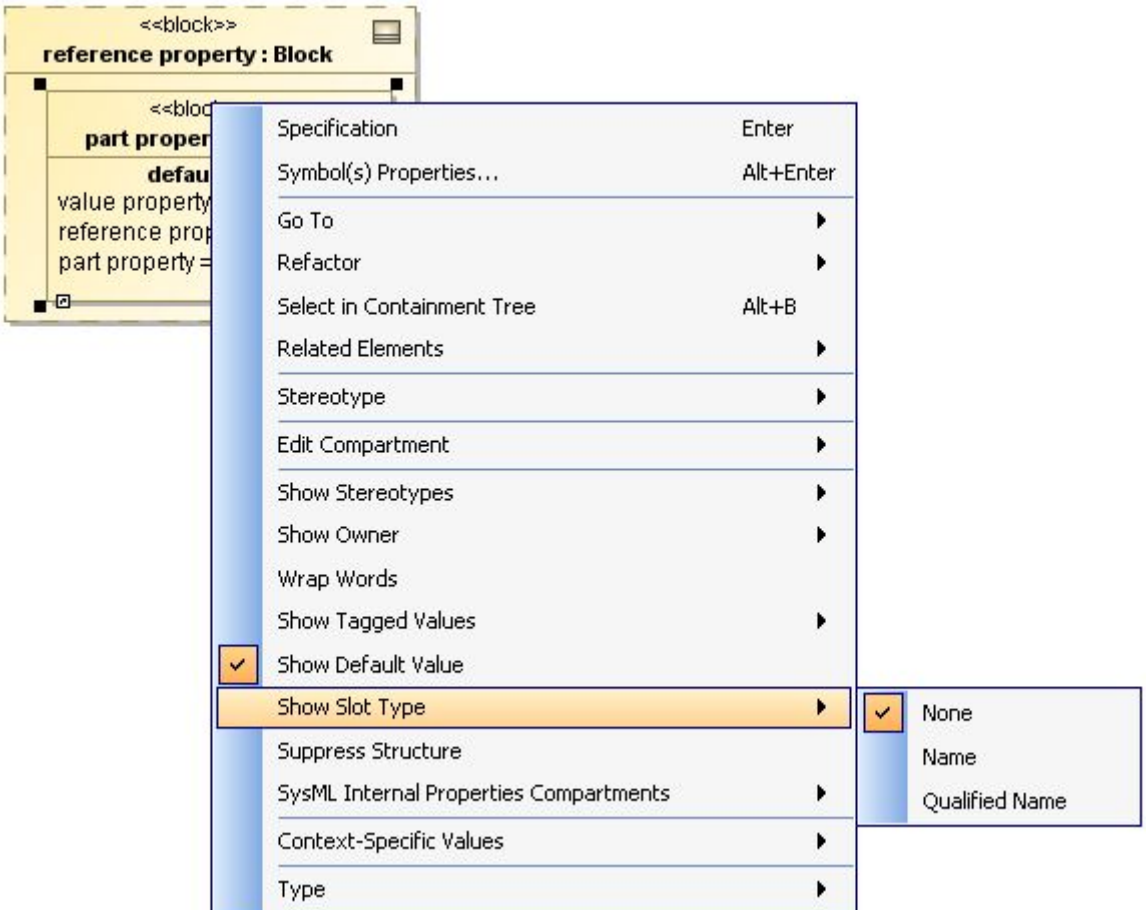


Figure 69 -- Property Shortcut Menu to Show Slot Types

2. If you select **Name** or **Qualified Name**, the slot types will be displayed (Figure 70).

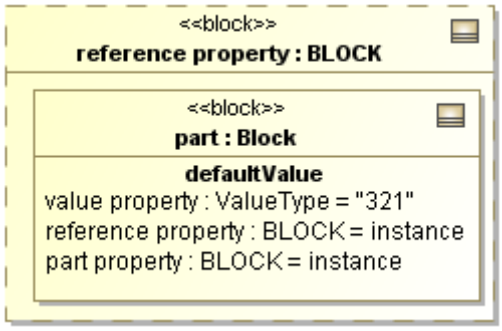


Figure 70 -- defaultValue Compartment with Slot Types

(v) Provided/Required Interfaces (Port shortcut / smart manipulator menu)

Provided/Required Interfaces help identify compatible ports that can be connected together in an IBD. On a port, you can either

(a) create a new Provided/Required Interface(s) using the port specification dialog, or

(b) display an existing Provided/Required Interface(s) using the port shortcut menu.

(a) Creating New Provided/Required Interface(s) Using the Port Specification Dialog

To create new Provided/Required Interface(s) of a port:

1. Either,
   - Right-click a port to open its shortcut menu, and then select **Specification** to open the **Specification** dialog. Then, select the **Provided/Required Interfaces** group to open the **Provided/Required Interfaced** pane (Figure 72).

   OR

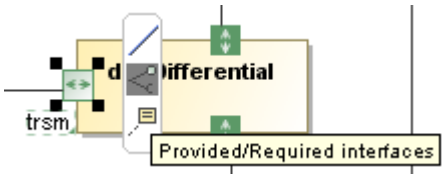


Figure 71 -- Port Smart Manipulator Menu - Provided/Required Interfaces

   - Click a port in a diagram to open its smartmanipulator menu, and then select the **Provided/Required interfaces** icon to open the **Provided/Required Interfaced** pane(Figure 72).

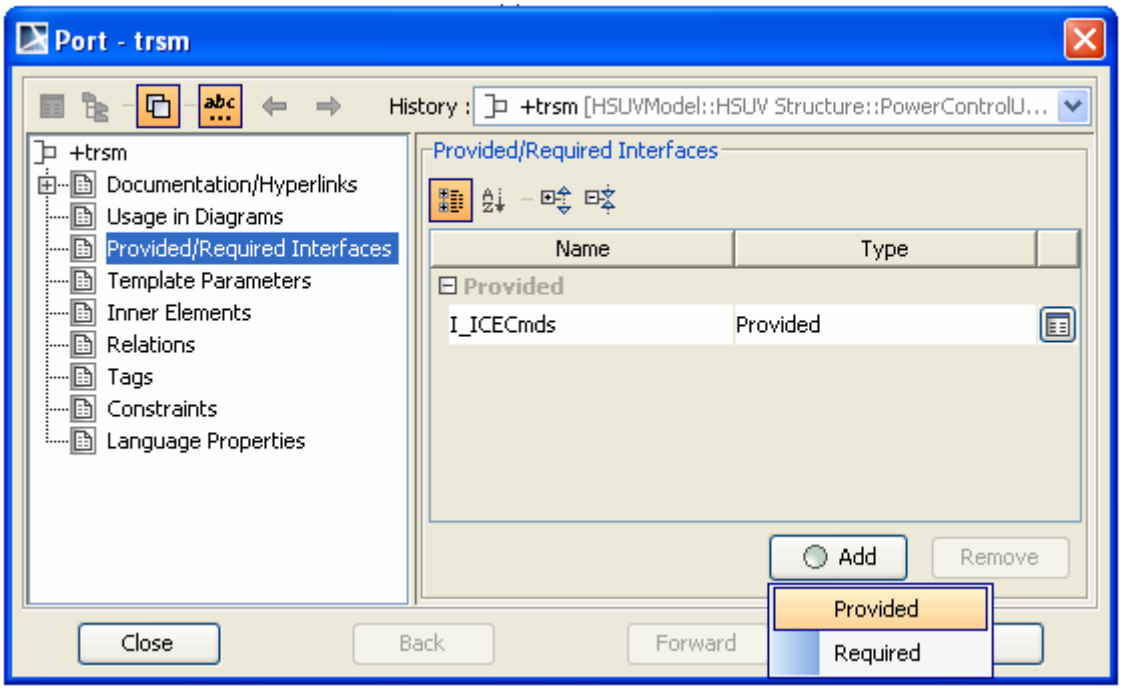


Figure 72 -- Port Specification Dialog, Provided/Required Interfaces Group

NOTE	Only typed ports can **realize** / **use** interfaces.

2. Click **Add** (Figure 72) and then select either (i) **Provided** or (ii) **Required**.

Case 1) If the port is typed, the **Select Interface** dialog will open (Figure 73). You can then either:

- select any of the existing interfaces (and flow specifications) to be used as the Provided / Required Interface of the port, or
- click **Create** to create a new interface. The interface specification dialog will then be displayed, prompting you to type in its name. The new interface will then be used as the Provided / Required Interface of the port.

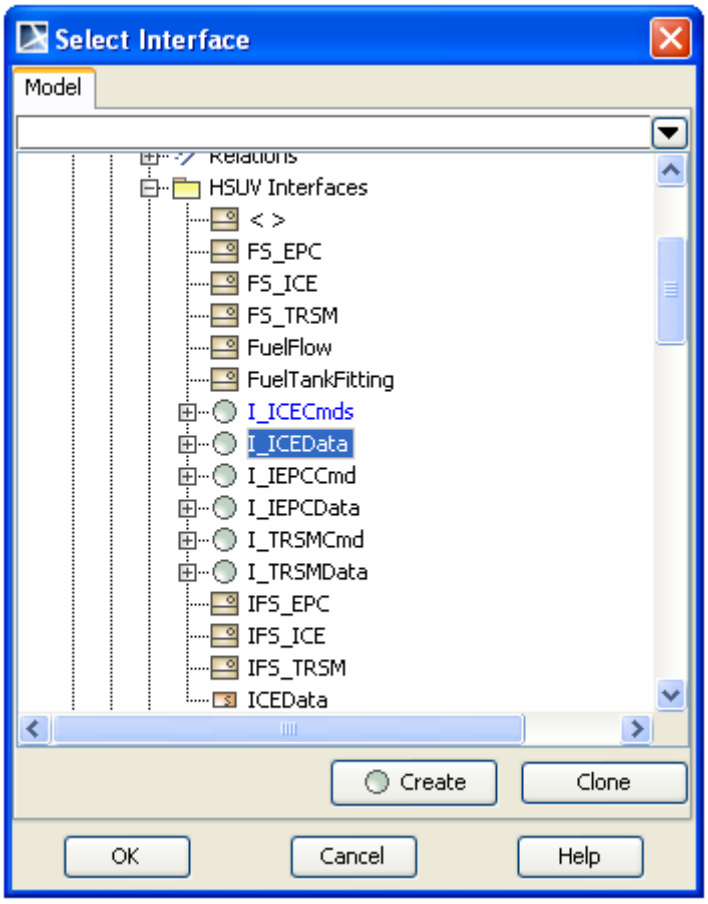


Figure 73 -- Select Interface Dialog

Case 2) If the port is not typed, the **Select Port Type** menu will then display (Figure 74 if **Provided** is selected, and Figure 75 if **Required** is selected).

Figure 74 -- Select Port Type Menu - Provided Interface

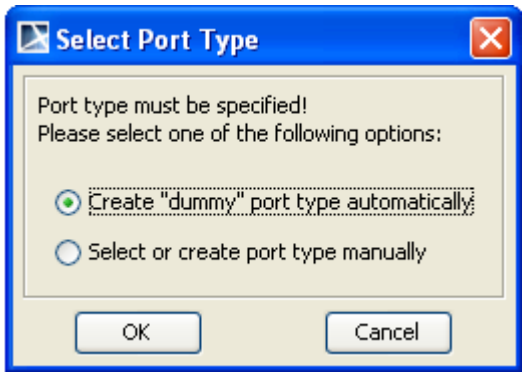


Figure 75 -- Select Port Type Menu - Required Interface

You can then select:

- (For Provided Interface only) **Set provided interface as port type**. The **Select Interface** dialog (Figure 73) will then open. In the dialog, you can either choose an existing interface or create a new one, to be used as the Provided Interface and the type of the port.
- **Create "dummy" port type automatically**. The **Select Interface** dialog (Figure 73) will then open. In the dialog, you can either choose an existing interface or create a new one, to be used as the Provided or Required Interface (as selected in Figure 72) of the port. In addition, a dummy classifier, realizing (for Provided) or using (for Required) the interface, will be automatically created and used as the type of the port.
- **Select or create port type manually**. The **Select Port Type** dialog (Figure 76) will then open. You can then choose a classifier to be used as the type of the port. Click **OK**, the **Select Interface** dialog (Figure 73) will then open. In the dialog, you can either choose an existing interface or create a new one, to be used as the Provided or Required Interface (as selected in Figure 72) of the port. In addition, a Realization (or Usage) dependency will be automatically created from the port type to the Provided (or Required) Interface of the port.

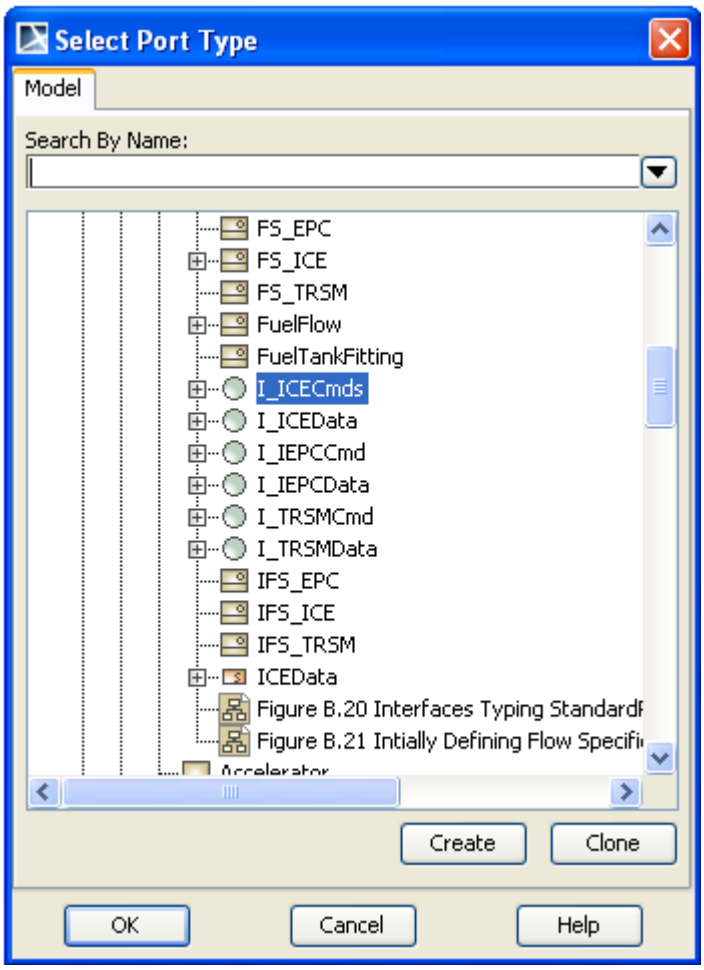


Figure 76 -- Select Port Type Dialog for Provided / Required Interface

(b) Displaying Existing Provided/Required Interface(s) Using the Port Shortcut Menu

To display the existing Provided/Required Interface(s) of a port:

1. Right-click a port to open its shortcut menu. Then, either;
   - select **Show Required Interfaces** or **Show Provided Interfaces** (Figure 77),

   or
   - select **Related Elements > Display Provided/Required Interfaces** (Figure 78).

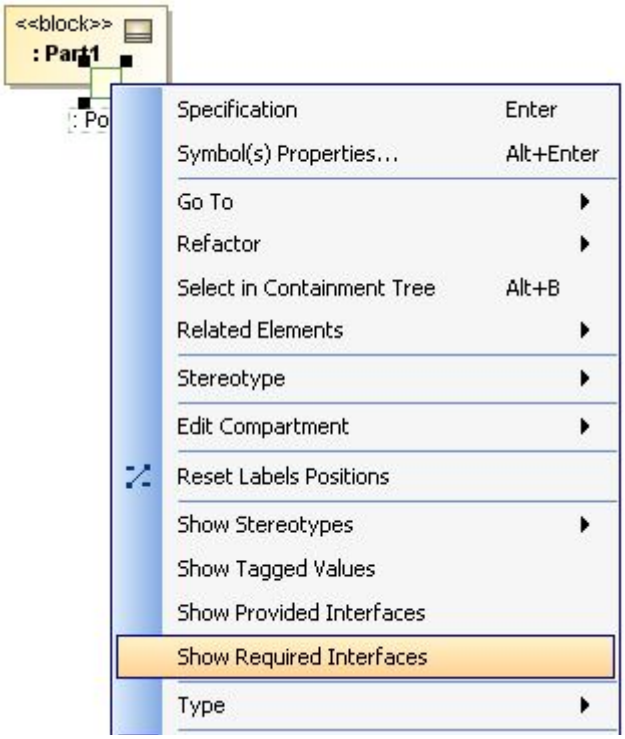


Figure 77 -- Port Shortcut Menu to Display Provided or Required Interface(s)

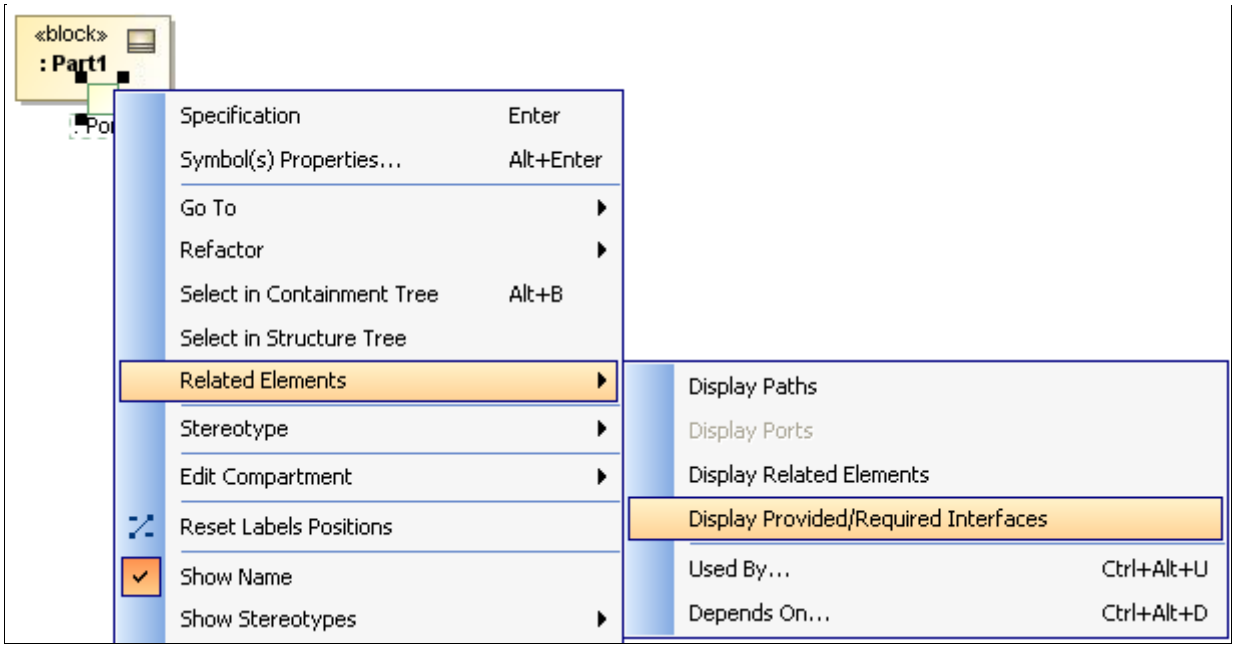


Figure 78 -- Port Shortcut Menu to Display Provided and Required Interface(s)

2. The Required / Provided Interfaces will be displayed on the port, in the form of ball-socket (lollipop) notation (Figure 79).

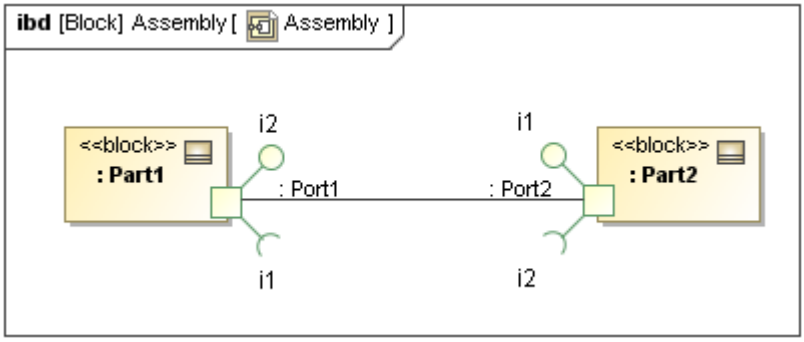


Figure 79 -- IBD with Required and Provided Interfaces Displayed

The model in Figure 79 corresponds to the model in Figure 80.

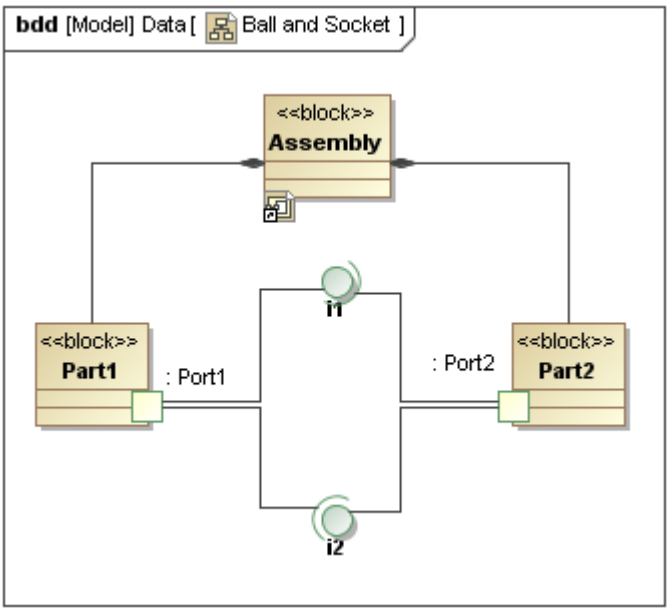


Figure 80 -- BDD with Parts, Ports and Interfaces

(vi) Display/Suppress Structure Compartment (Property shortcut menu)

OMG SysML specifications allow properties to have structure compartments so that their internal properties (structures) can be shown.

To display the structure compartment of a property:

1. Right-click a propterty and clear the **Suppress Structure** option on the shortcut menu (Figure 81) (do the opposite to suppress the structure compartment).

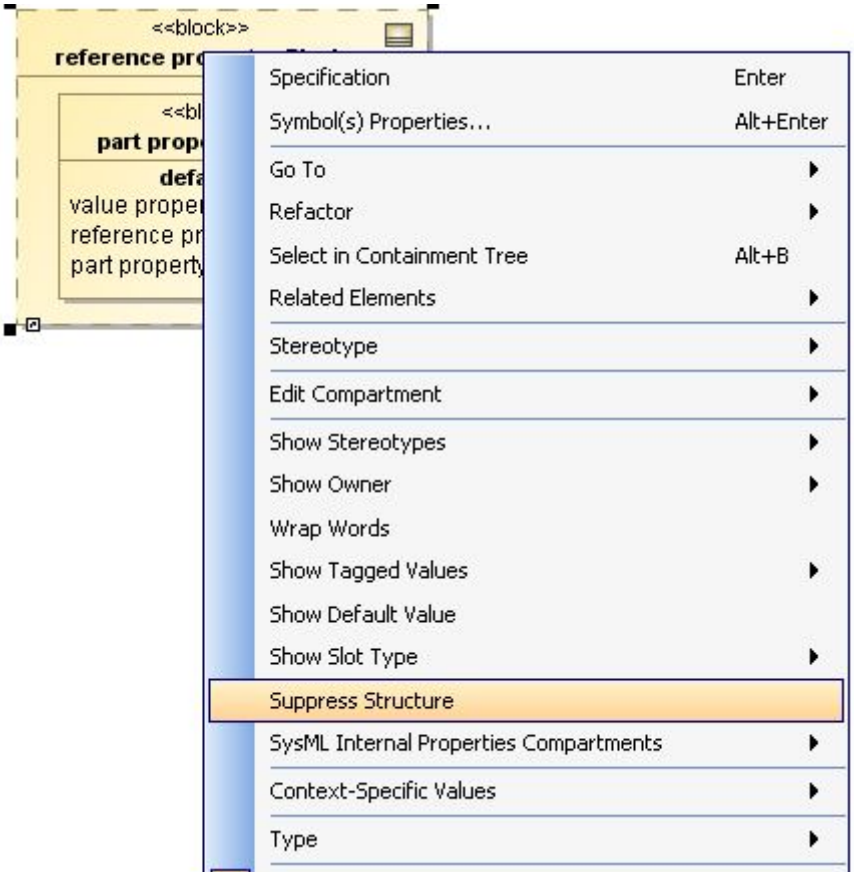


Figure 81 -- Property Shortcut Menu to Display Structure Compartment

2. The structure compartment of the property will be displayed (Figure 83). Otherwise, the property will look like in Figure 82.

Figure 82 -- Part without Structure Compartment

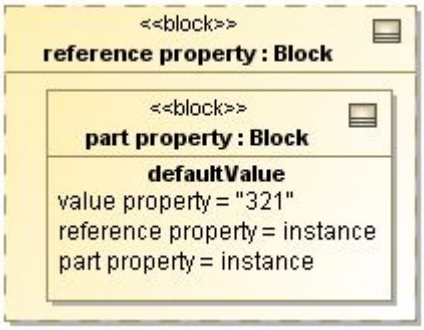


Figure 83 -- Part with Structure Compartment

NOTE	Regarding a typed property with its structure compartment displayed, you can also drag a classifier to the compartment to create a new property (part) typed by that classifier.

(vii) Select Nested Part

Use the **Select Nested Part** button on the IBD toobar to display a nested part inside a given context. We will demonstrate how to use the button using the example in Figure 84.

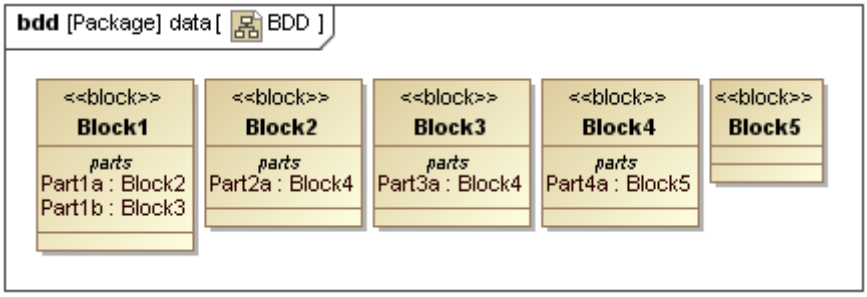


Figure 84 -- BDD with Blocks and Their Properties

To display a nested part:

1. Click the **Select Nested Part** button on the IBD toolbar.
2. Click on the diagram pane. The **Select Element** dialog will appear, showing all parts (properties) nested inside the context of the IBD, for example, Block1 (Figure 85).

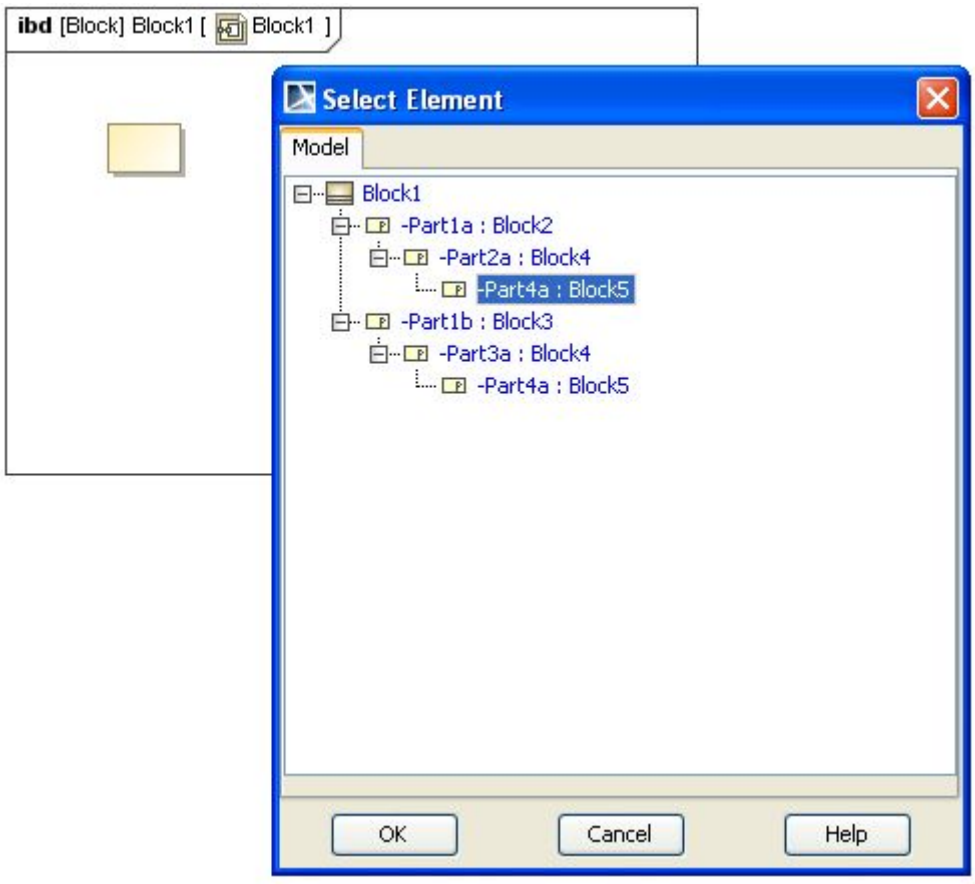


Figure 85 -- Select Element Dialog

3. Select a part and click **OK**. If **Part4a** (typed by Block5) is selected, the following part will be displayed (Figure 86).

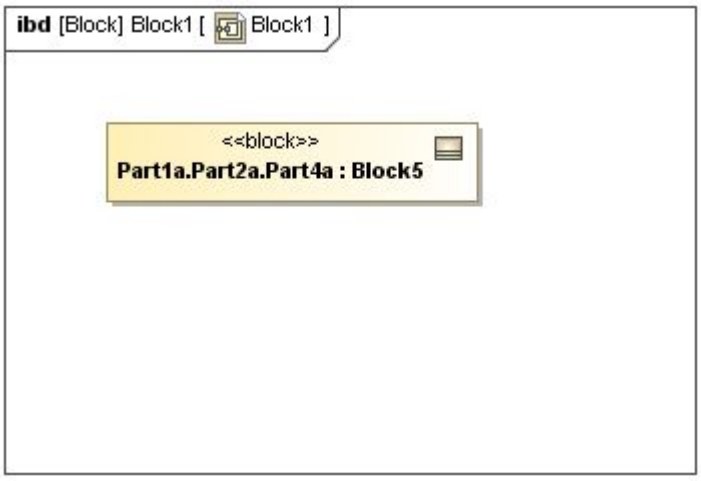


Figure 86 -- IBD of Block1 and the Selected Nested Properties

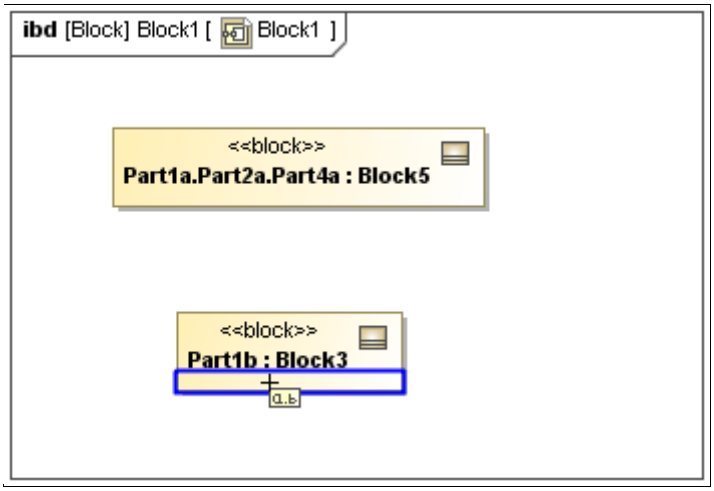


Figure 87 -- Creating a New Property

4. Here is another example. If a property of Block1 block; part1b (typed by Block3) is placed on **Block1** of the IBD (Figure 87), select the **Select Nested Part** button on the IBD toolbar and place it on the **part1b : Block3** symbol. The following **Select Element** dialog will open (Figure 88).

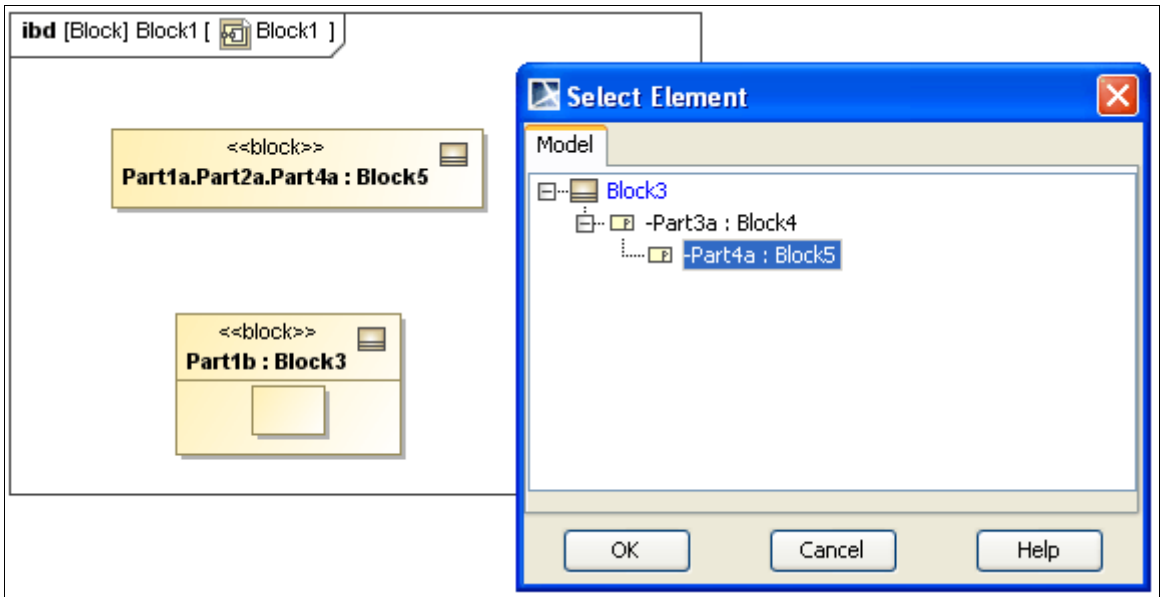


Figure 88 -- Placing the newly-created Property on the IBD as a Neste Part

5. In this last example, the dialog in Figure 88 shows all parts (properties) nested inside Block3. If **part4a** (typed by Block5) is selected, the result will be as in Figure 89.

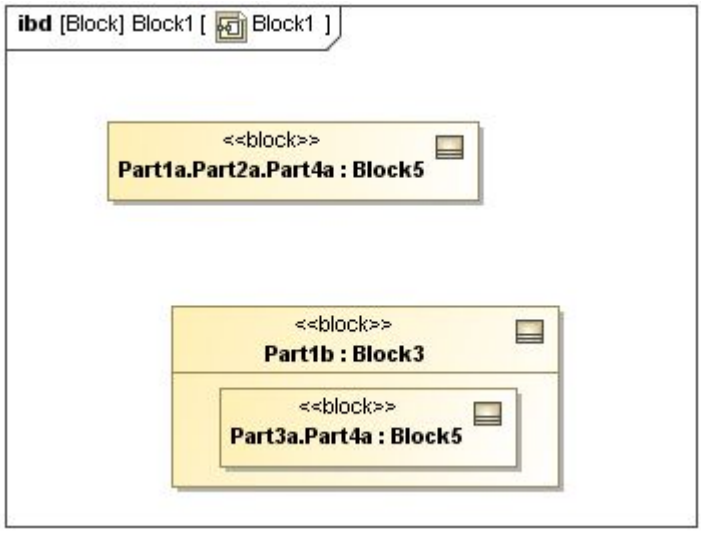


Figure 89 -- The Selected Nested Part Displayed

As these examples show, the **Select Nested Part** button allows you to display a deep-nested part, without having to display its parent(s) first.

5.2.4 Displaying Structures of Blocks in Compartments or in IBDs

MagicDraw Composite Structure diagrams will not let you display the already-defined internal structures of Blocks reused as parts in other structures (deep-nested structures). The same problem exists when you need to modify/extend existing structures in subtypes. Composite Structure diagrams will only let you display:

- parts
- ports on the frame
- ports on every part;and

- paths for every part and port.

Thus, to redisplay an internal structure in another structure, you have to recreate the internal structure manually. The graphical layout must also be applied manually, making it a time-consuming activity.

With the **Display Internal Structure** feature you can copy-and-paste (display) an existing structure diagram defining a Block (Class) in either:

- the structure compartment of that Block, a subtype of that Block, a part typed by that Block, or a part typed by a subtype of that Block, or
- another diagram defining either a subtype of that Block or that Block itself.

With this feature, you can now display the already-defined internal structures of Blocks, reused as parts in other structures (deep nested structures).

To redisplay a Block structure, already-defined in, at least, one structure diagram:

1. Suppose there is the **FrontWheelsAssembly** IBD, having the **FrontWheelsAssembly** block as its context.
2. Right-click the property and select **Related Elements** > **Display Internal Structure** from the shortcut menu (Figure 90). Each IBD having either the type or a supertype of the type of the property as its context will be available for you to select. For example, in Figure 90, the **FrontWheelsAssembly** IBD is available. Select it to display the structure of **FrontWheelsAssembly** block in the property (Figure 91).

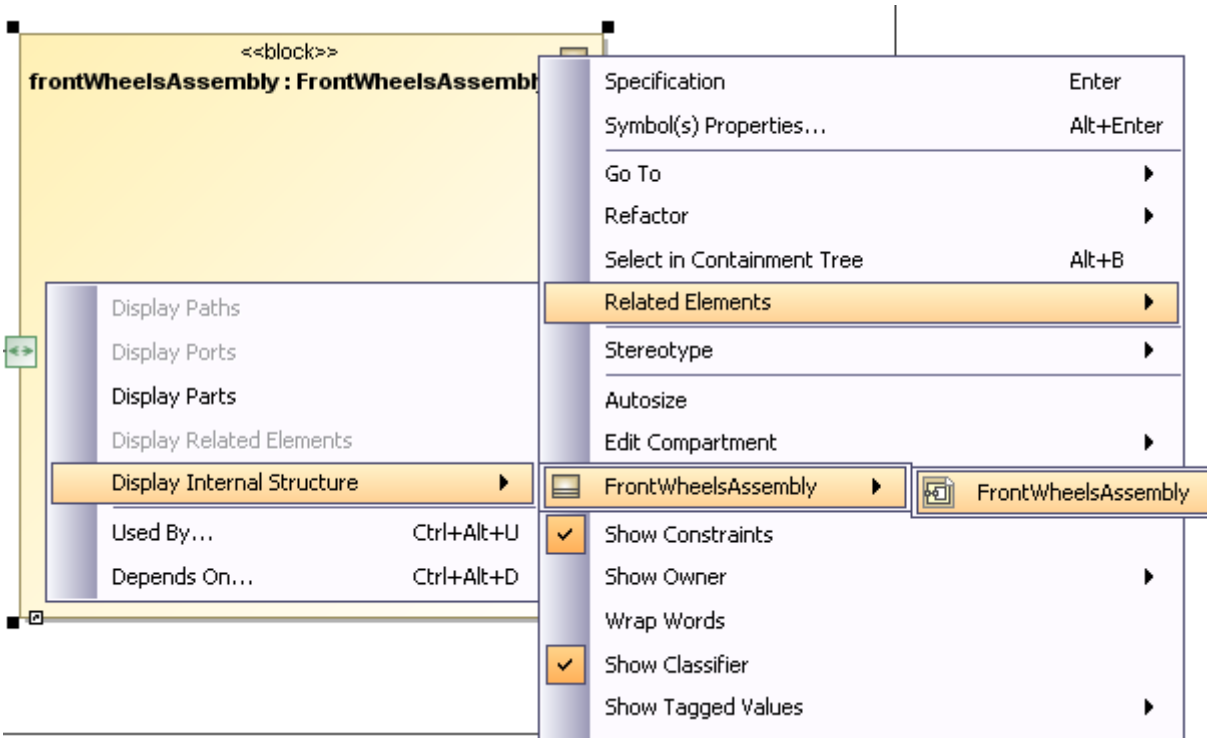


Figure 90 -- Display Structure Block Shortcut Menu

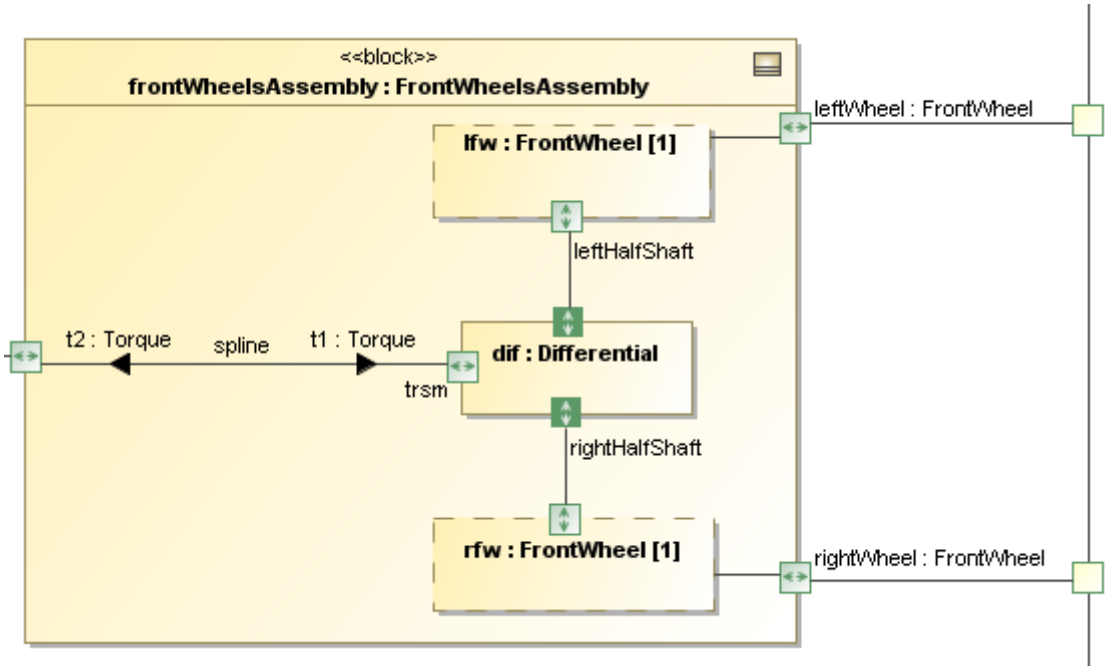


Figure 91 -- Sample of Structure Displayed in Property

3. You can also display the structure in a new blank IBD, having the **FrontWheelsAssembly** block or a subtype of the **FrontWheelsAssembly** block (Figure 92) as its context, using the IBD shortcut menu (Figure 93). The structure will be as in Figure 94.

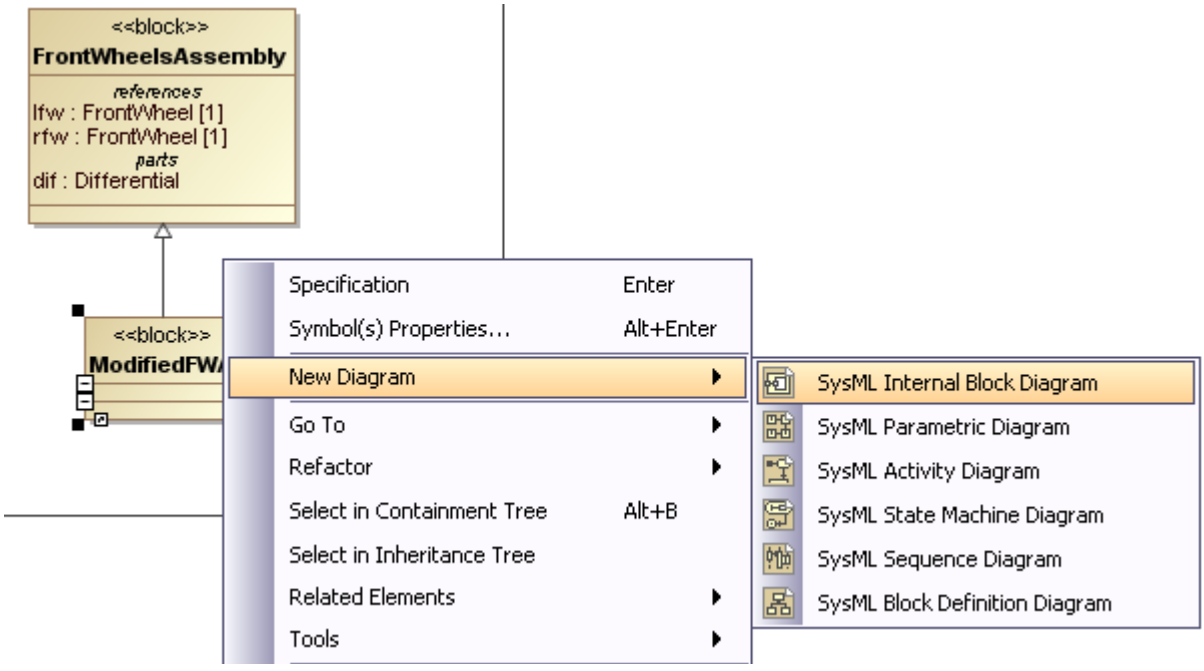


Figure 92 -- Creating an IBD for the Subtype of the FrontWheelsAssembly Block

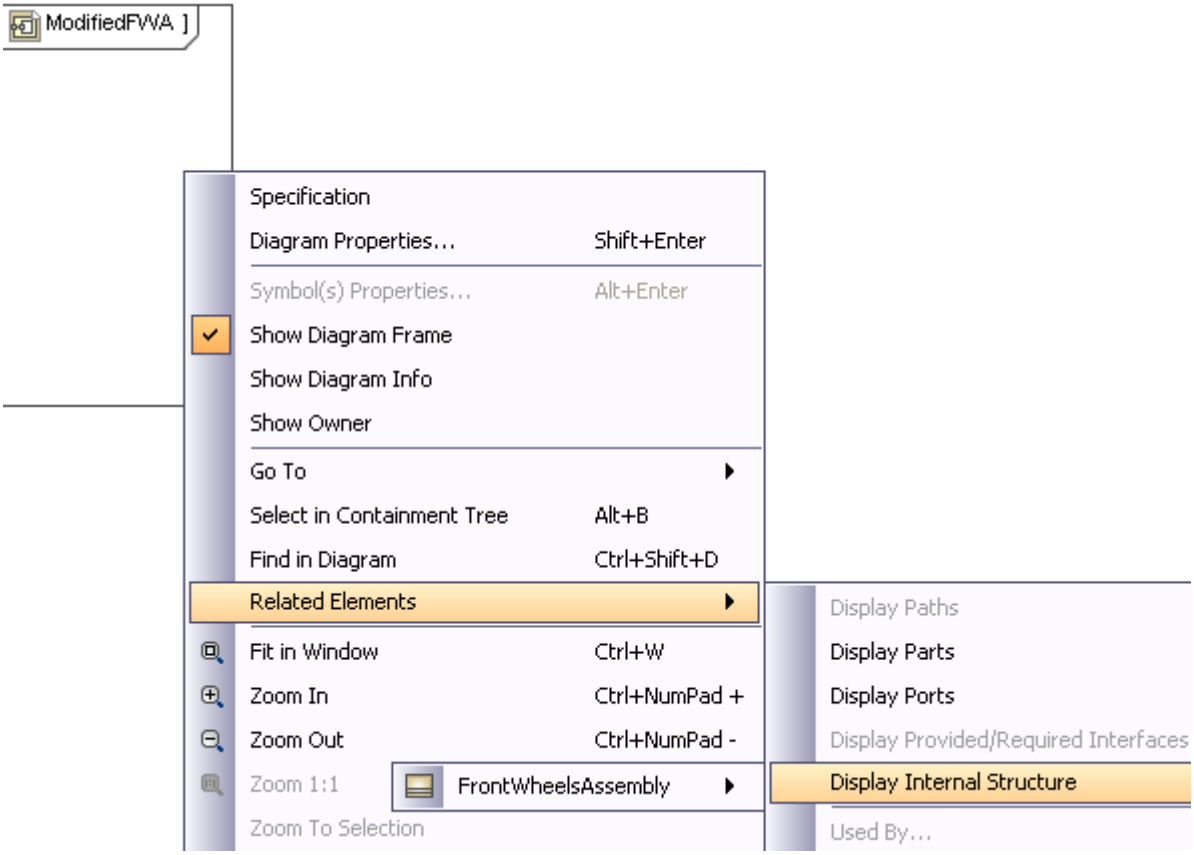


Figure 93 -- IBD Shortcut Menu to Display Structure

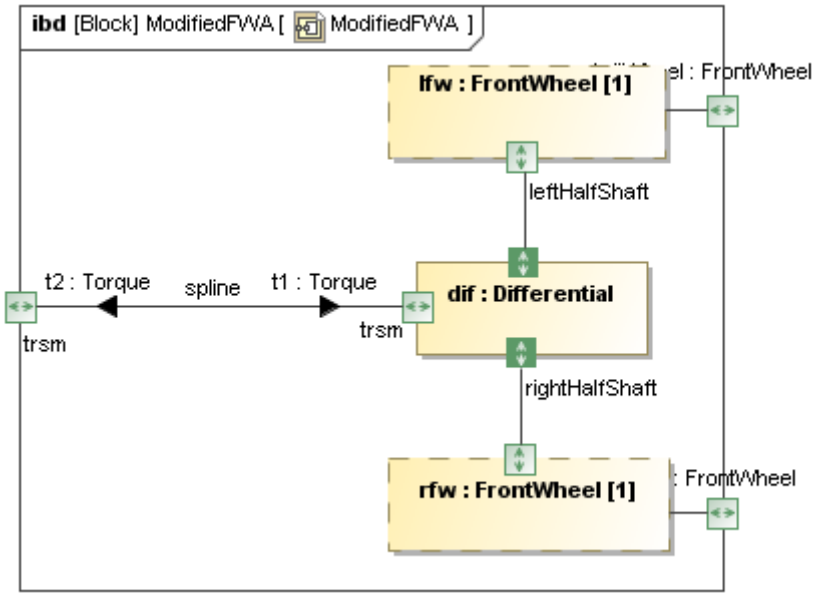


Figure 94 -- Sample of Structure Displayed in IBD

4. You can also display the structure of the **FrontWheelsAssembly** block in the structure compartment of the block itself.

5.2.5 Extract Structure

Extract Structure is the first advanced automated refactoring method in our newly-introduced promising “Refactoring” tools group.

Extract Structure allows you to easily select a portion of an existing system structure and transform it into another reusable Block (or Subsystem) which may then be used as parts in many other structures. In addition, this Extract Structure feature can also play a 'move' or 'decompose' role when a structure becomes too complex and requires to be decomposed into several smaller reusable parts.

Recursive decomposition of structure and behavior is an important aspect of the iterative development process. This feature is particularly useful for the automotive, aerospace, and defense communities for modeling complex systems-of-systems and building reusable components.

To extract a new structure from an existing structure in a classifier:

1. In an Internal Block Diagram or a structure compartment (Figure 95), right-click a portion of the internal structure (part(s)) which you want to move or reuse (see the red selection rectangle).

NOTE	These selected symbols must be owned by the same Classifier.

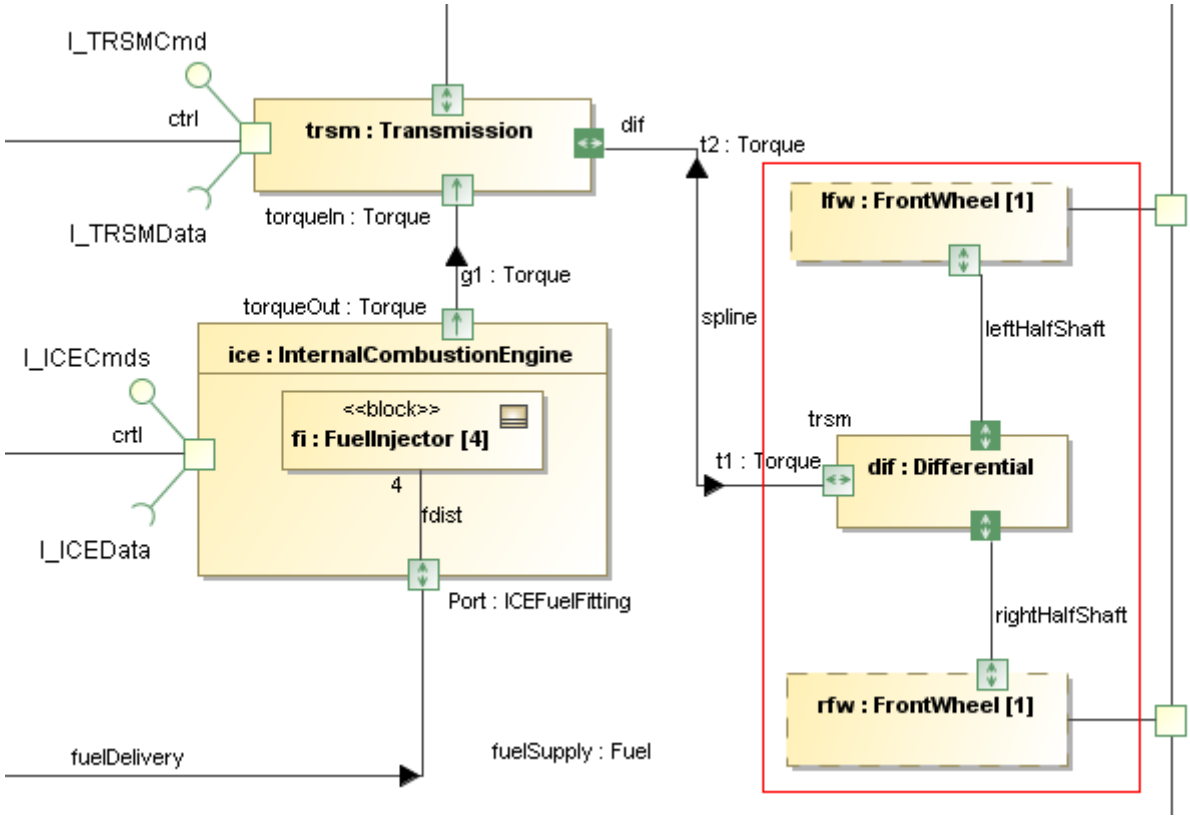


Figure 95 -- Internal Block Diagram Before Extracting a Structure

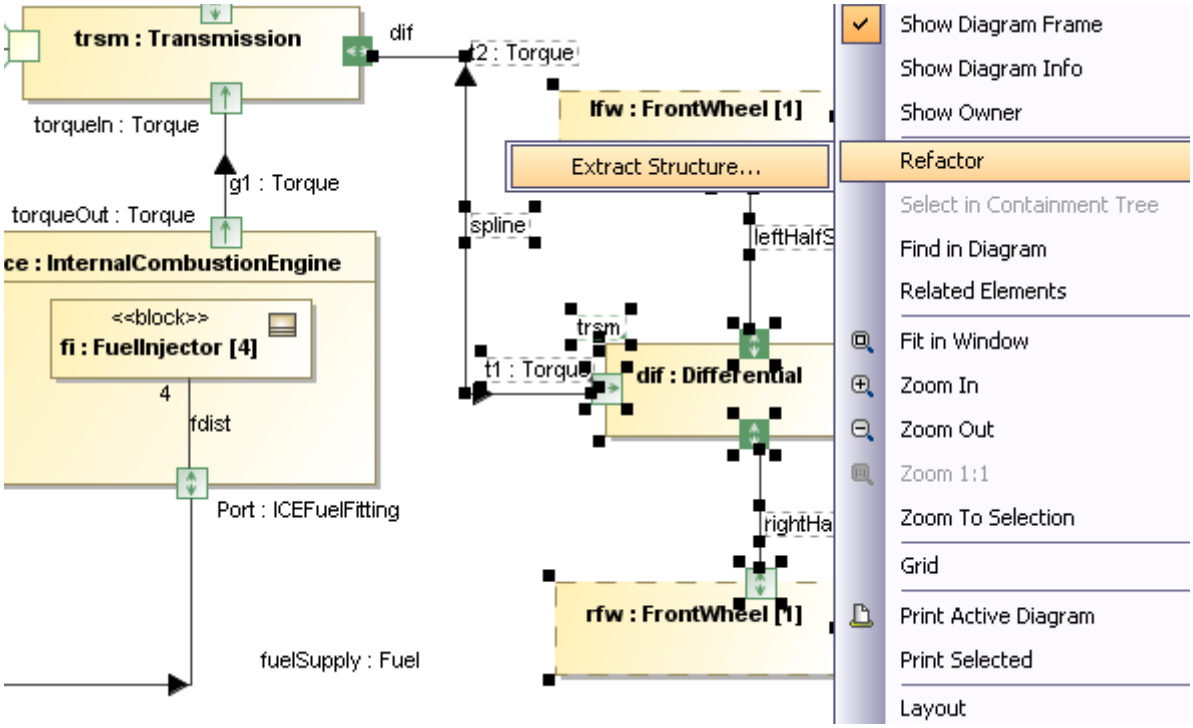


Figure 96 -- Shortcut Menu - Extract Structure (Refactoring)

2. Select **Refactor** > **Extract Structure...** (Figure 96). The **Extract Structure** wizard dialog will open, listing the three steps to extracts a structure: (i) Create a classifier, (ii) Select part(s), and (iii) Create a property (Figure 97).

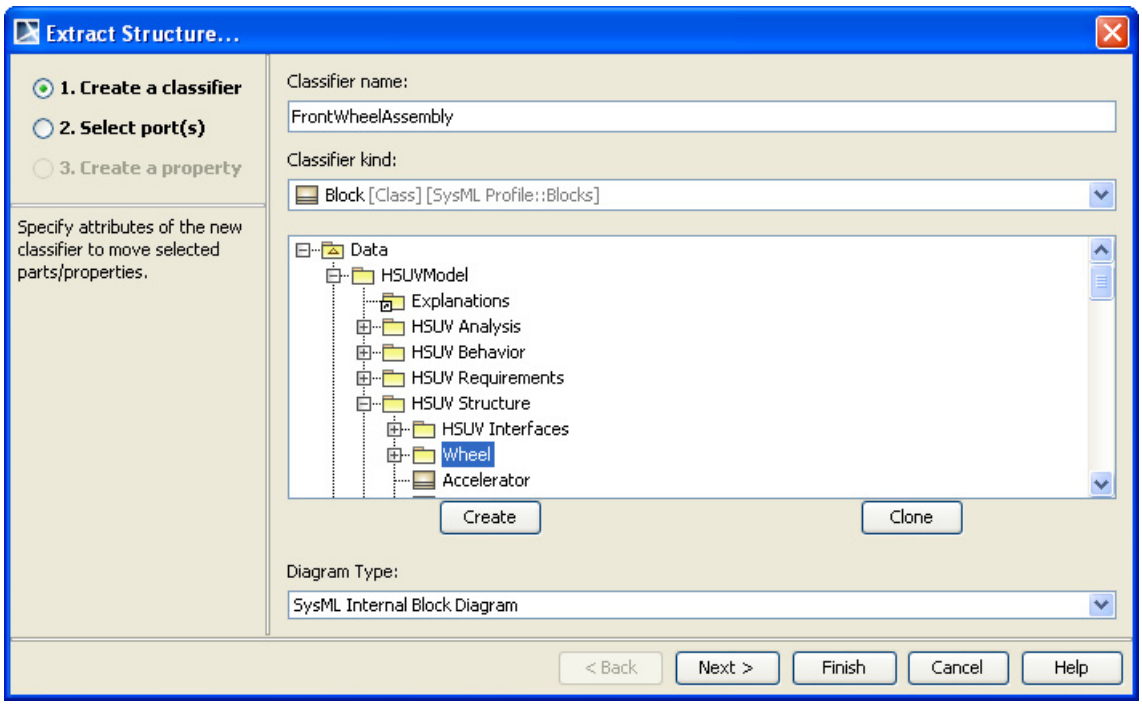


Figure 97 -- Create a Classifier Step

3. **Step 1: Create a classifier**:
   - Specify the name of the classifier you want to create and use for holding the structure to be extracted (called extracted classifier) in the **Classifier name** box (Figure 97).

- Select the kind of extracted classifier from the **Classifier kind** box by clicking the arrow button. The classifier kind can be a Class, Block, or Subtype of Block (Figure 97).
- Specify the owner of the extracted classifier by selecting a Package, Model, or Profile in the **Classifier owner** tree. You can also click the **Create** button to create a new Package, Model, or Profile, or click the **Clone** button to clone the selected Package, Model, or Profile (Figure 97).
- Select the diagram type that will show the internal structure of the extracted classifier from the Diagram Type box by clicking the arrow button. The diagram type can be a SysML Internal Block Diagram, SysML Parametric Diagram, or Composite Structure Diagram. If you do not want to create any diagram, select **None**.
- Click either **Next** to proceed to the next step or **Finish** to finish extracting a structure (Figure 97).

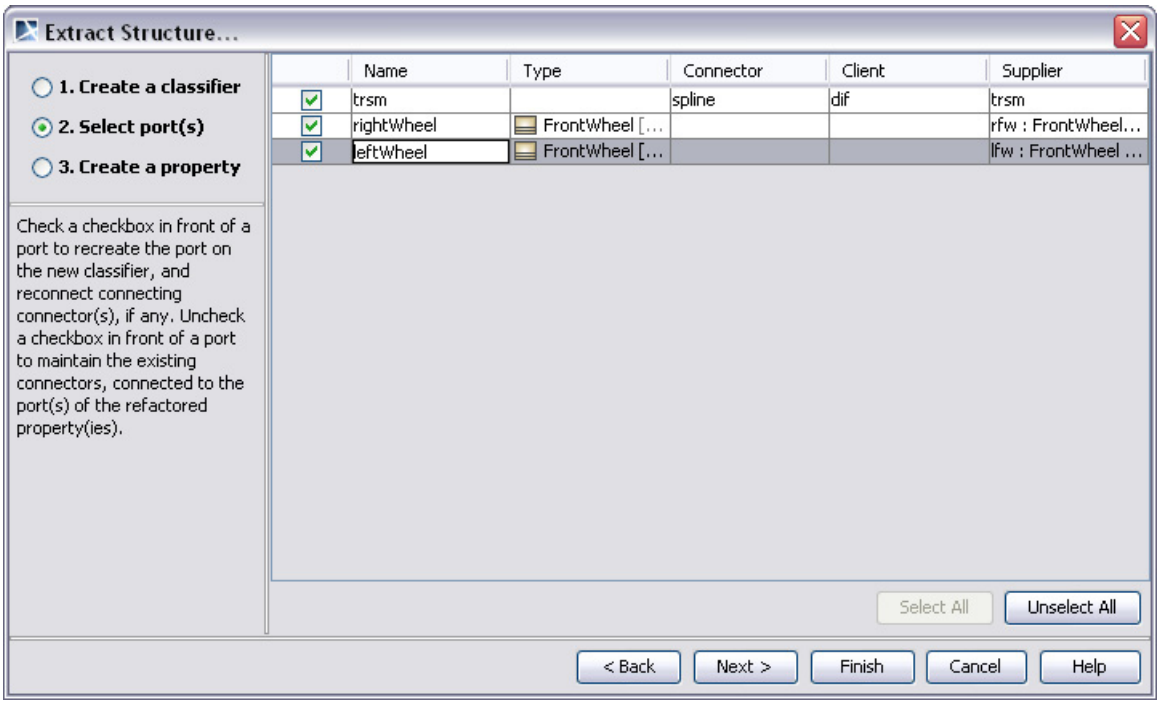


Figure 98 -- Step 2 - Select port(s) Pane

4. **Step 2: Select port(s)**:
   All the ports available to be defined on the Classifier to be created are listed in the table as shown in Figure 98. If you do not need a port, remove it by clearing the check box in front of the port name. If you clear any of the ports' check boxes, the connectors will be directly connected to the structure inside the extracted classifier.

   - In the first column, select the ports which you want to create for the connectors that are connected to the elements outside the extracted classifier. The connectors which are shown in the **Connector** column will be reconnected to these ports instead of being connected to the selected structures (Figure 98).
   - You can change the port name in the **Name** column (Figure 98).
   - You can change the port type using the drop-down list in the **Type** column (Figure 98).
   - The **Connector** column shows the name of the connector which is connected to the created port after a structure has been extracted (Figure 98).
   - The **Client** and **Supplier** columns show the client and supplier elements of the connectors defined in the **Connector** column (Figure 98).

- Click either **Next** to proceed to the next step or **Finish** to finish extracting a structure (Figure 98).

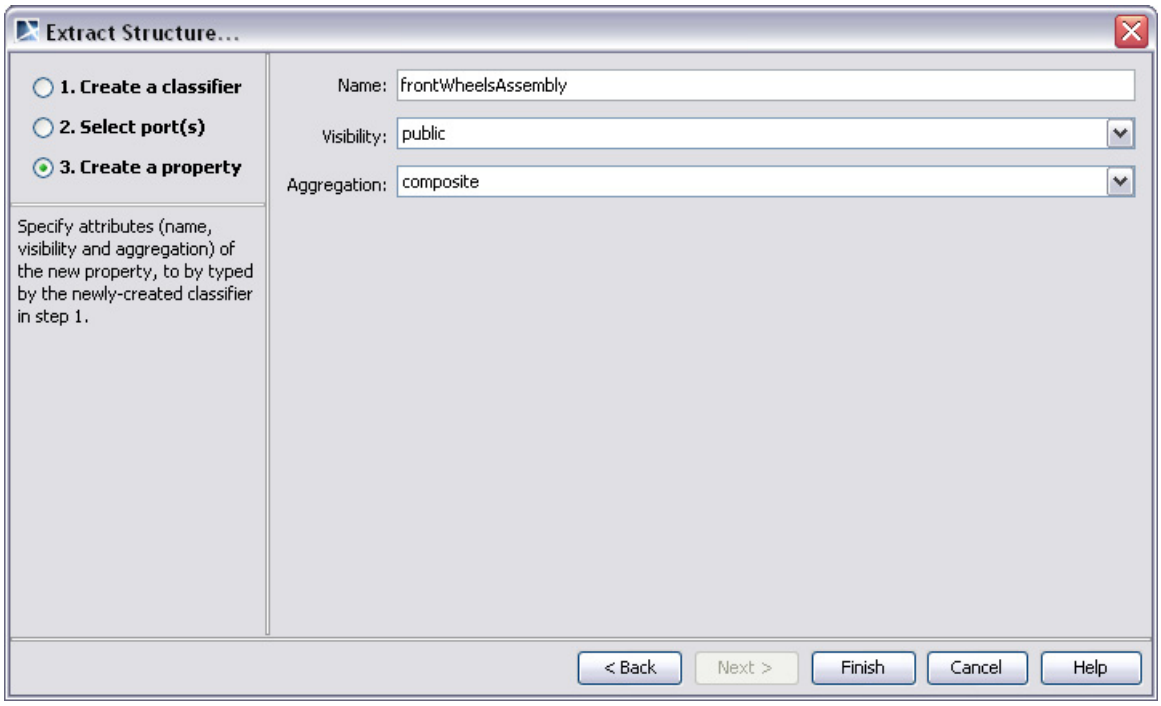


Figure 99 -- Step 3 - Create a property Pane

5. **Step 3: Create a property**:
   - The selected parts will be replaced by a new property which is typed by the classifier in Step 1. Enter the name, visibility, and aggregation of the new property (Figure 99).
   - Specify the name of the new property in the **Name** box (Figure 99).
   - Select the visibility of the new property from the **Visibility** box (Figure 99).
   - Select the aggregation kind of the new property from the **Aggregation** box (Figure 99).
   - Click **Finish** to finish extracting a structure (Figure 99).
6. Figure 100 shows the IBD after the structure was extracted. Since it preserves the diagram space of the previous structure, the original diagram will have minimal distortion and the existing layout will remain.

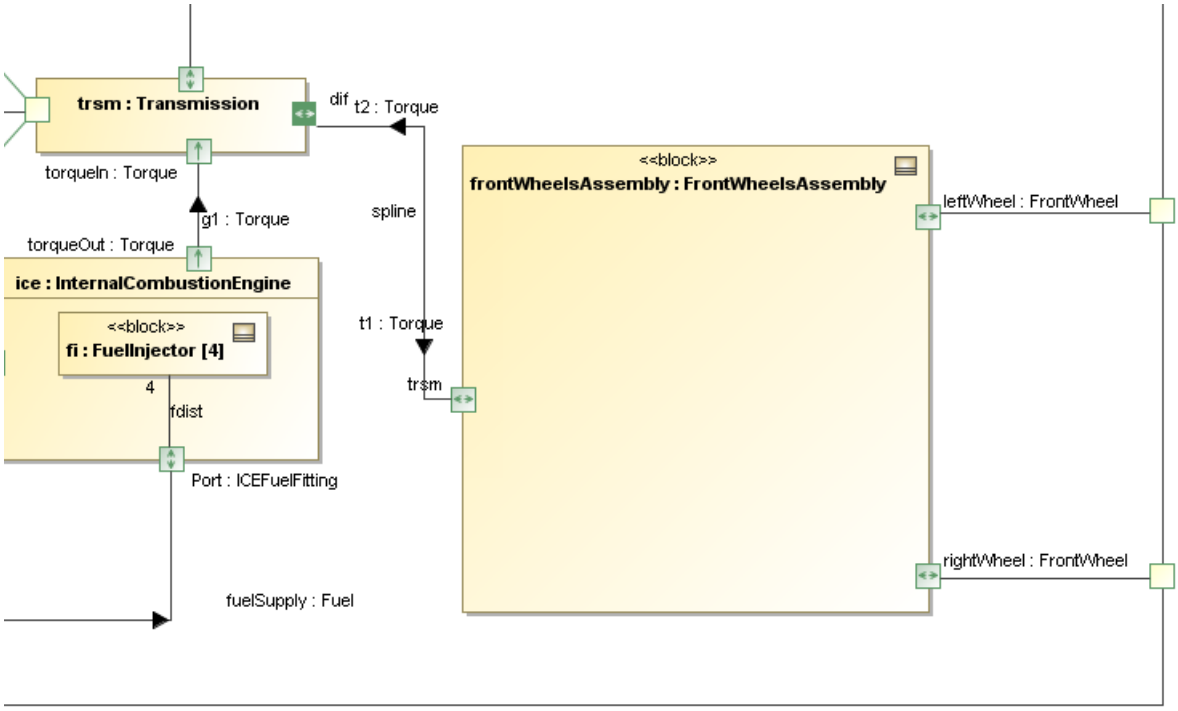


Figure 100 -- Internal Block Diagram After Extracting a Structure

7. You can check how the automatically-created new Block looks like by right-clicking the part and select **Go To** > **Type <name>** to select the Block in the browser (Figure 101).

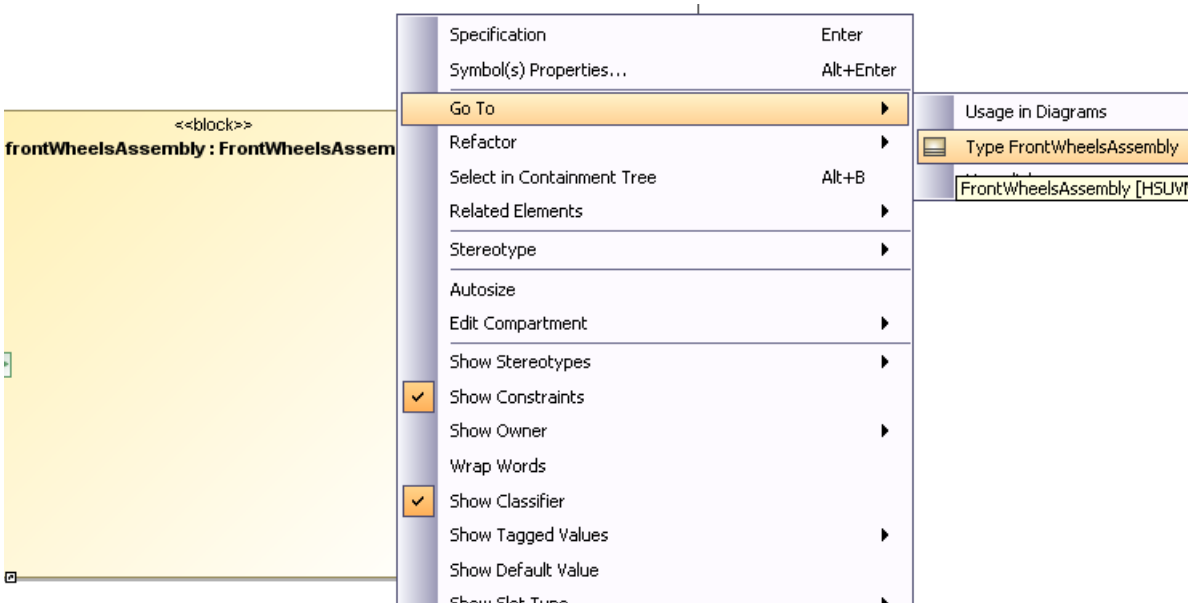


Figure 101 -- Go To > Type Function

8. Open the created IBD to display the structure which was recently extracted (Figure 102). The structure view will be ready (Figure 103).

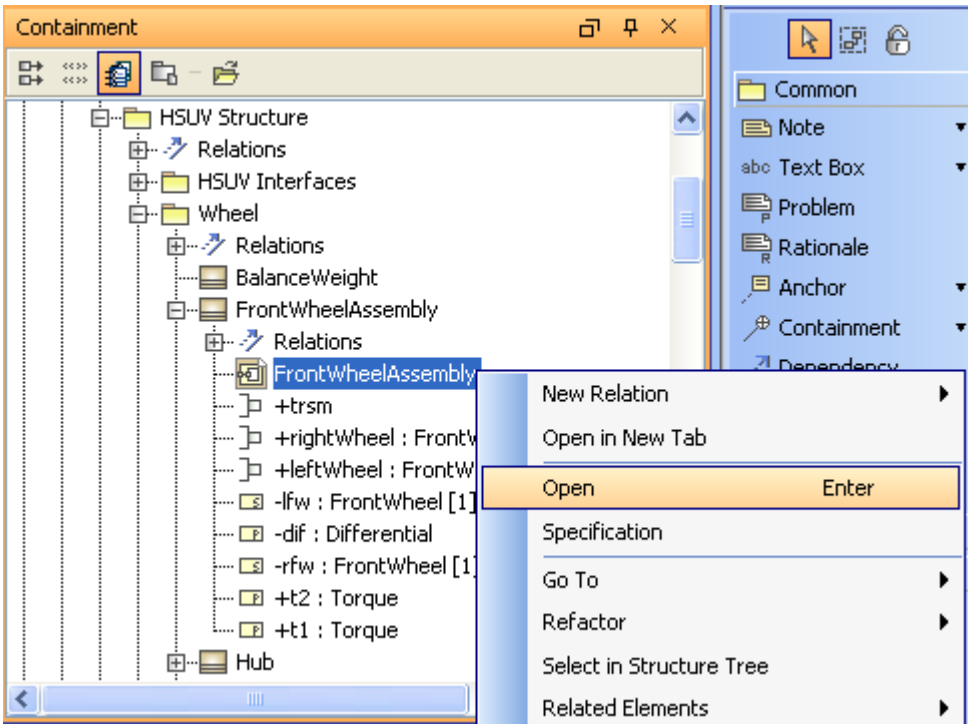


Figure 102 -- The Created IBD of Extracted Classifier

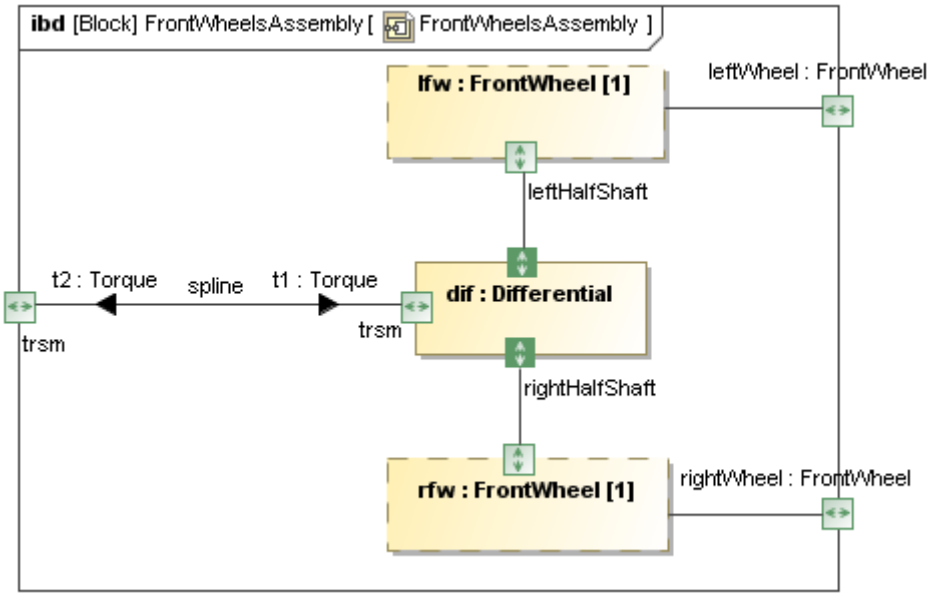


Figure 103 -- Displayed Extracted Structure

5.2.6 Using SysML IBD Elements

Flow Port

In general, a port / flow port should be defined in a BDD. However, you can also create a flow port on a part in an IBD by using the IBD toolbar button.

To create a flow port on a part:

1. Click the **Flow Port** button either:
   - on the IBD toolbar, or
   - in the smart manipulator of the part (Figure 104).

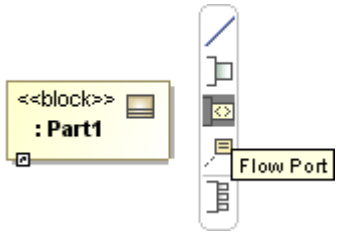


Figure 104 -- Part Smart Manipulator - Flow Port

2. If you click the **Flow Port** button on the IBD toolbar, select a part where the flow port will be created (Figure 105). If you clicked the smart manipulator of the part, go directly to step 3.

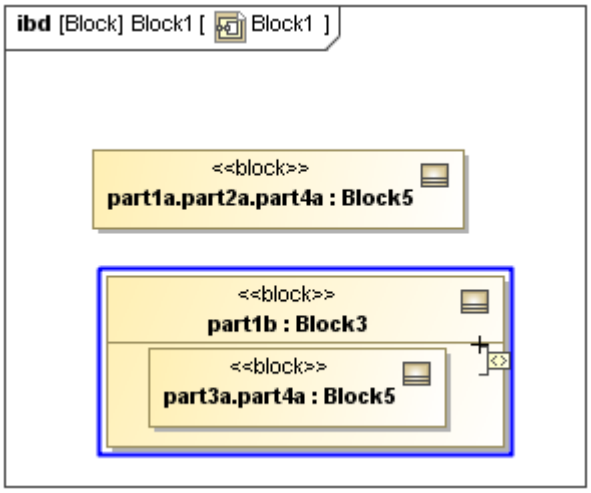


Figure 105 -- Flow Port Created on a Part

3. Select a port type in the **Select Port Type** dialog (Figure 106). The flow port will then be created, having an 'inout' direction.

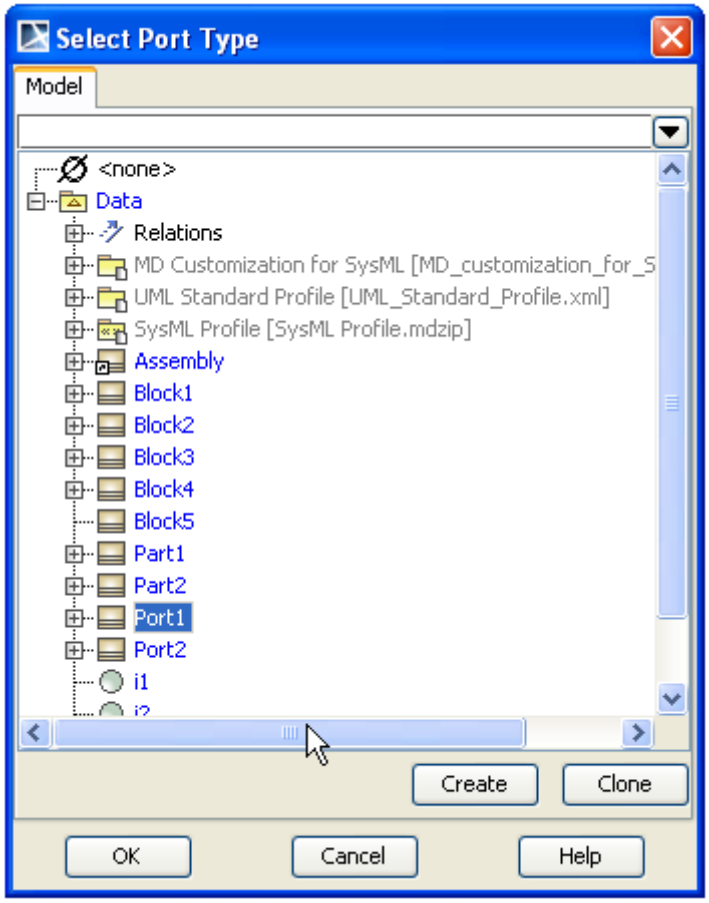


Figure 106 -- Select Port Type Dialog

4. You can change its direction using the port shortcut menu (Figure 107). Note that, without a direction, the flow port will be just like a normal port (it will not enforce any direction on the item(s) flowing in/out of the port).

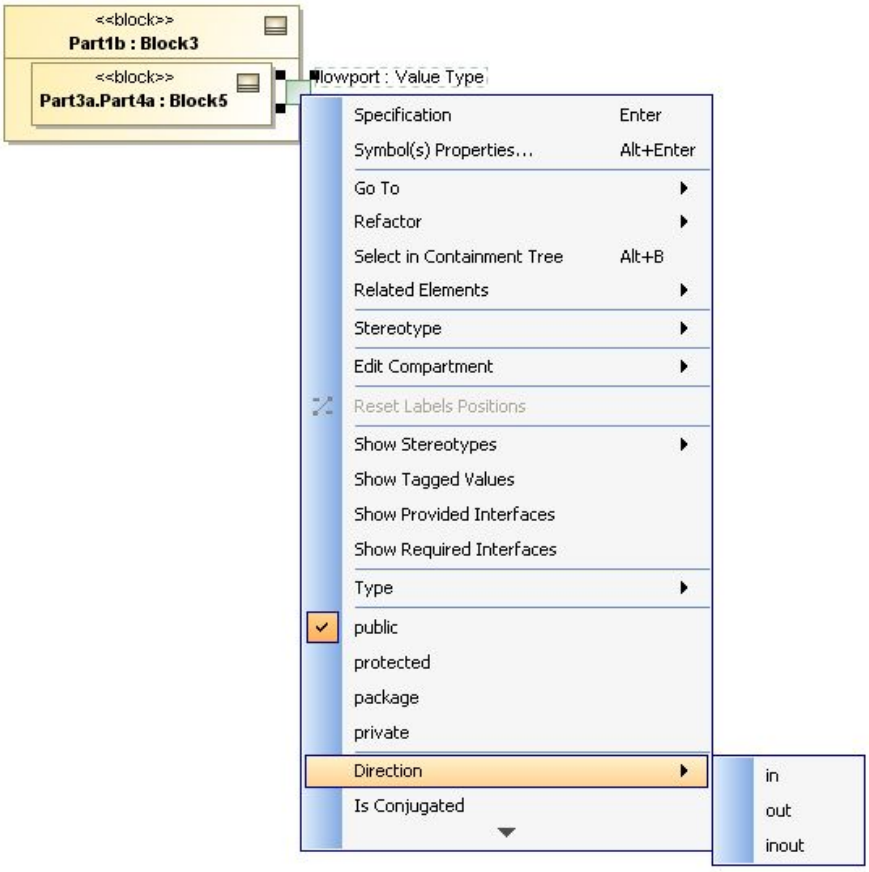


Figure 107 -- Flow Port Shortcut Menu - Flow Port Direction

NOTE	The Flow Port direction must be defined.

ItemProperty

Item Property is the only attribute of Item Flow. An Item Flow describes the flow of items across a connector or an association. If an Item Flow is assigned to a connector, in general, you can specify this optional attribute, Item Property, to relate the flowing item to the instances of the connectors' enclosing block.

In general, Item Flows (and Item Property) are defined on connectors in IBDs.

To create an Item Flow having the Item Property tag initialized on a connector:

1. Either:
   - (i) click the **Item Property** button on the IBD diagram toolbar, and then select the connector, or
   - (ii) click the **Item Property** icon on the connector smart manipulator menu, or
   - (iii) drag the property to be used as the item property, and drop it to the connector.
2. The **Item Flow / Item Property** dialog will then open (Figure 108).

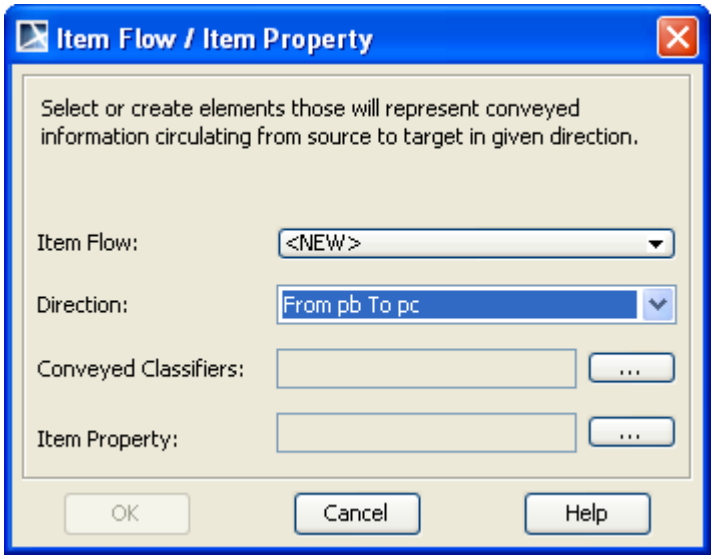


Figure 108 -- Item Flow / Item Property Dialog

3. The existing item flows on the selected connector can be selected for setting the item property using the Item Flow drop-down menu. The item flows, whose realizing connector property contains the selected connector, will be listed in this drop-down menu (Figure 109).

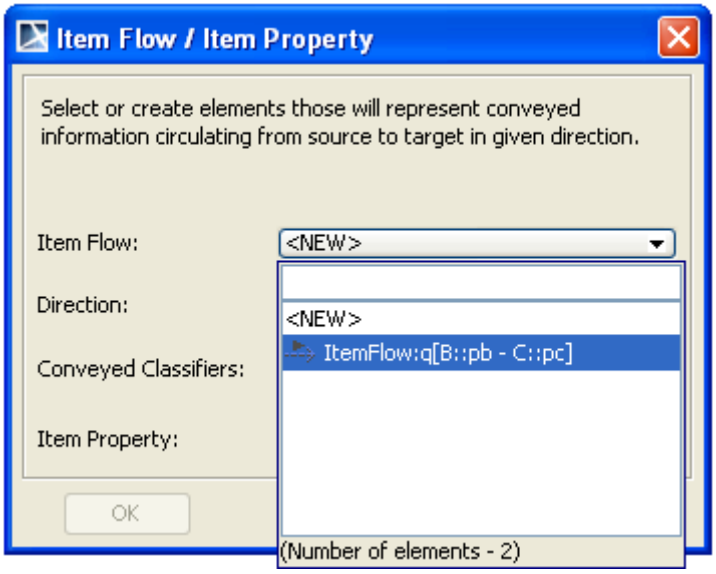


Figure 109 -- Item Flow / Item Property Dialog - Item Flow Selection

4. You can also create a new item flow by selecting <NEW> in the drop-down menu.
5. In the Item Flow / Item Property dialog, you can also choose the direction of the Item Flow from the Direction drop-down menu (Figure 110).

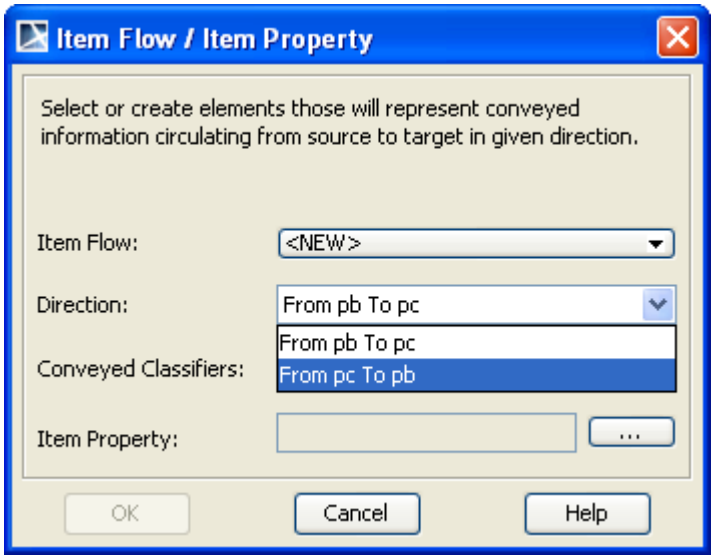


Figure 110 -- Item Flow / Item Property Dialog - Direction Selection

6. Click the browse button … next to the Conveyed Classifiers box. The Select Conveyed Classifier dialog will open (Figure 111).
7. Select a classifier to be used as the Conveyed Classifier and click OK.

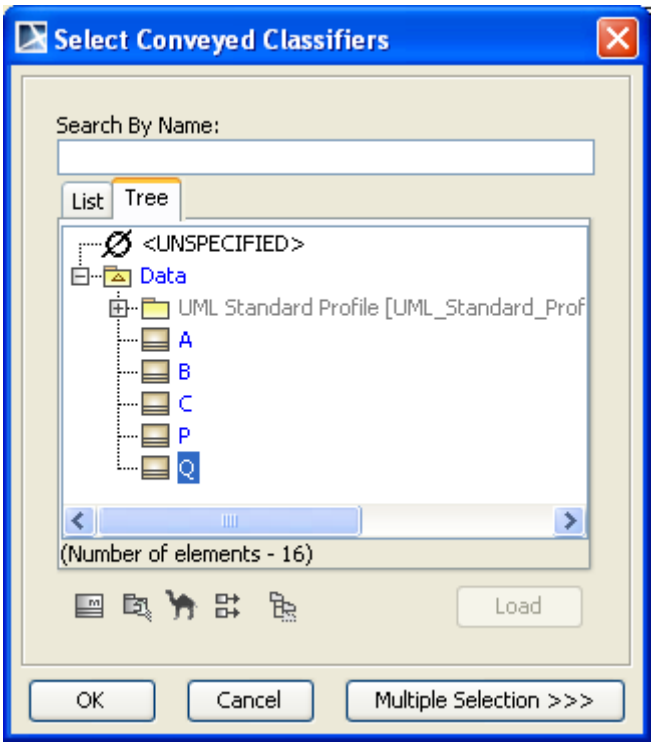


Figure 111 -- Select Conveyed Classifiers Dialog

8. Click the browse button … next to the Item Property box. The Select Item Property dialog will open (Figure 112).
9. Select a part (property) to be used as the Item Property and click OK.

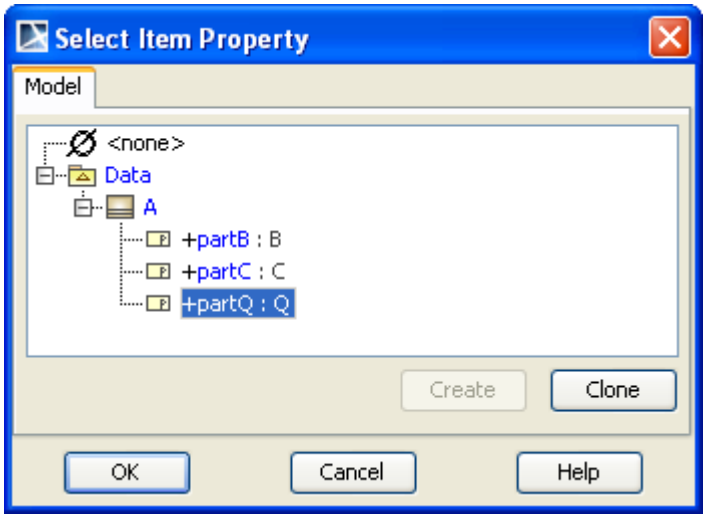


Figure 112 -- Select Item Property Dialog

10. Click OK in the Item Flow / Item Property dialog. An Item Flow having the selected property as its Item Property will then be created on the connector.

NOTE	You can create a new conveyed classifier on either a new item flow or on the existing item flow by dragging a classifier and dropping it to the connector or association. The dropped classifier will be a conveyed classifier of the item flow.

5.3 SysML Package Diagrams

Package diagrams typically enable you to organize models by partitioning model elements into packageable elements and establishing dependencies between packages and/or model elements within these packages. Since Package diagrams are used to organize models in packages and views, they can include a wide array of packageable elements.

A package is a construct that enables you to organize model elements, such as use cases or classes, into groups. Packages define namespaces for packageable elements. Model elements from one package can be imported and/or accessed by another package. This organizational principle is intended to help establish unique naming of the model elements and avoid overloading a particular model element's name. Packages can also be shown on Block Definition diagrams or Requirements diagrams.

5.3.1 SysML Package Diagram Metamodel and Elements

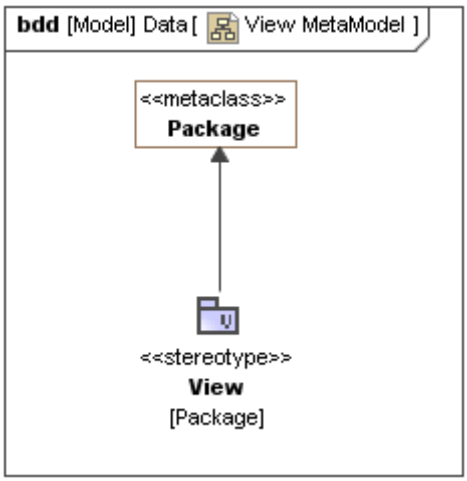


Figure 113 -- View Metamodel

Icon	Description
	Package [UML]: A package is a namespace for its members, and it can contain other packages. Only packageable elements can be owned by members of a package. By virtue of being a namespace, a package can import either individual members of other packages, or all the members of other packages.
	View [SysML]: A view is a representation of a whole system from the perspective of a single viewpoint. A view can only own element import, package import, comment, and constraint elements.

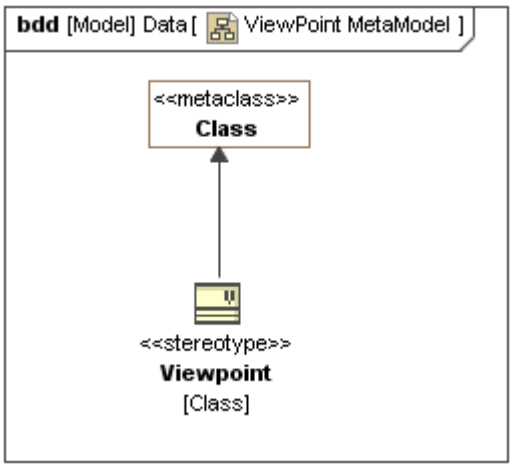


Figure 114 -- Viewpoint Metamodel

Icon	Description
	ViewPoint [SysML]: A viewpoint is a specification of the conventions and rules for constructing and using a view for the purpose of addressing a set of stakeholder concerns. The languages and methods for specifying a view can reference methods and languages in another viewpoint. They specify the elements expected to be represented in the view that may be formally or informally defined.

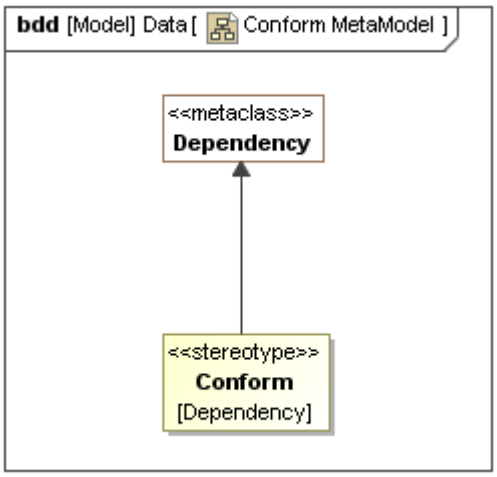


Figure 115 -- Conform Metamodel

Icon	Description
	Conform [SysML]: A Conform relationship is a dependency between a view and a viewpoint. The view conforms to the rules and conventions specified in the viewpoint.

5.3.2 SysML Package Diagram Toolbar

Element	Button (hot key)
Package: See Section 5.3.1 for description.	(P)
Model [UML]: A Model is a special kind of Package. It contains a (hierarchical) set of elements that describe the physical system being modeled. A model owns or imports all the elements needed to represent a complete physical system according to its purpose.	(M)

Element	Button (hot key)
View: See Section 5.3.1 for description.	
ViewPoint: See Section 5.3.1 for description.	
Conform: See Section 5.3.1 for description.	
Package Import [UML]: A Package Import is defined as a directed relationship that identifies a package whose members are to be imported by a namespace.	
Element Import [UML]: An Element Import is defined as a directed relationship between an importing namespace and a packageable element. The name of the packageable element or its alias are to be added to the namespace of the importing namespace.	

5.3.3 Using SysML Package Diagram Elements

Package 

You can display the name of a package either on top of it or on its tab.

To display a package name:

1. Right-click a package and select **Header Position** on the shortcut menu (Figure 116).

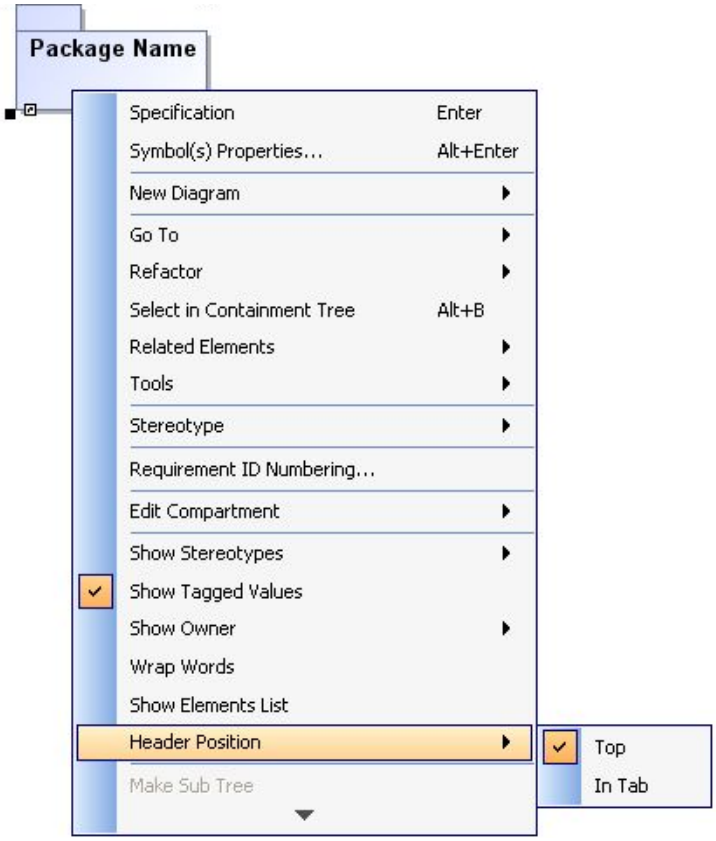


Figure 116 -- Package Shortcut Menu: Header Position

2. Select either (i) **Top** to display the package name on top (Figure 117) or (ii) **In Tab** to display it in the tab (Figure 118).

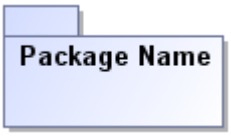


Figure 117 -- Package Name on Top

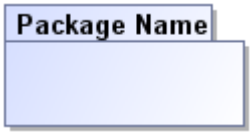


Figure 118 -- Package Name in Tab

You can also show a list of elements owned by a package.

To show an element list:

1. Right-click a package and select **Show Elements List** on the shortcut menu (Figure 119).
2. The element(s) owned by the package will then be displayed in the package (Figure 120). If the package owns no element, the package will look like in Figure 121.

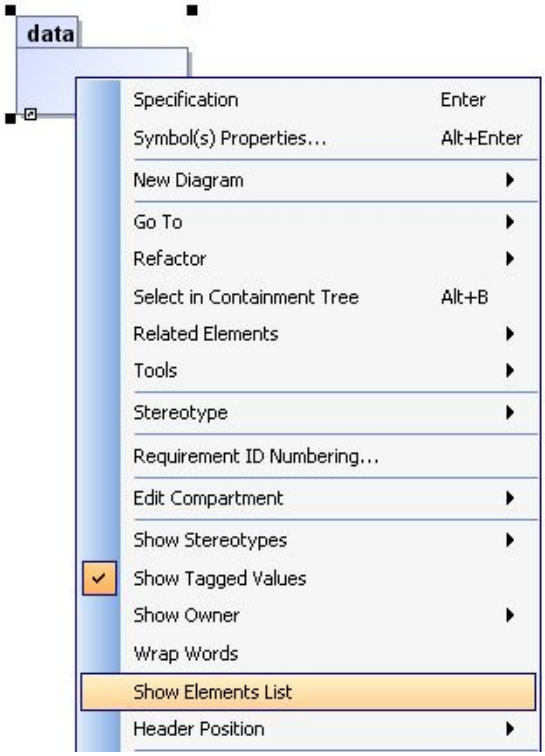


Figure 119 -- Package Shortcut Menu: Show Elements List

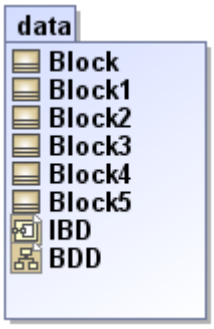


Figure 120 -- Element List is Shown

Figure 121 -- Element List is not Shown

View and Viewpoint

The Viewpoint of a View is derived from the supplier of the "conform" dependency whose client is the View itself.

A view can only own element imports, package imports, comments, and constraint elements.

A viewpoint cannot own any operation nor attribute.

5.4 SysML Parametric Diagrams

Parametric diagrams can be defined as restricted forms of IBDs. They are similar to IBDs except that the only connectors allowed are binding connectors, each having at least one end connected to a constraint parameter.

A Parametric diagram includes the usage of a constraint block to constrain the properties of another block. It contains constraint properties and constraint parameters as well as other properties from within that internal block context. All properties displayed, other than the constraints themselves, must either be bound directly to a constraint parameter or contain a property that is bound to a constraint parameter (through any number of containment levels). A constraint block generally contain many constraints, each of them containing many constraint parameters.

Constrained properties typically have simple value types that can also carry units, quantity kinds, and probability distributions. This allows for a value property that may be deeply nested within a containing hierarchy to be referenced at the outer containing level. The context for the usages of constraint blocks must also be specified in a parametric diagram to maintain the proper namespaces for the nested properties.

The state of the system can be specified in terms of the values of some of its properties. A change in state will result in a different set of constraint equations to be recalculated. This can be accommodated by specifying constraints that are conditioned on the value of the property with state.

Parametric diagrams can be used to support trade-off analysis. A constraint block can define an objective function to compare alternative solutions.

5.4.1 SysML Parametric Diagram Metamodel and Elements

For the description of the SysML properties, MagicDraw SysML properties, and flow port metamodels, refer to the ‘SysML Internal Block Diagrams (IBD)’ section.

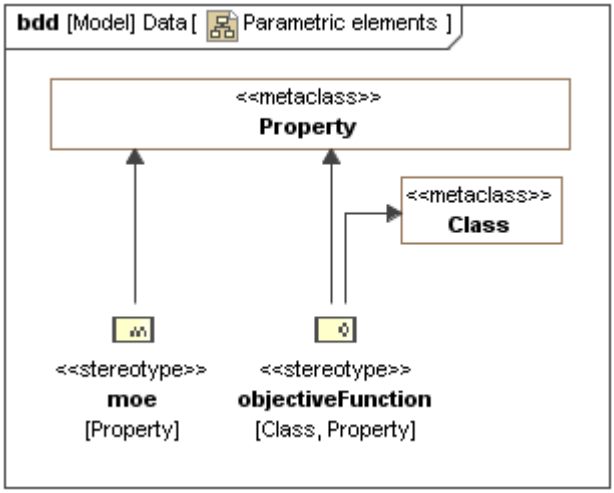


Figure 122 -- moe and Objective Function Metamodel

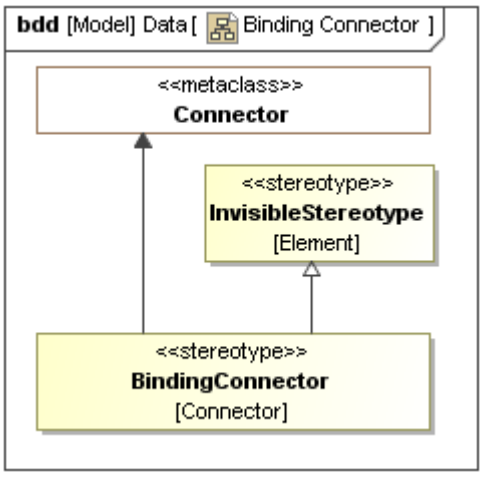


Figure 123 -- Binding Connector Metamodel

Icon	Description
	**Moe [SysML]:** moe (measure of effectiveness) represents a parameter whose value is critical for achieving the desired cost effectiveness mission.
	**Objective Function [SysML]:** An Objective Function (also known as 'optimization' or 'cost function') is used for determining the overall value of an alternative in terms of weighted criteria and/or moe's.

Icon	Description
	Connector [UML]: A connector is used for binding two ports together, demonstrating relationship between those ports. A connector can be typed by an association. A logical connector can be allocated to a more complex physical path depicting a set of parts, ports, and connectors.
	Binding Connector [SysML]: A Binding Connector is a connector which specifies that the properties at both ends of the connector have equal values. If the properties at both ends of a binding connector are typed by DataTypes or ValueTypes, it means that the instances of the properties at both ends must hold equal values, recursively through any nested properties within the connected properties. If the properties at both ends of a binding connector are typed by Blocks, it means that the instances of the properties must refer to the same block instance. As with any connector owned by a SysML Block, each end of a binding connector may be nested within a multi-level path of properties accessible from the owning Block. The NestedConnectorEnd stereotype is used to represent such nested ends, just as for nested ends of other SysML connectors.

5.4.2 SysML Parametric Diagram Toolbar

Element	Button (hot key)
Value Property [MDSysML]: A Value Property is a property that specifies a quantitative property of its containing Block. Every Value Property is typed by either a SysML Value Type or UML Data Type. Value Properties are displayed in the ‘values’ compartment.	
Part Property [MDSysML]: A Part Property is a property that specifies a part with strong ownership and coincidental lifetime of its containing Block. It describes a local usage or role of the typing Block in the context of the containing Block. Every Part Property has ‘composite’ AggregationKind and is typed by a Block. Part Properties are displayed in the ‘parts’ compartment.	
Shared Property [MDSysML]: A Shared Property is a property that specifies a shared part of its containing block. Every Shared Property has ‘shared’ Aggregationkind and is typed by a block. Shared Properties are displayed in the ‘references’ compartment.	
Reference Property [MDSysML]: A Reference Property is a property that specifies a reference of its containing Block to another Block. Every Reference Property has ‘none’ AggregationKind and is typed by a block. Reference Properties are displayed in the ‘references’ compartment.	
Constraint Property [SysML]: A Constraint Property is a property that specifies the constraints of other properties in its containing Block. Every Constraint Property is typed by a Constraint Block. Constraint Properties are displayed in the ‘constraints’ compartment.	

Element	Button (hot key)
Distributed Property [SysML]: A Distributed Property is a property of a Block or a Value Type, used for applying a probability distribution to the values of the property. Specific distributions can be defined by applying a subclass of the DistributedProperty stereotype to the property.	
Select Nested Part: Click this button to display a nested part inside a given context. For more information, see Section 5.2.3 SysML IBD Specific Features: (vii) Select Nested Part.	
Flow Property [SysML]: A FlowProperty signifies a single flow element that can flow to/from a block. Flow properties are defined directly on blocks or flow specifications that are those specifications which type the flow ports. Flow properties enable item flows across connectors connecting parts of the corresponding block types, either directly (in case of the property is defined on the block) or via flowPorts. A flow property's values are either received from or transmitted to an external block.	
Moe: See Section 5.4.1 for description.	
Objective Function: See Section 5.4.1 for description.	
Port [UML]: A Port defines an interaction point on a Block or a part, allowing you to specify what can flow in/out of the Block/part or what services the block/part requires (expects) from or provides (offers) to its environment. Ports are connected by connectors to other parts or ports.	
Flow Port [SysML]: A Flow Port is a port that specifies the input and output items that can flow between a Block and its environment. Flow Ports are interactions points through which data, material, or energy "can" enter or leave the owning Block. The specification of what can flow is achieved by typing the Flow Port with a specification of things that flow. This can include typing an atomic Flow Port with a single type (Block, Value Type or Signal) representing the items that flow in or out, or typing a non-atomic Flow Port with a Flow Specification which lists multiple items that can flow. In general, Flow Ports are intended to be used for asynchronous, broadcast, or send-and-forget interactions. Note that only non-atomic Flow Ports can be conjugated. Once conjugated, all the directions of the typing Flow Specification's items are negated.	
Connector: See Section 5.4.1 for description.	 (C)
Binding Connector: See Section 5.4.1 for description.	

Element	Button (hot key)
Item Property [SysML]: An optional property that relates the flowing item to the instances of the connector's enclosing block. This property is applicable only for item flows assigned to connectors. The multiplicity is zero if the item flow is assigned to an Association.	

5.4.3 SysML Parametric Diagram Specific Features

SysML Parametric Diagram features include **Display Parameters** and the other seven specific features similar to IBD. These are:

(i) Display Parts (Diagram shortcut menu)

(ii) Display Ports (Property shortcut menu)

(iii) Edit Compartment (Property shortcut menu)

(iv) Show Default Value and Show Slot Type (Property shortcut menus)

(v) Provided/Required Interfaces (Port shortcut / smart manipulator menu)

(vi) Display/Suppress Structure Compartment (Property shortcut menu)

(vii) Select Nested Part

For more information on these features, see the 'SysML IBD Specific Features' section.

(i) Display Parameters (Property shortcut menu)

This feature enables you to display the constraint parameters of a constraint block on a Constraint Property typed by the Constraint Block.

To display constraint parameters:

1. Either (i) select **Display Parameters** on the property shortcut menu (Figure 124) or (ii) click the **Display Parameters** icon on the property smart manipulator (Figure 125).

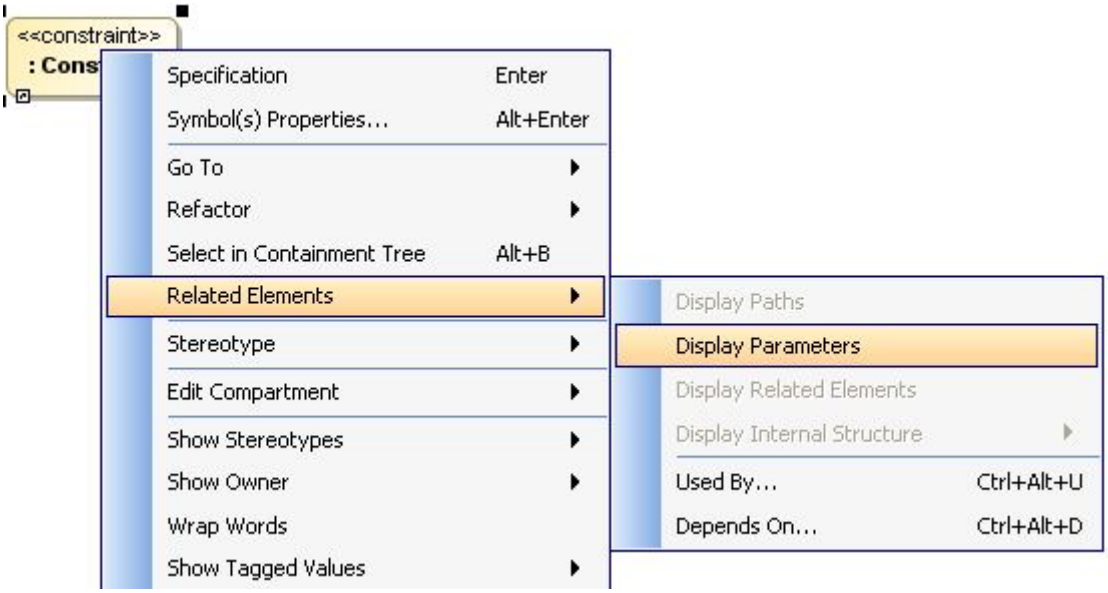


Figure 124 -- Shortcut Menu for Displaying Constraint Parameters

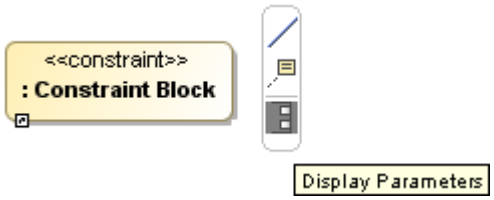


Figure 125 -- Smart Manipulator for Displaying Constraint Parameters

2. The **Select Parameters** dialog will open and the constraint parameter(s) owned by the type of the constraint property will be listed in the dialog (Figure 126).
3. Select constraint parameters to be shown on the constraint property symbol. The selected constraint parameters will be displayed as small square boxes (Figure 127).

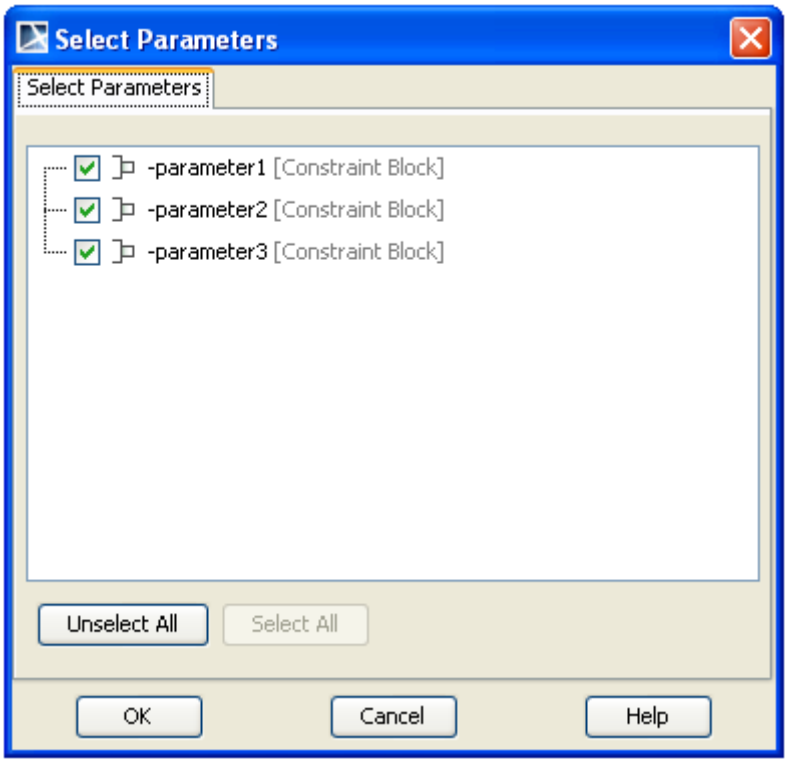


Figure 126 -- Select Parameters Dialog

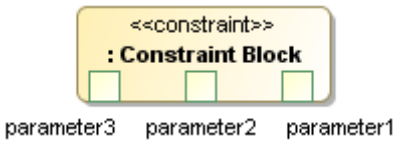


Figure 127 -- Constraint Property with its Constraint Parameters

5.4.4 Using Parametric Diagram Elements

Constraint Blocks

Constraint blocks can only be defined on a BDD or a package diagram. A constraint block typically contains one or more constraint parameters, which are bound to properties of other blocks in a surrounding context where the constraint is used.

All properties of a constraint block are constraint parameters, with the exception of constraint properties that hold the internally-nested usages of other constraint blocks. Constraints are specified only in an informal language, but a more formal language such as OCL or MathML could also be used.

Constraint blocks can only be defined on a BDD or a SysML package diagram.

Binding Connectors

Binding connectors enable you to bind each constraint block parameter to the property of another block in the surrounding context of that constraint block. Binding connectors are the only connectors allowed to bind constraint parameters to the properties of other blocks.

To create a binding connector:

1. Click either (i) the **Binding Connector** button on the Parametric diagram toolbar or (ii) the **Binding Connector** icon on the smart manipulator of a constraint parameter or a part (property) (Figure 128 and Figure 129, respectively).

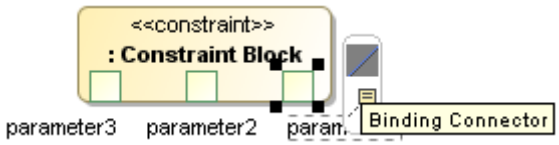


Figure 128 -- Constraint parameter smart manipulator

Figure 129 -- Smart manipulator of a part

2. If you have clicked (i) the **Binding Connector** button on the toolbar, select a part as the connector's origin, but if you clicked (ii) the **Binding Connector** icon from the smart manipulator, go directly to step 3.
3. Select a part / constraint parameter as the connector's destination.

5.5 SysML Requirement Diagrams

SysML Requirement Diagrams provide modeling constructs to represent text-based requirements and relate them to other modeling elements. These requirement modeling constructs are intended to provide a bridge between traditional requirement management tools and other SysML models.

Requirement diagrams display requirements, packages, other classifiers, test cases, rationales, and relationships. Possible relationships available for Requirement diagrams are containments, deriveReqt and requirement dependencies ('Copy', 'Refine', 'Satisfy', 'Trace', and 'Verify'). The callout notation can also be used to reflect the relationships of other models.

Requirements can also be shown on other diagrams to illustrate their relationships to other modeling elements.

5.5.1 SysML Requirement Diagram Metamodel and Elements

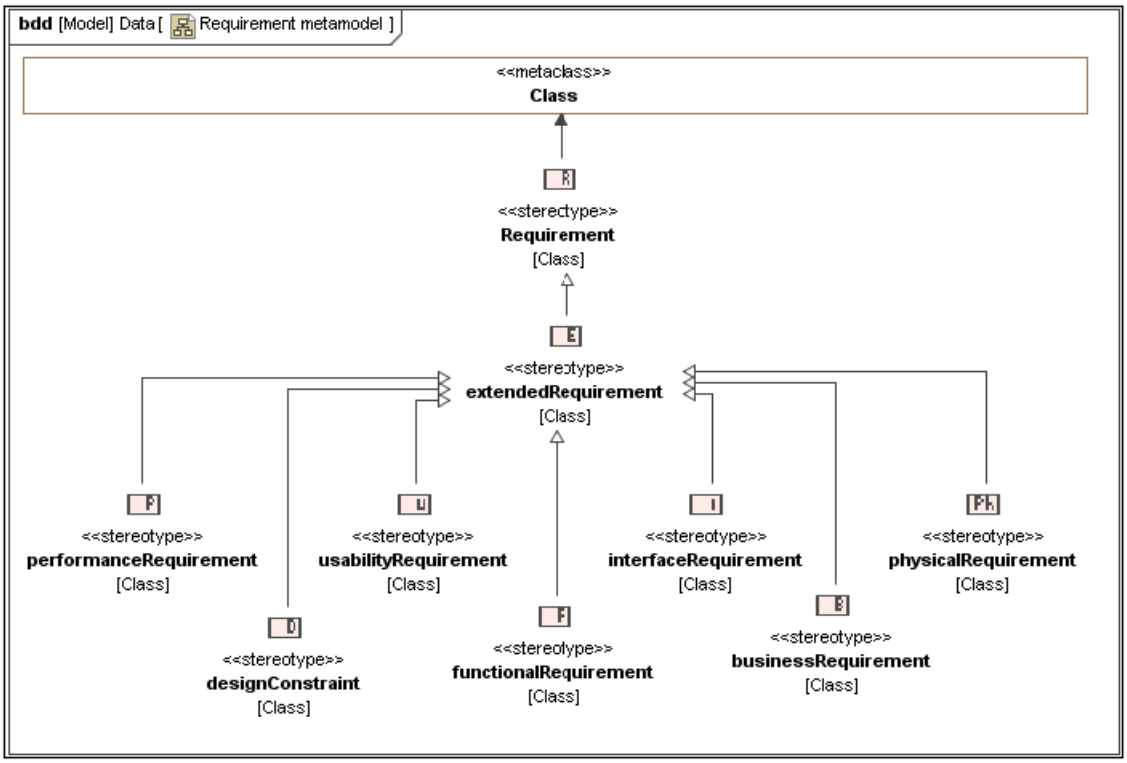


Figure 130 -- Requirement Metamodel

Icon	Description
	Requirement [SysML]: A Requirement specifies a capability or a condition that must (or should) be satisfied. Requirements are used to establish a contract between the customer (or other stakeholders) and those responsible for designing and implementing the system. A requirement can also appear on other diagrams to show its relationship to other modeling elements.
	Extended Requirement [SysML]: An Extended Requirement adds some properties to the requirement element. These properties are important for requirement management. Specific projects should add their own properties.
	Functional Requirement [SysML]: A Functional Requirement is a requirement that specifies a behavior that a system or part of a system must perform.
	Interface Requirement [SysML]: An Interface Requirement is a requirement that specifies the ports for connecting systems and parts of a system. Optionally, it may include the items that flow across the connector and/or the Interface constraints.
	Performance Requirement [SysML]: A Performance Requirement refers to a requirement that quantitatively measures the extent to which a system or a system part satisfy a required capability or condition.

Icon	Description
	**Physical Requirement [SysML]:** A Physical Requirement specifies the physical characteristics and/or physical constraints of a system, or a system part.
	**Design Constraint [SysML]:** A Design Constraint is a requirement that specifies a constraint on the implementation of a system or on part of it.
	**Business Requirement [MDSysML]:** A Business Requirement is a requirement that specifies characteristics of the business process that must be satisfied by the system.
	**Usability Requirement [MDSysML]:** A Usability Requirement specifies the fitness for use of a system for its users and other actors.

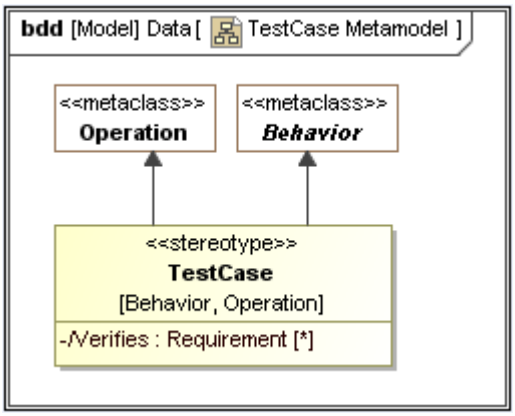


Figure 131 -- Test Case Metamodel

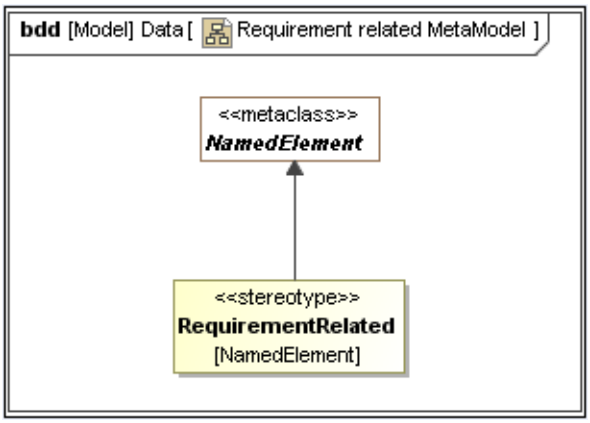


Figure 132 -- Requirement-related Metamodel

Icon	Description
  	**Test Case (Activity / StateMachine / Interaction) [SysML]:** A test case is a method for verifying a requirement.

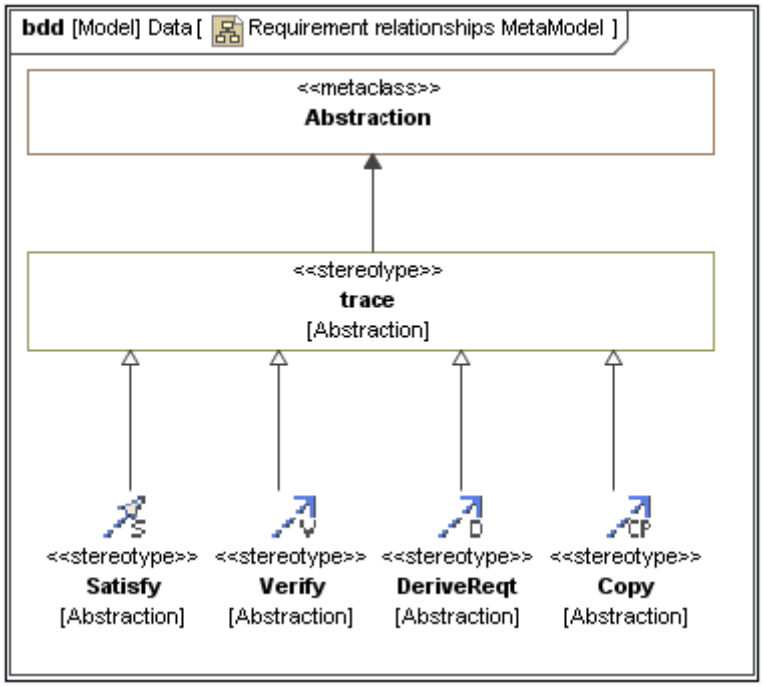


Figure 133 -- Requirement Relationship Metamodel

Icon	Description
	**Trace [UML]:** A ‘Trace’ relationship is a dependency that provides a general purpose relationship between a requirement and any other model elements.
	**Satisfy [SysML]:** A 'Satisfy' relationship is a dependency between a requirement and a model element that fulfills that requirement. As with other dependencies, the arrow direction points from the satisfying (client) model element to the (supplier) requirement that is satisfied.
	**Verify [SysML]:** A 'Verfiy' relationship is a dependency between a requirement and a test case or a model element that can determine whether the system fulfills the requirement. As with other dependencies, the arrow direction points from the (client) test case to the (supplier) requirement.
	**Derive [SysML]:** A 'Derive' relationship is a dependency between two requirements (a derived requirement and a source requirement), where the derived requirement is generated or inferred from the source requirement.
	**Copy [SysML]:** A 'Copy' relationship is a dependency between a supplier requirement (master) and a client requirement (slave), specifying that the client requirement text is a read-only copy of the supplier requirement text.

5.5.2 SysML Requirement Diagram Toolbar

Element	Button (hot key)
Requirement: See Section 5.5.1 for description.	
Extended Requirement: See Section 5.5.1 for description.	
Business Requirement: See Section 5.5.1 for description.	
Usability Requirement: See Section 5.5.1 for description.	
Functional Requirement: See Section 5.5.1 for description.	
Interface Requirement: See Section 5.5.1 for description.	
Performance Requirement: See Section 5.5.1 for description.	
Physical Requirement: See Section 5.5.1 for description.	
Design Constraint: See Section 5.5.1 for description.	
Satisfy: See Section 5.5.1 for description.	
Derive: See Section 5.5.1 for description.	
Copy: See Section 5.5.1 for description.	
Trace: See Section 5.5.1 for description.	
Verify: See Section 5.5.1 for description.	
Refine [UML]: A 'Refine' relationship is a dependency intended to describe how a model element or a set of elements are used to further refine a requirement. Alternatively, it can be used to show how a text-based requirement refines a model element.	

Element	Button (hot key)
Test Case (Activity / StateMachine / Interaction): See Section 5.5.1 for description.	

5.5.3 SysML Requirement Diagram Specific Features

(i) Changing the Requirement Type

Use this feature to change one or several requirement types to another requirement type.

To change one or more requirement types to another requirement type:

1. Right-click a requirement(s) whose type(s) you would like to change and select **Refactor** > **Convert To** (Figure 134).

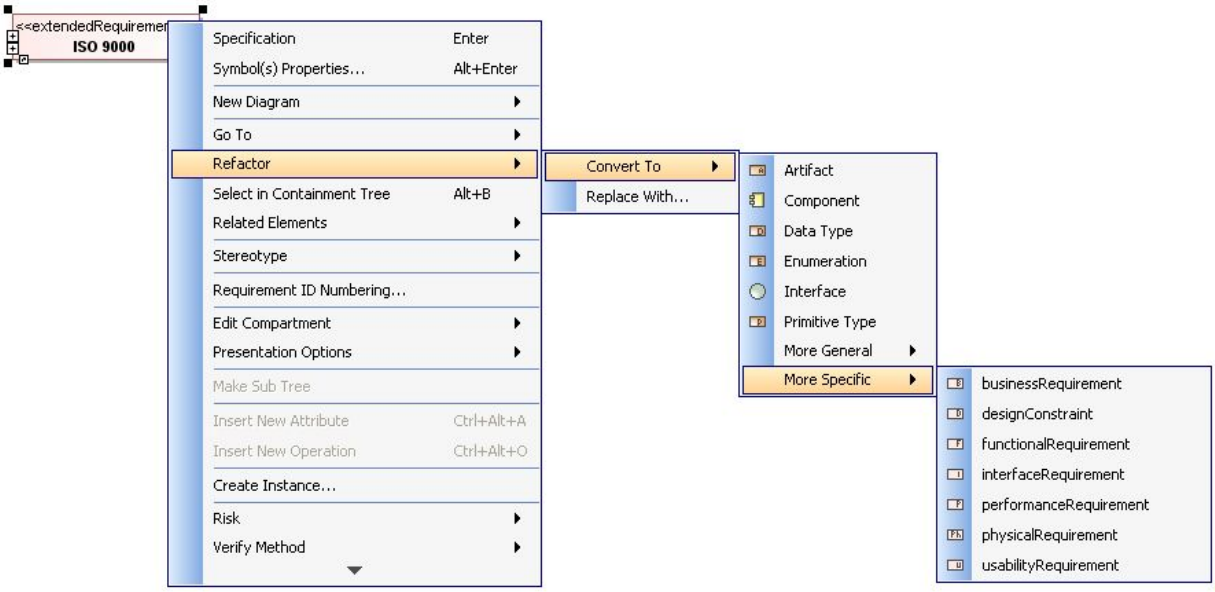


Figure 134 -- Change Requirement Type Shortcut Menu - More Specific

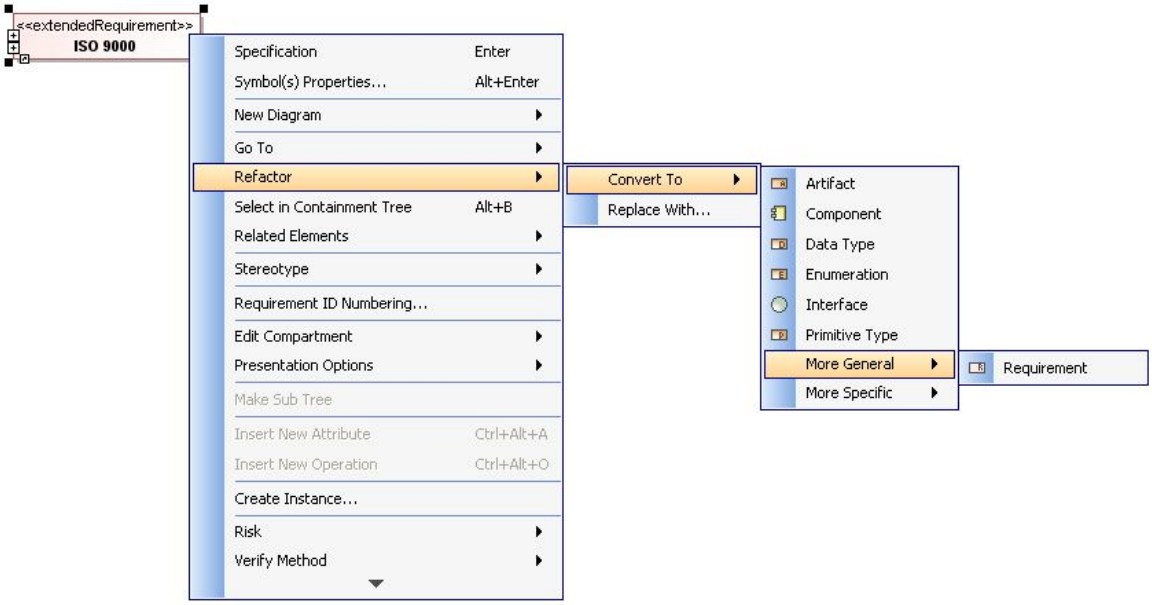


Figure 135 -- Change Requirement Type Shortcut Menu - More General

2. Select **More Specific** (Figure 134), **More General** (Figure 135), or **Other**. The requirement type options will be displayed.
3. Select a new requirement type from the options. The type(s) of the selected requirement(s) will then be changed.

(ii) Creating a SysML Requirement Diagram for Sub-requirements

MagicDraw SysML provides an easy way to create a SysML requirement diagram for sub-requirements of the selected requirement symbol.

To create SysML requirement diagram for sub-requirements:

1. Click on the requirement symbol in which you want to create the SysML requirement diagram for its sub-requirements.
2. Click the **Create diagram for sub-requirements** button from the smart manipulator (Figure 136).

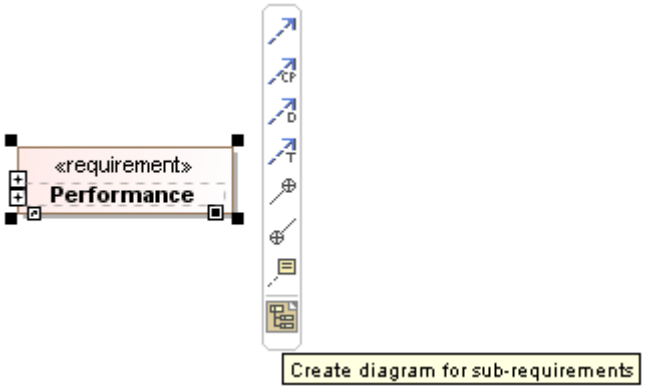


Figure 136 -- Smart Manipulator Buttons on the Requirement Symbol

3. The new SysML requirement diagram for the sub-requirements will then be created (Figure 137) with the same name as that of the selected requirement.

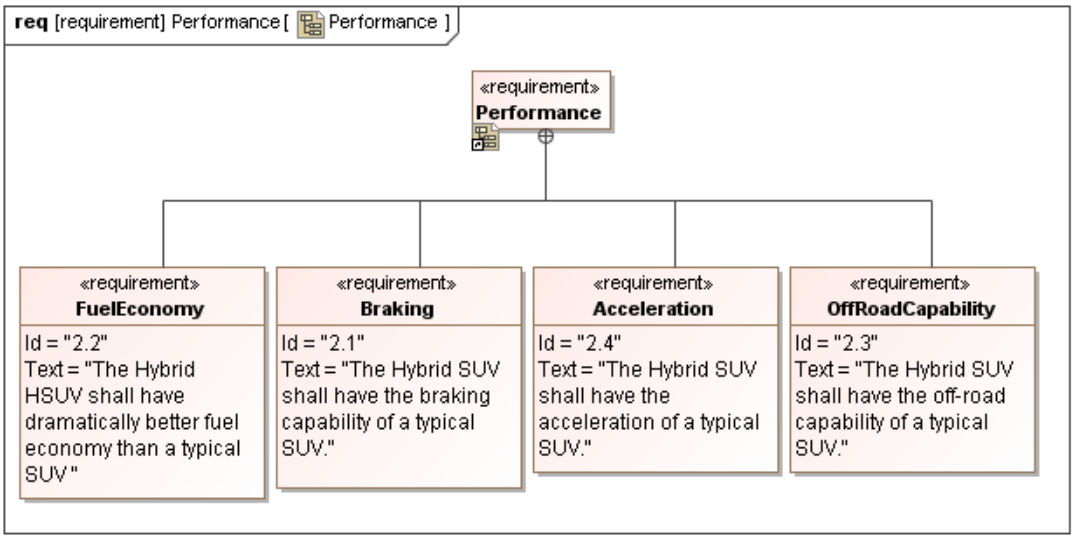


Figure 137 -- SysML Requirement Diagram for Sub-requirements

5.5.4 Numbering Requirement IDs

Numbering requirements' IDs is a trivial, time-consuming task, in particular, when working with a large SysML project. Starting with version 16.5, SysML Plugin provides an additional feature to facilitate such a task: **Requirement ID Numbering**. This feature consists of three functionalities: (i) Manual Numbering, (ii) Automatic Numbering and (iii) Suggested Solutions for Invalid Requirement's ID.

(i) Manual Numbering

This functionality refers to the use of the **Requirement ID Numbering** dialog to number requirements' IDs.

To number requirements' IDs manually using the Requirement ID Numbering dialog:

1. Open the **Requirement ID Numbering** dialog by selecting the **Requirement ID Numbering** option on:
   - the diagram shortcut menu of the package containing the requirement(s), for example, the **HSUV Specification** package in Figure 138, or of the requirement you would like to number; or
   - the browser shortcut menu of the package containing the requirement(s) or of the requirement you would like to number; or
   - the diagram shortcut menu.

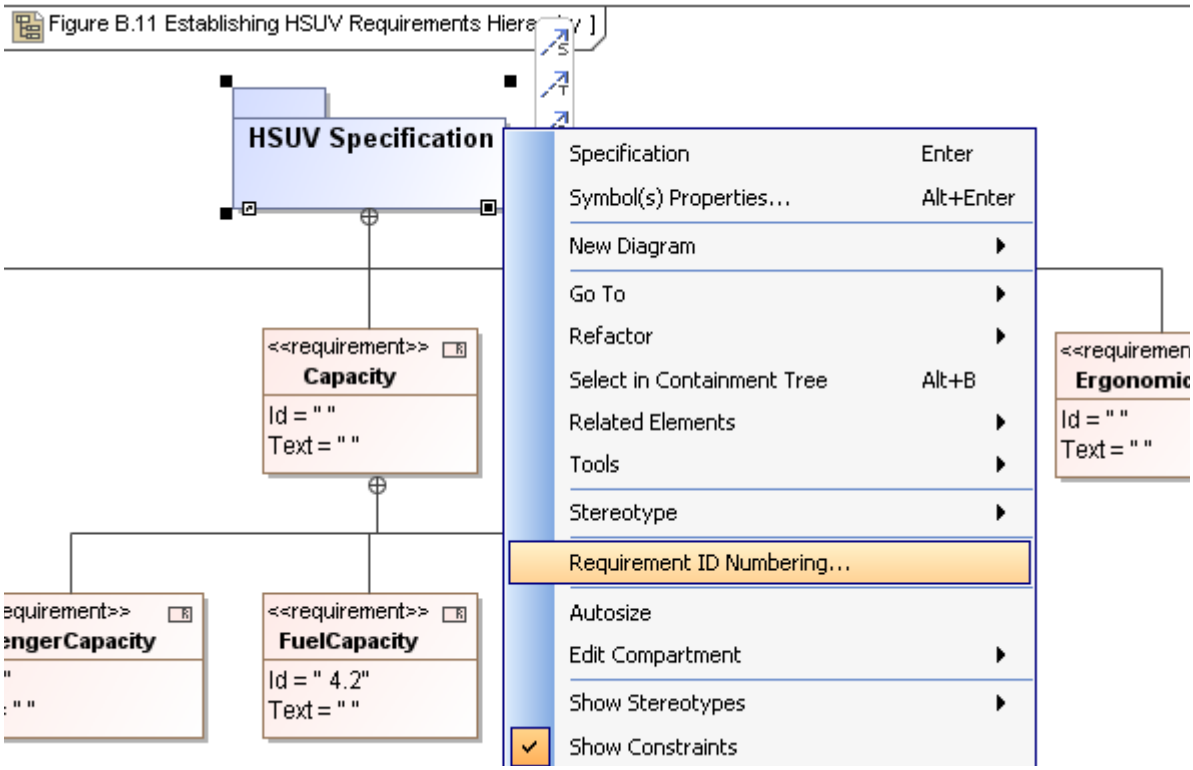


Figure 138 -- Requirement ID Numbering Shortcut Menu

2. The **Requirement ID Numbering** dialog will open (Figure 139). Select, for example, the **HSUV Specification** package in the browser on the left-hand side of the dialog. The requirements owned by the package will appear in the **Requirements** pane on the right-hand side of the dialog (Figure 139).

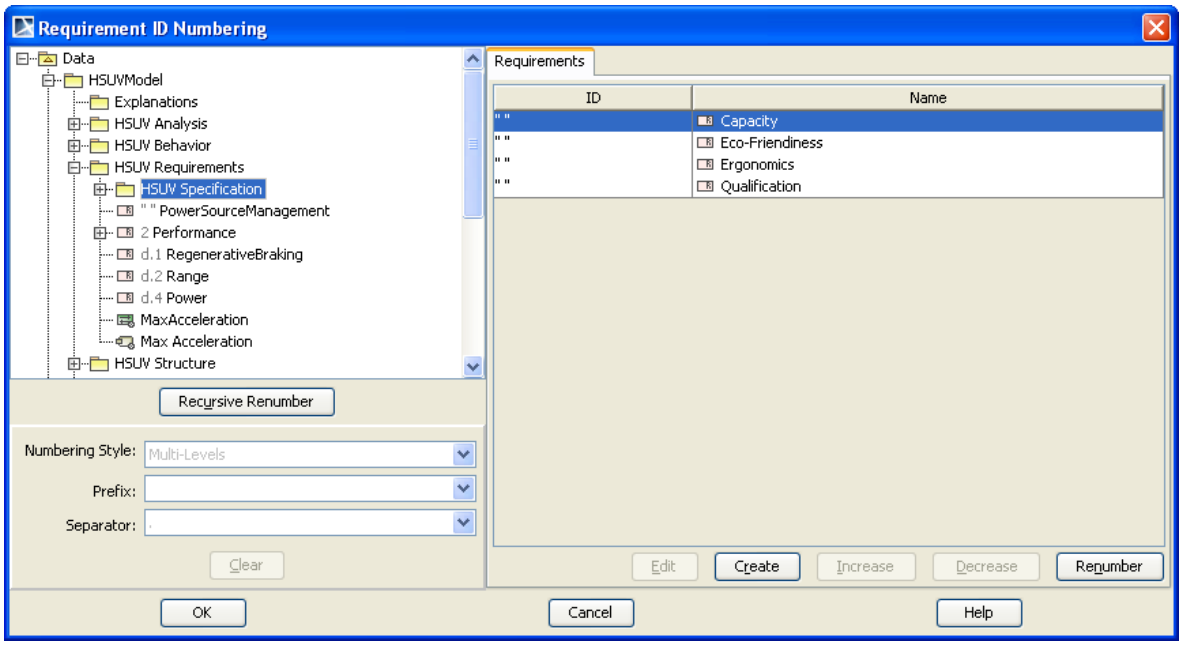


Figure 139 -- Requirement ID Numbering Dialog

3. In the **Requirements** pane, select the requirement(s). Use the **Edit**, **Create/Remove**, **Increase**, **Decrease**, or **Renumber** button to number the selected requirements' IDs.

NOTE	These five buttons are used to add / edit / remove the IDs of the requirements **directly owned by the package or the requirement of interest** (selected in the browser on the left-hand side of the **Requirement ID Numbering** dialog) only.

Table 3 -- Requirement ID Numbering Buttons

Button	Multiple Selection Support	Enable Criteria	Function
Edit	N	Enabled when select a requirement with non-empty ID.	To arbitrarily number the ID of a requirement.
Create/ Remove	Y	**Create** button is enabled when all selected requirement(s) has(have) no ID(s). Otherwise, **Remove** button is enabled.	To assign or unassign ID(s) to the selected requirement(s).
Increase	Y	Enabled when all selected requirement(s) has(have) ID(s).	To increase the ID(s) of the selected requirement(s) by one.
Decrease	Y	Enabled when all selected requirement(s) has(have) ID(s).	To decrease the ID(s) of the selected requirement(s) by one.
Renumber	n/a	Always enabled.	To renumber all the requirements appeared in the **Requirements** pane on the right-hand side of the **Requirement ID Numbering** dialog, starting from ‘1’.

4. For example, if you select the **Renumber** button, the requirements under the package selected in the browser on the left-hand side of the dialog will be renumbered using the pre-defined **Numbering Style**, **Prefix** and **Separator**, as shown in Figure 140.

NOTE	• SysML Plugin provides two numbering styles to number requirement IDs: (i) **Consecutive** (previously called normal style) and (ii) **Multi-Levels** (previously called nested style). (i) Using the Consecutive numbering style, each requirement ID is numbered with a prefix, followed by numbers, without any separator. (ii) Using the Multi-Levels numbering style, each requirement ID is numbered with a prefix, followed by numbers. A separator is used to separate each level of number. The level will be increased by the containing level of the requirement. • You can use a character or a symbol, excluding number, as a **Separator**.

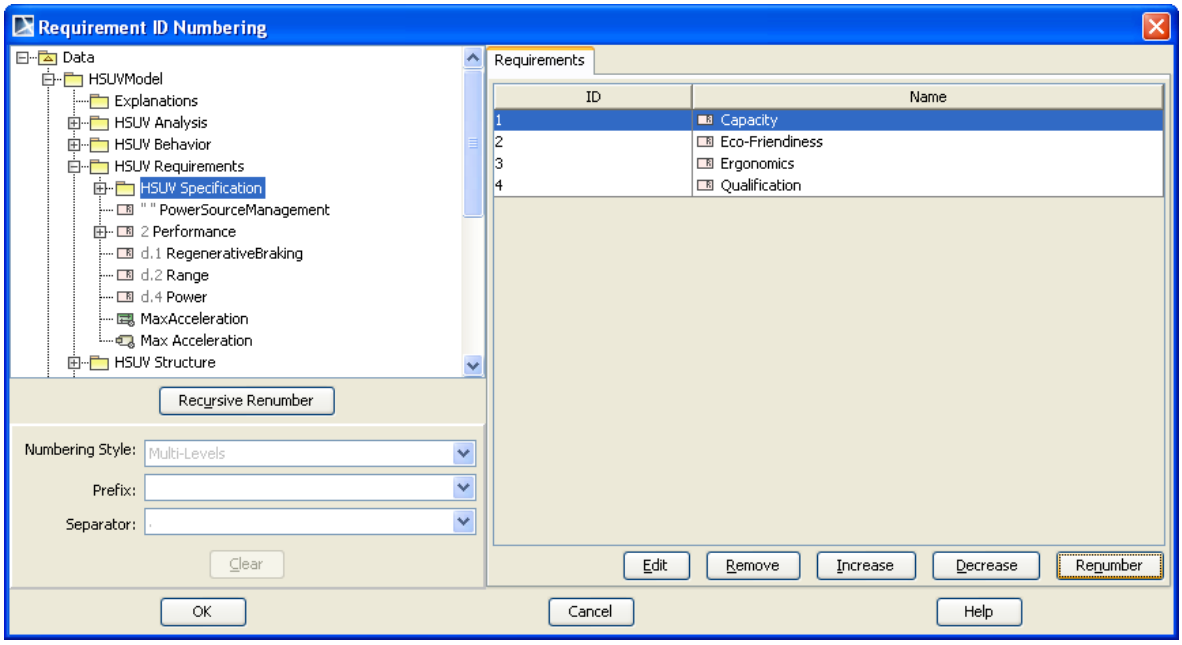


Figure 140 -- Renumbering Requirements IDs

NOTE	• **Numbering Style**, **Prefix** and **Separator** can be defined at a package or a top-level requirement. A requirement is considered to be top-level only if it is directly owned by a package, model, or profile. A requirement owned by another requirement is NOT considered as a top-level requirement. A top-level requirement ID cannot contain any separator. • The **Numbering Style**, **Prefix** and **Separator** values defined in an upper-level node (package, model, profile) will be overridden by the values defined in a lower-level node (package, model, profile, top-level requirement). • The 'Data' package contains the default **Numbering Style**, **Prefix** and **Separator** values defined for your project (Numbering Style = Multi-Levels, Prefix = '', and Separator = '.').

5. In Figure 140, the requirements in the 'HSUV Specification' package (under '**Data** > **HSUV-Model** > **HSUV Requirements**') were renumbered. Since there is no **Numbering Style**, **Prefix** and **Separator** values defined in the 'HSUV Specification', 'HSUV Requirements' and 'HSUV-Model' packages, the values defined in the 'Data' package (default) will be used instead (Numbering Style = Multi-Levels, Prefix = '', and Separator = '.'), as shown in Figure 141.

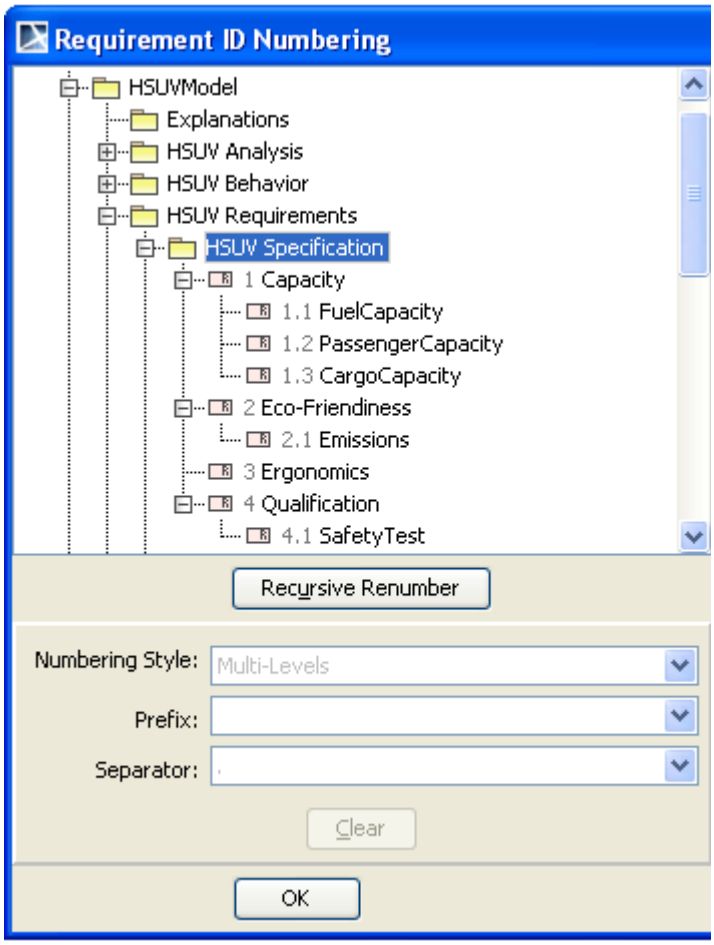


Figure 141 -- Example of Numbered Requirements

6. You can change the **Numbering Style**, **Prefix** and **Separator** values defined in the 'HSUV Specification' package (called Package-specific Numbering Configuration) to renumber the requirements in this package (Figure 142).

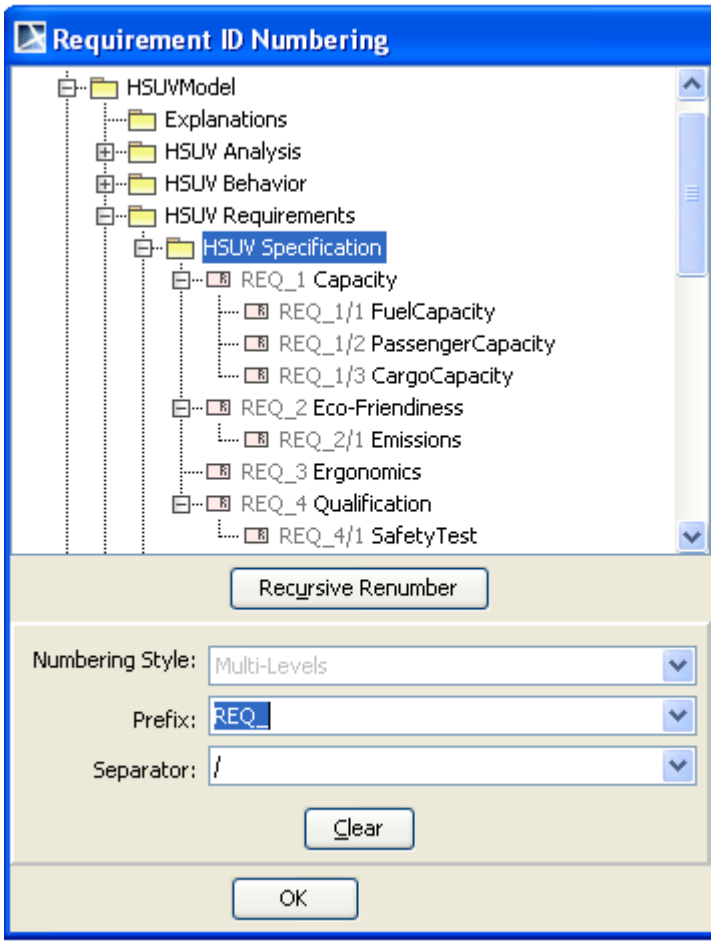


Figure 142 -- Customizing Numbering Style, Prefix, and Separator Values Defined for a Package

7. You can click the **Recursive Renumber** button to renumber all requirements that are recursively contained inside the selected node. The Numbering Style, Prefix and Separator, which are defined in the selected node, will be used for recursive renumbering. If the Package-specific Numbering Configuration of the lower-level nodes exists, then a message box will open to ask whether to replace the existing values with the values of the selected node (Figure 143).

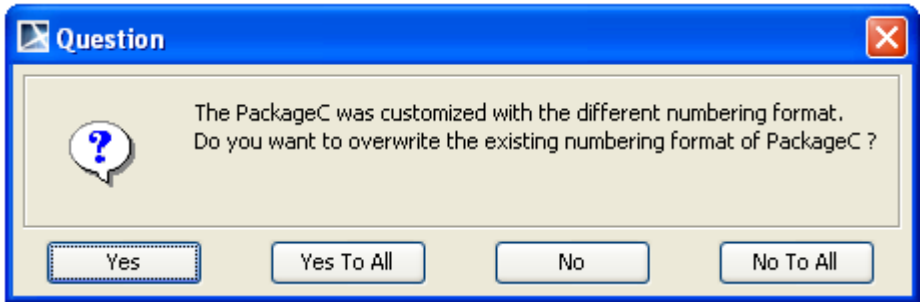


Figure 143 -- Question Dialog - Recursive Numbering Confirmation

8. You can click the **Clear** button under the **Separator** box to remove the Package-specific Numbering Configuration. For example, select the 'HSUV Specification' package in the browser (Figure 142) and click the **Clear** button. The Package-specific Numbering Configuration of the 'HSUV Specification' package will then be removed. Thus, the available 'numbering configuration' in an owning package will be used instead, which is, in this case, the 'Data' package.
9. Click **OK** (Figure 140) to update the renumbered requirement IDs to your model, or click **Cancel** (Figure 140) to ignore the requirement IDs numbered using this dialog.

(ii) Automatic Numbering

Once this functionality is turned on, the IDs of the newly-created requirements will be numbered automatically.

To number requirement IDs automatically:

1. Click **Options** > **Project** on the main menu. The **Project Options** dialog will open (Figure 144).

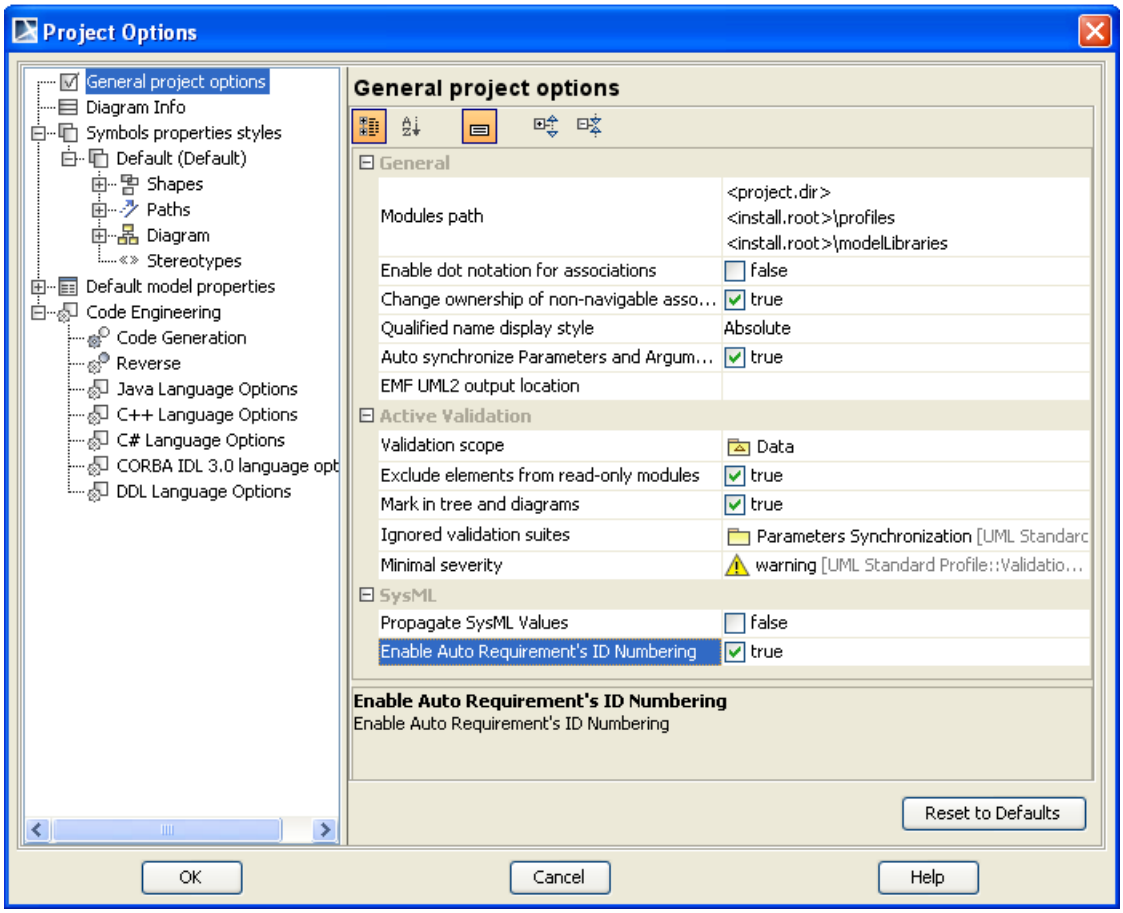


Figure 144 -- Automatic Requirement Numbering in Project Options Dialog

2. Under the **SysML** group, make sure that the **Enable Auto Requirement's ID Numbering** option is selected (selecting the check box means 'true') (Figure 144).
3. The IDs of any newly-created requirements will now be numbered automatically with the Numbering Style, Prefix and Separator which are defined in the requirement owner.

NOTE	Automatic Numbering will NOT modify any existing ID. Thus, requirements with IDs will NOT participate in Automatic Numbering.

(iii) Suggested Solutions for Invalid Requirement's ID

When the ID of an requirement element is invalid with respect to the validation constraint 'Requirement[A]' (Requirement's ID must be unique), the requirement with invalid ID will be highlighted. When select such requirement, the requirement smart manipulator menu will also propose the suggested solutions (Figure 145, Figure 147):

1. **Open Requirement ID Numbering dialog** (Figure 145): this solution will open the Requirement ID numbering dialog. The selected requirement will be shown in the requirements list on your right hand side. The owner of the selected requirement will be selected on the tree in the panel on your left hand side (Figure 146)

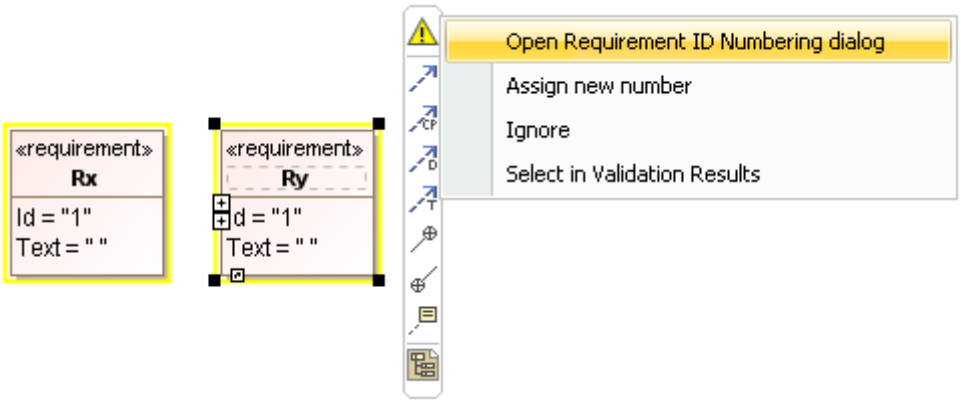


Figure 145 -- Suggested Solution for Open Requirement ID Numbering Dialog

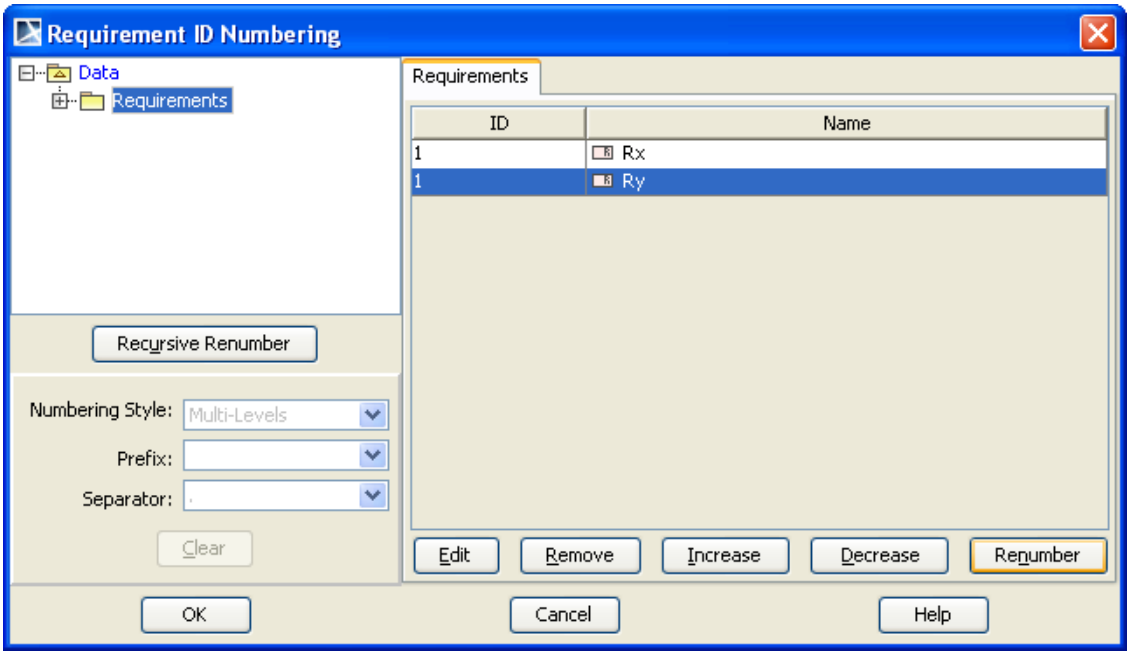


Figure 146 -- Requirement ID Numbering Dialog

2. **Assign New Number** (Figure 147): you can also use this solution to automatically re-assign the new requirement's ID to the selected requirement. The first available correct ID will be assigned to the requirement automatically.

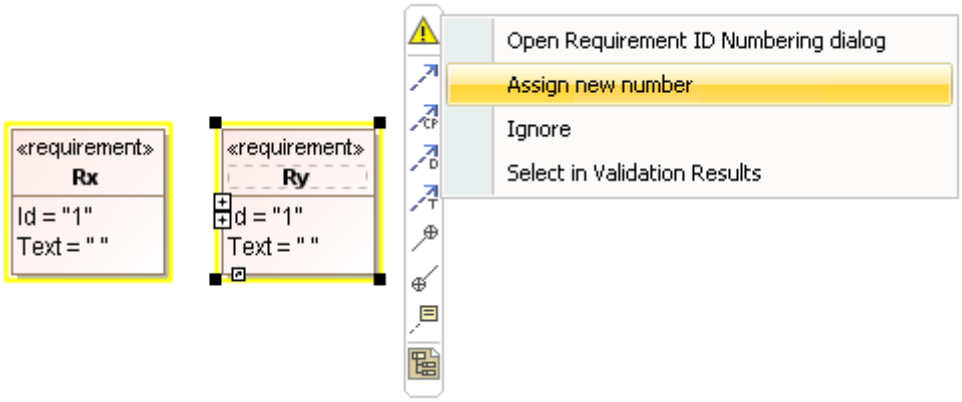


Figure 147 -- Suggested Solution for Assign New Number

(iv) Finding a Requirement

To find a requirement in Containment Tree and Tree of Requirement ID Numbering dialog:

- Select tree in the containment browser or the tree in Requirement ID Numbering dialog.
- To search for a requirement by its ID, type the ID of the requirement. The matched requirement will be selected, if found.

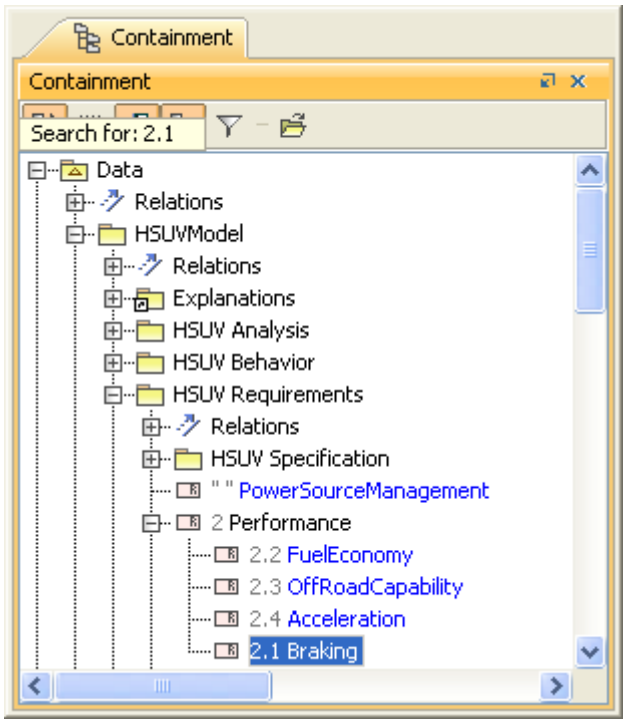


Figure 148 -- Finding requirement by ID in Containment Tree

- To search for a requirement by its name, type "*" followed by the name of the requirement. The corresponding requirement will be selected, if found.

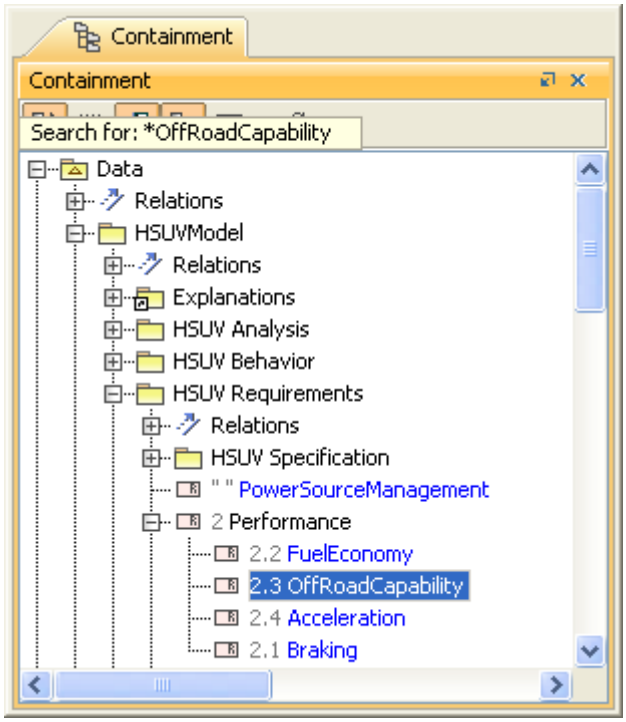


Figure 149 -- Finding requirement by name in Containment Tree

NOTE	This type of search cannot find an element if the element is not shown in browser when searching.

To find the requirement using the Find dialog:

- You can either select **Edit > Find...** in the main menu, or press Ctrl + F to open the **Find** dialog.
- To search for a requirement by its ID, select the tab for searching element by tag value in the Find dialog. In **Name** combo box, type “Id” and then type the ID of the requirement into the **Value** combo box. Click **Find** button.

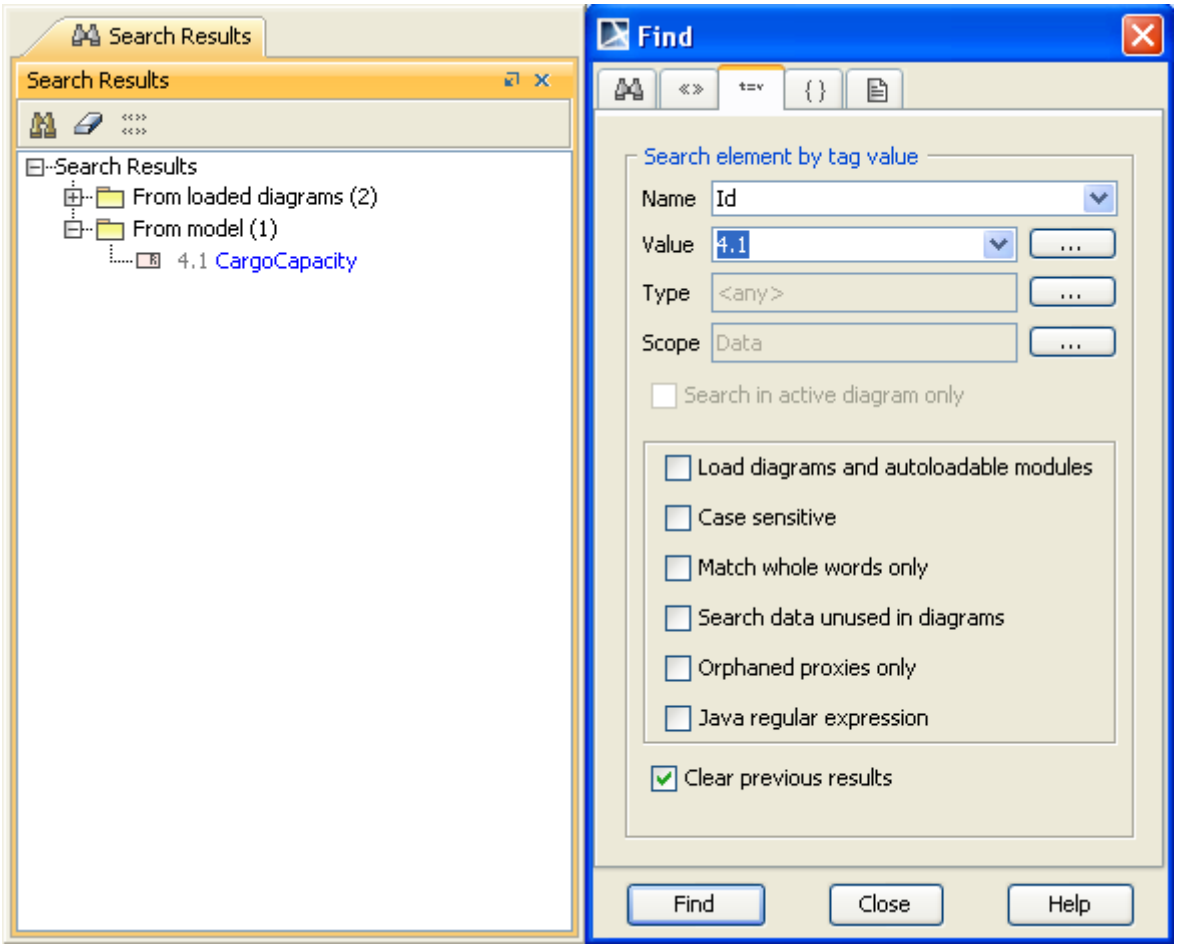


Figure 150 -- Finding requirement by ID using Find dialog

- To search for a requirement by its name, select the tab for searching element by name. Type the name of requirement into the **Name** combo box. Then click browse button (…) after the Type text field and select the **Requirement**. Finally, click **Find** button.

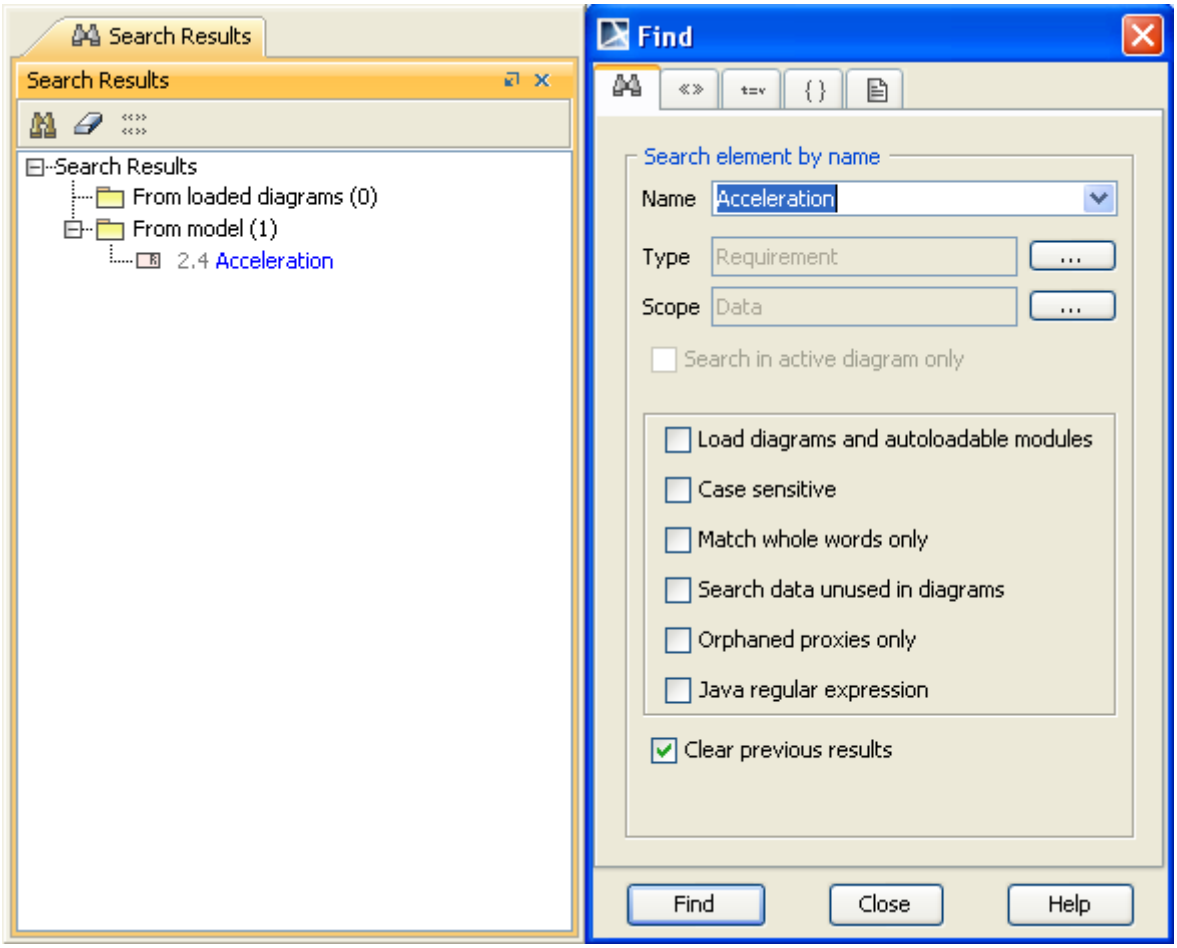


Figure 151 -- Finding requirement by name using Find dialog

To find the requirement using the Quick Find dialog:

- You can either select **Edit > Quick Find...** in the main menu or press Ctrl + Alt + F to open the Quick Find dialog.
- To search for a requirement by its ID, type the ID of the requirement into the combo box **Type Name** in the Quick Find dialog.

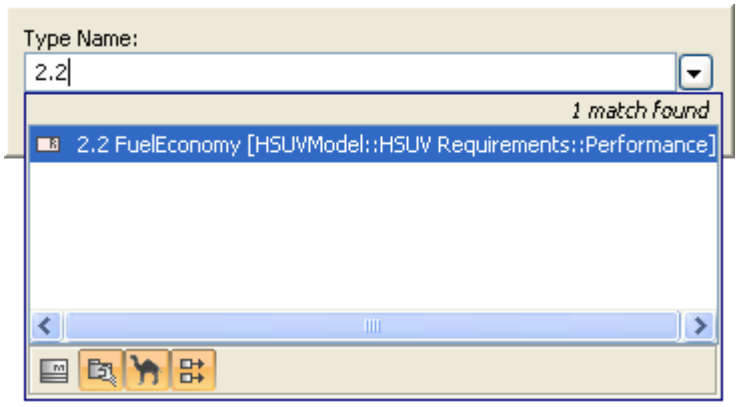


Figure 152 -- Finding requirement by ID using Quick Find dialog

- To search for a requirement by its name, type “*” before the name of the requirement in the combo box Type Name.

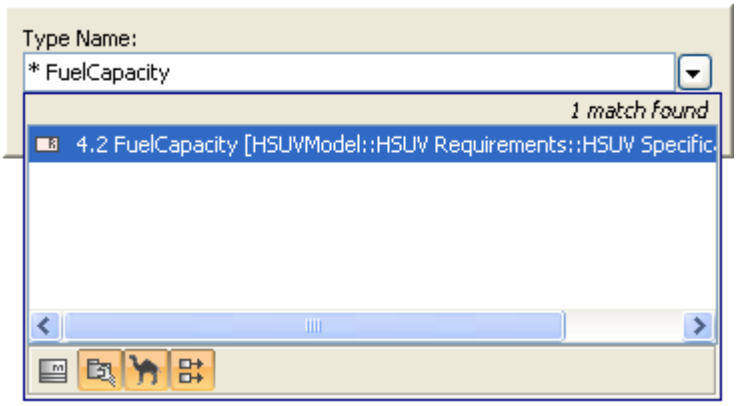


Figure 153 -- Finding requirement by name using Quick Find dialog

5.5.5 Using SysML Requirement Diagram Elements

Requirement

(a) Using Requirements

A requirement specifies a capability or a condition that a system must (or should) satisfy. The default interpretation of a compound requirement, unless stated differently by the compound requirement itself, is that all its subrequirements must be satisfied for the compound requirement to be satisfied. Subrequirements can be accessed through the "nestedClassifier" property of a class.

When a requirement nests other requirements, all the nested requirements apply as part of the container requirement (the requirement that contains all the nested requirements). Deleting the container requirement will thus delete all the nested requirements it contains; a functionality inherited from UML.

(b) Showing Requirement Tagged Values

Use Show Tagged Values to select a displaying mode for a text and ID requirements; either displaying them on shapes, in compartments, or not displaying them at all.

To select one of the displaying modes:

1. Right-click a requirement and select **Presentation Options** > **Show Tagged Values**. The 3 displaying modes will appear (Figure 154).

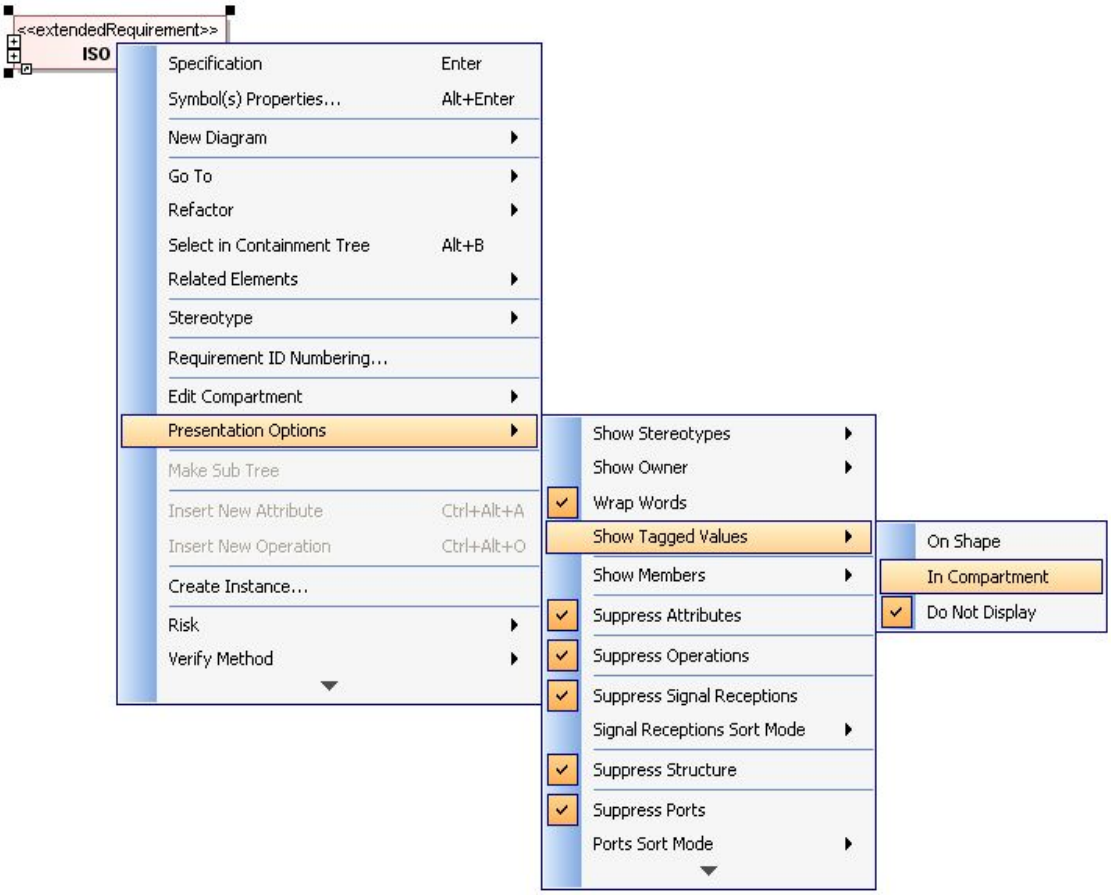


Figure 154 -- Displaying Mode of text and ID

2. Select one of the displaying modes. The result is shown in Figure 155.

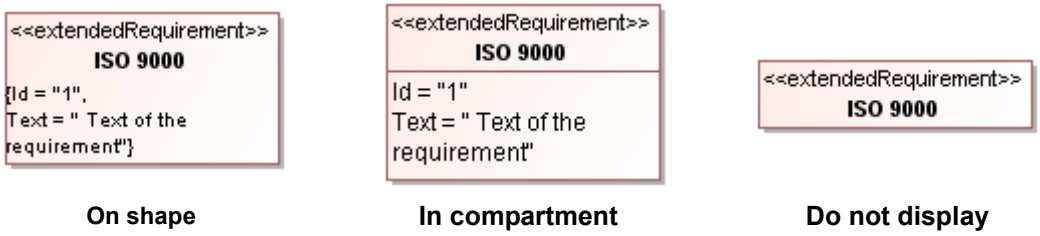


Figure 155 -- Different Displays of Requirement Elements

(c) Creating Your Own Requirement Type (Subtype)

You can define an additional requirement type by creating a new stereotype that generalizes the requirement stereotype (Figure 156).

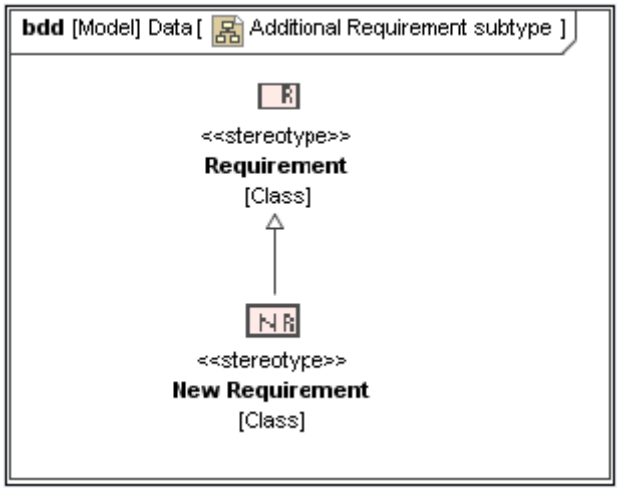


Figure 156 -- New Requirement Type

Requirement Subtypes

A Functional Requirement is satisfied by an operation or a behavior.

An Interface Requirement is satisfied by a port, connector, item flow, and/or a constraint property.

A Performance Requirement is satisfied by a value property.

A Physical Requirement is satisfied by a structural element.

A Design Constraint is satisfied by a block or a part.

The following table provides the definitions of the non-normative enumerations that are used to type the properties of the requirement subtypes.

Table 4 -- Non-normative Enumeration for Requirements

Enumeration	Enumeration Literals	Function
RiskKind	High	To indicate an unacceptable level of risk.
	Medium	To indicate an acceptable level of risk.
	Low	To indicate a minimal level of risk or no risk.
Verification-MethodKind	Analysis	To indicate that verification will be performed by technical evaluation using mathematical representations, charts, graphs, circuit diagrams, data reduction, or other representative data. Analysis also includes the requirement verification under conditions, which are simulated or modeled; where results are derived from the analysis of the results produced by the model.

Enumeration	Enumeration Literals	Function
	Demonstration	To indicate that verification will be performed by the operation, movement, or adjustment of the item under specific conditions to perform the design functions without the record of quantitative data. Demonstration is typically considered the least restrictive verification type.
	Inspection	To indicate that verification will be performed by examining the item, reviewing descriptive documentation, and comparing the appropriate characteristics with a predetermined standard to determine conformance to the requirements without the use of special laboratory equipment or procedures.
	Test	To indicate that verification will be performed through systematic exercising of the applicable item under appropriate conditions with instrumentation to measure the required parameters and the collection, analysis, and evaluation of quantitative data to show that the measured parameters are equal to or exceed the specified requirements.

Test Cases

The type of return parameter (Direction = return) of a Test Case element must be VerdictKind (an enumeration).

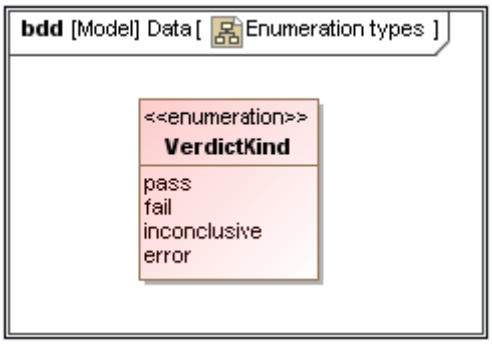


Figure 157 -- VerdictKind Enumeration

Requirement Relationships

Derive Relationship (Dependency)

As with other dependencies, the arrow direction points from the derived (client) requirement to the (supplier) requirement from which it is derived.

The supplier and the client of a Derive dependency must be requirement elements or requirement subtype elements.

Satisfy Relationship (Dependency)

The supplier must be a requirement element or one requirement subtype.

Copy Relationship (Dependency)

A Copy dependency created between two requirements maintains a master/slave relationship between the two elements for the purpose of requirements reuse in different contexts. When a Copy dependency exists between two requirements, the requirement text of the client requirement is a copy of the requirement text of the requirement at the supplier end of the dependency.

The supplier and the client of a Copy dependency must be requirement elements or requirement subtype elements.

5.5.6 SysML Requirements Table

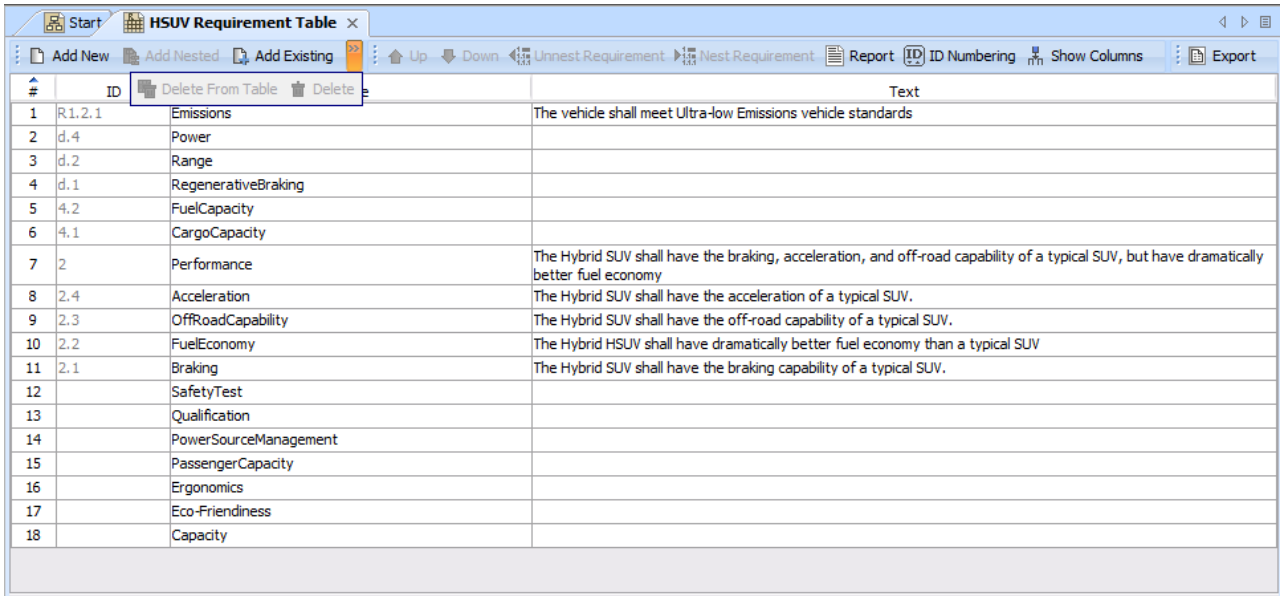
As requirements are text-based, it is more convenient to enter text using spreadsheet-like tabular format, i.e. SysML Requirements Table, instead of limited-size boxes in a diagram. This table is consistent with OMG SysML specifications.

SysML Requirements Table contains requirements. Each row in the table represents a requirement. When creating such table, it will consist of 9 columns, 4 of them visible, representing the properties of each requirement in the table. Table 5 below lists the name and description of each column. With this table, you can:

- Create new requirements directly in the table, or import the existing ones from your model to the table.
- Directly edit the properties of the requirements in the table.
- Directly generate requirement reports, renumber requirements' IDs, or export the table into CSV or HTML format.

Table 5 -- SysML Requirements Table Default Columns

Column Name	Visible by default	Description
#	Y	Row number.
ID	Y	Requirement ID.
Name	Y	Requirement name.
Text	Y	Requirement text.
Requirement Type	N	Type of requirement, e.g., business requirement, design constraint, etc.
Owner	N	Requirement owner.
Source	N	(For extendedRequirement and its subtypes only) source of the requirement.
Risk	N	(For extendedRequirement and its subtypes only) level of risk of the requirement. See Table 4 for more information.
Verify Method	N	(For extendedRequirement and its subtypes only) method to verify a requirement. See Table 4 for more information.



#	ID		Text
1	R1.2.1	Emissions	The vehicle shall meet Ultra-low Emissions vehicle standards
2	d.4	Power	
3	d.2	Range	
4	d.1	RegenerativeBraking	
5	4.2	FuelCapacity	
6	4.1	CargoCapacity	
7	2	Performance	The Hybrid SUV shall have the braking, acceleration, and off-road capability of a typical SUV, but have dramatically better fuel economy
8	2.4	Acceleration	The Hybrid SUV shall have the acceleration of a typical SUV.
9	2.3	OffRoadCapability	The Hybrid SUV shall have the off-road capability of a typical SUV.
10	2.2	FuelEconomy	The Hybrid HSUV shall have dramatically better fuel economy than a typical SUV
11	2.1	Braking	The Hybrid SUV shall have the braking capability of a typical SUV.
12		SafetyTest	
13		Qualification	
14		PowerSourceManagement	
15		PassengerCapacity	
16		Ergonomics	
17		Eco-Friendiness	
18		Capacity	

Figure 158 -- SysML Requirements Table

(i) Creating a SysML Requirements Table

You can create a SysML Requirements Table using the (a) main toolbar, (b) main menu, or (c) Containment Tree.

(a) To create a SysML Requirements Table using the main toolbar:

1. Click the **SysML Requirements Table** icon on the main toolbar (Figure 159). The **Create Diagram** dialog will open (Figure 160).

Figure 159 -- Main Toolbar

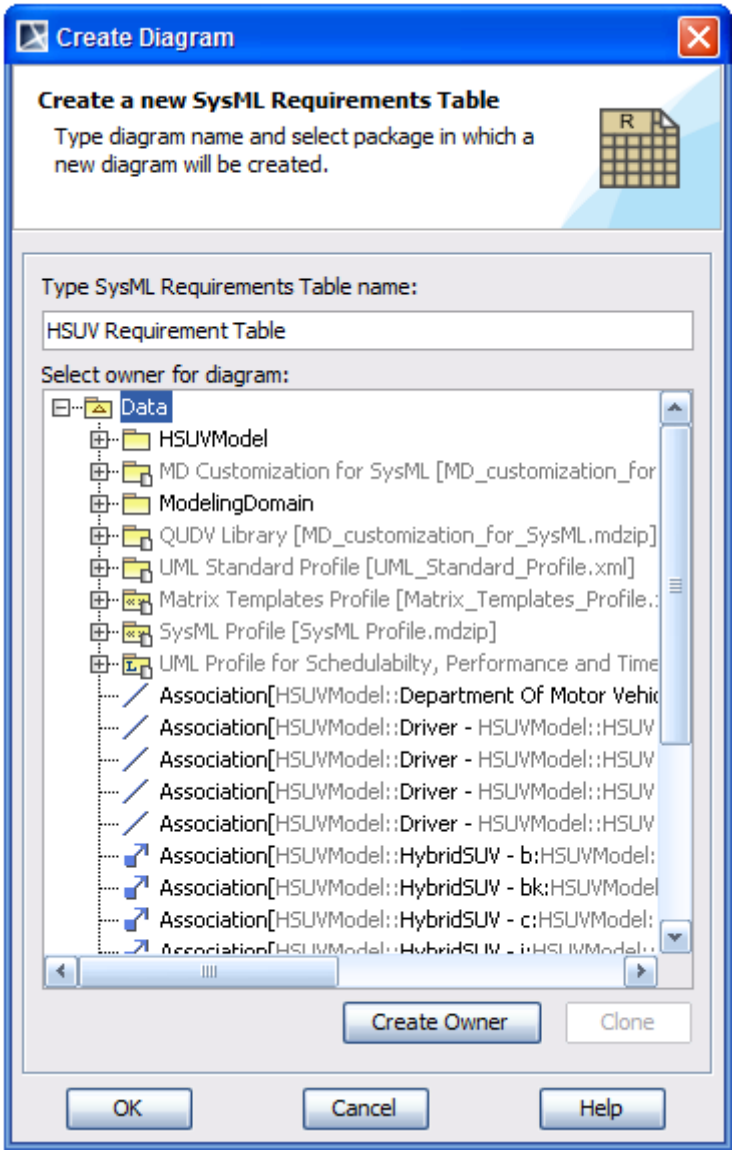


Figure 160 -- Create Diagram Dialog

2. Type in the name for the SysML Requirements Table to be created, and select its owner in the element tree (Figure 160).
3. Click **OK**.

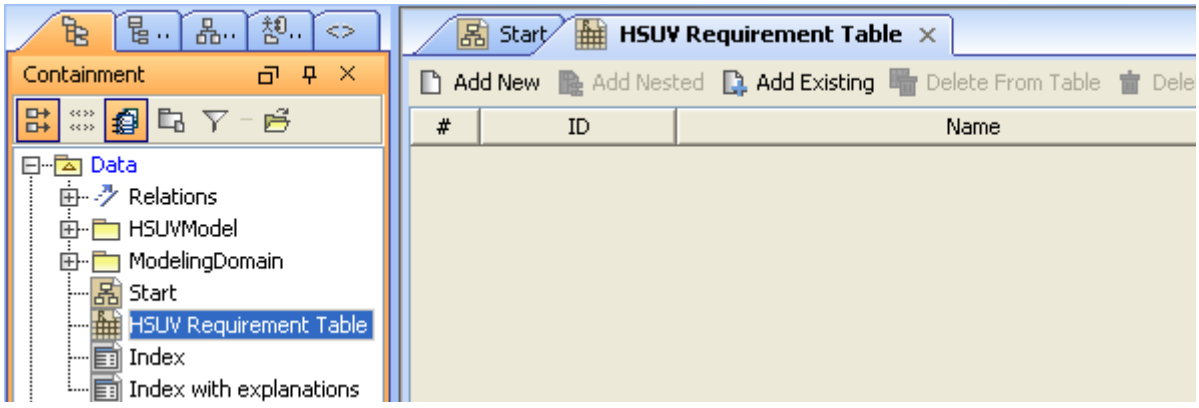


Figure 161 -- Blank SysML Requirements Table

(b) To create a SysML Requirements table using the main menu:

1. Click **Diagram** > **SysML Diagrams** > **SysML Requirements Table...** on the main menu (Figure 162). The **SysML Requirements Table** dialog (Figure 163) will open.

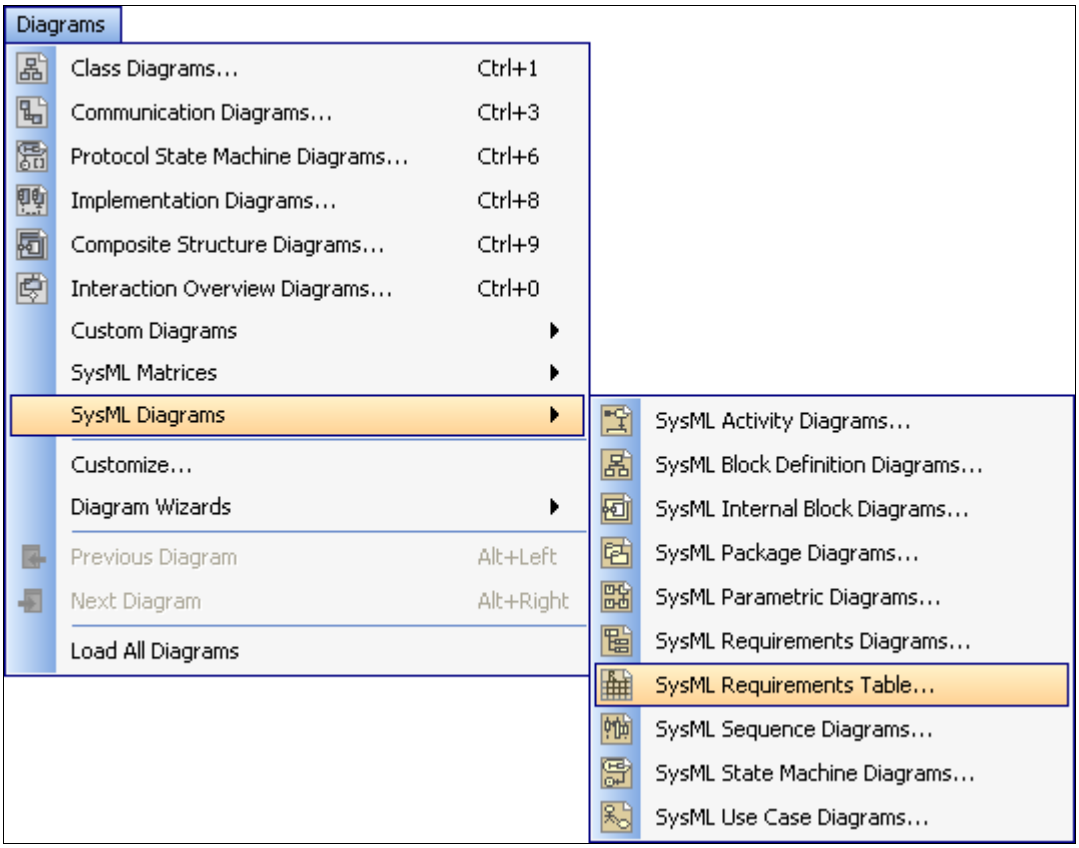


Figure 162 -- Creating SysML Requirements Table Using Main Menu

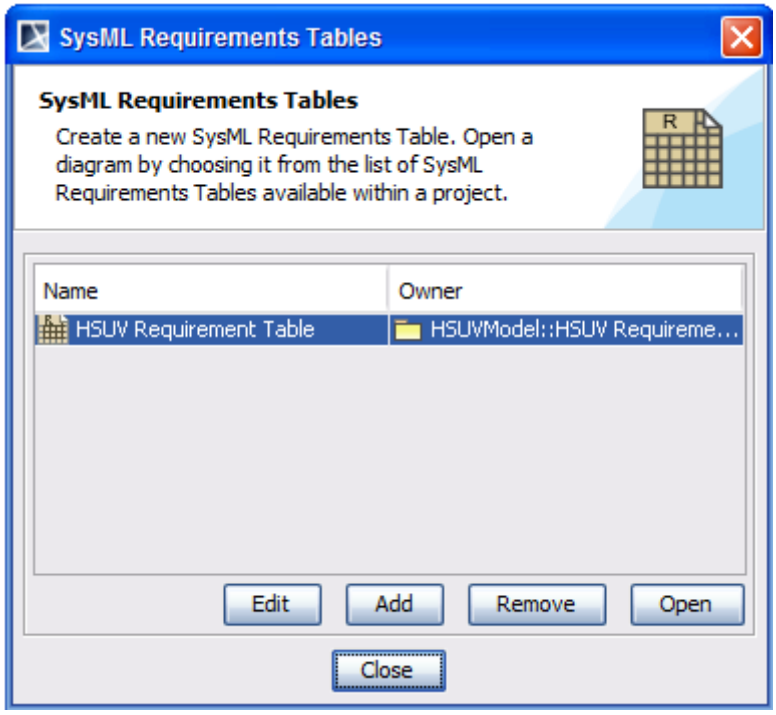


Figure 163 -- SysML Requirements Table Dialog

2. Click the **Add** button. The **Create Diagram** dialog (Figure 160) will open.
3. Type in the name for the SysML Requirements Table to be created, and select its owner in the element tree (Figure 160).
4. Click **OK**.

(c) To create a SysML Requirements table using the Containment Tree:

1. Right-click the element, which will be the owner of the SysML Requirements table, in the Containment Tree.

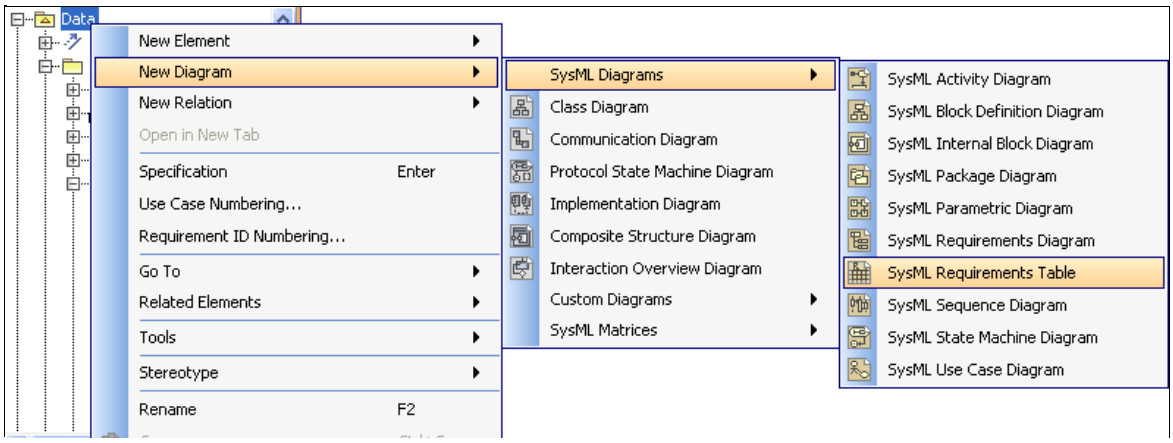


Figure 164 -- Creating SysML Requirements Table Using Containment Tree

2. Click **New Diagram** > **SysML Diagrams** > **SysML Requirements Table** (Figure 164).
3. Type in the name for the SysML Requirements Table in the Containment Tree, and then press **Enter**.

(ii) SysML Requirements Table Toolbar

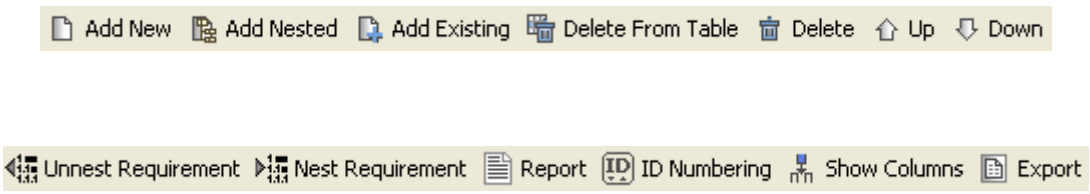


Figure 165 -- SysML Requirements Table Toolbar

The SysML Requirements table toolbar (Figure 165) is located on the main toolbar. There are 13 Requirements table icons on the Requirements table toolbar: (a) Add New, (b) Add Nested, (c) Add Existing, (d) Delete From Table, (e) Delete, (f) Up, (g) Down, (h) Unnest Requirement, (i) Nest Requirement, (j) Report, (k) ID Numbering, (m) Export, and (l) Show Columns.

Table 6 -- SysML Requirements Table Toolbar Icons

Icon	Name	Keyboard Shortcut
	Add New	Insert Ctrl + I (on MAC)
	Add Nested	Alt + Insert Alt + I (on MAC)
	Add Existing	Ctrl + Insert Ctrl + E (on MAC)
	Delete From Table	Delete
	Delete	Ctrl + D
	Up	Ctrl + Open Bracket
	Down	Ctrl + Close Bracket
	Unnest Requirement	n/a
	Nest Requirement	n/a
	Report	n/a
	ID Numbering	n/a
	Show Columns	n/a
	Export	n/a

(a) Add New

You can either click the **Add New** icon on the table toolbar or press **Insert** (Table 6) to add a new requirement which will then be automatically added to the table.

If you click the icon, the available requirement types will be listed in the drop-down menu (Figure 166). If you have created your own custom requirement types, they will appear under the **Custom Requirements** group in

the menu, e.g., “myRequirement” in Figure 166. Then, select a requirement type that you want to create from the drop-down menu. A requirement of the selected type will then be created and added to the table.

NOTE	• The owner of the newly-created requirement will be similar to the owner of the table. • To select a different owner, hold **Shift** and then select a requirement type from the drop-down menu. The **Select Owner** dialog will then open, enabling you to choose a different owner. • If a table row is selected, the requirement in that row will be selected in the **Select Owner** dialog automatically. • If the selected owner is a requirement, then you are creating a new nested requirement.

If you press the buttons, a requirement will be created promptly. You can then change the type of the newly-created requirement directly in the table.

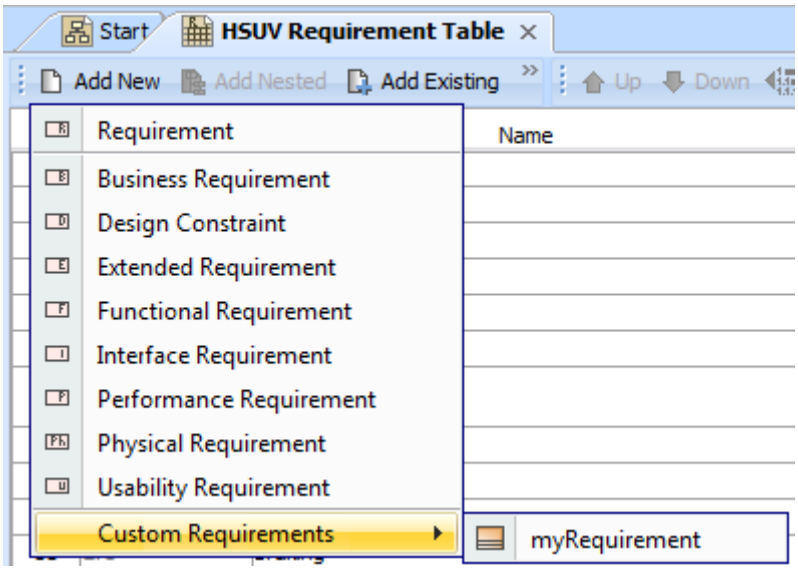


Figure 166 -- Requirement Type Drop Down Menu for SysML Requirements Table

(b) Add Nested

When a requirement is highlighted in the table, you can either click the **Add Nested** icon on the table toolbar or press **Alt + Insert** (Table 6) to add a new nested requirement, owned by the highlighted requirement, to the table.

Like **Add New**, if you click the icon, the available requirement types will be listed in the drop-down menu. Then, select a requirement type that you want to create from the drop-down menu. A nested requirement of the selected type will then be created, being owned by the requirement highlighted in the table.

(c) Add Existing

To add requirement(s) already existed in your model to a SysML Requirements Table:

1. Click the **Add Existing** icon on the table toolbar or press **Ctrl + Insert** (Table 6). The **Select Requirement** dialog will open (Figure 167).

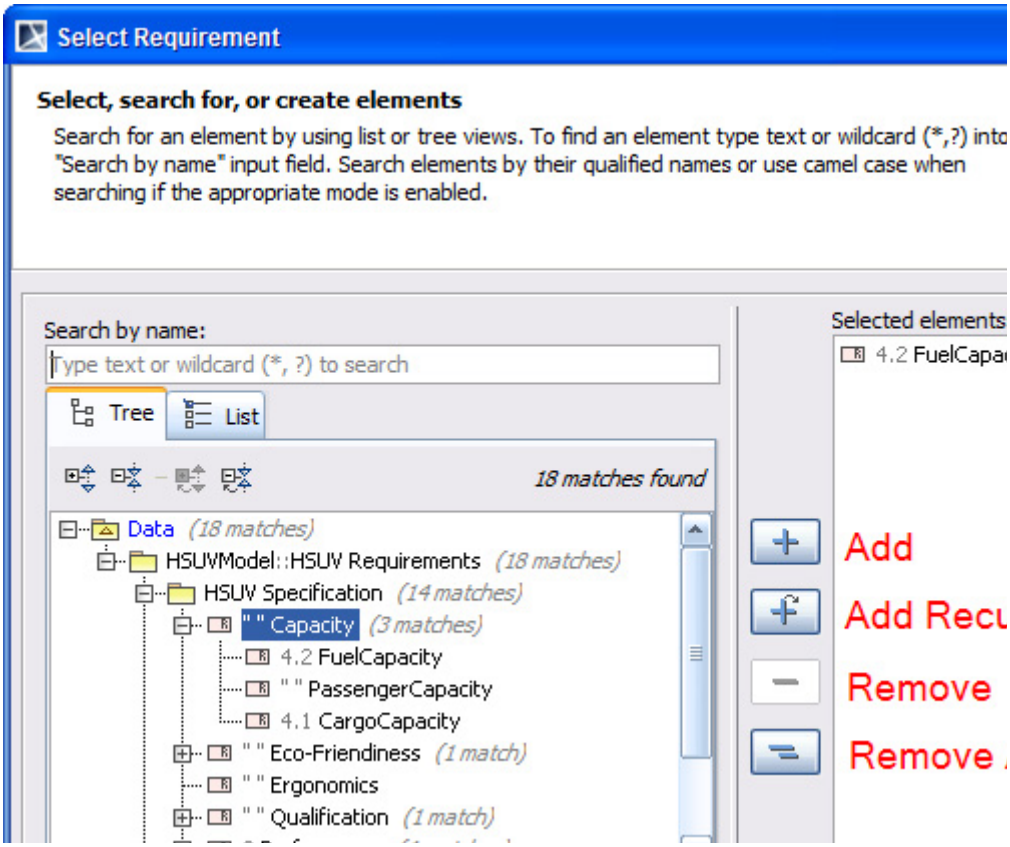


Figure 167 -- Select Requirement Dialog - Add Existing Requirements to Table

2. Select the requirement element(s) which you want to add to the table.
   - Use the **Add** button in Figure 167 to add a requirement selected in the element tree to the **Selected elements:** pane.
   - Use the **Add Recursively** button in Figure 167 to add all requirements listed under the requirement selected in the element tree and the selected requirement itself to the **Selected elements:** pane.
   - Use the **Remove** button in Figure 167 to remove the selected requirement from the **Selected elements:** pane.
   - Use the **Remove All** button in Figure 167 to remove all requirements from the **Selected elements:** pane.
3. In the **Select Requirement** dialog (Figure 167), click
   - **OK** to add all requirements in the **Selected elements:** pane to the table, or
   - **Cancel** to cancel the operation.

(d) Delete From Table

To remove requirement(s) from a SysML Requirements Table:

1. Select the row(s) of the requirement(s) you want to remove.
2. Click the **Delete From Table** icon on the table toolbar or press **Delete** (Table 6).
3. The selected requirement(s) will then be removed from the table.

NOTE	Requirement(s) removed from the table still exist(s) in your model. To remove requirements from your project, see Section **(e) Delete** below.

(e) Delete

To remove requirement(s) from your model:

1. Select the row(s) of requirement(s) you want to remove.
2. Click the **Delete** icon on the table toolbar or press **Ctrl + D** (Table 6).
3. The selected requirement(s) will then be removed from the table and from your project.

(f) Up

To move the selected row of requirement up, either click the **Up** icon on the table toolbar or press **Ctrl + Open Bracket** (Table 6).

(g) Down

To move the selected row of requirement down, either click the **Down** icon on the table toolbar or press **Ctrl + Close Bracket** (Table 6).

(h) Unnest Requirement

When a nested requirement is selected in the Requirements Table, you can click the **Unnest Requirement** to move the selected requirement to be owned by the owner of the current one. The requirement's id will be changed accordingly. **Unnest Requirement** also supports for the multiple selection of the nested requirements which are owned by the same owner.

(i) Nest Requirement

You can select a requirement in the Requirements Table and then click on the **Nest Requirement** to move the selected requirement to be owned by the requirement in the previous row. Nest Requirement also support for the multiple selection of the requirements.

(j) Report

The SysML Requirements Table allows you to generate a requirement report directly from the table. The default report template used is **Requirement Table (Type A)**.

To generate a report, click the **Report** icon on the table toolbar (Table 6). The template drow-down menu will then open (Figure 168).

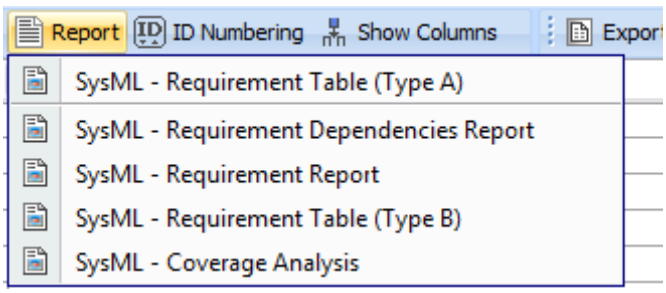


Figure 168 -- Template Drow-down Menu

Select the report template you would like to use. The **Generate Report** dialog will then open (Figure 169). Choose the report output filename and then click **Generate** to instantly generate the report.

NOTE	• All requirements in the table will be used as the scope of the generated report. • To change the scope of the report, activate **Report Wizard** by clicking the **Wizard** button in the **Generate Report** dialog (Figure 169). Click the **Next** button in the **Report Wizard** twice to proceed to the **Select Element Scope** pane. You can then change the report scope using this pane. • The **Built-in** report data (in the **Select Report Data** pane of **Report Wizard**) must be selected, in order to generate a report from this table.

See Section **12. Report Wizard and Template** for more information on report generation.

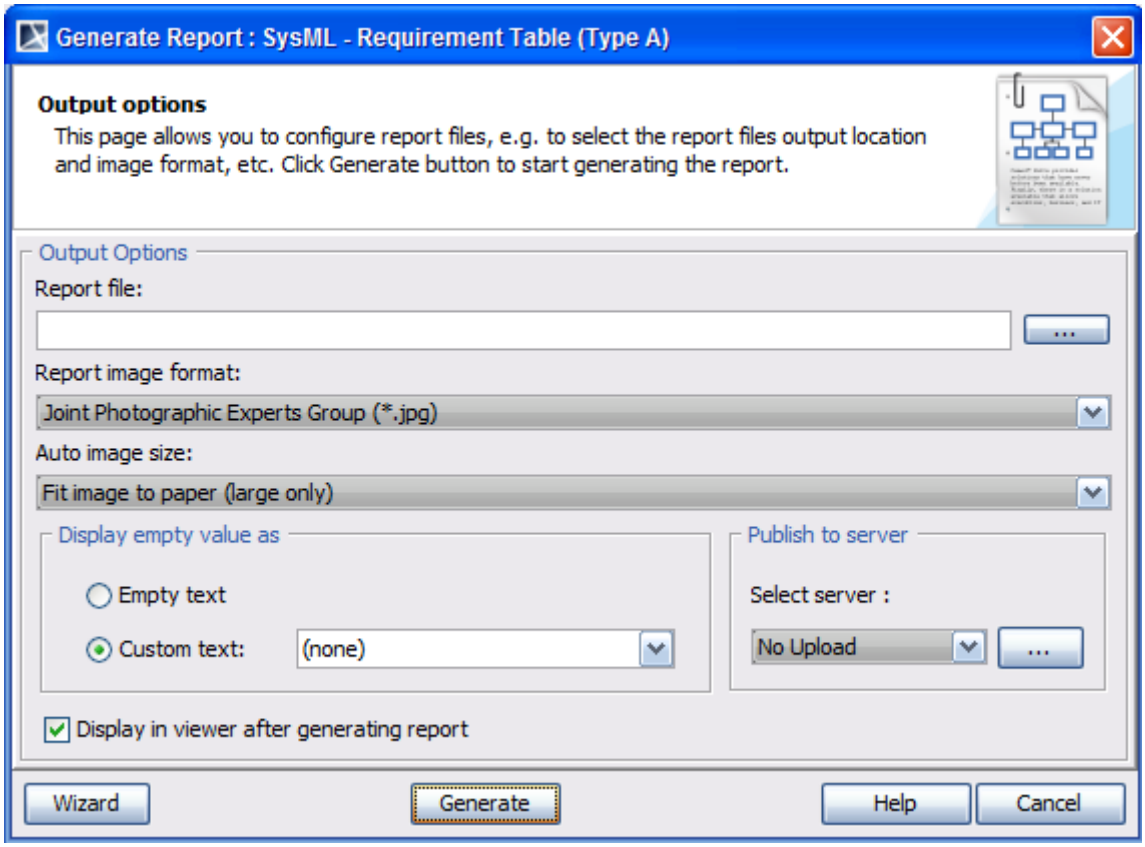


Figure 169 -- Generate Report Dialog - SysML Requirements Table

(k) ID Numbering

You can activate the **Numbering Requirement IDs** feature from a SysML Requirements Table by clicking the **ID Numbering** icon on the table toolbar (Table 6).

To edit the ID of a requirement, select the requirement in the table and click the **ID Numbering** icon on the table toolbar.

(l) Show Columns

To show/hide columns in the table, click the **Show Columns** icon on the table toolbar (Table 6). The **Table Column** drop down menu will then display (Figure 170).

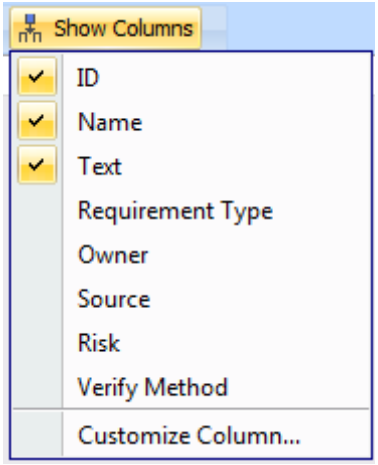


Figure 170 -- Table Column Drop Down Menu for SysML Requirements Table

Check a column name to display that column on the table (or uncheck a column name to hide that column). To customize displayed columns, select **Customize Column...** in Figure 170. The **Select Custom Requirement Columns** dialog will then display (Figure 171).

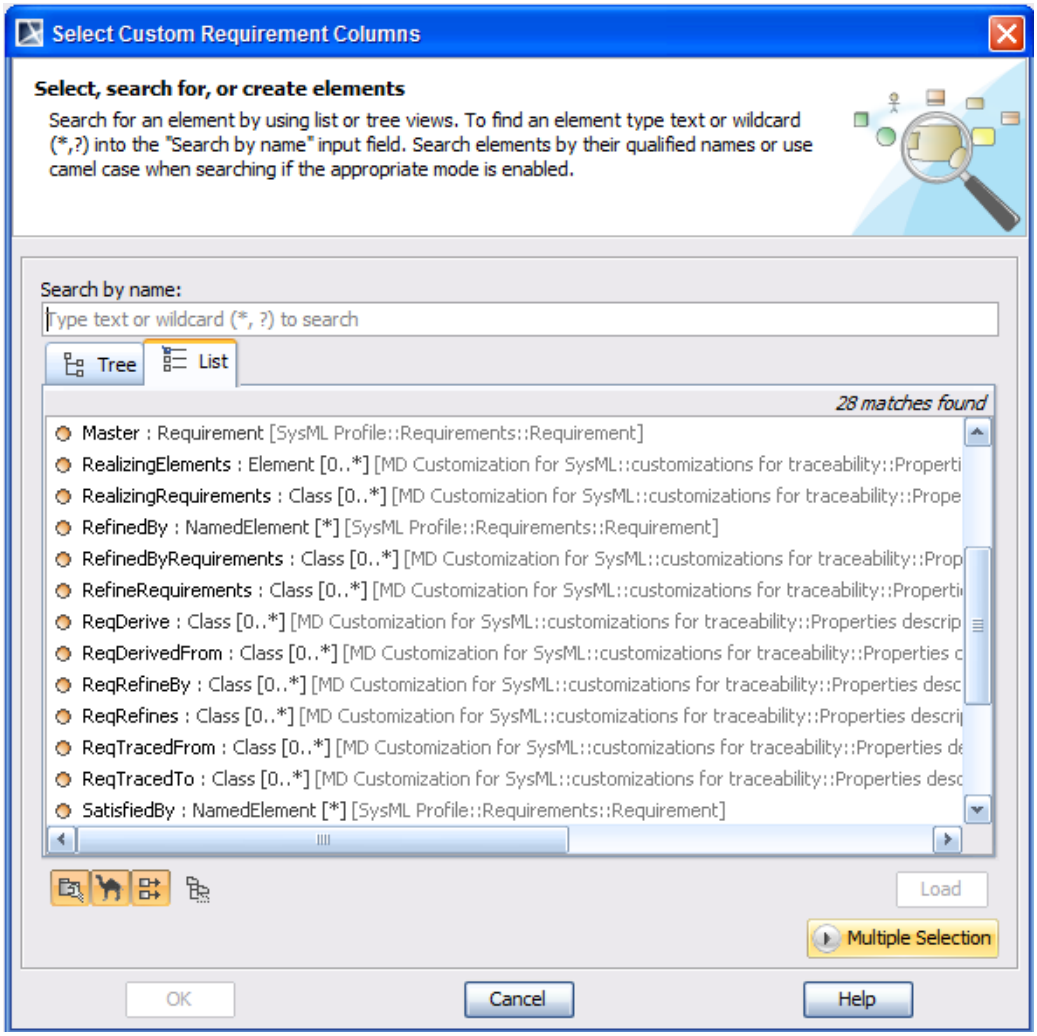


Figure 171 -- Select Custom Requirement Columns Dialog

Select a property / tag to be displayed as a new column of the Requirement Table, and then press **OK**. The new column will then display on the table. To be able to select multiple properties / tags to be displayed, use the **Multiple Selection** button (Figure 171).

(m) Export

You can also export a SysML Requirements Table to an HTML or CSV file by clicking the **Export** icon on the table toolbar (Table 6). All requirements in the table will be exported to a file of the selected file format.

5.6 SysML Activity Diagrams

Activity diagrams describe control, input, and output flows among actions. They represent the system business and operational work flows. They capture actions and display their results. They are typically used for business process modeling and used in situations where all or most of the events represent the completion of internally-generated actions.

Though Activity diagrams are often classified alongside interaction diagrams, they actually focus on the flows driven by internal processes (as opposed to external events).

SysML extends control in Activity diagrams and provides extensions that might be very loosely grouped under the term "continuous," but are generally applicable to any distributed flow of information and physical items through a system. It also introduces probability concepts to activities.

5.6.1 SysML Activity Diagram Metamodel and Elements

For more information on notation elements, see the *Activity Diagram* in the 'UML Diagrams' section of the MagicDraw User Manual.

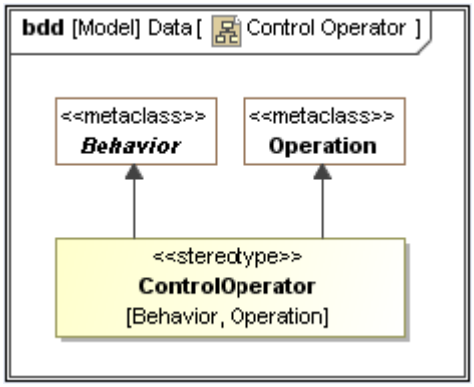


Figure 172 -- Control Operator Metamodel

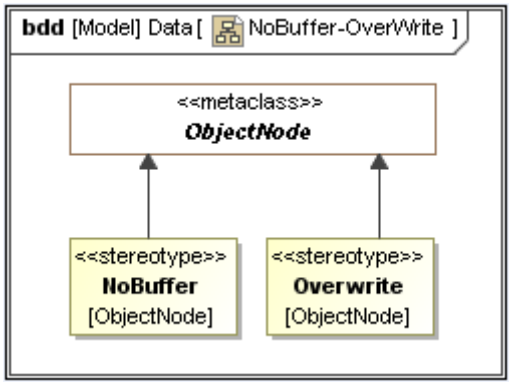


Figure 173 -- No Buffer and Overwrite Metamodel

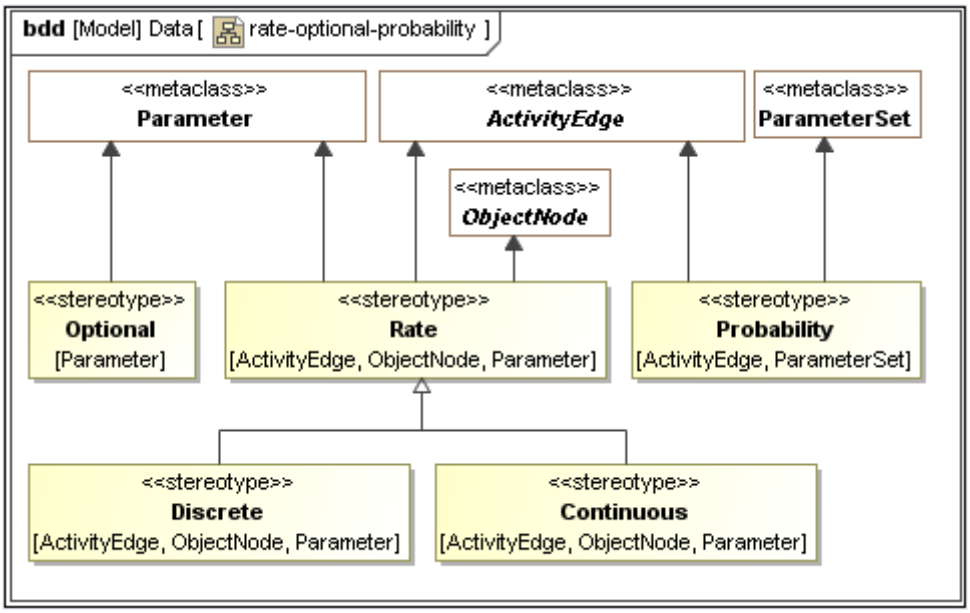


Figure 174 -- Rate, Optional, Probability, Discrete and Continuous Metamodel

Icon	Description
	**Object Node [UML]:** An Object Node is an abstract activity node that is part of defining object flow in an activity. Object nodes can be used in a variety of ways, depending on where objects are flowing from and to.

5.6.2 SysML Activity Diagram Toolbar

Element	Button (hot key)
Action [UML]: An action is a named element that is the fundamental unit of an executable functionality. The execution of an action represents some transformations or processing in the modeled system. When the action is to be executed or what its actual inputs are is determined by the concrete action and the behaviors in which it is used.	 (B)
Call Operation Action [UML]: A Call Operation Action is an action that transmits an operation call request to the target object, where it may cause the invocation of the associated behavior. The argument values of the action are available to the execution of the invoked behavior.	 (O)
Opaque Action [UML]: An Opaque Action is an action that introduces discipline to implement specific actions or to be used as a temporary placeholder before some other actions are chosen.	

Element	Button (hot key)
Any Action [UML]: This element is introduced in order to maintain any other desirable action element with an appropriate metaclass stereotype applied.	
Object Node: See Section 5.6.1 for description.	 (SHIFT+B)
Data Store [UML]: A Data Store node is a central buffer node for a non-transient information. A data store keeps all tokens that enter it, copies them when they are chosen to move downstream. Incoming tokens containing a particular object replace any tokens in the object node containing that object.	 (SHIFT+D)
Activity Parameter Node [UML]: An Activity Parameter Node is an object node for inputs and outputs to the activities. The Activity parameters are object nodes at the beginning and end of the flows, to accept inputs to an activity and provide outputs from it.	
Input Expansion Node [UML]: An Input Expansion Node is an object node used for indicating a flow across the boundary of an expansion region. A flow into a region contains a collection that is broken into its individual elements inside the region, which is executed once per element.	
Output Expansion Node [UML]: An Output Expansion Node is an object node used for indicating a flow out of a region that combines individual elements into a collection for use outside the region.	
Object Flow [UML]: An Object Flow is an activity edge that can have objects or data passing along it. An object flow models the flow of values to or from the object nodes.	 (SHIFT+F)
Control Flow [UML]: A Control Flow is an edge that starts an activity node after the previous one is finished. Objects and data cannot pass along the control flow edge.	 (F)
Send Signal Action [UML]: A Send Signal Action is an action that creates a signal instance from its inputs, and transmits it to the target object, where it may trigger the state machine transition or the execution of an activity.	 (SHIFT+S)
Accept Event Action [UML]: An Accept Event Action is an action that waits for the occurrence of an event that meets the conditions specified. Accept event actions handle event occurrences detected by the object owning the behavior.	 (E)
Time Event [UML]: A Time Event specifies a point of time with an expression, which may be absolute or might be relative to some other points of time.	 (I)

Element	Button (hot key)
Initial Node [UML]: An Initial Node is a starting point for executing an activity. It has no incoming edges.	 (T)
Activity Final [UML]: An Activity Final is a node that stops all flows in an activity.	 (D)
Flow Final [UML]: A Flow Final refers to the final node that terminates a flow and destroys all tokens that arrive at it. It has no impact on other flows in the activity.	 (L)
Decision [UML]: A Decision is a control node that chooses between outgoing flows. A decision node has one incoming edge and multiple outgoing activity edges.	 (G)
Merge [UML]: A Merge is a control node that brings together multiple alternate flows. It is not used to synchronize concurrent flows, but to accept one among several alternate flows.	 (G)
Fork/Join Horizontal [UML]: To help control parallel actions.	 (K)
Fork/Join Vertical [UML]: To help control parallel actions.	 (SHIFT+K)
Exception Handler [UML]: An Exception Handler is an element that specifies a body to execute in case the specified exception occurs during the execution of the protected node.	 (P)
Structured Activity Node [UML]: A Structured Activity Node is an executable activity node that may have an expansion into the subordinate nodes. The structured activity node represents a structured portion of the activity that is not shared with any other structured node, except for nesting.	
Expansion Region [UML]: An Expansion Region is a structured activity region that executes multiple times corresponding to the elements of an input collection.	
Conditional Node [UML]: A Conditional Node is a structured activity node that represents an exclusive choice among alternatives.	
Loop Node [UML]: A Loop Node is a structured activity node that represents a loop with the setup, test, and body sections.	

Element	Button (hot key)
Sequence Node [UML]: A Sequence Node is a structured activity node that executes its actions in order.	
Input Pin [UML]: An Input Pin is a pin that holds input values to be consumed by an action. Input pins are object nodes that receive values from other actions through object flows.	 (SHIFT+I)
Output Pin [UML]: An Output Pin is a pin that holds output values produced by an action. Output pins are object nodes that deliver values to other actions through object flows.	 (SHIFT+O)
Value Pin [UML]: A Value Pin is an input pin that provides a value to an action that does not come from an incoming object flow edge.	
Swimlanes [UML]: Swimlanes are used to organize actions and sub-activities according to the class allocated to each swimlane header and partition an activity diagram.	 (SHIFT+ V)  (SHIFT + W)

5.6.3 SysML Activity Diagram Specific Features

SysML Activity Diagram specific features include:

(i) Name Display Mode (Action shortcut menu)

(ii) Behavior (Action shortcut menu)

(iii) Select Operation (Call Operation Action shortcut menu)

(iv) Dynamic Centerlines

(v) Streaming Parameter

(i) Name Display Mode (Action shortcut menu)

Select **Name Display Mode** on the action shortcut menu (Figure 175) to show (a) the name of the action, (b) the behavior name of the action, or (c) both (Figure 176).

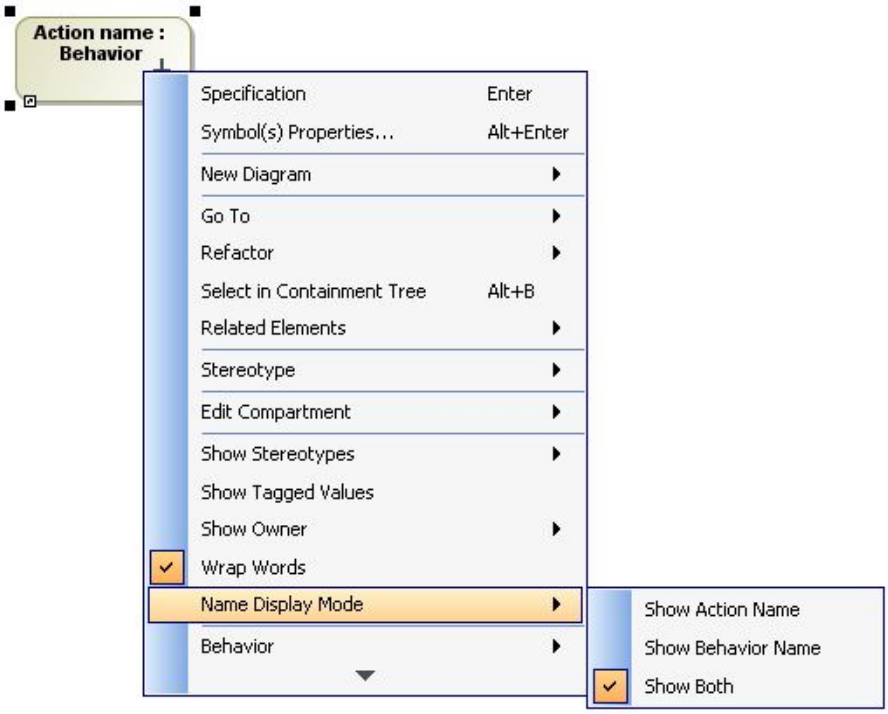
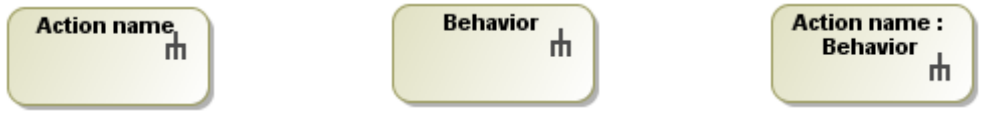


Figure 175 -- Action Shortcut Menu for Name Display Mode



Show Action name **Show Behavior name** **Show both**

Figure 176 -- Name Display Modes

NOTE	You can also change the Name Display Mode of an action in the action Symbol Properties dialog.

(ii) Behavior (Action shortcut menu)

Select **Behavior** from the action shortcut menu to choose the Behavior of the action (Figure 177).

.

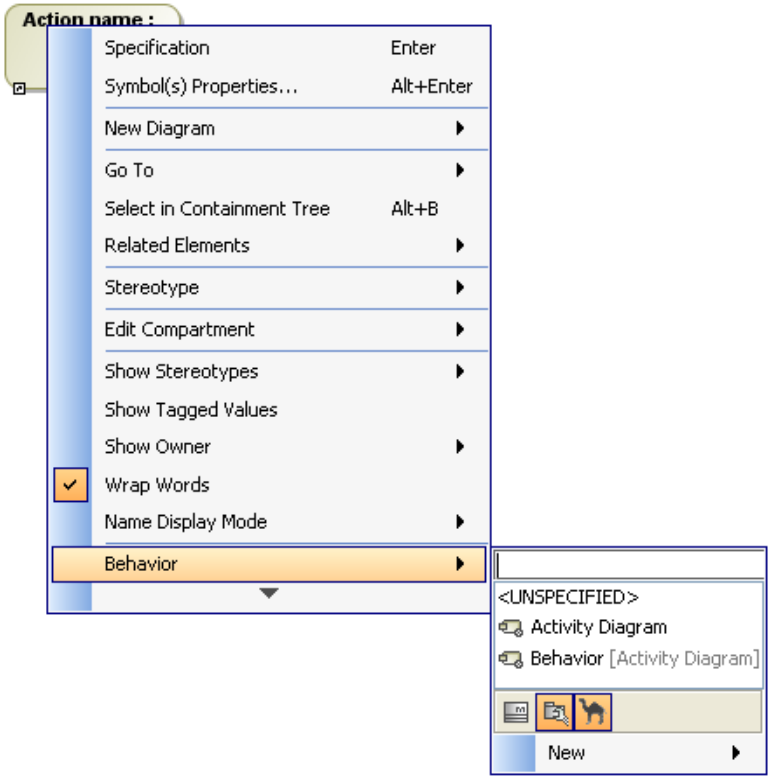


Figure 177 -- Action Shortcut Menu for Behavior Selection

NOTE	You can also change the behavior of an action in the action Specification dialog.

(iii) Select Operation (Call Operation Action shortcut menu)

Click **Select Operation** on the Call Operation Action shortcut menu (Figure 178) to select an operation for that Call Operation Action (Figure 179).

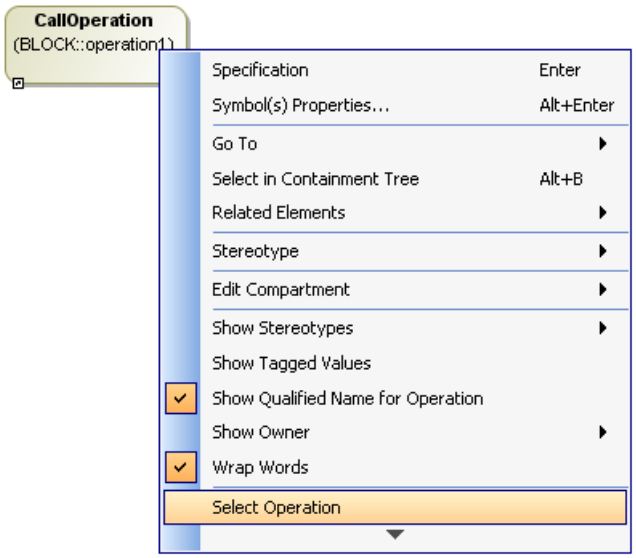


Figure 178 -- Call Operation Action Shortcut for Select Operation

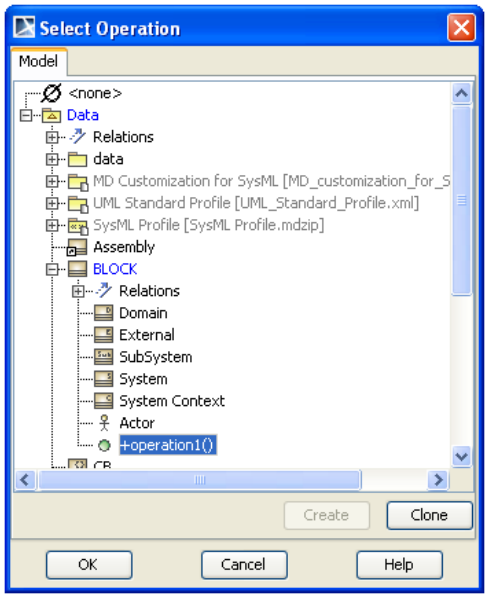


Figure 179 -- Select Operation Dialog

(iv) Dynamic Centerlines

This feature will display a horizontal or vertical centerline to make it easier for you to align a newly-created shape (or an existing one that is being shifted around) with one or two existing shapes in a SysML Activity Diagram (Figure 180).

This centerline, however, will only be displayed in situations where the center of the newly-created or shifted shape coincides with the horizontal or vertical axis of the shape(s) with which it is being aligned, regardless of how close to or remote from that shape it is.

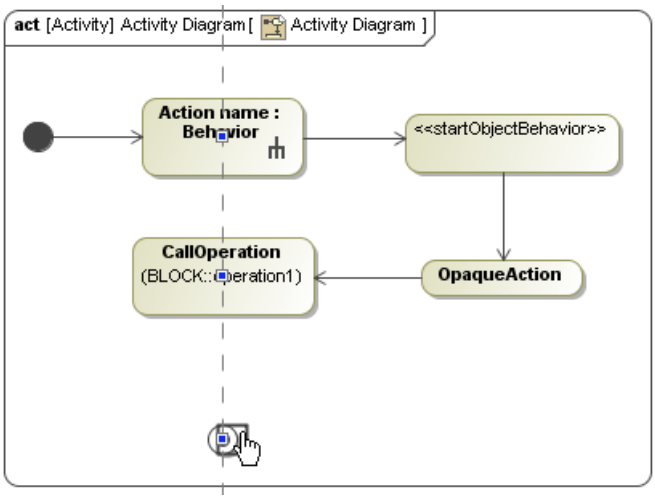


Figure 180 -- Dynamic Vertical Centerline

Dynamic Centerlines is enabled by default, So, if you do not want to have an horizontal or vertical centerline displayed in your diagram, you need to disable it.

To disable Dynamic Centerlines:

- Click the **Show Centerlines** button (Figure 181) on the activity diagram toolbar; or
- Press **C**; or
- Select **Options** > **Environment** on the main menu. The **Environment Options** dialog will then open. Clear the **Show centerlines in flow diagrams** option under the **Diagram > Display** group of the **Environment Options** dialog.

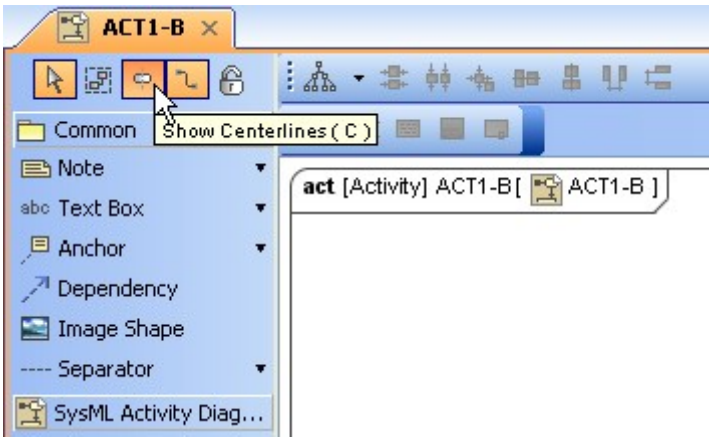


Figure 181 -- Show Centerlines Button

(v) Streaming Parameter

Right click on the Activity Parameter Node or Pin which has a parameter (Figure 182 and Figure 183). Check or uncheck the **Stream** menu for setting the value of **isStream** of the corresponding parameter to **true** or **false** respectively.

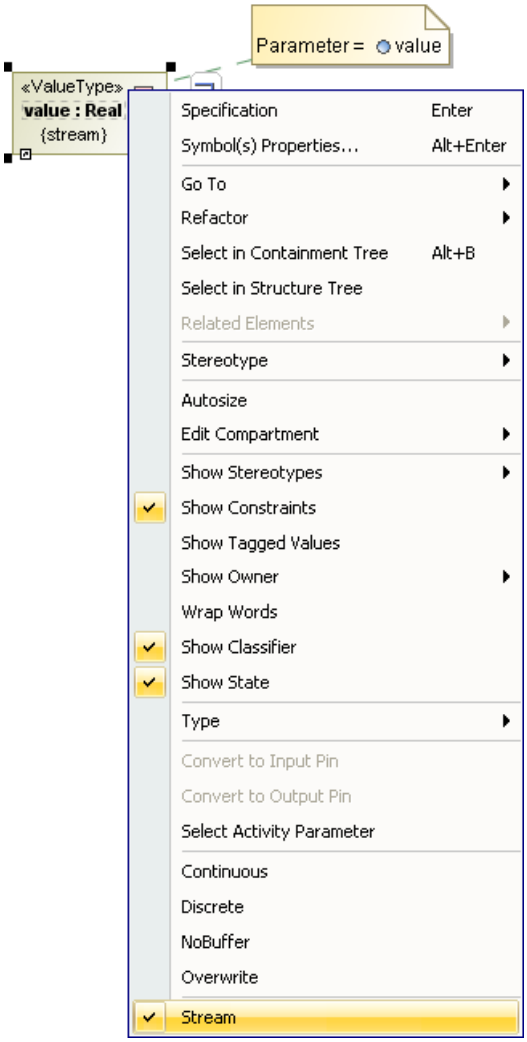


Figure 182 -- Context menu of Activity Parameter Node

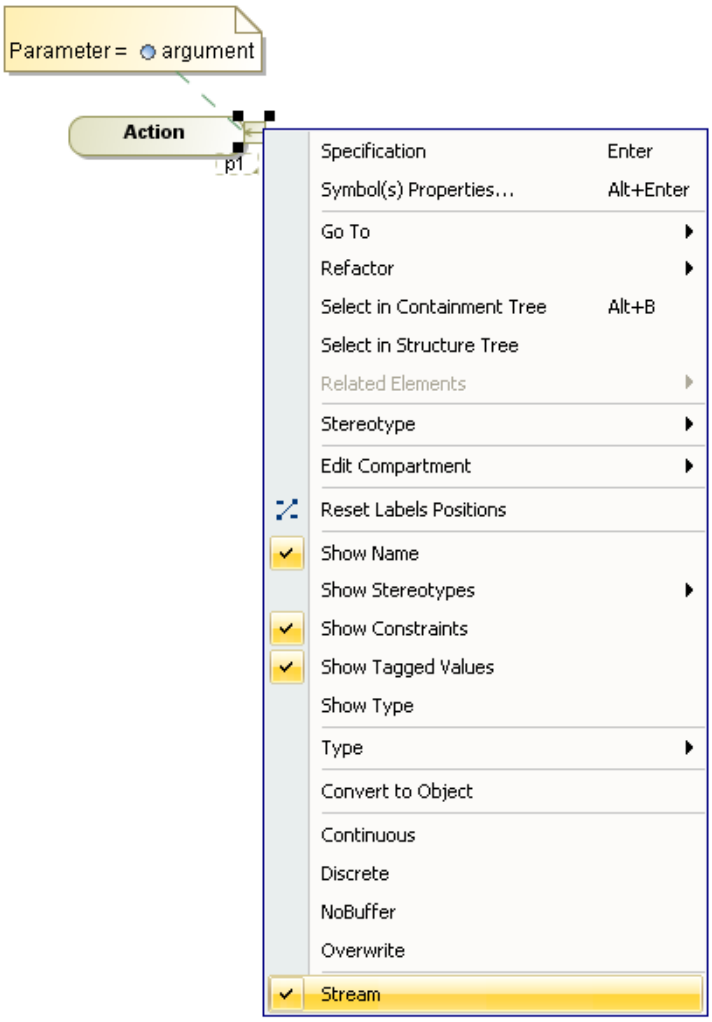


Figure 183 -- Context menu on Pin

5.6.4 Using Activity Diagram Elements

Activity Decomposition Hierarchy Wizard

You can decompose activities using the Activity Decomposition Hierarchy Wizard, which makes it possible to convert activities into Class Diagrams or into SysML BDDs, and represent, analyze, or document activity hierarchies in a diagram structure.

To decompose activities using the Activity Decomposition Hierarchy Wizard:

1. Select either:
   - **Activity Decomposition Hierarchy Wizard** on the SysML Activity Diagram shortcut menu (Figure 184),
   - **Diagrams > Diagram Wizards** > **Activity Decomposition Hierarchy Wizard** on the main menu, or
   - **Analyze > Model Visualizer** on the main menu. The **Model Visualizer** dialog will then be displayed. Select the **Activity Decomposition Hierarchy Wizard** from the dialog.

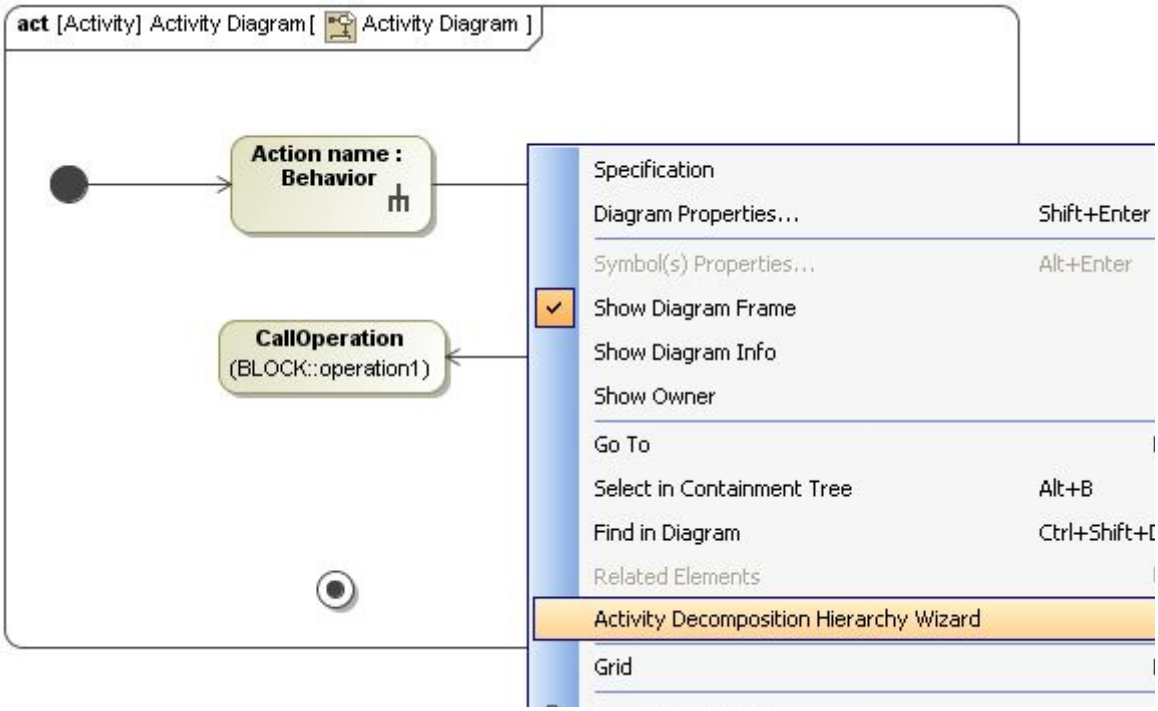


Figure 184 -- Activity Decomposition Hierarchy Wizard Shortcut Menu

2. Follow the three steps in the **Activity Decomposition Hierarchy Wizard** dialog (Figure 185).
3. **Step 1 Specify name and package**. Enter the name, type (SysML BDD or Class Diagram), and select or create the owner of the diagram to be created (Figure 185).

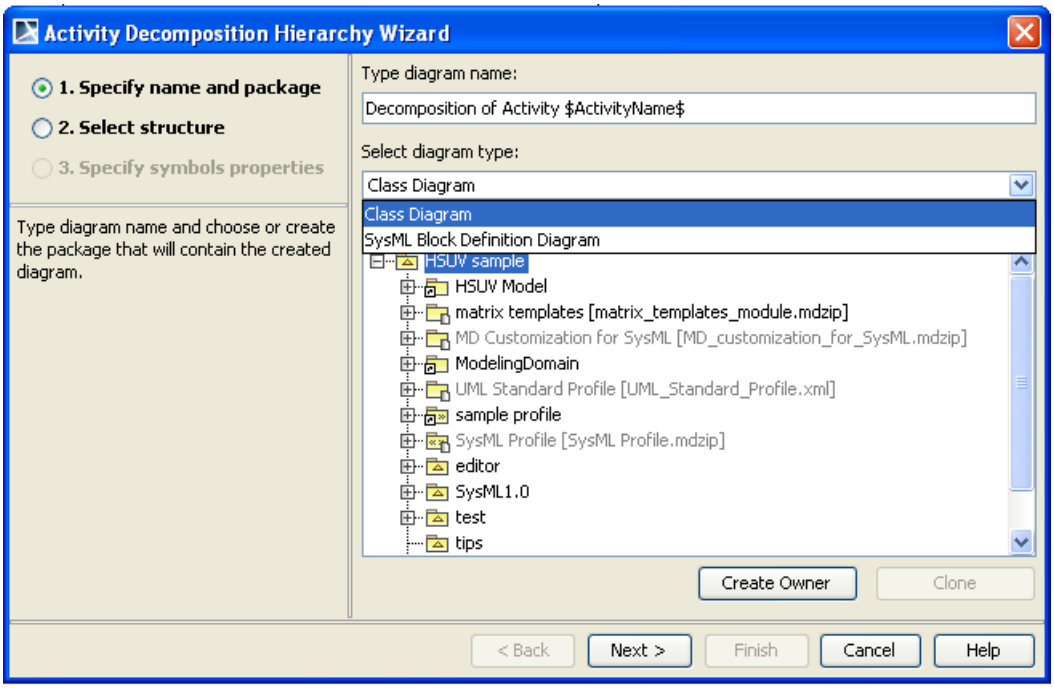


Figure 185 -- Activity Decomposition Hierarchy Wizard Dialog: Specify Name and Package

4. **Step 2 Select structure**. Select the activities to be decomposed:
   - Mark the activity(ies) to be decomposed (Figure 186).

- Select **Add all structures into one diagram** to add all the activities into the diagram you want to create. If you do not select this option, one diagram will be created for each activity selected (Figure 186).
- Then, click **Next** if you want to customize the symbol properties of the diagram(s) to be created (step 3 below). Otherwise, click **Finish** (Figure 186).

NOTE	
	• The **Children Count** column (Figure 186, upper right-hand side) shows the number of behaviors included (plus the number of object nodes owned if the **Add contained Object Nodes** option is selected). • The **Add contained Object Nodes** option is selected by default. This option will display the types of the object nodes and connect them to the composition with activities containing object nodes. • The number of behaviors included also depends on the **Search recursively** option (selected by default). If not selected, the search will be conducted at only one level of the activity(ies) selected. If selected, the search will be conducted for each activity selected and for those activities invoked by call behavior actions in the selected activity, recursively.

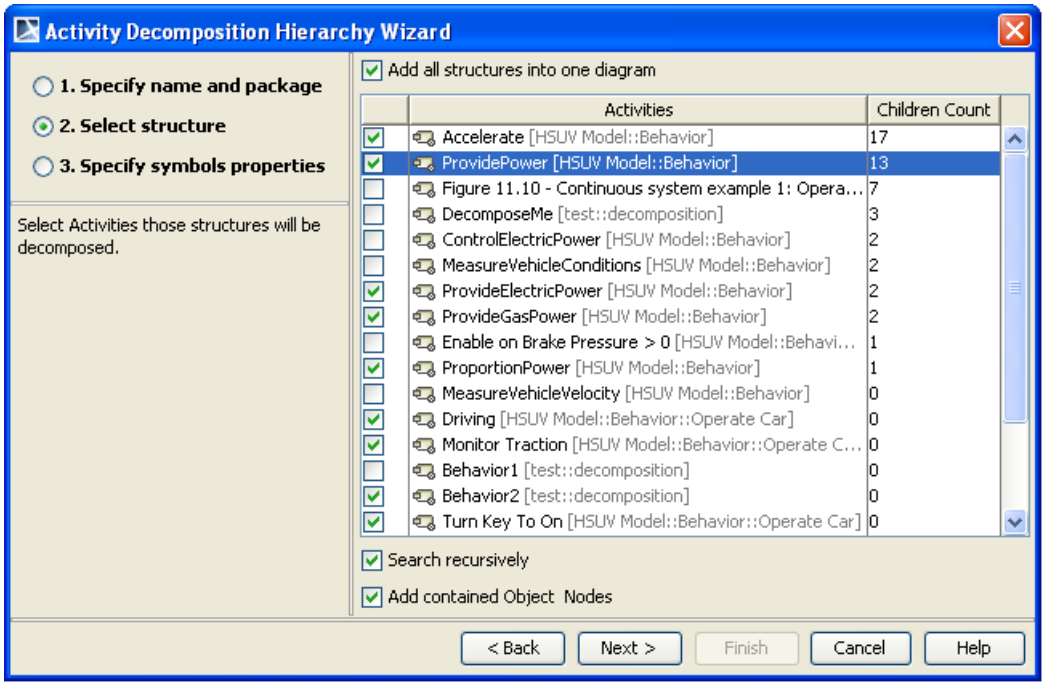


Figure 186 -- Activity Decomposition Hierarchy Wizard Dialog: Select Structure

5. **Step 3 Specify symbols properties**. Customize the symbol properties of the diagram(s) to be created (Figure 187).

NOTE	If you clicked **Finish** in Step 2, Step 3 will be skipped.

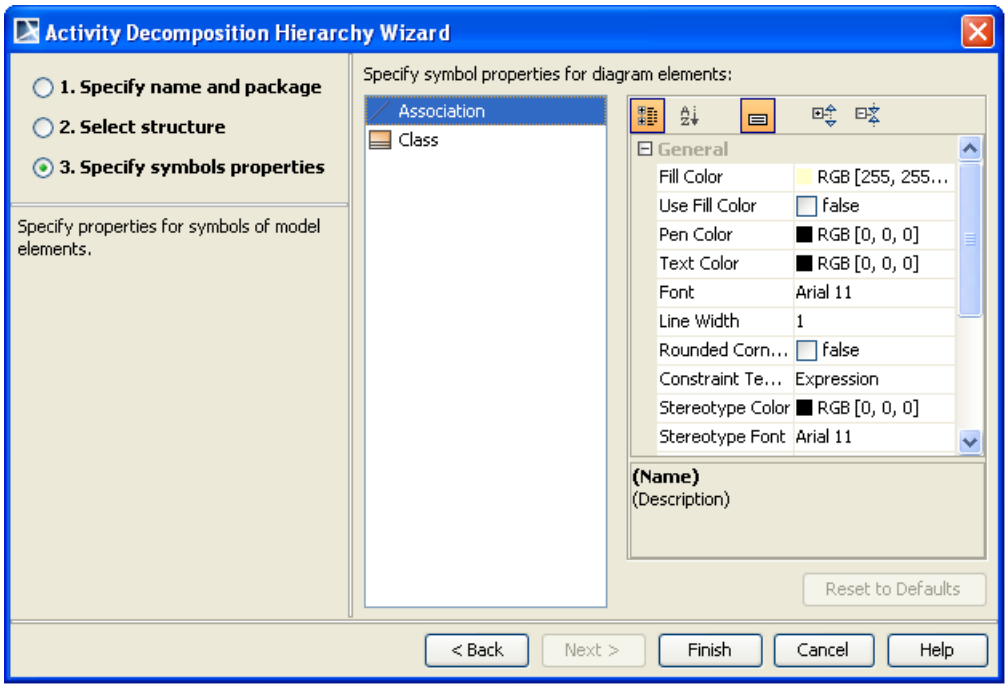


Figure 187 -- Activity Decomposition Hierarchy Wizard Dialog: Specify Symbols Properties

6. The Class Diagram will then be generated (Figure 188).

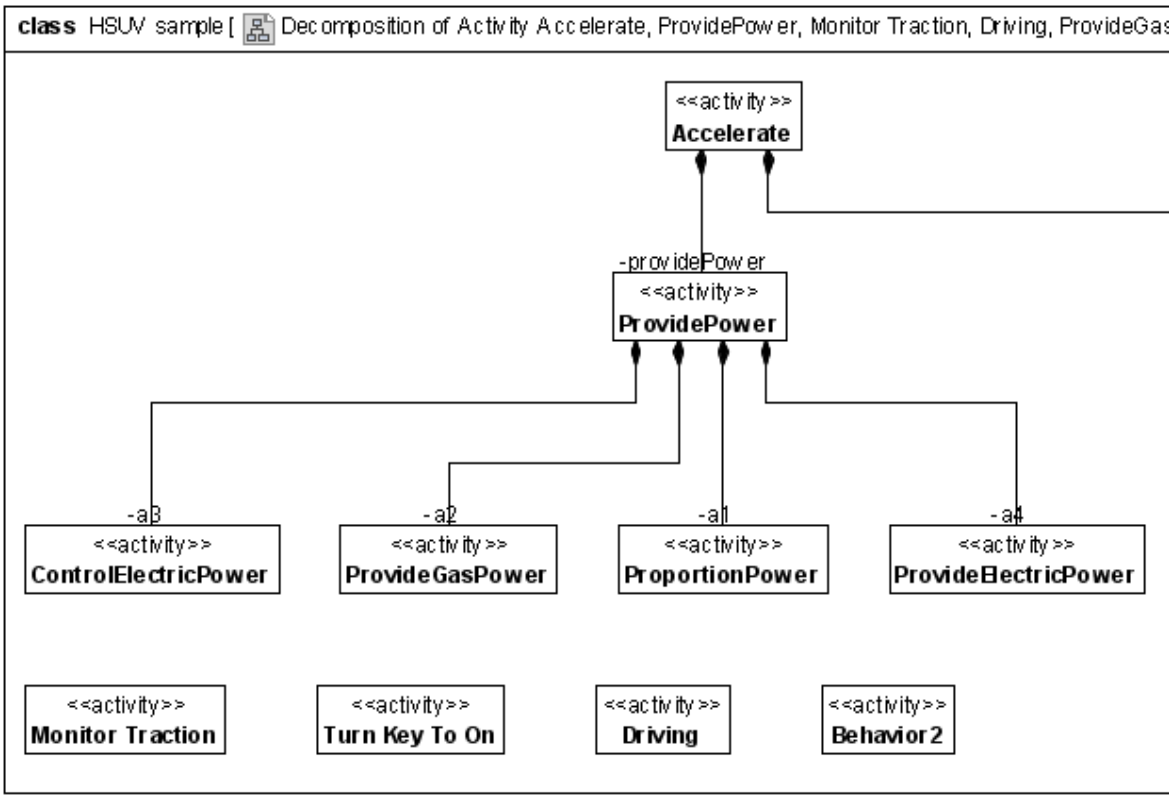


Figure 188 -- Class Diagram of the Decomposed Activities

Swimlane Allocations

An Activity Diagram or a SysML Activity Diagram can be organized using "swimlanes", each swimlane being separated from the neighboring ones by vertical or horizontal solid lines on both sides. Swimlanes provide a view of the behaviors invoked in the activities. Each swimlane must have a swimlane header assigned to a property. Drag the property over the swimlane header to have the property assigned to the swimlane.

The Allocation relationship can provide an effective means for navigating the model by establishing cross relationships and ensuring the various parts of the model are properly integrated.

The **<allocate>** stereotype can be applied to the swimlane header in order to allocate activity actions in the swimlane to the property in the header.

To stereotype a swimlane <allocate>:

1. Open the Swimlane Header shortcut menu and select **Allocated Activity Partition** (Figure 189). The swimlane will then be automatically stereotyped (the stereotype 'allocate' will appear as the swimlane header) (Figure 190).

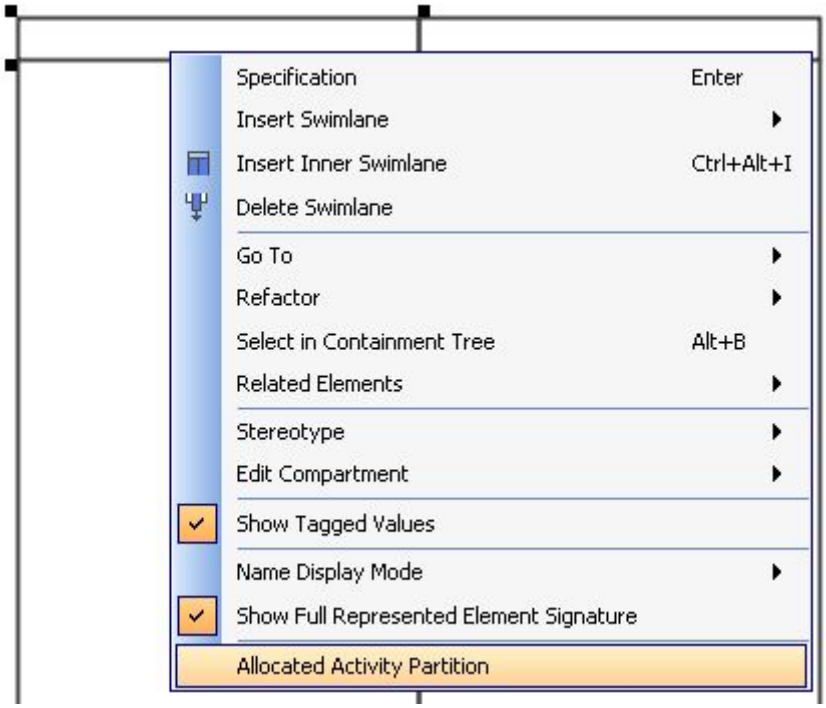


Figure 189 -- Swimlane Header Shortcut Menu: Allocated Activity Partition

Figure 190 -- Allocate Stereotype Applied on Swimlane Header

2. Drag a property, for example, **partProperty : BLOCK**, to the stereotyped swimlane header (Figure 191).

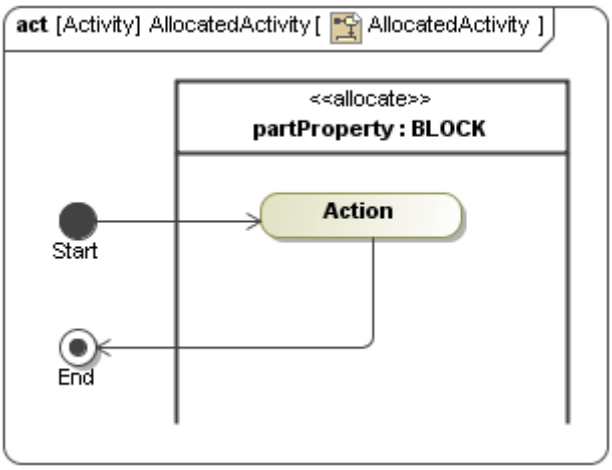


Figure 191 -- partProperty Allocated to the Stereotyped Swimlane

If you create an action, for example, **Action**, in the stereotyped swimlane, the action will be allocated to the property. This means that:

- The value of the **allocatedTo** tag, under the **Allocated** stereotype, of the **Action** is **partProperty** (Figure 192).
- The value of the **allocatedFrom** tag, under the **Allocated** stereotype, of the **partProperty** is **Action** (Figure 193).

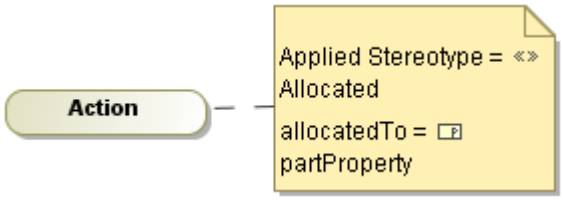


Figure 192 -- An Action allocated to a partProperty

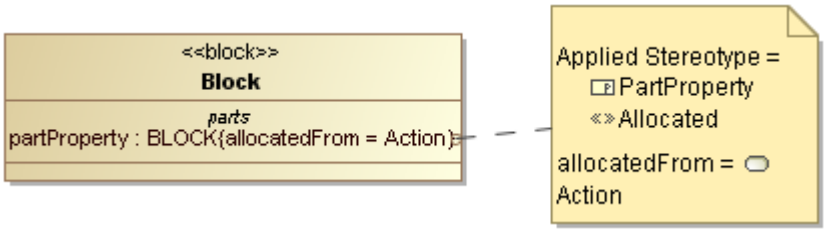


Figure 193 -- A partProperty Allocated from an Action

5.7 SysML Use Case Diagrams

The purpose of a Use Case Diagram is to give a graphical overview of the functionalities provided by a system in terms of actors, their goals (represented as use cases), and any dependencies among those use cases.

A Use Case Diagram describes the usage of a system. The associations between actors and use cases represent the communications that occur between the actors and the subjects to accomplish the functionalities associated with the use cases. The subject of a use case can be represented through a system boundary. The use cases enclosed in the system boundary represent the functionalities performed by behaviors (activity diagrams, sequence diagrams, and state machine diagrams).

Actors may interact either directly or indirectly with the system. They are often specialized so as to represent a taxonomy of user types or external systems. The only relationship allowed between actors in a use case diagram is generalization. This is useful in defining overlapping roles between actors. Actors are connected to use cases through communication paths, each represented by a relationship. There are four use case relationships: (i) communication, (ii) include, (iii) extend, and (iv) generalization.

(i) Communication

A *communication* path represents an association between two Deployment Targets. It connects actors to use cases.

(ii) Include

An *include* relationship provides a mechanism for factoring out a common functionality that is shared among multiple use cases and is always performed as part of the base use case.

(iii) Extend

An *extend* relationship provides an optional functionality, which extends the base use case at defined extension points under specified conditions.

(iv) Generalization

A *generalization* relationship provides a mechanism to specify variants of the base use case.

Use cases are often organized into packages with the corresponding dependencies among the use cases included in the packages.

5.7.1 SysML Use Case Diagram Metamodel and Elements

For more information on notation elements, see the *Use Case Diagram* in the 'UML Diagrams' section of the MagicDraw User Manual.

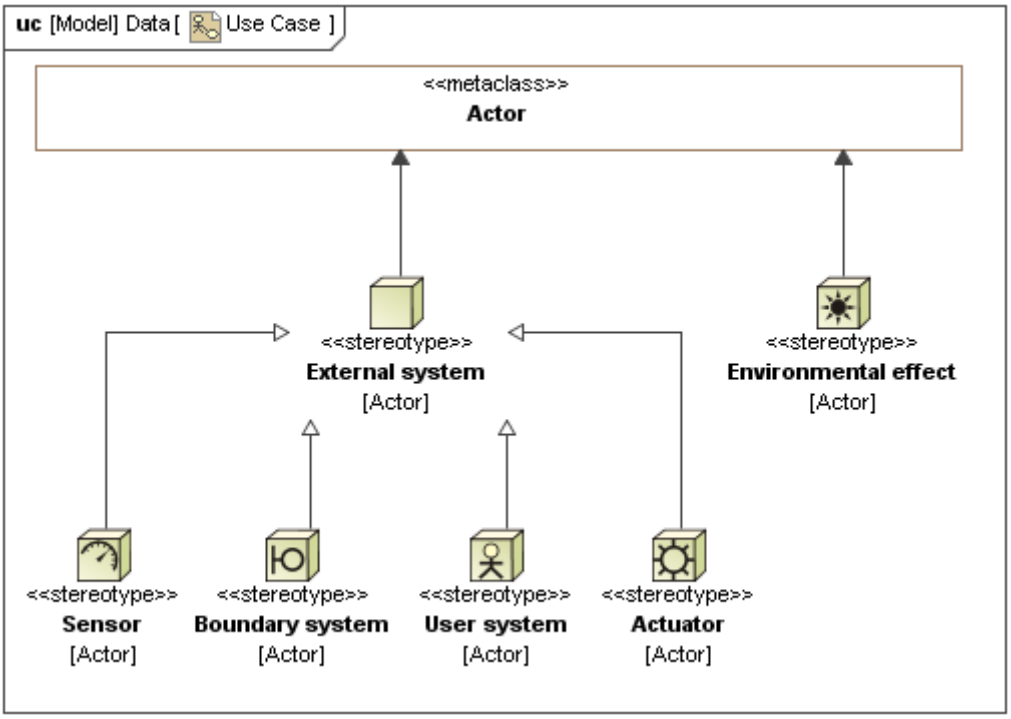


Figure 194 -- MagicDraw SysML Actor subtypes metamodel

Icon	Description
	**Actor [UML]:** Actors represent roles played by human users, external hardware, and other subjects. An actor does not necessarily represent a specific physical entity but merely a particular facet (i.e. the "role") of some entities that are relevant to the specifications of its associated use cases.
	**External System:** An External System is a system that interacts with the system under development. For example, **Information server** or **Monitoring system** [1].
	**Sensor:** A Sensor is a special external system that forwards information from the environment to the system under development. For example, **Temperature sensor** [1].
	**Boundary System:** A Boundary System is a special external system that serves as medium between another system and the system under development without having its own interests in the communication. For example, **Bus system** or **Communication system** [1].
	**User System:** An User System is a special external system that serves as medium between a user and the system without having its own interests in the communication. For example, **Input Device** or **Display** [1].
	**Actuator:** An Actuator is a special external system that influences the environment of the system under development. For example, **Heater assembly** or **Central locking system** of a car [1].
	**Environmental Effect:** An Environmental Effect is an influence on the system from the environment without communicating with it directly. For example, **Temperature** or **Humidity** [1].

5.7.2 SysML Use Case Diagram Toolbar

Element	Button (hot key)
Actor: See Section 5.7.1 for description.	 (A)
Actuator: See Section 5.7.1 for description.	
Boundary System: See Section 5.7.1 for description.	
Environmental Effect: See Section 5.7.1 for description.	
External System: See Section 5.7.1 for description.	
Sensor: See Section 5.7.1 for description.	
User System: See Section 5.7.1 for description.	
Use Case [UML]: A Use Case is a kind of behavior-related classifier that represents a declaration of an offered behavior. Each use case specifies a particular behavior, possibly including the variants that the subject can perform in collaboration with one or more actors. The subject of a use case could be a physical system or any other element that may initiate a behavior, such as a component, a subsystem, or a class.	 (U)
Package [UML]: A Package is a namespace for its members, and it can contain other packages. Only packageable elements can be owned by members of a package. By virtue of being a namespace, a package can import either individual members of other packages or all the members of other packages.	 (P)
System Boundary [UML]: A System Boundary is another kind of representation of a package. A system boundary element consists of use cases related by Exclude or Include (uses) relationships, which are visually located inside the system boundary rectangle.	 (B)
Subsystem [UML]: A Subsystem is treated as an abstract single unit. It groups model elements by representing the behavioral unit in a physical system.	
Include [UML]: An Include (uses) relationship from use case A to use case B indicates that an instance of the use case A will also contain the behavior as specified by B.	 (C)

Element	Button (hot key)
Extend [UML]: An Extend is a relationship from an extending use case to an extended use case, specifying how and when the behavior defined in the extending use case can be inserted into the behavior defined in the extended use case. The extension takes place at one or more specific extension points defined in the extended use case. Choose a different Extend direction from the toolbar to draw a line with an opposite arrow end.	 (E)
Association [UML] An Association represents a semantic relationship between two classifiers. It is used for referencing two Blocks with one another, thus creating two Reference Properties at both ends. The aggregation values of both ends of an Association are 'none'.	 (S)
Generalization [UML] A Generalization is a taxonomic relationship between a more general classifier and a more specific one. Each Instance of the specific classifier is also an indirect Instance of the general classifier. Thus, the specific classifier indirectly has the features of the general classifier.	 (G)

[1] Stereotypes taken from the SYSMOD process: `http://www.sysmod.de` by Tim Weilkiens, oose Innovative Informatic GmbH.

5.7.3 SysML Use Case Diagram Specific Features

The SysML Use Case diagram specific features include:

(i) Use Case Numbering
(ii) Use Case Dependency Matrix Template

(i) Use Case Numbering

To number the use cases in a Use Case diagram:

1. Select **Use Case Numbering...** on the diagram shortcut menu (Figure 195). A **Question** dialog will open, indicating that this feature requires **UseCase Description Profile**, and ask if you would like to use it.

NOTE	You can also select **Use Case Numbering...** on: • Use Case shortcut menu • Package shortcut menu

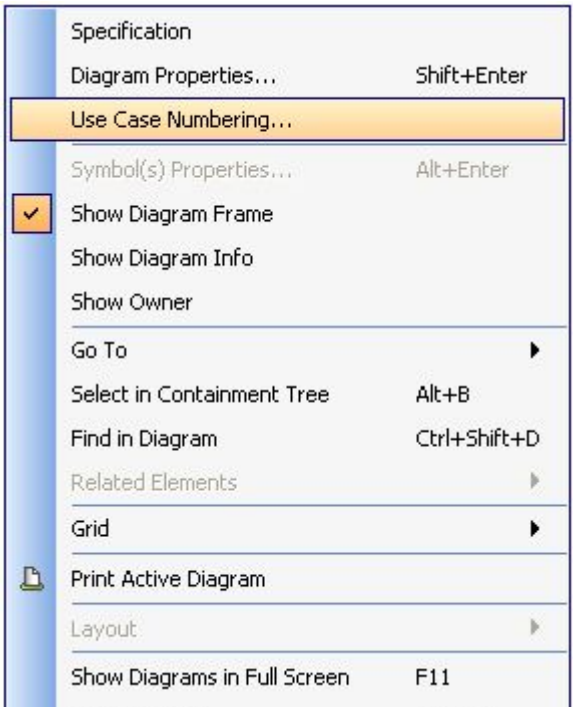


Figure 195 -- Use Case Diagram Shortcut Menu: Numbering

2. Click **Yes**. The **Change Use Cases Numbering** dialog will open (Figure 196).

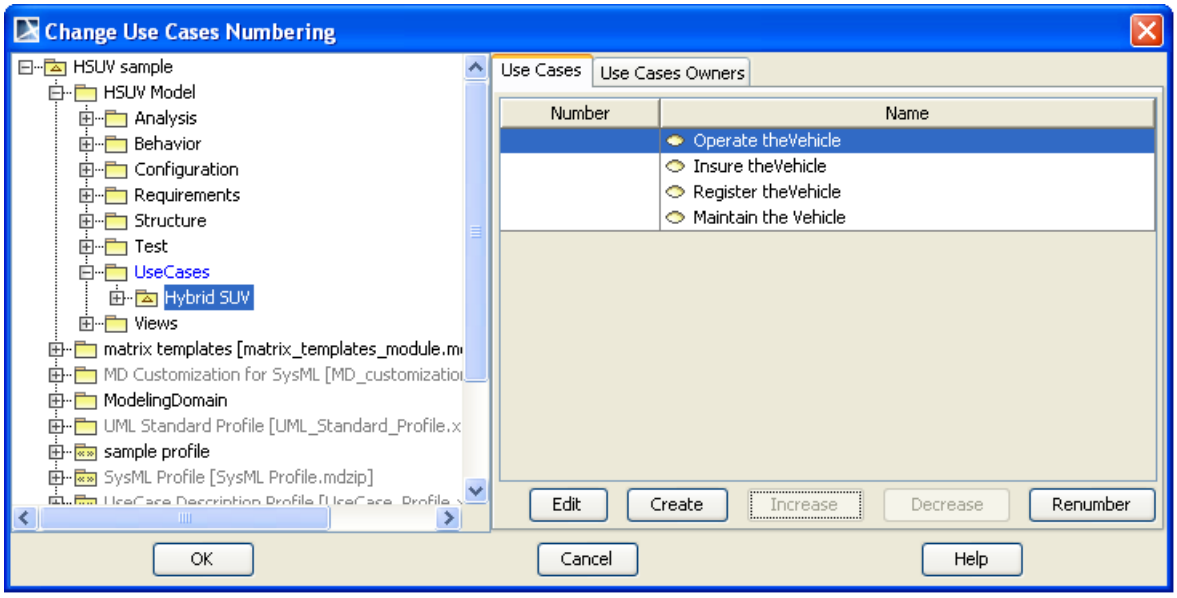


Figure 196 -- Change Use Cases Numbering Dialog

3. Click **Create** to automatically number the selected use case. Each use case number will be increased by increments of one. For example, if the **Operate theVehicle** use case is numbered '1' (Figure 196), select the **Insure theVehicle** use case, and then click the **Create** button to number the use case to '2' (Figure 197).

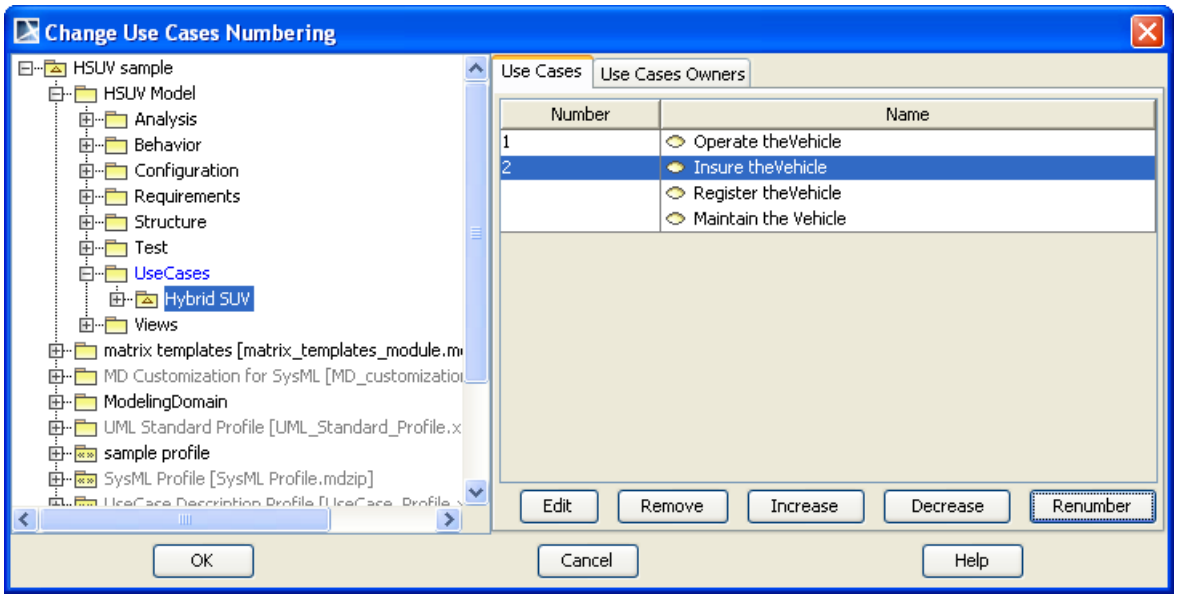


Figure 197 -- Example of Use Case Numbers

4. Click **Remove**, **Increase**, or **Decrease** to subsequently remove, increase-by-one, or decrease-by-one a use case number previously ascribed.
5. Click **Edit** to arbitrarily create a new number or change an existing number to another number. Once selected, the **Type Number** dialog will open (Figure 198).

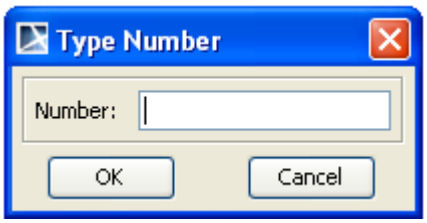


Figure 198 -- Type Number Dialog for Editing Use Case Number

(ii) Use Case Dependency Matrix Template

MagicDraw provides a use case dependency matrix template. This template shows Use Case implementations with behavioral diagrams (state, activity, sequence and communication). Behavior diagrams are grouped by Behaviors: State Machine, Activity, and Interaction.

For more information on this feature, see the *Dependency matrix* in the 'Model Analysis' section of the MagicDraw User Manual, and the 'Dependency Matrix' section in this manual.

5.7.4 Using SysML Use Case Diagram Elements

Inserting New Extension Points

Use **Insert New Extension Point** to insert new extension points in a SysML Use Case diagram.

To insert a new extension, select any of the following:

- Select **Insert New Extension Point** on the Use Case smart manipulator (Figure 199);
- Select **Insert New Extension Point** on the Use Case shortcut menu (Figure 200); or
- Press **Ctrl + Alt + E**.

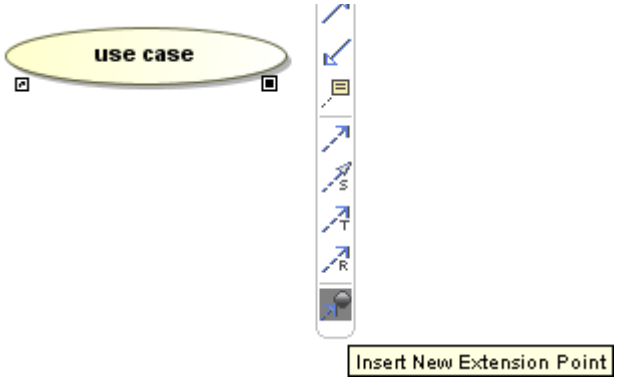


Figure 199 -- Use Case Smart Manipulator

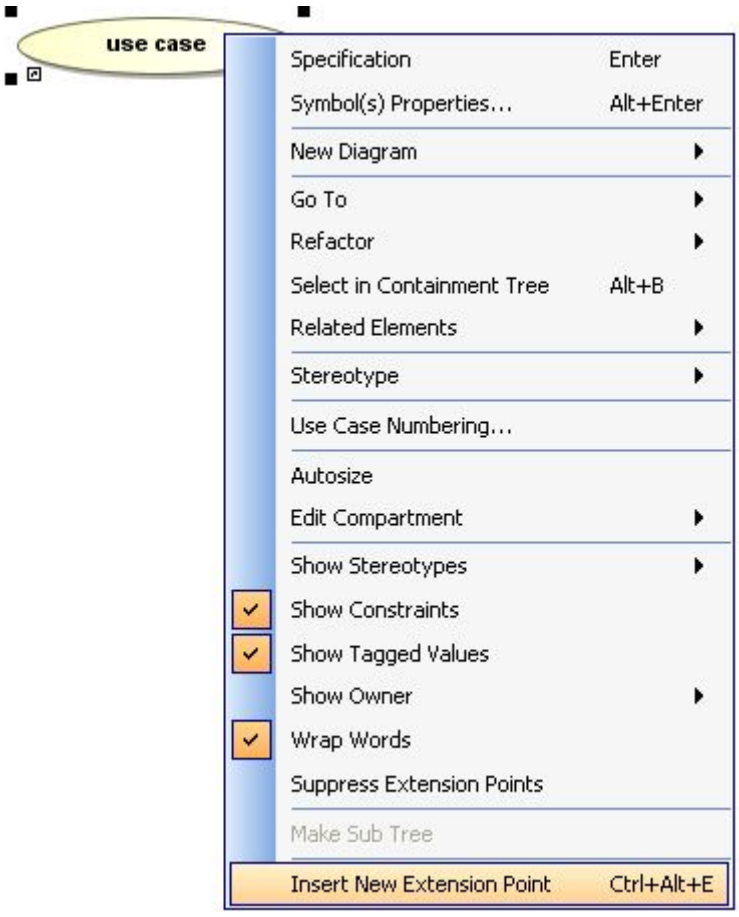


Figure 200 -- Use Case Shortcut Menu

6. Validation

MagicDraw provides the Validation functionality to validate user-created models against a set of constraints. Use SysML validation suite (**SysML ValSuite**) in SysML Plugin with this MagicDraw functionality to validate SysML models.

See MagicDraw User Manual for more information on this MagicDraw functionality.

SysML ValSuite includes seven validation suites:

1. **SysML ValSuite - Activities**
   This suite contains SysML constraints on the following elements: Control Operator, Control Value, Discrete, noBuffer, Optional, Probability and Rate.
2. **SysML ValSuite - Blocks**
   This suite contains SysML constraints on the following elements: Binding Connector, Block, Distributed Property, Part Property, Reference Property, Shared Property, Value Property and Value Type.
3. **SysML ValSuite - Constraint Blocks**
   This suite contains SysML constraints on the following elements: Constraint Block and Constraint Property.
4. **SysML ValSuite - Model Elements**
   This suite contains SysML constraints on the following elements: View and Viewpoint.
5. **SysML ValSuite - Non-normative Extensions**
   This suite contains SysML constraints on the following elements: nonStreaming, Streaming, Design Constraint, Functional Requirement, Interface Requirement and Performance Requirement.
6. **SysML ValSuite - Port and Flows**
   This suite contains SysML constraints on the following elements: Flow Port, Flow Property, Flow Specification and Item Flow.
7. **SysML ValSuite - Requirements**
   This suite contains SysML constraints on the following elements: Copy, DeriveReqt, Requirement and Test Case.

NOTE	If you use **SysML ValSuite** as the validation criteria, your model will be validated against all seven SysML validation suites at the same time.

To validate a SysML project:

1. Click **Analyze** > **Validation** > **Validation** on the main menu (Figure 201).

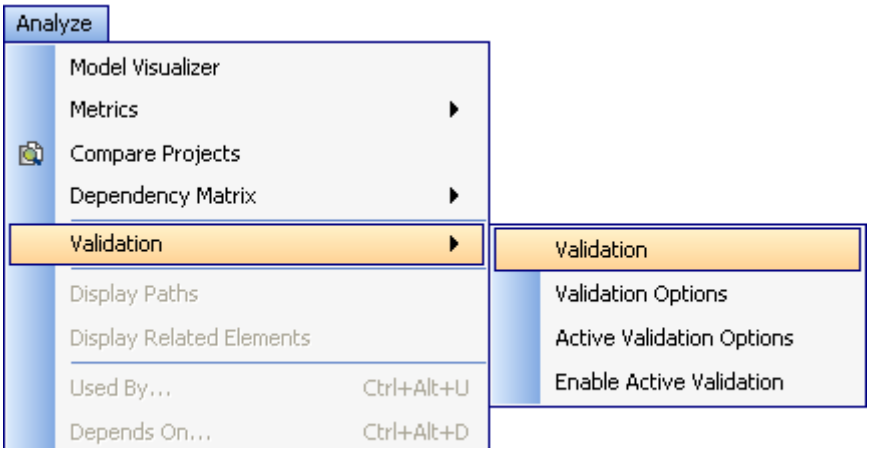


Figure 201 -- Validation Menu

2. The **Validation** dialog will open (Figure 202).
3. Select a validation suite, for example, **SysML ValSuite [MD Customization for SysML::SysML constraints]**, in the **Validation Suite** drop-down list to validate your model against a set of SysML constraints, in this example, all of them (Figure 202).

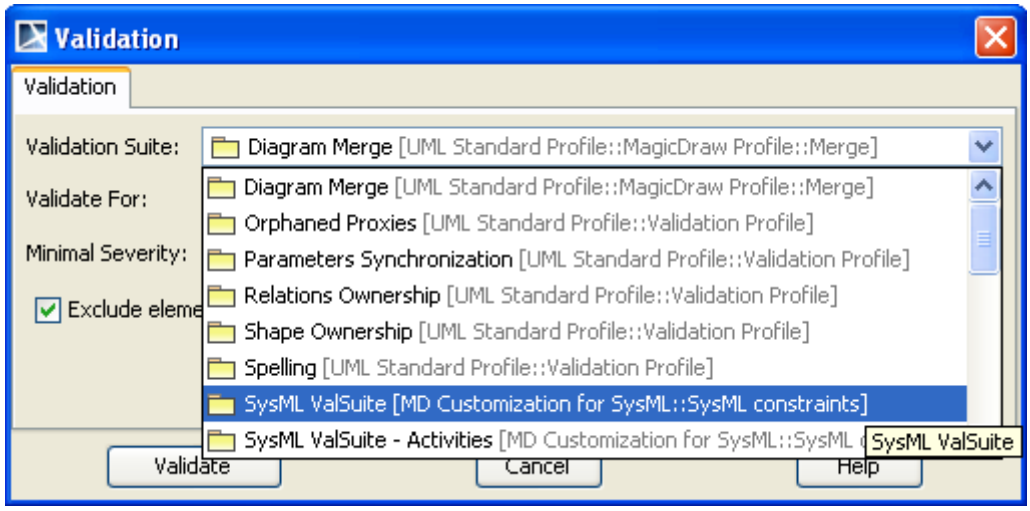


Figure 202 -- validation Suite Package Selection

NOTE	To limit the scope of the constraints to be validated against, select another smaller validation suite, for example, **SysML ValSuite - Blocks** to validate against the constraints in OMG SysML specifications, chapter 8: Blocks. This is useful because, generally, a user has a limited scope of concerns. Business Analysts, for example, only concern themselves with Requirements, thus **SysML ValSuite - Requirements** should be chosen.

4. In the **Validate For** drop-down list, select either:
   - **Whole Project** to validate the entire SysML project (Figure 203), or
   - **Validation Selection** to validate only specific elements in that SysML project (Figure 203).

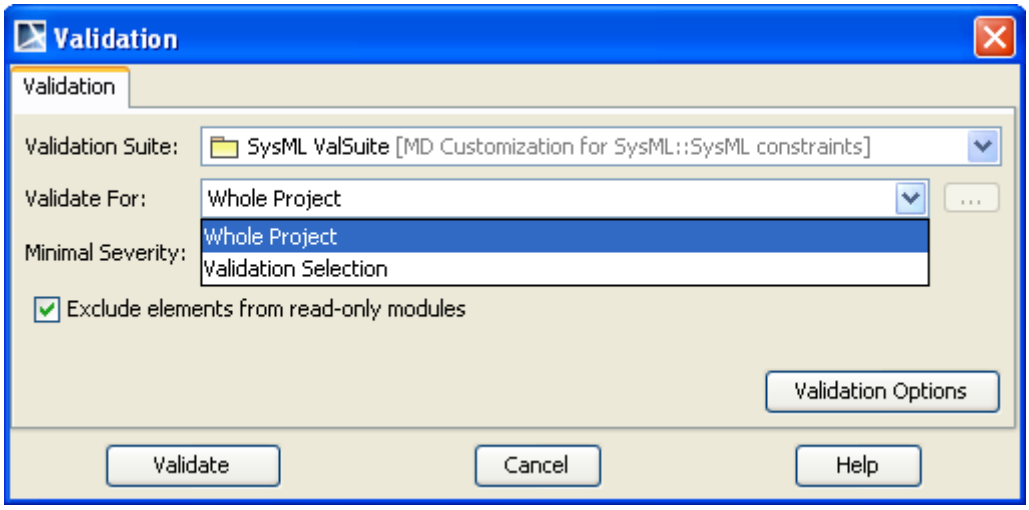


Figure 203 -- Validation Element Selection

5. If you have selected **Validation Selection**, click the browse button **...** to open the **Select Elements** dialog. Add elements to to the **Selected objects** pane using buttons in the middle of the dialog (Figure 204). Only the element(s) listed in the **Selected objects** pane will then be validated (Figure 204). When all required elements are selected, click **OK**.

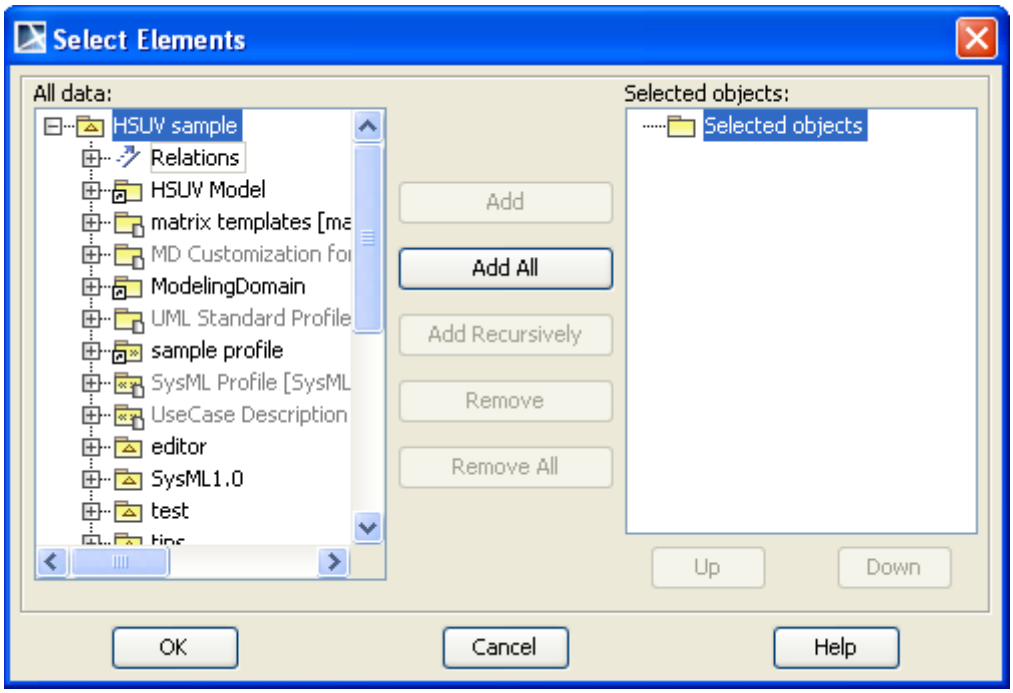


Figure 204 -- Select Elements Dialog

6. Click the **Validate** button in the **Validation** dialog (Figure 203) once elements have been selected to be validated. When the validation process is completed, the results of the validation will be displayed in the **Validation Results** window, usually located at the bottom of the MagicDraw window (Figure 205).

NOTE	• Mark **Exclude elements from read-only modules** to ignore the elements in read-only modules from the validation process. • Validation may take several minutes if your model is large.

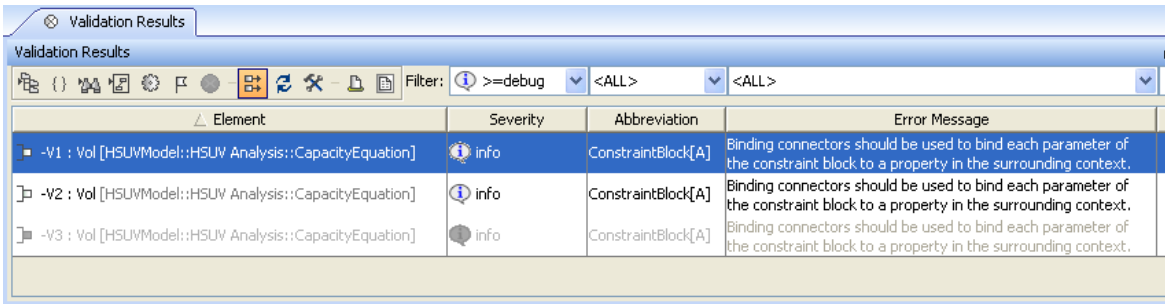


Figure 205 -- Validation Results Window

7. The **Validation Results** window will show the elements that do not conform to some constraints in the selected validation suite. These elements are called "invalid" elements and are highlighted. If a highlighted invalid element is selected, for example, the Loss of Fluid requirement element, a warning will appear (Figure 206).

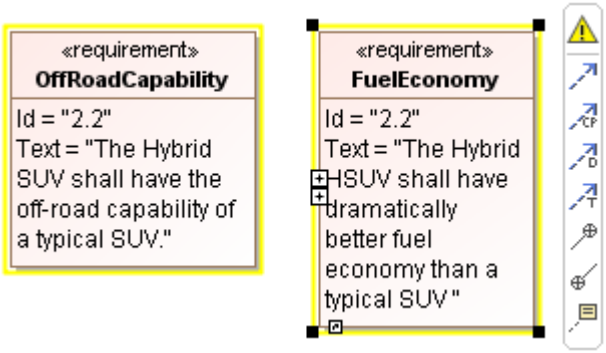


Figure 206 -- Invalid Elements Highlighted after Validation

8. Place your mouse pointer on the warning icon to display the error message corresponding to the broken constraint (Figure 207).

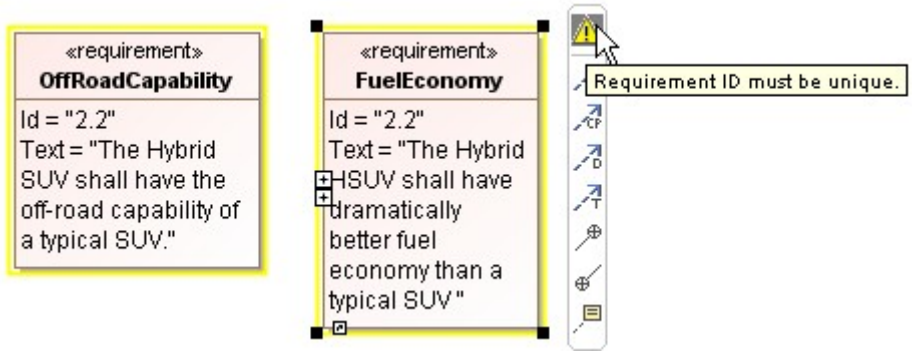


Figure 207 -- Error Message Displayed by the Warning Symbol

9. Click the warning icon to display a menu. Then, select either **Ignore** or **Select in the Validation Results** (Figure 208).
   - If you select **Ignore**, the invalid element will then be excluded from the next validation process.
   - If you select **Select in the Validation Results**, the element will then be selected in the **Validation Results** window. This option helps identify the invalid element instantly, especially when there are a number of invalid elements displayed in the **Validation Results** window.

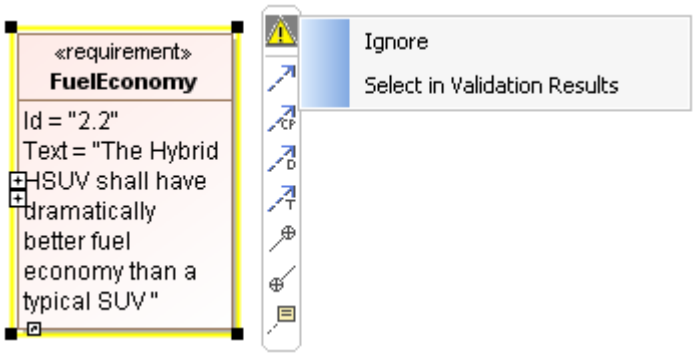


Figure 208 -- Invalid Element Validation Options

10. The Validation Results window includes the following icons. If you click the:

-  icon (Select in Containment Tree), you will be redirected to the selected invalid element in the Containment Tree.
-  icon (Select Rule in the Containment Tree), you will be redirected to the broken constraint of the selected invalid element in the Containment Tree.
-  icon (Open all diagrams containing the selected element), any diagram containing the selected invalid element will then be displayed.
-  icon (Solve), you can either ignore the selected element (which will thus not be considered in the next validation process), or select one of the solutions provided to resolve the invalidity.
-  icon (Run validation with current settings), the validation process will be executed immediately, using the previous setting.
-  icon (Run validation with a new settings), the **Validation Suite Packages Selection** dialog will open. You can then change the settings and re-validate your model again.

NOTE	Additional validation rules / constraints can be added and grouped into a validation suite (either in a newly-created one or in an existing one).

For more information on the Validation feature, see the *Model Analysis* in the 'Validation' section in the MagicDraw User Manual.

6.1 Active Validation

This feature enables you to check at once if a model is correct and complete. Unlike the regular Validation feature in the 'Validation' section above, Active Validation will instantly display any errors in the model and suggest appropriate solutions.

To validate a SysML model, **SysML ActiveValSuite** package contains six active validation suites:

1. **SysML_activeValSuite - Activities**
   This suite contains SysML constraints on the following elements: Discrete and noBuffer.
2. **SysML_activeValSuite - Blocks**
   This suite contains SysML constraints on the following elements: Binding Connector, Block, Distributed Property and Value Type.
3. **SysML_activeValSuite - Constraint Blocks**
   This suite contains SysML constraints on the following elements: Constraint Block and Constraint Property.
4. **SysML_activeValSuite - Non-normative Extensions**
   This suite contains SysML constraints on the following elements: nonStreaming, Streaming, Design Constraint, Functional Requirement, Interface Requirement and Performance Requirement.
5. **SysML_activeValSuite - Port and Flows**
   This suite contains SysML constraints on the following elements: Flow Port, Flow Property, Flow Specification and Item Flow.
6. **SysML_activeValSuite - Requirements**
   This suite contains SysML constraints on the following elements: Copy, Requirement and Test Case.

To turn on the Active Validation feature:

1. Click **Analyze** > **Validation** > **Enable Active Validation**, making sure that **Enable Active Validation** is selected (Figure 209). The Active Validation engine will validate in real time the model

you are working on whenever the need arises, for example, when a project is loaded or an element of a model changed.

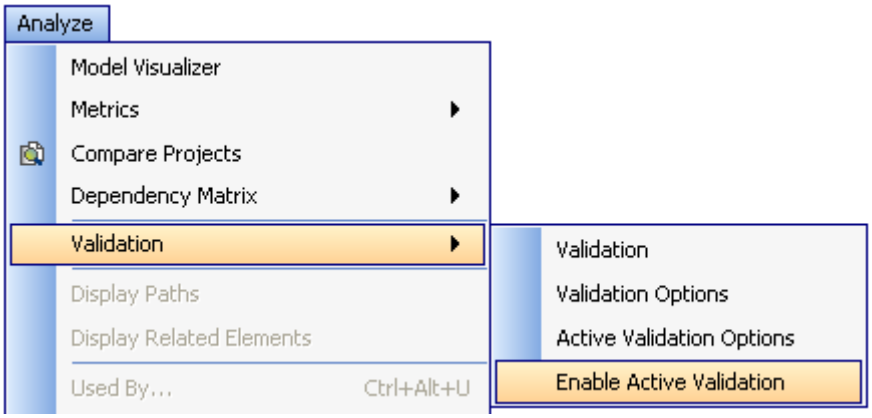


Figure 209 -- Enable Active Validation Menu

The following example, a simple SysML project with three requirements and a Copy dependency, illustrates how this Active Validation feature works (Figure 210).

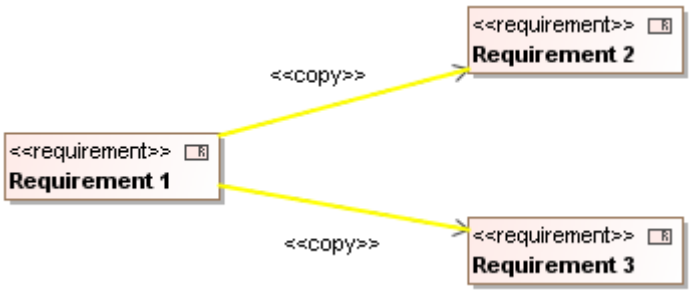


Figure 210 -- Invalid Elements Detected by the Active Validation

The model in this project was designed so that **Requirement 1** copies **Requirement 2** and **Requirement 3** at the same time. However, one of the constraints of a 'Copy' dependency is that a requirement cannot copy more than one requirement at a time. Thus, this model is invalid since some elements are invalid against the constraint.

2. Whenever an element is invalid, it will be highlighted in the diagram («copy» in the example, Figure 210). On the status bar at the bottom of the screen (Figure 211 and 212),
   - a notification symbol (info, warning or error), and
   - number(s) and severity(ies) of invalid element(s),

   will be displayed. For example,
   - **4 W** in Figure 211 means that there are 4 invalid elements violating constraint(s) of the 'warning' severity.
   - **1 E, 7 W, 92 I** in Figure 212 means that there are 1, 7 and 92 invalid elements violating constraint(s) of the 'error', 'warning' and 'info' severities, respectively.

Figure 211 -- Status Bar with Warning Symbol

Figure 212 -- Status Bar with Error Symbol

3. To find out the reason why an element is invalid, you can either:
   - Click the warning symbol on the status bar (Figure 211). The **Active Validation Results** window will then open (usually at the bottom of the screen), displaying the element(s) that does not conform to some constraint(s) in the active validation suite(s) and the reason for the invalidity (Figure 213).

.

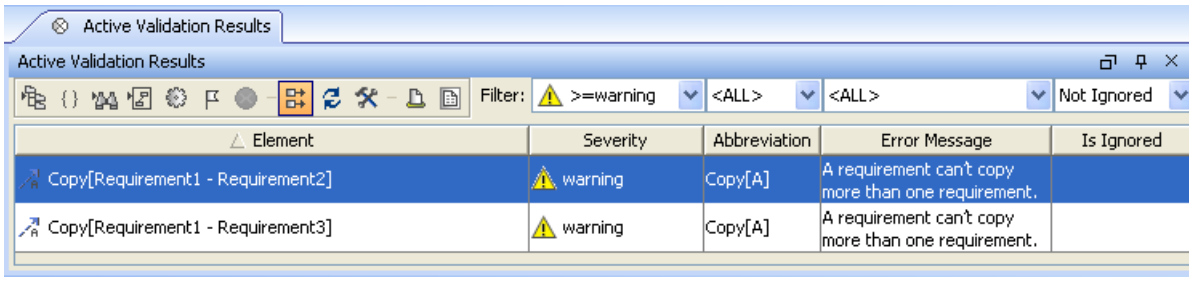


Figure 213 -- Active Validation Results

Or

- Select a highlighted invalid element in the diagram («copy» in the example, Figure 210). Once a highlighted invalid element has been selected in the diagram, a warning symbol will appear (Figure 214). Place your pointer on the warning symbol to see the error message related to the constraint, for instance, *A requirement can't copy more than one requirement* (Figure 214).

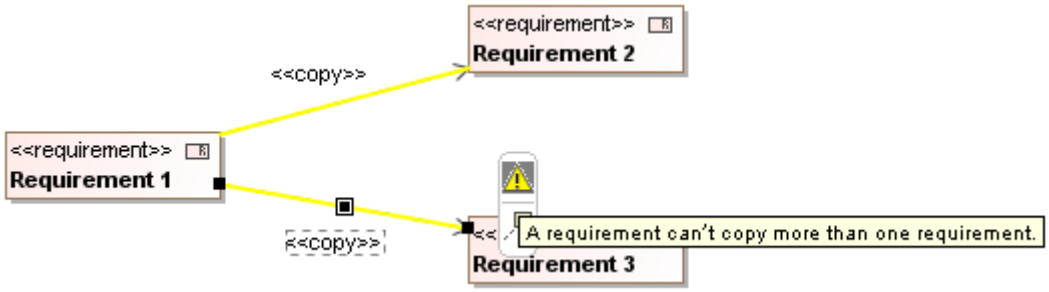


Figure 214 -- Invalid Copy Dependency Usage

4. Unlike the Validation feature in the *Validation* section, this Active Validation feature will, in most cases, also suggest solution(s) to fix model invalidity problem(s). To see the list of appropriate solution(s) for an invalid element, you can either:
   - Right-click the invalid element in the **Active Validation Results** window (Figure 213) if you have open this window before.

   Or

   - Click the warning symbol after you have clicked the invalid element in the diagram (Figure 214). After clicking, for example, solutions will then be displayed (Figure 215).

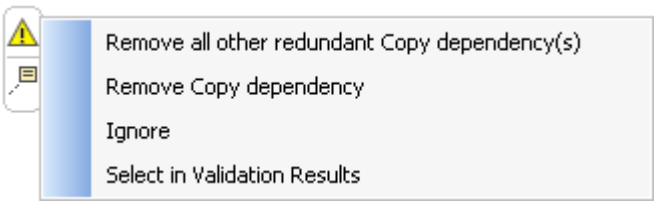


Figure 215 -- Proposed Solutions for the Invalid Copy Dependency

5. The **Active Validation Results** window includes the following icons. If you click the:
   -  icon (Select in Containment Tree), you will be redirected to the selected invalid element in the Containment Tree.
   -  icon (Select Rule in the Containment Tree), you will be redirected to the broken constraint of the selected invalid element in the Containment Tree.
   -  icon (Open all diagrams containing the selected element), any diagram containing the selected invalid element will then be displayed.
   -  icon (Solve), you can either ignore the selected element (which will thus not be considered in the next validation process), or select one of the solutions provided to resolve the invalidity.
   -  icon (Active Validation Options), the **Project Options** dialog will then open for you to customize all the options listed under **Active Validation**.
6. In the example below (Figure 216), a constraint, referenced as “Copy[A]”, is broken. If the solution suggested by the Active Validation feature, in this case, *Remove all other redundant Copy dependency(s)*, is selected, the correctness of the model will be satisfied as shown in Figure 217.

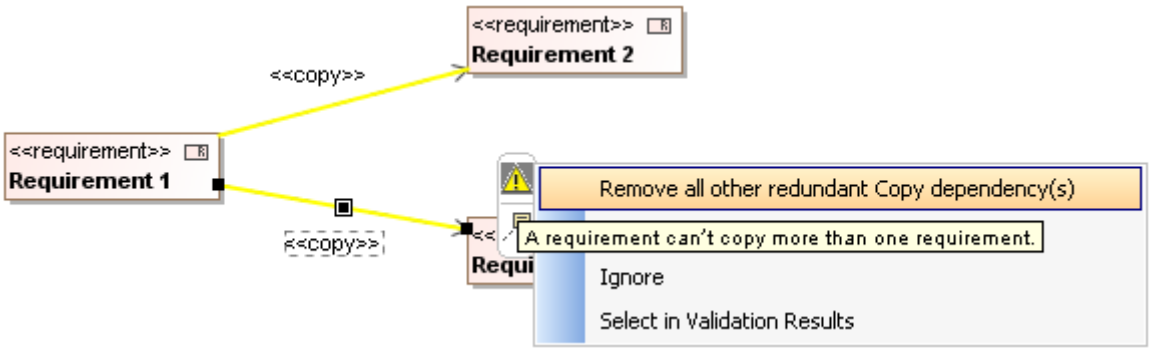


Figure 216 -- Selection of the First Solution

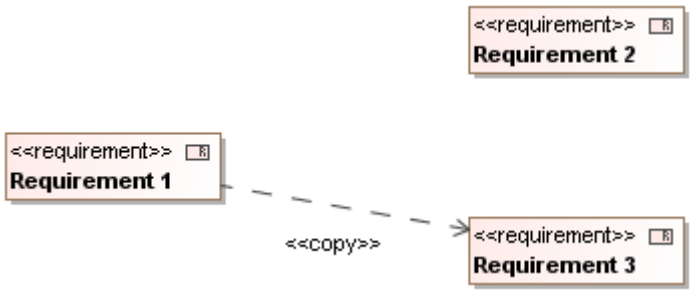


Figure 217 -- Valid Elements

NOTE	Each implemented constraint has its own appropriate solutions. The Active Validation feature ensures that SysML modeling is consistent with OMG SysML Specifications.

6.1.1 Active Validation Options

You can customize the Active Validation feature using the five options in Figure 218:

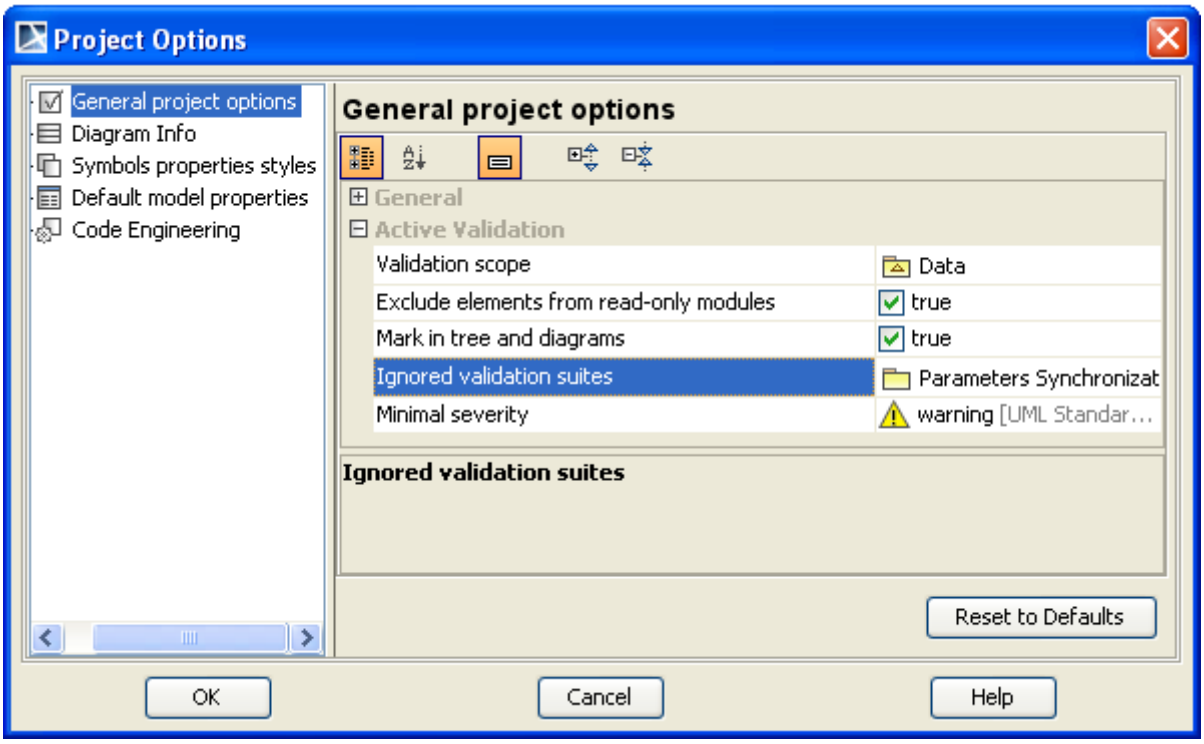


Figure 218 -- Project Option Dialog

1. **Validation scope** (default = data): use this option to limit the scope of elements to be actively validated.
2. **Exclude elements from read-only modules** (default = true): if this option is selected (selecting the check box means 'true'), read-only modules, for example read-only profiles, will not be actively validated.
3. **Mark in tree and diagrams** (default = true): if this option is selected (selecting the check box means 'true'), invalid elements will be marked with small icons in the Containment Tree and highlighted in the diagrams.
4. **Ignored validation suites**: you can enter the active validation suite(s) you would like to exclude from the Active Validation process.
5. **Minimal severity**: you can specify the minimal severity level of the constraints to be validated against. There are five levels of severities:
    - **>=debug**: All constraints will be included in the active validation.
    - **>=info**: Constraints with infos, warnings, errors, or fatal severities will be included.
    - **>=warning (default)**: Constraints with warnings, errors, or fatal severities will be included.
    - **>=error**: Constraints with error or fatal severities will be included.
    - **Fatal**: Only constraints with fatal severities will be included.

To open the Active Validation Options dialog:

1. Click **Analyze** > **Validation** > **Active Validation Options** (Figure 219). The **Project Options** dialog will open (Figure 218).

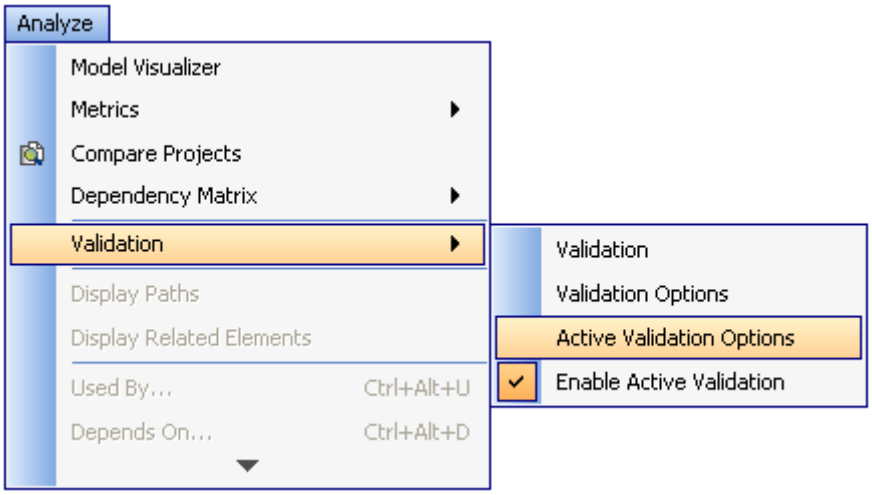


Figure 219 -- Active Validation Options

2. Go to the **General project options** pane and select **Active Validation** > **Ignored validation suites** (Figure 218).

To ignore some unused or unimportant active validation suites:

1. Click the **Browse** ... button. The **Select Suites** dialog will open (Figure 220).

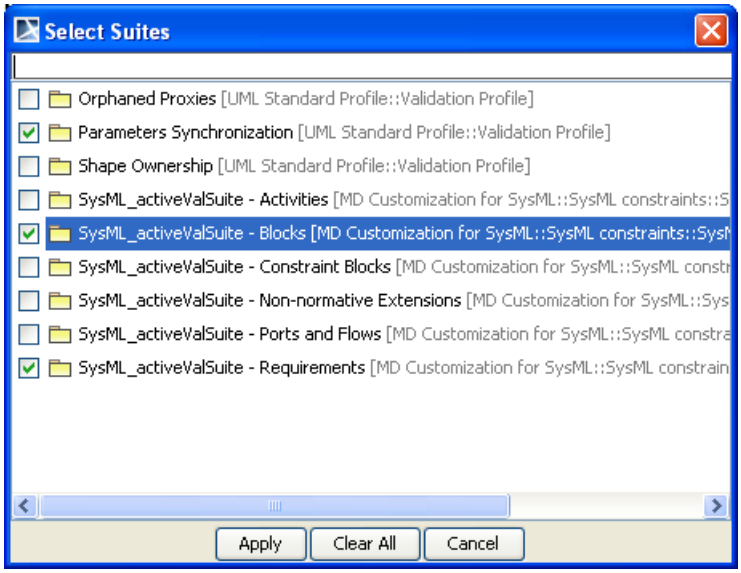


Figure 220 -- Select Suites Dialog

2. Select the check boxes in order to ignore the active validation suites, and then click **Apply**. In this example, three validation suites will be excluded from the validation process (Figure 220).

NOTE	Additional validation rules / constraints can be added and grouped into an active validation suite (in a newly-created one or in an existing one).

For more information on the Active Validation feature, see the *Model Analysis* in the 'Validation' section in the MagicDraw User Manual.

6.2 SysML Constraints

SysML constraints implementation for SysML validation suites and active validation suites include:

Constraint		Constraint Description (Description excerpts have been taken from the OMG SysML Specifications 1.2 with permission.)	Directly specified in OMG SysML spec	Derived from OMG SysML spec
Binding Connector	1	The two ends of a Binding Connector must have either the same type or types that are compatible, so that equality of their values can be defined.	8.3.2.1	
Block	7	Within an instance of a SysML Block, the instances of properties with composite aggregation must form an acyclic graph.	8.3.2.2	
Block	8	Any classifier which specializes a Block must also have the «Block» stereotype applied.	8.3.2.2	
Block	A	If isEncapsulated of a block is true, then the block is treated as a black box. A part typed by this black box can only be connected to its ports or directly to its outer boundary.		8.3.2.2
BlockProperty	A	The block's properties must be applied with the matching stereotype. • Part property, which is the property that is typed by Block and has composite aggregation, must be applied with «PartProperty». • Shared property, which is the property that is typed by Block and has shared aggregation, must be applied with «SharedProperty». • Reference property, which is the property that is typed by Block and has none aggregation, must be applied with «ReferenceProperty». • Value property, which is the property that is typed by value type, must be applied with «ValueProperty».		
ValueProperty	A	The type of a value property must be a value type.		8.3.2.2
DistributedProperty	1	The «DistributedProperty» stereotype may be applied only to properties of classifiers stereotyped by Block or Value Type.	8.3.2.4	
ValueType	1	Any classifier which specializes a ValueType must also have the «ValueType» stereotype applied.	8.3.2.10	
ValueType	A	If a value is present for the 'unit' attribute, the 'quantity kind' attribute must be equal to the value of the 'quantity kind' attribute of the referenced unit.		8.3.2.10
FlowPort	1	A FlowPort must be typed by a Flow Specification, Block, Signal, or Value Type	9.3.2.3	

Constraint		Constraint Description (Description excerpts have been taken from the OMG SysML Specifications 1.2 with permission.)	Directly specified in OMG SysML spec	Derived from OMG SysML spec
FlowPort	2	If the FlowPort is atomic (isAtomic=True), the direction must be specified (has a value) and isConjugated must not specified (has no value).	9.3.2.3	
FlowPort	3	If the FlowPort is nonatomic and if all of the Flow Properties of the Flow Specification typing the port have ‘in’ direction, the FlowPort direction will be ‘in’ (or ‘out’ if isConjugated=true). If all the Flow Properties are ‘out’, the FlowPort direction will be ‘out’ (or ‘in’ if isConjugated=true). If the Flow Properties are both ‘in’ and ‘out’, the direction will be ‘inout’.	9.3.2.3	
FlowPort	4	A FlowPort can be connected (via connectors) to one or more flow ports that have matching Flow Properties. There are three options in matching Flow Properties: • 1. Type Matching: The type being sent is the same type or a sub-type of the type being received. • 2. Direction Matching: If the connector connects two parts that are external to one another, then the direction of the Flow Properties must be opposite, or at least one of the ends should be ‘inout’. If the connector is internal to the owner of one of the flow ports, then the direction should be the same or at least one of the ends should be ‘inout’. • 3. Name Matching: If the type and direction match several Flow Properties at the other end, the property that has the same name at the other end is selected. If there is no such property, then the connection will then be ambiguous (ill-formed).	9.3.2.3	
FlowPort (non-active)	A	The default direction of the atomic FlowPort should be set to ‘inout’ when creating a new atomic FlowPort or changing nonatomic to atomic type.		9.3.2.3
FlowPort	B	A FlowPort can only be applied to a port which is owned by a Block or its subtype.		9.3.2.3
FlowProperty	1	FlowProperties must be typed by a ValueType, Block, or a Signal.	9.3.2.4	
FlowProperty	B	A Flow Property must have its direction specified and the default value of the direction should be ‘inout’.		9.3.2.4
FlowSpecification	A	A FlowSpecification can be used as a type of a FlowPort only.		9.3.2.5
ItemFlow	2	An ItemFlow itemProperty must be typed by a Block or by a ValueType.	9.3.2.6	

Constraint		Constraint Description (Description excerpts have been taken from the OMG SysML Specifications 1.2 with permission.)	Directly specified in OMG SysML spec	Derived from OMG SysML spec
ItemFlow	3	An ItemProperty must be a property of the block that owns the source and the target.	9.3.2.6	
ItemFlow	4	The type of itemProperty should be the same or a subtype of the conveyedClassifier.	9.3.2.6	
ItemFlow	5	An Item property cannot have a value if there is only one association between the source and the target of the InformationFlow.	9.3.2.6	
ItemFlow	7	If an ItemFlow has an itemProperty, its name should be the same as the name of the item flow.	9.3.2.6	
ItemFlow	A	The conveyed classifiers must be the same or subtype of classifier that type flow property of flow specification.		9.3.2.6
ConstraintBlock	1	A ConstraintBlock cannot own any structural or behavioral elements beyond: • constraint parameters. • constraint properties that hold internal usages of constraint blocks. • binding connectors between its internally nested constraint parameters. • constraint expressions that define an interpretation for the constraint block. • general purpose model management and crosscutting elements.	10.3.2.1	
ConstraintBlock	2	Any classifier which specializes a Constraint-Block must also have the «ConstraintBlock» stereotype applied.	10.3.2.1	
ConstraintBlock	A	Binding connectors are used to bind each parameter of the constraint block to a property in the surrounding context.		10.3.2.1
ConstraintProperty (non-active)	1	A property to which the «ConstraintProperty» stereotype is applied, must be owned by a SysML Block.	10.3.2.2	
Discrete	1	The «discrete» and «continuous» stereotypes cannot be applied to the same element at the same time.	11.3.2.3	
NoBuffer	1	The «nobuffer» and «overwrite» stereotypes cannot be applied to the same element at the same time.	11.3.2.4	
Overwrite	1	The «overwrite» and «nobuffer» stereotypes cannot be applied to the same element at the same time.	11.3.2.5	
AllocateActivityPartition	A	The represented element of the activity partition which is applied with «AllocateActivityPartition» stereotype, should be the Property.		15.3.2.3

Constraint		Constraint Description (Description excerpts have been taken from the OMG SysML Specifications 1.2 with permission.)	Directly specified in OMG SysML spec	Derived from OMG SysML spec
AllocateActivityPartition	B	An Action appearing in an AllocateActivityPartition will be the /client (from) end of an allocate dependency. The element that represents the AllocateActivityPartition will be the /supplier (to) end of the same allocate dependency.		15.3.2.3
Copy	1	A 'Copy' dependency may only be created between two classes that have the «requirement» stereotype, or a subtype of the «requirement» stereotype applied.	16.3.2.1	
Copy	2	The text property of the client requirement is constrained to be a copy of the text property of the supplier requirement.	16.3.2.1	
Copy	A	A requirement cannot copy more than one requirement.		16.3.2.1
Copy	B	'Copy' dependencies should not form a cyclic graph.		16.3.2.1
Copy	C	If the supplier requirement has sub requirements, copies of the sub requirements are made recursively in the context of the client requirement. 'Copy' dependencies are created between each sub requirement and the associated copy.		16.3.2.1
Requirement	5	A nested classifier of a class that is stereotyped by «requirement» must also be stereotyped by «requirement».	16.3.2.3	
Requirement	A	A Requirement ID must be unique.		16.3.2.3
TestCase	1	The type of return parameter of the stereotyped model element must be VerdictKind. (Note this is consistent with the UML Testing Profile.)	16.3.2.5	
streaming	1	The activity has at least one streaming parameter.	C.1.2	
streaming/nonStreaming	A	The «streaming» and «nonstreaming» stereotypes cannot be applied to the same element at the same time.		C.1.2
nonStreaming	1	The activity has no streaming parameter.	C.1.2	
functionalRequirement	1	Must be satisfied by an operation or a behavior.	C.2.2	
interfaceRequirement	1	Must be satisfied by a port, connector, item flow, and/or a constraint property.	C.2.2	
performanceRequirement	1	Must be satisfied by a value property.	C.2.2	
designConstraint	1	Must be satisfied by a block or a part.	C.2.2	

Constraint		Constraint Description (Description excerpts have been taken from the OMG SysML Specifications 1.2 with permission.)	Directly specified in OMG SysML spec	Derived from OMG SysML spec
PropertySpecific-Type (non-active)	1	A classifier to which the «PropertySpecific-Type» stereotype is applied must be referenced as the type of one and only one property.	8.3.2.7	
PropertySpecific-Type (non-active)	2	The name of a classifier to which a «PropertySpecificType» is applied must be missing (The "name" attribute of the NamedElement metaclass must be empty).	8.3.2.7	
PropertySpecific-Type (non-active)	A	Classifiers with the «PropertySpecificType» stereotype are owned by the block which owns the property which has the property-specific type.		8.3.2.7
PropertySpecific-Type (non-active)	B	Property which is typed by the «PropertySpecificType» should be owned by block or subtypes of block.		8.3.2.7

7. Feature-based Compartments

SysML Plugin feature-based compartments allow you to display additional compartments in internal properties. There are six feature-based compartments:

- :values
- :parts
- :references
- :constraints
- :properties (formerly :UML properties)
- :operations

For any given property, these compartments will show information from the classifier of the property (Figure 221, right-hand side) in conformity with SysML specifications outlined in the ‘Compartment on Internal Properties’ section.

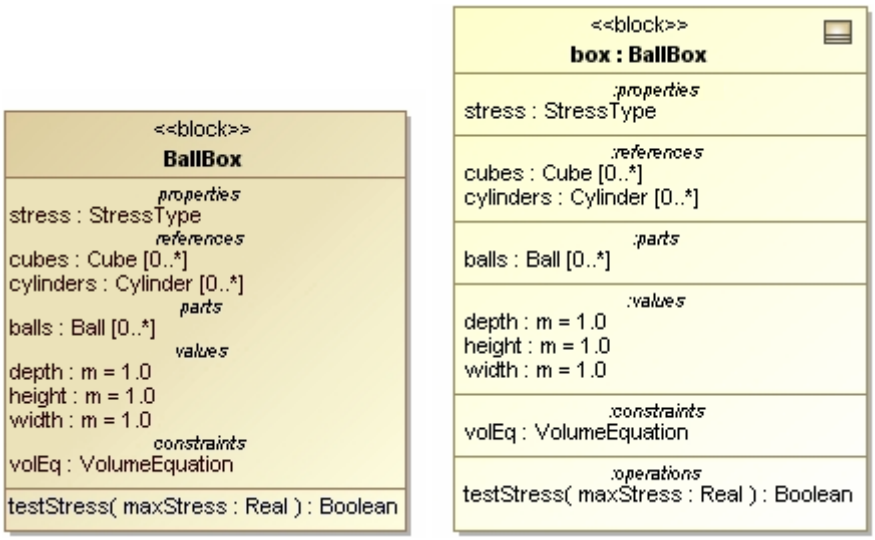


Figure 221 -- Compartments in a Block vs. Feature-based Compartments in an Internal Property

For any property typed by a Block, feature-based compartments will contain the same information as that of the compartments on the Block symbol, such as values, parts, references, constraints, UML properties, and operations compartments.

7.1 Expanding and Suppressing Feature-based Compartments

You can expand or suppress feature-based compartments using either (i) the Symbols Properties dialog or (ii) the property shortcut menu.

(i) Using the Symbol(s) Properties Dialog of an Internal Property

To expand or suppress a feature-based compartment(s) using the Symbol(s) Properties dialog:

1. Either right-click the property symbol and select **Symbol(s) Properties…** (Figure 222) or select the property and press **Alt** + **Enter**. The **Properties** dialog will open.

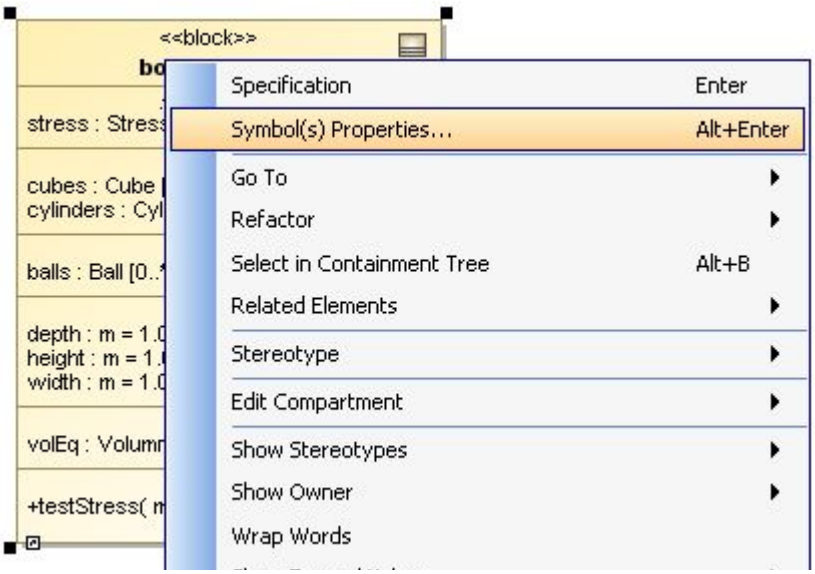


Figure 222 -- Symbol(s) Properties… Shortcut Menu

2. The symbol properties for expanding or suppressing feature-based compartments will be listed under **SysML Internal Properties Compartments** (Figure 223).

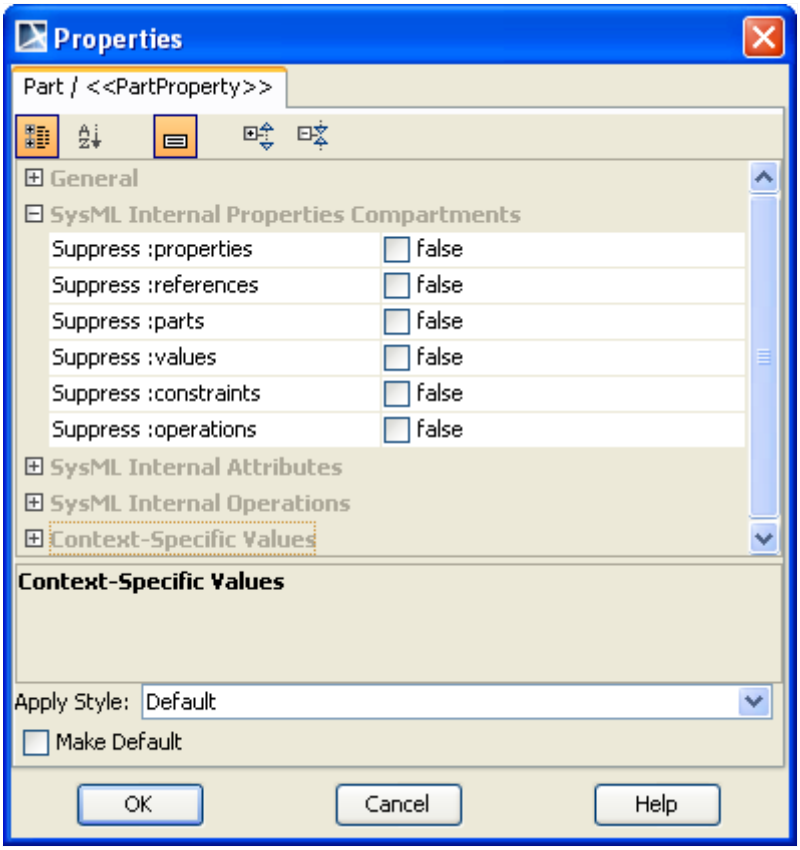


Figure 223 -- Symbol(s) Properties Dialog - SysML Internal Properties Compartments

To expand a feature-based compartment:

- Set the value of the corresponding symbol property to **false** by clearing the check box. For example, to show **:values** and **:parts** compartments, clear the **Suppress :values** and **Suppress :parts** check boxes.

To suppress a feature-based compartment:

- Set the value of the corresponding symbol property to **true** by selecting the check box. For example, to hide **:properties** and **:operations compartment**, select the **Suppress :properties** and **Suppress :operations** check boxes.

(ii) Using the Property Shortcut Menu

The submenus for suppressing or expanding feature-based compartments are listed inside the **SysML Internal Properties Compartments** option on the property shortcut menu (Figure 224).

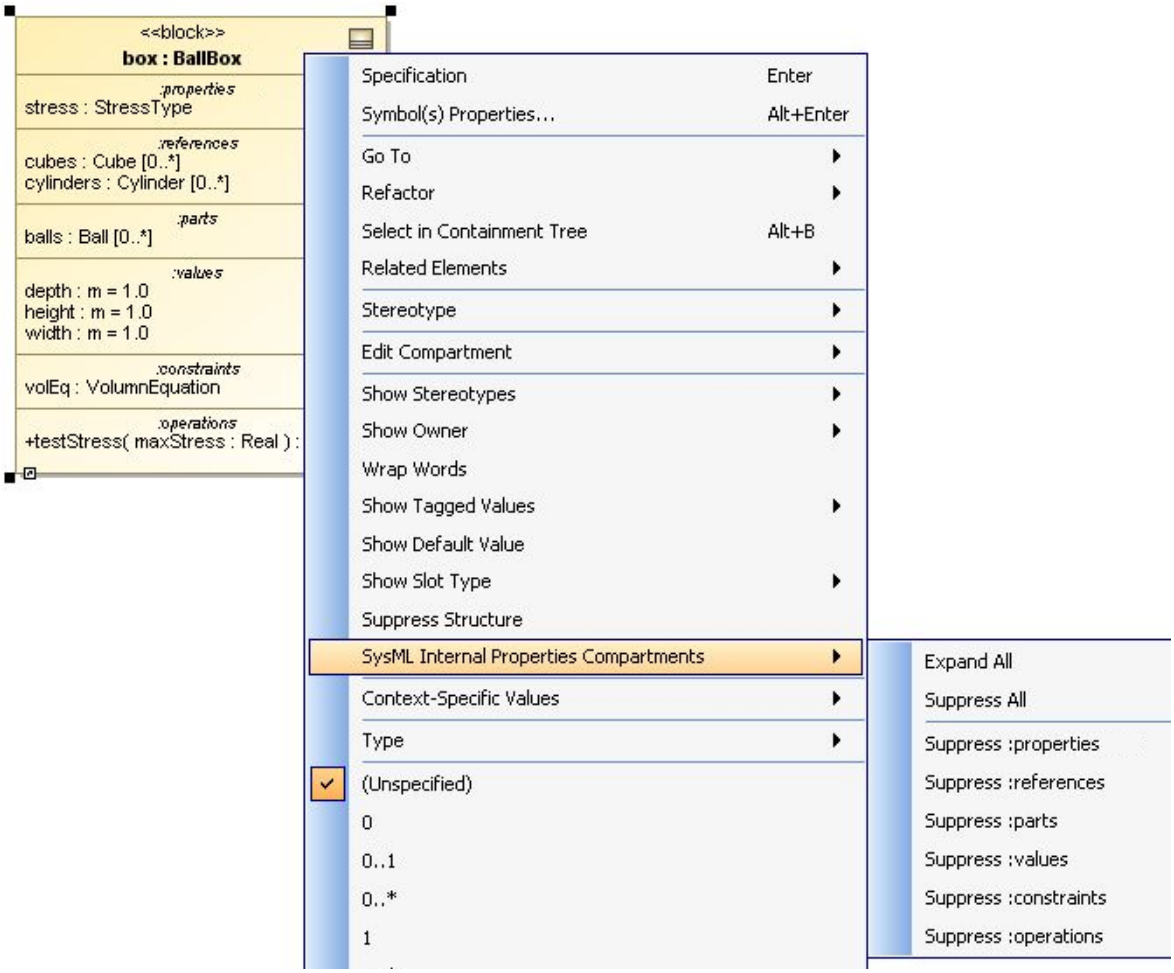


Figure 224 -- SysML Internal Properties Compartments Shortcut Menu

To suppress a feature-based compartment:

- Select the submenu for that compartment.

To expand a feature-based compartment:

- Clear the submenu for that compartment.

To suppress all feature-based compartments:

- Select **Suppress All**.

To expand all feature-based compartments:

- Select **Expand All**.

7.2 Displaying Options in Feature-based Compartments

Elements displayed in the feature-based compartments of a property can be customized using the symbol properties listed under **SysML Internal Attributes** and **SysML Internal Operations** in the **Symbol(s) Properties** dialog of each property (Figure 225).

To customize the display of the elements in the feature-based compartments:

- Select or clear any of the check boxes as shown in Figure 225.

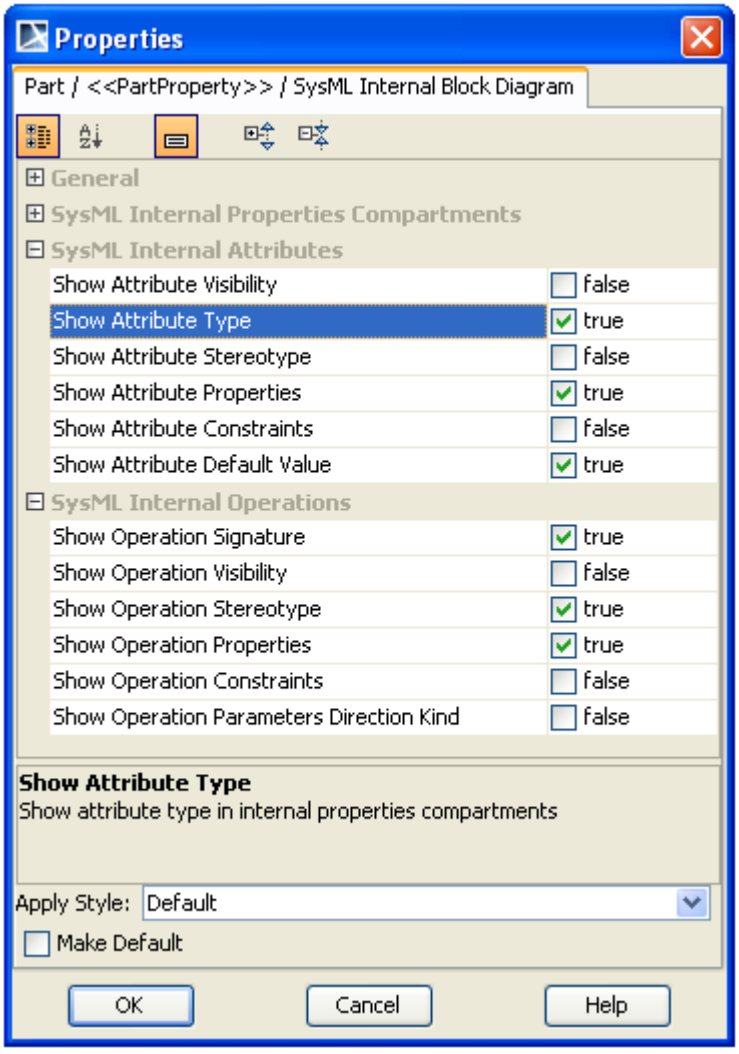


Figure 225 -- Symbol(s) Properties Dialog: SysML Internal Attributes and Operations

8. Context-Specific Value Compartments

8.1 Progressive Reconfiguration

Progressive Reconfiguration enables MagicDraw SysML to handle a wide range of systems engineering configuration tasks. Progressive Reconfiguration continuously applies the following values:

- Static class-level default values.
- Inherited Property-specific initial values.
- Redefined Property-specific initial values.
- Property-specific initial values.

Property-specific initial values are specific to the usage of a Block as a Part Property in a higher context (i.e. another structured block or "assembly"). If there are many Part Properties of the same type, these Part Properties may have different property-specific default values and will then be initialized differently.

Property-specific initial values are managed by the higher-context structured block, which owns the Part Properties that initialize or configure their (possibly different) values on instantiation. For example, the generic capacity of a **FuelTank** (not any particular one) is 40 liters (class-level default value). For a vehicle, however, the generic capacity of its **FuelTank** is 46 liters. An abstract **Vehicle** block will thus configure its **tank:FuelTank** part property by initializing it with a new capacity value. This can be done with Progressive Reconfiguration that will assign the instance specification **tank:FuelTank** to the property **tank:FuelTank** of the **Vehicle** block (Figure 226).

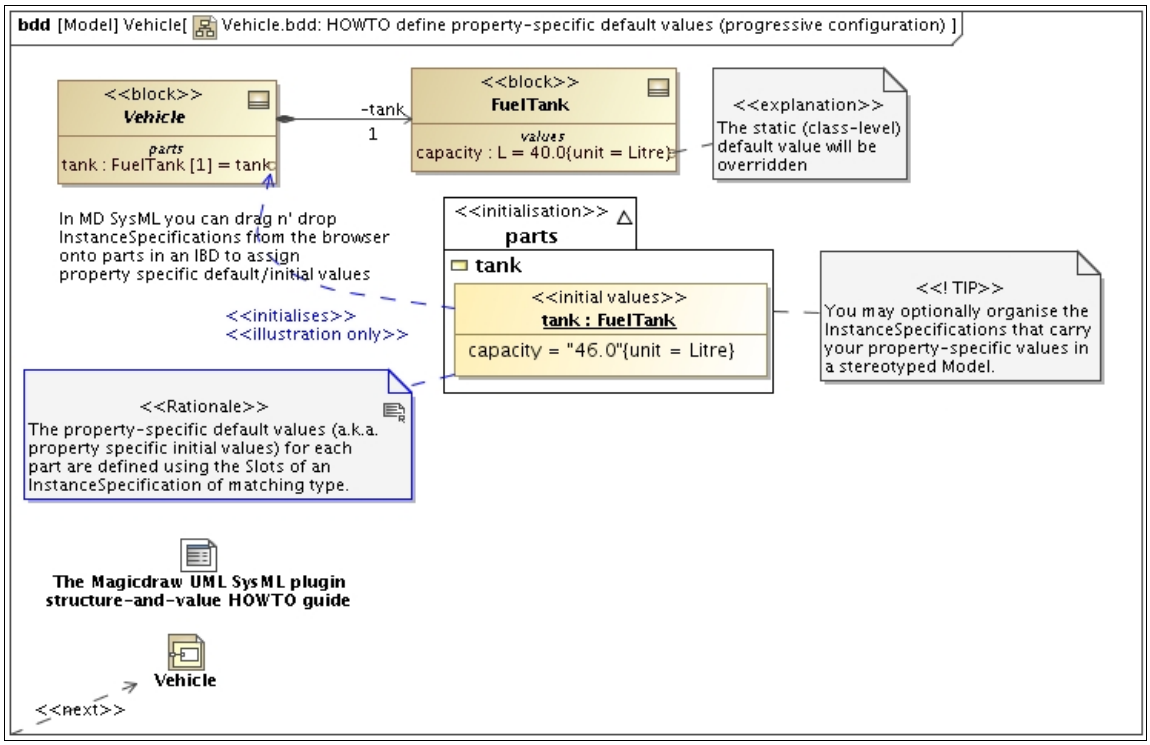


Figure 226 -- Progressive Reconfiguration

For more information on Progressive Reconfiguration, see `http://training.nomagic.com`.

8.2 Deep Reconfiguration

Deep Reconfiguration enables you to configure deep-nested part(s) with context-specific value(s). Consider, for example, the case of a truck reusing a complex **WheelHubAssembly** for three pairs of wheels, each with different characteristics. Although the basic **WheelHubAssembly** might be suitable for a range of vehicles (a car, touring car, and minivan), it is not nearly suitable for a large truck. Some of the **WheelHubAssembly** parts and subparts required for a truck are larger and must be stronger to handle heavy loads. They include:

- the diameter of the **Tire**, **TireBead**, and **Rim** will be larger.
- the **inflationPressure** value of the **WheelAssembly** will be higher.
- the **LugBoltJoint** will be subject to greater **torque** and **boltTension**.

- the **LugBoltThreadedHole** will have larger **lugBoltSize** and **threadSize**.

In this case, Progressive Reconfiguration will fail because the new configuration requirements "cascade" throughout the entire complex **WheelHubAssembly** from the outermost context to the deepest part. Since no Progressive Reconfiguration approach can handle this deep reconfiguration of complex assemblies, you need to use Deep Reconfiguration.

You can start with a completely new **TruckWheelHubAssembly** that configures a completely new **Truck-WheelAssembly**, right down to a **TruckLugBoltJoint**.

However, you could use, instead, SysML PropertySpecificType strategy, which is a set of "on-the-fly" extensions (subtypes) of each Block used in a complex assembly hierarchy, to afford a point of redefinition of the Part Properties and their Value Properties as required. See the ‘PropertySpecificType‘ section in OMG SysML specifications.

For more information on Deep Reconfiguration, see `http://training.nomagic.com`.

8.3 Context-Specific Value Compartments

The purpose of Context-specific Value Compartments is to show various values as a result of a reconfigured selected context. In the **FuelTank** example [see (8.1) Progressive Reconfiguration above], the capacity of a **FuelTank** in a **Vehicle** context is reconfigured to 46 litres. In the **WheelHubAssembly** example, [see (8.2) Deep Reconfiguration above], the diameter of the **Tire**, **Tire Bead** and **Rim**, the **inflationPressure** of the **WheelAssembly**, etc., in a **Truck** context will be reconfigured to suit the truck.

This section contains the following subsections:

You can see a sample of a Deep Reconfiguration project by opening **context specific values.mdzip** in the ***<md.install.dir>/samples/SysML*** directory.

8.3.1 Advantages of Context-Specific Value Compartments

Context-Specific Value Compartments allow you to:

- create different configurations for the same structure and display them directly in IBD diagram(s)
- have different values for the same part in different contexts
- assign a different initial value to an inherited property

8.3.2 Using Context-Specific Value Compartments

A Context-Specific Value Compartment is a part symbol compartment. Only part symbols can have Context-Specific Value compartments. A Context-Specific Value compartment displays the values of the properties (parts) reconfigured in a selected context (Progressive or Deep Reconfiguration).

An example of **Progressive Reconfiguration** is when the values of *y* and *z* of a **Location** are reconfigured to *1* in the **Thing** context. Thus, the “values (Thing)” compartment in the **I:Location** part (in the **Thing** package) will display *1* as the values of *y* and *z* (Figure 227).

An example of **Deep Reconfiguration** is when the value of *x* of a **Location** in the **UniverseContext** package is reconfigured to *3* in the **UniverseContext** context. Thus, the “values (UniverseContext)” compartment in the **l:Location** part (in the **t1:Thing** part in the **UniverseContext** package) will display *3* as the value of *x*. If **UniverseContext** is selected, the value of *z*, instead of *x*, will be reconfigured to *2* (Figure 227).

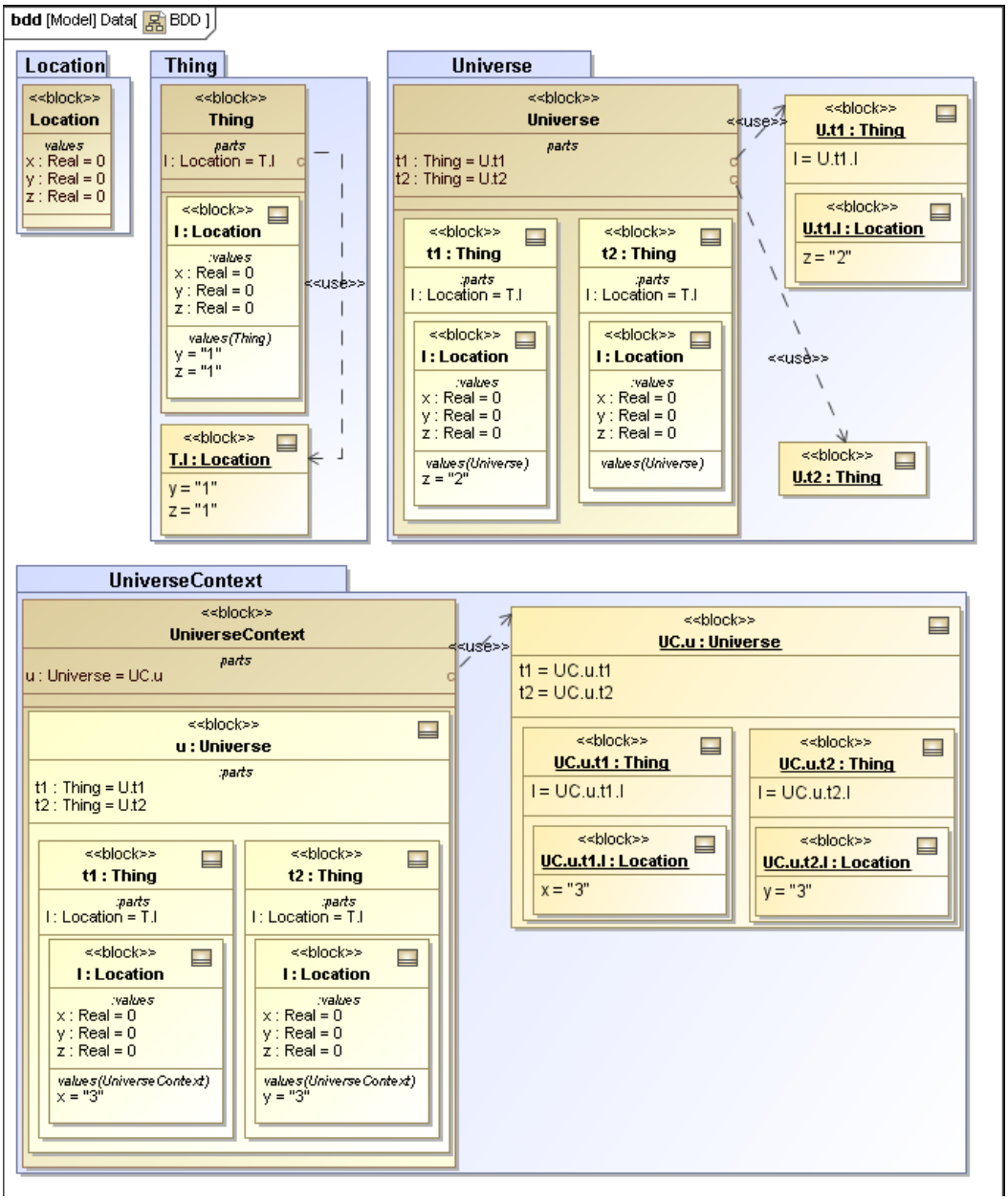


Figure 227 -- Block Definition Diagram

8.3.3 Displaying Context-Specific Value Compartments

You can display (or suppress) the Context-Specific Value Compartment of a part using either (i) the **Symbol(s) Properties** dialog or (ii) the part shortcut menu.

(i) Using the Symbols Properties Dialog

To open the Symbol(s) Properties dialog:

- Either right-click the part symbol and select **Symbol(s) Properties…** or select the part symbol and press **Alt + Enter**.

To display a compartment using the Symbol(s) Properties dialog:

- In the **Symbol(s) Properties** dialog, set the value of the **Suppress Context Specific Values** symbol property under the **Context Specific Values** group to **false** by clearing the check box (Figure 228).

To suppress a compartment using the Symbol(s) Properties dialog:

- In the **Symbol(s) Properties** dialog, set the value of the **Suppress Context Specific Values** symbol property under the **Context Specific Values** group to **true** by selecting the check box (Figure 228).

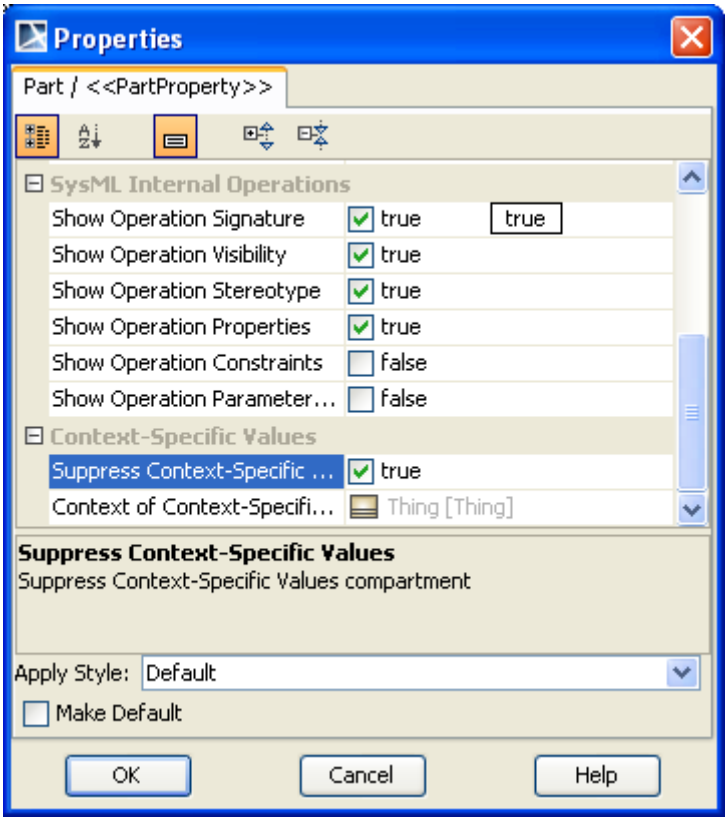


Figure 228 -- Symbol(s) Properties DialogSymbol(s) Properties Dialog - Suppress Context Specific Values

(ii) Using the Part Shortcut Menu

To display a compartment using the part shortcut menu:

- On the shortcut menu, clear the **Suppress Context Specific Values** option under the **Context Specific Values** group (Figure 229).

To suppress a compartment using the part shortcut menu:

- On the shortcut menu, select the **Suppress Context Specific Values** option under the **Context Specific Values** group (Figure 229).

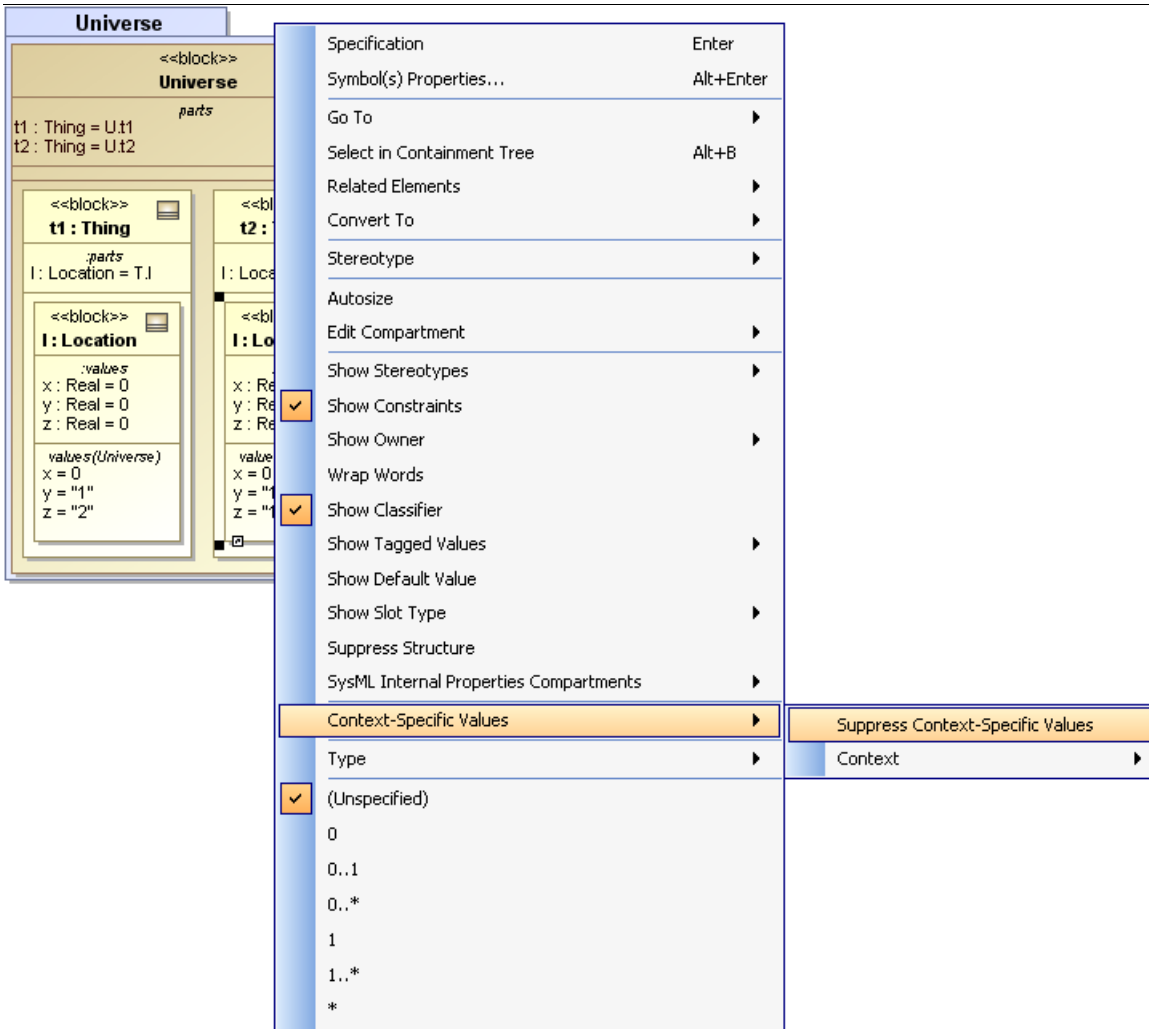


Figure 229 -- Shortcut Menu for Suppress Context Specific Values

8.3.4 Selecting the Context of Context-Specific Value Compartments

The properties' values shown in the Context-Specific Value Compartment of a part and the compartment label will change according to the selected context. For example, if the selected context is **A** then the compartment label will be **values (A)**.

To select a context using the shortcut menu:

- Right-click the part and select **Context Specific Values** > **Context** (Figure 230).

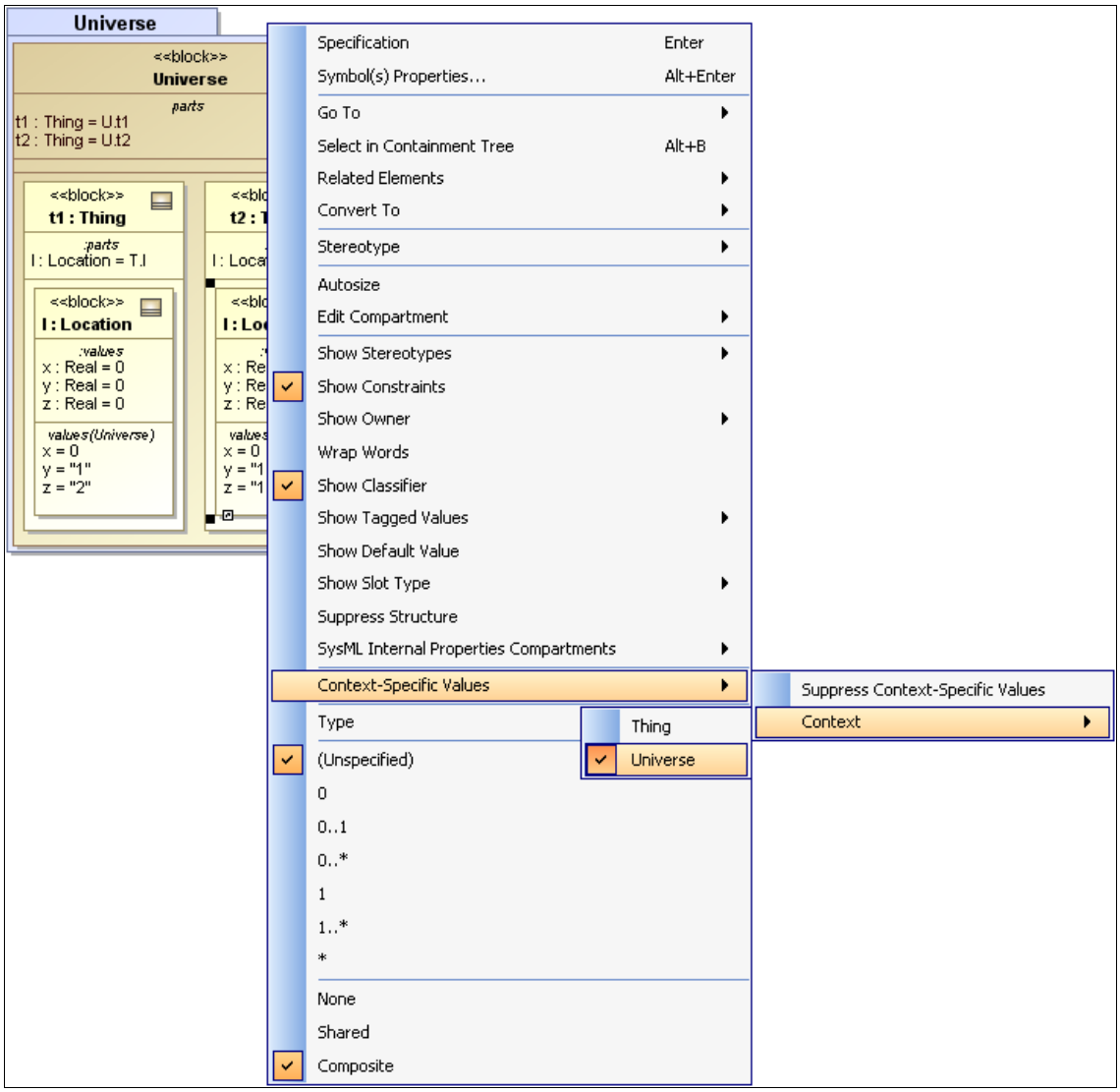


Figure 230 -- Shortcut Menu - Select Context

8.3.5 Customizing Context-Specific Value Compartment Display

You can display or hide the elements types in the Context-Specific Value Compartment of a part using either (i) the **Symbol(s) Properties** dialog or (ii) the part shortcut menu.

(i) Using the Symbol(s) Properties Dialog

To display or hide element type(s) using the Symbol(s) Properties dialog:

1. Right-click the part and select the **Symbol(s) Properties...** option.
2. Three display modes are available in the **Symbol(s) Properties** dialog (Figure 231):
   - **None**: to hide types
   - **Name**: to display the names of the element types
   - **Qualified Name**: to display the qualified names of the element types

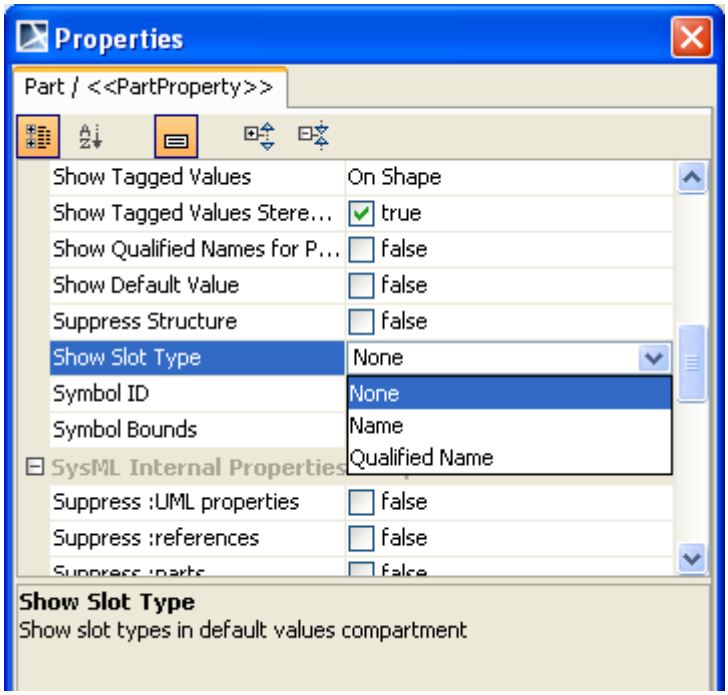


Figure 231 -- Symbol(s) Properties Dialog - Show Slot Type

(ii) Using the Part Shortcut Menu

To display or hide element type(s) using the part shortcut menu:

- Right-click the part to open its shortcut menu, select **Show Slot Type**, and then select a display mode (Figure 232).

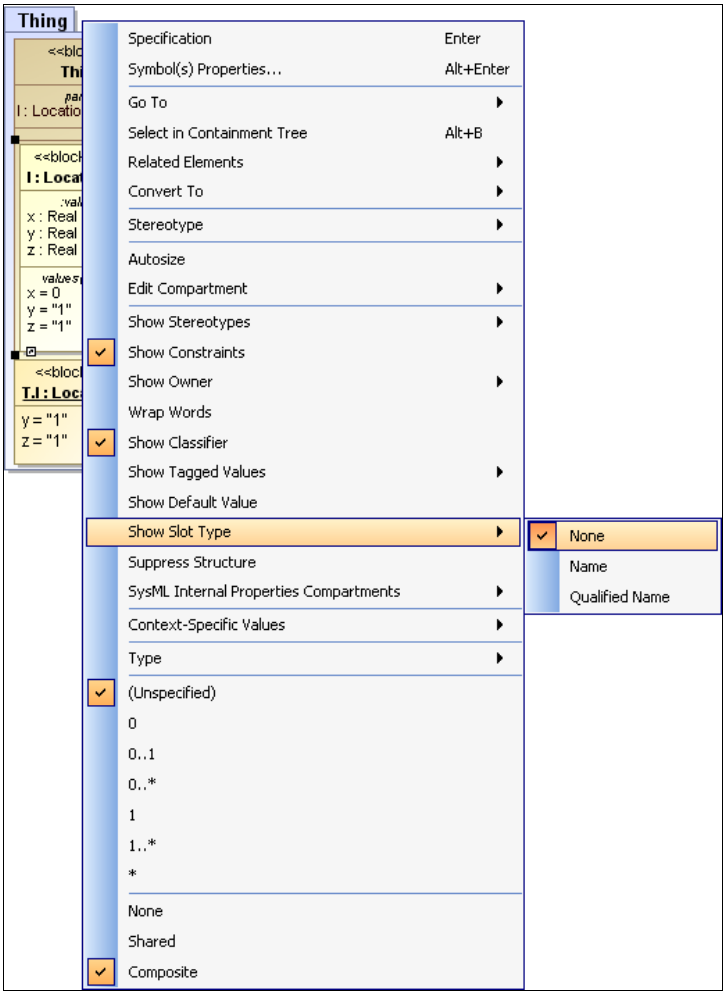


Figure 232 -- Shortcut Menu - Show Slot Type

8.3.6 Value Propagation

The Value Propagation mechanism enables values that are not overridden by the values from the selected context in a Context-Specific Value Compartment to be displayed.

Assuming the property and the Value Propagation options are enabled, the value available in the next context will be used to reconfigure the property if there is no value in the selected context to reconfigure the property. However, if there is no value available in any context, the class-level default value will be displayed in the Context-Specific Value Compartment, indicating that the property is not reconfigured at all.

See Figure 233 for an example of the Context-specific Values Compartments having the Value Propagation enabled.

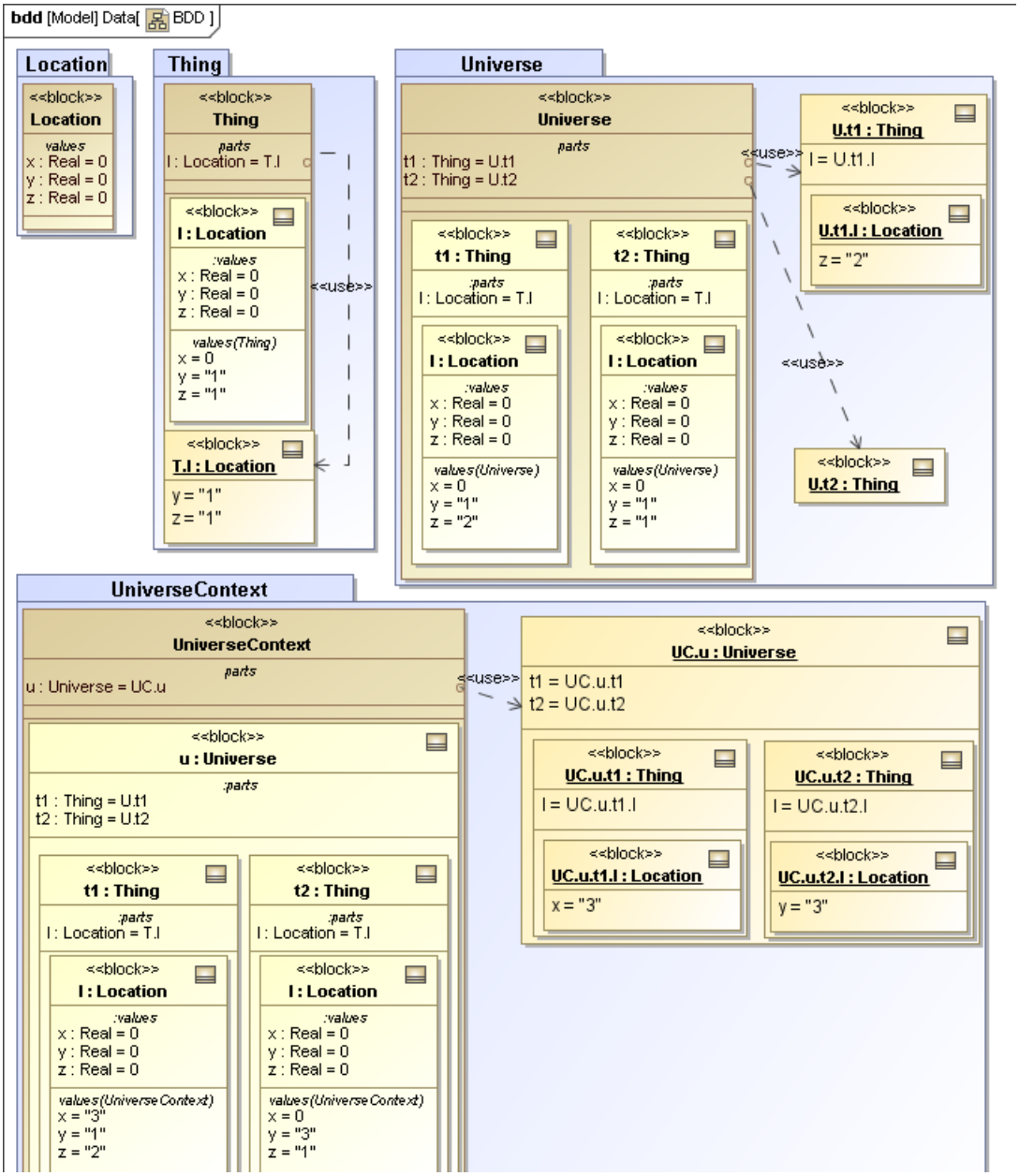


Figure 233 -- BDD Value Propagate

In the **UniverseContext** package, only the value of *x* of a **Location** is reconfigured to *3* in the **UniverseContext** context. The values of *y* and *z* are not set by the selected context. Since the value propagation is enabled, the next context, **Universe**, is considered. In the **Universe** context, the value of *z* is set to *2*. However, the value of *y* is still missing; therefore, the next context, **Thing**, is considered.

In the **Thing** context, the value of *y* is set to *1*. Now, all attributes of the **Location** are set as follows:

- *x = 3*
- *y = 1*
- *z = 2*

For more information on Value Propagation, see `http://training.nomagic.com`.

To enable the value propagation mechanism:

1. Click **Options** > **Project** on the main menu (Figure 234) to open the **Project Options** dialog (Figure 235).

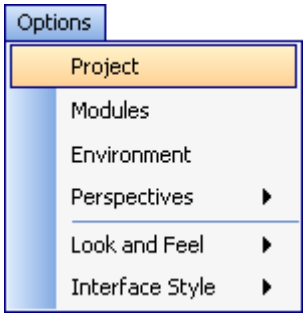


Figure 234 -- Project Options Menu

2. Select **General project options** > **SysML**.
3. Select the **Propagate SysML Values** check box and click **OK** (Figure 235).

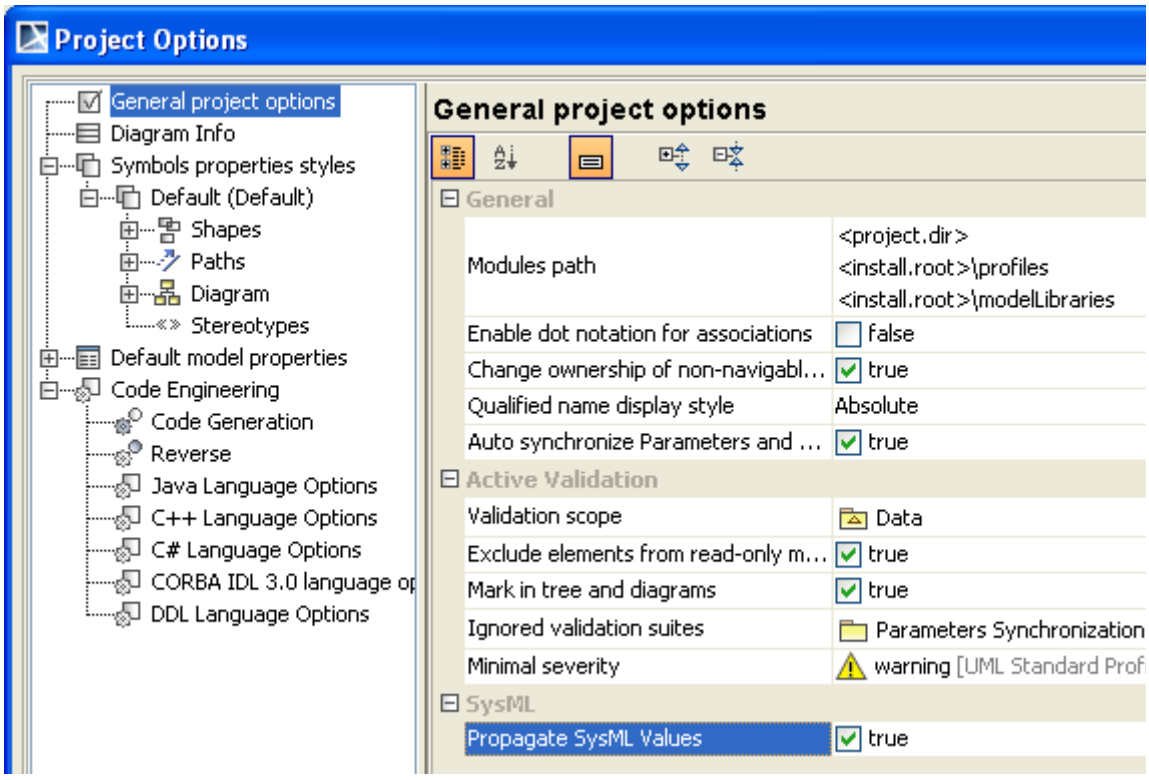


Figure 235 -- Project Options - Propagate SysML Values

NOTE	Clear the **Propagate SysML Values** check box to disable the Value Propagation mechanism.

9. Structure Browser

The Structure browser allows you to browse for deep nested structures of the structure classifier in your model. The property nodes, which are shown inside the property node (the parent property node), are the properties of the classifier that type the parent property node. In Figure 236, the node: **diameter:m** represents the property: **diameter:m** of the classifier: **Cylinder Liner** and also the property: **cylinderLiner : Cylinder Liner** is the property of the classifier: **Engine**.

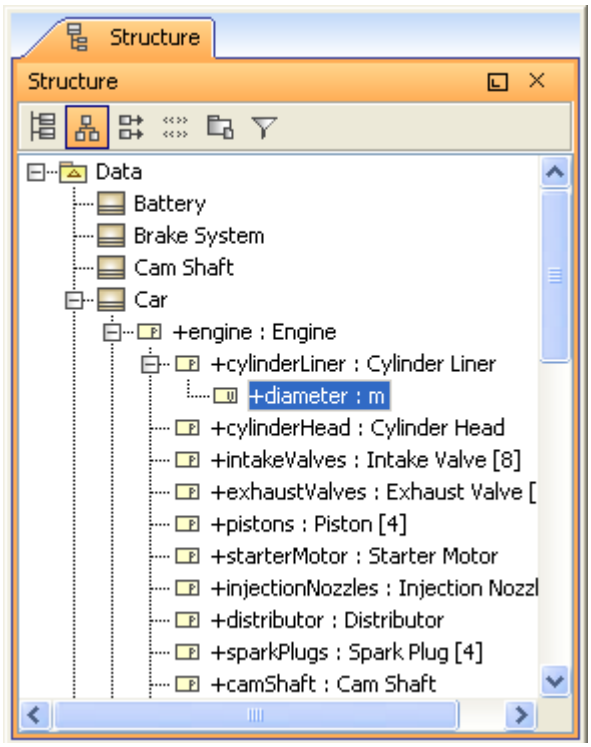


Figure 236 -- Structure Browser

9.1 Opening Structure Browser

You can open the Structure browser by clicking **Window** > **Structure** on the main menu (Figure 237).

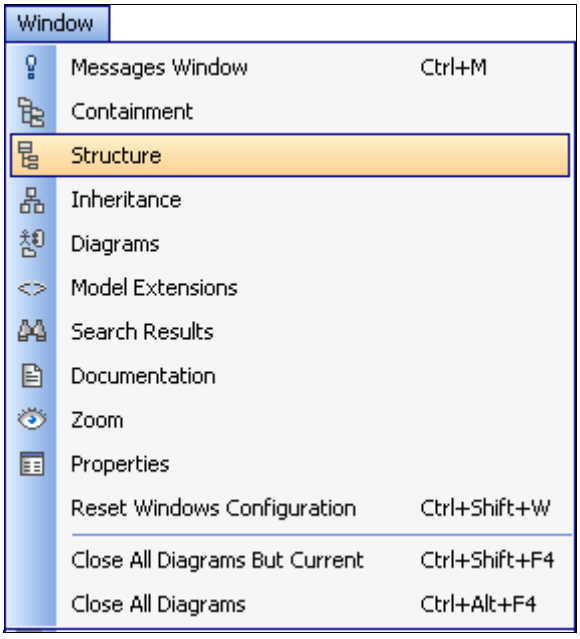


Figure 237 -- Opening Structure Browser from Main Menu

9.2 Customizing Structure Browser Display

You can customize the display of the Structure browser by using:

(9.2.1) Structure Browser Shortcut Menu

(9.2.2) Structure Browser Toolbar

9.2.1 Structure Browser Shortcut Menu

You can customize the display of the Structure browser by right-clicking its background to open its shortcut menu, and then mark/clear display option(s) on the menu.

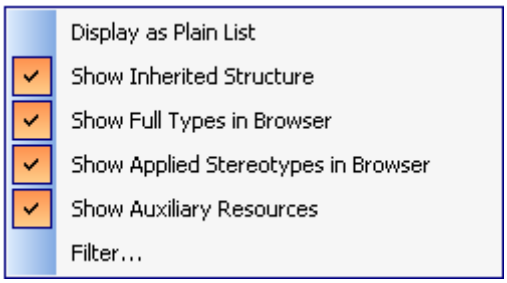


Figure 238 -- Opening Structure Browser from Context Menu

9.2.2 Structure Browser Toolbar

You can also customize the display of the Structure browser by clicking the icons on its toolbar.

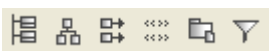


Figure 239 -- Structure Browser Toolbar

Table 7 -- The Structure Browser Toolbar Icons

Icons	Function
	To display the browser as a plain list of classifiers.
	To show inherited structures.
	To show full type in the browser.
	To show applied stereotypes in the browser.
	To show auxiliary resources in the browser.
	To filter type(s) of elements to be shown in the browser.

9.3 Display Options

You can select to customize the Structure browser in six display options:

(9.3.1) Display as Plain List
(9.3.2) Show Inherited Structure
(9.3.3) Show Full Type in Browser
(9.3.4) Show Applied Stereotypes in Browser
(9.3.5) Show Auxiliary Resources
(9.3.6) Filter

9.3.1 Display as Plain List

The classifiers of structure in your model will be normally displayed in a Package, Model, or Profile hierarchy. Use the **Display as Plain List** option to show all classifiers of the structure in the model in the same level with-

out consideration of their owner. When you select the Display in Plain List option, the classifiers will be sorted by their name.

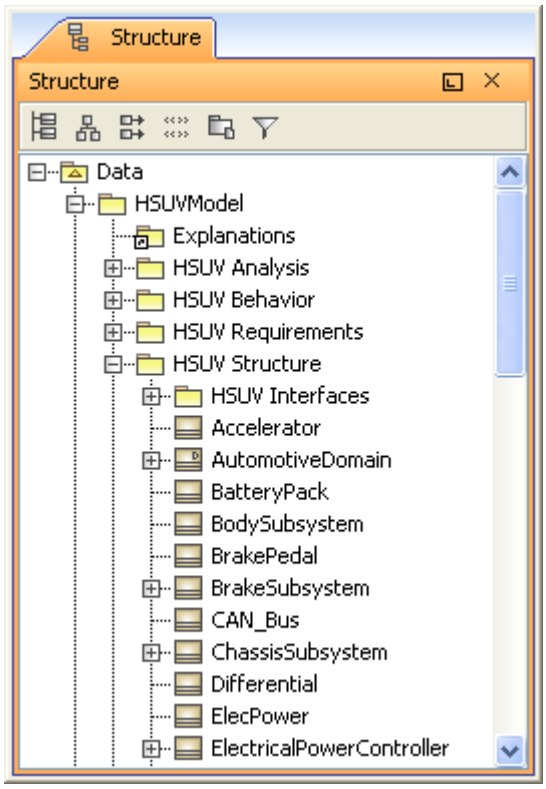


Figure 240 -- Structure Browser Normal Display

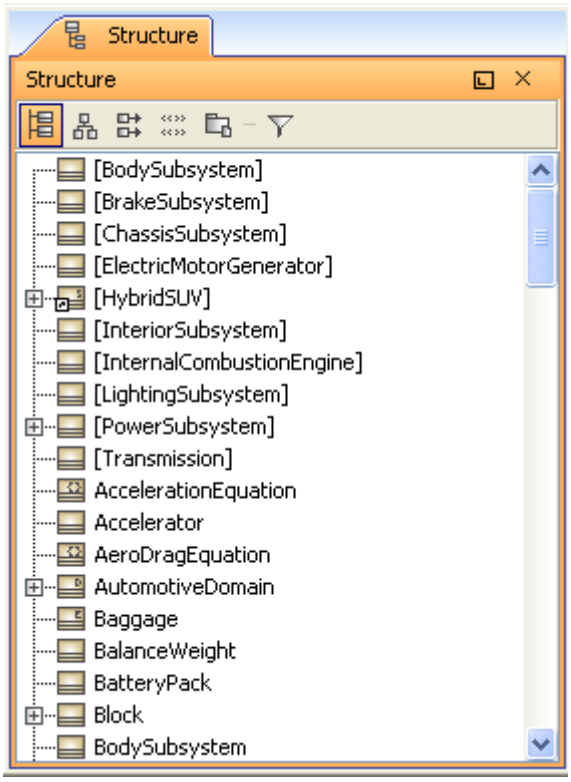


Figure 241 -- Structure Browser Plain List Display

9.3.2 Show Inherited Structure

The Structure browser can show the properties that are inherited from the generalization classifier.

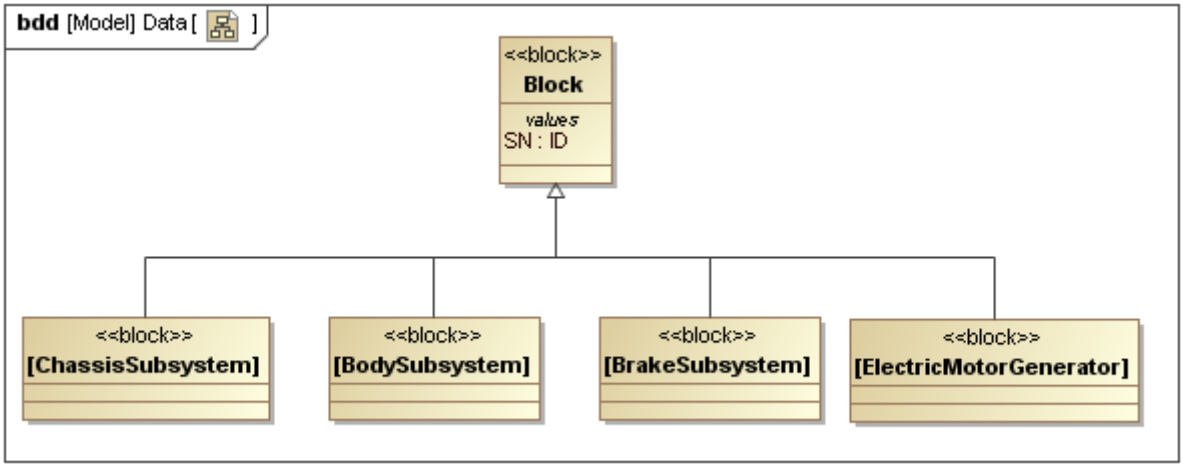


Figure 242 -- Four Specialization Classifiers of Blocks

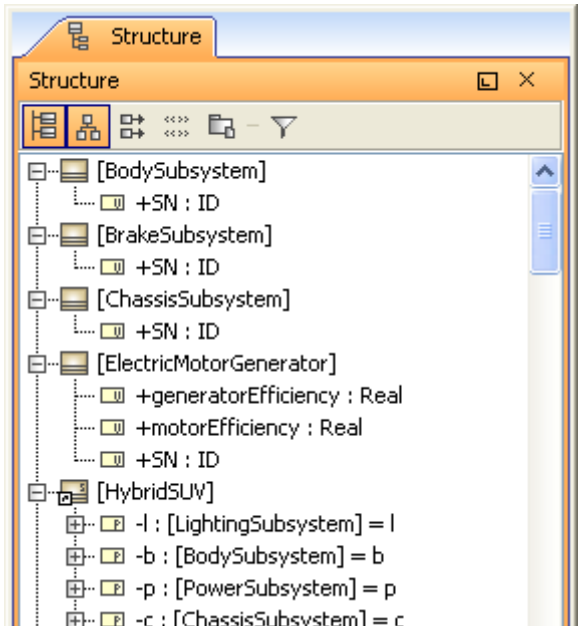


Figure 243 -- Inherited Structures of Blocks

9.3.3 Show Full Type in Browser

You can also see the full type of the classifiers that type the properties of the classifier in the Structure browser.

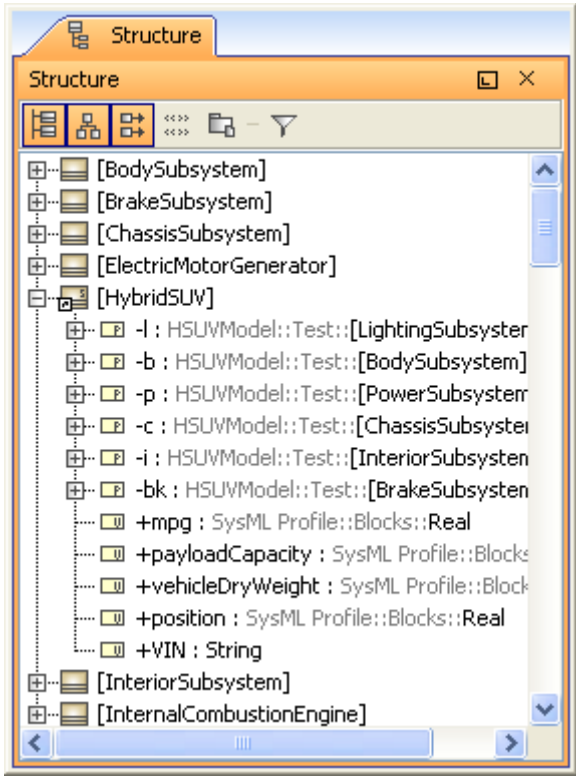


Figure 244 -- Structure Browser Displaying Full Type of Classifiers

9.3.4 Show Applied Stereotypes in Browser

Use the Show Applied Stereotypes in Browser option to show (or hide) the applied stereotypes of the elements in the browser.

9.3.5 Show Auxiliary Resources

Use the Show Auxiliary Resources option to show or hide auxiliary resources, e.g., SysML Profile, in the Structure browser.

9.3.6 Filter

Use the Filter option to customize the display of elements in the Structure browser. Mark the check box in front of the element you would like to display. Clear the checkbox to hide the element.

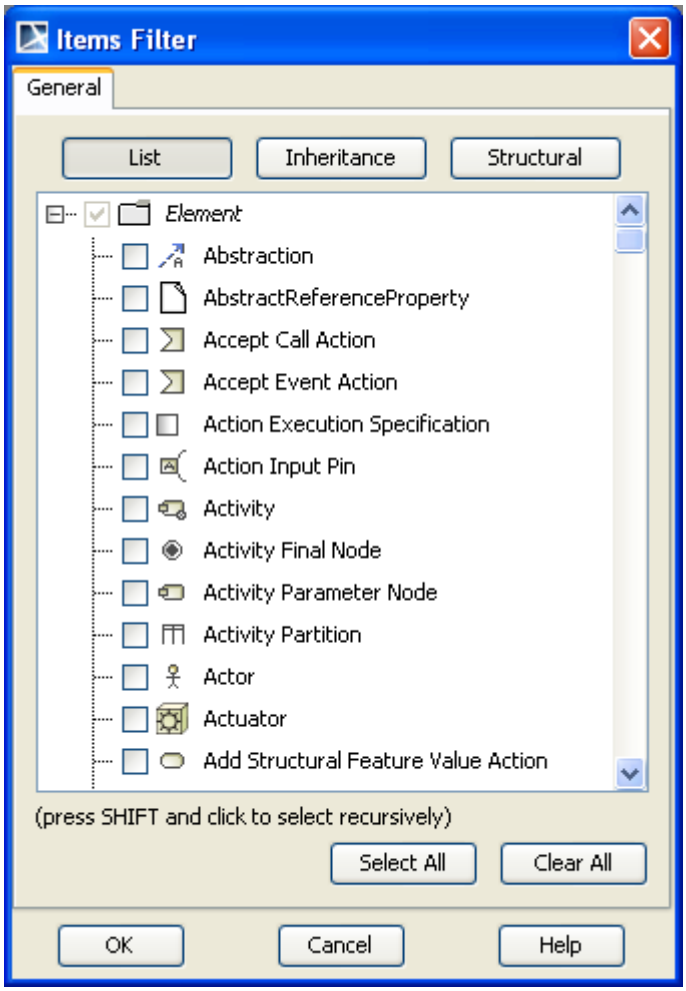


Figure 245 -- Items Filter Dialog for Customizing Elements Display in Structure Browser

9.4 Additional Structure Browser Menus

The Structure browser provides two menus to perform some additional actions.

(9.4.1) Go To > Type <name> in Structure Tree Menu

(9.4.2) Go To > Owner Menu

To open the **Go To** menu in the Structure browser:

1. Right-click a property in the Structure browser.
2. Click **Go To** and select the option you want from the submenu.

9.4.1 Go To > Type <name> in Structure Tree Menu

Click **Go To** > **Type <name> in Structure Tree** to navigate, in the Structure browser, to the classifier node of the classifier that types the property of the selected property node. The result of the selection is the classifier node in the Structure tree. For example, after selecting **Type WheelHubAssembly in Structure Tree** in Figure 246, the **WheelHubAssembly** block will then be selected in the Structure browser.

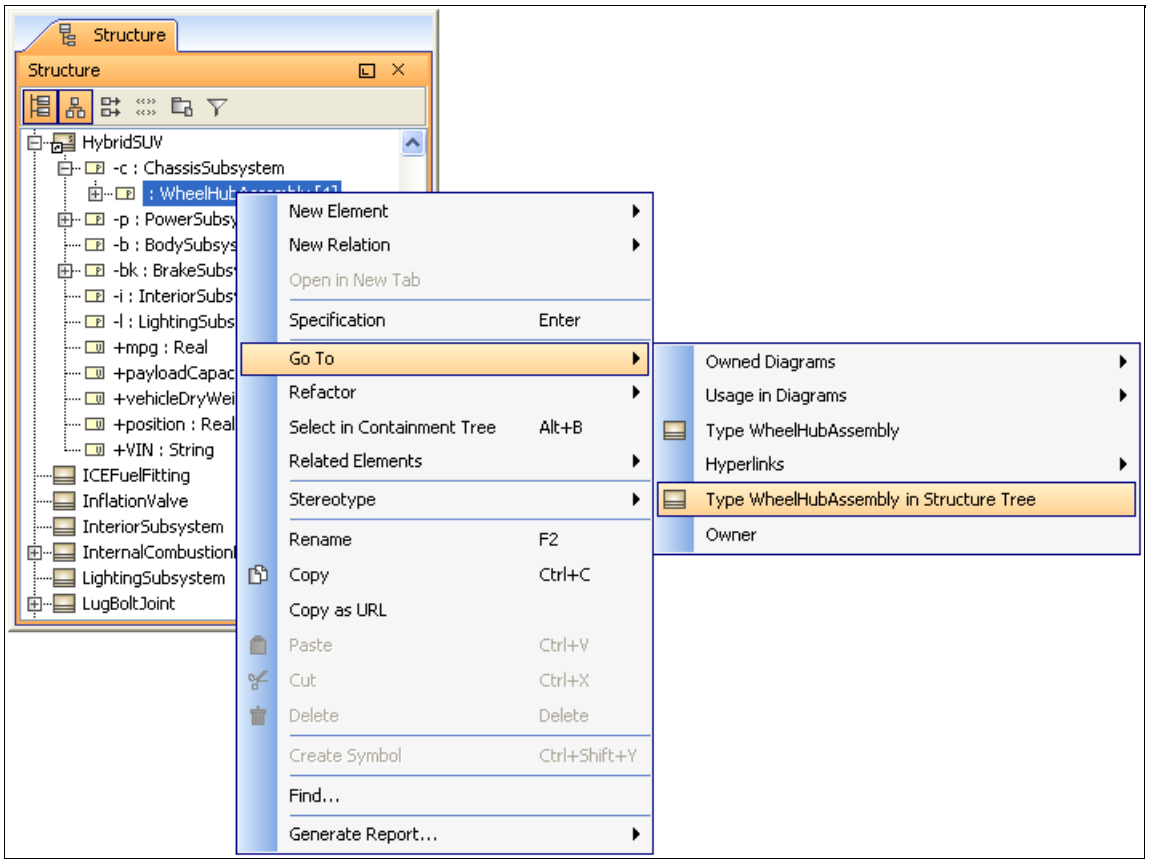


Figure 246 -- Go To > Type Shortcut Menu

9.4.2 Go To > Owner Menu

Click **Go To** > **Owner** (Figure 247) to navigate to the classifier node of the classifier that is the owner of the property of the selected property node. The result of the selection is the classifier node in the Structure tree.

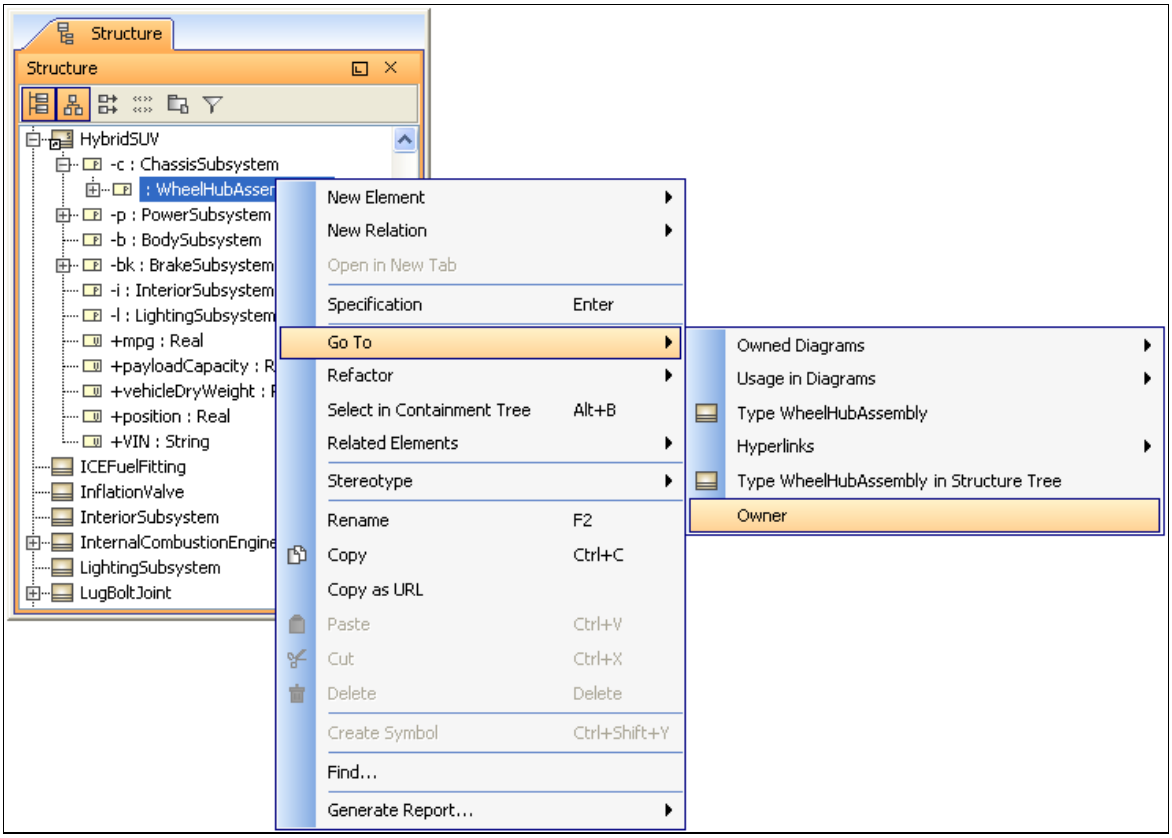


Figure 247 -- Go To > Owner Shortcut Menu

9.5 Additional Diagram Menu

9.5.1 Select in Structure Tree Menu

Use the **Select in Structure Tree** menu on the part shortcut menu (Figure 248), on Internal Block, Parametric, or Composite Structure diagram, to select, in the Structure browser, the structure node corresponding to the selected part symbol.

For instance, in Figure 248, the context of the IBD is **MEP**. When using the **Select in Structure Tree** menu with the **diameter : m** (**car.engine.cylinderLiner.diameter : m**) part, the corresponding **diameter : m** node (under **car : Car > engine : Engine > cylinderLiner : Cylinder Liner** of the **MEP** classifier) will then be selected in the Structure browser (Figure 249).

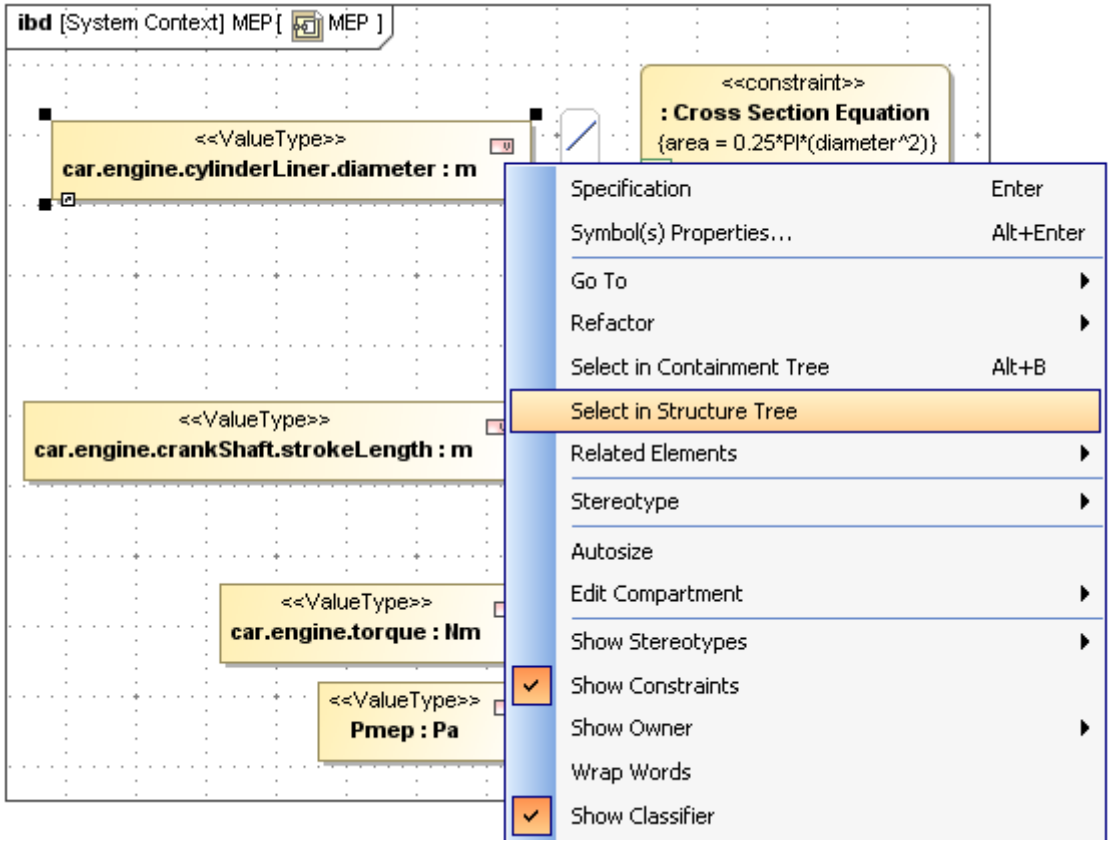


Figure 248 -- Select in Structure Tree Menu

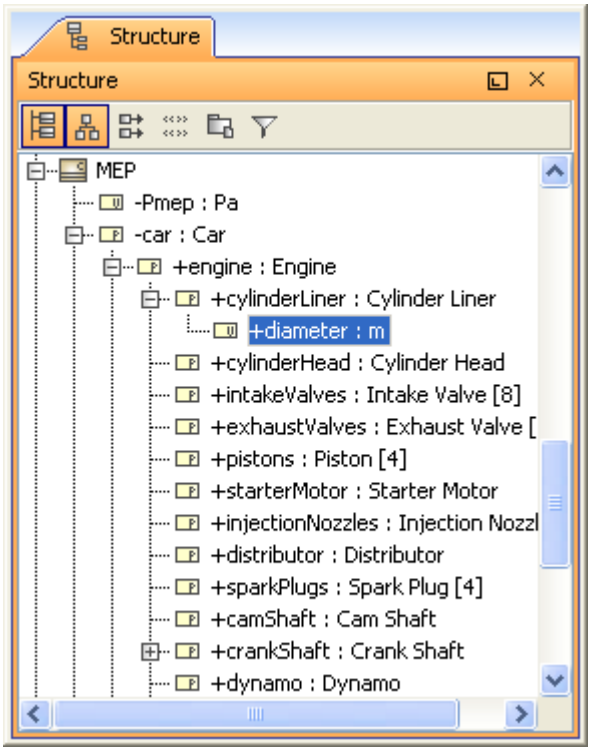


Figure 249 -- Select in Structure Tree Menu - Example of Result

10. Dependency Matrix

Dependency Matrix enables you to visualize and represent your particular model in a tabular form, depending on the scopes and dependency criteria you have selected.

- **Scope**: there are two types of scope: (i) row scope and (ii) column scope. You can select diagrams, UML elements, and/or SysML elements as a scope.
- **Dependency criteria**: include UML relationships, SysML relationships, semantic dependencies (dependency through property), and relationships through tags.

Cells in a dependency matrix show where the elements in the selected scope are associated with or related to one another. A dependency matrix allows you to visualize the many-to-many traceability of elements from different diagrams, particularly for elements interconnected in a large system.

A dependency matrix helps you:

- Quickly visualize dependency criteria.
- Compactly visualize the relationships of a large system, which cannot be easily represented by a diagram on a single sheet of paper because of the diagram complexity.
- Visualize domain-specific relationships through your own matrix templates for such domains.
- Understand relationships from a particular scope by filtering the unimportant kinds of model elements.
- Display relationships that cannot be represented in diagrams, such as representations (classes by lifeline), behavior representations in other diagrams, operation representations by Call Behavior Actions, etc.

10.1 Opening Dependency Matrix

A matrix element in a model is similar to a diagram element. When created, the new matrix will appear in the Browser as a model element. To open the matrix pane, double-click the matrix name in the Browser. All functions that can be performed with diagrams can also be performed with matrices.

You can open a Dependency matrix from any of the following:

- Diagrams main menu (Figure 250)
- Analyze main menu (Figure 251)
- Package shortcut menu in the browser (Figure 252)
- Custom Diagrams toolbar (Figure 253)

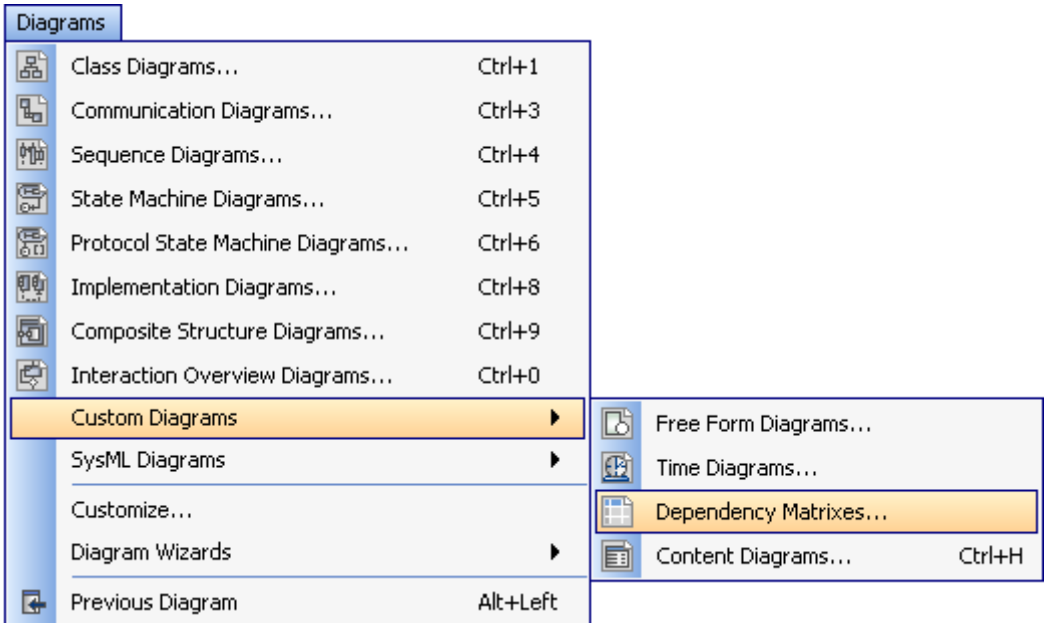


Figure 250 -- Opening Dependency Matrix from Diagrams Main Menu

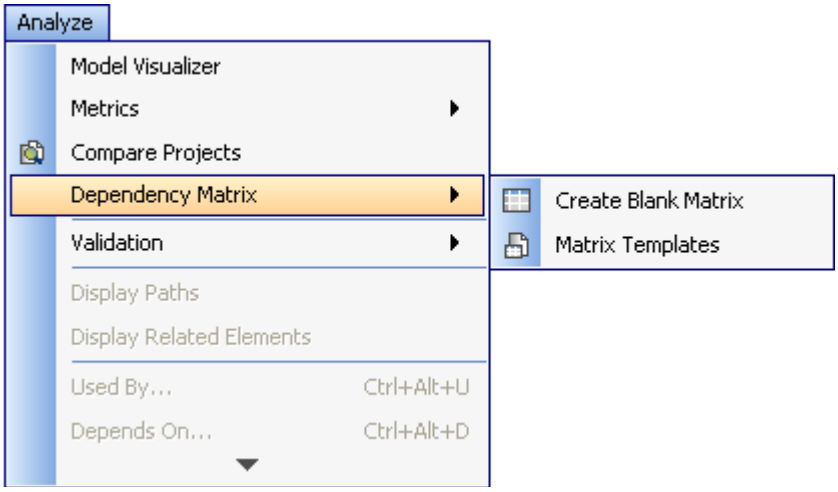


Figure 251 -- Opening Dependency Matrix from the Analyze Main Menu

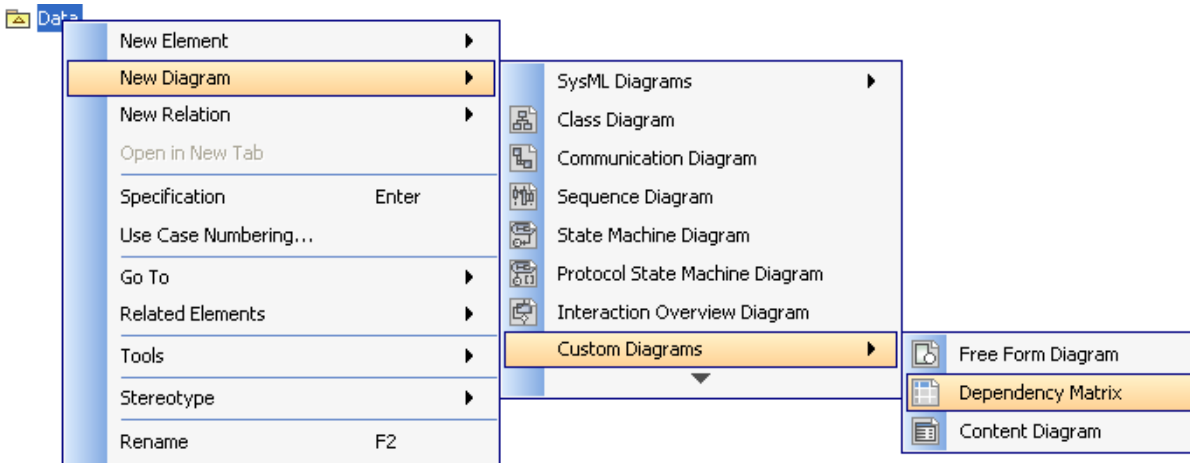


Figure 252 -- Opening Dependency Matrix from the Package Shortcut Menu in the Browser

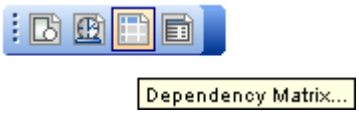


Figure 253 -- Dependency Matrix Button on the Custom Diagram Toolbar

10.2 Working with Dependency Matrix Templates

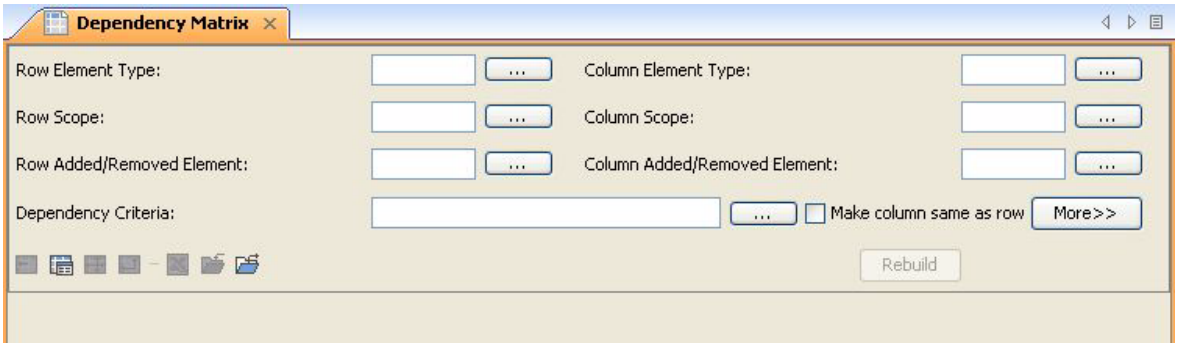


Figure 254 -- Dependency Matrix View

Matrix properties and filter configurations are stored in MagicDraw. The matrix configuration is called a matrix template. It is used for storing the configuration of a dependency matrix (filters and matrix properties) independently of a project. The configuration stored in a matrix template can then be used later or shared with your colleagues.

NOTE	• To create a new matrix template, it is easier for you to start with a pre-defined template. • The matrix template can be imported and exported as a file.

You can open a built-in matrix template by using either (i) the **Analyze** menu in the main menu, or (ii) the **Load Matrix Template** button in a dependency matrix view.

(i) To open a built-in matrix using the **Analyze** menu on the main menu:

1. Click **Analyze** > **Dependency Matrix** > **Matrix Templates** on the main menu. The **Dependency Matrix Templates** dialog will open.
2. Select a built-in matrix template, and then click **OK**.

(ii) To open a built-in matrix using the **Load Matrix Template** button in a dependency matrix view:

1. You must have a dependency matrix open.
2. Click the **Load Matrix Template** button  in the dependency matrix view. The **Load Matrix Template** dialog will open.
3. Select a built-in matrix template, and then click **OK**.

SysML Plugin provides four different dependency matrix templates:

- **SysML Allocation Matrix template**

  This template is used for creating a matrix to show ‘Allocation’ dependencies between clients in rows and suppliers in columns. Allocations can be used early in a design as precursors to more

detailed rigorous specifications and implementations. Allocation dependencies provide effective means for navigating your model by establishing cross relationships and ensuring the various parts of your model are properly integrated.

- **SysML Refine_Requirement Matrix template**

  This template is used for creating a matrix to show 'Refine' dependencies describing how a model element or a set of elements refine a requirement. For example, a use case or activity diagram may be used to refine a text-based functional requirement. Alternatively, it may be used to show how a text-based requirement refines a model element. In this case, some elaborated text could be used to refine a less fine-grained model element.

- **SysML Satisfy_Requirement Matrix template**

  This template is used for creating a matrix to show 'Satisfy' dependencies between requirements and model elements that fulfill the requirements. Each arrow direction points from the satisfying (client) model element to the satisfied (supplier) requirement.

- **SysML Verify_Requirement Matrix template**

  This template is used for creating a matrix to show 'Verify' dependencies between requirements and named elements that can determine whether the systems fulfill the requirements. Each arrow direction points from the (client) named element to the (supplier) requirement.

For more information on the Dependency Matrix feature, see the *Model Analysis* in the 'Dependency Matrix' section in the MagicDraw User Manual.

10.3 SysML Editable Matrices

Starting from version 16.6 of SysML Plugin, three of SysML matrix templates are editable. Beside display of dependencies between elements, you can add / delete dependency(ies) directly in the editable matrices.Therefore, SysML provides three different matrices: SysML Allocation Matrix, SysML Satisfy_Requirement Matrix and SysML Verify_Requirement Matrix.

10.3.1 SysML Allocation Matrix

The SysML Allocation Matrix consists of:

- Row: a named element that can be the client element of the Allocate dependency.
- Column: a named element that can be the supplier element of the Allocate dependency.

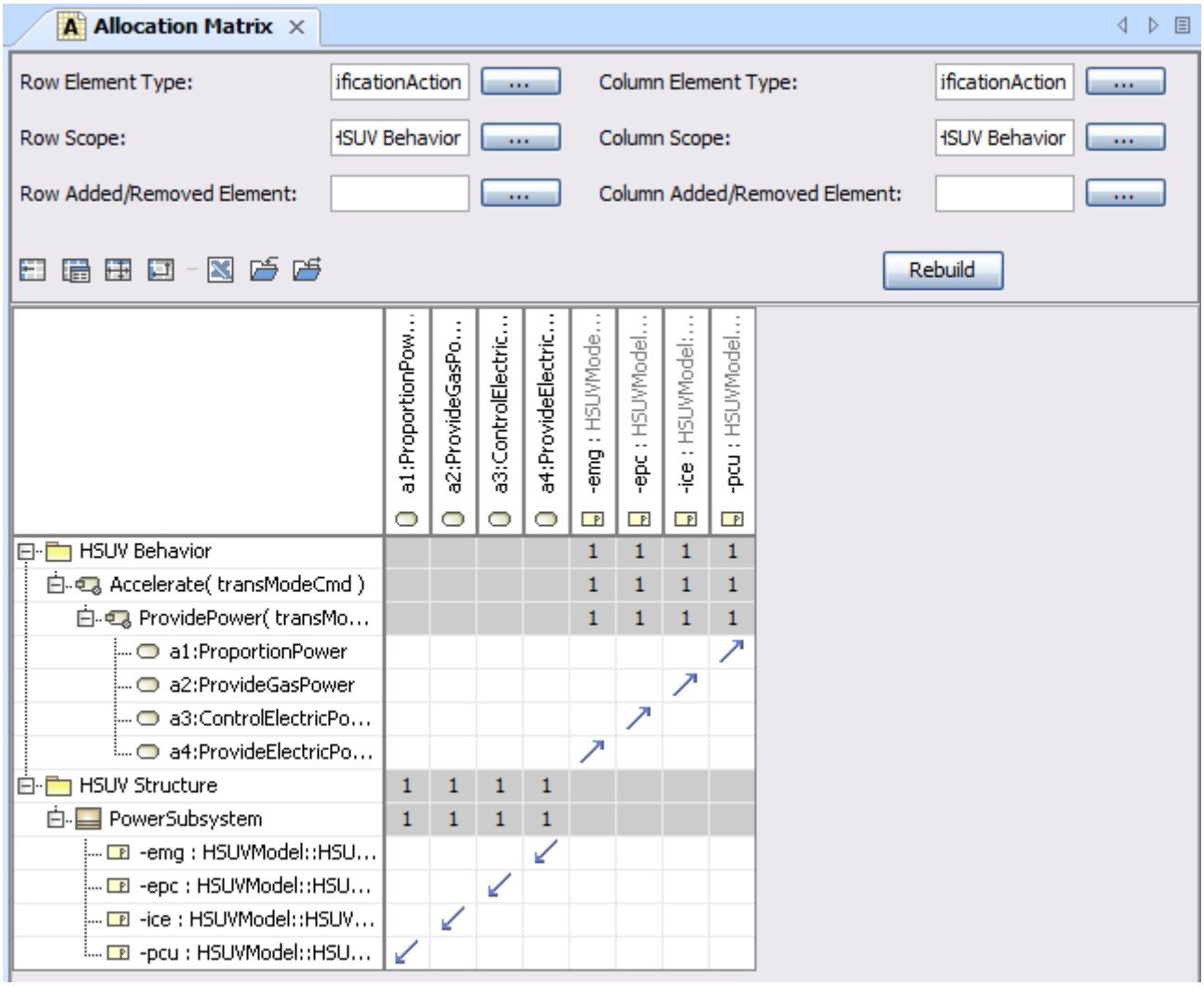


Figure 255 -- SysML Allocation Matrix

10.3.2 SysML Satisfy_Requirement Matrix

SysML Satisfy_Requirement Matrix consists of:

- Row: a named element that can be the client element of the Satisfy dependency.
- Column: a Requirement Element that can be the supplier element of the Satisfy dependency.

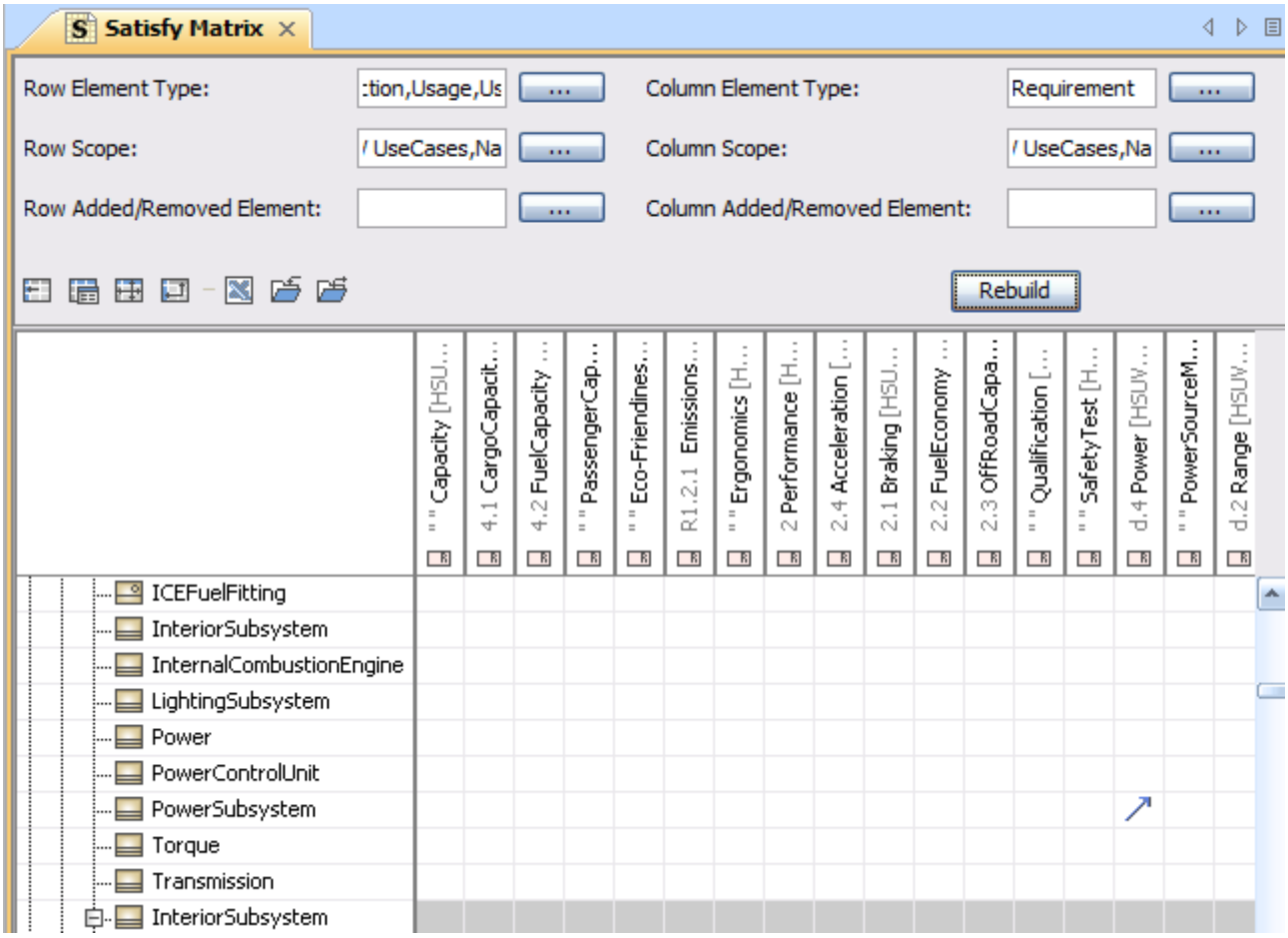


Figure 256 -- SysML Satisfy_Requirement Matrix

10.3.3 SysML Verify_Requirement Matrix

The SysML Verify_Requirement matrix consists of:

- Row: Named element which can be the client element of Verify dependency.
- Column: Requirement Element which can be the supplier element of Verify dependency.

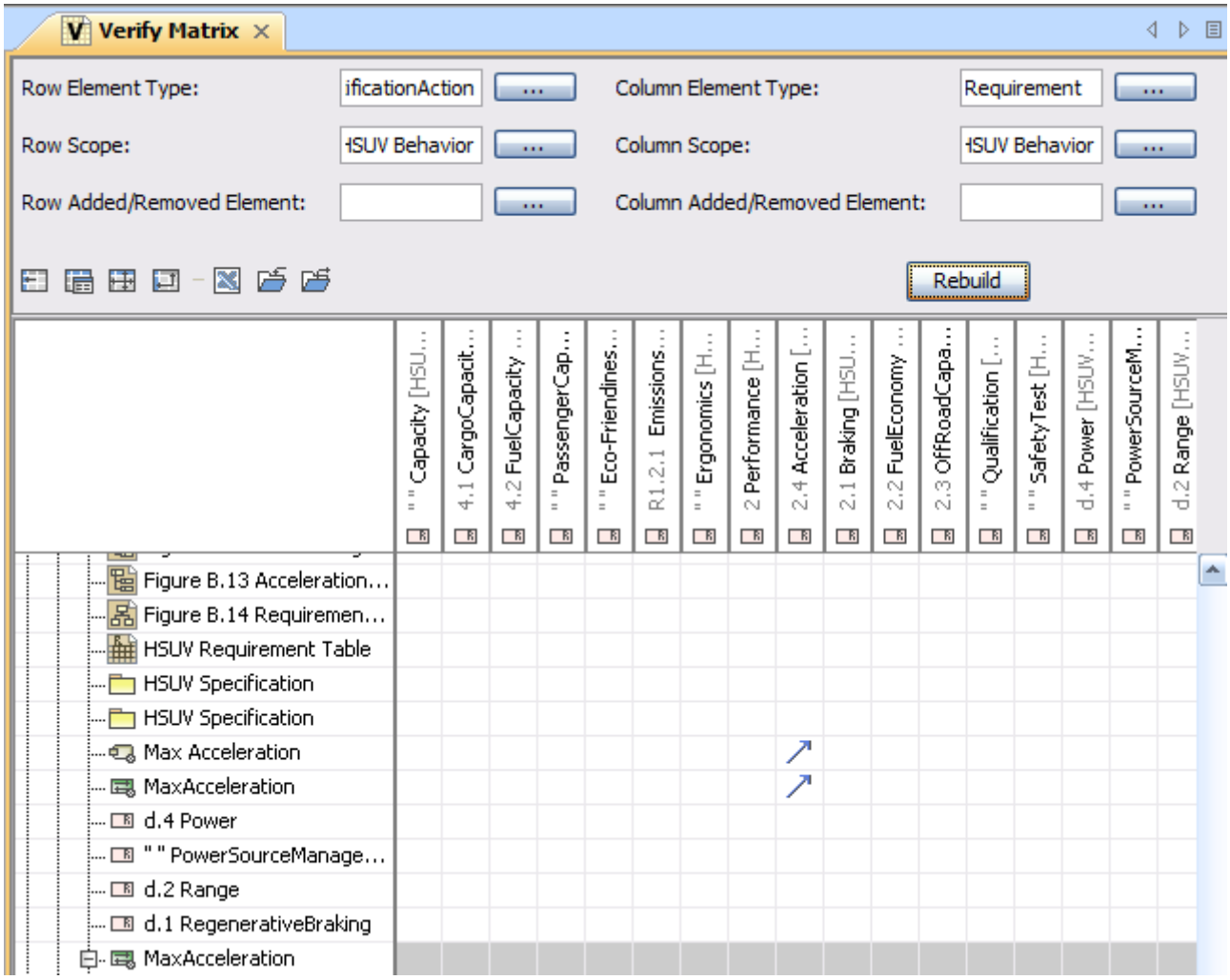


Figure 257 -- SysML Verify_Requirement Matrix

10.3.4 Creating SysML Editable Matrices

You can create SysML matrices by using either the (i) main toolbar, (ii) main menu, or (iii) Containment Tree.

(i) To create a SysML Editable Matrix using the main toolbar:

1. Click the icon of the editable matrix that you want to create on the main toobar (Figure 258):
   - SysML Allocation Matrix
   - SysML Satisfy_Requirement Matrix
   - SysML Verify_Requirement Matrix

   The **Create Diagram** dialog will open (Figure 259).

Figure 258 -- SysML Matrices Toolbar

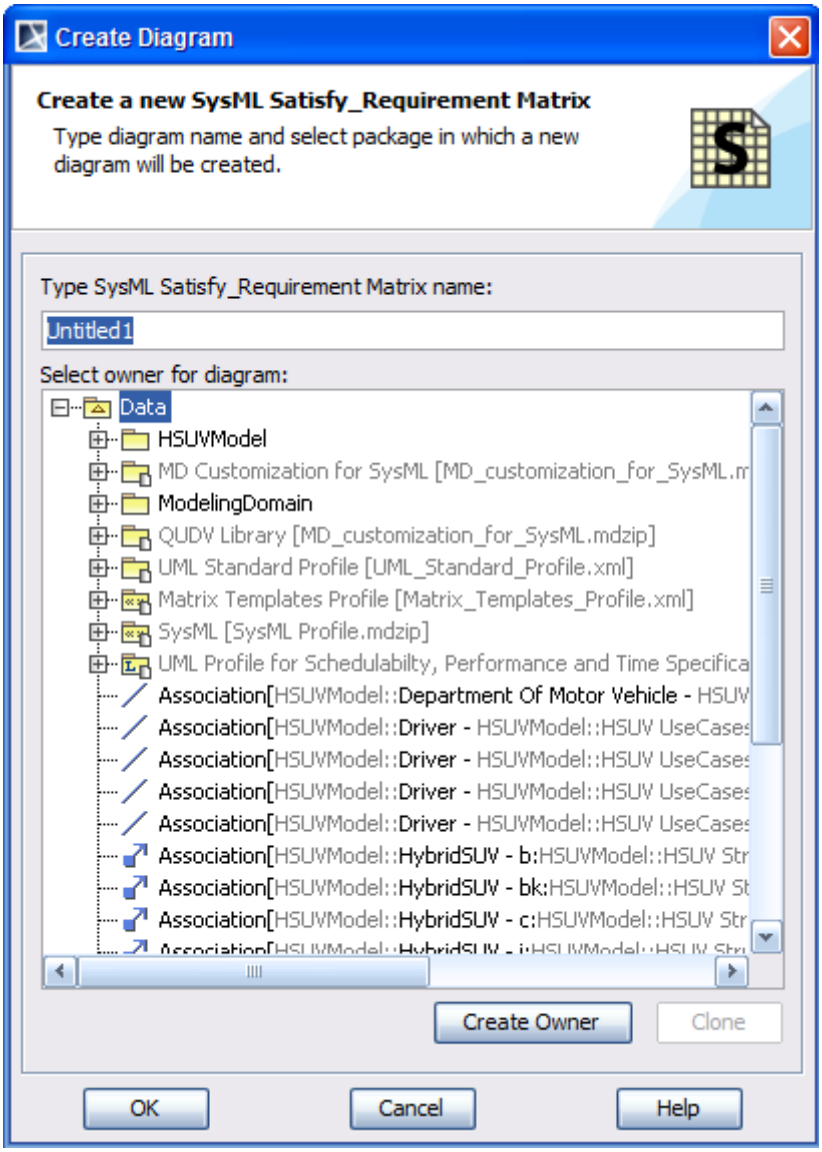


Figure 259 -- Create Diagram Dialog

2. Type the name of the editable matrix you want to create, and select its owner from the element tree.
3. Click **OK**.

(ii) To create a SysML Edtiable Matrix using the main menu:

1. Click **Diagram** > **SysML Matrices** on the main menu (Figure 260).
2. Select a SysML Edtiable Matrix that you want to create from the submenu (Figure 260).

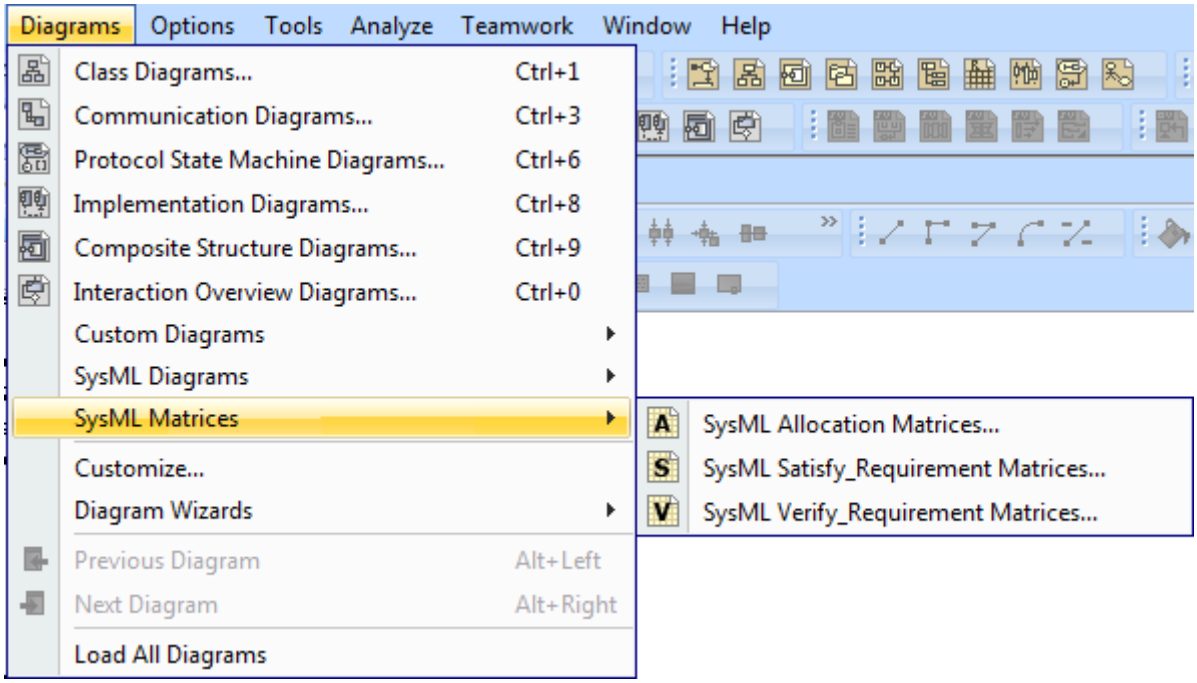


Figure 260 -- SysML Matrices Menu

3. A dialog of the selected matrix will open. For example, select **SysML Allocation Matrices...**, the **SysML Allocation Matrix** dialog will then open (Figure 261). Click the **Add** button in the dialog.

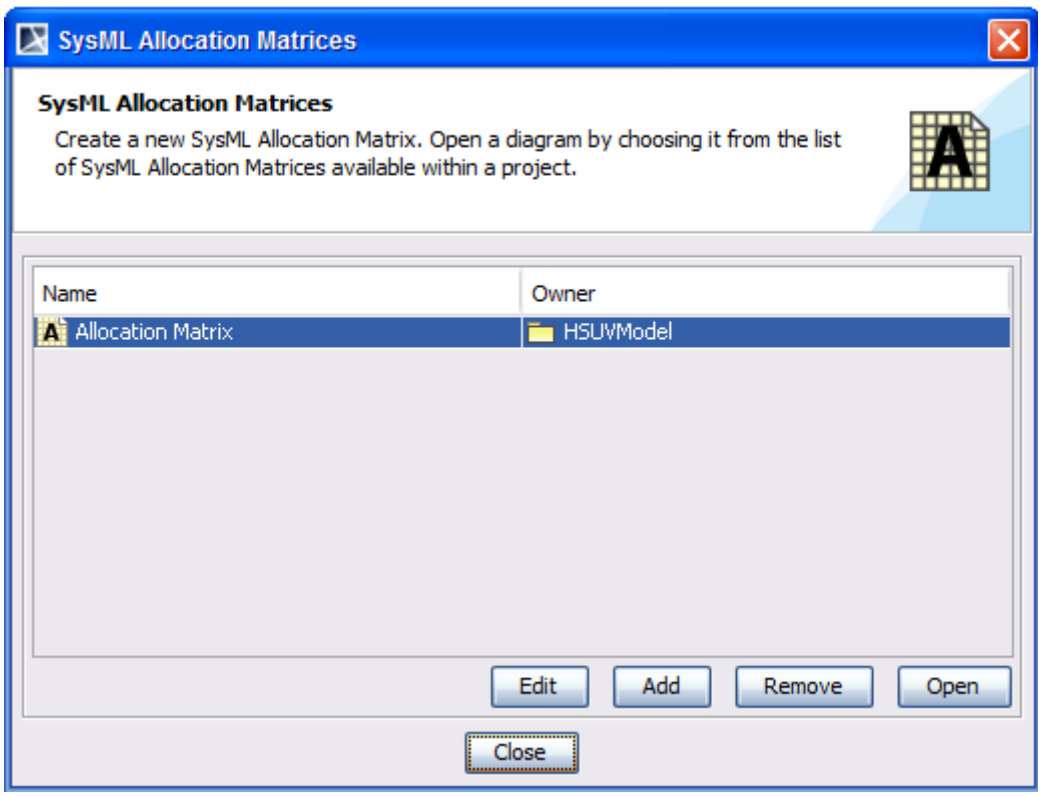


Figure 261 -- SysML Allocation Matrix Dialog

4. The **Create Diagram** dialog will open (Figure 259). Type the name of the editable matrix you want to create, and select its owner from the element tree.
5. Click **OK**.

(iii) To create a SysML Editable Matrix using the Containment Tree:

1. Right-click the element, which will be the owner of the SysML Editable Matrix, in the Containment Tree. The element shortcut menu will then display (Figure 262).

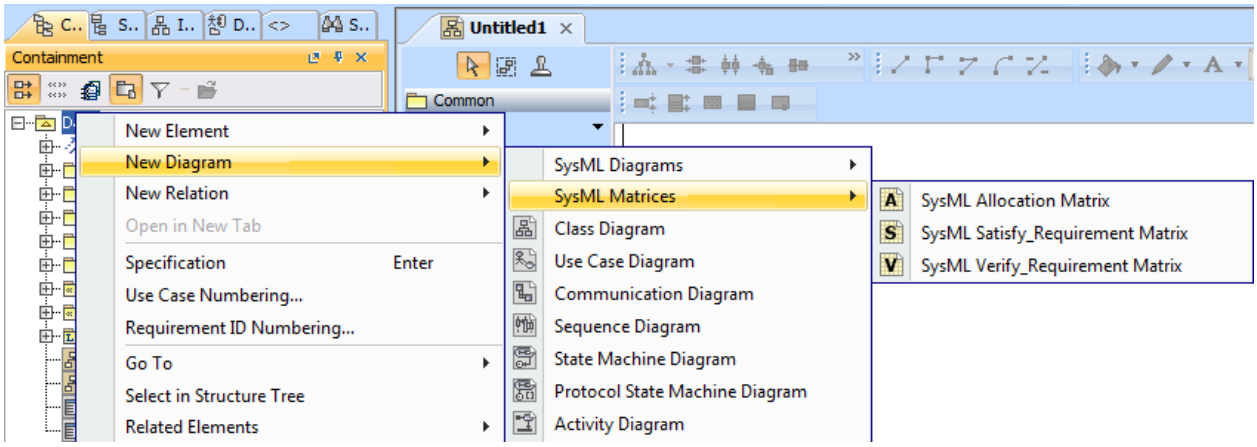


Figure 262 -- SysML Matrices Menu in Browser

2. In the shortcut menu, select **New Diagram** > **SysML Matrices**, and select a SysML Editable Matrix that you want to create on the submenu.
3. Type the name of the matrix in the Containment Tree.
4. Press **Enter** to finish.

10.3.5 Building Matrices

The matrices you have created in Section 10.3.4 (Creating SysML Editable Matrices) are empty matrices. To build a complete matrix, you must also provide the row and column scopes of the matrix. All valid elements in the selected scope will be used to build the matrix.

To select the row and column scopes of a matrix:

1. Click the **...** button next to the **Row Scope** in the matrix pane (Figure 263). The **Scope** dialog will open (Figure 264).

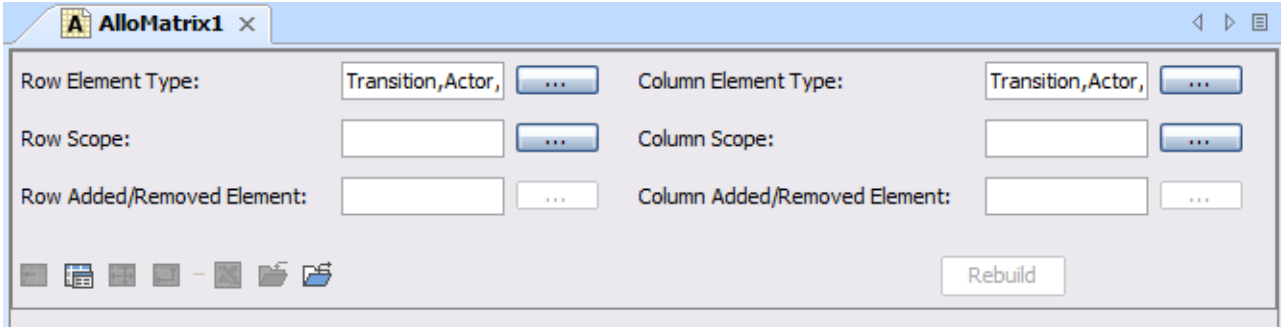


Figure 263 -- Scope Button

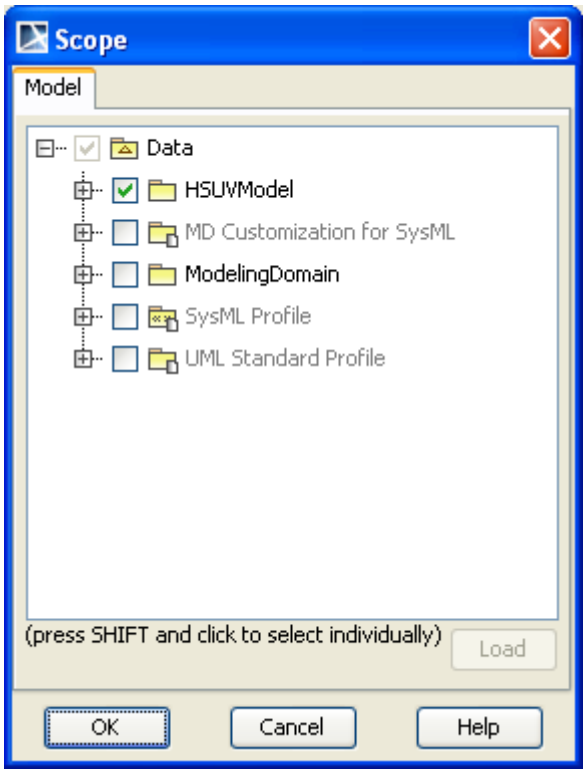


Figure 264 -- Scope Dialog

2. Select the check box(es) in front of the packages, models, or profiles that will be the row scope.
3. Click **OK** to close the **Scope** dialog.
4. Click the **...** button next to the **Column Scope** in the matrix pane (Figure 263). The **Scope** dialog will open (Figure 264).
5. Select the check box(es) in front of the packages, models, or profiles that will be the column scope.
6. Click **OK** to close the **Scope** dialog.
7. Click the **Rebuild** button.

10.3.6 Editing Matrix

You can create or remove dependencies directly in an editable matrix. Double-click on an empty rectangle in the matrix to create a new dependency, or double-click an existing dependency in the matrix to remove it.

(i) Creating New Dependencies

You can create a corresponding dependency of each matrix directly in the matrix by double-clicking on the intersection of the row and column elements. The row and column elements will become the client and supplier elements of the created dependency respectively.

Another way to create a dependency is by right-clicking on the intersection of the row and column elements. Then, select **New Relation > Outgoing**, and select the dependency you would like to create (Figure 265).

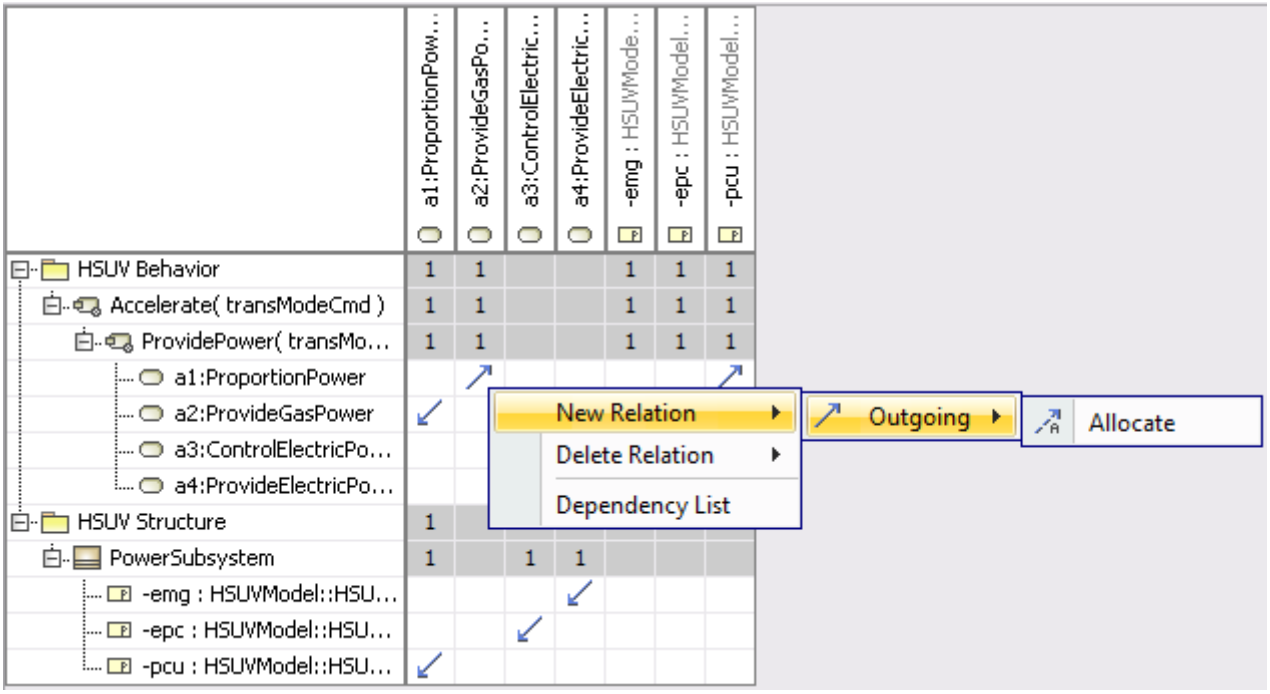


Figure 265 -- Editable Matrix Context Menu

(ii) Removing Existing Dependencies

You can also remove an existing dependency of each matrix by double-clicking on that particular dependency that you want to remove.

Another way to remove a dependency is by right-clicking on the intersection of the row and column elements. Then, select **Delete Relation**, and select the dependency you would like to delete (Figure 265).

(iii) Dependency List

You can view a list of dependencies associated with a cell in an editable matrix by right-clicking on the cell, and then select **Dependency List** from the context menu (Figure 265). The Dependency List dialog will then display (Figure 266).

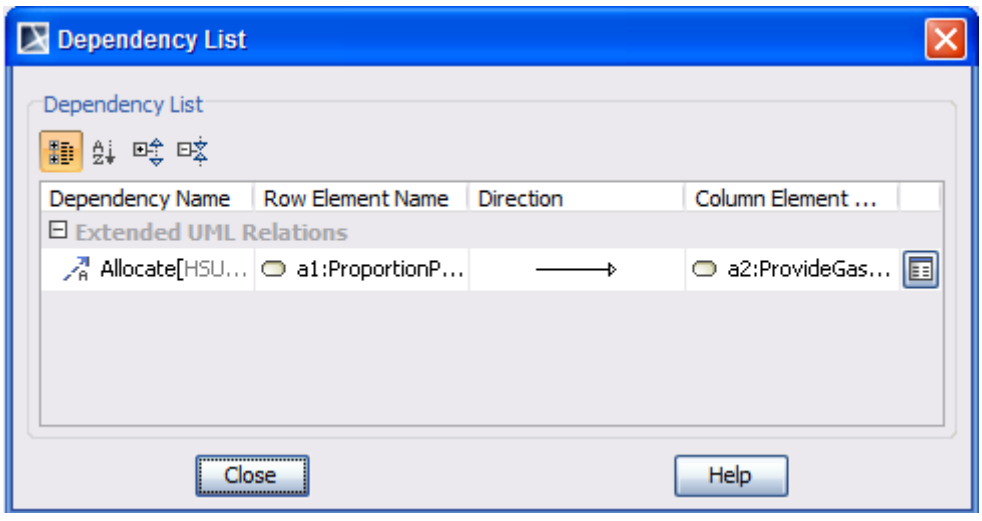


Figure 266 -- Dependency List Dialog

11. Teamwork

11.1 Working with Teamwork Project

MagicDraw Teamwork Server allows you to work simultaneously on the same project (a teamwork project) using multiple workstations. Teamwork Server also provides you with a **user access control** mechanism, together with **versioning** ability.

Once a teamwork project is stored on Teamwork Server, it can be shared with multiple MagicDraw applications at the same time.

NOTE	• To use Teamwork Server with MagicDraw SysML, the Teamwork Server version must be the same as the MagicDraw version. • To be able to completely work with a teamwork project, you must obtain a permission; either System-level 'Edit model' permission, or Project-level 'Edit model' permission for that project.

To work with a Teamwork project:

1. Select **Login** on the Teamwork main menu to log in to Teamwork Server (Figure 267).

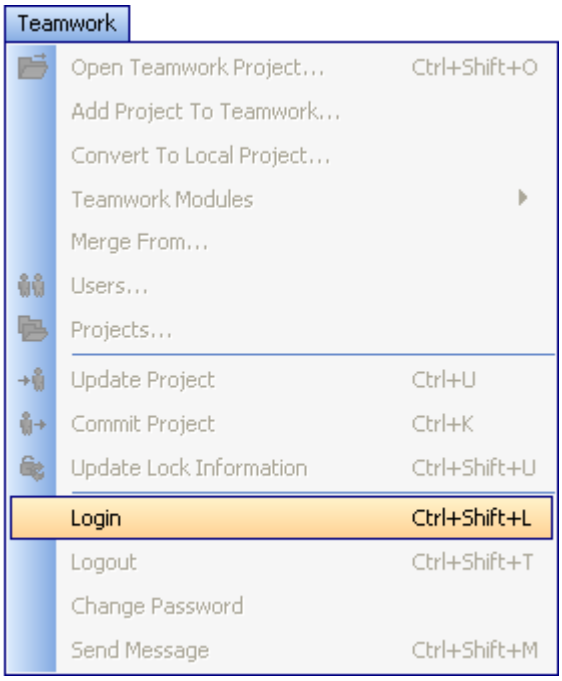


Figure 267 -- TeamWork Main Menu

2. Enter your Username, Password, and the Teamwork Server name (**IPaddress:portNumber** or just **IPaddress** if the port number is 1100 (default)) in the **Login** dialog.
3. Create or open a Teamwork project.
4. **Lock for edit** elements before editing or deleting them.
5. Commit the changed project. Before committing a project, select the locked elements to commit the change. The elements that are committed will be automatically unlocked.

For more information on Teamwork Server, see the MagicDraw TeamWork User Guide.

12. Report Wizard and Template

This section contains only introductory information about the Report Wizard and SysML report templates. For detailed information on how to use the Report Wizard engine, see the MagicDraw Report Wizard user guide.

12.1 Report Wizard

To launch Report Wizard:

1. Click **Tools** > **Report Wizard…** on the main menu (Figure 268). The **Report Wizard** dialog will open (Figure 269).

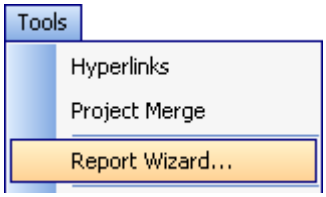


Figure 268 -- Report Wizard Menu

2. The following nine built-in SysML report templates will appear in the **Report Wizard** dialog (Figure 269):

- Requirement Diagram
- Requirement Table (Type A)
- Requirement Table (Type B)
- Requirement Report
- Coverage Analysis
- Requirement Dependencies Report
- Requirements Table Diagram Report
- Allocation Table (Type A)
- Allocation Table (Type B)
- Allocation Table (Type C)

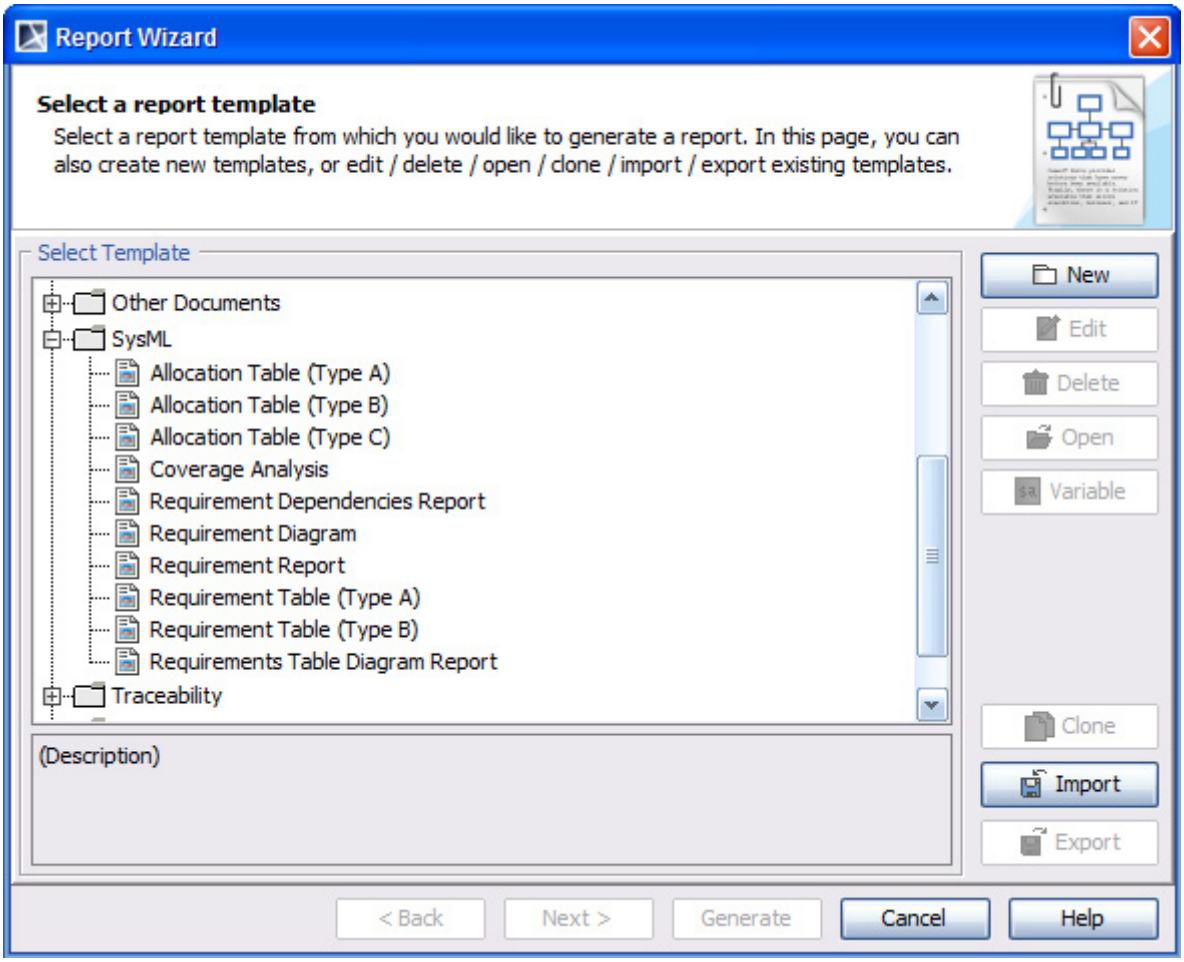


Figure 269 -- Report Wizard Dialog - Template Selection

To create a report using a SysML report template:

1. Select a report template and click **Next** in the **Report Wizard** dialog (Figure 269). The **Select Report Data** pane will open. You can then select a pre-defined report data for the selected template (default = Built-in) in Figure 270.

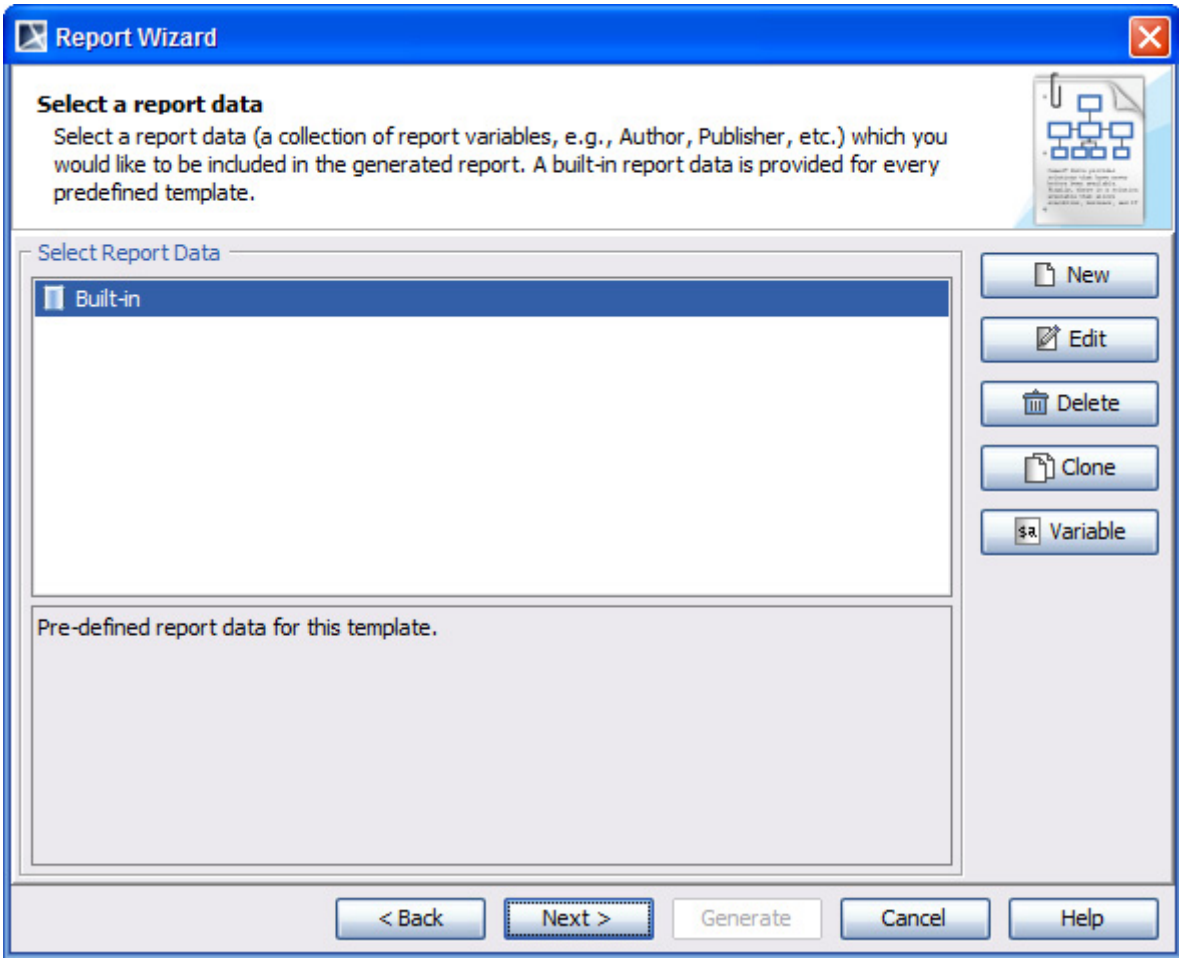


Figure 270 -- Report Wizard Dialog - Pre-defined Report Data Selection

2. You can modify the introductory information of a report, i.e. **Variables** (formerly called “User Defined Fields”), by clicking the **Variable** button on the **Select Report Data** pane (Figure 270). The **Variables** dialog will then display (Figure 271). You can then add/modify the variableof the report to be generated, such as author, company name, company address, report purpose, report scope, etc. This information will appear in the report generated.

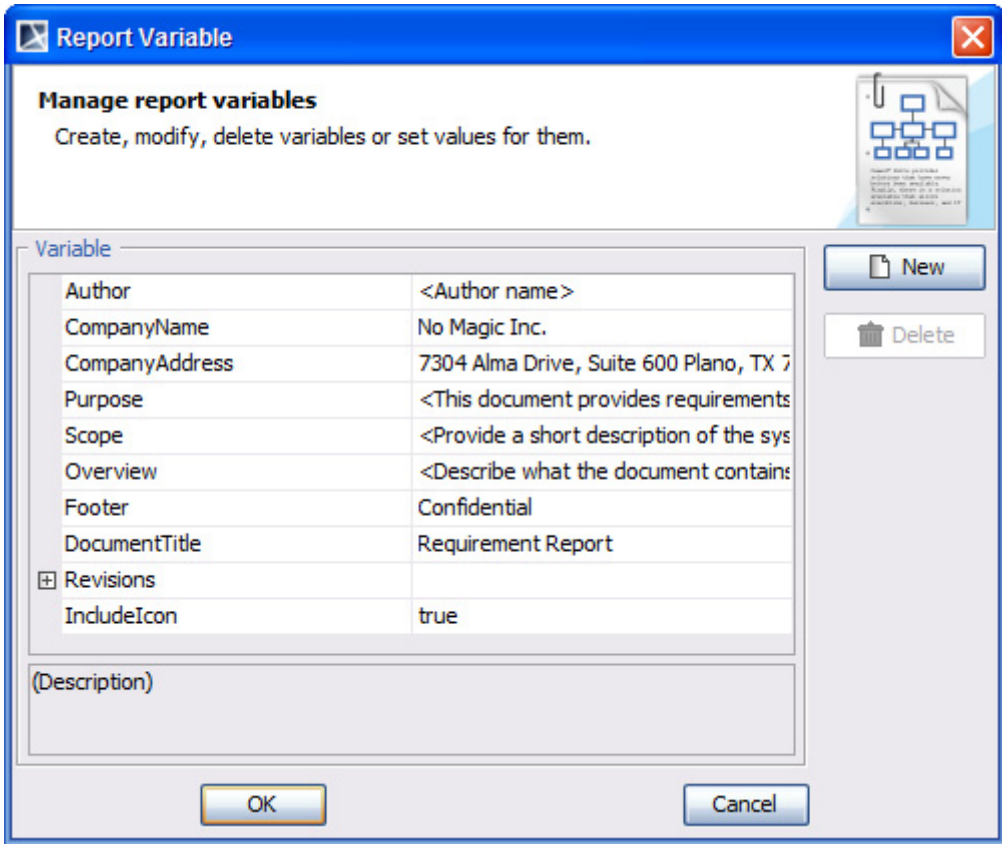


Figure 271 -- Report Wizard Dialog - Variable

3. Click **OK** to return to the **Select Report Data** pane (Figure 270). In the **Select Report Data** pane, click **Next**. The **Select Element Scope** pane will then display (Figure 272).

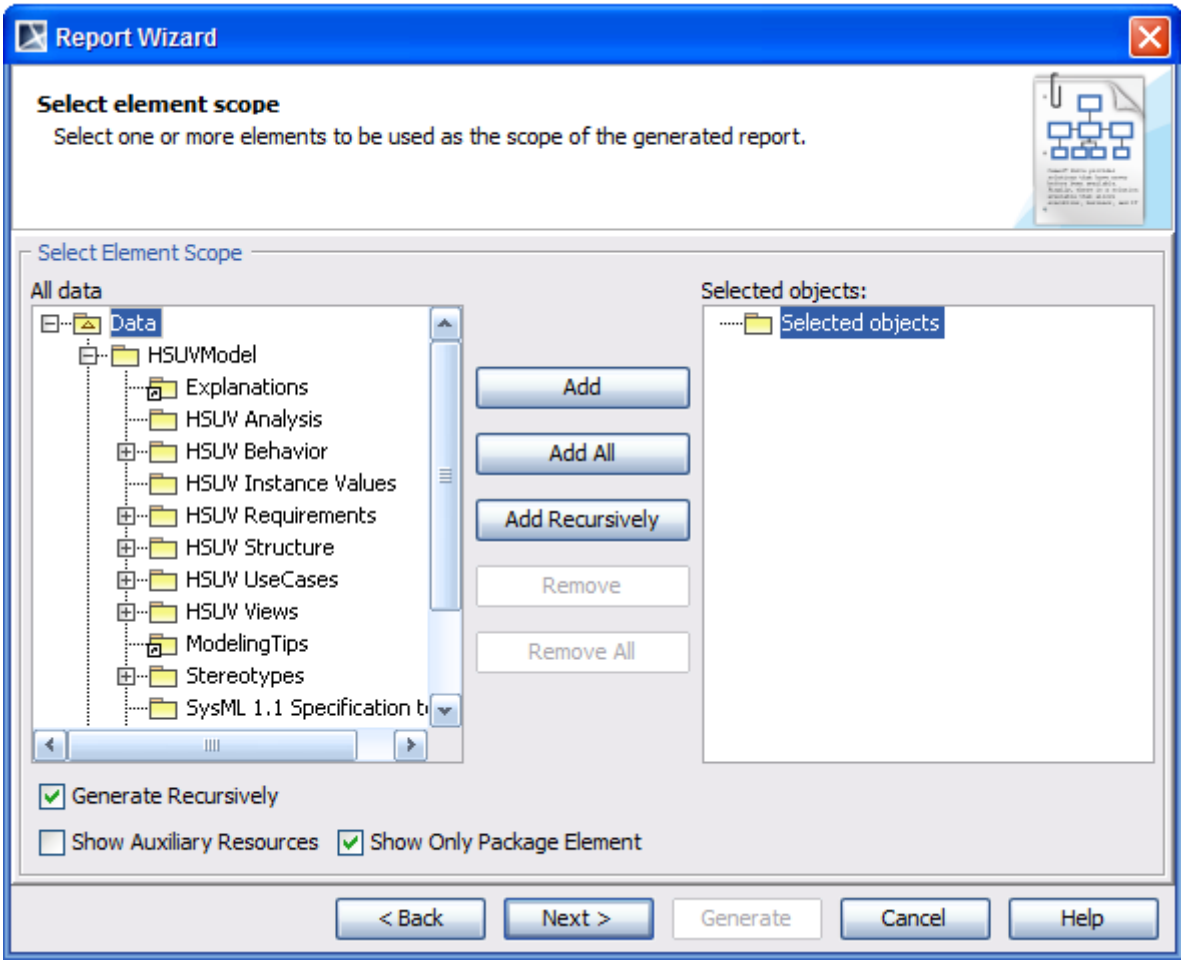


Figure 272 -- Report Wizard Dialog - Select Element Scope

4. In the **Select Element Scope** pane:
   - Use the **Add** button in Figure 272 to add an element selected in the element tree to the **Selected objects** pane.
   - Use the **Add All** button in Figure 272 to add all elements directly owned by the element selected in the element tree to the **Selected objects** pane.
   - Use the **Add Recursively** button in Figure 272 to add all elements listed under the element selected in the element tree to the **Selected objects** pane.
   - Use the **Remove** button in Figure 272 to remove the selected element from the **Selected objects** pane.
   - Use the **Remove All** button in Figure 272 to remove all selected elements from the **Selected objects** pane.

NOTE	To add all elements under a package to the report, select the package in the element tree, and then click **Add Recursively** (Figure 272).

5. After the scope of the report is defined, click **Next** to proceed to the **Output Options** pane (Figure 273).

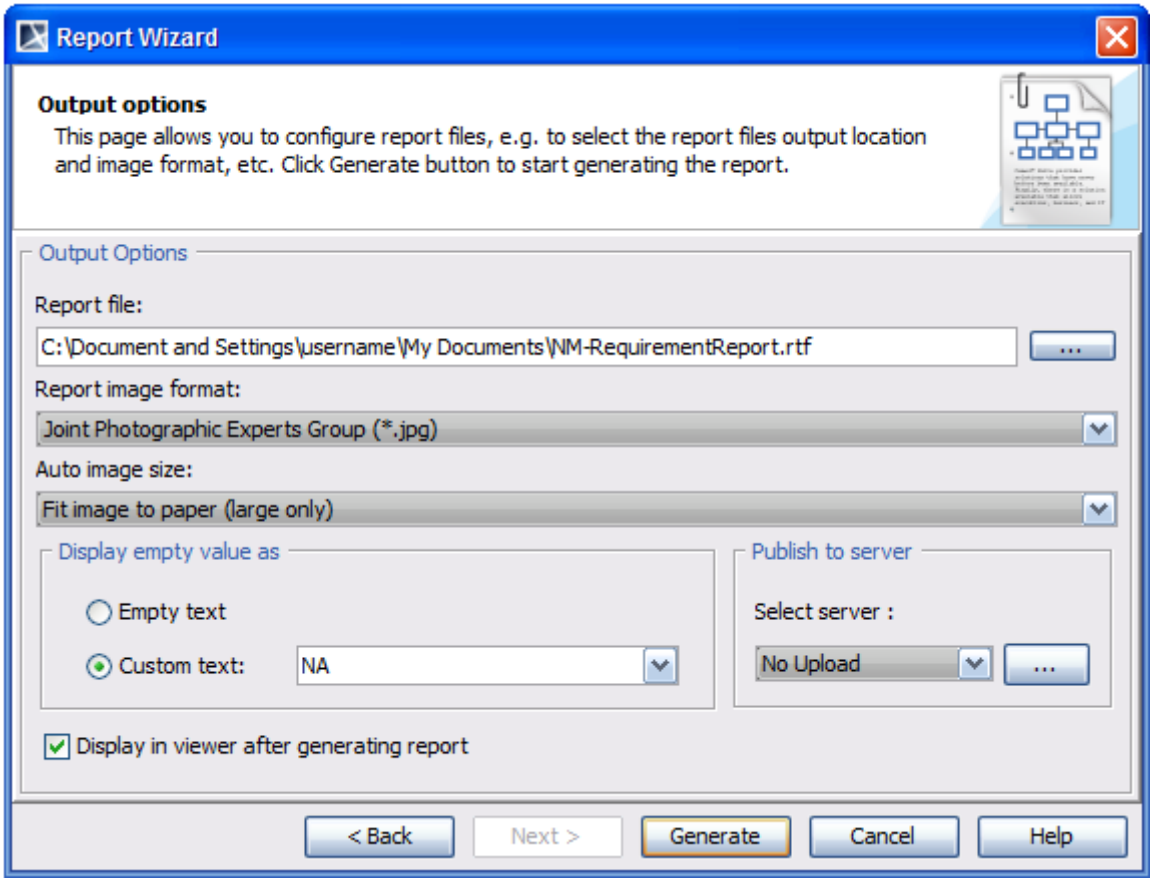


Figure 273 -- Report Wizard Dialog - Output Options

6. Specify the report file name, report file format, and image file format (Figure 273). It is recommended to use RTF as the report file format.
7. Click **Generate** to create the report (Figure 273). Your report will then be generated. Once generated, it will automatically open in the default document editor.

See the MagicDraw Report Wizard user guide for more information on this Report Wizard dialog.

12.2 Requirement Report Templates

Use a Requirement Report template to generate a Requirement report that provides a summary of the requirement modeling in a SysML project. You can generate a Requirement report on the whole project or on some specific elements selected from the **Report Wizard** dialog. There are six built-in Requirement Report templates:

(12.2.1) Requirement Diagram

(12.2.2) Requirement Table (Type A)

(12.2.3) Requirement Table (Type B)

(12.2.4) Requirement Report

(12.2.5) Coverage Analysis

(12.2.6) Requirement Dependencies Report

(12.2.7) Requirements Table Diagram Report

12.2.1 Requirement Diagram

Use this report template to generate basic reports for SysML requirements. Requirement Diagram reports provide Requirement diagrams and tables describing the elements in the diagrams (Figure 274).

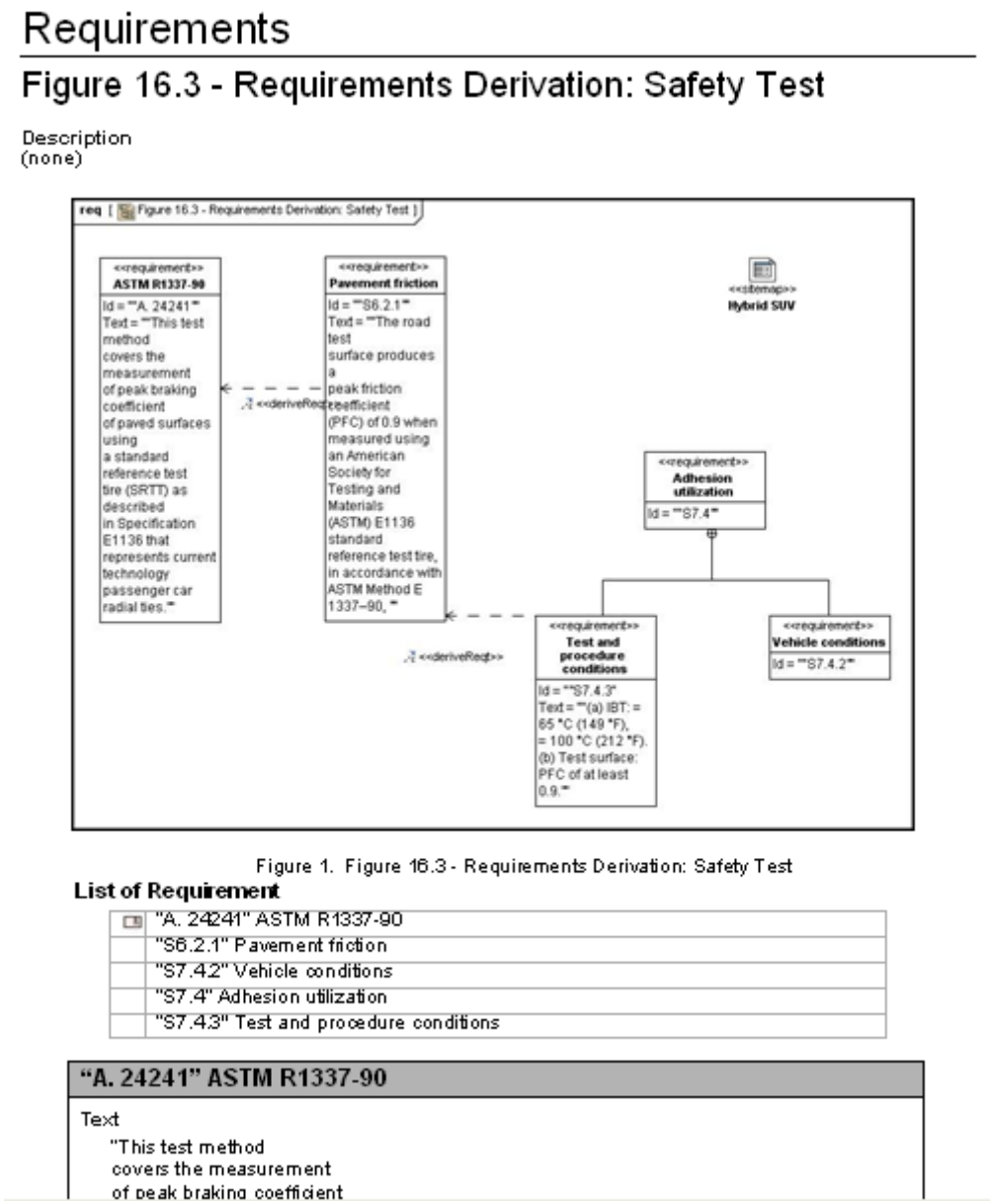
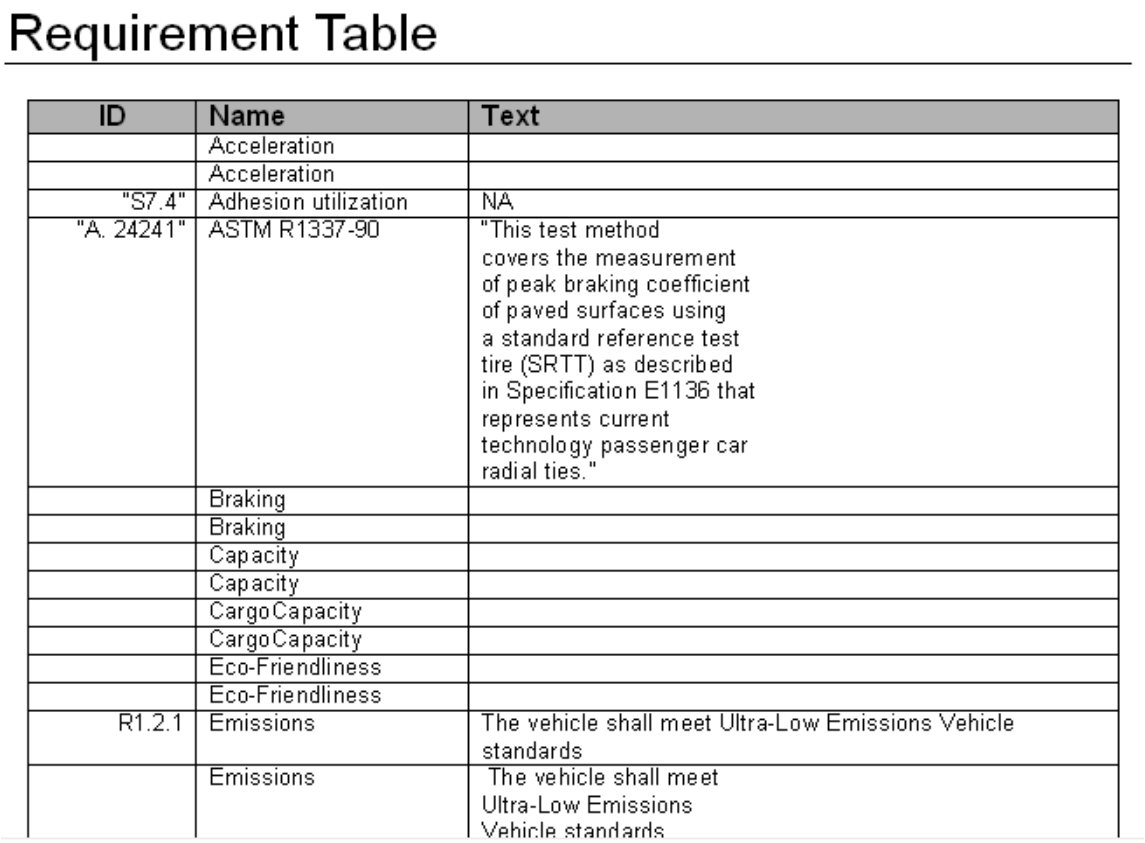


Figure 274 -- Example of Requirement Diagram Report

12.2.2 Requirement Table (Type A)

Use this report template to generate basic SysML Requirement reports in a tabular format. Each table shows the requirements with their properties including the requirement ID, Name, and Text (Figure 275).

This table shows only the requirements with their properties including the requirement ID, requirement name, and requirement text.



Requirement Table

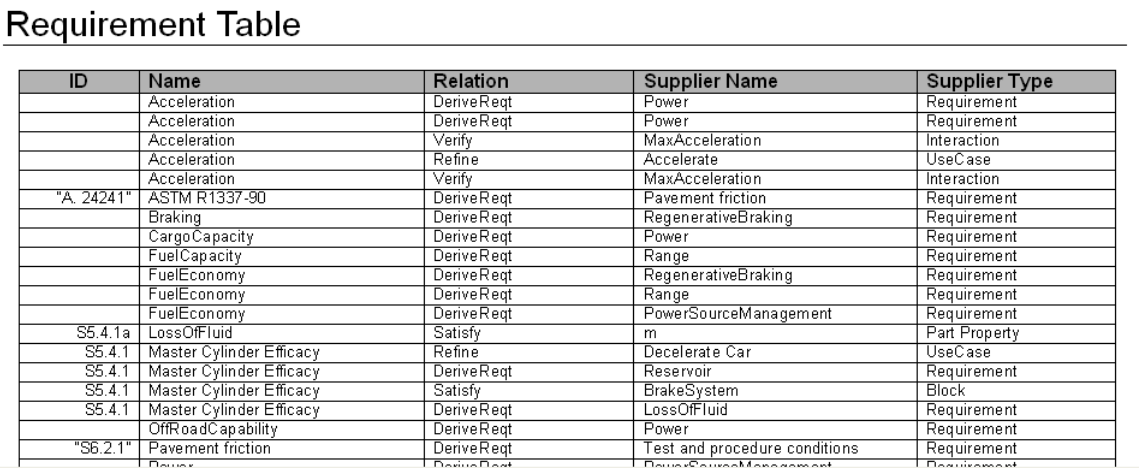
ID	Name	Text
	Acceleration	
	Acceleration	
"S7.4"	Adhesion utilization	NA
"A. 24241"	ASTM R1337-90	"This test method covers the measurement of peak braking coefficient of paved surfaces using a standard reference test tire (SRTT) as described in Specification E1136 that represents current technology passenger car radial ties."
	Braking	
	Braking	
	Capacity	
	Capacity	
	CargoCapacity	
	CargoCapacity	
	Eco-Friendliness	
	Eco-Friendliness	
R1.2.1	Emissions	The vehicle shall meet Ultra-Low Emissions Vehicle standards
	Emissions	The vehicle shall meet Ultra-Low Emissions Vehicle standards

Figure 275 -- Example of Requirement Table A Report

12.2.3 Requirement Table (Type B)

Use this report template to generate SysML Requirement reports in another specific tabular format. Each table shows the requirements and their dependency relationships with other requirements (Figure 276).

This table is similar to the one in OMG SysML specifications.



Requirement Table

ID	Name	Relation	Supplier Name	Supplier Type
	Acceleration	DeriveReqt	Power	Requirement
	Acceleration	DeriveReqt	Power	Requirement
	Acceleration	Verify	MaxAcceleration	Interaction
	Acceleration	Refine	Accelerate	UseCase
	Acceleration	Verify	MaxAcceleration	Interaction
"A. 24241"	ASTM R1337-90	DeriveReqt	Pavement friction	Requirement
	Braking	DeriveReqt	RegenerativeBraking	Requirement
	CargoCapacity	DeriveReqt	Power	Requirement
	FuelCapacity	DeriveReqt	Range	Requirement
	FuelEconomy	DeriveReqt	RegenerativeBraking	Requirement
	FuelEconomy	DeriveReqt	Range	Requirement
	FuelEconomy	DeriveReqt	PowerSourceManagement	Requirement
S5.4.1a	LossOfFluid	Satisfy	m	Part Property
S5.4.1	Master Cylinder Efficacy	Refine	Decelerate Car	UseCase
S5.4.1	Master Cylinder Efficacy	DeriveReqt	Reservoir	Requirement
S5.4.1	Master Cylinder Efficacy	Satisfy	BrakeSystem	Block
S5.4.1	Master Cylinder Efficacy	DeriveReqt	LossOfFluid	Requirement
	OffRoadCapability	DeriveReqt	Power	Requirement
"S6.2.1"	Pavement friction	DeriveReqt	Test and procedure conditions	Requirement
	Power	DeriveReqt	PowerSourceManagement	Requirement

Figure 276 -- Example of Requirement Table B Report

12.2.4 Requirement Report

Use the Requirement Report template to generate a requirement report of the selected requirement elements. A Requirement Report template will show the properties of all selected requirements (Figure 277).

Figure 277 -- Sample of Requirement Report Template

The content in this kind of report contains:

- (i) Category of Information Generated from Requirements
- (ii) Requirements Sort in Reports
- (iii) Anchored Elements of Requirement
- (iv) Appendix A for Captured Diagram Images
- (v) Hyperlinks in Generated Reports

(i) Category of Information Generated from Requirements

Information generated from each selected requirement can be categorized into five sections:

- (a) Heading section
- (b) Text description section
- (c) Documentation section
- (d) Requirement properties section
- (e) Requirement related element section

(a) Heading section

This section contains a requirement heading that consists of a requirement ID number and name.

(b) Text description section

This section contains a text property that describes the requirement.

(c) Documentation section

This section consists of documentation, hyperlinks, and texts of anchored elements to the requirement.

(d) Requirement properties section

This section will contain properties such as Master, Risk, Source, VerifyMethod, and also additional tags of user defined requirement stereotypes.

(e) Requirement related element section

This section will show model elements that are related to the requirement.

(ii) Requirements Sort in Reports

Requirements in reports will be arranged in the requirements hierarchy starting with the package that contains the selected requirements. The heading section, which contains sub packages and requirements, will be labeled with the package name. The requirements in the same level will be sorted by their ID numbers.

(iii) Anchored Elements of Requirement

Notes and comments, which are anchored to a selected requirement, will also be shown in the generated report. Comment elements will be grouped by the applied stereotype, for example, Rationale or Problem.

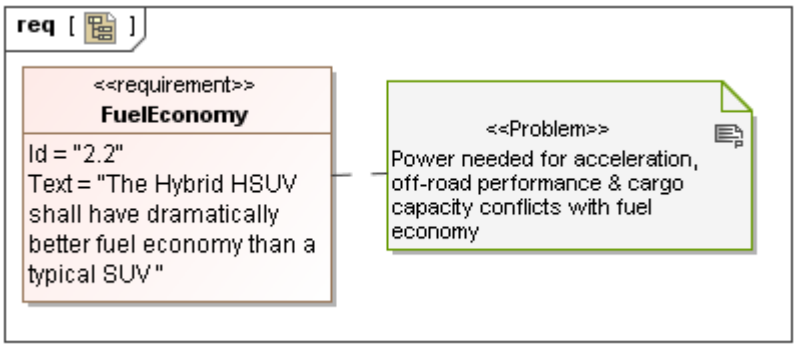


Figure 278 -- Fuel Economy Requirement Anchored by Problem Element

2.2 FuelEconomy

The Hybrid HSUV shall have dramatically better fuel economy than a typical SUV

Problems:

Power needed for acceleration, off-road performance & cargo capacity conflicts with fuel economy

Figure 279 -- Generated Text of Problem Element in the Report

An image object, which is anchored to the anchored comment element of the requirement, will be captured into the report document under the anchored comment element text.

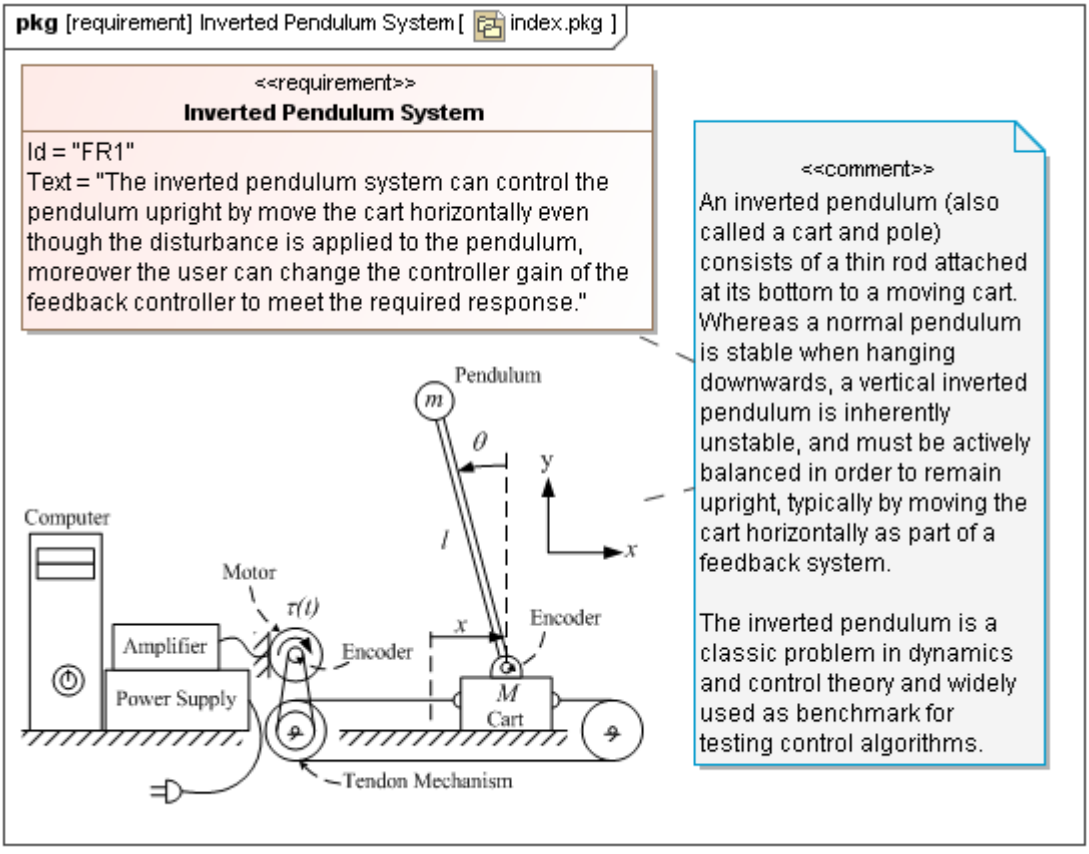


Figure 280 -- Image Object Anchored to the Comment Element of Requirement

InvertedPendulum
Date: July 17, 2009

Requirement Report
Revision: 1.0

FR1 Inverted Pendulum System

The inverted pendulum system can control the pendulum upright by move the cart horizontally even though the disturbance is applied to the pendulum, moreover the user can change the controller gain of the feedback controller to meet the required response.

Comment:

An inverted pendulum (also called a cart and pole) consists of a thin rod attached at its bottom to a moving cart. Whereas a normal pendulum is stable when hanging downwards, a vertical inverted pendulum is inherently unstable, and must be actively balanced in order to remain upright, typically by moving the cart horizontally as part of a feedback system.

The inverted pendulum is a classic problem in dynamics and control theory and widely used as benchmark for testing control algorithms.

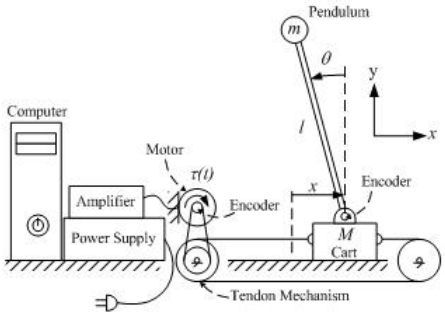


Figure1.Inverted Pendulum System Image

Figure 281 -- Generated Report with Generated Image Object

(iv) Appendix A for Captured Diagram Images

If the elements generated in the document have hyperlinks to diagrams, the diagrams will be captured and given in Appendix A: Diagrams.

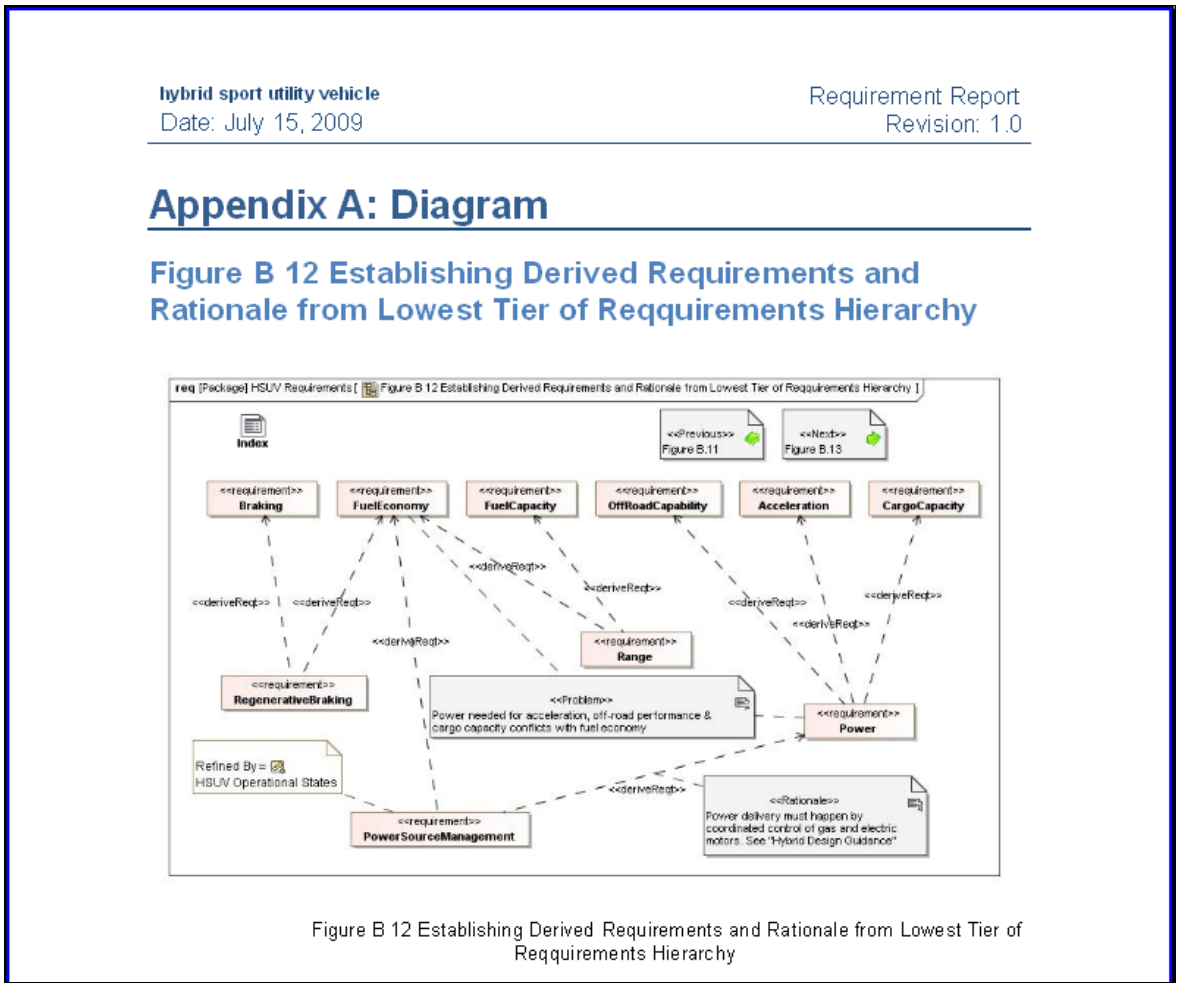


Figure 282 -- Sample of Appendix A: Diagrams

(v) Hyperlinks in Generated Reports

If the text of related elements generated in the document is a requirement element, a hyperlink will be created for navigating to the section that contains the information of the related requirement. For a non-requirement element that has an active hyperlink to a diagram, a hyperlink text will be generated for the element and will navigate to the captured image of the diagram in the appendix.

As for the generated text of an hyperlink that links to a diagram, the diagram will be captured as an image and given in the appendix of the generated document. Then the hyperlink text is then generated to navigate to the captured image of the diagram.

12.2.5 Coverage Analysis

This report lists the elements for coverage analysis at higher and lower levels of abstraction. Coverage analysis is indicated by traceability properties pointing to higher level of abstraction (Specification) and lower level of abstraction (Realization) elements, providing visibility of other related elements. This section allows you to visualize and verify that Analysis, Design, and Implementation model elements are well covered.

Coverage Analysis

The report section lists the elements for coverage analysis at higher and lower levels of abstraction. Not covered parts for verification of implementation completeness and redundant artifacts are indicated in this report.

Coverage analysis is indicated by traceability properties pointing to higher level of abstraction (Specification) and lower level of abstraction (Realization) elements, providing visibility of other related elements.

The main objective of this report is to visualize and verify that Analysis, Design, and Implementation model elements are all covered. For example, all requirements are covered with at least one test case to verify them.

Note: MagicDraw can automatically create advanced tables presenting the impact of a change on a set of artifacts at any level in the development process.

Forward Traceability – Realization

Forward traceability ensures that all specified requirements are implemented.

Realizing Requirements for Leaf Requirements

The Realizing Requirements property of a Requirement shows how the Requirement is directly realized by other Requirement(s) in lower level of abstraction. Requirements are connected through one of the relations: Refine, Derive, Copy, Ownership.

The All Realizing Requirements property of a Requirement shows how the Requirement is directly/indirectly realized by other Requirement(s) in all lower levels of abstraction.

The following table demonstrates leaf Requirements' coverage by other requirements, where a leaf Requirement refers to the Requirement which does not own any Requirement.

Leaf Requirements	Realizing Requirements	All Realizing Requirements
2.4 Acceleration [HSUVModel::HSUV Requirements::HSUV Specification::Performance]	d.4 Power [HSUVModel::HSUV Requirements]	NA PowerSourceManagement d.4 Power
2.1 Braking [HSUVModel::HSUV Requirements::HSUV Specification::Performa	d.1 RegenerativeBraking [HSUVModel::HSUV Requirements]	d.1 RegenerativeBraking

Figure 283 -- Sample of Appendix B: Coverage Analysis

12.2.6 Requirement Dependencies Report

Use the Requirement Dependencies template to generate reports showing the properties of the related requirement elements in a specific scope. The properties are Master, Derived From, Refined By, Satisfied By, Traced To, and Verified By. The content in this kind of report contains:

(i) Dependency Table

(ii) Appendix for Requirements Text Table

(iii) Appendix for Captured Diagram Images

(iv) Hyperlinks in Generated Reports

(i) Dependency Table

They will be categorized in the table of related dependencies. The requirement Dependencies template can generate six tables:

(a) Copy Table

(b) Derive Table

(c) Refine Table

(d) Satisfy Table

(e) Trace Table

(f) Verify Table

(a) Copy Table

The Copy table shows the requirement and its master requirement. The table consists of three columns: (a) ID, (b) Name, and (c) Master respectively. Requirements in this table will be sorted by the requirement ID.

- (a) ID: This column shows the requirement ID of the copied requirement, which is the client of the **Copy** dependency.
- (b) Name: This column shows the name of the copied requirement (the client of the **Copy** dependency).
- (c) Master: This column shows the requirement that is the supplier of the **Copy** dependency.

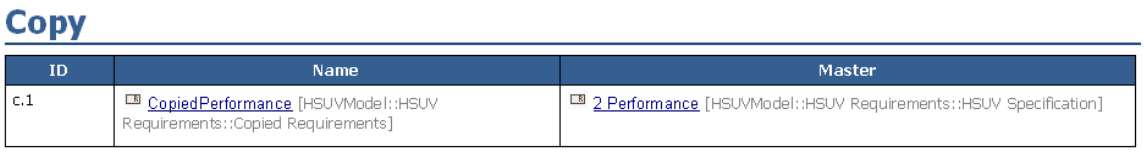


Figure 284 -- Copy Table

(b) Derive Table

The Derive table shows the relationship between the requirements that are related and the deriveReqt dependency. There are three columns in this table: (a) ID, (b) Name, and (c) Derived From respectively. Requirements in this table will be sorted by the requirement ID.

- (a) ID: This column shows the requirement ID of the derived requirement, which is the client of the **deriveReqt** dependency.
- (b) Name: This column shows the name of the derived requirement (the client of the **deriveReqt** dependency).
- (c) Derived From: This column shows the requirements that are the suppliers of the **deriveReqt** dependency whose client is the derived requirement represented by the requirement ID and name.

Derive

ID	Name	Derived From
d.1	RegenerativeBraking [HSUVModel::HSUV Requirements]	2.1 Braking [HSUVModel::HSUV Requirements::HSUV Specification::Performance] 2.2 FuelEconomy [HSUVModel::HSUV Requirements::HSUV Specification::Performance]
d.2	Range [HSUVModel::HSUV Requirements]	2.2 FuelEconomy [HSUVModel::HSUV Requirements::HSUV Specification::Performance] 3.1 FuelCapacity [HSUVModel::HSUV Requirements::HSUV Specification::Capacity]
d.3	PowerSourceManagement [HSUVModel::HSUV Requirements]	2.2 FuelEconomy [HSUVModel::HSUV Requirements::HSUV Specification::Performance] d.4 Power [HSUVModel::HSUV Requirements]
d.4	Power [HSUVModel::HSUV Requirements]	2.3 OffRoadCapability [HSUVModel::HSUV Requirements::HSUV Specification::Performance] 2.4 Acceleration [HSUVModel::HSUV Requirements::HSUV Specification::Performance] 3.3 CargoCapacity [HSUVModel::HSUV Requirements::HSUV Specification::Capacity]

Figure 285 -- Derive Table

(c) Refine Table

The **Refine** table shows requirements and the elements that refine them. The requirements in this table will be sorted by the requirement ID. There are three columns in this table: (a) ID, (b) Name, and (c) Refined By respectively.

- (a) ID: This column shows the ID of the requirement, which is the supplier of the **Refine** dependency.
- (b) Name: This column shows the name of the requirement (the supplier of the **Refine** dependency).
- (c) Refined By: This column shows the elements that refine the requirement (the client of the **Refine** dependency).

Refine

ID	Name	Refined By
2.4	Acceleration [HSUVModel::HSUV Requirements::HSUV Specification::Performance]	Acclerate [HSUVModel::HSUV UseCases::Hybridge SUV]
d.3	PowerSourceManagement [HSUVModel::HSUV Requirements]	HSUV Operational States [HSUVModel::HSUV Behavior]

Figure 286 -- Refine Table

(d) Satisfy Table

The Satisfy table shows requirements and the elements which satisfy them. The requirements in this table will be sorted by the requirement ID. There are three columns in this table: (a) ID, (b) Name, and (c) Satisfied By respectively.

- (a) ID: This column shows the ID of the requirement, which is the supplier of the **Satisfy** dependency.
- (b) Name: This column shows the name of the requirement (the supplier of the **Satisfy** dependency).
- (c) Satisfied By: This column shows the elements that satisfy the requirement (the client of the **Satisfy** dependency).

Satisfy

ID	Name	Satisfied By
3.3	CargoCapacity [HSUVModel::HSUV Requirements::HSUV Specification::Capacity]	Baggage [HSUVModel]
5.1	SafetyTest [HSUVModel::HSUV Requirements::HSUV Specification::Qualification]	ExternalObject [HSUVModel]
d.4	Power [HSUVModel::HSUV Requirements]	PowerSubsystem [HSUVModel::HSUV Structure]

Figure 287 -- Satisfy Table

(e) Trace Table

The Trace table shows requirements and the elements to which they trace. The requirements in this table will be sorted by the requirement ID in the first column. There are three columns in this table: (a) ID, (b) Name, and (c) Traced To respectively.

- (a) ID: This column shows the ID of the requirement, which is the supplier of the **Trace** dependency.
- (b) Name: This column shows the name of the requirement (the supplier of the **Trace** dependency).
- (c) Traced To: This column shows the elements to which the requirement is traced (the client of the **Trace** dependency).

Trace

ID	Name	Traced To
2.4	Acceleration [HSUVModel::HSUV Requirements::HSUV Specification::Performance]	Power [HSUVModel::HSUV Structure]

Figure 288 -- Trace Table

(f) Verify Table

The verify table shows the requirements and the elements which verify them. The requirements in this table will be sorted by the requirement ID. There are three columns in this table: (a) ID, (b) Name, and (c) Verified By respectively.

- (a) ID: This column shows theID of the requirement, which is the supplier of the **Verify** dependency.
- (b) Name: The column shows the name of the requirement (the supplier of the **Verify** dependency).
- (c) Verified By: The column shows the elements which verify the requirement (the client of the **Verify** dependency).

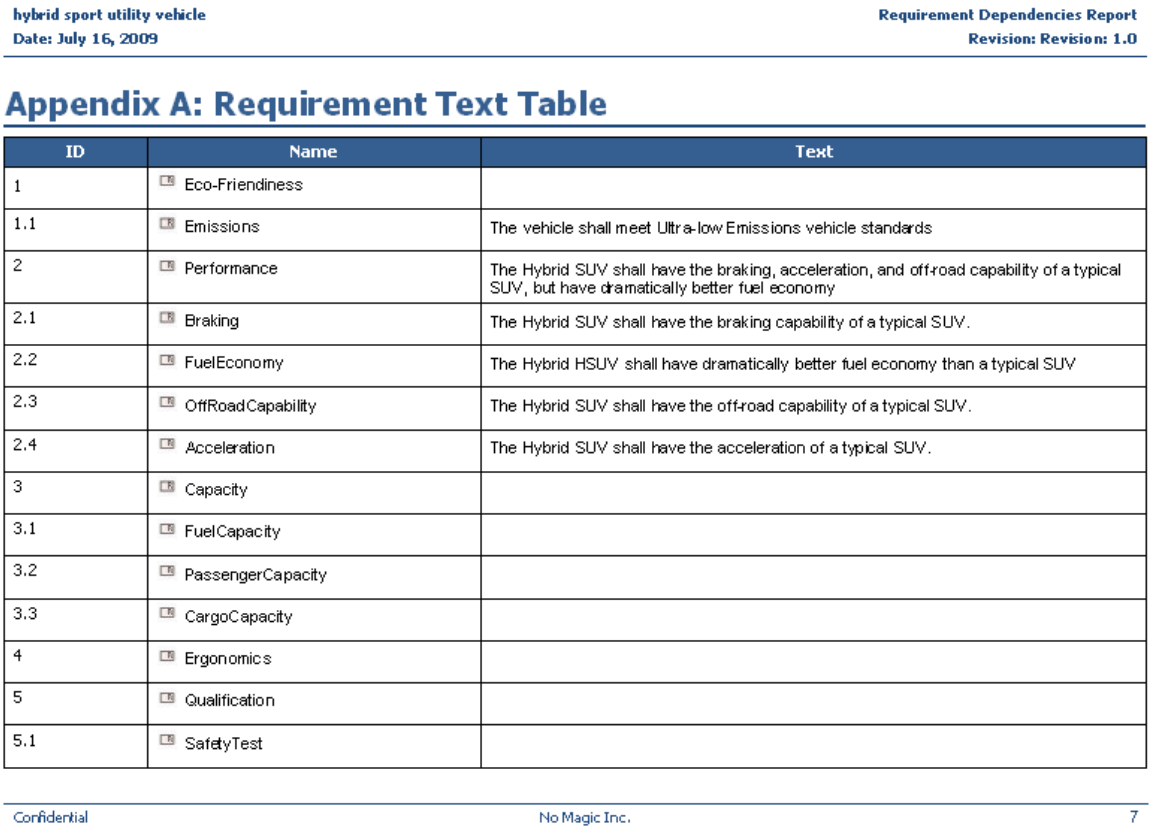
Verify

ID	Name	Verified By
1.1	Emissions [HSUVModel::HSUV Requirements::HSUV Specification::Eco-Friendliness]	EAPFuelEconomyTest [HSUVModel::Test]
2.4	Acceleration [HSUVModel::HSUV Requirements::HSUV Specification::Performance]	Max Acceleration [HSUVModel::HSUV Requirements] Max Acceleration [HSUVModel::HSUV Requirements]

Figure 289 -- Verify Table

(ii) Appendix for Requirements Text Table

All requirements shown in the table of requriement dependencies will be given in the requirement table in Appendix A: Requirement. The table will contain text that describes each requirement.



hybrid sport utility vehicle
Date: July 16, 2009

Requirement Dependencies Report
Revision: Revision: 1.0

Appendix A: Requirement Text Table

ID	Name	Text
1	Eco-Friendiness	
1.1	Emissions	The vehicle shall meet Ultra-low Emissions vehicle standards
2	Performance	The Hybrid SUV shall have the braking, acceleration, and off-road capability of a typical SUV, but have dramatically better fuel economy
2.1	Braking	The Hybrid SUV shall have the braking capability of a typical SUV.
2.2	FuelEconomy	The Hybrid HSUV shall have dramatically better fuel economy than a typical SUV
2.3	OffRoadCapability	The Hybrid SUV shall have the off-road capability of a typical SUV.
2.4	Acceleration	The Hybrid SUV shall have the acceleration of a typical SUV.
3	Capacity	
3.1	FuelCapacity	
3.2	PassengerCapacity	
3.3	CargoCapacity	
4	Ergonomics	
5	Qualification	
5.1	SafetyTest	

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Figure 290 -- Appendix A: Requirement Text Table

(iii) Appendix for Captured Diagram Images

If the elements generated in the document have hyperlinks to the diagrams, the diagrams will be captured and given in Appendix B: Diagrams.

(iv) Hyperlinks in Generated Reports

If the text of a related element generated in the document is a requirement element, a hyperlink for navigating to the section that contains the information of the related requirement in Appendix A will be created. In the appendix, if the requirement has an active hyperlink to the diagram, the hyperlink text will be generated and will navigate to the captured image of the diagram in Appendix B of the document.

12.2.7 Requirements Table Diagram Report

Use the Requirements Table Diagram template to generate a requirement report document in the tabular style of the SysML Requirements Table diagram. The generated table will consist of 8 columns:

(a) ID,

(b) Name,

(c) Text,

(d) Requirement Type,

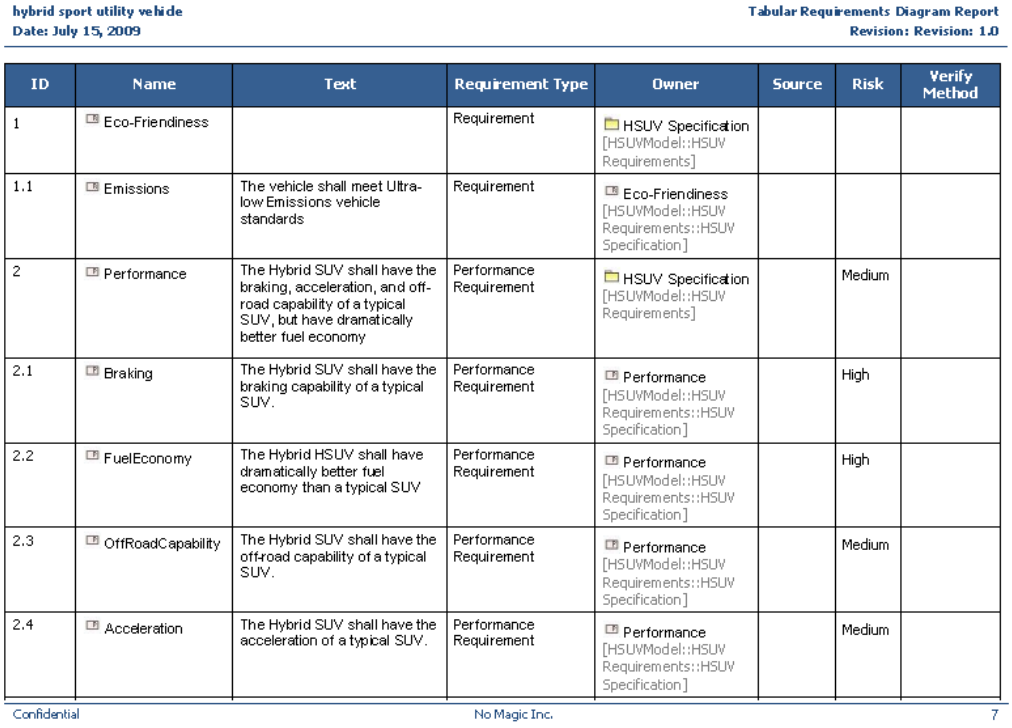
(e) Owner,

(f) Risk,

(g) Source, and

(h) Verify Method.

Requirements in the table will be sorted by the requirement ID. This template will be used to generate requirement reports from the Requirements Table diagrams.



hybrid sport utility vehicle
Date: July 15, 2009

Tabular Requirements Diagram Report
Revision: Revision: 1.0

ID	Name	Text	Requirement Type	Owner	Source	Risk	Verify Method
1	Eco-Friendliness		Requirement	HSUV Specification [HSUVModel::HSUV Requirements]			
1.1	Emissions	The vehicle shall meet Ultra-low Emissions vehicle standards	Requirement	Eco-Friendliness [HSUVModel::HSUV Requirements::HSUV Specification]			
2	Performance	The Hybrid SUV shall have the braking, acceleration, and off-road capability of a typical SUV, but have dramatically better fuel economy	Performance Requirement	HSUV Specification [HSUVModel::HSUV Requirements]		Medium	
2.1	Braking	The Hybrid SUV shall have the braking capability of a typical SUV.	Performance Requirement	Performance [HSUVModel::HSUV Requirements::HSUV Specification]		High	
2.2	FuelEconomy	The Hybrid HSUV shall have dramatically better fuel economy than a typical SUV	Performance Requirement	Performance [HSUVModel::HSUV Requirements::HSUV Specification]		High	
2.3	OffRoadCapability	The Hybrid SUV shall have the off-road capability of a typical SUV.	Performance Requirement	Performance [HSUVModel::HSUV Requirements::HSUV Specification]		Medium	
2.4	Acceleration	The Hybrid SUV shall have the acceleration of a typical SUV.	Performance Requirement	Performance [HSUVModel::HSUV Requirements::HSUV Specification]		Medium	

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Figure 291 -- Report Generated Using SysML Requirements Table Diagram Template

(i) Appendix for Captured Diagram Images

If the requirements generated in the document have active hyperlinks to the diagrams, the diagrams will be captured and given in Appendix A: Diagrams.

(ii) Hyperlinks in Generated Reports

For a requirement that has an active hyperlink to the diagram, a hyperlink text will be generated for the name of the requirement in the Name column. The hyperlink will navigate to the captured image of the diagram in Appendix A of the document.

12.3 Allocation Report Templates

Use Allocation Report Templates to generate Allocation reports, each report providing a summary of the «allocate» dependency in a SysML project.

OMG SysML Specifications recommend Allocation dependencies to be depicted in tables, which facilitate automated verification and validation (V&V) and gap analysis. The tables generally contain information on «allocate» dependencies, their clients, and suppliers, and also on the types of the clients and suppliers. You can generate an Allocation report using the whole project or some elements selected from the **Report Wizard** dialog.

There are three available template styles:

12.3.1 Allocation Table (Type A)

This table shows a summary of the «allocate» dependencies with their properties, including the supplier types and names as well as the client types and names (Figure 292).

Allocation Table

Type	Name	End	Relation	End	Type	Name
Call Behavior Action	a1:ProportionPower	from	allocate	to	Part Property	pcu
Call Behavior Action	a2:ProvideGasPower	from	allocate	to	Part Property	ice
Call Behavior Action	a3:ControlElectricPower	from	allocate	to	Part Property	epc
Call Behavior Action	a4:ProvideElectricPower	from	allocate	to	Part Property	em

Figure 292 -- Example of Allocation Table A Report

12.3.2 Allocation Table (Type B)

This table differs from Type A in that it shows «allocate» dependencies with their properties in another format that, in addtion to including their supplier types and names, client types and names, as in Type A, also displays the Allocation names (Figure 293).

Allocation Table

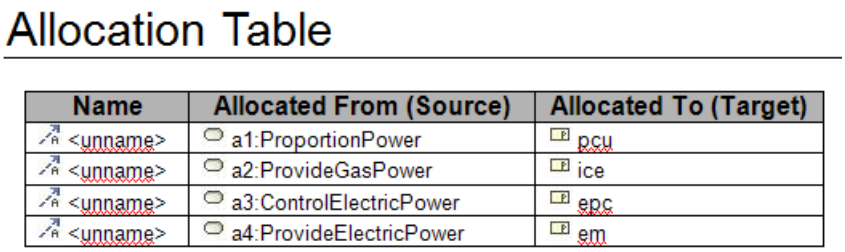
Allocate	Allocated From (Source)		Allocated To (Target)	
Name	Name	Type	Name	Type
<unname>	a1:ProportionPower	Call Behavior Action	pcu	Part Property
<unname>	a2:ProvideGasPower	Call Behavior Action	ice	Part Property
<unname>	a3:ControlElectricPower	Call Behavior Action	epc	Part Property
<unname>	a4:ProvideElectricPower	Call Behavior Action	em	Part Property

Figure 293 -- Example of Allocation Table B Report

12.3.3 Allocation Table (Type C)

This table differs from Type A and B in that it shows «allocate» dependencies with their properties in another format that, in addtion to including their names, and their supplier types and names, client types and names , as in Type A and B, also display their client and supplier type icons (Figure 294).

You can further customize a report by opting whether to include information from the model or not. It is optional to include element documentation and empty sections.



Allocation Table

Name	Allocated From (Source)	Allocated To (Target)
<unname>	a1:ProportionPower	pcu
<unname>	a2:ProvideGasPower	ice
<unname>	a3:ControlElectricPower	epc
<unname>	a4:ProvideElectricPower	em

Figure 294 -- Example of Allocation Table C Report

13. Model Library for Quantities, Units, Dimensions and Values (QUDV)

SysML specifications v.1.2 define the model of the quantities, units and dimensions (quantity kind) in the Annex C : Non-normative Extensions. You can define your own quantity and unit using the QuantityKind and Unit blocks defined in QUDV Library.

13.1 QUDV Model Library in SysML Plugin

QUDV Model Library is available for use in every new SysML project, created from SysML plugin 16.8 (or newer). The library, located in ***<md.install.dir>/modelLibraries*** directory, consists of four sub-libraries:

- QUDV
- SI Definitions
- SI Specializations
- SI Value Type Library

13.1.1 QUDV

The QUDV library (QUDV.mdzip) consists of the main definitions of the new units and quantity kinds system, as specified in OMG SysML specifications 1.2, e.g., SimpleUnit, SimpleQuantityKind, DerivedUnit, DerivedQuantityKind, AffineConversionUnit, UnitFactor, QuantityKindFactor, etc. For more detail on these definitions, see Annex C : Non-normative Extensions in OMG SysML specifications 1.2.

13.1.2 SI Definitions

The SI Definitions library (SIDefinitions.mdzip) consists of predefined units and quantity kinds in QUDV system for using in your model. You can use them in your customized units and value types.

13.1.3 SI Specializations

The SI Specializations library (SISpecializations.mdzip) consists of a diagram (and Blocks), demonstrating how to extend the current QUDV system.

13.1.4 SI Value Type Library

MagicDraw SysML provides the model library that contains the pre-defined value types. You can use them for typing the value properties in your SysML model. These value types are using the units and quantity kinds defined in the QUDV model library.

Table 8 -- New SI Value Type Library (QUDV-based)

Name	Unit	Quantity Kind
A	ampere : SimpleUnit	electricCurrentQK : SimpleQuantityKind
A/m	amperePerMeter : DerivedUnit	magneticFieldStrength : DerivedQuantityKind
A/m²	amperePerSquareMeter : DerivedUnit	currentDensity : DerivedQuantityKind
Bq	becquerel : DerivedUnit	radionuclideActivity : DerivedQuantityKind
C	coulomb : DerivedUnit	electricChargeQK : DerivedQuantityKind
cd	candela : SimpleUnit	luminousIntensityQK : SimpleQuantityKind
cd/m²	candelaPerSquareMeter : DerivedUnit	luminance : DerivedQuantityKind
F	farad : DerivedUnit	capacitance : DerivedQuantityKind
Gy	gray : DerivedUnit	absorbedDoseQK : DerivedQuantityKind
H	henry : DerivedUnit	inductanceQK : DerivedQuantityKind
Hz	hertz : DerivedUnit	frequency : DerivedQuantityKind
J	joule : DerivedUnit	energyQK : DerivedQuantityKind
K	kelvin : SimpleUnit	thermodynamicTemperatureQK : SimpleQuantityKind
kat	katal : DerivedUnit	catalyticActivityQK : DerivedQuantityKind
kg	kilogram : SimpleUnit	massQK : SimpleQuantityKind
kg/m³	kilogramPerCubicMeter : DerivedUnit	massDensityQK : DerivedQuantityKind
lm	lumen : DerivedUnit	luminousFluxQK : DerivedQuantityKind
lx	lux : DerivedUnit	illuminanceQK : DerivedQuantityKind
m	meter : SimpleUnit	lengthQK : SimpleQuantityKind
m/s	meterPerSecond : DerivedUnit	velocityQK : DerivedQuantityKind
m/s²	meterPerSecondSquared : DerivedUnit	accelerationQK : DerivedQuantityKind
mol	mole : SimpleUnit	amountOfSubstanceQK : SimpleQuantityKind
mol/m³	molePerCubicMeter : DerivedUnit	amountOfSubstanceConcentration : DerivedQuantityKind
m²	squareMeter : DerivedUnit	areaQK : DerivedQuantityKind
m³	cubicMeter : DerivedUnit	volumeQK : DerivedQuantityKind
m³/kg	cubicMeterPerKilogram : DerivedUnit	specificVolumeQK : DerivedQuantityKind
m⁻¹	reciprocalMeter : DerivedUnit	waveNumberQK : DerivedQuantityKind
N	newton : DerivedUnit	forceQK : DerivedQuantityKind
Pa	pascal : DerivedUnit	pressureQK : DerivedQuantityKind
rad	radian : DerivedUnit	planeAngle : DerivedQuantityKind

Name	Unit	Quantity Kind
s	second : SimpleUnit	timeQK : SimpleUnit
S	siemens : DerivedUnit	electricConductanceQK : DerivedQuantityKind
sr	steradian : DerivedUnit	solidAngle : DerivedQuantityKind
Sv	sievert : DerivedUnit	doseEquivalentQK : DerivedQuantityKind
T	tesla : DerivedUnit	magneticFluxDensityQK : DerivedQuantityKind
V	volt : DerivedUnit	electricPotentialDifferenceQK : DerivedQuantityKind
W	watt : DerivedUnit	powerQK : DerivedQuantityKind
Wb	weber : DerivedUnit	magneticFluxQK : DerivedQuantityKind
°C	celciusTemperature : AffineConversionUnit	celciusTemperatureQK : DerivedQuantityKind
Ω	ohm : DerivedUnit	electricResistanceQK : DerivedQuantityKind

13.2 Migrating Existing SysML Project To Use QUDV Model Library

If your SysML project was created by an older version of SysML Plugin, or by the **SysML without QUDV** template, QUDV is not used in your project yet.

To migrate your SysML project to use QUDV model library:

- Using QUDV Model Library in SysML Project
- Replacing/Modifying Existing Value Types
- Modifying Units and Quantity Kinds of Existing Value Types

13.2.1 Using QUDV Model Library in SysML Project

To use QUDV model library in your SysML project:

1. Open your SysML project.
2. Select **File > Use Module...** on the main menu.
3. The **Use Module** dialog will then open.
4. In step **1. Select module**, select **From predefined location** radio button, and then select **<install.root>/modelLibraries**.
5. Select **QUDV** model library.
6. To also use **SI Definitions**, **SI Specializations** and/or **SI Value Type Library** model library(ies), repeat step 2 to 4. Then, select the required model library.

13.2.2 Replacing/Modifying Existing Value Types

Next, you should substitute your existing Value Types with ones from the **SI Value Type Library** model library. If any Value Type is missing from the **SI Value Type Library** model library, you can either

(i) create a new Value Type by following the instructions in Section 13.3.3 Creating New Value Type, or

(ii) modify the existing Value Type in your project by modifying its unit and quantity kind to be consistent with QUDV specification (see Section 13.2.3).

13.2.3 Modifying Units and Quantity Kinds of Existing Value Types

Since SysML plugin version 16.6, units and quantity kinds' base classes can be either DataType (standard style) or InstanceSpecification (QUDV style). To adopt QUDV in your SysML project, user-defined units and quantity kinds should be changed from DataType to InstanceSpecification. To do that, you must replace each existing unit and quantity kind defined as a DataType with a new one defined as an InstanceSpecification. See section "13.3.2 Creating New Unit" and "13.3.1 Creating New Quantity Kind" on how to create a new InstanceSpecification-based unit and quantity kind, respectively.

See Annex "C.5 Model Library for Quantities, Units, Dimensions and Values (QUDV)" in OMG SysML specifications 1.2 for more detail.

13.3 Creating New Quantity Kind, Unit or Value Type in QUDV Library

13.3.1 Creating New Quantity Kind

For the quantity kind, you can create a new quantity kind by creating an InstanceSpecification whose classifier is one of QuantityKind subtype, i.e. SimpleQuantityKind, DerivedQuantityKind and SpecializedQuantityKind. You can create a quantity kind using either Browser Shortcut Menu or Diagram Toolbar (of BDD). Open the quantity kind's specification dialog, and then change its slot value(s) according to the QUDV specification.

To create, for example, the "celsiusTemperatureQK" quantity kind in the **SI Definitions** model library:

1. Create a Quantity Kind using either Browser Shortcut Menu or Diagram Toolbar (of BDD).
2. Since there is another temperature quantity kind "thermodynamicTemperatureQK" already defined in the **SI Definitions** model library, the newly-created quantity kind can be derived from such quantity kind. Thus, choose the DerivedQuantityKind to be the base classifier of the newly-created quantity kind.
3. If not already exist, create a new InstanceSpecification "thermodynamicTemperature^1QKF", having "QuantityKindFactor" as its base classifier, in order to define the quantity kind factor to be used in the newly-created quantity kind. Open the InstanceSpecification specification dialog, and then assign the following values to its slots:
   - quantityKind : QuantityKind = thermodynamicTemperatureQK
   - exponent : Rational = "1,1" (means "1/1" or "1")

   where Rational is of the format "numerator : Integer, denominator : Integer" which refers to a rational number: numerator / denominator.

   A quantity kind using such factor (thermodynamicTemperature^1QKF) actually refers to the same dimension as thermodynamicTemperatureQK quantity kind.
4. Open the newly-created quantity kind specfication dialog.
5. Assign the name of the quantity kind to be "celsiusTemperatureQK".
6. Select the Slots property group, and then assign the corresponding slot values:
   - name : String (mandatory) = "Celsius temperature"
   - factor : QuantityKindFactor = "thermodynamicTemperature^1QKF"

See Annex "C.5 Model Library for Quantities, Units, Dimensions and Values (QUDV)" in OMG SysML specifications 1.2 for more detail.

13.3.2 Creating New Unit

To create a new unit, you have to create an InstanceSpecification whose classifier is one of Unit subtype, i.e. SimpleUnit, DerivedUnit, GeneralConversionUnit, AffineConversionUnit, LinearConversionUnit and PrefixUnit. You can create a unit using either Browser Shortcut Menu or Diagram Toolbar (of BDD). Open the unit's specification dialog, and then change its slot value(s) according to the QUDV specification.

To create, for example, the "celsiusTemperature" unit in the **SI Definitions** model library:

1. Create a Unit using either Browser Shortcut Menu or Diagram Toolbar (of BDD).
2. Since there is another temperature unit already defined in the **SI Definitions** model library, i.e. "kelvin", and the conversion from "kelvin" to "celsius" is of the format defined in Annex 3.5.2.1 AffineConversionUnit in OMG SysML specifications 1.2; choose the AffineConversionUnit to be the base classifier of the newly-created unit.
3. Open the unit specfication dialog.
4. Assign the name of the unit to be "celsiusTemperature".
5. Select the corresponding Quantity Kind, e.g., "celsiusTemperatureQK" or "thermodynamicTemperatureQK".
6. Select the Slots property group, and then assign the corresponding slot values:
   - name : String (mandatory) = "celsius temperature"
   - quantityKind : QuantityKind (mandatory) = celsiusTemperatureQK
   - isInvertible : Boolean = true (always true for AffineConversionUnit)
   - symbol : String = "\degree C"
   - referenceUnit : Unit = kelvin
   - factor : Rational = "1,1" (means "1/1" or "1")
   - offset : Rational = "273.15,1" (means "273.15/1" or "273.15")

   where Rational is of the format "numerator : Integer, denominator : Integer" which refers to a rational number: numerator / denominator.

See Annex "C.5 Model Library for Quantities, Units, Dimensions and Values (QUDV)" in OMG SysML specifications 1.2 for more detail.

13.3.3 Creating New Value Type

13.3.3.1 Create a new Value Type using existing Unit and Quantity Kind in the SIDefinition model library

1. Create a new Value Type using diagram toolbar of SysML Block Definition Diagram or Containment browser context menu **New Elements > SysML Values > ValueType**.
2. Specify the Unit and Quantity Kind attributes of this Value Type with a Unit and the corresponding Quantity Kind in SIDefinition model library.
3. Optional: Create a new Value Type specializing another Value Type, e.g. Quantity, Real, Complex, etc.

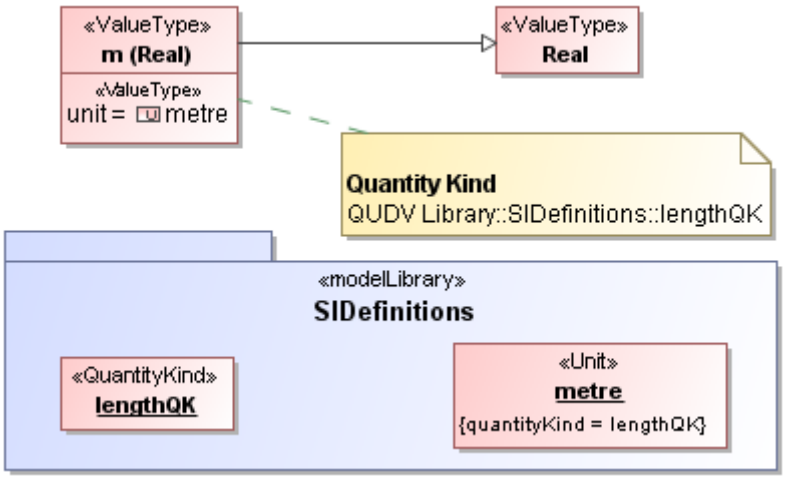


Figure 295 -- Value Type with the Existing Unit and QuantityKind in SIDefiniton Model Library

13.3.3.2 Create a new Value Type using a new Unit and an existing Quantity Kind in the SIDefinition model library

1. Create a new Unit from the diagram toolbar of Block Definition Diagram. Then, assign a Quantity Kind in the SIDefinition model library to the newly-create Unit.
2. Create a new Value Type, and specify the unit and quantity kind attributes with the Unit and Quantity Kind in step 1.

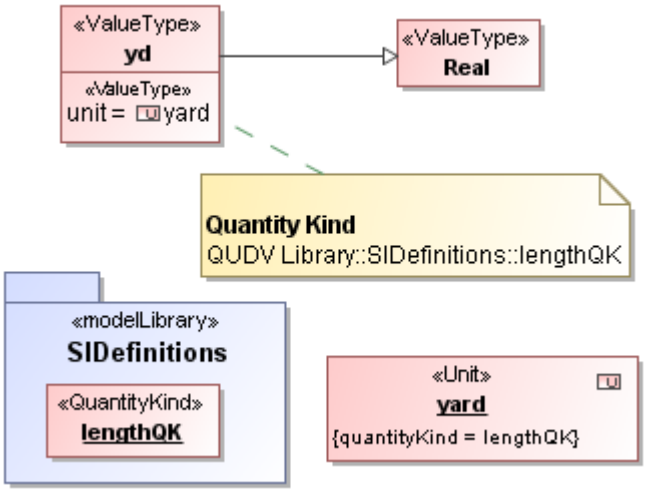


Figure 296 -- Value Type with the New Unit and the Existing QuantityKind in SIDefiniton Model Library

13.3.3.3 Create a new Value Type using new Unit and Quantity Kind

1. Create a new Quantity Kind from the diagram toolbar of Block Definition Diagram.
2. Create a new Unit from the diagram toolbar of Block Definition Diagram. Then, assign the Quantity Kind in step 1 to the newly-create Unit.
3. Create a new Value Type, and specify the unit and quantity kind attributes with the Unit and Quantity Kind from step 2 and step 1, respectively.

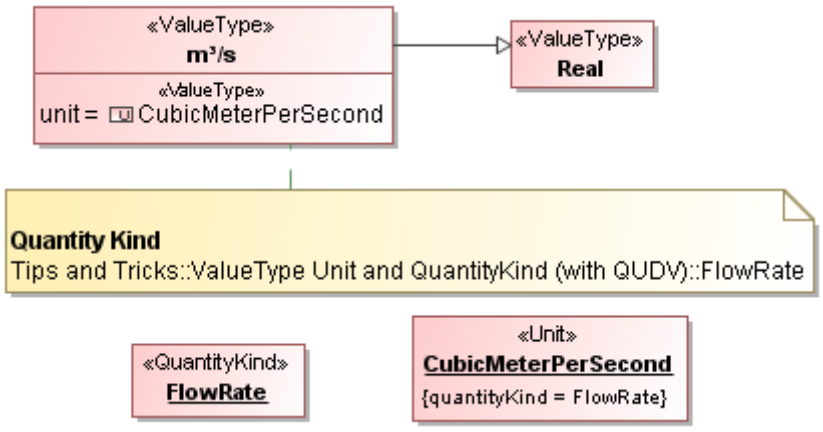


Figure 297 -- Value Type with the New Unit and QuantityKind

13.3.3.4 Create a new ValueType which is specialized the Quantity value type in QUDV

1. Create a new ValueType with one of the steps described above without any generalization relationship.
2. Make the newly-created ValueType to be specialized of the Quantity by creating a generalization relationship from the newly-created ValueType to the Quantity [QUDV Library::QUDV]
3. Create a new property of the newly-created ValueType. It will be redefined property of the Quantity::value. This property will be named 'value' and typed by the subtype of Number (Real, Complex, Integer).
4. Create a new static property of the created ValueType. It will be redefined property of Quantity::unit. The created property will be named 'unit' and typed by a Unit. The multiplicity of this static property is [0..1] and the default value of this property will be set to the InstanceSpecification which is the unit of the created ValueType.
5. Create a new static property of the created ValueType. It will be redefined property of Quantity::quantityKind. The created property will be named 'quantityKind' and typed by QuantityKind. The multiplicity of this static property is [0..1] and the default value of this property will be set to the InstanceSpecification which is the quantity kind of the created ValueType.

13.4 Validation Rules for Detecting the Using of Obsoleted Units and Quantities

Since MagicDraw SysML plugin version 17.0.1, the validation rules for detecting the using of unit and quantities which are data types are added. These validation rules detect the units and quantities which are data type, as the invalid elements (as obsoleted unit and quantity). The suggested solutions will be provided to help you solving the problems.

Suggested solutions for obsoleted unit

1. **Replace with a new QUDV simple unit**: When this suggested solution is selected, a new QUDV simple unit will be created. It is an InstanceSpecification whose classifier is the SimpleUnit that defined in QUDV library. This instance will be applied with the <<unit>> stereotype. The name and the quantity kind of the newly created QUDV simple unit will be the same as the name and the quantity kind of the obsoleted unit. After create a new QUDV simple unit for replacing the obsoleted one, the unit attribute of all value types which are defined with this obsoleted unit, will be replaced with the new one.

2. **Replace with a new QUDV derived unit**: This suggested solution is similar to the previous suggested solution except, the classifier of the created InstanceSpecification is the DerivedUnit instead of SimpleUnit.
3. **Replace with the selected QUDV unit**: This suggested solution allows you to selected the existing QUDV unit for replacing the obsoleted one.

Suggested solutions for obsoleted quantity

1. **Replace with a new QUDV simple quantity**: This suggested solution will create a new QUDV simple quantity which is an InstanceSpecification whose classifier is the SimpleQuantity that defined in QUDV library. This instance will be applied with the <<quantity>> stereotype. The name of the new QUDV simple quantity will be the same as the name of the obsoleted quantity. After create a new QUDV simple quantity, the quantity kind attribute of all value types and units which are defined with this obsoleted quantity, will be replaced with the new one.
2. **Replace with a new QUDV derived quantity**: This suggested solution is similar to the previous suggested solution except, the classifier of the created InstanceSpecification is the DerivedQuantity instead of SimpleQuantity.
3. **Replace with the selected QUDV quantity**: This suggested solution allows you to selected the existing QUDV quantity for replacing the obsoleted one.

Suggested solutions for value types that use obsoleted units and quantities.

There are two validation rules detects the value types that have defined units or quantities with the obsolted units and quantities defined in the **SI Value Type Library** model library (one for detecting the using of obsoleted unit and another for detecting the using of obsoleted quantity). When the value type is detected, the following suggested solution will be provided for solving the problem:

1. **Replace with recommend unit**: This suggested solution will replace the using of the obsoleted unit, which are defined in SI Value Type Library, with the equivalent QUDV unit defined in SIDefinition library.
2. **Replace with reccomment quantity**: This suggested solution will replace the obsoleted quantity with the equivalent QUDV quantity that defined in SIDefinition library.

14. Traceability

Traceability includes new derived properties, Relation Map, etc. Relation Map is a very powerful tool for visualizing traceability (select Analyze > Create Relation Map in the main menu).

The main feature of this feature is traceability between different levels of abstraction which makes it possible to find more specific and realizing elements, usually not from the same view. This allows for handy specification and realization discovery, and navigation. The effectiveness of traceability across a whole project is supported by the following MagicDraw capabilities:

- Relation Maps (for the analysis of traces among multiple levels of abstraction) - see “Introduction to SysML.mdzip” located in ***<md.install.dir>/samples/SysML*** directory for sample use.
- Traceability Reports (for coverage analysis) - see Coverage Analysis.
- Dependency Matrices (for the analysis of traces between any two levels of abstraction) - two matrices for traceability are provided: “SysML Traceability Requirement All Specifying Elements Matrix” and “SysML Traceability Requirement All Realizing Elements Matrix”. See section 10. Dependency Matrix for more detail on how to use such matrices.

Traceability solution is based on recent DSL improvements in MagicDraw for extendable metamodels with derived properties and two-level properties groups.

For more detail on the Traceability feature, visit http://www.magicdraw.com/newandnoteworthy/sysml.

15. Open API

15.1 Stereotype Usage

Standard stereotypes in SysML plugin are defined in SysML Profile and MD Customization for SysML Profile. Both profiles have their corresponding API classes: com.nomagic.magicdraw.sysml.util.SysMLProfile and com.nomagic.magicdraw.sysml.util.MDCustomizationForSysMLProfile, respectively. Each class allows you to:

- Get a string constant for each property of stereotype (tag).
- Get a stereotype element.
- Check if an element is stereotyped.

See **index.html** in **SysMLProfileJavaDoc.zip**, located at “plugins/com.nomagic.magicdraw.sysml/openapi/docs”, for the JavaDoc for the two API classes.

15.1.1 SysML Profile

You need to import com.nomagic.magicdraw.sysml.util.SysMLProfile to use this API class.

a) Get a string constant for each property of stereotype (tag)

Usage includes “SysMLProfile.*STEREOTYPE_PROPERTY_NAME*”.

For example, SysMLProfile.ALLOCATED_ALLOCATEDFROM_PROPERTY returns a string of “allocatedFrom”.

b) Get a stereotype element

Usage includes:

- “SysMLProfile.getInstance(project).*getStereotype()*” - where project refers to the project which uses SysML Profile.
- “SysMLProfile.getInstance(element).*getStereotype()*” - where element refers to the element in the project which uses SysML Profile.

For example, SysMLProfile.getInstance(project).getBlock() returns the reference to the <<Block>> stereotype object.

c) Check if an element is stereotyped

Usage includes “SysMLProfile.*isStereotype*(Elem)” - where Elem is the element you would like to check.

For example, given an element “Elem”, SysMLProfile.isBlock(Elem) returns True if the element “Elem” has <<Block>> stereotype applied, and returns false otherwise.

15.1.2 MD Customization for SysML Profile

You need to import com.nomagic.magicdraw.sysml.util.MDCustomizationForSysMLProfile to use this API class.

a) Get a string constant for each property of stereotype (tag)

Usage includes “MDCustomizationForSysMLProfile.*STEREOTYPE_PROPERTY_NAME*”.

For example, MDCustomizationForSysMLProfile.NUMBEROWNER_PREFIX_PROPERTY returns a string of “prefix”.

b) Get a stereotype element

Usage includes:

- “MDCustomizationForSysMLProfile.getInstance(project).*getStereotype()*” - where project refers to the project which uses MD Customization for SysML Profile.
- “MDCustomizationForSysMLProfile.getInstance(element).*getStereotype()*” - where element refers to the element in the project which uses MD Customization for SysML Profile.

For example, MDCustomizationForSysMLProfile.getInstance(project).getPartProperty() returns the reference to the <<PartProperty>> stereotype object.

c) Check if an element is stereotyped

Usage includes “MDCustomizationForSysMLProfile.*isStereotype*(Elem)” - where Elem is the element you would like to check.

For example, given an element “Elem”, MDCustomizationForSysMLProfile.isValueProperty(Elem) returns True if the element “Elem” has <<ValueProperty>> stereotype applied, and returns false otherwise.

A. Glossary

Accept Event Action [UML]: An Accept Event Action is an action that waits for the occurrence of an event that meets the conditions specified. Accept event actions handle event occurrences detected by the object owning the behavior. 136

Action [UML]: An action is a named element that is the fundamental unit of an executable functionality. The execution of an action represents some transformations or processing in the modeled system. When the action is to be executed or what its actual inputs are is determined by the concrete action and the behaviors in which it is used. 135

Activity Final [UML]: An Activity Final is a node that stops all flows in an activity. 137

Activity Parameter Node [UML]: An Activity Parameter Node is an object node for inputs and outputs to the activities. The Activity parameters are object nodes at the beginning and end of the flows, to accept inputs to an activity and provide outputs from it. 136

Actor [UML]: Actors represent roles played by human users, external hardware, and other subjects. An actor does not necessarily represent a specific physical entity but merely a particular facet (i.e. the "role") of some entities that are relevant to the specifications of its associated use cases. 151

Actuator: An Actuator is a special external system that influences the environment of the system under development. For example, Heater assembly or Central locking system of a car [1]. 151

Aggregation [UML]: An Aggregation is a special form of Association that specifies a part-whole relationship from an ‘aggregate’ (whole / source) to a ‘component part’ (target). Creating an Aggregation will also create a Shared Property, typed by the ‘component part’, in the ‘aggregate’ and a Reference Property, typed by the ‘aggregate’, in the ‘component part’. The aggregation values of the target and source ends are 'shared' and 'none', respectively. 19

Any Action [UML]: This element is introduced in order to maintain any other desirable action element with an appropriate metaclass stereotype applied. 136

Association [UML]: An Association represents a semantic relationship between two classifiers. It is used for referencing two Blocks with one another, thus creating two Reference Properties at both ends. The aggregation values of the both ends of an Association are 'none'. 19

Association Block [SysML]: An Association Block is an Association Class (a kind of Association) stereotyped by «Block». Like any other Block, an Association Block can own properties and connectors. 18

Binding Connector [SysML]: A Binding Connector is a connector which specifies that the properties at both ends of the connector have equal values. If the properties at both ends of a binding connector are typed by DataTypes or ValueTypes, it means that the instances of the properties at both ends must hold equal values, recursively through any nested properties within the connected properties. If the properties at both ends of a binding connector are typed by Blocks, it means that the instances of the properties must refer to the same block instance. As with any connector owned by a SysML Block, each end of a binding connector may be nested within a multi-level path of properties accessible from the owning Block. The NestedConnectorEnd stereotype is used to represent such nested ends, just as for nested ends of other SysML connectors. 95

Block [SysML]: Blocks provide a general purpose capability to describe the architecture of a system, and represent the system hierarchy in terms of systems and subsystems. Blocks describe not only the connectivity relationships within / between a system and its subsystems, but also quantitative values as well as other information about that system (for example, documentation). 14

Boundary System: A Boundary System is a special external system that serves as medium between another system and the system under development without having its own interests in the communication. For example, Bus system or Communication system [1]. 151

Business Requirement [MDSysML]: A Business Requirement is a requirement that specifies characteristics of the business process that must be satisfied by the system. 101

Call Operation Action [UML]: A Call Operation Action is an action that transmits an operation call request to the target object, where it may cause the invocation of the associated behavior. The argument values of the action are available to the execution of the invoked behavior. 135

Composition [UML]: A Composition is a special form of Aggregation which requires that a part of a Block instance be included in, at most, one composite object at a time. The composite object is responsible for the creation and destruction of its parts. In other words, a Composition specifies a 'strong' part-whole relationship from a ‘composite’ (whole / source) to a ‘composite part’ (target). Creating a Composition will also create a Part Property, typed by the ‘composite part’, in the ‘composite’ and a Reference Property, typed by the ‘composite’, in the ‘composite part’. The aggregation values of the target and source ends are 'composite' and 'none', respectively. 19

Conditional Node [UML]: A Conditional Node is a structured activity node that represents an exclusive choice among alternatives. 137

Conform [SysML]: A Conform relationship is a dependency between a view and a viewpoint. The view conforms to the rules and conventions specified in the viewpoint. 90

Connector [UML]: A connector is used to bind two ports together, representing a relationship between those ports. A connector can be typed by an association. A logical connector can be allocated to a more complex physical path depicting a set of parts, ports, and connectors (refer to allocation). 56

Constraint Block [SysML]: Constraint Blocks provide a mechanism to integrate engineering analysis, such as performance and reliability models, with other SysML models. Constraint Blocks can be used to specify a network of constraints representing mathematical expressions, which constrain the physical properties of a system. Constraint Blocks are generally defined in Block Definition Diagrams and then used in Parametric diagrams. 15

Constraint Property [SysML]: A Constraint Property is a property that specifies the constraints of other properties in its containing Block. Every Constraint Property is typed by a Constraint Block. Constraint Properties are displayed in the ‘constraints’ compartment. 54

Control Flow [UML]: A Control Flow is an edge that starts an activity node after the previous one is finished. Objects and data cannot pass along the control flow edge. 136

Copy [SysML]: A 'Copy' relationship is a dependency between a supplier requirement (master) and a client requirement (slave), specifying that the client requirement text is a read-only copy of the supplier requirement text. 102

Data Store [UML]: A Data Store node is a central buffer node for a non-transient information. A data store keeps all tokens that enter it, copies them when they are chosen to move downstream. Incoming tokens containing a particular object replace any tokens in the object node containing that object. 136

Data Type [UML]: A Data Type is a type whose instances are identified only by their values. A typical use of Data Types would be to represent the primitive types of the programming language used. For example, integer and string types are often treated as data types. 17

Decision [UML]: A Decision is a control node that chooses between outgoing flows. A decision node has one incoming edge and multiple outgoing activity edges. 137

Derive [SysML]: A 'Derive' relationship is a dependency between two requirements (a derived requirement and a source requirement), where the derived requirement is generated or inferred from the source requirement. 102

Design Constraint [SysML]: A Design Constraint is a requirement that specifies a constraint on the implementation of a system or on part of it. 101

Directed Aggregation [UML]: A Directed Aggregation is a one-direction Aggregation relationship which references from a Block ('aggregate') to another Block ('component part'), thus creating one Shared Property, typed by the 'component part', in the 'aggregate'. The aggregation value of the target end of a Directed Aggregation is 'shared'. 19

Directed Association [UML]: A Directed Association is a one-direction Association which references from a Block to another Block, thus creating one Reference Property, typed by the target Block, in the source end. The aggregation value of the target end of a Directed Association is 'none'. 19

Directed Composition [UML]: A Directed Composition is a one-direction Composition relationship which references from a Block ('composite') to another Block ('composite part'), thus creating one Part Property, typed by the 'composite part', in the 'composite'. The aggregation value of the target end of a Directed Composition is 'composite'. 19

Distributed Property [SysML]: A Distributed Property is a property of a Block or a Value Type, used to apply a probability distribution to the values of the property. Specific distributions can be defined by applying a subclass of the DistributedProperty stereotype to the property. 55

Domain: A Domain block represents an entity, a concept, a location, or a person from the real-world domain. A domain block is part of the system knowledge [1]. 15

Element Import [UML]: An Element Import is defined as a directed relationship between an importing namespace and a packageable element. The name of the packageable element or its alias are to be added to the namespace of the importing namespace. 91

Enumeration [UML]: An Enumeration is a kind of Data Type whose instances may be any of the user-predefined enumeration literals. It is possible to extend the set of applicable enumeration literals to other packages or profiles. 17

Environmental Effect: An Environmental Effect is an influence on the system from the environment without communicating with it directly. For example, Temperature or Humidity [1]. 151

Exception Handler [UML]: An Exception Handler is an element that specifies a body to execute in case the specified exception occurs during the execution of the protected node. 137

Expansion Region [UML]: An Expansion Region is a structured activity region that executes multiple times corresponding to the elements of an input collection. 137

Extend [UML]: An Extend is a relationship from an extending use case to an extended use case, specifying how and when the behavior defined in the extending use case can be inserted into the behavior defined in the extended use case. The extension takes place at one or more specific extension points defined in the extended use case. Choose a different Extend direction from the toolbar to draw a line with an opposite arrow end. 153

Extended Requirement [SysML]: An Extended Requirement adds some properties to the requirement element. These properties are important for requirement management. Specific projects should add their own properties. 100

External System: An External System is a system that interacts with the system under development. For example, Information server or Monitoring system [1]. 151

External: An External block is a block that represents an actor. It facilitates a more detailed modeling of actors like ports or internal structures [1]. 15

Flow Final [UML]: A Flow Final refers to the final node that terminates a flow and destroys all tokens that arrive at it. It has no impact on other flows in the activity. 137

Flow Port [SysML]: A Flow Port is a port that specifies the input and output items that can flow between a Block and its environment. Flow Ports are interaction points through which data, material, or energy “can” enter or leave the owning Block. The specification of what can flow is achieved by typing the Flow Port with a specification of things that flow. This can include typing an atomic Flow Port with a single type (Block, Value Type, Data Type, or Signal) representing the items that flow in or out, or typing a non-atomic Flow Port with a Flow Specification which lists multiple items that can flow. In general, Flow Ports are intended to be used for asynchronous, broadcast, or send-and-forget interactions. Note that only non-atomic Flow Ports can be conjugated. Once conjugated, all the directions of the typing Flow Specification’s items will be negated. 18

Flow Property: A FlowProperty signifies a single flow element that can flow to/from a block. Flow properties are defined directly on blocks or flow specifications that are those specifications which type the flow ports. Flow properties enable item flows across connectors connecting parts of the corresponding block types, either directly (in case of the property is defined on the block) or via flowPorts. A flow property’s values are either received from or transmitted to an external block. 56

Flow Specification [SysML]: A Flow Specification specifies inputs and outputs that can flow through a port in terms of Flow properties. Flow Specifications are used by Flow Ports to specify what items can flow via those ports. 16

Fork/Join Horizontal [UML]: To help control parallel actions. 137

Fork/Join Vertical [UML]: To help control parallel actions. 137

Functional Requirement [SysML]: A Functional Requirement is a requirement that specifies a behavior that a system or part of a system must perform. 100

Generalization [UML]: A Generalization is a taxonomic relationship between a more general classifier and a more specific one. Each instance of the specific classifier is also an indirect instance of the general classifier. Thus, the specific classifier indirectly has the features of the general classifier. 19

Include [UML]: An Include (uses) relationship from use case A to use case B indicates that an instance of the use case A will also contain the behavior as specified by B. 152

Initial Node [UML]: An Initial Node is a starting point for executing an activity. It has no incoming edges. 137

Input Expansion Node [UML]: An Input Expansion Node is an object node used for indicating a flow across the boundary of an expansion region. A flow into a region contains a collection that is broken into its individual elements inside the region, which is executed once per element. 136

Input Pin [UML]: An Input Pin is a pin that holds input values to be consumed by an action. Input pins are object nodes that receive values from other actions through object flows. 138

Instance [UML]: To create an instance specification of a classifier. 18

Interface [UML]: An Interface specifies operations or signals. If an Interface is provided to a port, the external parts may call operations or send signals to the Block owning the port via that port. If an Interface is required for a port, the Block owning the port may call operations or send signals to its environment via that port. 16

Interface Realization [UML]: An Interface Realization is a specialized Realization relationship between a Classifier and an Interface. This relationship signifies that the realizing classifier conforms to the contract specified by the Interface. 18

Interface Requirement [SysML]: An Interface Requirement is a requirement that specifies the ports for connecting systems and parts of a system. Optionally, it may include the items that flow across the connector and/or the Interface constraints. 100

Item Property [SysML]: An optional property that relates the flowing item to the instances of the connector’s enclosing block. This property is applicable only for item flows assigned to connectors. The multiplicity is zero if the item flow is assigned to an Association. 56

Link [UML]: A Link is a connection between two objects. 18

Loop Node [UML]: A Loop Node is a structured activity node that represents a loop with the setup, test, and body sections. 137

Merge [UML]: A Merge is a control node that brings together multiple alternate flows. It is not used to synchronize concurrent flows, but to accept one among several alternate flows. 137

Model [UML]: A Model is a special kind of Package. It contains a (hierarchical) set of elements that describe the physical system being modeled. A model owns or imports all the elements needed to represent a complete physical system according to its purpose. 90

moe [SysML]: moe (measure of effectiveness) represents a parameter whose value is critical for achieving the desired cost effectiveness mission. 94

Object Flow [UML]: An Object Flow is an activity edge that can have objects or data passing along it. An object flow models the flow of values to or from the object nodes. 136

Object Node [UML]: An Object Node is an abstract activity node that is part of defining object flow in an activity. Object nodes can be used in a variety of ways, depending on where objects are flowing from and to. 135

Objective Function [SysML]: An Objective Function (also known as 'optimization' or 'cost function') is used for determining the overall value of an alternative in terms of weighted criteria and/or moe's. 94

Opaque Action [UML]: An Opaque Action is an action that introduces discipline to implement specific actions or to be used as a temporary placeholder before some other actions are chosen. 135

Output Expansion Node [UML]: An Output Expansion Node is an object node used for indicating a flow out of a region that combines individual elements into a collection for use outside the region. 136

Output Pin [UML]: An Output Pin is a pin that holds output values produced by an action. Output pins are object nodes that deliver values to other actions through object flows. 138

Package [UML]: A package is a namespace for its members, and it can contain other packages. Only packageable elements can be owned by members of a package. By virtue of being a namespace, a package can import either individual members of other packages, or all the members of other packages. 89

Package Import [UML]: A Package Import is defined as a directed relationship that identifies a package whose members are to be imported by a namespace. 91

Part Property [MDSysML]: A Part Property is a property that specifies a part with strong ownership and coincidental lifetime of its containing Block. It describes a local usage or a role of the typing Block in the context of the containing Block. Every Part Property has ‘composite’ AggregationKind and is typed by a Block. Part Properties are displayed in the ‘parts’ compartment. 54

Performance Requirement [SysML]: A Performance Requirement refers to a requirement that quantitatively measures the extent to which a system or a system part satisfy a required capability or condition. 100

Physical Requirement [SysML]: A Physical Requirement specifies the physical characteristics and/or physical constraints of a system, or a system part. 101

Port [UML]: A Port defines an interaction point on a Block or a part, allowing you to specify what can flow in/out of the Block/part or what services the block/part requires (expects) from or provides (offers) to its environment. Ports are connected by connectors to other parts or other ports. 18

Quantity Kind [SysML]: A Quantity Kind (in SysML 1.0 and 1.1, called ‘Dimension’) is a kind of quantity that can be measured using defined and unrestricted units of measurement. For example, length, a quantity kind, may be measured by meter, kilometer, or foot units. 16

Reference Property [MDSysML]: A Reference Property is a property that specifies a reference of its containing Block to another Block. Every Reference Property has ‘none’ AggregationKind and is typed by a block. Reference Properties are displayed in the ‘references’ compartment. 54

Refine [UML]: A 'Refine' relationship is a dependency intended to describe how a model element or a set of elements are used to further refine a requirement. Alternatively, it can be used to show how a text-based requirement refines a model element. 103

Requirement [SysML]: A Requirement specifies a capability or a condition that must (or should) be satisfied. Requirements are used to establish a contract between the customer (or other stakeholders) and those responsible for designing and implementing the system. A requirement can also appear on other diagrams to show its relationship to other modeling elements. 100

Satisfy [SysML]: A 'Satisfy' relationship is a dependency between a requirement and a model element that fulfills that requirement. As with other dependencies, the arrow direction points from the satisfying (client) model element to the (supplier) requirement that is satisfied. 102

Select Nested Part: Click this button to display a nested part inside a given context. For more information, see Section 5.2.3 SysML IBD Specific Features: (vii) Select Nested Part. 56

Send Signal Action [UML]: A Send Signal Action is an action that creates a signal instance from its inputs, and transmits it to the target object, where it may trigger the state machine transition or the execution of an activity. 136

Sensor: A Sensor is a special external system that forwards information from the environment to the system under development. For example, Temperature sensor [1]. 151

Sequence Node [UML]: A Sequence Node is a structured activity node that executes its actions in order. 138

Shared Property [MDSysML]: A Shared Property is a property that specifies a shared part of its containing block. Every Shared Property has ‘shared’ Aggregationkind and is typed by a block. Shared Properties are displayed in the ‘references’ compartment. 54

Structured Activity Node [UML]: A Structured Activity Node is an executable activity node that may have an expansion into the subordinate nodes. The structured activity node represents a structured portion of the activity that is not shared with any other structured node, except for nesting. 137

Structured Block [SysML]: A Structured block is a Block element that contains an Internal Block Diagram and a hyperlink to it. 17

Subsystem [UML]: A Subsystem is treated as an abstract single unit. It groups model elements by representing the behavioral unit in a physical system. 152

Subsystem: A Subsystem is a typically large, encapsulated block within a larger system [1]. 15

Swimlanes [UML]: Swimlanes are used to organize actions and sub-activities according to the class allocated to each swimlane header and partition an activity diagram. 138

System Boundary [UML]: A System Boundary is another kind of representation of a package. A system boundary element consists of use cases related by Exclude or Include (uses) relationships, which are visually located inside the system boundary rectangle. 152

System Context: A System context element is a virtual container that includes the entire system and its actors [1]. 15

System: A System is an artificial artifact consisting of blocks that pursue a common goal which cannot be achieved by the system's individual elements. A block can be a software, hardware, a person, or an arbitrary unit [1]. 15

Test Case (Activity / StateMachine / Interaction) [SysML]: A test case is a method for verifying a requirement. 101

Time Event [UML]: A Time Event specifies a point of time with an expression, which may be absolute or might be relative to some other points of time. 136

Trace [UML]: A ‘Trace’ relationship is a dependency that provides a general purpose relationship between a requirement and any other model elements. 102

Unit [SysML]: A Unit is a particular value that can be used to specify a quantity of a dimension. A unit often relies on precise and reproducible measuring techniques. For example, a unit of length such as meter may be specified as a multiple of a particular wavelength of light. A unit can also use less stable or precise ways to express some values, such as costs expressed in some currencies, or a severity rating measured by a numerical scale. 16

Usability Requirement [MDSysML]: A Usability Requirement specifies the fitness for use of a system for its users and other actors. 101

Usage [UML]: A Usage is a dependency in which one element (the client) requires the presence of another element (the supplier) for its correct functioning or implementation. 19

Use Case [UML]: A Use Case is a kind of behavior-related classifier that represents a declaration of an offered behavior. Each use case specifies a particular behavior, possibly including the variants that the subject can perform in collaboration with one or more actors. The subject of a use case could be a physical system or any other element that may initiate a behavior, such as a component, a subsystem, or a class. 152

User System: An User System is a special external system that serves as medium between a user and the system without having its own interests in the communication. For example, Input Device or Display [1]. 151

Value Pin [UML]: A Value Pin is an input pin that provides a value to an action that does not come from an incoming object flow edge. 138

Value Property [MDSysML]: A Value Property is a property that specifies the quantitative property of its containing Block. Every Value Property is typed by either a SysML Value Type or UML Data Type. Value Properties are displayed in the ‘values’ compartment. 54

Value Type [SysML]: A Value Type is a type which defines values that can be used to provide information on a system, but cannot be identified as the target of any reference. These values may be used to type properties, operation parameters, or, potentially, other elements within SysML. 16

Verify [SysML]: A 'Verfiy' relationship is a dependency between a requirement and a test case or a model element that can determine whether the system fulfills the requirement. As with other dependencies, the arrow direction points from the (client) test case to the (supplier) requirement. 102

View [SysML]: A view is a representation of a whole system from the perspective of a single viewpoint. A view can only own element import, package import, comment, and constraint elements. 89

ViewPoint [SysML]: A viewpoint is a specification of the conventions and rules for constructing and using a view for the purpose of addressing a set of stakeholder concerns. The languages and methods for specifying a view can reference methods

and languages in another viewpoint. They specify the elements expected to be represented in the view that may be formally or informally defined. 90

B. Index