

# Smart Home Example

for Eclipse Papyrus extended with MetaModelAgent

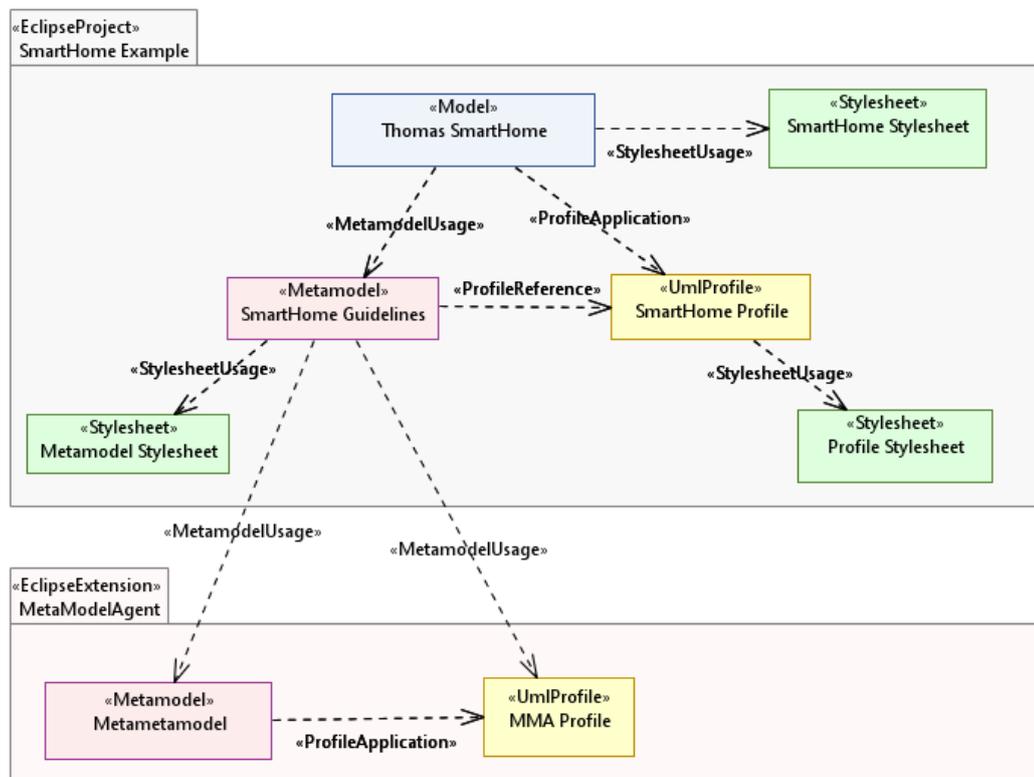
## Introduction

This document describes the **Smart Home Example**. Containing a metamodel that defines a modeling language for smart homes and an example model of a smart home which conforms to the metamodel.

The purpose is to demonstrate domain-specific modeling provided by Eclipse Papyrus extended with MetaModelAgent.

The example is not intended for professional use. It represents electronic devices in the author's home and has only been developed as an example of the capabilities in Papyrus and MetaModelAgent.

## Artifacts included in the example



**Figure 1:** *Schematic diagram of included artifacts and how they refer to each other and to artifacts provided by MetaModelAgent.*

## Thomas Smart Home (Example Model)

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This is an example of a smart home model which captures a subset (living room) of the author's smart home.

The model uses the *SmartHome profile* and conforms to the metamodel *SmartHome Guidelines*. The diagrams in the model are styled by the *Smart Home Stylesheet*.

## Smart Home Profile

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A **UML-profile** that defines a minimal set of extensions to UML to represent the concepts needed in the Smart Home domain. The *Thomas Smart Home Example Model* uses this profile. The profile together with the Smart Home Metamodel defines the modeling language for smart homes. See next chapter for details.

## Smart Home Guidelines (Metamodel)

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The **Smart Home Metamodel** defines the modeling rules for Smart Home models. The metamodel is used by MetaModelAgent to provide a customized UI together with model validation, model analysis and web publishing capabilities.

The metamodel uses the MMA UML-profile which is built into the MetaModelAgent extension. The metaclasses in the metamodel refers to stereotypes in the *Smart Home UML-profile*.

The metamodel together with the Smart Home profile defines the modeling language for smart homes See next chapter for details.

## Stylesheets

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CSS Stylesheets are used by Papyrus to customize the graphical presentation of elements and relationships in diagrams. Stylesheets makes it easy to achieve a uniform look of the diagrams.

### Smart Home Stylesheet

Defines how the concepts are displayed in the diagrams in a Smart Home Model.

### Profile Stylesheet

Defines how profile concepts are displayed in the diagrams in a UML-profile.

### Metamodel Stylesheet

Defines how metamodel concepts are displayed in the diagrams in a metamodel.

## MetaModelAgent artifacts

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The following artifacts are not part of the example. They are embedded in MetaModelAgent and only referred from the example. They are not visible in the workbench.

## MMA profile

A UML-profile that is included in MetaModelAgent. The profile defines the concept used in metamodels to be used by MetaModelAgent. This profile must be applied to all metamodels to be used by MetaModelAgent.

## Meta-metamodel

A metamodel is included in MetaModelAgent and contain all modeling rules for a metamodel. The Smart Home Metamodel and all other metamodels to be used by MetaModelAgent must conform to this metamodel.

# Smart Home Modeling Language

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This chapter describes the modeling language used to model Smart Homes. The language is based on composite structure modeling in UML using components, ports, and connectors.

A UML-profile for Smart Homes defines stereotypes needed for clarification and differentiation, otherwise standard UML elements are used as is, as far as possible.

It is possible to organize electronic devices in rooms and then use several nested composite structures. But for a simple model, the communication of all devices in a home can be modeled in one single composite structure.

## Smart Home Elements

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The following modeling elements are used when modeling Smart Homes:

### Electronic Device

An **Electronic Device** is a type of device that can communicate with other devices. A device has ports through which communication can occur.

An **Electronic Device** is represented by a UML Device element.

### Room

A **Room** is a physical location in a **Home**. Each **Room** hold its own set of **Electronic Device instances** and all connections between them as a composite structure.

A **Room** is represented by a UML Node element stereotyped by «Room».

A **Room** may have **Ports** that denotes the possibility to communicate with **Electronic Devices** in other **Rooms**.

### Home

A **Home** is the top-most physical location. A **Home** will contain **Room Instances** and/or **Electronic Device Instances** and all connections between them as a composite structure.

A **Home** is represented by a UML Node element stereotyped by «Home».

A **Home** may have **Ports** that denotes the possibility for external communication.

### Electronic Device Instance

An **Electronic Device Instance** is a specific **Electronic Device** in a specific location, either in a specific **Room** or in the **Home** itself (e.g., unspecified room).

An **Electronic Device Instance** is represented by a UML Property element owned by a **Room** or the **Home**. The value of the Type property of an **Electronic Device Instance** must be a reference to an **Electronic Device**.

## Room Instance

A **Room Instance** is a specific **Room** in a **Home**.

A **Room Instance** is represented by a UML Property element owned by a **Home**. The value of its Type property must be a reference to a **Room**.

## Port

A **Port** is a connection plug that resist on an **Electronic Device, Room** or **Home**. A **Port** can send and/or receive signals from **Ports** of the same type to/from another device/room.

A **Port** is represented by a UML Port element. There are two variants:

- A **Physical Port** represent a physical connection point (socket). It must have the stereotype «PhysicalPort» applied.
- A **Wireless Port** represent a wireless connection point. It must have the stereotype «WirelessPort» applied.

A **Port** must have a type that denotes what kind of connection it represents. There is no fix set of port types defined.

A **Port** can receive and/or send information. The potential direction of the information is captured in the enumerated property **Direction** which is defined for the stereotypes «PhysicalPort» and «Wireless Port».

## Port Type

A **Port Type** is used to specify the type of a port and indirect what kind of connection there is between a pair of ports. Typical port types are Wi-Fi, HDMI and USB. A **Port Type** is represented by a UML Data Type element.

## Connection

A **Connection** defines a potential communication channel between a pair of ports on **Electronic Device Instances, Room Instances** or **Home**. Both ports of the channel must be of the same type.

A **Connection** is represented by a UML Connector element. There are two variants:

- **Cable Connection**, physical communication channel. It must have the stereotype «Cable» applied.
- **Wireless Connection**. A wireless communication channel. It must have the stereotype «Wireless» applied.

## Summary of Elements

Concept	UML element	Stereotype	Description
<b>Home</b>	<u>Node</u>	« <u>Home</u> »	A Physical home
<b>Room</b>	<u>Node</u>	« <u>Room</u> »	A physical room
<b>Electronic Device</b>	<u>Device</u>		An electronic device that can communicate with other devices.
<b>Electronic Device Instance</b>	<u>Property</u>		A specific device in a specific room. The type of the property must be an

			Electronic Device.
<b>Room Instance</b>	<u>Property</u>		A specific room in a home. The type of the property must be a Room.
<b>Physical Port</b>	<u>Port</u>	« <u>PhysicalPort</u> »	A physical port of an Electronic Device, Room or Home.
<b>Wireless Port</b>	<u>Port</u>	« <u>WirelessPort</u> »	A wireless port of an Electronic Device, Room or Home.
<b>Port Type</b>	<u>Data Type</u>		The kind of port
<b>Cable Connection</b>	<u>Connector</u>	« <u>Cable</u> »	A cable connection between two ports.
<b>Wireless Connection</b>	<u>Connector</u>	« <u>Wireless</u> »	A wireless connection between two ports.

## Diagrams

The following diagrams are used when modeling Smart Homes:

### Devices & Ports Overview Diagram

A UML Class Diagram used to display an overview all kind of **Electronic Devices** used in a **Home**. Each **Electronic device** should have a compartment list of all its **Ports**.

### Rooms & Devices Overview Diagram

A UML Class Diagram used to display an overview of all **Rooms** in a **Home**. Each **Room** should have a compartment list of all its **Electronic Device Instances**.

### Connection Kind Overview Diagram

A UML Class Diagram used to display an overview of all **Connection kinds** utilized in the **Home**.

### Connections Diagram

A UML Composite Structure Diagram within a Home or a Room. Each Home and Room must have a Connections Diagram.

- Within a **Home** the diagram displays all the **Room Instances** in the **Home** and the **Electronic Device Instances** that does not belong to any room. This is typically mobile devices that can be moved between rooms, for example mobile phones and laptops.
- Within a **Room** the diagram displays all the **Electronic Device Instances** that belongs to the specific **Room**.

For both kind of connections Diagrams, the **Ports** of the displayed **Room Instances** and **Electronic Device Instances** that are utilized should be visible and the connections between them should be drawn.

### Summary of Diagrams

Diagram Name	UML Diagram Kind	Description
<b>Devices &amp; Ports Overview Diagram</b>	<u>Class Diagram</u>	Displays all devices in the model. Each device contains a list of its ports.

<b>Connection Kind Overview Diagram</b>	<u>Class Diagram</u>	Display all connection kinds utilized in the model.
<b>Rooms &amp; Devices Overview Diagram</b>	<u>Class Diagram</u>	Displays all rooms in the model. Each room contains a list of its devices.
<b>Connections Diagram</b>	<u>Composite Structure Diagram</u>	Displays all connections between devices in a specific room or in the home.

## Modeling Smart Homes

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This chapter describes how to use Papyrus and MetaModelAgent together with the **Smart Home metamodel** to model a Smart Home.

The **Smart Home Metamodel** contains modeling rules for how to use the **Smart Home profile** and some additional rules for how to organize different types of elements.

The prerequisites are that the **MMA Demo Smart Home** project is available in your workspace.

### Creating a new Smart Home Model

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1. Select the **MMA Demo Smart Home** in the project explorer and select New -> Metamodel to open the New Model Wizard
2. Select to *Search for metamodel in workspace* in the drop-down list.
3. Enter a wildcard (\*) in the search field to display all available metamodels.
4. Select *SmartHome\_Guidelines (Metamodel).uml* from the list of metamodels. Close the dialog and press Next in the Wizard
5. Enter a file name for the new model and press Next.
6. Enter a name for the root of the new model and press Next. You can let the root element have the same name as the model file.
7. Let the three checkboxes be checked so that the mandatory libraries (UML Packages) for organizing **Electronic Devices** and **Port Types** are created together with an overview diagram. Press Next.
8. On the following wizard pages, you might add the first **Electronic Device** and **Port Type** together with additional diagrams. Do it separately afterwards by unchecking all checkboxes on the succeeding pages. Instead, press *Finish* when that button is available.

### Adding Electronic Devices

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9. Select the **Electronic Device Library** and create an **Electronic Device** element for each type of device you have in your home, using the MMA Add Wizard (*MetaModelAgent -> Add -> Electronic Device*).
10. Select the **Port Type Library** and create a **Port Type** for each kind of connection used in your home, using the MMA Add Wizard (*MetaModelAgent -> Add -> Port Type*).
11. Add a **Port** to your **Electronic Devices** for each input and/or output port there are, using the MMA Add Wizard (*MetaModelAgent -> Add -> Wireless Port or Physical Port*). Type each **Port** with the correct **Port Type** and adjust its direction.

## Adding Rooms

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Rooms are optional concepts that can be used if you want to distinguish the electronic devices based on which room in the home they belong to.

1. Create a **Room** using the MMA Add Wizard (*MetaModelAgent -> Add -> Room*).
2. For each **Room**:
  - 2.1. Create a **Connections Diagram** in the **Room**, using the MMA Add Wizard (*MetaModelAgent -> Add -> Connections Diagram*).
  - 2.2. Drag and drop all **Electronic Devices** that exist in the room from the *Model Explorer View* into the **Connections Diagram** to create **Electronic Device Instances**.
  - 2.3. Drag all utilized **Ports** within each **Electronic Device** from the *Model Explorer View* to the border of the corresponding **Electronic Device Instance** in the **Connections Diagram**.
  - 2.4. Add **Connections** between the **Electronic Device Instance's Ports** in the **Connections diagram**, by using the *Connector* edge in the *Diagram Palette*. Bring up the *MetaModelAgent -> Change* to submenu and select to let the connector represent a **Wireless connection** or **Cable connection**.

## Adding a Home

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1. Create a **Home** using the MMA Add Wizard (*MetaModelAgent -> Add -> Home*).
2. Create a **Connections Diagram** in the **Home**, using the MMA Add Wizard (*MetaModelAgent -> Add -> Connections Diagram*).
3. If you have divided your **Home** into **Rooms**:
  - 3.1. Drag and drop all **Rooms** from the *Model Explorer View* into the *Connections Diagram* of the **Home** to create **Room Instances**.
  - 3.2. Drag all utilized **Ports** within each **Electronic Device** from the *Model Explorer View* into the corresponding **Electronic Device Instance** in the **Connections Diagram**.
4. If you have **Electronic Devices** that have not been organized into rooms:
  - 4.1. Drag and drop all **Electronic Devices** that should exist in the **Home** from the *Model Explorer View* into the **Connections Diagram** to create **Electronic Device Instances**.
  - 4.2. Drag all utilized **Ports** within each **Electronic Device** from the *Model Explorer View* to the border of the corresponding **Electronic Device Instance** in the **Connections Diagram**.
5. Add connections between the **Ports** on **Rooms** and **Electronic Devices** in the **Connections diagram**, by using the *Connector* edge in the *Diagram Palette*. For each connection: Bring up the *MetaModelAgent -> Change* to submenu and select to let the connector represent a **Wireless connection** or **Cable connection**.

## References

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- [1] Eclipse Foundation home page  
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