Tutorial

UML Statemachine

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Tutorial	Actifsource Tutorial – State Machine
Required Time	• 70 Minutes
Prerequisites	• Actifsource Tutorial – Installing Actifsource • Actifsource Tutorial – Simple Service • Actifsource Tutorial – Domain Diagram Type • Actifsource Tutorial – Domain Diagram Type II
Goal	• Create UML State Machines using the built-in Actifsource solution
Topics covered	• Create UML State Machines with states, superstates, history states, (entry, exit, state) actions and transition guards
Notation	↳ To do ⓘ Information • **Bold**: Terms from actifsource or other technologies and tools • <u>**Bold underlined**</u>: actifsource Resources • <u>Underlined</u>: User Resources • <u>*UnderlinedItalics*</u>: Resource Functions • `Monospaced`: User input • *Italics*: Important terms in current situation
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Compatibility	Created with actifsource Version 6.8.1

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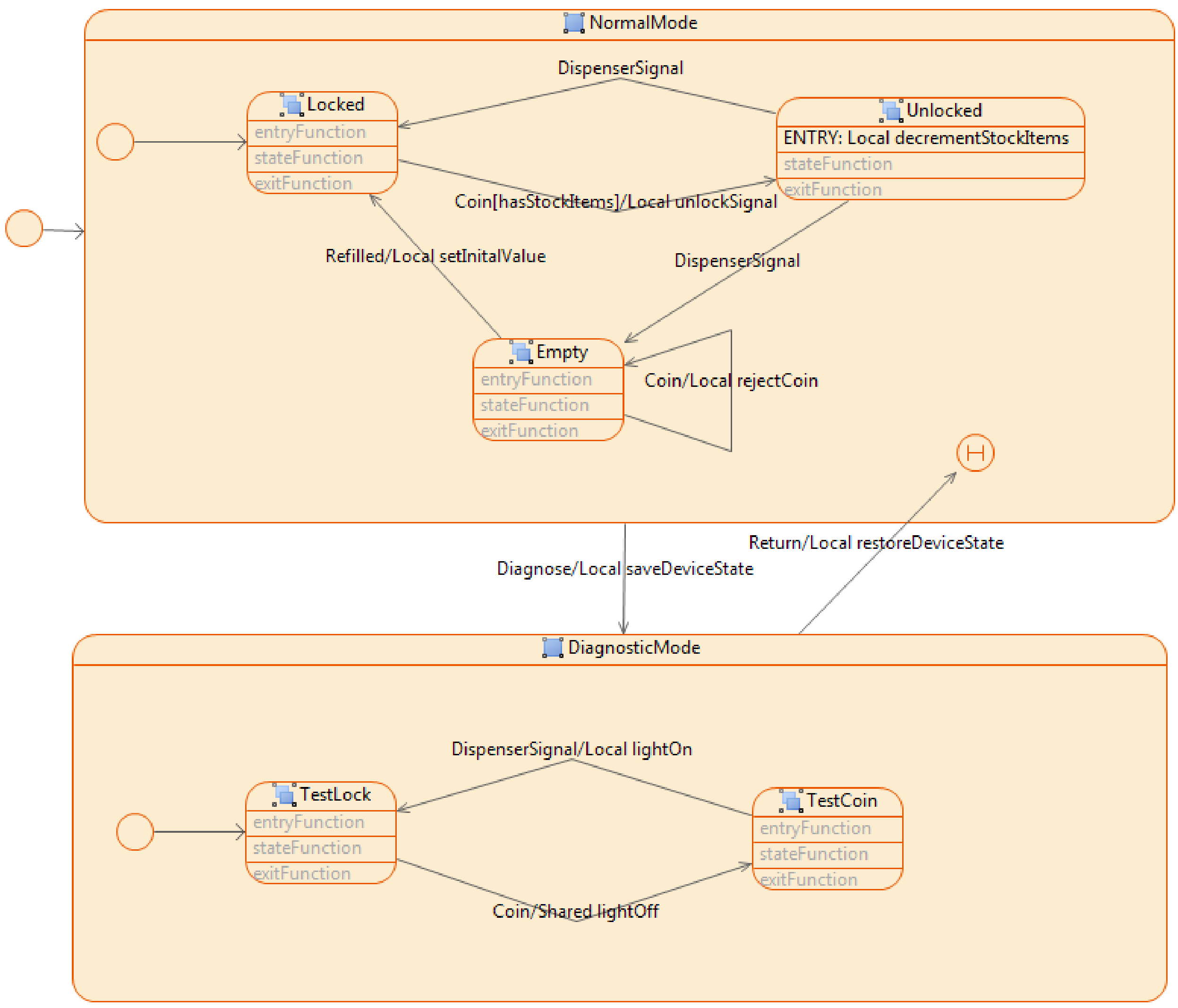
- Design an UML state machine for a simple coin machine process and create a state diagram that represents the UML state machine:



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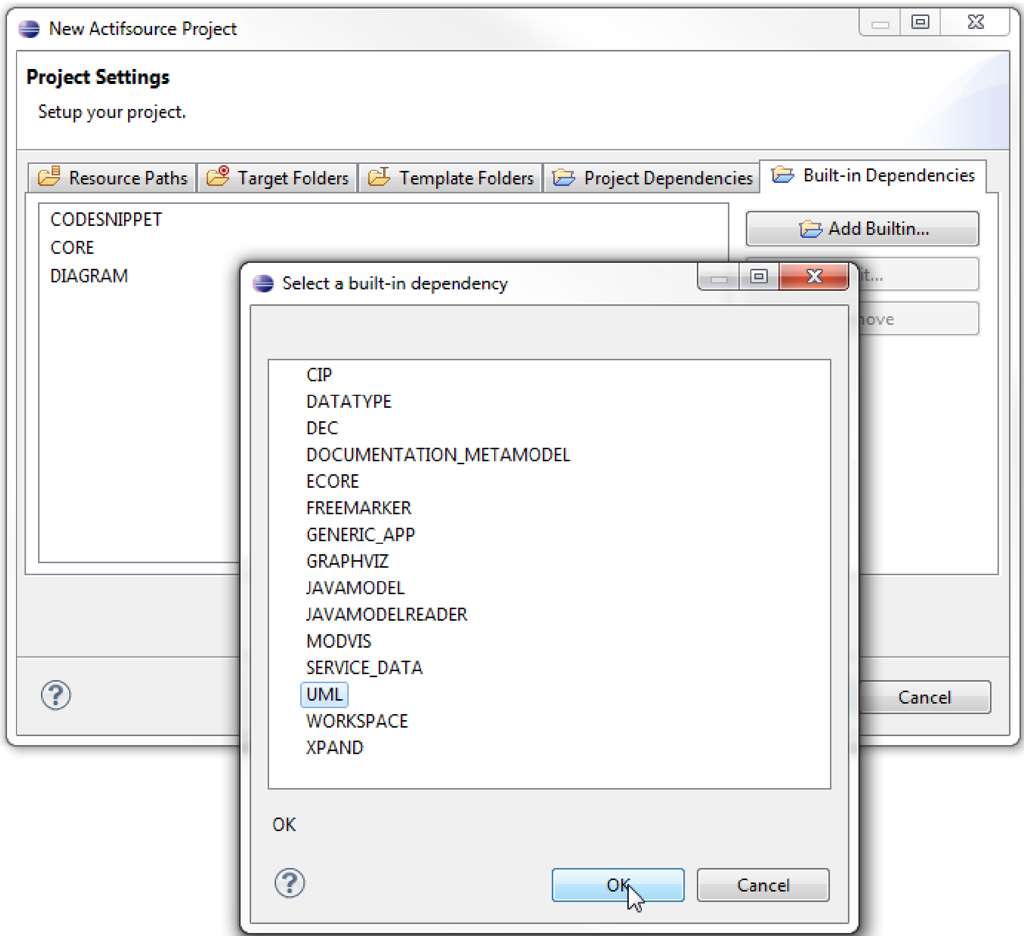
Part I: Preparation



- Create a new Actifsource project with the name com.actifsource.umlstatemachine
- Change to the tab **Built-in Dependencies** in the **New Actifsource Project** dialog
- Add the built-in dependency **UML** (which makes all resource needed to build and represent UML state machines available in our new project).
- Close both dialogs by clicking OK and Finish

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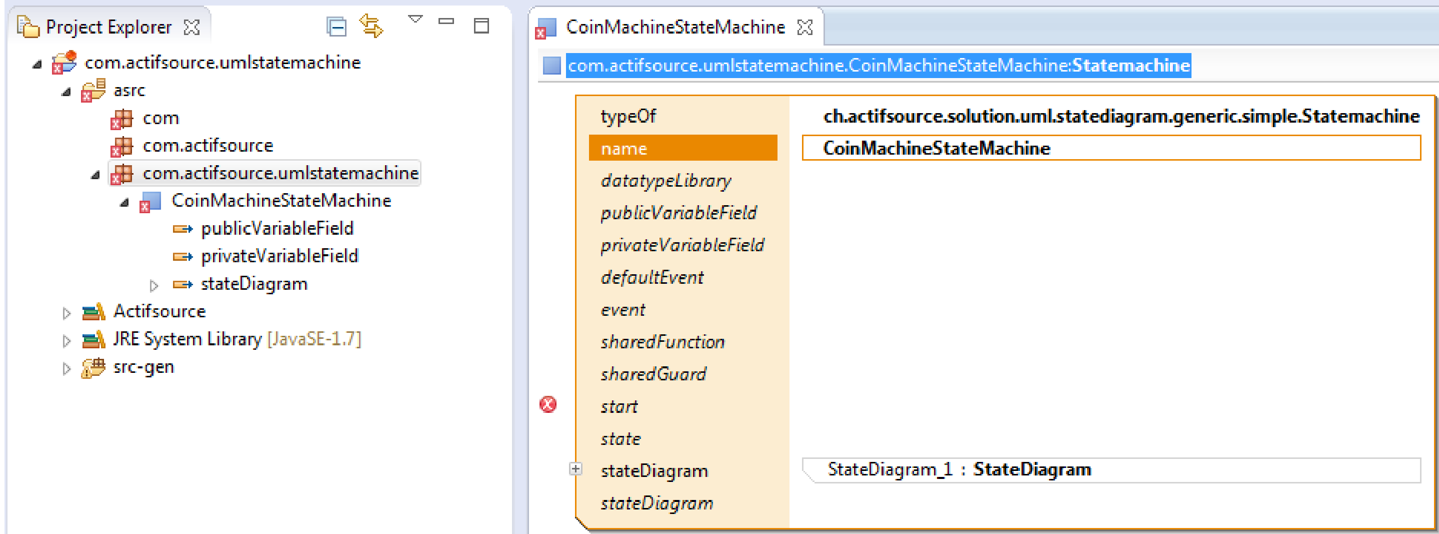
Part II:

Design an UML State Machine



- Create a new resource of type ch.actifsource.solution.uml.statediagram.generic.simple.Statemachine
- Enter CoinMachineStateMachine as the name of the new resource

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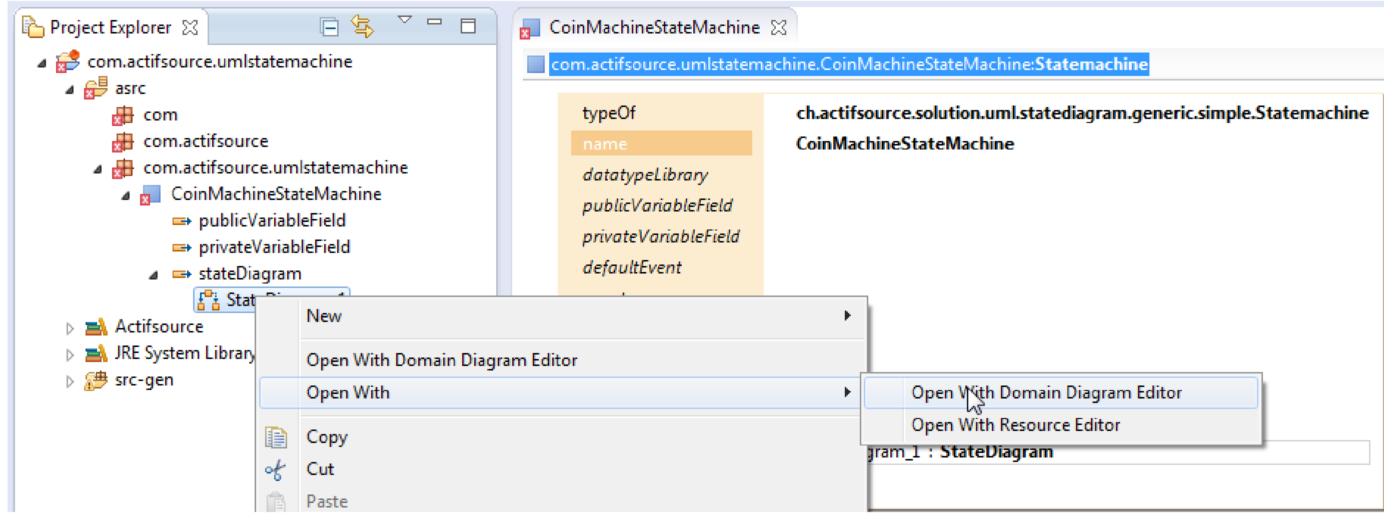

↳ Open the state diagram of CoinMachineStateMachine, StateDiagram_1, in the **Domain Diagram Editor**

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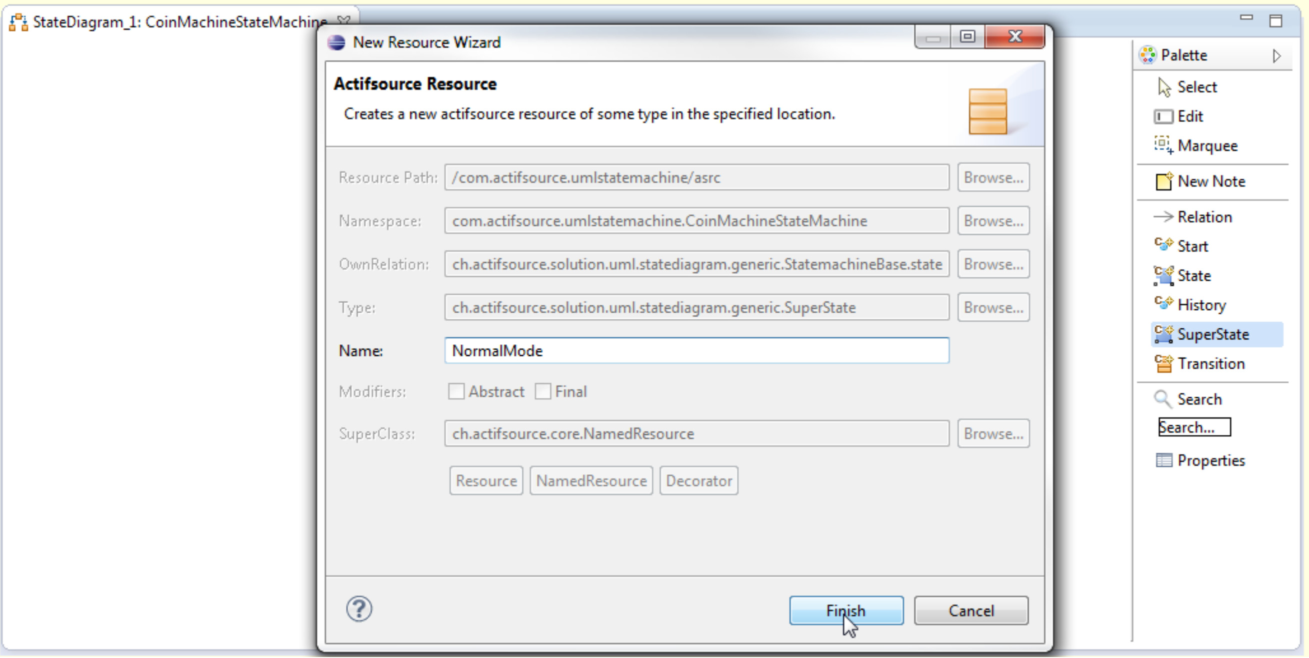

First, we create two superstates, called NormalMode and DiagnosticMode:

- Select SuperState from the Palette and left-click in the **Diagram Editor** to create a superstate
- Enter `NormalMode` as the name of the new SuperState in the **New Resource Wizard**
- In the same way, create a SuperState called DiagnosticMode
- Select Start from the palette and right-click in the **Diagram Editor** to create a start state (i.e., the default or initial state of the state machine)
- In the Select mode, you can now re-size and re-position the states as usual in the **Diagram Editor**

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↳ Select Relation from the Palette and insert a relation from the start state symbol to the superstate NormalMode

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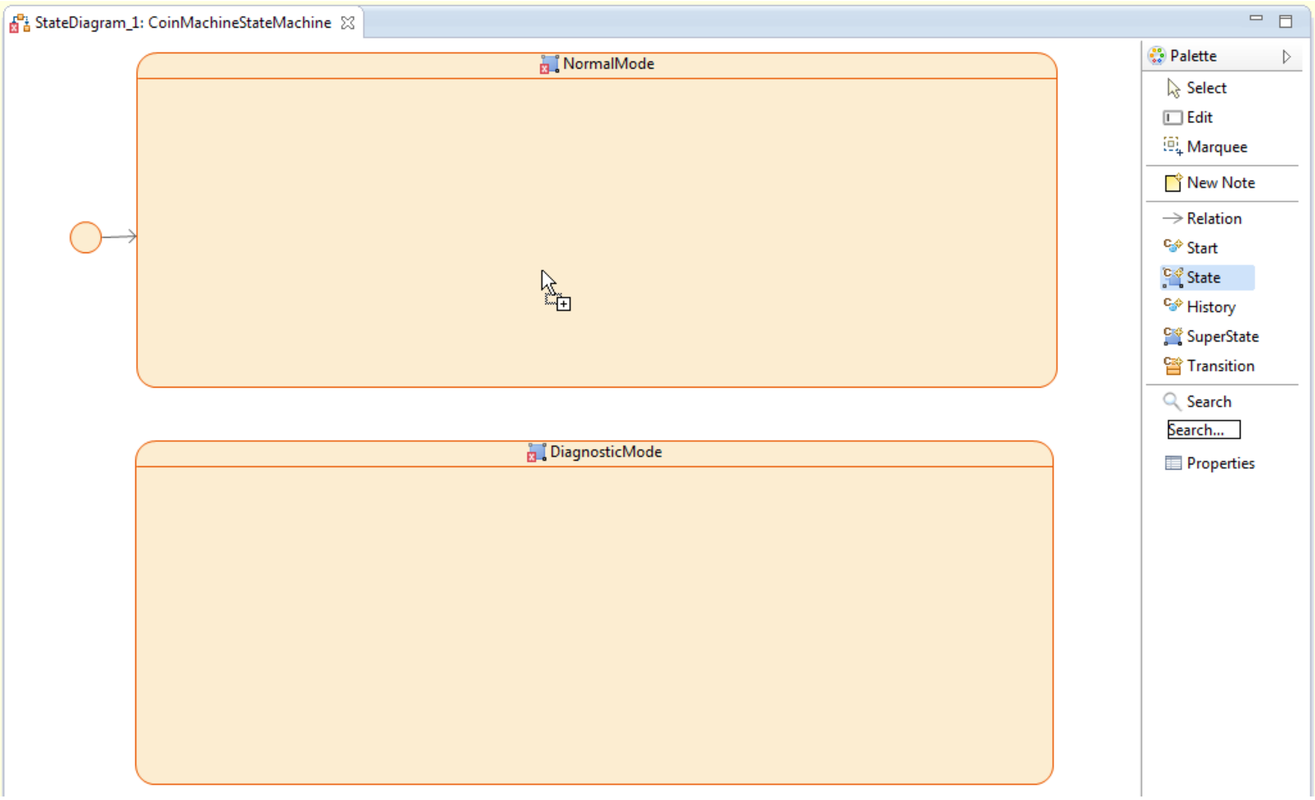

Now, we create nested states to define the behavior in the NormalMode:

- Select State from the Palette and left-click in the lower section of the NormalMode state to create a nested state in the superstate NormalMode
- Enter the name `Locked` as name of the State in the **New Resource Wizard**
- In the same way create the two nested states Locked and Empty in the NormalMode and the two nested states TestLock and TestCoin in the superstate DiagnosticMode

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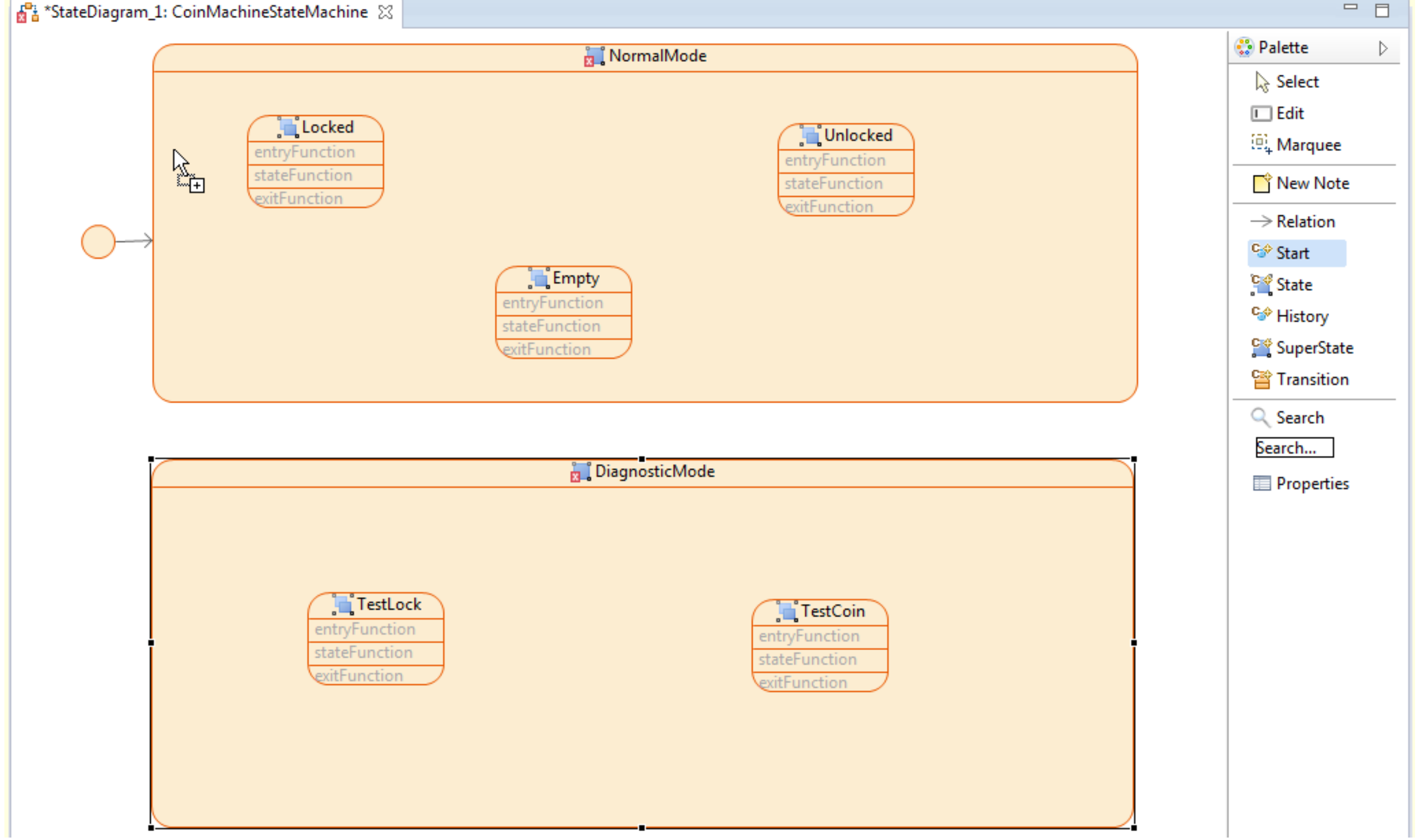

- Select Start from the Palette and left-click in the lower section of the NormalMode state (see above) to create a default or start state
- As before, select Relation from the Palette and create a relation from the start state to the state Locked
- In the same way, create a start state in the DiagnosticMode and create a relation from this start state to the state TestLock

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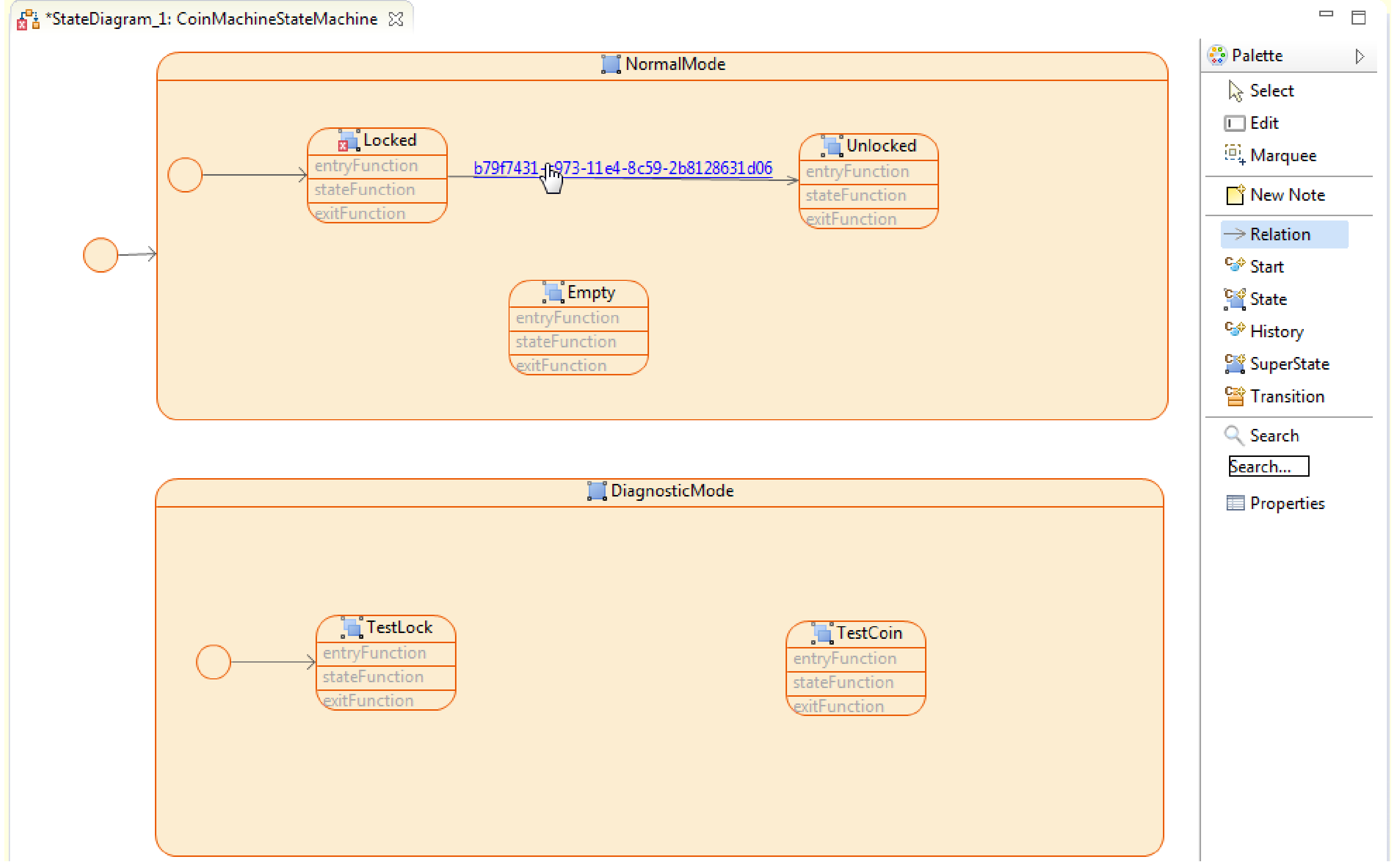

Next, we define the state transitions and events:

- Select Relation from the Palette and create a relation from the state Locked to the state Unlocked
- With Control+Click on the GUID of the newly created relation, you can now open the transition in the **Resource Editor**

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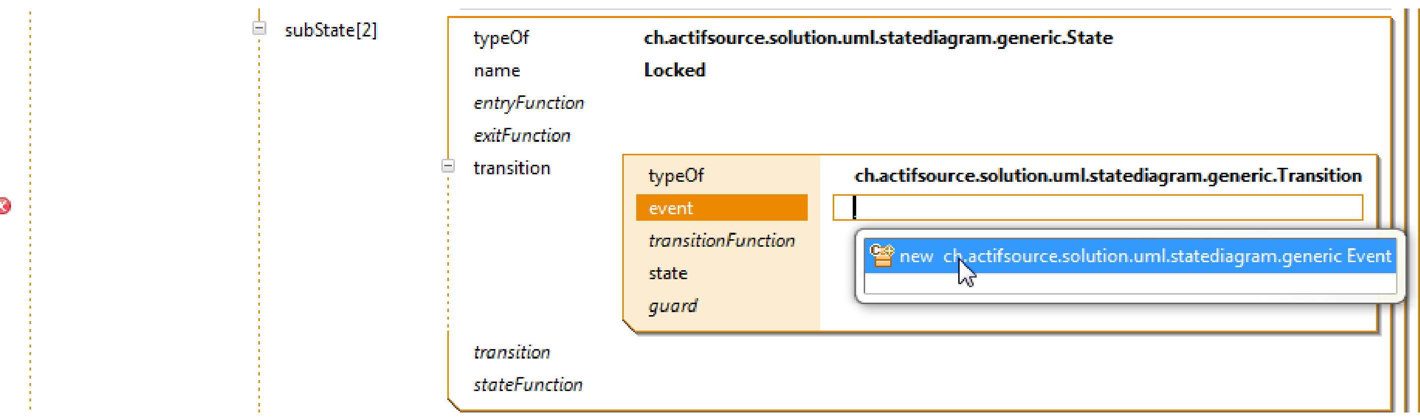

- In the **Resource Editor**, create a new Event for the transition from state Locked to Unlocked
- Give the name `Coin` to the newly created event

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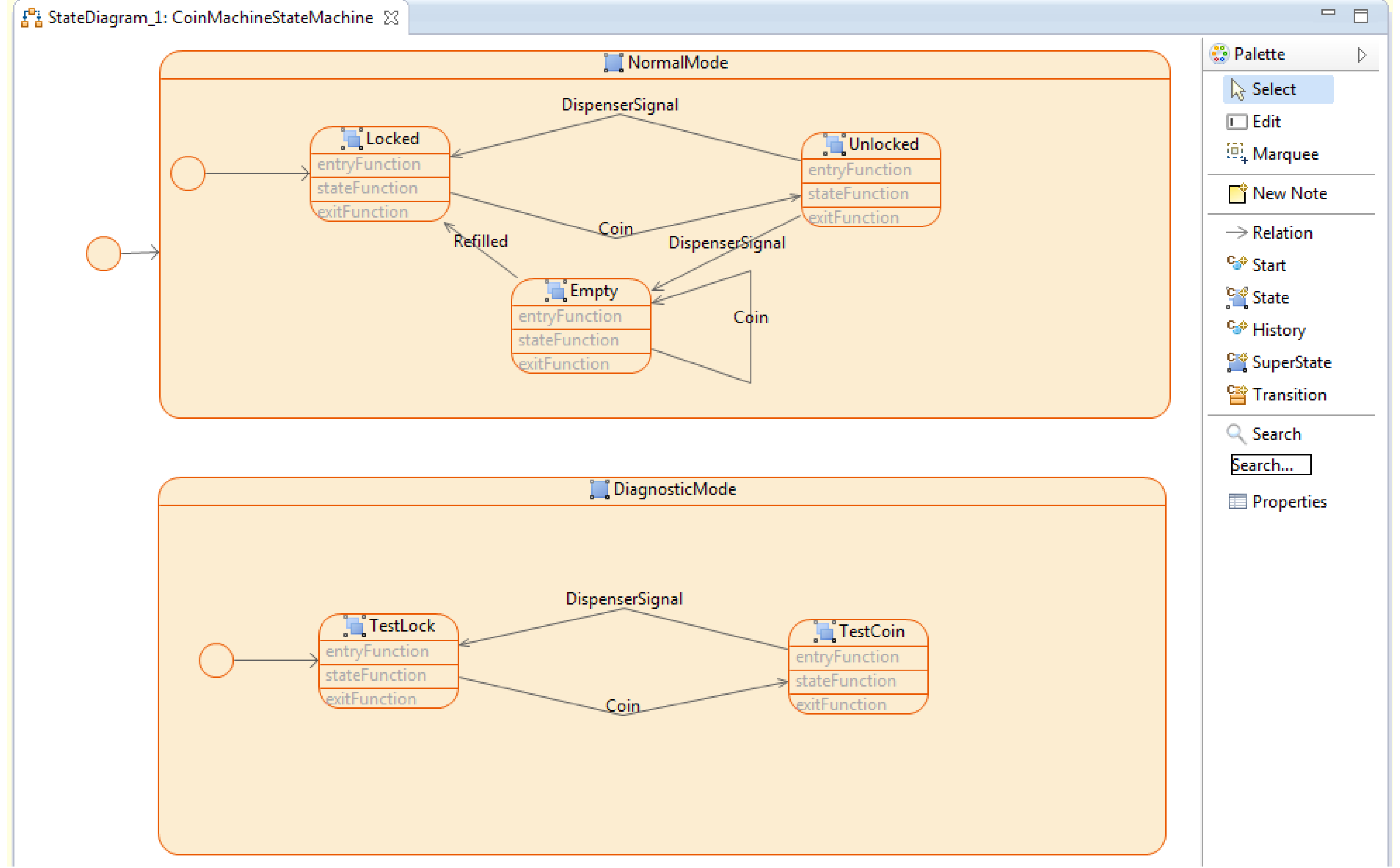

- Switch to the open StateDiagram_1 in the **Diagram Editor** and check that the transition from Locked to Unlocked is now labeled 'Coin'
- In the same way, create the following transition and events: Unlocked-(DispenserSignal)->Locked, Empty-(Refilled)->Locked, Empty-(Coin)->Empty, TestCoin-(DispenserSignal)->TestLock, TestLock-(Coin)->TestCoin

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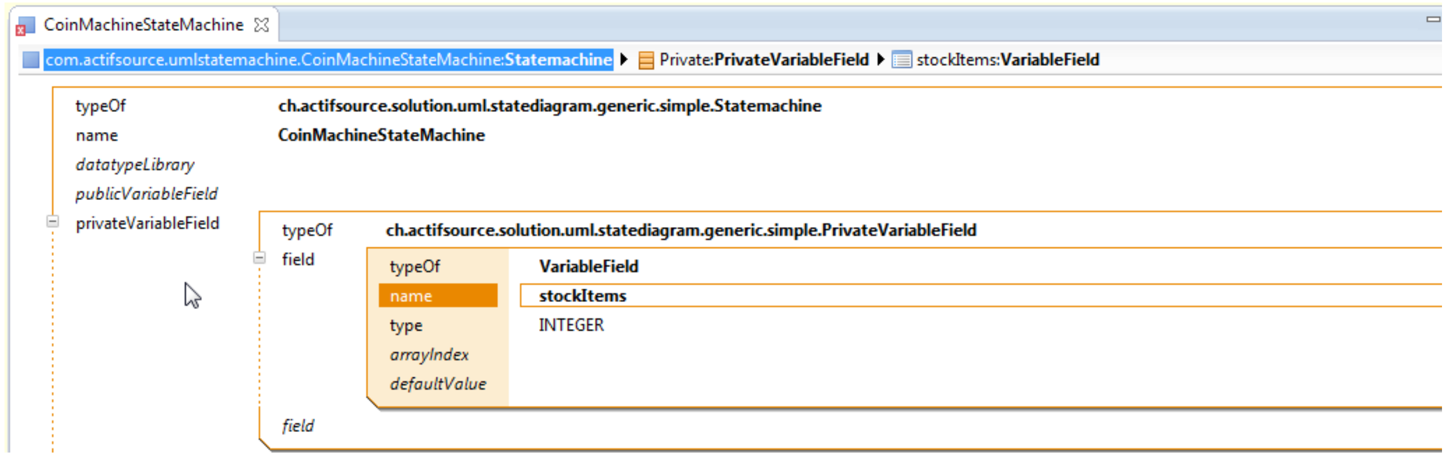

We want to create a condition that is only true if the machine is non-empty. Thereto, we introduce a variable stockItems that keeps track of the number of items left in the machine:

- Open CoinMachineStateMachine the **Resource Editor**
- Add a **PrivateVariableField** to the CoinMachineStateMachine
- Create a **VariableField** with name `stockItems` and with type INTEGER as **field**

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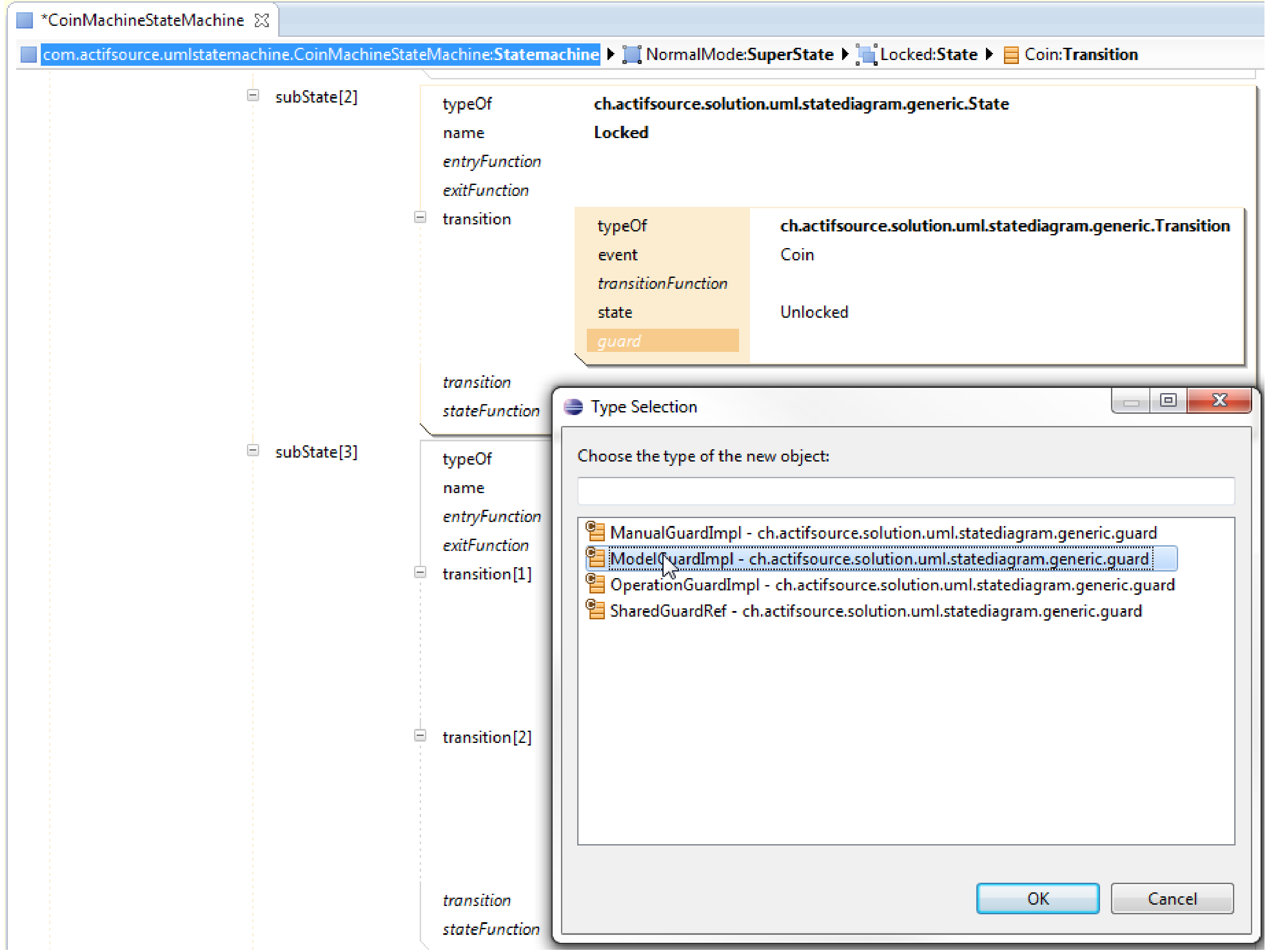

Next, we add guards to transitions such that the corresponding transitions only "fire" if the guard evaluates to TRUE:

- By Control+Click on the transition Unlocked-(Coin)->Locked, open the transition in the resource editor
- Use the Content Assist to create a new **ModelGuardImpl** named hasStockItems as guard of the transition (see above)

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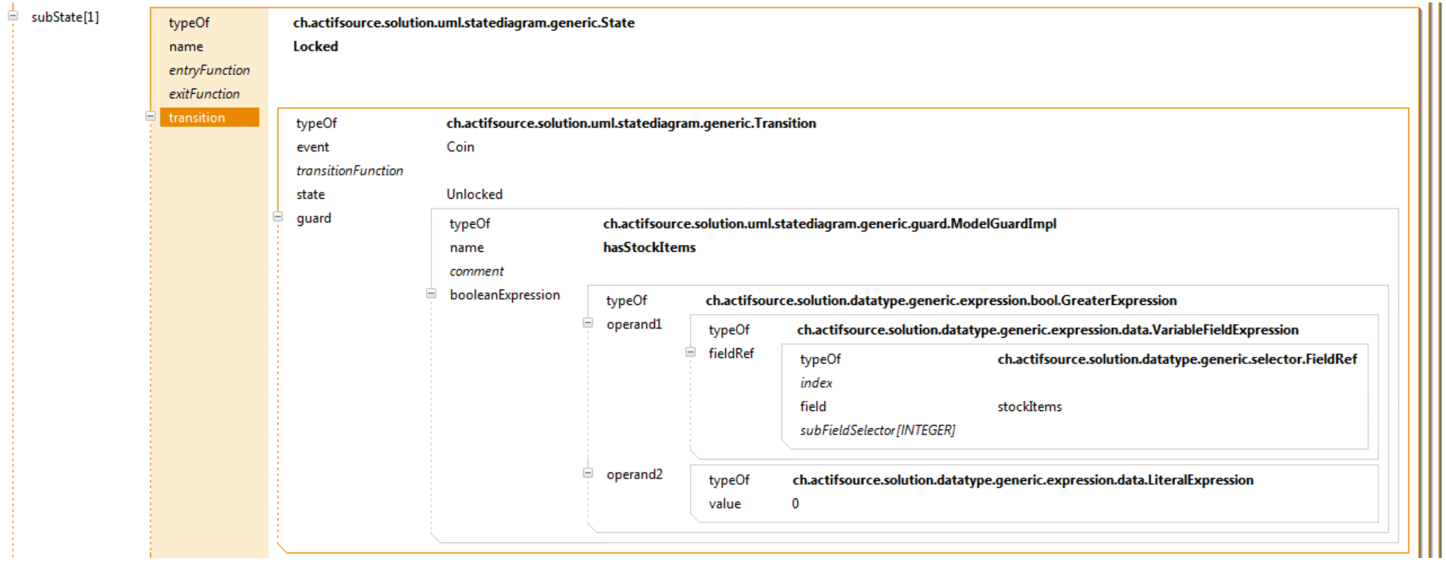
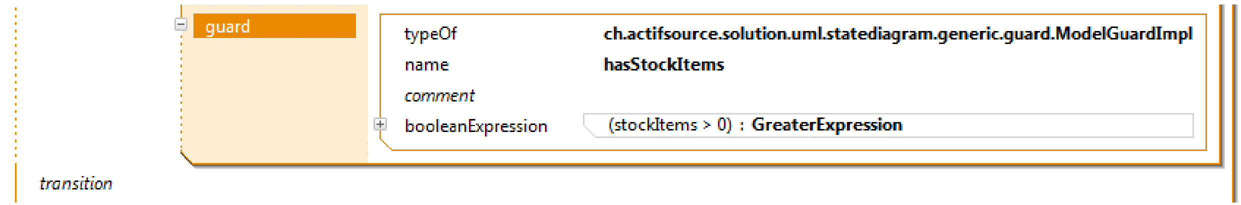


- Add a **GreaterExpression** as booleanExpression to the **ModelGuardImpl**
- Create an **operand1** of type **VariableFieldExpression** with a fieldRef with the **VariableField** stockItems as field
- Create an **operand2** of type **LiteralExpression** with value 0
- Close the **booleanExpression**: Note that the Boolean expression stockItems > 0 is now displayed to represent the condition of the guard



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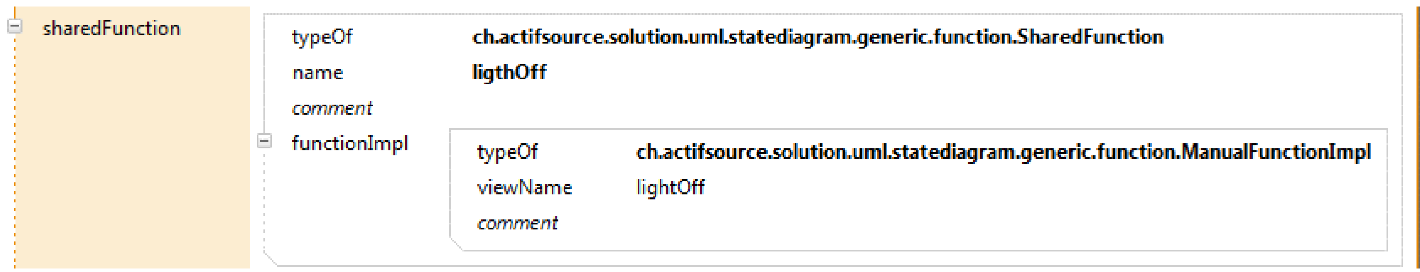

Next, we add actions that are executed together with transitions and introduce shared functions which can be used as actions by multiple transitions:

- Open CoinMachineStateMachine in the **Resource Editor**
- Create a new **SharedFunction** called lightOff as **sharedFunction** to CoinMachineStateMachine
- Create a new **ManualFunctionImpl** with **viewName** lightOff as **functionImpl** to the **SharedFunction**

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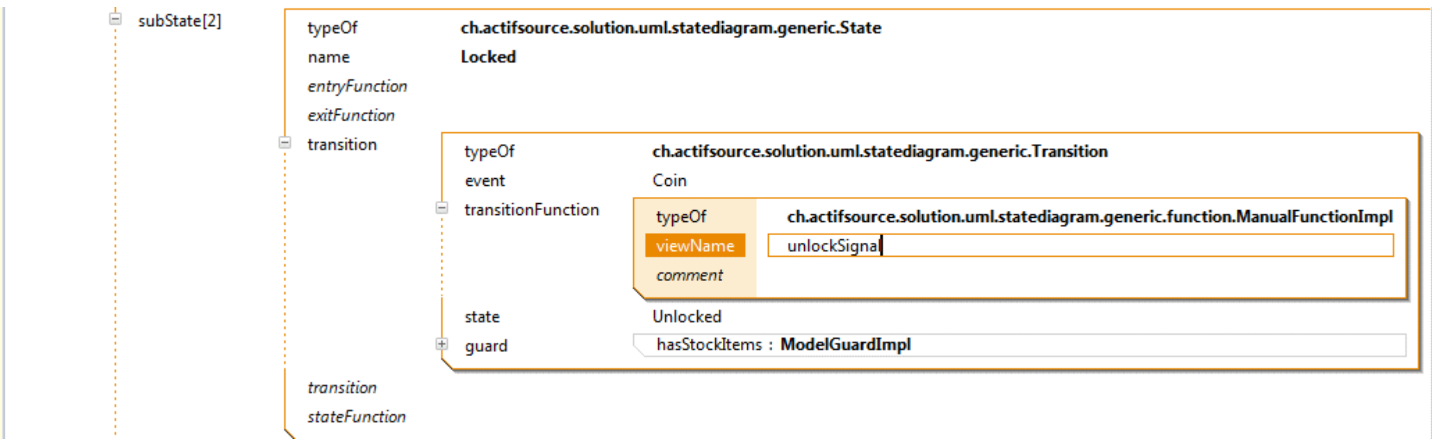
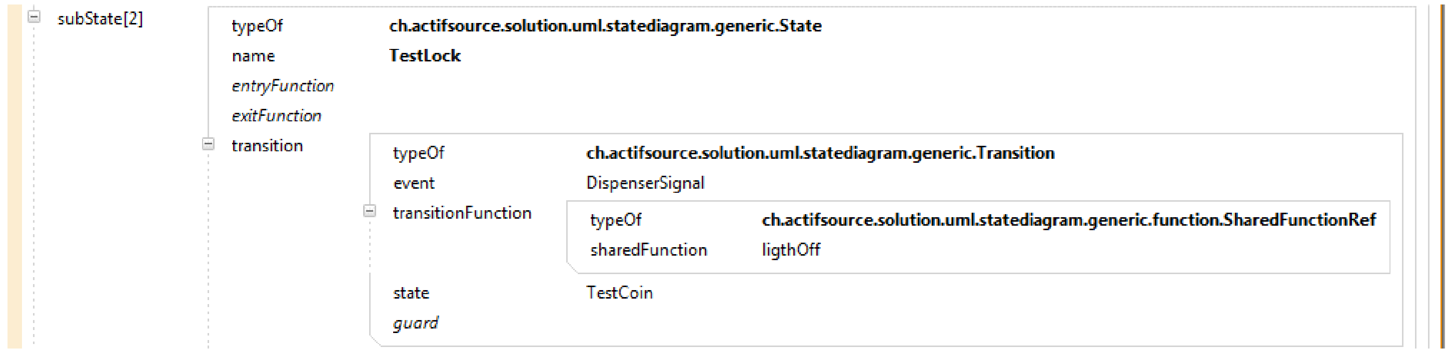


- Add a **transitionFunction** of type **ManualFunctionImpl** to the transition Locked->Unlocked (see above)
- In the same way create the following transitionFunctions of type **ManualFunctionImpl**:
  - rejectCoin (Empty->Empty)
  - lightOn (TestCoin->TestLock)



- Add a **transitionFunction** of type **SharedFunctionRef** to the transition TestLock->TestCoin which uses the **sharedFunction** lightOff

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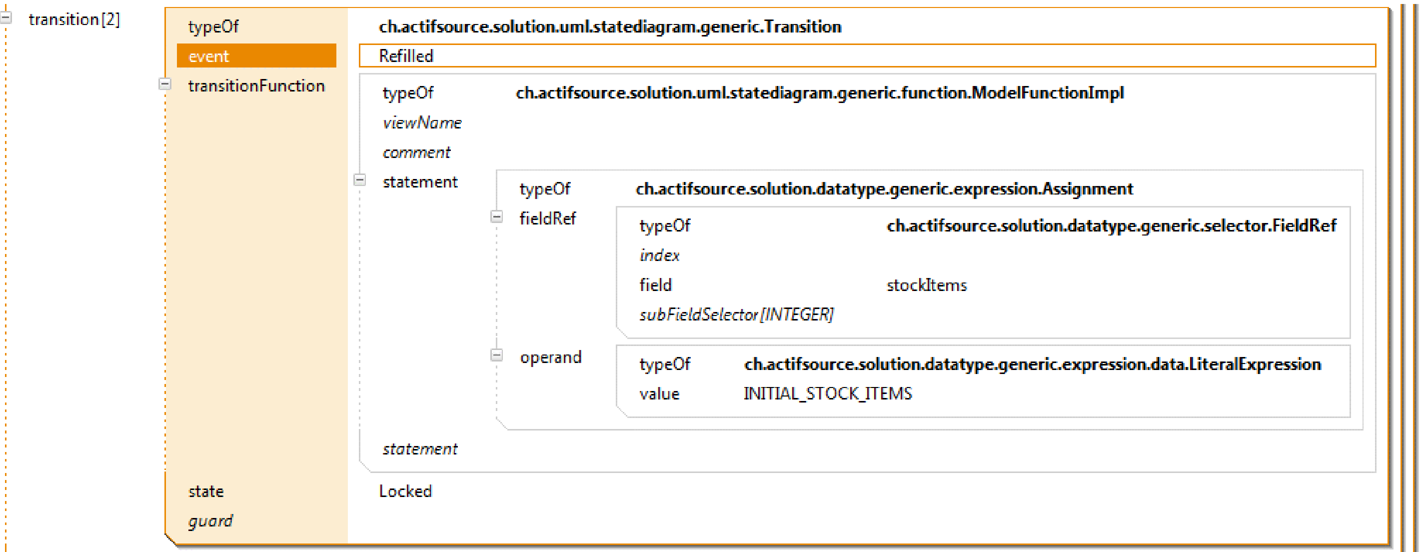

When the event Refilled occurs, the variable stockItems (i.e, the private variable that counts the number of stock items) should be set to the initial numbers of items:

- Add a transitionFunction of type **ModelFunctionImpl** to the transition Empty-(Refilled)->Locked
- Add a **statement** of type **Assignment** to the **ModelFunctionImpl**
- Insert a fieldRef with field stockItems
- Add an **operand** of **LiteralExpression** with **value** INITIAL_STOCK_ITEMS

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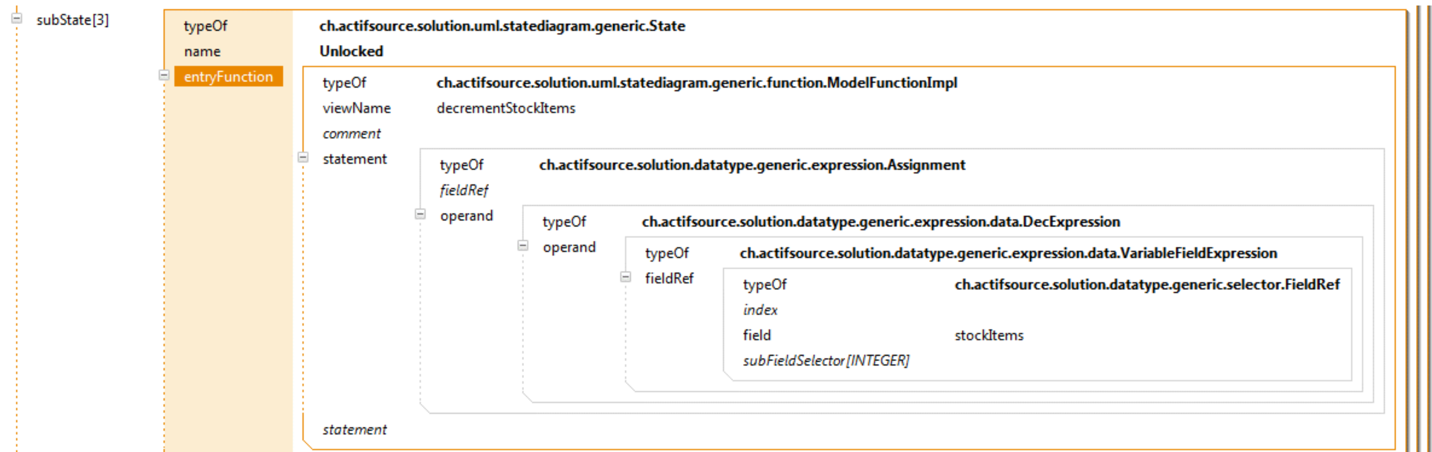

Each time the machine is unlocked, the number of stock items should be decremented by one:

- Create a new **ModelFunctionImpl** named decrementStockItems as entryFunction of the state Unlocked
- Add an **Assignment** as **statement** with an **operand** of type **DecExpression**
- Add an **operand** of type **VariableFieldExpression** to the **DecExpression**
- Add a **fieldRef** of type **FieldRef** to the **VariableFieldExpression** and use stockItems as field

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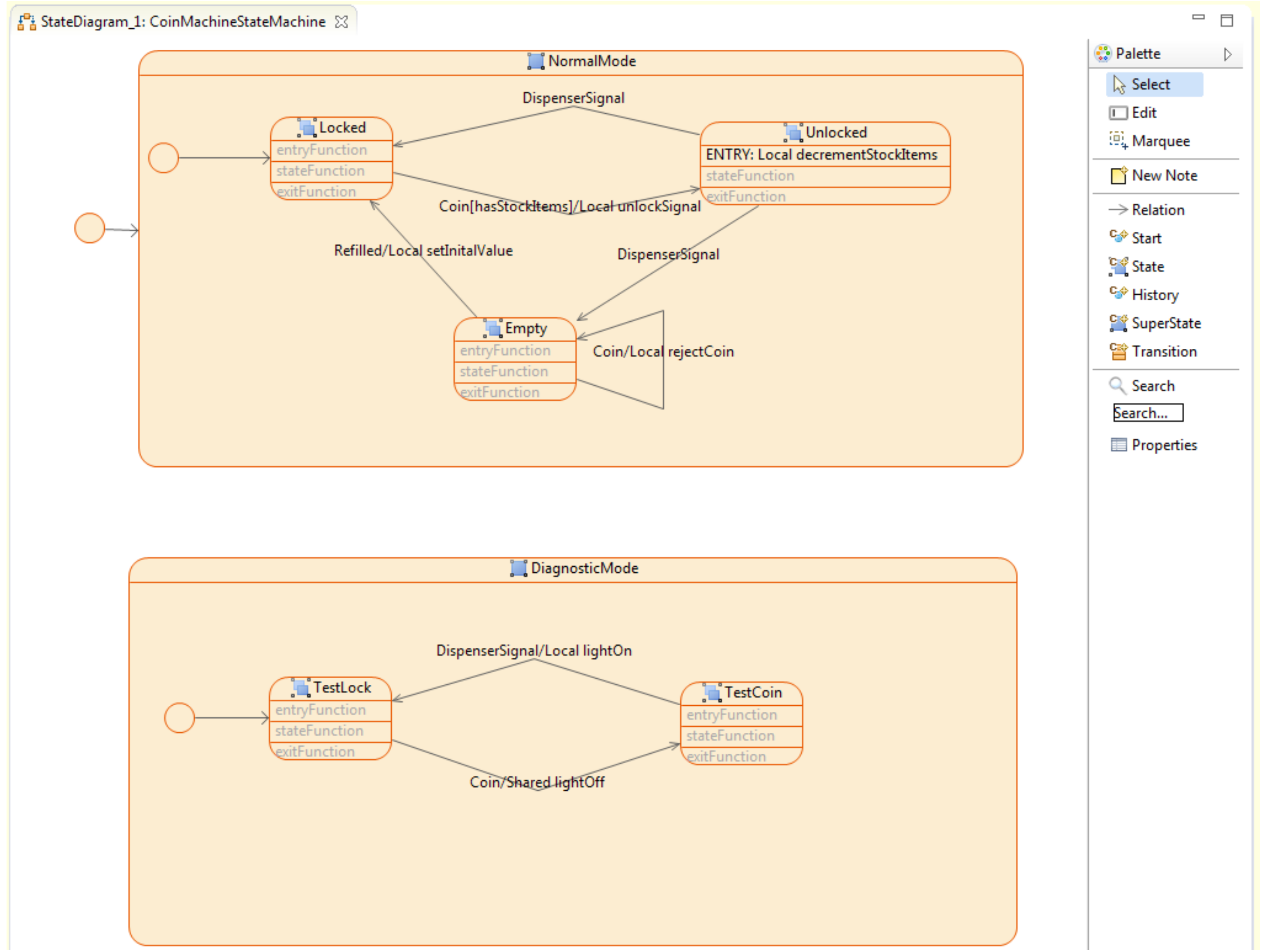

↳ Open the StateDiagram_1 in the **Diagram Editor** and check that all the actions are displayed correctly as shown above

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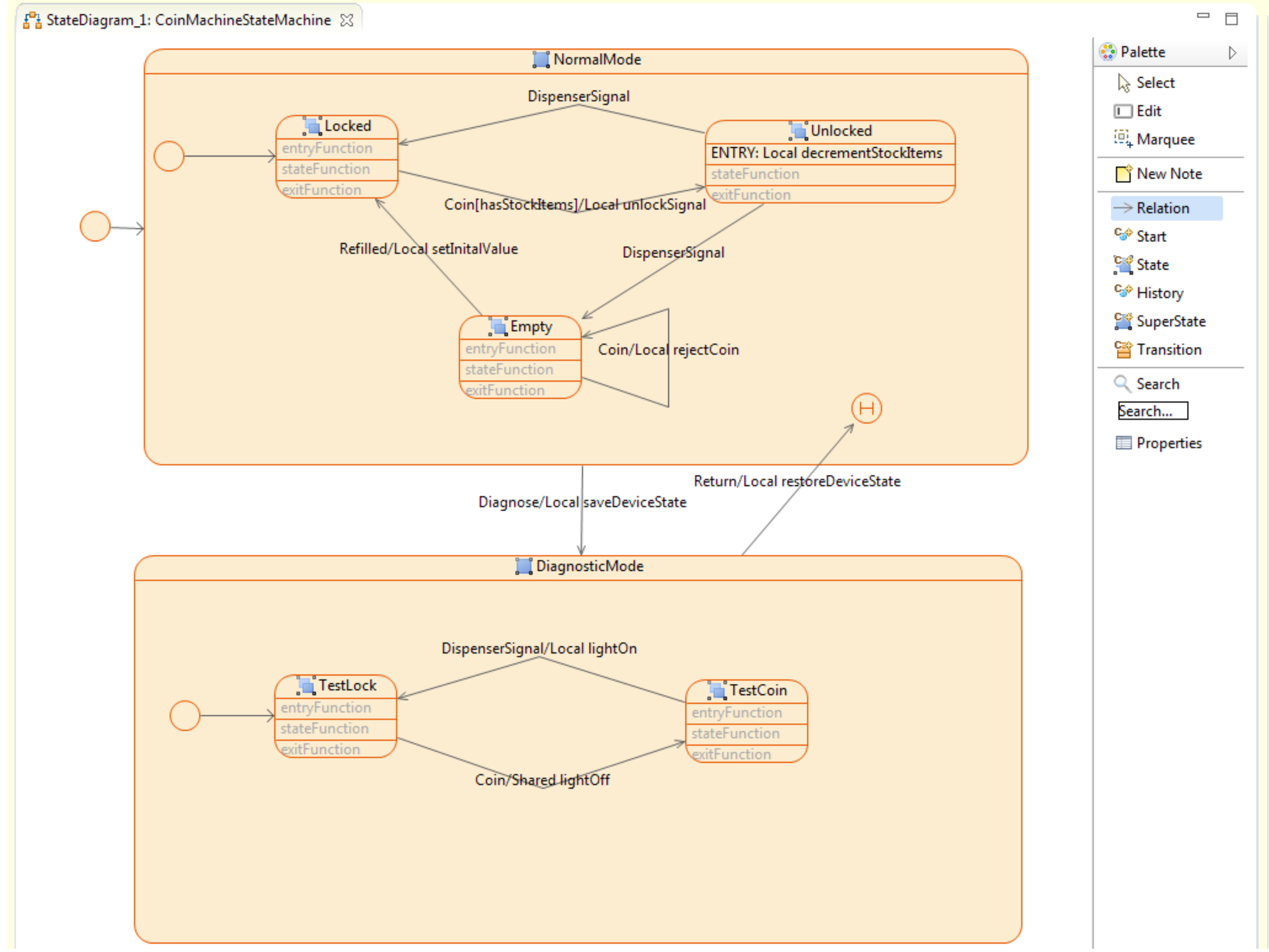

We add a transition that is triggered by an event Diagnose from the NormalMode to the DiagnosticMode (i.e., a technician should be able to switch to this diagnose state from any state in the normal mode). To save the state of the machine before switching modes, we introduce a history state:

- Add a history state by selecting History from the Palette
- Insert a transition triggered by a new event Return from the DiagnosticMode to the history state
- Create a transition triggered by a new event Diagnose from the NormalMode to the DiagnosticMode

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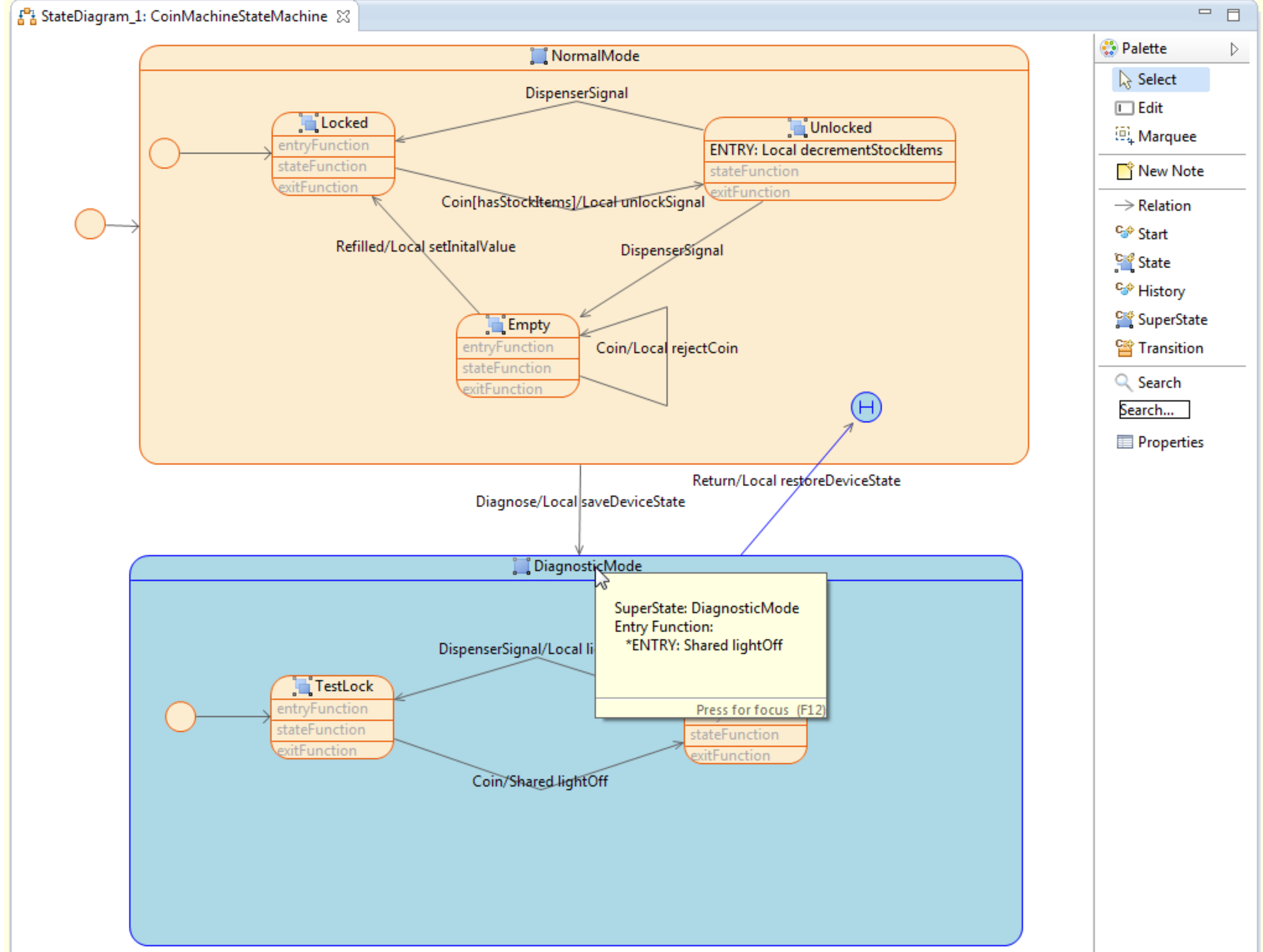

Since the state of the DiagnosticMode is not saved before returning to the NormalMode, the light should be switched off when entering the diagnostic mode:

- Open the CoinMachineStateMachine in the **Resource Editor**
- Add an **entryFunction** of type **SharedFunctionRef** to the DiagnosticMode and use lightOff as the **sharedFunction**
- The entry function is now displayed when selecting the DiagnosticMode in the **Diagram Editor** (see above)

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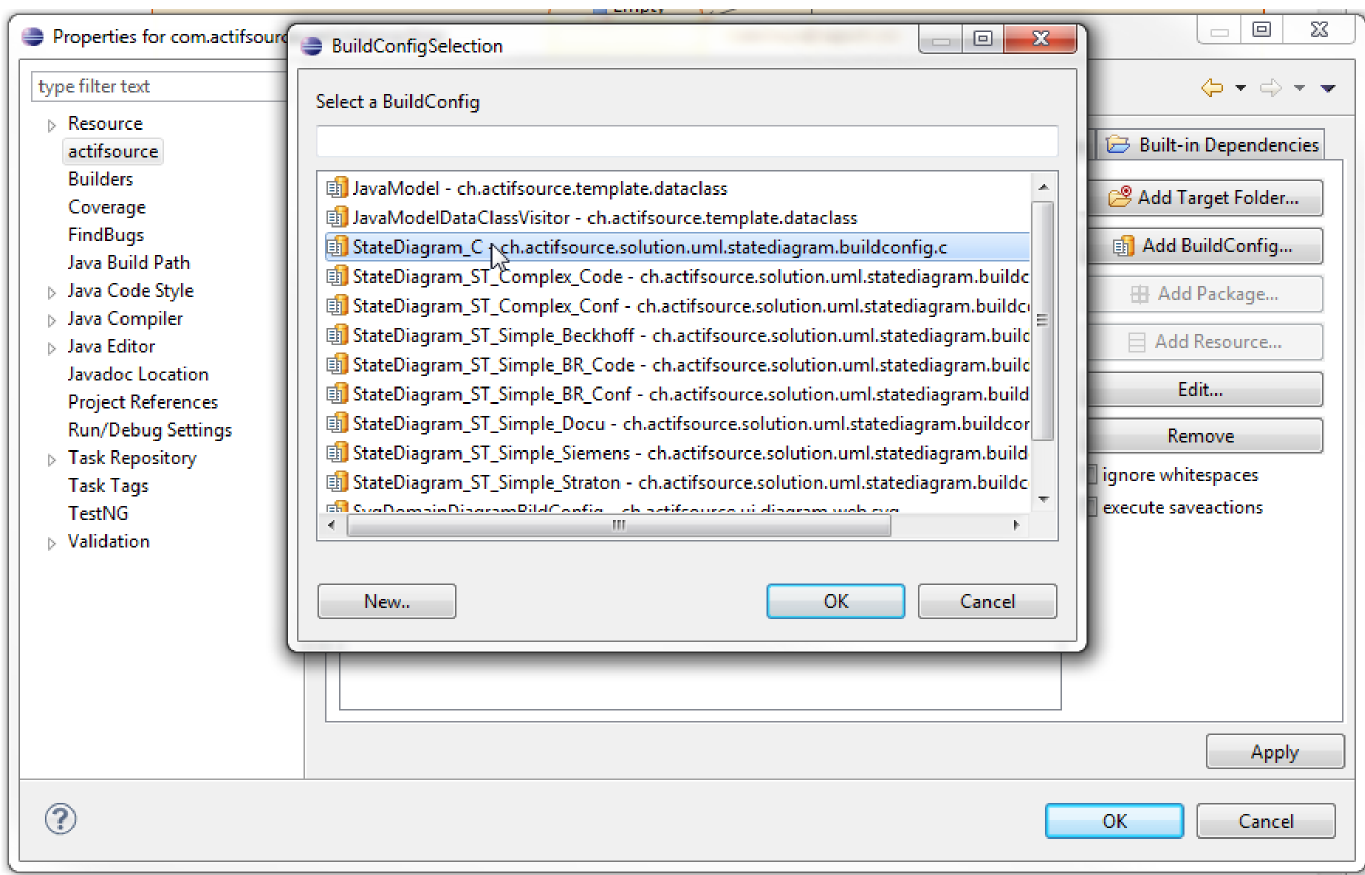
Part III: Generate code from an UML State Machine



Finally, we want to generate code that implements the specified UML state machine:

- Right-click on the project com.actifsource.umlstatemachine in the **Project Explorer** and select Properties from the menu
- Select actifsource in the Properties dialog and go to the **Target Folder** tab
- Click on **Add Target Folder**, create a new folder called src, select this folder and click OK
- Select the folder src and click on **Add BuildConfig** and choose the build configuration **StateDiagram_C** from the dialog. Close both dialogs by clicking OK

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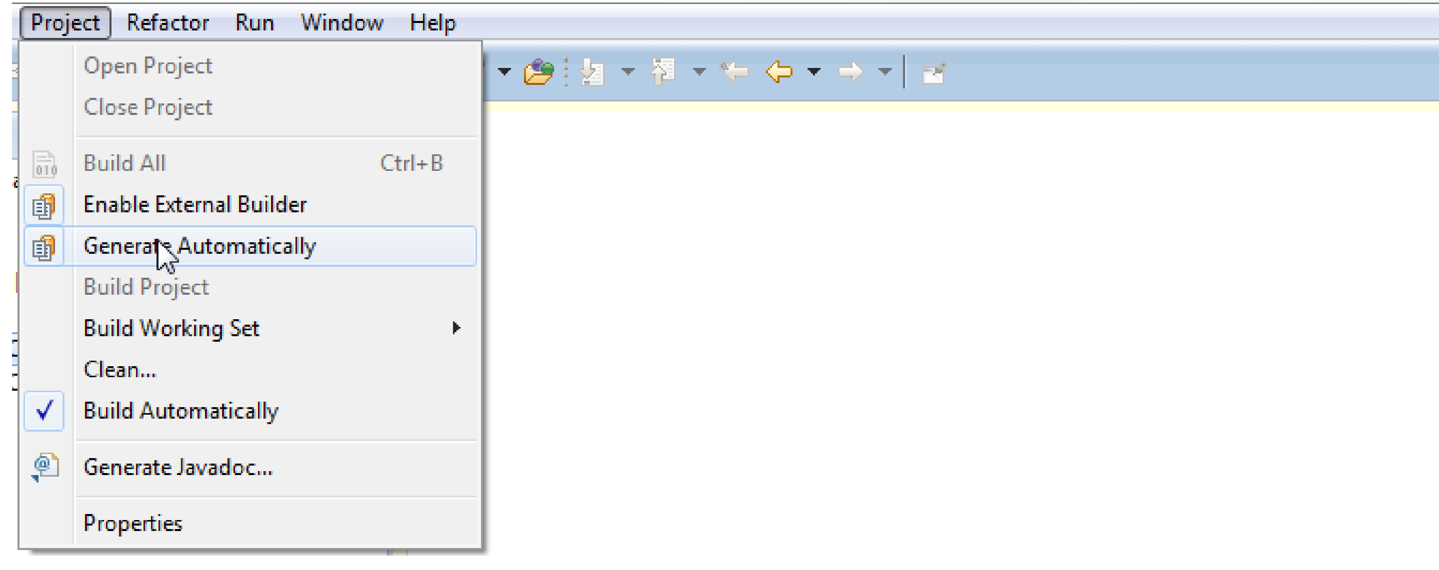
Project Explorer

- com.actifsource.umlstatemachine
  - asrc
  - Actifsource
  - JRE System Library [JavaSE-1.7]
  - src
    - Statemachine_CoinMachineStateMachine.c
    - Statemachine_CoinMachineStateMachine.h
  - src-gen

Statemachine_CoinMachineStateMachine.h | Statemachine_CoinMachineStateMachine.c

```
// (C) Copyright Actifsource GmbH  2012-2015

#ifndef Statemachine_CoinMachineStateMachine_H_
#define Statemachine_CoinMachineStateMachine_H_

// Header files from the environment

// Header files from external components

// Header files from own component

// Type and Forward declarations

/** Events for StatemachineBase CoinMachineStateMachine. */
typedef enum Event_CoinMachineStateMachine
{
  CoinMachineStateMachineEvent__Entry = -3,
  CoinMachineStateMachineEvent__State = -2,
  CoinMachineStateMachineEvent__Exit = -1,
  CoinMachineStateMachineEvent_Coin,
  CoinMachineStateMachineEvent_DispenserSignal,
  CoinMachineStateMachineEvent_Refilled,
  CoinMachineStateMachineEvent_Return,
```

- Open the folder src and make sure that the two files Statemachine_CoinMachineStateMachine.c and Statemachine_CoinMachineStateMachine.h have been generated and inspect the generated code
- ⓘ If the two files have not been generated, check that the option **Generate Automatically** is active. If not, the code can also be generated manually as follows: right-click on the project in the Project Explorer and choose **Generate Code** from the menu.



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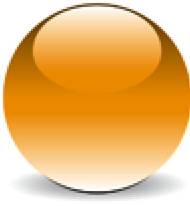

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