

A QoS-aware Integrated Model Checking Environment for Developing and Validating DRE Applications

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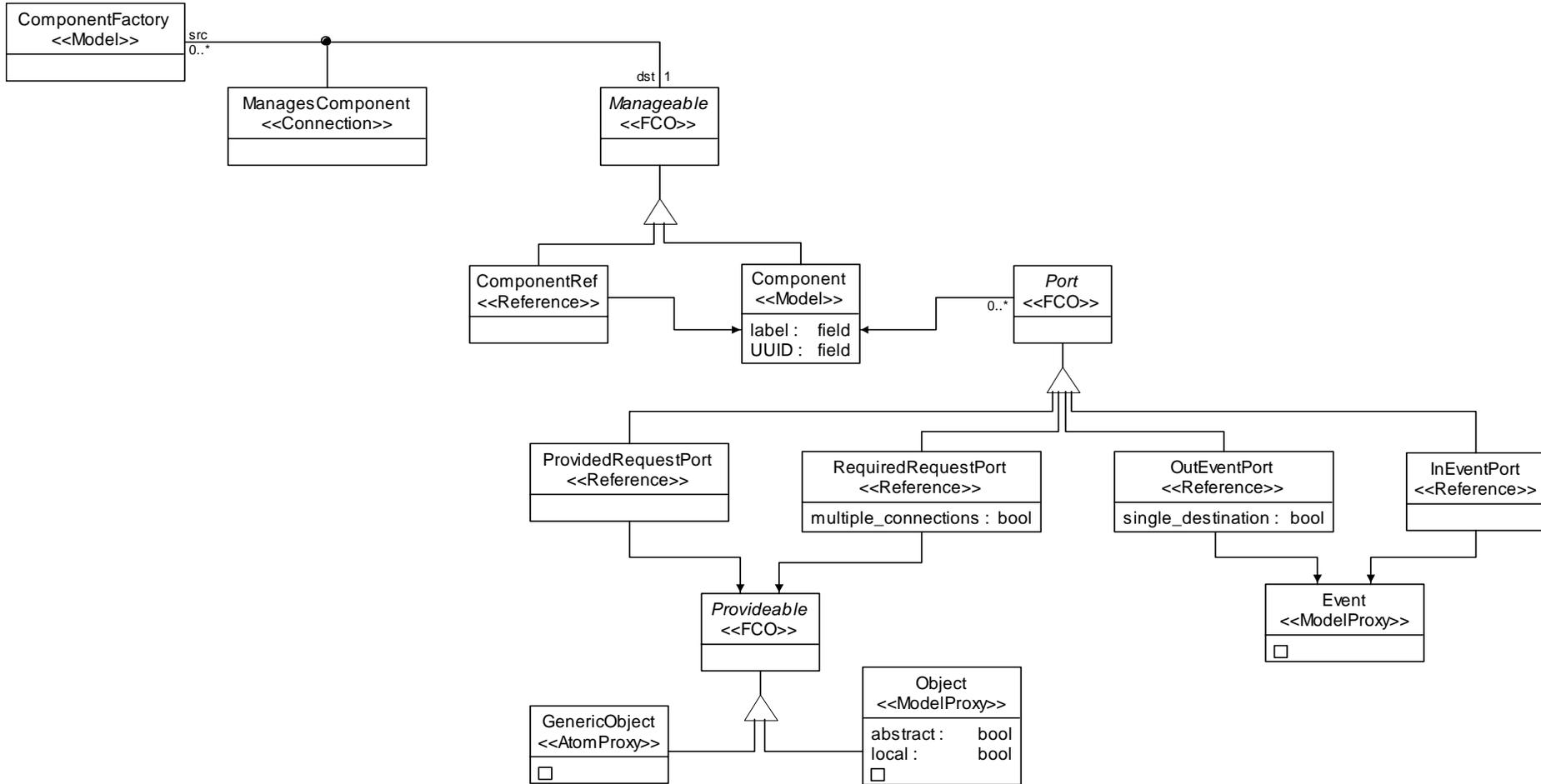


Platform Independent Component Modelling Language

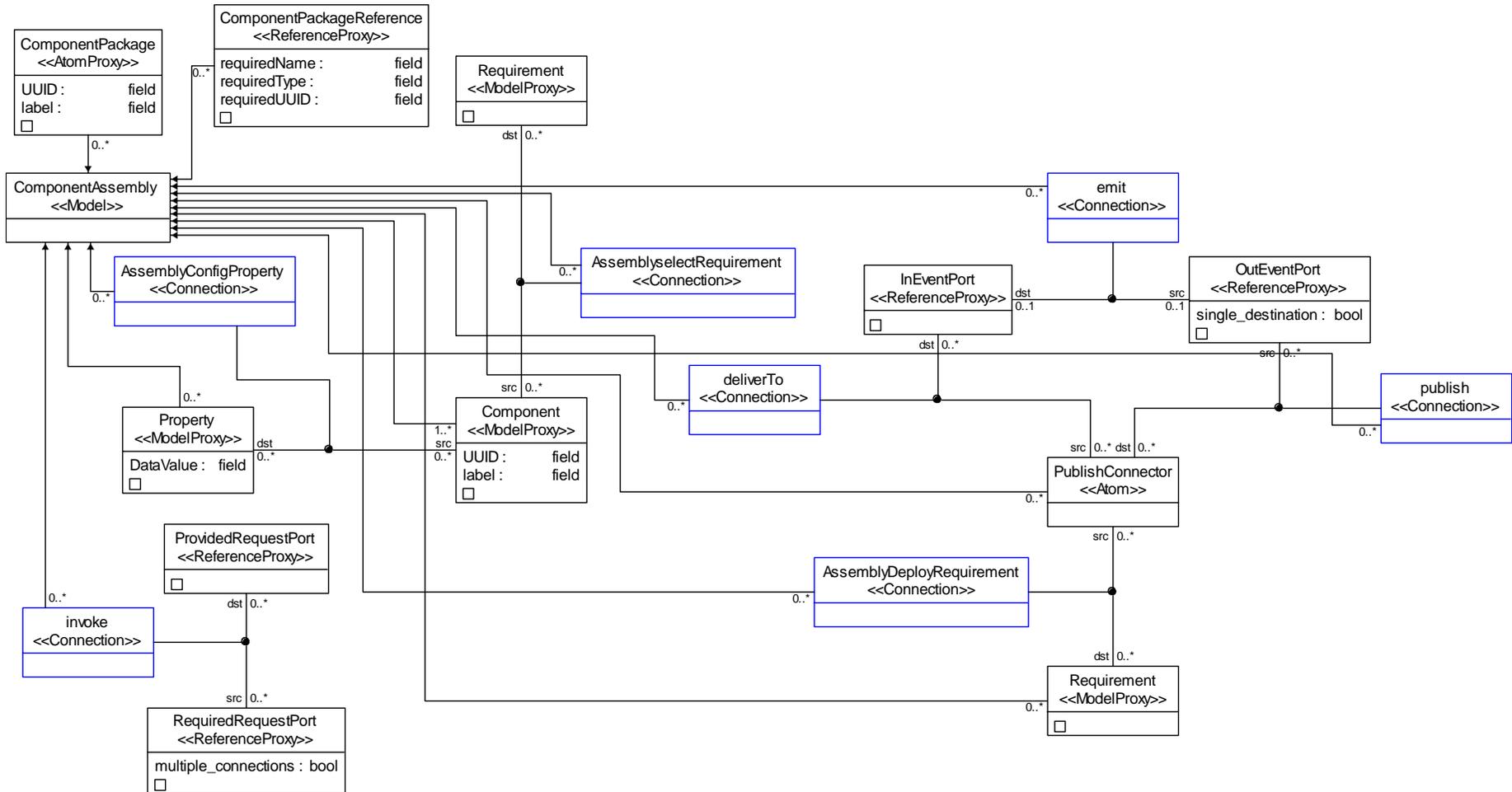


K-State
Kansas State University

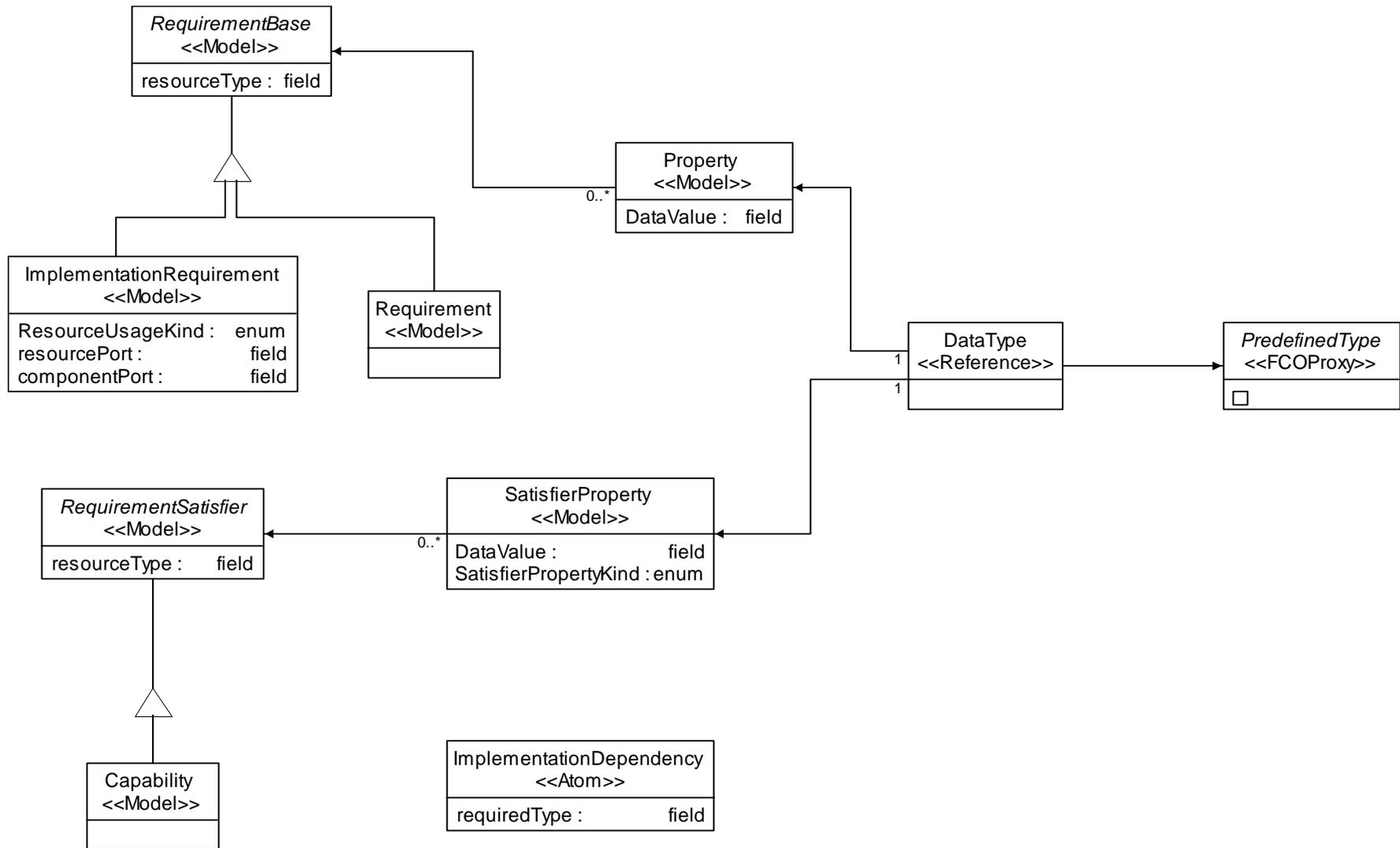
PICML Meta: Components



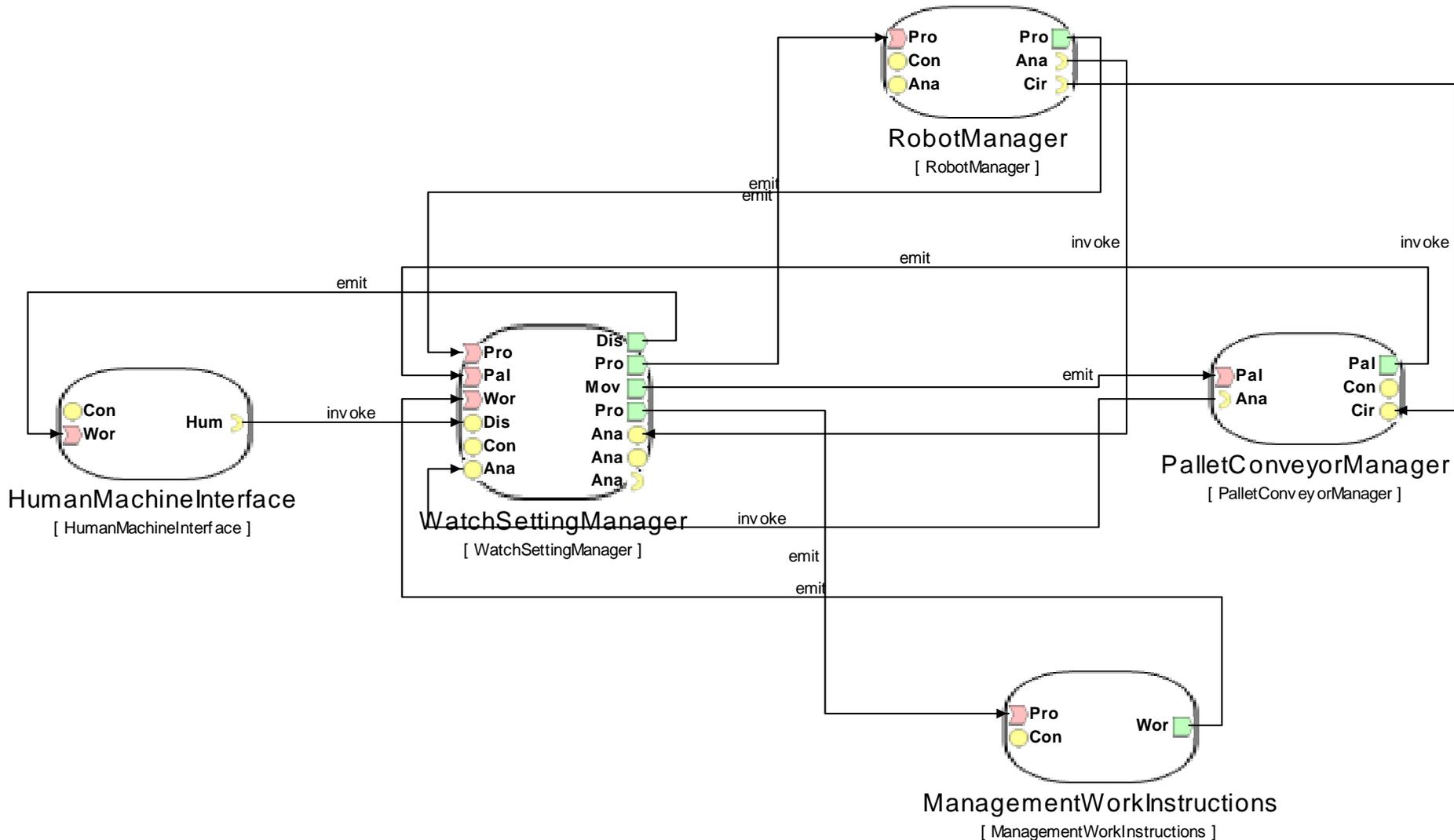
PICML Meta: Assemblies



PICML Meta: Properties & Requirements



A PICML Instance: Robot - Assembly



PICML Instance: Robot-Component Def.

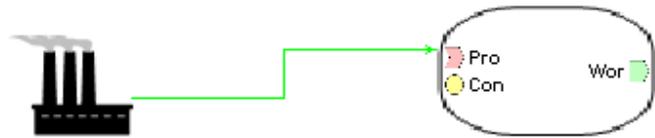
The screenshot displays the PICME IDE interface. The main workspace shows a UML diagram for the `HumanMachineInterface` component. The diagram includes four elements: a yellow circle labeled `Controller`, a yellow crescent moon labeled `HumanResponse`, a pink arrow labeled `WorkDisplayUpdate`, and a blue square with a pencil labeled `HumanLanguage`. The `HumanLanguage` element is highlighted with a red selection box.

On the right side, the Project Explorer shows a tree view of the project structure. The `HumanMachineInterface` package is selected, showing its contents: `HumanLanguage`, `HumanMachineInterfaceHome`, `Management/col/Instructions`, `Management/col/InstructionsHome`, `PalletConveyorManager`, `PalletConveyorManagerHome`, `RobotManager`, `RobotManagerHome`, `WatchGetInghManager`, and `WatchGetInghManagerHome`.

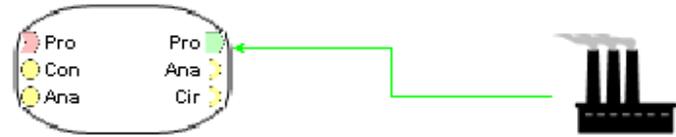
At the bottom, there is a palette of UML symbols for defining components and relationships. The symbols include: `Attribute` (blue square with pencil), `InEventPort` (pink arrow), `Inherits` (white arrow with open head), `OutEventPort` (green arrow), `ProvidedRequestPort` (yellow circle), `ReadOnlyAttribute` (blue square with pencil and red slash), `RequiredRequestPort` (yellow crescent moon), and `Supports` (cloud with arrow).

The bottom right corner of the IDE shows the `HumanMachineInterface` class details, including tabs for `Attributes`, `Preferences`, and `Properties`. The `Attributes` tab is active, showing a table with columns for `AccessFlag`, `SpecialFlag`, and `Label`.

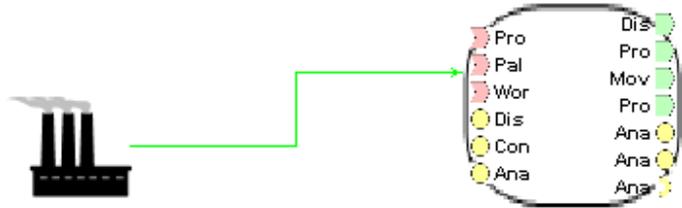
PICML Instance: Robot-ComponentHomes



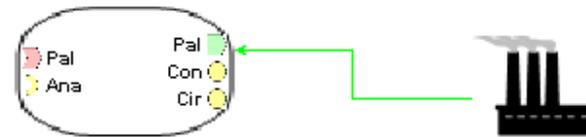
ManagementWorkInstructionsHome ManagementWorkInstructions



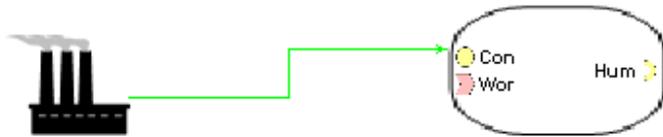
RobotManager RobotManagerHome



WatchSettingManagerHome WatchSettingManager



PalletConveyorManager PalletConveyorManagerHome

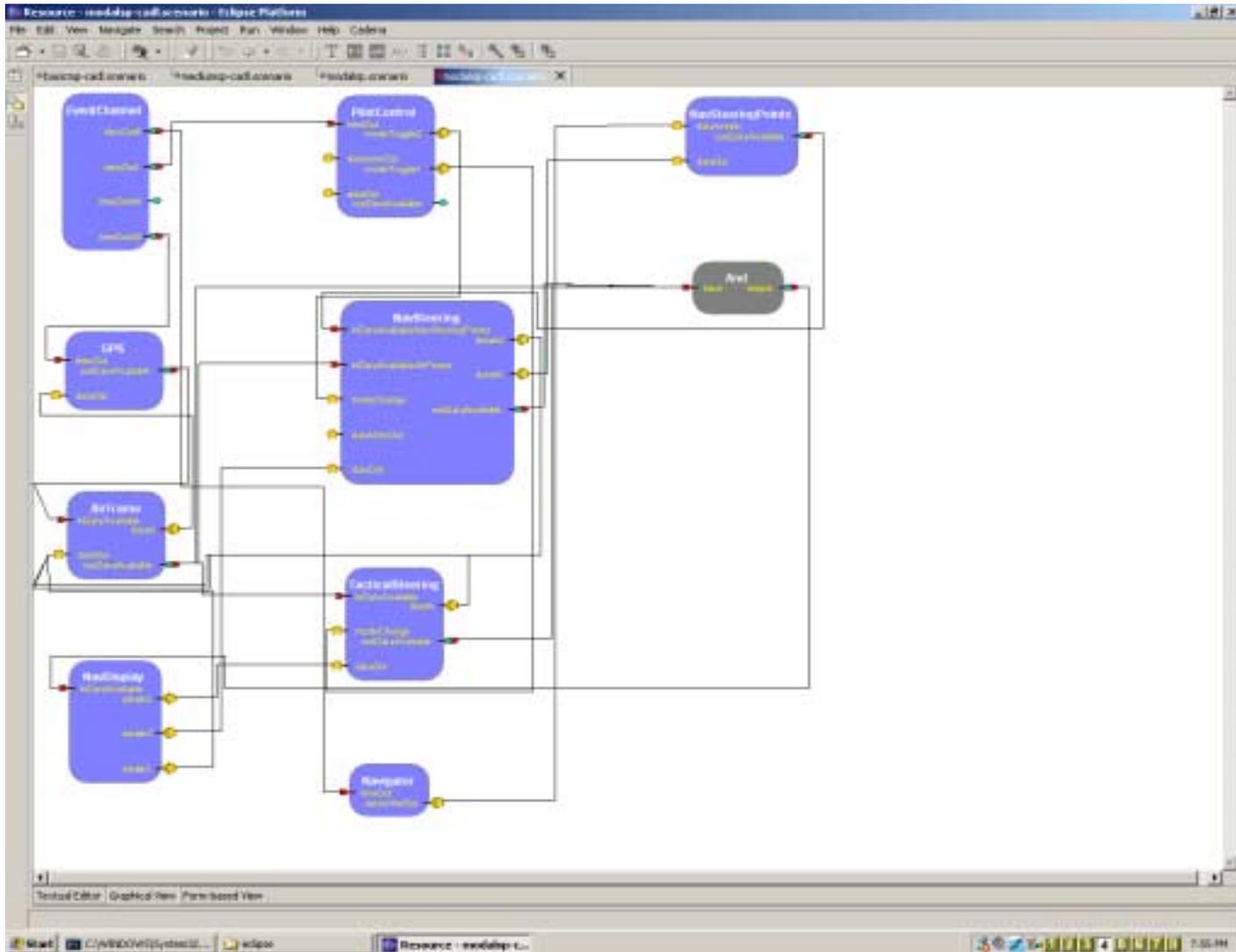


HumanMachineInterfaceHome HumanMachineInterface

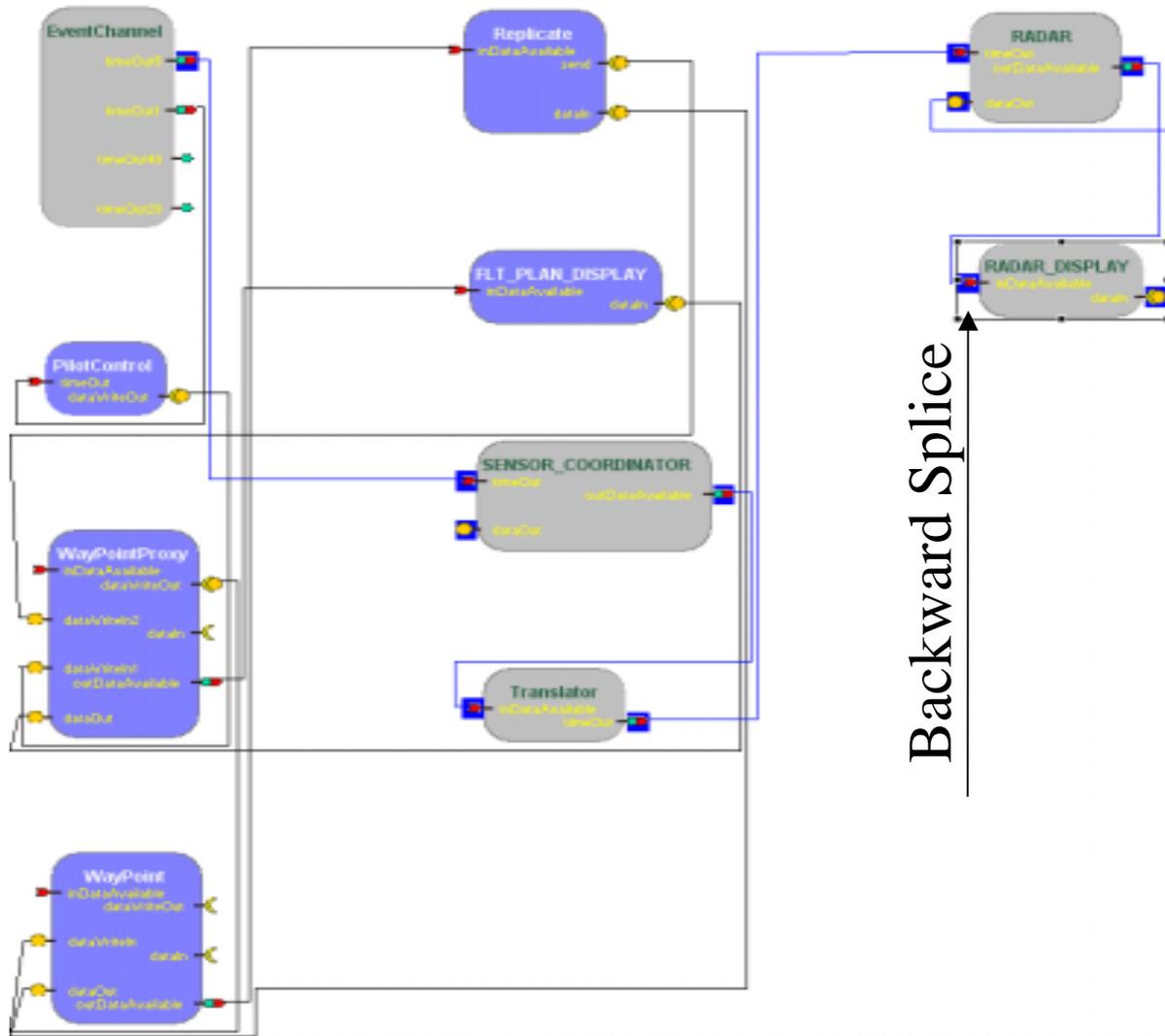
Cadena



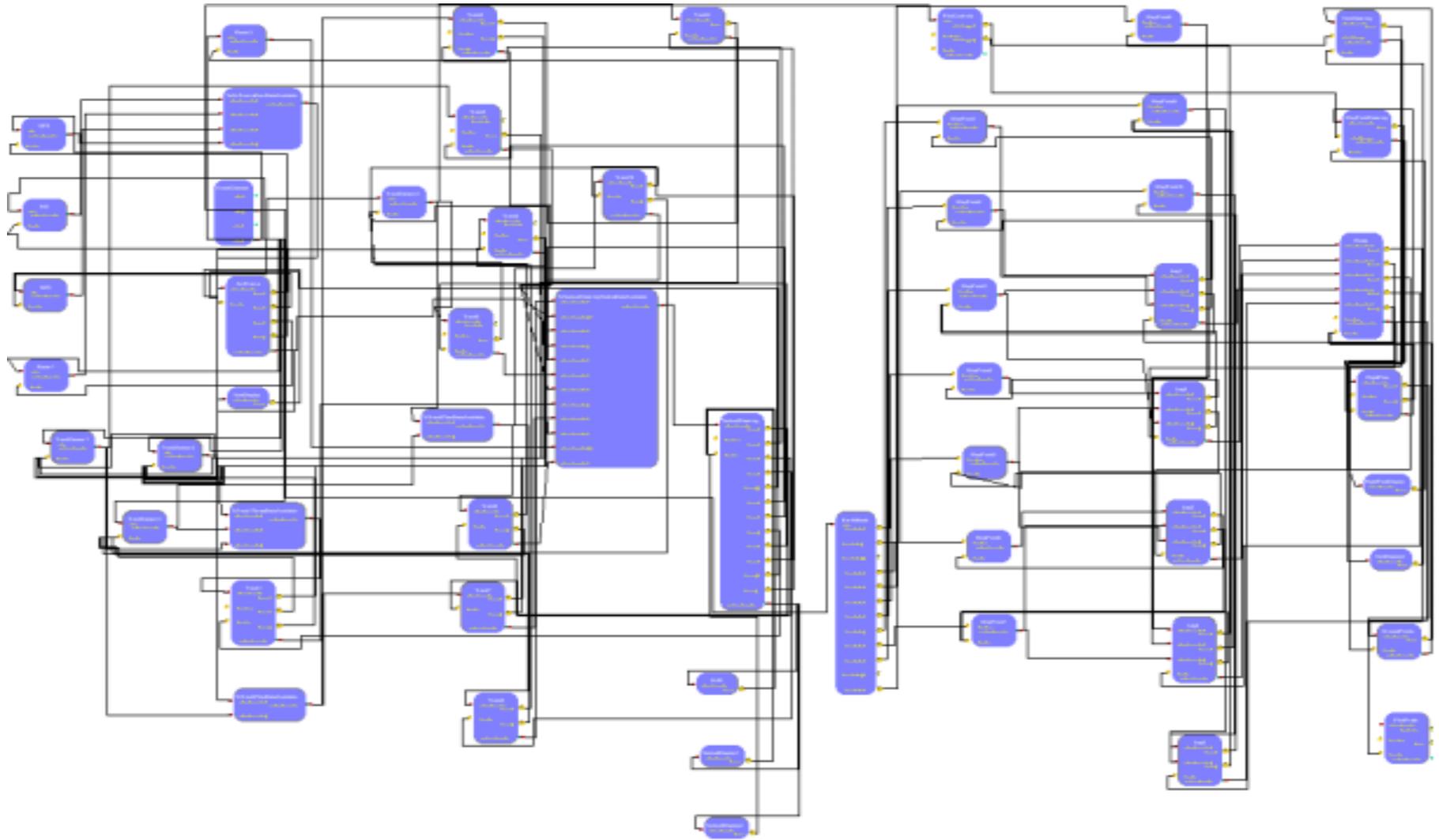
Cadena examples - ModalSP



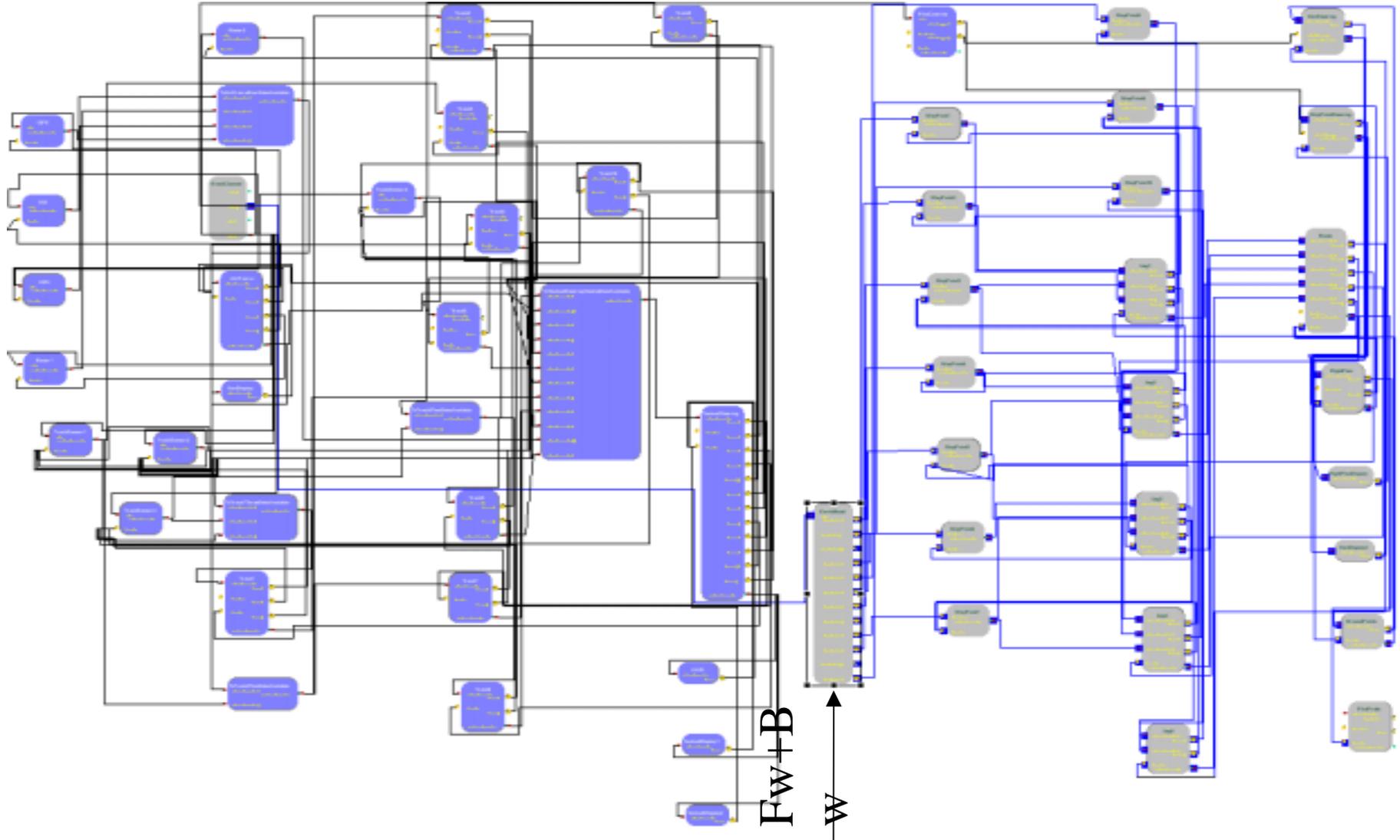
[MultirateMP] Backward Splice



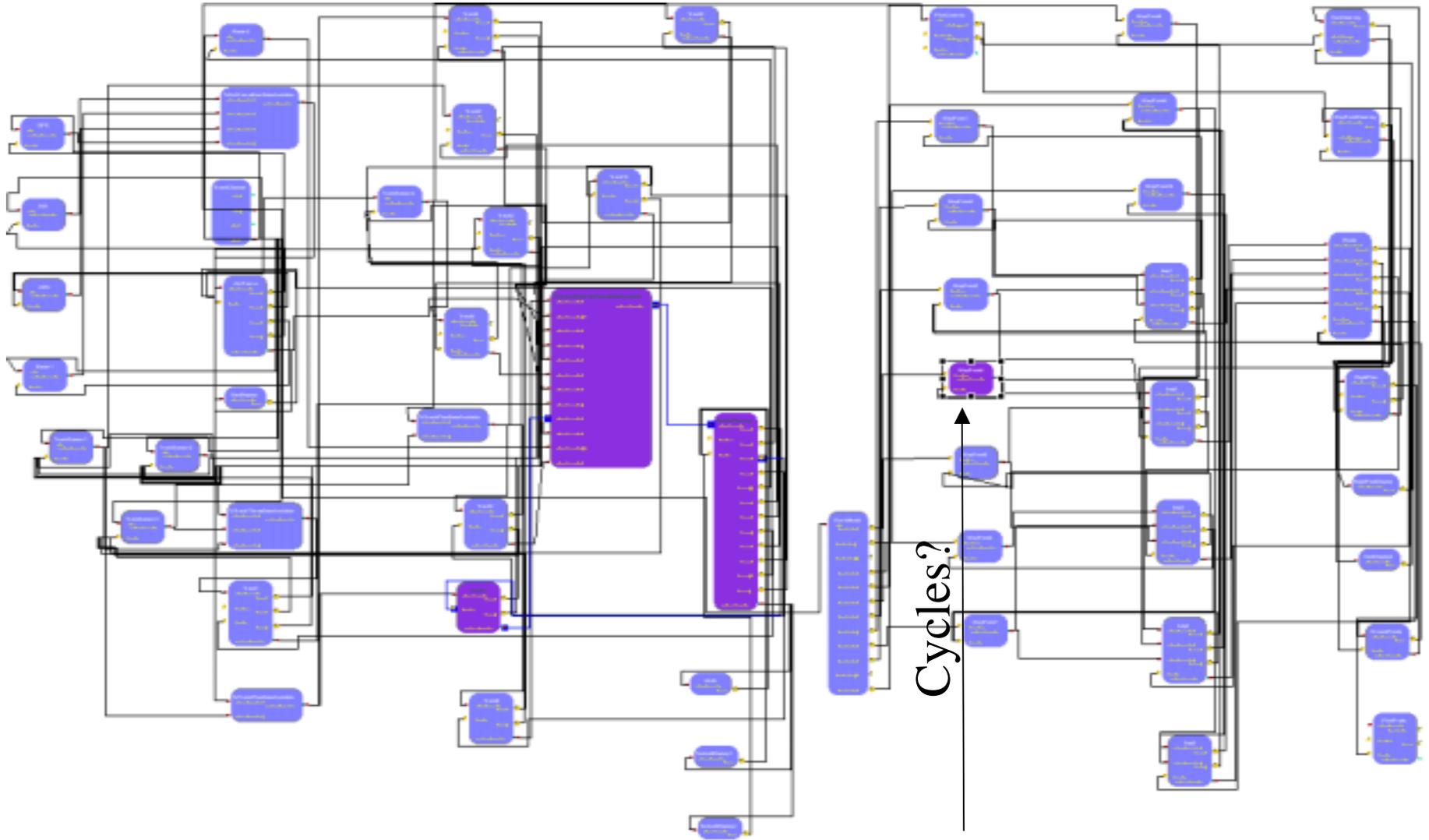
MediumSP



Forward + Backward splice



Cycle Detection



Incremental Specification

Specifications

Component Structure



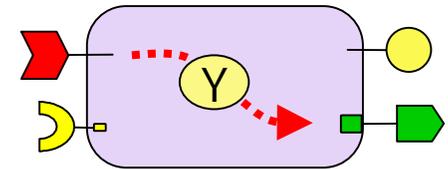
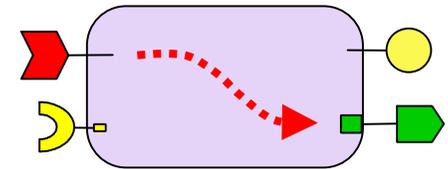
port action dependencies

refinement

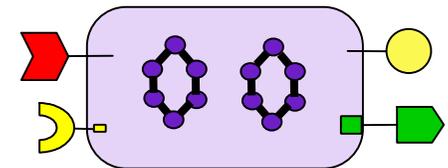
mode-based dependencies

refinement

component transition semantics



...only in mode Y

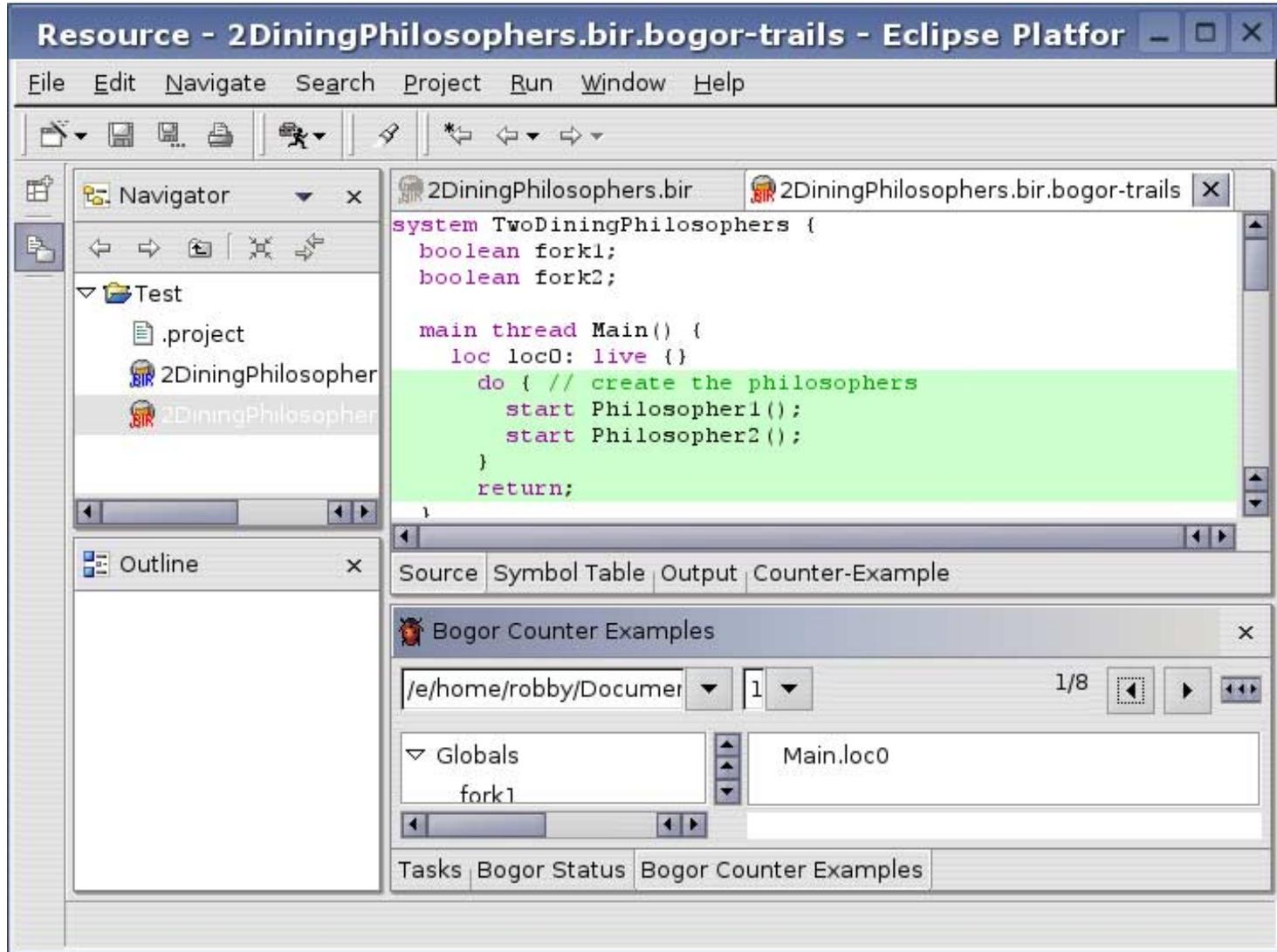


...state machines give abstract behavior

Bogor



Bogor example – 2 Dining Philosophers



The screenshot displays the Eclipse IDE interface for the DRE model checker. The main editor shows the source code for a system named `TwoDiningPhilosophers`. The code defines two boolean variables, `fork1` and `fork2`, and a main thread `Main()` that starts two philosopher threads, `Philosopher1()` and `Philosopher2()`. The code is as follows:

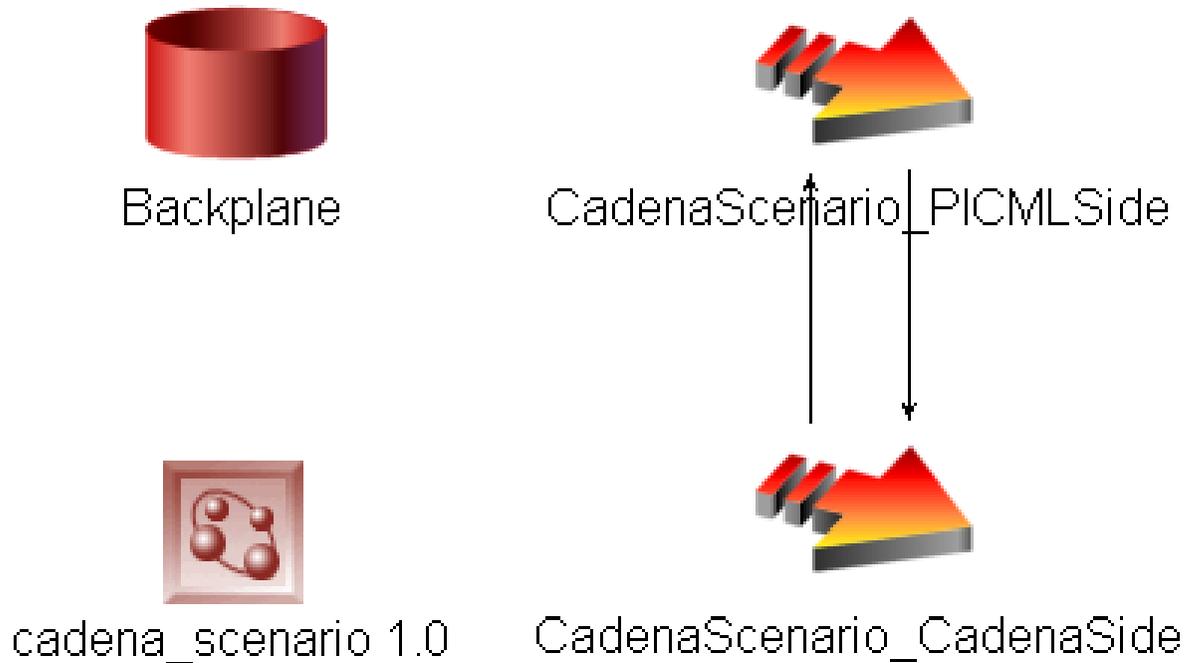
```
system TwoDiningPhilosophers {  
  boolean fork1;  
  boolean fork2;  
  
  main thread Main() {  
    loc loc0: live {}  
    do { // create the philosophers  
      start Philosopher1();  
      start Philosopher2();  
    }  
    return;  
  }  
}
```

The IDE interface includes a Navigator on the left showing the project structure, an Outline view, and a Counter-Examples view at the bottom. The Counter-Examples view shows the current counter example path: `/e/home/robby/Documer` with a counter value of `1` out of `1/8`. The view also displays the current state of the system, including the `Main.loc0` location and the `fork1` variable.

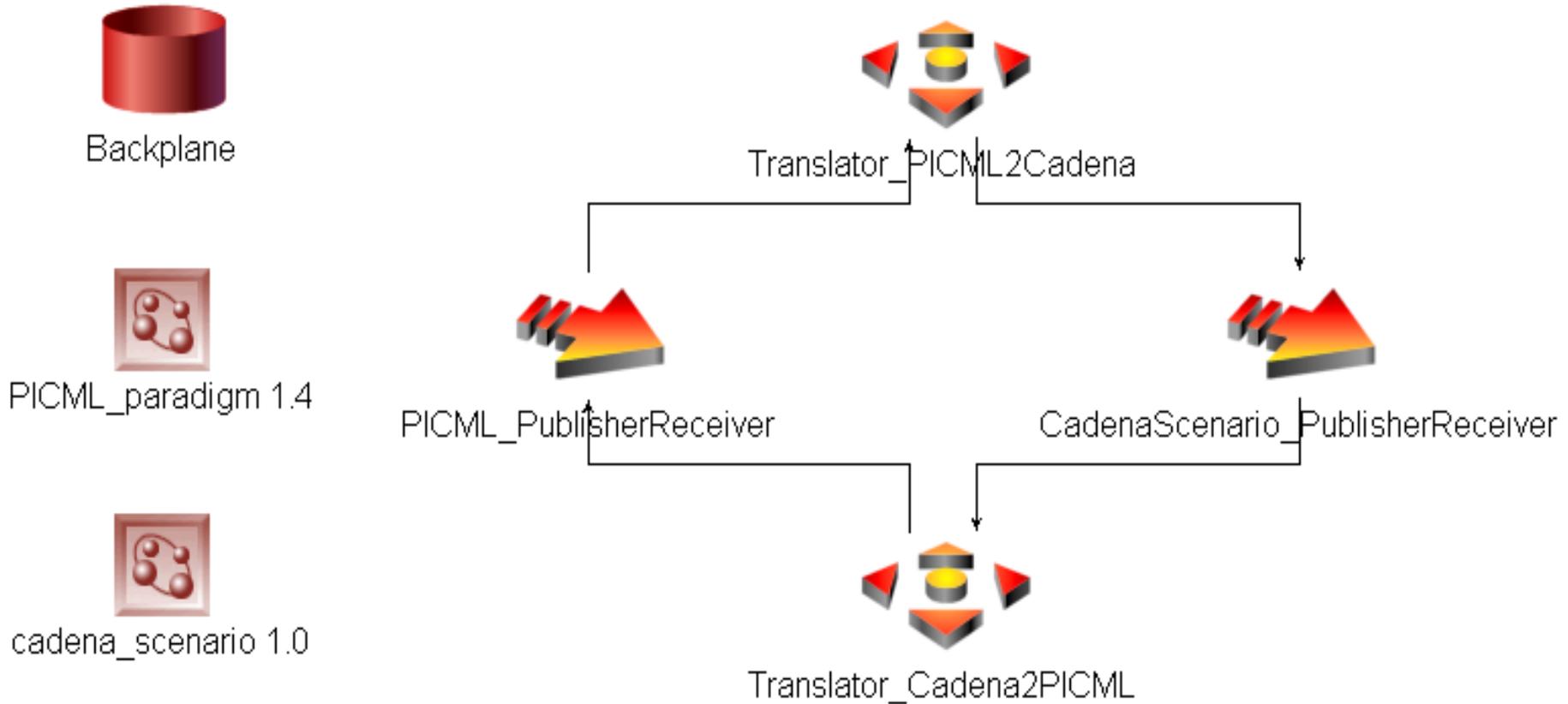
Open Tool Integration Framework



OTIF - Integration Workflow



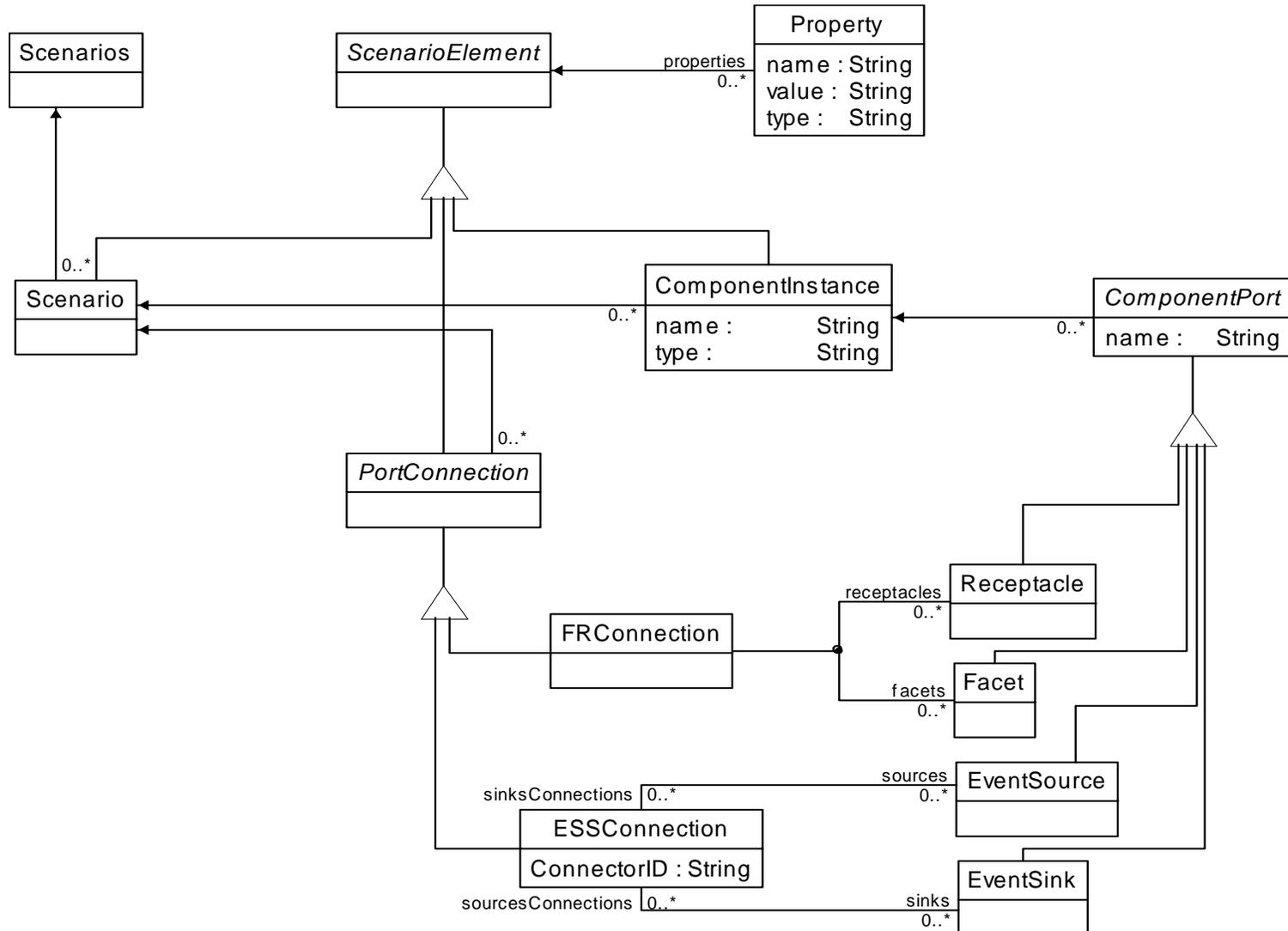
Future workflow



Interchange Format



CadenaScenario – UML meta



Generated Schema

```

<?xml version="1.0" encoding="UTF-8" ?>
<?udm interface="cadena_scenario" version="1.00"?>
- <xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema">
- <!-- generated on Mon Jun 14 01:27:17 2004
-->
- <xsd:complexType name="ESSConnectionType">
- <xsd:sequence>
  <xsd:element name="Property" type="PropertyType" minOccurs="0"
maxOccurs="unbounded" />
</xsd:sequence>
  <xsd:attribute name="ConnectorID" type="xsd:string" use="required"
/>
  <xsd:attribute name="sources" type="xsd>IDREFS" />
  <xsd:attribute name="sinks" type="xsd>IDREFS" />
  <xsd:attribute name="_id" type="xsd>ID" />
  <xsd:attribute name="_archetype" type="xsd>IDREF" />
  <xsd:attribute name="_derived" type="xsd>IDREFS" />
  <xsd:attribute name="_instances" type="xsd>IDREFS" />
  <xsd:attribute name="_desynched_atts" type="xsd:string" />
  <xsd:attribute name="_real_archetype" type="xsd:boolean" />
  <xsd:attribute name="_subtype" type="xsd:boolean" />
</xsd:complexType>
- <xsd:complexType name="ScenariosType">
- <xsd:sequence>
  <xsd:element name="Scenario" type="ScenarioType" minOccurs="0"
maxOccurs="unbounded" />
</xsd:sequence>
  <xsd:attribute name="_id" type="xsd>ID" />
  <xsd:attribute name="_archetype" type="xsd>IDREF" />
  <xsd:attribute name="_derived" type="xsd>IDREFS" />
  <xsd:attribute name="_instances" type="xsd>IDREFS" />
  <xsd:attribute name="_desynched_atts" type="xsd:string" />
  <xsd:attribute name="_real_archetype" type="xsd:boolean" />
  <xsd:attribute name="_subtype" type="xsd:boolean" />
</xsd:complexType>

```

```

- <xsd:complexType name="FRConnectionType">
- <xsd:sequence>
  <xsd:element name="Property" type="PropertyType" minOccurs="0"
maxOccurs="unbounded" />
</xsd:sequence>
  <xsd:attribute name="facets_end_" type="xsd>IDREF" />
  <xsd:attribute name="receptacles_end_" type="xsd>IDREF" />
  <xsd:attribute name="_id" type="xsd>ID" />
  <xsd:attribute name="_archetype" type="xsd>IDREF" />
  <xsd:attribute name="_derived" type="xsd>IDREFS" />
  <xsd:attribute name="_instances" type="xsd>IDREFS" />
  <xsd:attribute name="_desynched_atts" type="xsd:string" />
  <xsd:attribute name="_real_archetype" type="xsd:boolean" />
  <xsd:attribute name="_subtype" type="xsd:boolean" />
</xsd:complexType>
- <xsd:complexType name="EventSinkType">
  <xsd:attribute name="name" type="xsd:string" use="required" />
  <xsd:attribute name="sourcesConnections" type="xsd>IDREFS" />
  <xsd:attribute name="_id" type="xsd>ID" />
  <xsd:attribute name="_archetype" type="xsd>IDREF" />
  <xsd:attribute name="_derived" type="xsd>IDREFS" />
  <xsd:attribute name="_instances" type="xsd>IDREFS" />
  <xsd:attribute name="_desynched_atts" type="xsd:string" />
  <xsd:attribute name="_real_archetype" type="xsd:boolean" />
  <xsd:attribute name="_subtype" type="xsd:boolean" />
</xsd:complexType>
- <xsd:complexType name="EventSourceType">
  <xsd:attribute name="name" type="xsd:string" use="required" />
  <xsd:attribute name="sinksConnections" type="xsd>IDREFS" />
  <xsd:attribute name="_id" type="xsd>ID" />
  <xsd:attribute name="_archetype" type="xsd>IDREF" />
  <xsd:attribute name="_derived" type="xsd>IDREFS" />
  <xsd:attribute name="_instances" type="xsd>IDREFS" />
  <xsd:attribute name="_desynched_atts" type="xsd:string" />

```

[.....]

Robot Assembly – Equivalent XML

```

- <Scenarios xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:noNamespaceSchemaLocation="..\Udm\cadena_scenarios.xsd">
- <Scenario>
- <ComponentInstance name="HumanMachineInterface" type="RobotAssembly/HumanMachineInterface">
  <EventSink _id="id18a4" name="WorkDisplayUpdate" sourcesConnections="id18a5" />
  <Facet name="AnalysisController" />
  <Facet name="Controller" />
  <Receptacle _id="id18a6" name="HumanResponse" facets="id18a7" />
</ComponentInstance>
- <ComponentInstance name="ManagementWorkInstructions"
type="RobotAssembly/ManagementWorkInstructions">
  <EventSink _id="id18aa" name="ProductionReport" sourcesConnections="id18ab" />
  <EventSource _id="id18a8" name="WorkOrder" sinksConnections="id18a9" />
  <Facet name="Controller" />
</ComponentInstance>
- <ComponentInstance name="WatchSettingManager" type="RobotAssembly/WatchSettingManager">
  <EventSink _id="id18b2" name="ProcessingStatus" sourcesConnections="id18b3" />
  <EventSink _id="id18b4" name="PalletStatus" sourcesConnections="id18b5" />
  <EventSink _id="id18b6" name="WorkOrder" sourcesConnections="id18a9" />
  <EventSource _id="id18ac" name="Display" sinksConnections="id18a5" />
  <EventSource _id="id18ad" name="ProductionControl" sinksConnections="id18ae" />
  <EventSource _id="id18af" name="MovePallet" sinksConnections="id18b0" />
  <EventSource _id="id18b1" name="ProductionReport" sinksConnections="id18ab" />
  <Facet name="AnalysisCalls" />
  <Facet _id="id18b7" name="DisplayResponse" receptacles="id18a7" />
  <Facet name="Controller" />
  <Facet _id="id18b8" name="AnalysisOne" receptacles="id18b9" />
  <Facet _id="id18ba" name="AnalysisTwo" receptacles="id18bb" />
</ComponentInstance>
[.....]

```

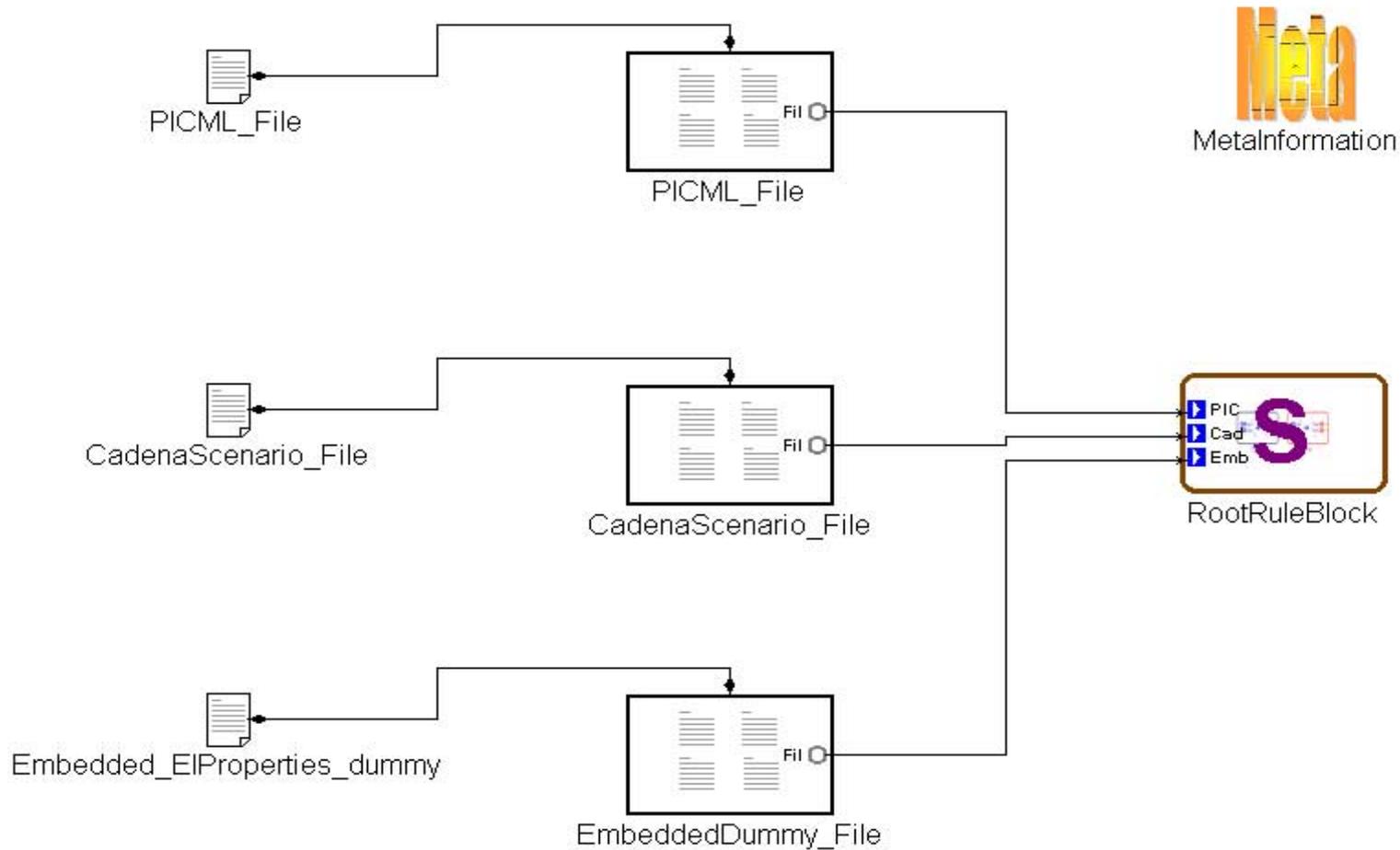
Cross-Meta Graph Transformation

A Model-To-Model driven approach

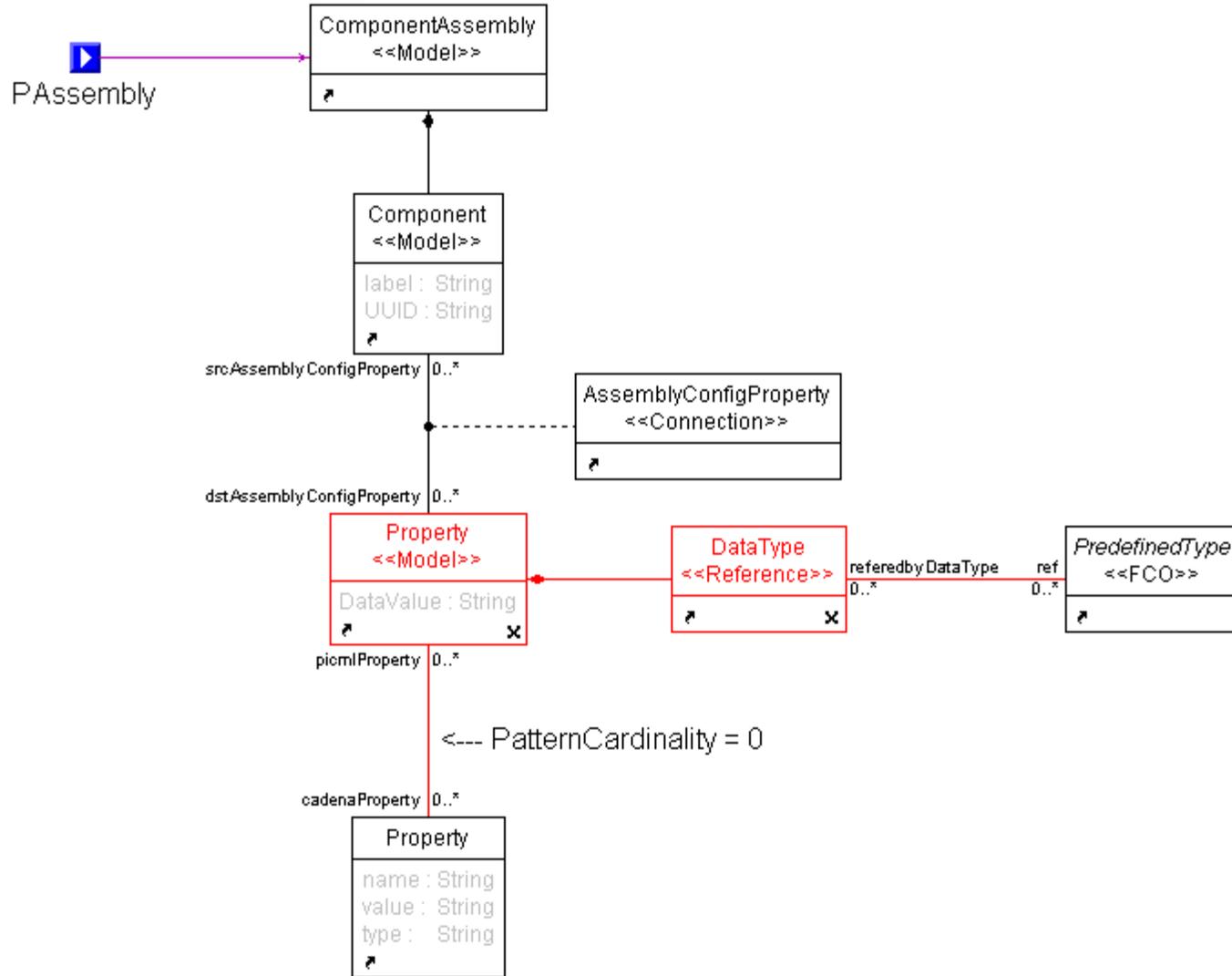


Graph Transformation

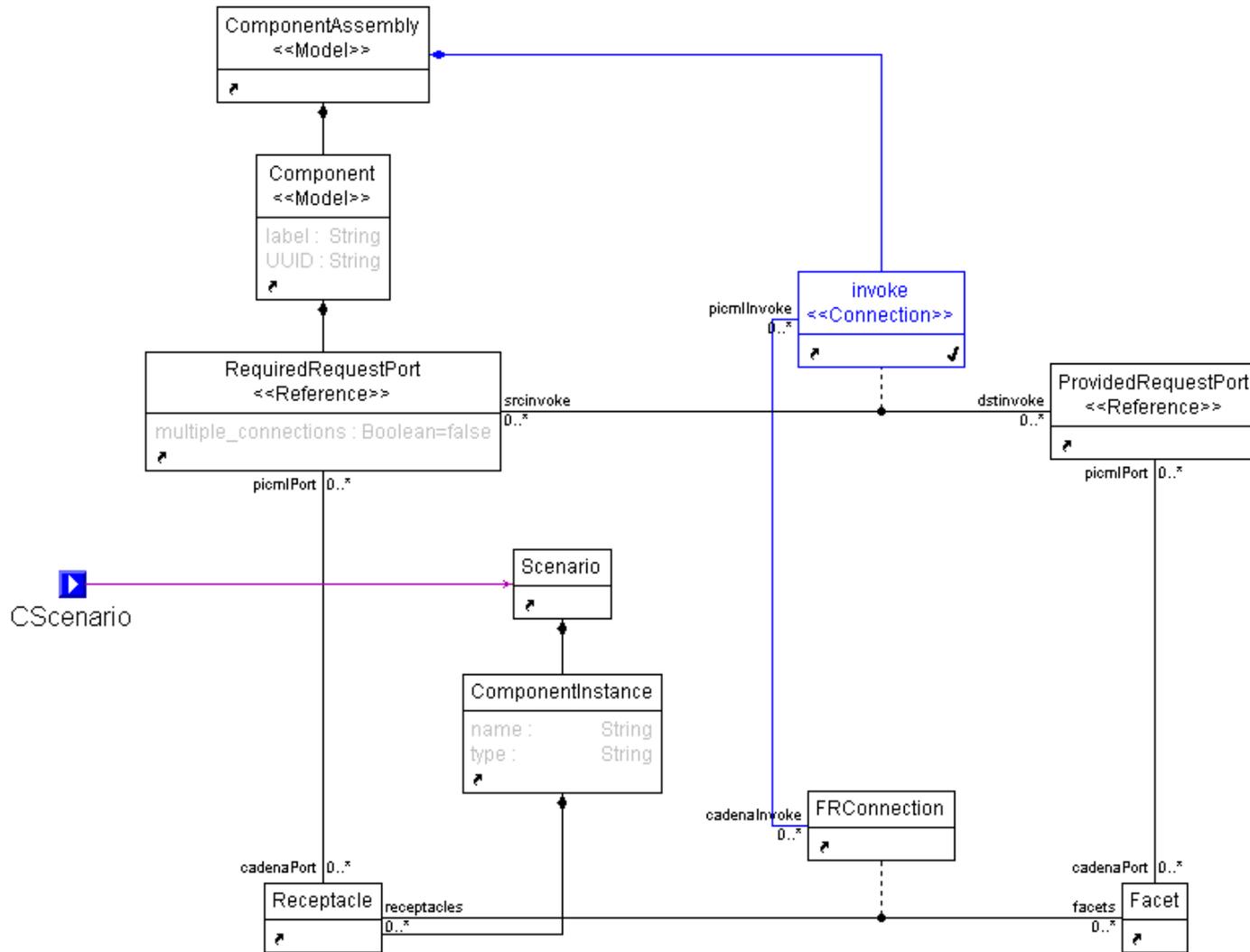
A Model-To-Model driven approach



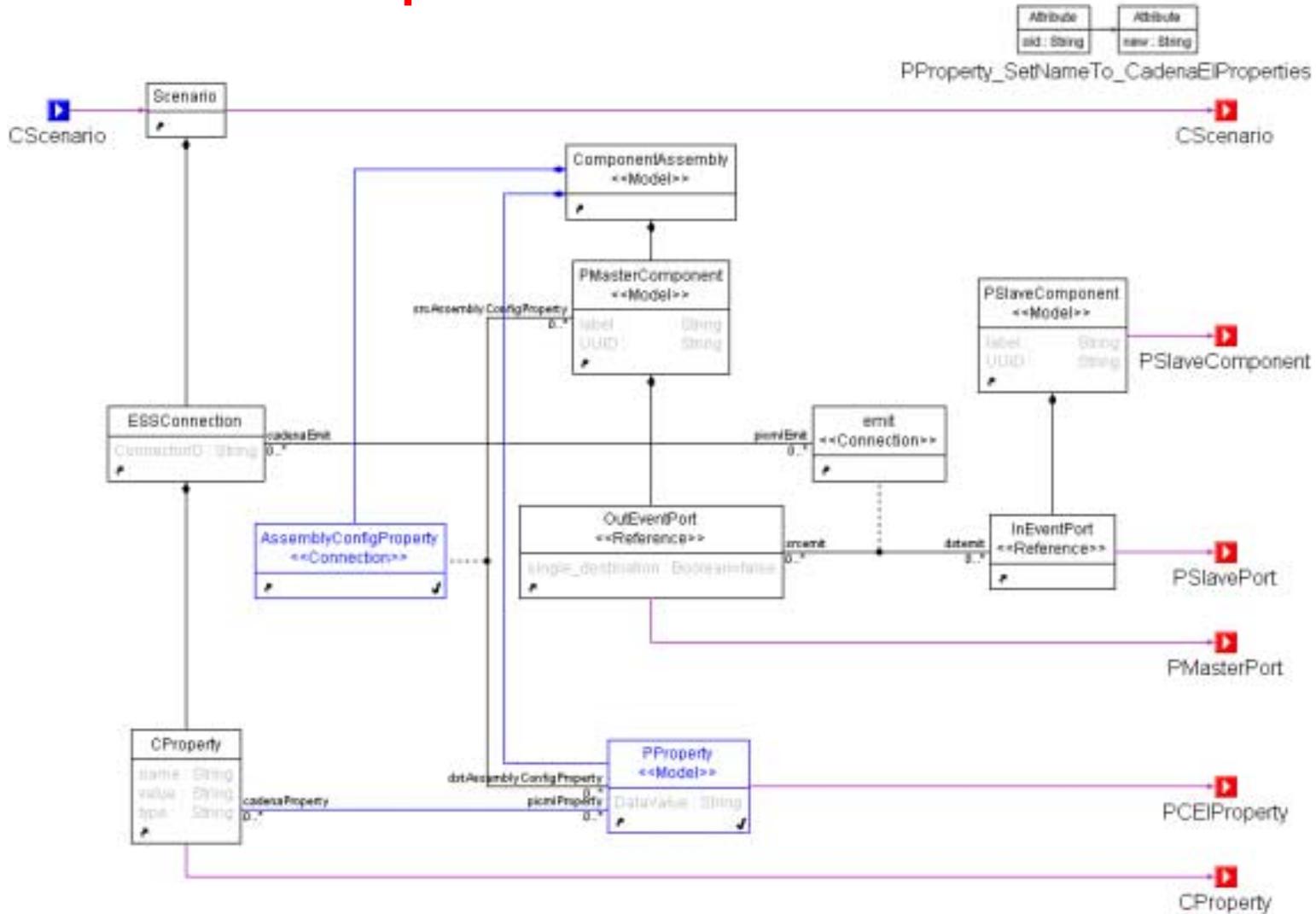
Graph Transformation



Graph Transformation



Graph Transformation



Graph Transformation

Algorithm for importing ConnectorIDs:

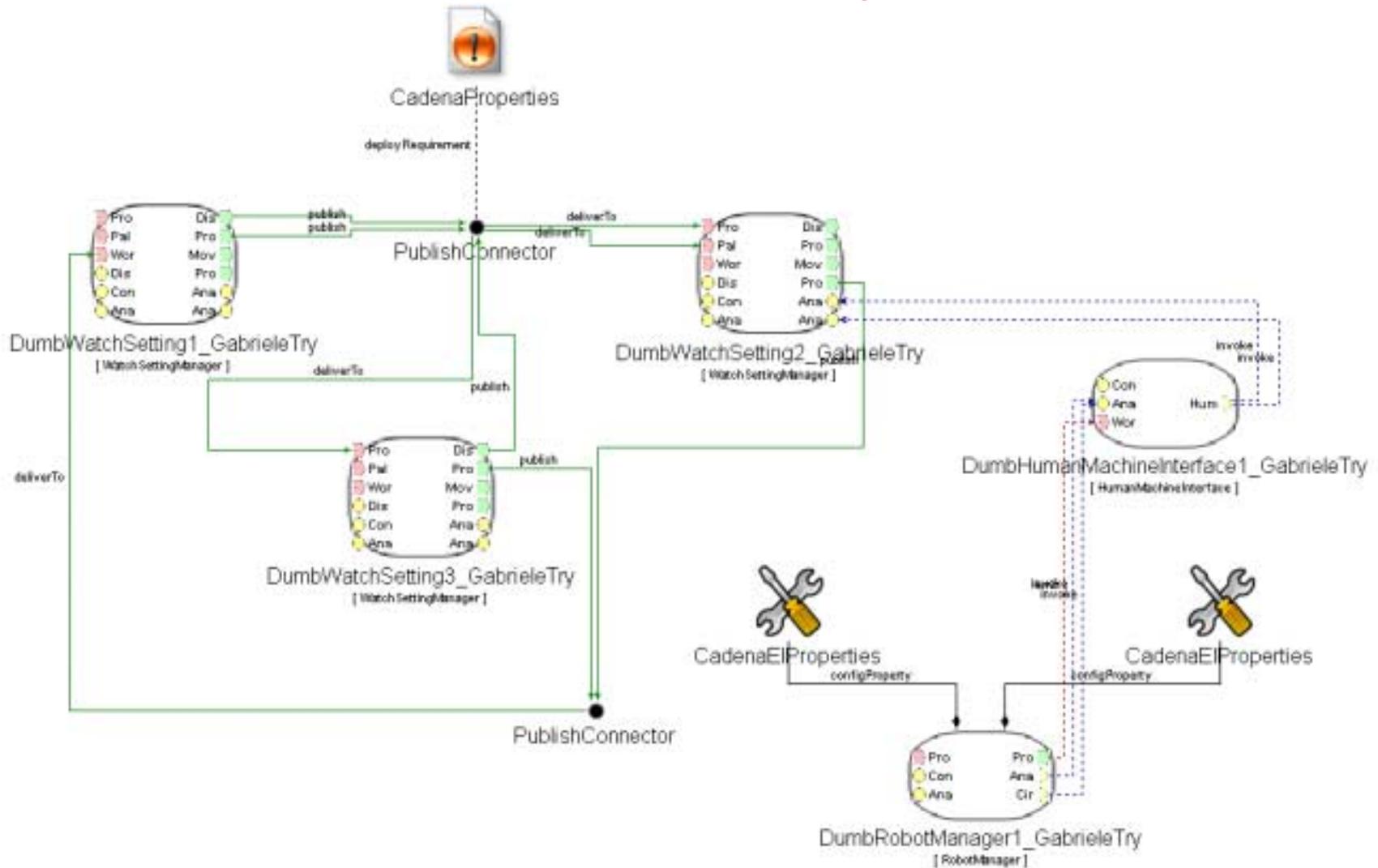
1. Those with empty ConnectorID => emit
2. Then, those flagged with emit and more than one participant => empty
3. Then, those unlinked which are not emit => make PublishConnector (if empty => don't make ConnectorID)

Test Drive



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Tweaked-RobotAssembly: before export



TweakedRobotAssembly: exported

```

- <Scenario xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:noNamespaceSchemaLocation="..\Udm\cadena_scenario.xs">
- <Scenario>
- <ComponentInstance name="HumanMachineInterface" type="RobotAssembly/HumanMachineInterface">
  <EventSink _id="id18a4" name="WorkDisplayUpdate" sourcesConnections="id18a5" />
  <Facet name="AnalysisController" />
  <Facet name="Controller" />
  <Property name="Prop_Longint_999thousand" type="INT" value="999000" />
  <Receptacle _id="id18a6" name="HumanResponse" facets="id18a7" />
</ComponentInstance>
- <ComponentInstance name="ManagementWorkInstructions" type="RobotAssembly/ManagementWorkInstructions">
  <EventSink _id="id18aa" name="ProductionReport" sourcesConnections="id18ab" />
  <EventSource _id="id18a8" name="WorkOrder" sinksConnections="id18a9" />
  <Facet name="Controller" />
  <Property name="Prop_Longint_999thousand" type="INT" value="999000" />
  <Property name="Prop_str_hi_foo" type="STRING" value="Hi foo!!" />
</ComponentInstance>
- <ComponentInstance name="WatchSettingManager" type="RobotAssembly/WatchSettingManager">
  <EventSink _id="id18b2" name="ProcessingStatus" sourcesConnections="id18b3" />
  <EventSink _id="id18b4" name="PaletteStatus" sourcesConnections="id18b5" />
  <EventSink _id="id18b6" name="WorkOrder" sourcesConnections="id18a9" />
  <EventSource _id="id18ac" name="Display" sinksConnections="id18a5" />
  <EventSource _id="id18ad" name="ProductionControl" sinksConnections="id18ae" />
  <EventSource _id="id18af" name="MovePalette" sinksConnections="id18b0" />
  <EventSource _id="id18b1" name="ProductionReport" sinksConnections="id18ab" />
  <Facet name="AnalysisCalls" />
  <Facet _id="id18b7" name="DisplayResponse" receptacles="id18a7" />
  <Facet name="Controller" />
  <Facet _id="id18b8" name="AnalysisOne" receptacles="id18b9" />
  <Facet _id="id18ba" name="AnalysisTwo" receptacles="id18bb" />
  <Property name="Prop_bool_true" type="BOOLEAN" value="TRUE" />
</ComponentInstance>
- <ComponentInstance name="PaletteConveyorManager" type="RobotAssembly/PaletteConveyorManager">
  <EventSink _id="id18bd" name="PaletteRequests" sourcesConnections="id18b0" />
  <EventSource _id="id18bc" name="PaletteStatus" sinksConnections="id18b5" />
  <Facet name="Controller" />
  <Facet _id="id18bf" name="CircleAnalysis" receptacles="id18c0" />
  <Receptacle _id="id18be" name="AnalysisTwo" facets="id18bb" />
</ComponentInstance>
[.....]

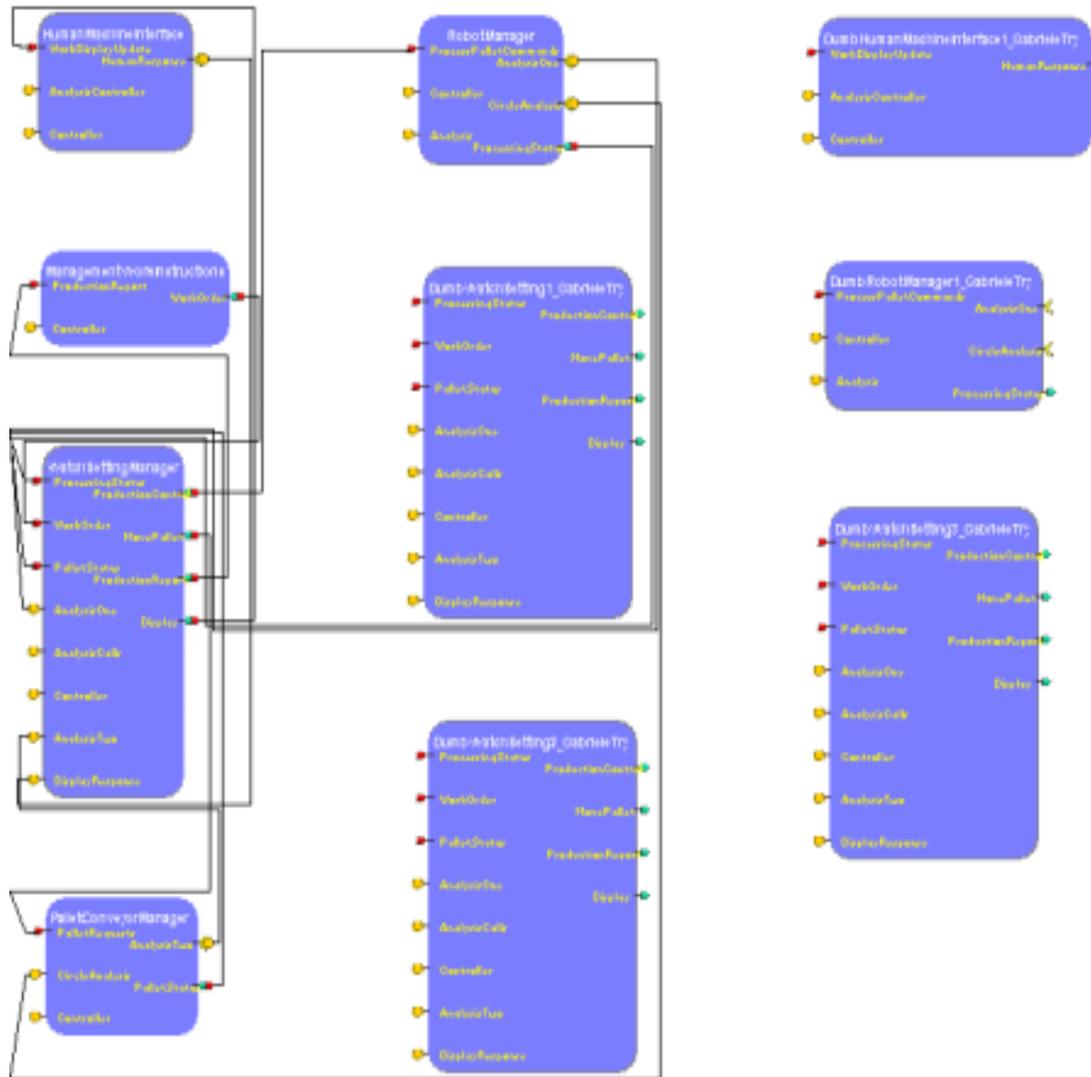
```

Importing scenario in Cadena

Tasks (14 items)						
	✓	!	Description	Resource	In Folder	Location
			Expecting same types for source and destination of connection	RobotAss...	Integration_TestDrive/sys...	line 42
			Expecting same types for source and destination of connection	RobotAss...	Integration_TestDrive/sys...	line 48
			Expecting same types for source and destination of connection	RobotAss...	Integration_TestDrive/sys...	line 54
			Expecting same types for source and destination of connection	RobotAss...	Integration_TestDrive/sys...	line 60
			Expecting same types for source and destination of connection	RobotAss...	Integration_TestDrive/sys...	line 66
			Expecting same types for source and destination of connection	RobotAss...	Integration_TestDrive/sys...	line 72
			Expecting instance_name.port for Display or DumbWatchSetting3_GabrieleTry.ProcessingStatus	RobotAss...	Integration_TestDrive/sys...	line 78
			Expecting same types for source and destination of connection	RobotAss...	Integration_TestDrive/sys...	line 84
			Expecting same types for source and destination of connection	RobotAss...	Integration_TestDrive/sys...	line 88
			Expecting same types for source and destination of connection	RobotAss...	Integration_TestDrive/sys...	line 120
			Expecting same types for source and destination of connection	RobotAss...	Integration_TestDrive/sys...	line 139
			Expecting same types for source and destination of connection	RobotAss...	Integration_TestDrive/sys...	line 142
			Expecting same types for source and destination of connection	RobotAss...	Integration_TestDrive/sys...	line 145
			Expecting same types for source and destination of connection	RobotAss...	Integration_TestDrive/sys...	line 149

Cadena detects type inconsistencies for connections

Imported in Cadena



Reimporting scenario in PICML

GR Engine v1.3.1.

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Engine Started. Loading relevent files...

Running...

Executing Block RootRuleBlock

Executing Rule Assembly_and_Scenario_Finder

-- InputPackets:1 Matches:1 OutputPackets:1

Executing Block Associate_Components_n_PublishConnectors

Executing Rule AssociatePublishConnectors

-- InputPackets:1 Matches:0 OutputPackets:1

Executing Rule AssociateComponents

-- InputPackets:1 Matches:10 OutputPackets:10

Executing Block CreateDestroy_Components_n_PublishConnectors

Executing Block CreatePublishConnectors_step1

Executing Rule CreatePublishConnectors_step1_rule

-- InputPackets:1 Matches:0 OutputPackets:1

Executing Block CreatePublishConnectors_step2

Executing Rule CreatePublishConnectors_step2_rule

-- InputPackets:1 Matches:0 OutputPackets:1

Executing Block CreatePublishConnectors_step3

Executing Rule CreatePublishConnectors_step3_rule

-- InputPackets:1 Matches:0 OutputPackets:1

Executing Rule DestroyPublishConnectors

-- InputPackets:1 Matches:2 OutputPackets:2

Executing Rule FindComponents2BDeleted

-- InputPackets:1 Matches:0 OutputPackets:0

Executing Rule CreateComponents_step1

-- InputPackets:1 Matches:0 OutputPackets:0

Executing Block TearDown_Connections

Executing Rule Optimization_FindComponents

-- InputPackets:1 Matches:10 OutputPackets:10

Executing Rule TD_Emits

-- InputPackets:10 Matches:8 OutputPackets:13

Executing Rule TD_Invokes

-- InputPackets:10 Matches:8 OutputPackets:13

Executing Rule TD_DeliverTo

-- InputPackets:10 Matches:0 OutputPackets:10

Executing Rule TD_SrcPublish

-- InputPackets:10 Matches:0 OutputPackets:10

Executing Block Associate_Ports

Executing Rule Match_Components

-- InputPackets:1 Matches:10 OutputPackets:10

Executing Rule Associate_Ports_rule

-- InputPackets:10 Matches:76 OutputPackets:76

Executing Block ReCreate_Connections

Executing Rule Create_DeliverTo

-- InputPackets:1 Matches:0 OutputPackets:1

Executing Rule Create_SrcPublish

-- InputPackets:1 Matches:0 OutputPackets:1

Executing Rule Create_Invokes

-- InputPackets:1 Matches:4 OutputPackets:4

Executing Rule Create_Emits

-- InputPackets:1 Matches:7 OutputPackets:7

Executing Block Associate_Properties

Executing Rule Associate_CadenaProperties_on_PublishConnectors

-- InputPackets:1 Matches:0 OutputPackets:1

[.....]

The Transformation took 45.347seconds

Done!

Reimporting scenario in PICML



DumbWatchSetting1_GabrieleTry
[WatchSettingManager]



DumbWatchSetting2_GabrieleTry
[WatchSettingManager]



DumbWatchSetting3_GabrieleTry
[WatchSettingManager]

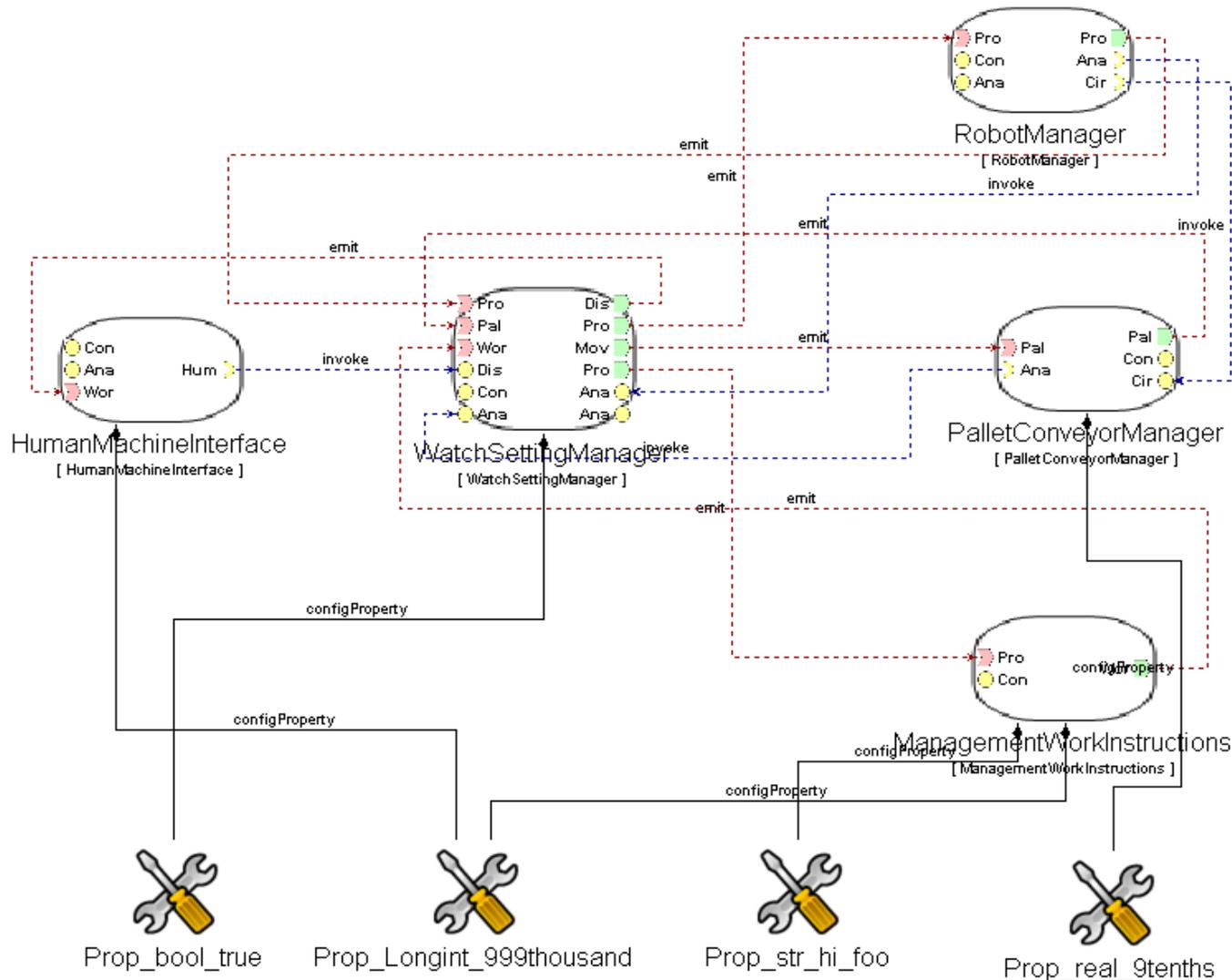


DumbHumanMachineInterface1_GabrieleTry
[HumanMachineInterface]



DumbRobotManager1_GabrieleTry
[RobotManager]

Reimporting scenario in PICML (valid part)



Special Thanks

Special Thanks to:

Institute for Software Integrated Systems - Vanderbilt University
Computer and Information Systems Department - Kansas State University
Object Management Group
Developers of: Cadena, GME, GReAT, OTIF, UDM, Python.org

More information about this opensource integration project
and the latest version of the slides at:

WEBPAGE: <http://www.dre.vanderbilt.edu/~gtrombetti/>

E-MAIL: gtrombetti [at] dre [dot] vanderbilt [dot] edu

Gabriele A. Trombetti

QUESTIONS

