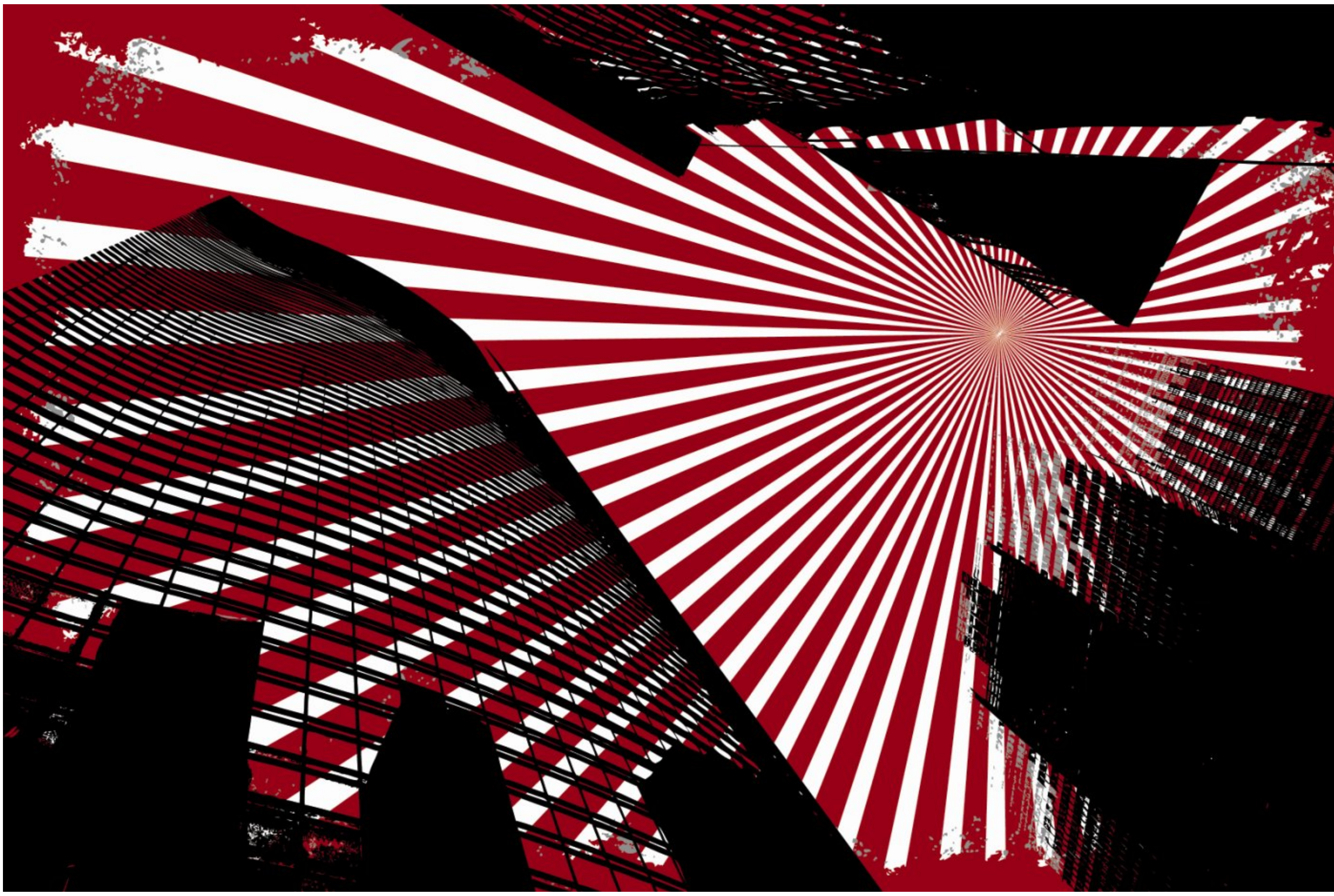

openArchitectureWare User Guide

Version 4.2

openArchitectureWare

2007-09-15

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Part I. Getting Started

Chapter 1. EMF Tutorial

This example uses Eclipse EMF as the basis for code generation. One of the essential new features of oAW4 is EMF support. While not all aspects of EMF as good and nice to use as one would wish, the large amount of available 3rd party tools makes EMF a good basis. Specifically, better tools for building EMF metamodels are on the horizon already. To get a deeper understanding of EMF, we recommend that you first read the EMF tutorial at

- http://www-128.ibm.com/developerworks/library/os-ecemf1/
- http://www-128.ibm.com/developerworks/library/os-ecemf2/
- http://www-128.ibm.com/developerworks/library/os-ecemf3/

You can also run the tutorial without completely understanding EMF, but the tutorial might "feel" unnecessarily complex.

1.1. Installing the pre-built tutorial

You need to have openArchitectureWare 4.2 installed. Please consider http://www.eclipse.org/gmt/oaw/download for details.

You can also install the code for the tutorial. It can be downloaded from the URL above, it is part of the the EMF samples ZIP file. Installing the demos is easy: Just add the projects to your workspace. Note that in the openArchitectureWare preferences (either globally for the workspace, or specific for the sample projects, you have to select *EMF metamodels* for these examples to work.

1.2. Tutorial overview

The purpose of this tutorial is to illustrate code generation with openArchitectureWare from EMF models. The process we're going to go through will start by defining a meta model (using EMF tooling), coming up with some example data, writing code generation templates, running the generator and finally adding some constraint checks.

The actual content of the example is rather trivial – we will generate Java classes following the Java Beans conventions. The model will contain entities (such as Person or Vehicle) including some attributes and relationships among them – a rather typical data model. From these entities in the model we want to generate the Beans for implementation in Java. In a real setting, we might also want to generate persistence mappings, etc. We will not to this for this simple introduction.

1.3. Defining an EMF metamodel

To illustrate the metamodel before we deal with the intricacies of EMF here is the metamodel in UML:

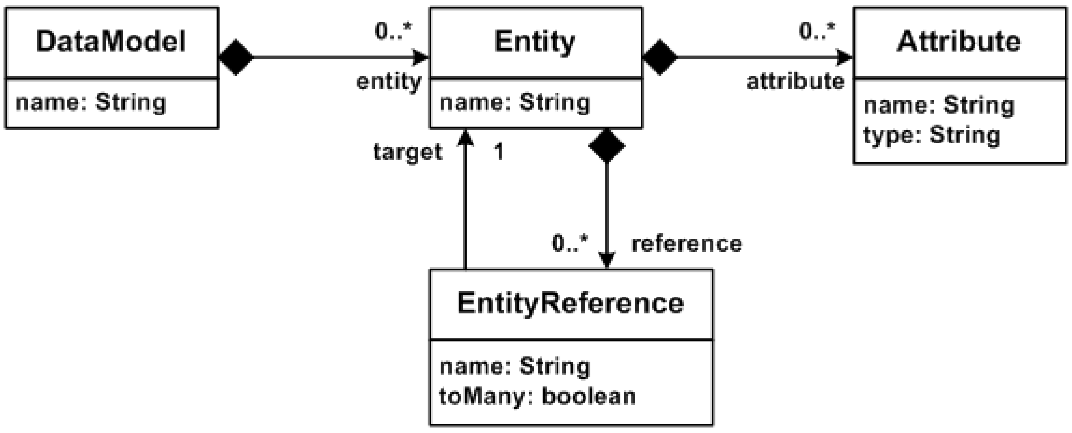
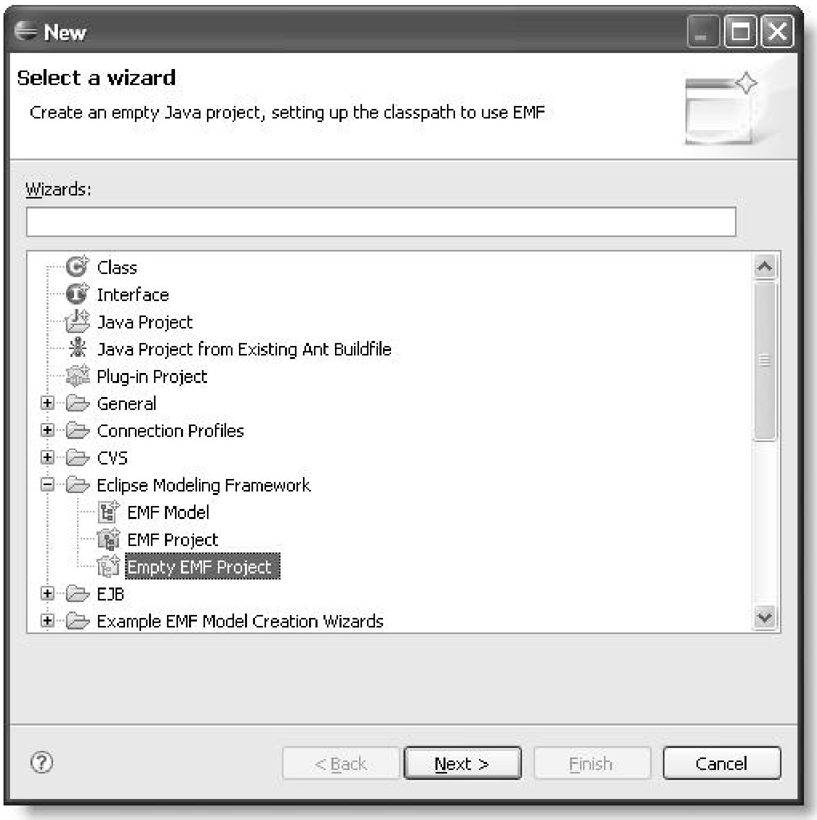


Figure 1.1. Sample metamodel

1.3.1. Creating an EMF project

Create an EMF project as depicted below:



New

Select a wizard

Create an empty Java project, setting up the classpath to use EMF

Wizards:

Figure 1.2. Create EMF project

It is important that you create an EMF project, not just a simple or a Java project. Name it `oaw4.demo.emf.datamodel`.

1.3.2. Defining the (meta)model

Create a new source folder `metamodel` in that project. Create a new Ecore model in that source folder named `data.ecore`. Use EPackage as the model object.

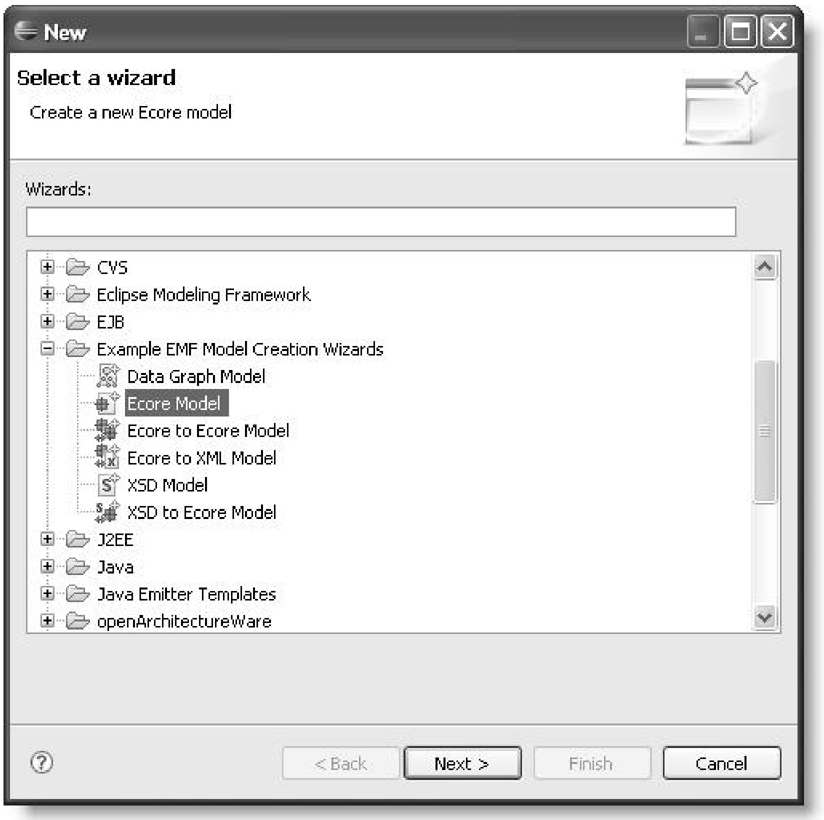
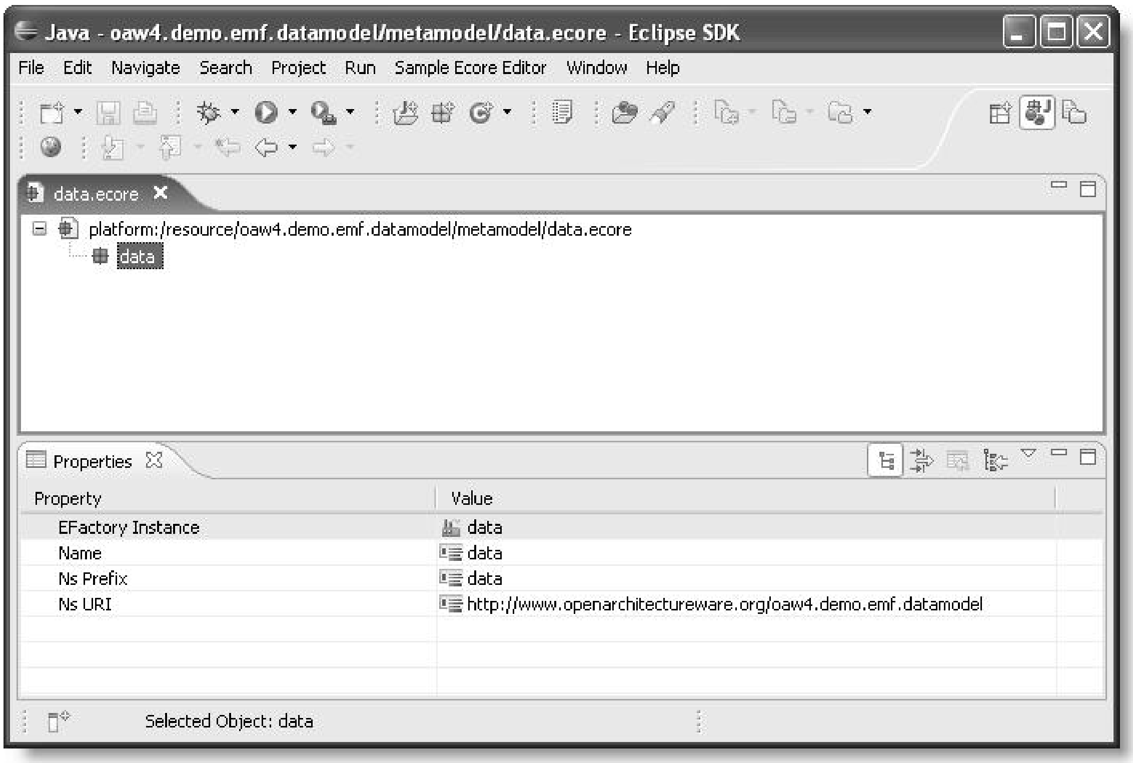


Figure 1.3. Create new Ecore model

This opens the Ecore Editor. You will see a root package with name `null`. Open the Properties View (context menu). Set the following properties for the package:

- Name: data
- Ns prefix: data
- Ns URI: http://www.openarchitectureware.org/oaw4.demo.emf.datamodel


Java - oaw4.demo.emf.datamodel/metamodel/data.ecore - Eclipse SDK
File Edit Navigate Search Project Run Sample Ecore Editor Window Help
data.ecore
Properties

platform:/resource/oaw4.demo.emf.datamodel/metamodel/data.ecore
data

Property	Value
EFactory Instance	data
Name	data
Ns Prefix	data
Ns URI	http://www.openarchitectureware.org/oaw4.demo.emf.datamodel

Selected Object: data

Figure 1.4. Adjust namespace settings

Create the following Ecore model[1]. Make sure you set the following properties *exactly* as described next:

Within the data package create these `EClass` elements with their attributes [2]:

EClass name	EAttribute name	EAttribute EType
DataModel		
	name	EString
Entity		
	name	EString
Attribute		
	name	EString
	type	EString
EntityReference		
	name	EString
	toMany	EBoolean

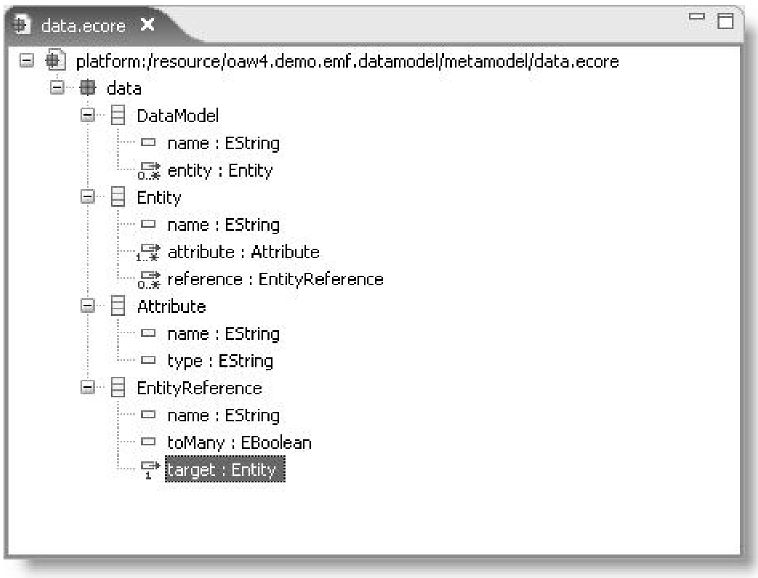
Now it is time to create references between the model elements. Add childs of type `EReferences` as follows[3].

[1]To add children, right-click on the element to which you want to add children and select the type of the child from the list. To configure the properties, open the properties dialog by selecting Show Properties View at the bottom of any of the context menus. Note that this is not an EMF tutorial. For more details on how to build EMF (meta-)models please refer to the EMF documentation.

[2] Attributes are childs of type `EAttribute`. Fill the Name and the EType properties.

[3]Note: there are a couple of *-1's* ... don't miss the minus! Also, the containment flag is essential. If containment is `true` you will be able to create childs of the referenced type, otherwise you can only reference them.

EClass	**EReference name**	**EReference attribute name**	**EReference attribute value**
DataModel			
	entity		
		EType	Entity
		containment	true
		Lowerbound	0
		Upperbound	-1
Entity			
	attribute		
		EType	Attribute
		containment	true
		Lowerbound	1
		Upperbound	-1
Entity			
	reference		
		EType	EntityReference
		containment	true
		Lowerbound	0
		Upperbound	-1
EntityReference			
	target		
		EType	Entity
		containment	false
		Lowerbound	1
		Upperbound	1



```
data.ecore
platform:/resource/oaw4.demo.emf.datamodel/metamodel/data.ecore
  data
    DataModel
      name : EString
      entity : Entity
    Entity
      name : EString
      attribute : Attribute
      reference : EntityReference
    Attribute
      name : EString
      type : EString
    EntityReference
      name : EString
      toMany : EBoolean
      target : Entity
```

Figure 1.5. Metamodel structure

EMF saves the model we created above in its own dialect of XMI. To avoid any ambiguities, here is the complete XMI source for the metamodel. It goes into the file `data.ecore`:

```
<?xml version="1.0" encoding="UTF-8"?>
<ecore:EPackage xmi:version="2.0"
    xmlns:xmi="http://www.omg.org/XMI" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:ecore="http://www.eclipse.org/emf/2002/Ecore" name="data"
    nsURI="http://www.openarchitectureware.org/oaw4.demo.emf.datamodel" nsPrefix="data">
  <eClassifiers xsi:type="ecore:EClass" name="DataModel">
    <eStructuralFeatures xsi:type="ecore:EAttribute" name="name"
     eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#//EString"/>
    <eStructuralFeatures xsi:type="ecore:EReference" name="entity" upperBound="-1"
        eType="#//Entity" containment="true"/>
  </eClassifiers>
  <eClassifiers xsi:type="ecore:EClass" name="Entity">
    <eStructuralFeatures xsi:type="ecore:EAttribute" name="name"
     eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#//EString"/>
    <eStructuralFeatures xsi:type="ecore:EReference" name="attribute" lowerBound="1"
        upperBound="-1" eType="#//Attribute" containment="true"/>
    <eStructuralFeatures xsi:type="ecore:EReference" name="reference" upperBound="-1"
        eType="#//EntityReference" containment="true"/>
  </eClassifiers>
  <eClassifiers xsi:type="ecore:EClass" name="Attribute">
    <eStructuralFeatures xsi:type="ecore:EAttribute" name="name"
     eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#//EString"/>
    <eStructuralFeatures xsi:type="ecore:EAttribute" name="type"
     eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#//EString"/>
  </eClassifiers>
  <eClassifiers xsi:type="ecore:EClass" name="EntityReference">
    <eStructuralFeatures xsi:type="ecore:EAttribute" name="name"
     eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#//EString"/>
    <eStructuralFeatures xsi:type="ecore:EAttribute" name="toMany"
     eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#//EBoolean"/>
    <eStructuralFeatures xsi:type="ecore:EReference" name="target" lowerBound="1"
        eType="#//Entity"/>
  </eClassifiers>
</ecore:EPackage>
```

1.4. Generating the EMF tooling

In addition to providing the Ecore meta meta model, EMF also comes with support for building (more or less usable) editors. These are generated automatically from the metamodel we just defined. In order to define example models (which we'll do below) we have to generate these editors. Also, we have to generate the implementation classes for our metamodel. To generate all these things, we have to define a markup model that contains a number of specifics to control the generation of the various artifacts. This markup model is called *genmodel*.

So we have to define the *genmodel* first. Select the `data.ecore` model in the explorer and right mouse click to New -> Other -> Eclipse Modelling Framework -> EMF Model. Follow the following five steps; note that they are also illustrated in the next figure.

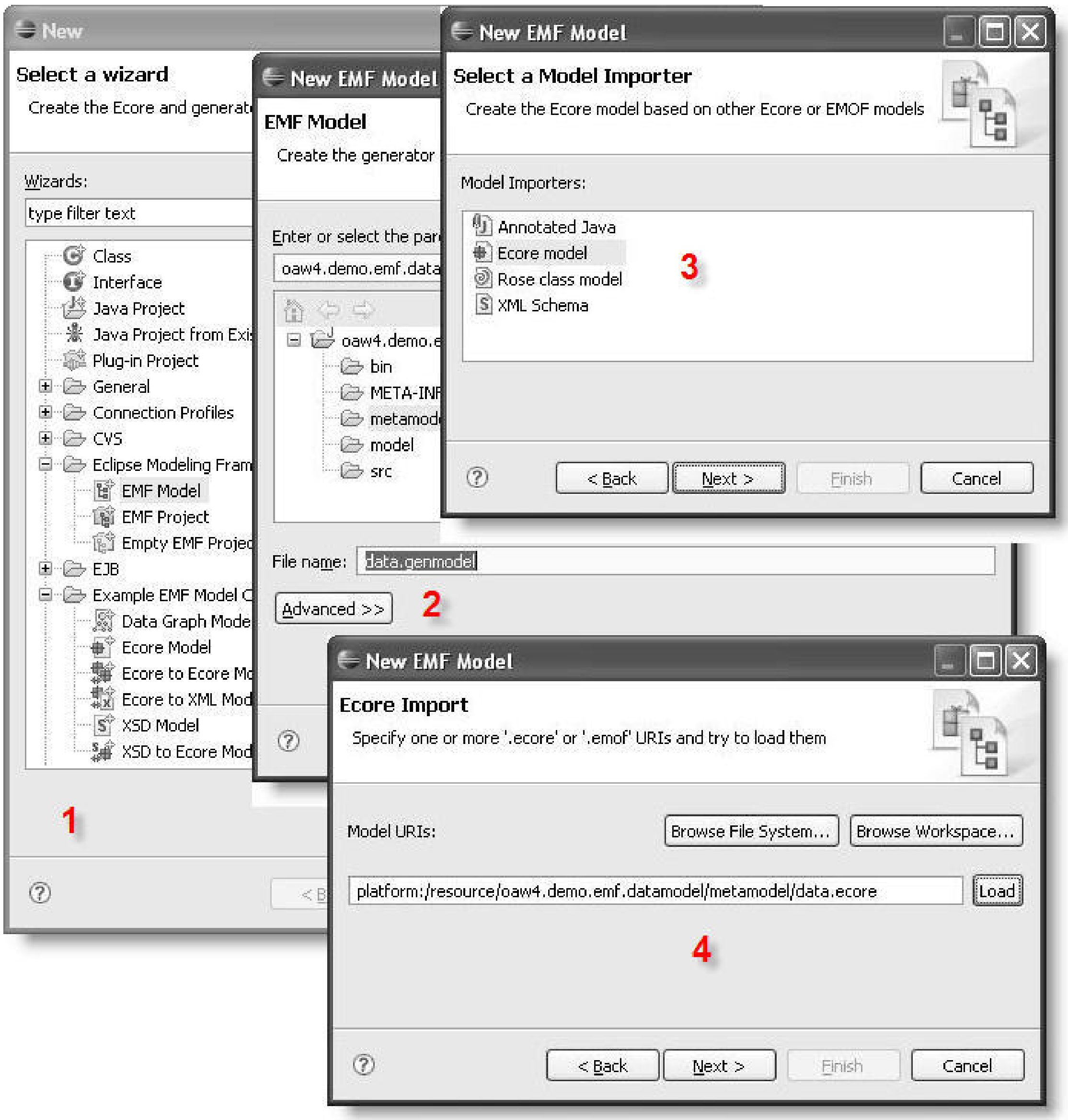
1. select EMF model

2. define the name

3. select the folder

4. select ecore model as source

5. press the *Load* button and then *Finish*

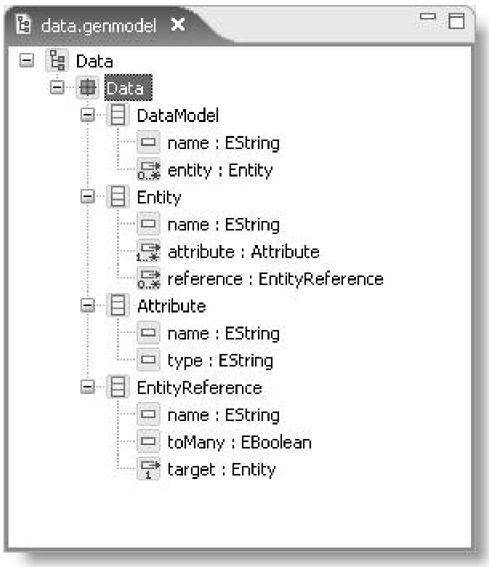


File name: data.genmodel

Model URIs: platform:/resource/oaw4.demo.emf.datamodel/metamodel/data.ecore

Figure 1.6. Creating the genmodel

As a consequence you’ll get the finished EMF genmodel. It is a kind of "wrapper" around the original metamodel; thus it has the same structure, but the model elements have different properties. As of now, you don't have to change any of these.



data.genmodel

- Data
  - Data
    - DataModel
      - name : EString
      - entity : Entity
    - Entity
      - name : EString
      - attribute : Attribute
      - reference : EntityReference
    - Attribute
      - name : EString
      - type : EString
    - EntityReference
      - name : EString
      - toMany : EBoolean
      - target : Entity

Figure 1.7. Structure of the genmodel

You can now generate the other projects.

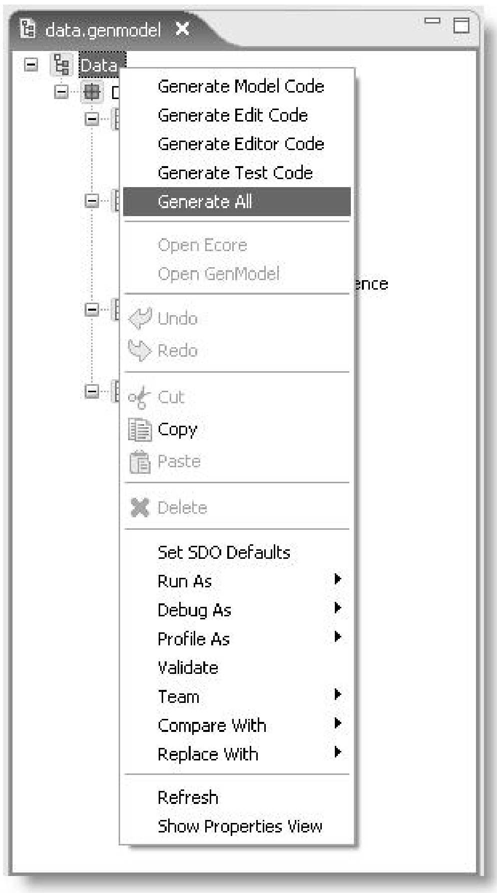


Figure 1.8. Generate editing projects

You now have all the generated additional projects.

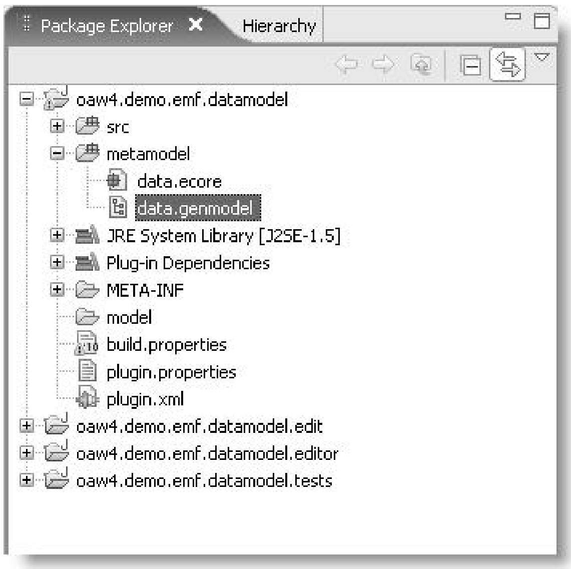


Figure 1.9. Generated projects

We won't look any deeper at these additional projects for now. However, there is one important thing to point out: The generator also generated the implementation classes for the metamodel. If you take a look into `oaw4.demo.emf.datamodel/src` folder you can find classes (actually, interfaces at the top level) that represent the concepts defined in your metamodel. These can be used to access the model. For some more details on how to use the EMF model APIs as well as the reflective cousins, take a look at http://voelterblog.blogspot.com/2005/12/codeblogck-emf_10.html.

1.5. Setting up the generator project

To make working with Eclipse EMF a bit less painless (we'd have to export the plugins, restart Eclipse, etc. etc.), we start another Eclipse in the IDE. This instance is called the *Runtime Workbench*. Therefore select the `oaw4.demo.emf.datamodel.edit1` project and choose from the context menu Run As -> Eclipse Application.

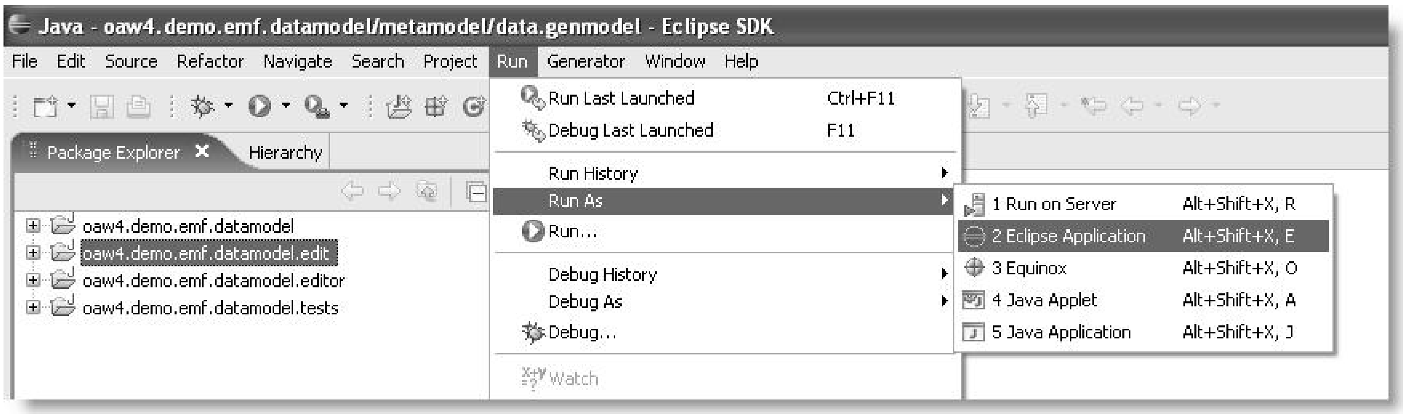

Java - oaw4.demo.emf.datamodel/metamodel/data.genmodel - Eclipse SDK
File Edit Source Refactor Navigate Search Project Run Generator Window Help
Package Explorer
Hierarchy
oaw4.demo.emf.datamodel
oaw4.demo.emf.datamodel.edit
oaw4.demo.emf.datamodel.editor
oaw4.demo.emf.datamodel.tests
Run Last Launched Ctrl+F11
Debug Last Launched F11
Run History
Run As
Run...
Debug History
Debug As
Debug...
Watch
1 Run on Server Alt+Shift+X, R
2 Eclipse Application Alt+Shift+X, E
3 Equinox Alt+Shift+X, O
4 Java Applet Alt+Shift+X, A
5 Java Application Alt+Shift+X, J

Figure 1.10. Launch runtime platform

If you are using a Mac or *nix you should now open the workspace preference page and change the default encoding to ISO-8859-11[4].

[4] Window -> Preferences -> General -> Workspace -> Text file encoding. This is necessary to have the guillemot brackets available.

Import the `oaw4.demo.emf.datamodel` project from your original workspace[5]. Note that importing the project does not physically move the files[6], so you can have the project be part of both workspaces at the same time.

Create a new openArchitectureWare Project[7] called `oaw4.demo.emf.datamodel.generator`. Do not choose the option "Generate a simple example".

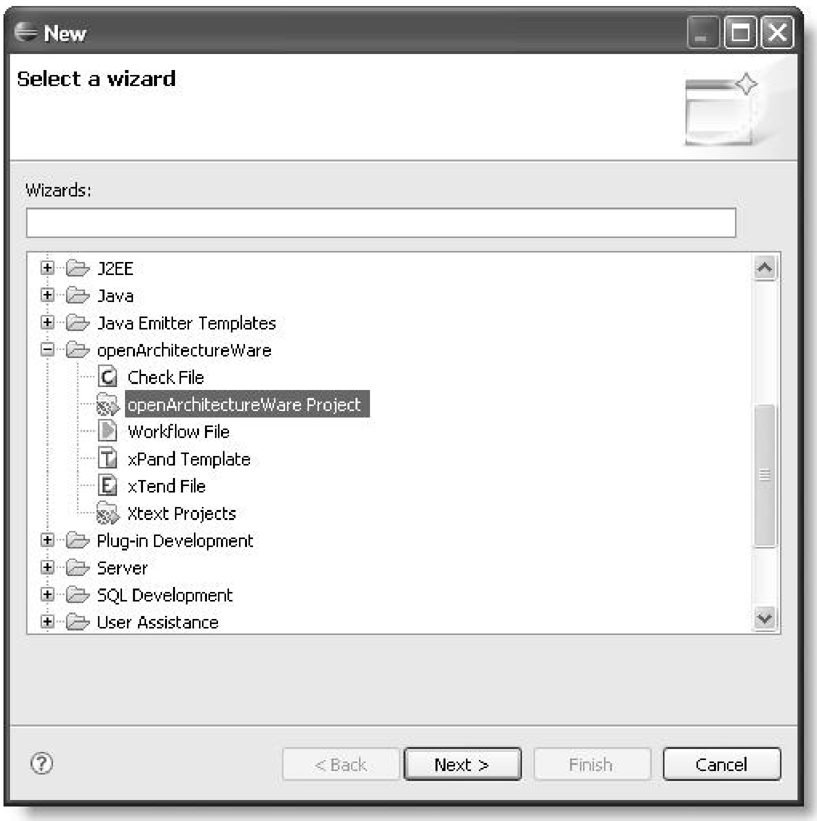


Figure 1.11. Create new oAW project

Your openArchitectureWare project will already be configured for use of EMF models. You can check this in the project properties dialog:

[5] File -> Import -> General -> Existing Project into Workspace

[6]Unless you checked the option "Copy projects into workspace"

[7] File -> New -> Project -> openArchitectureWare -> openArchitectureWare Project

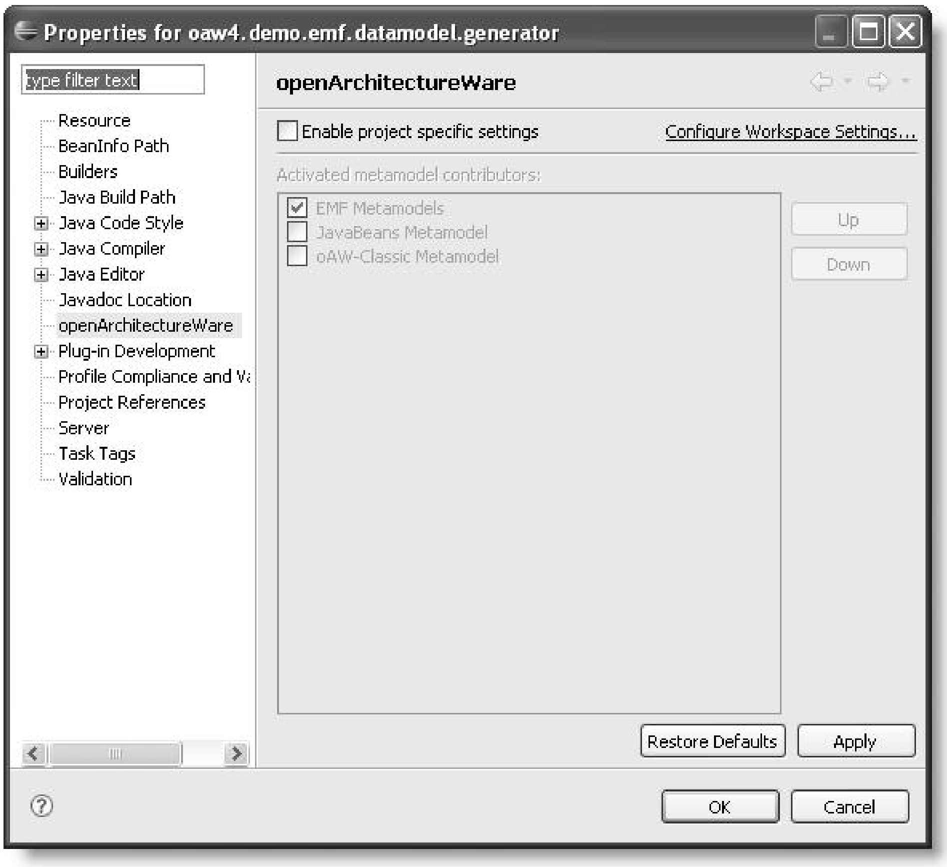


Figure 1.12. Project properties

1.6. Defining an Example Data Model

Select the `src` folder and then choose New -> Other -> Example EMF Model Creation Wizards -> Data Model. Create a new data model, call it `example.data`. On the last page of the wizard, select *Model* as model object.

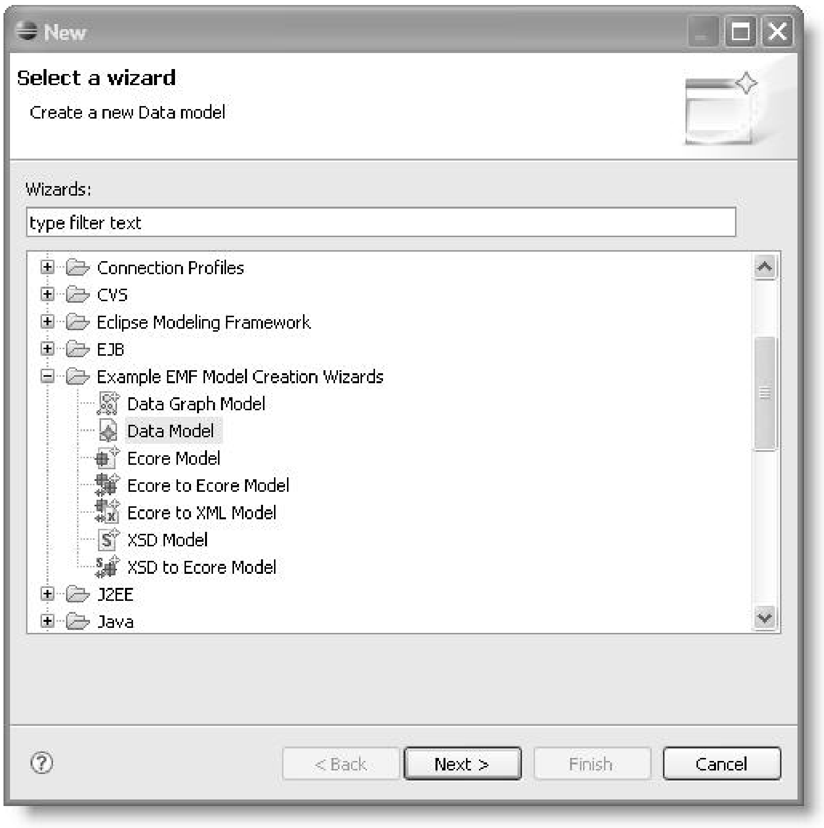
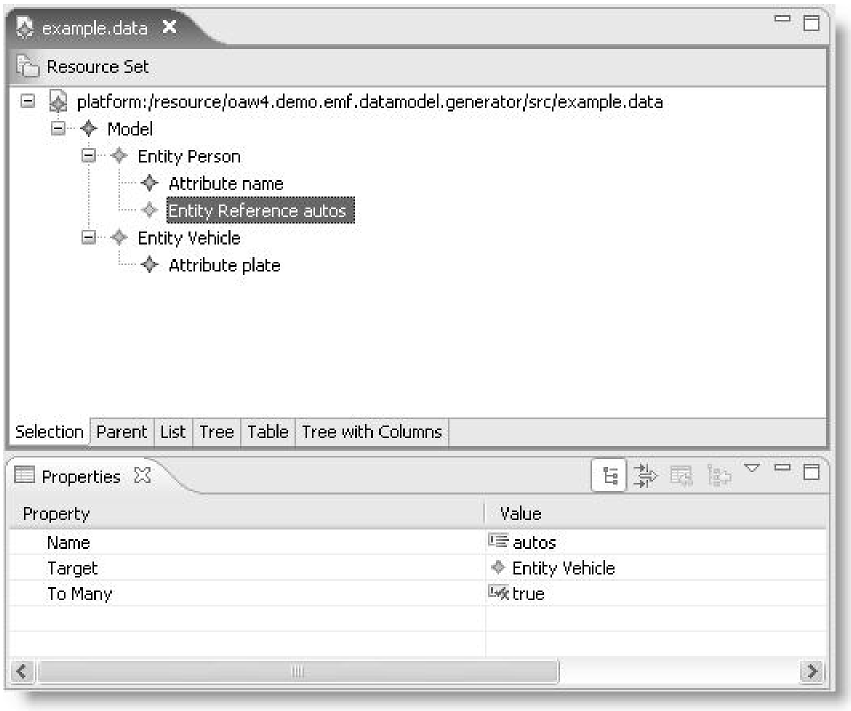


Figure 1.13. Create a sample data model

Next, populate this very model as following. Please note that in the case of attributes you have to define a type as well (i.e. String), not just a name.



Property	Value
Name	autos
Target	Entity Vehicle
To Many	true

Figure 1.14. Sample data model

Again, to avoid any typos here is the XMI for `example.data`:

```
<?xml version="1.0" encoding="UTF-8"?>
<data:DataModel
 xmi:version="2.0"
 xmlns:xmi="http://www.omg.org/XMI"
 xmlns:data="http://www.openarchitectureware.org/oaw4.demo.emf.datamodel">
 <entity name="Person">
  <attribute name="name" type="String"/>
  <reference name="autos" toMany="true" target="//@entity.1"/>
 </entity>
 <entity name="Vehicle">
  <attribute name="plate" type="String"/>
 </entity>
</data:DataModel>
```

1.7. Using Dynamic EMF

Instead of generating editors and metaclasses, you can also use dynamic EMF. This works by selecting, in the opened metamodel, the root class of the model you want to create (here: *DataModel*) and then selecting from the context menu. This opens an editor that can dynamically edit the respective instance. The created file bydefault has an `.xmi` extension.

Note that openArchitectureWare can work completely with dynamic models, there's no reason to generate code. However, if you want to programmatically work with the model, the generated metaclasses (not the editors!) are really helpful. Please also keep in mind: in subsequent parts of the tutorial, you'll specify the *metaModelPackage* in various component configurations in the workflow file, like this:

```
<metaModel id="mm"
 class="org.openarchitectureware.type.emf.EmfMetaModel">
 <metaModelPackage value="data.DataPackage"/>
</metaModel>
```

In case of dynamic EMF, there has no metamodel package been generated. So, you have to specify the meta model file instead, that is, the `.ecore` file you just created. Note that the `.ecore` file has to be in the classpath to make this work.

```
<metaModel id="mm"
 class="org.openarchitectureware.type.emf.EmfMetaModel">
 <metaModelFile value="data.ecore"/>
</metaModel>
```

1.8. Generating Code From the Example Model

1.8.1. The workflow definition

To run the openArchitectureWare generator you have to define a workflow. It controls which steps (loading models, checking them, generating code) the generator executes. For details on how workflow files work, please take a look at the *Workflow Reference Documentation*.

Create a `workflow.oaw` and a `workflow.properties` in the `src` folder. The contents of these files is shown below:

```
<workflow>
 <property file="workflow.properties"/>

 <component id="xmiParser"
```

```
  class="org.openarchitectureware.emf.XmiReader">
  <modelFile value="${modelFile}"/>
  <metaModelPackage value="data.DataPackage"/>
  <outputSlot value="model"/>
  <firstElementOnly value="true"/>
 </component>
</workflow>
```

The workflow tries to load stuff from the classpath; so, for example, the `data.DataPackage` class is resolved from the classpath, as is the model file specified in the properties (`modelFile=example.data`)

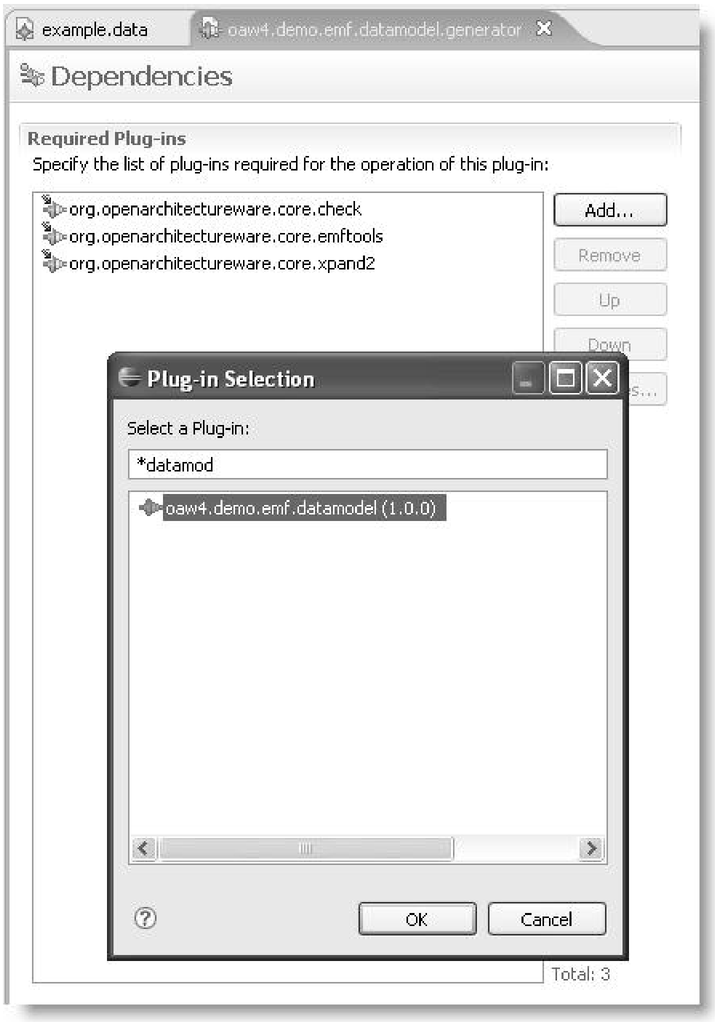
This instantiates the example model and stores in in a workflow slot named model. Note that in the *metamodelPackage* slot, you have to specify the EMF package object (here: `data.DataPackage`), not the Java package (which would be data here).

1.8.2. Running the workflow

Before you actually run the workflow, make sure you have a log4j configuration in the classpath; for example, you can put the following `log4j.properties` file directly into your source folder:

```
# Set root logger level to DEBUG and its only appender to A1.
log4j.rootLogger=INFO, A1

# A1 is set to be a ConsoleAppender.
log4j.appender.A1=org.apache.log4j.ConsoleAppender
log4j.appender.A1.layout=org.apache.log4j.PatternLayout
log4j.appender.A1.layout.ConversionPattern=%-4r %-5p - %m%n
```

Also, please make sure your metamodel can be found on the classpath. In our case, this can be achieved by adding the `oaw4.demo.emf.datamodel` project to the plug-in dependencies of `oaw4.demo.emf.datamodel.generator`. To do this, double click the file `oaw4.demo.emf.datamodel.generator/META-INF/MANIFEST.MF`. The manifest editor will appear. Go to the Dependencies tab and click on Add... to add a new dependency. In the dialog appearing, choose `oaw3.demo.emf.datamodel`:



Required Plug-ins
Specify the list of plug-ins required for the operation of this plug-in:

org.openarchitectureware.core.check
org.openarchitectureware.core.emftools
org.openarchitectureware.core.xpand2

Select a Plug-in:
*datamod
oaw4.demo.emf.datamodel (1.0.0)

Figure 1.15. Add metamodel dependency

Do not forget to save the manifest file!

Now, you can run the workflow from within Eclipse:

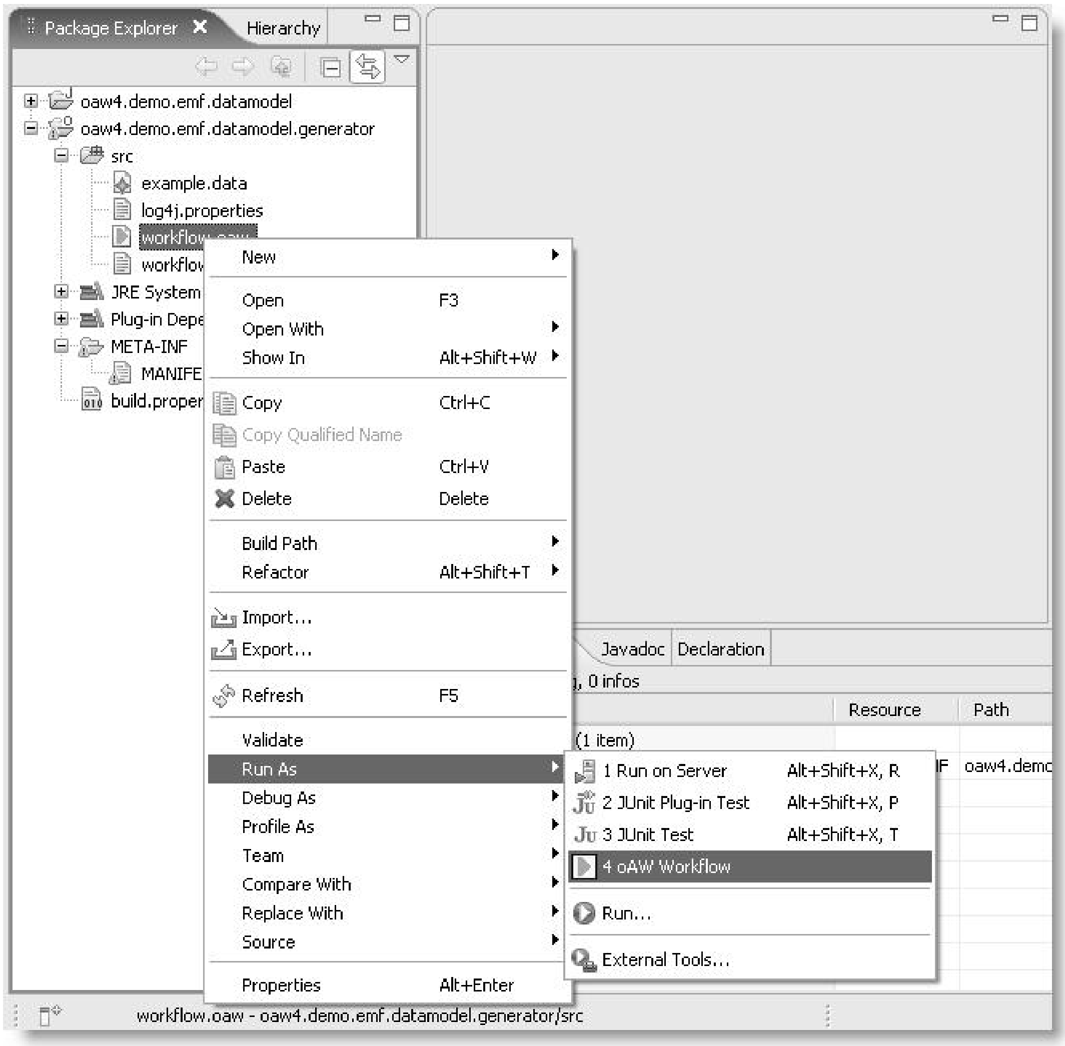


Figure 1.16. Sample data model

The following should be the output:

```
0    INFO  - -------------------------------------------------------------------------------------
171  INFO  - openArchitectureWare 4.1.2, Build v20070314
171  INFO  - (c) 2005-2007 openarchitectureware.org and contributors
171  INFO  - -------------------------------------------------------------------------------------
171  INFO  - running workflow: D:/oAW-emftutorial/oaw4.demo.emf.datamodel.generator/src/workflow.oaw
171  INFO  -
750  INFO  - xmiParser: file 'example.data' => slot 'model'
875  INFO  - workflow completed in 125ms!
```

1.8.3. Templates

No code is generated yet. This is not surprising, since we did not yet add any templates. Let's change this. Create a package templates in the `src`folder and within the package a file called `Root.xpt`.

The `Root.xpt` looks as follows. By the way, if you need to type the guillemots (« and »), the editor provides keyboard shortcuts with **Ctrl**+< and **Ctrl**+>.

```
«DEFINE Root FOR data::DataModel»
 «EXPAND Entity FOREACH entity»
«ENDDEFINE»
```

```
«DEFINE Entity FOR data::Entity»
 «FILE name + ".java"»
  public class «name» {
   «FOREACH attribute AS a»
    // bad practice
    private «a.type» «a.name»;
   «ENDFOREACH»
  }
 «ENDFILE»
«ENDDEFINE»
```

We have to extend the `workflow.oaw` file, in order to use the template just written:

```
<?xml version="1.0" encoding="windows-1252"?>
<workflow>
 <property file="workflow.properties"/>

 <component id="xmiParser"
  class="org.openarchitectureware.emf.XmiReader">
  ...
 </component>
```

First, we clean up the directory where we want to put the generated code.

```
 <component id="dirCleaner"
  class="org.openarchitectureware.workflow.common.DirectoryCleaner" >
  <directories value="${srcGenPath}"/>
 </component>
```

Then we start the generator component. It's configuration is slightly involved.

```
 <component id="generator"
  class="org.openarchitectureware.xpand2.Generator">
```

First of all, you have to define the meta model. In our case we use the `EmfMetaModel` since we want to work with EMF models. Also, you have to specific the class name of the EMF package that represents that metamodel. It must be on the classpath!

```
  <metaModel id="mm"
   class="org.openarchitectureware.type.emf.EmfMetaModel">
   <metaModelPackage value="data.DataPackage"/>
  </metaModel>
```

Then you have to define the *entry statement* for Xpand. Knowing that the model slot contains an instance of `data.DataModel` (the XMIReader had put the first element of the model into that slot, and we know from the data that it is a `DataModel`), we can write the following statement. Again, notice that model refers to a slot name here!

```
  <expand value="templates::Root::Root FOR model"/>
```

We then specify where the generator should put the generated code and that this generated code should be processed by a code beautifier:

```
  <outlet path="${srcGenPath}/">
   <postprocessor
    class="org.openarchitectureware.xpand2.output.JavaBeautifier"/>
  </outlet>
```

Now we are almost done.

```
 </component>
</workflow>
```

You also need to add the *srcGenPath* to the `workflow.properties` file.

```
modelFile=example.data
srcGenPath=src-gen
```

1.8.4. Running the generator again

So, if you restart the generator now, you should get a file generated that looks like this:

```
public class Person {
 // bad practice
 public String lastName;
}
```

1.9. Checking Constraints with the Checks Language

An alternative to checking constraints with pure Java is the declarative constraint checking language *Check*. For details of this language take a look at the *Check Language Reference*. We will provide a simple example here.

1.9.1. Defining the constraint

We start by defining the constraint itself. We create a new file called `checks.chk` in the `src` folder of our project. It is important that this file resides in the classpath! The file has the following content:

```
import data;
context Attribute ERROR
   "Names must be more than one char long" :
   name.length > 1;
```

This constraint says that for the metaclass `data::Attribute`, we require that the name be more than one characters long. If this expression evaluates to false, the error message given before the colon will be reported. A checks file can contain any number of such constraints. They will be evaluated for all instances of the respective metaclass.

To show a somewhat more involved constraint example, this one ensures that the names of the attributes have to be unique:

```
context Entity ERROR
 "Names of Entity attributes must be unique":
 attribute.forAll(a1| attribute.notExists(a2| a1 != a2 && a1.name == a2.name ) );
```

1.9.2. Integration into the workflow file

The following piece of XML is the workflow file we'd already used above.

```
<?xml version="1.0" encoding="windows-1252"?>
<workflow>
 <property file="workflow.properties"/>
```

```
<component id="xmiParser" class="org.openarchitectureware.emf.XmiReader">
 ...
</component>
```

After reading the model we add an additional component, namely the *CheckComponent*.

```
<component
 class="org.openarchitectureware.check.CheckComponent">
```

As with the code generator, we have to explain to the checker what meta meta model and which meta model we use.

```
 <metaModel id="mm" class="org.openarchitectureware.type.emf.EmfMetaModel">
  <metaModelPackage value="data.DataPackage"/>
 </metaModel>
```

We then have to provide the checks file. The component tries to load the file by appending `.chk` to the name and searching the classpath – that's why it has to be located in the classpath.

```
 <checkFile value="checks"/>
```

Finally, we have to tell the engine on which (part of) the model the checks should work. In general, you can use the `<expressionvalue="..."/>` element to define an arbitrary expression on slot contents. For our purpose, where we want to use the complete EMF data structure in the model slot, we can use the shortcut *emfAllChildrenSlot* property, which returns the complete subtree below a specific slot's content element, including the slot content element itself.

```
 <emfAllChildrenSlot value="model"/>
</component>
```

Running the workflow produces an error in case the length of the name is not greater than one. Again, it makes sense to add the `skipOnError="true"` to those subsequent component invocations that need to be skipped in case the constraint check found errors (typically code generators or transformers).

1.10. Extensions

It is often the case that you need additional properties in the templates; these properties should not be added to the metaclasses directly, since they are often specific to the specific code generation target and thus should not "pollute" the metamodel.

It is possible to define such extensions external to the metaclasses. For details see the *Extend Language Documentation*, we provide an simple example here.

1.10.1. Expression Extensions

Assume we wanted to change the *Attribute*s part of the template as follows:

```
«FOREACH attribute AS a»
 private «a.type» «a.name»;

 public void «a.setterName()»( «a.type» value ) {
  this.«a.name» = value;
 }

 public «a.type» «a.getterName()»() {
  return this.«a.name»;
 }
«ENDFOREACH»
```

To make this work, we need to define the `setterName()` and `getterName()` operations. We do this by writing a so-called extension file; we call it `java.ext`. It must have the `.ext` suffix to be recognized by oAW; the *java* name is because it contains Java-generation specific properties. We put this file directly into the `templates` directory under `src`, i.e. directly next to the `Root.xpt` file. The extension filelooks as follows:

First we have to import the data metamodel; otherwise we'd not be able to use the *Attribute* metaclass.

```
import data;
```

We can then define the two new operations `setterName` and `getterName`. Note that they take the type on which they're called as their first parameter, a kind of "explicitly this". After the colon we use an expression that returns the to-be-defined value.

```
String setterName(Attribute ele) :
 'set'+ele.name.toFirstUpper();

String getterName(Attribute ele) :
 'get'+ele.name.toFirstUpper();
```

To make these extensions work, we have to add the following line to the beginning of the `Root.xpt` template file:

```
«EXTENSION templates::java»
```

1.10.2. Java Extensions

In case you cannot express the "business logic" for the expression with the expression language, you can fall back to Java. Take a loot at the following extension definition file. It's called `util.ext` and is located in `src/datamodel/generator/util`:

```
String timestamp() :
 JAVA datamodel.generator.util.TemplateUtils.timestamp();
```

Here we define an extension that is independent of a specific model element, since it does not have a formal parameter! The implementation of the extension is delegated to a static operation of a Java class. Here is it's implementation:

```
public class TemplateUtils {
 public static String timestamp() {
  return String.valueOf( System.currentTimeMillis() );
 }
}
```

This element can be used independent of any model element – it's available globally.

Sometimes it's necessary to access extensions not just from templates (and Wombat scripts) but also from Java code. The following example is of this kind: we want to define properties that derive the name of the implementation class from the entity name itself; we'll need that property in the next section, the one on recipes. The best practice for this use case is to implement the derived property as a Java method, as above. The following piece of code declares properties for `Entity`:

```
package datamodel;

import data.Entity;

public class EntityHelper {

 public static String className( Entity e ) {
  return e.getName()+"Implementation";
 }

 public static String classFileName( Entity e ) {
  return className(e)+".java";
 }

}
```

In addition, to access the properties from the template files, we define an extension that uses the helper methods. The `helper.ext` file is located right next to the helper class shown above, i.e. in the datamodel package:

```
import data;

String className( Entity e ) :
   JAVA datamodel.EntityHelper.className(data.Entity);

String classFileName( Entity e ) :
   JAVA datamodel.EntityHelper.classFileName(data.Entity);
```

In addition to these new properties being accessible from Java code by invoking `EntityHelper.className(someEntity)`, we can now write the following template:

```
«EXTENSION templates::java»
«EXTENSION datamodel::generator::util::util»
«EXTENSION datamodel::helper»

«DEFINE Root FOR data::DataModel»
 «EXPAND Entity FOREACH entity»
«ENDDEFINE»

«DEFINE Entity FOR data::Entity»
 «FILE classFileName()»
  // generated at «timestamp()»
  public abstract class «className()» {
   «FOREACH attribute AS a»
    private «a.type» «a.name»;
    public void «a.setterName()»( «a.type» value ) {
     this.«a.name» = value;
    }

    public «a.type» «a.getterName()»() {
     return this.«a.name»;
    }
   «ENDFOREACH»
  }
 «ENDFILE»
«ENDDEFINE»
```

For completeness, the following illustration shows the resulting directory and file structure.

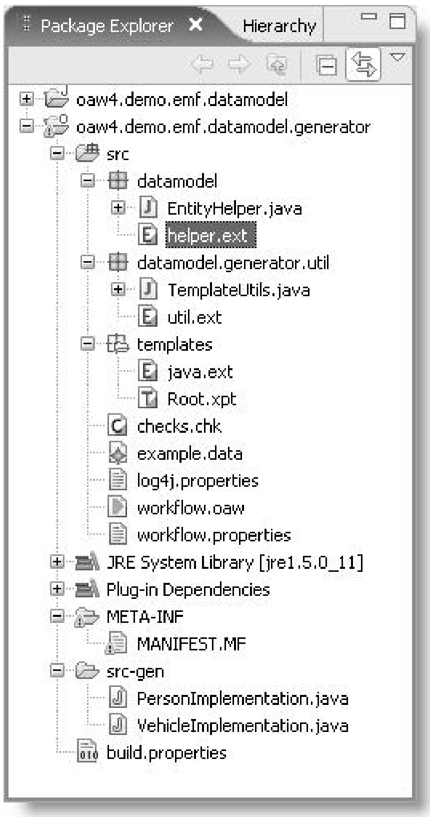


Figure 1.17. What has happened so far

1.11. Integrating Recipes

Let's assume we wanted to allow developers to add their own business logic to the entites, maybe adding a couple of derived properties. In that case, we have to integrate the generated code with manually written fragments. Let's further assume that you – just like me – don't like protected regions because the end up in versioning chaos. In such case you might want to let the generator create a base class that contains all generated aspects and developers have to inherit from this class to add their own logic. Let's first change the generator accordingly.

1.11.1. Adjusting project settings

We will now use openArchitectureWare's Recipe framework to achieve our task. Since this framework is an add-on we need to set up an additional dependency to it for our generator project. Otherwise the required classes won't be found.

Open the projects Manifest file `META-INF/MANIFEST.MF`, go to the *Dependencies* page and add the `org.openarchitectureware.recipe.*` plugins.

1.11.2. Adapting the existing generator

Let's first look at the template. Here we have to change the name of the generated class, and we have to make it abstract:

```
«DEFINE Entity FOR data::Entity»
 «FILE baseClassFileName()»
     // generated at «timestamp()»
        public abstract class «baseClassName()» {
```

```
   «FOREACH attribute AS a»
                     ...
   «ENDFOREACH»
  }
 «ENDFILE»
«ENDDEFINE»
```

To make this work, our extensions must be adapted; we now need `baseClassName` and `baseClassFileName`.

```
import data;

String baseClassName( Entity e ) :
   JAVA datamodel.EntityHelper.baseClassName(data.Entity);

String baseClassFileName( Entity e ) :
   JAVA datamodel.EntityHelper.baseClassFileName(data.Entity);
```

The implementation helper class must be adapted, too:

```
package datamodel;

import data.Entity;

public class EntityHelper {

 public static String baseClassName( Entity e ) {
  return e.getName()+"ImplBase";
 }

 public static String baseClassFileName( Entity e ) {
  return baseClassName(e)+".java";
 }

 public static String implementationClassName( Entity e ) {
  return e.getName();
 }

}
```

Note the additional property `implementationClassName`. This is the name of the class that developers have to write manually. While we expect that the generated code goes into the `src-gen` directory, we want the manually written code in `man-src`. Here is the generated base class for the `Person` entity:

```
// generated at 1138622360609
public abstract class PersonImplBase {
    private String name;

    public void setName(String value) {
        this.name = value;
    }

    public String getName() {
        return this.name;
    }
}
```

The manually written subclass could look as follows:

```
public class Person extends PersonImplBase {

}
```

Now, here's the issue: how do you make sure that developers actually write this class, that it has the right name and that it actually extends the generated base class? This is where the recipe framework comes into play. We want to define rules that allow Eclipse to verfy that these "programming guidelines" have been met by developers.

1.11.3. Implementing the Recipes

As of now there is no specific language to implement those recipe checks, you have to write a bunch of Java code. In summary, you have to implement a workflow component that produces the checks. Let's look at what you need to do.

In order to simplify life, your recipe creation component should use the `RecipeCreationComponent` base class.

```
public class RecipeCreator extends RecipeCreationComponent {
```

You then have to override the createRecipes operation.

```
 protected Collection createRecipes(Object modelSlotContent,
  String appProject, String srcPath) {
```

We now create a list that we use to collect all the checks we want to pass back to the framework.

```
  List checks = new ArrayList();
```

Since we need to implement such a check for each Entity in the model, we have to find all entities and iterate over them.

```
  Collection entities = EcoreUtil2.findAllByType(
   ((DataModel)modelSlotContent).eAllContents(),
   Entity.class );
  for (Iterator iter = entities.iterator(); iter.hasNext();) {
   Entity e = (Entity) iter.next();
```

We then create a composite check whose purpose is to act as a container for the more specific checks that follow. It will show as the root of a tree in the Recipe Framework view.

```
   ElementCompositeCheck ecc = new ElementCompositeCheck(e,
    "manual implementation of entity");
```

Then we add a check that verifies the exsitence of a certain class in a given project in a certain directory. The name of the class it needs to check for can be obtained from our EntityHelper!

```
   JavaClassExistenceCheck javaClassExistenceCheck =
    new JavaClassExistenceCheck(
     "you have to provide an implementation class.",
     appProject, srcPath,
     EntityHelper.implementationClassName(e)
    );
```

We then define a second check that checks that the class whose existence has been verified with the check above actually inherits from the generated base class. Again we use the `EntityHelper` to come up with the names. Note that they will be consistent with the names used in the code generation templates because both use the same `EntityHelper` implementation.

```
   JavaSupertypeCheck javaSuperclassCheck =
    new JavaSupertypeCheck(
     "the implementation class has to extend the "+
     "generated base class", appProject,
     EntityHelper.implementationClassName(e),
     EntityHelper.baseClassName(e)
    );
```

We then add the two specific checks to the composite check...

```
    ecc.addChild( javaClassExistenceCheck );
    ecc.addChild( javaSuperclassCheck );
```

... add the composite check to the list of checks we return to the framework, ...

```
    checks.add( ecc );
   }
```

... and return all the created checks to the framework after we finish iteration over `Entities`:

```
   return checks;
  }
 }
```

1.11.4. Workflow Integration

Here's the modified workflow file. We integrate our new component as the last step in the workflow.

```
[<?xml version="1.0" encoding="windows-1252"?>
<workflow>
 <property file="workflow.properties"/>

 <component id="xmiParser"
  class="org.openarchitectureware.emf.XmiReader">
  <modelFile value="${modelFile}"/>
  <metaModelPackage value="data.DataPackage"/>
  <outputSlot value="model"/>
  <firstElementOnly value="true"/>
 </component>

 <!-- all the stuff from before -->
```

The parameters we pass should be self-explanatory. The *`recipeFile`* parameter is where the checks will written to – it must have the `recipes` extension.

```
 <component id="recipe"
                  class="datamodel.generator.RecipeCreator">
  <appProject value="oaw4.demo.emf.datamodel.generator"/>
  <srcPath value="man-src"/>
  <modelSlot value="model"/>
  <recipeFile value="recipes.recipes"/>
 </component>

</workflow>
```

1.11.5. Running the Workflow and seeing the Effect

We can now run the workflow. After running it, you should see a `recipes.recipes` file in the root of your project. Right clicking on it reveals the button. Since the manual implementation of the `Vehicle` Entity is missing, we get the respective error.

We can now implement the class manually, in the `man-src` folder:

```
public class Vehicle extends VehicleImplBase {
}
```

After doing that, the remaining errors in the recipe view should go away automatically.

1.12. Transforming Models

It is often necessary to transform models before generating code from it. There are actually two forms of transformations:

1. An actual model *transformation* generates a completely new model – usually based on a different metamodel – from an input model. The transformation has no side effects wrt. to the input model.

2. A model *modification* completes/extends/finishes/modifies a model. No additional model is created.

Please take a look at the *xTend Example tutorial* to understand model transformations with the xTend language.

1.12.1. Model Modifications in Java

One way of doing modifications is to use Java. Take a look at the following piece of Java code. We extend from a class called `SimpleJavaTransformerComponent`. Instead of directly implementing the `WorkflowComponent` interface, we inherit from a more comfortable base class and implement the `doModification` operation.

```
public class Transformer extends SimpleJavaModificationComponent {

 protected void doModification(WorkflowContext ctx, ProgressMonitor
  monitor, Issues issues, Object model) {
```

We know that we have a `DataModel` object in the model slot (you can see in a moment where the model comes from).

```
  DataModel dm = (DataModel)model;
```

We then get us the factory to create new model elements (what this code does exactly you should learn from the EMF docs).

```
  DataFactory f = DataPackage.eINSTANCE.getDataFactory();
```

We then iterate over all entities.

```
  for (Iterator iter = dm.getEntity().iterator(); iter.hasNext();) {
   Entity e = (Entity) iter.next();
   handleEntity(e, f);
  }
 }
```

For each `Entity`...

```
 private void handleEntity(Entity e, DataFactory f) {
  for (Iterator iter = EcoreUtil2.clone( e.getAttribute() ).iterator(); iter.hasNext();) {
   Attribute a = (Attribute) iter.next();
```

We create a new attribute with the same type, and a name with a "2" postfixed. We then add this new attribute to the entity.

```
   Attribute a2 = f.createAttribute();
   a2.setName( a.getName()+"2" );
   a2.setType( a.getType() );
   e.getAttribute().add(a2);
  }
 }
}
```

To execute this component, we just have to add it to the workflow:

```
[<component class="datamodel.generator.Transformer">
 <modelSlot value="model"/>
</component>
```

We have to specify the model slot. The super class (`SimpleJavaTransformerComponent`) provides the slot-setter and passes the object from that slot to the `doTransform` operation.

Chapter 2. Xtext Tutorial

This tutorial shows how easy it is to define an external DSL .

2.1. Installing the pre-built tutorial

The tutorial is based on the Xtext framework as it is contained in oAW 4.2. Make sure that you have installed oAW 4.2 into an Eclipse 3.3 workbench running on Java >=5. The easiest way to get a working IDE is to download the Eclipse 3.3 distribution for RCP/Plug-in developers from `eclipse.org` and the oAW all-in-one release from oAW's website.

2.2. Tutorial overview

The purpose of this tutorial is to illustrate definition of external DSLs using Xtext. The process we're going to go through will start by defining an Xtext grammar for our DSL, generate a parser, a meta model and a corresponding text editor out of it. Afterwards we will see how to refine the DSL and it's editor using provided facilities. In the end we will see how one can generate code out of textual models.

The actual content of this example is rather trivial – we will generate Java classes following the Java Beans conventions. The model will contain entities (such as Person or Address) including some attributes and relationships among them – a rather typical data model. From these entities in the model we want to generate the Beans for implementation in Java. In a real setting, we might also want to generate persistence mappings, etc. We will not do this for this simple introduction.

2.3. Defining the DSL

We'll define a DSL for simple domain models following some concepts of Domain-Driven Design.

We don't want to define too much semantic for each of these concepts here because this tutorial is about *how* to develope a DSL not *why*. In addition, most of the semantics of a DSL's concept is usually implemented in a generator or an interpreter, which is not the focus of this turorial.

We use this example because the concepts are well known (even if the meaning is not formally defined). So we don't need to explain them or motivate the example but can focus on other things.

The following UML diagram shows the abstract syntax of the DSL we're going to define:

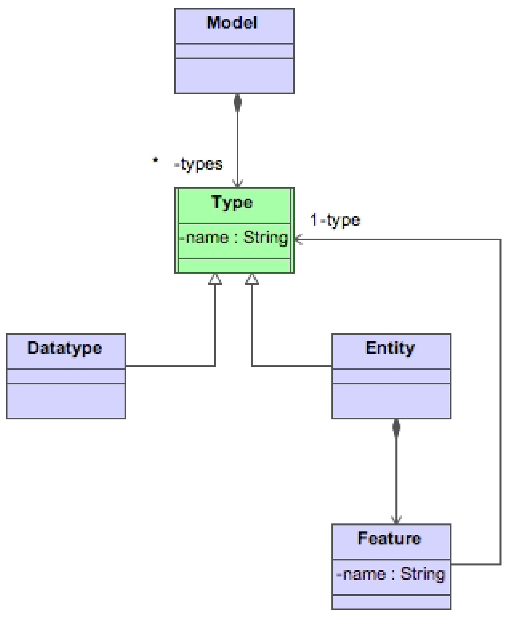


Figure 2.1. Meta model as UML diagram

2.3.1. Creating Xtext projects

To get started we need to create some projects. Therefore we use the provided Xtext wizard:

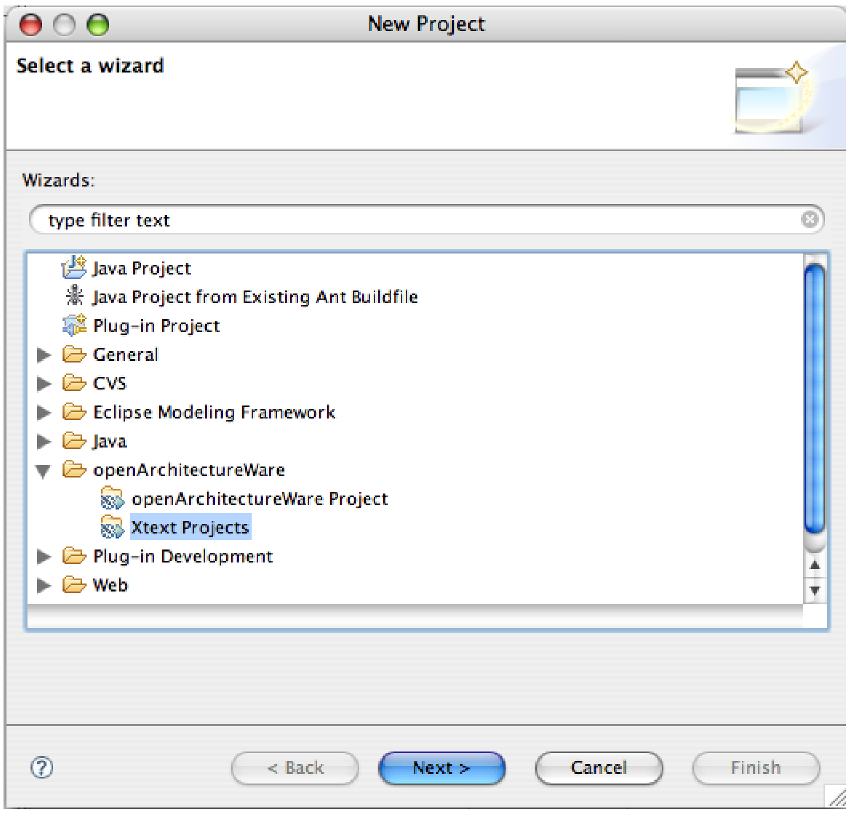
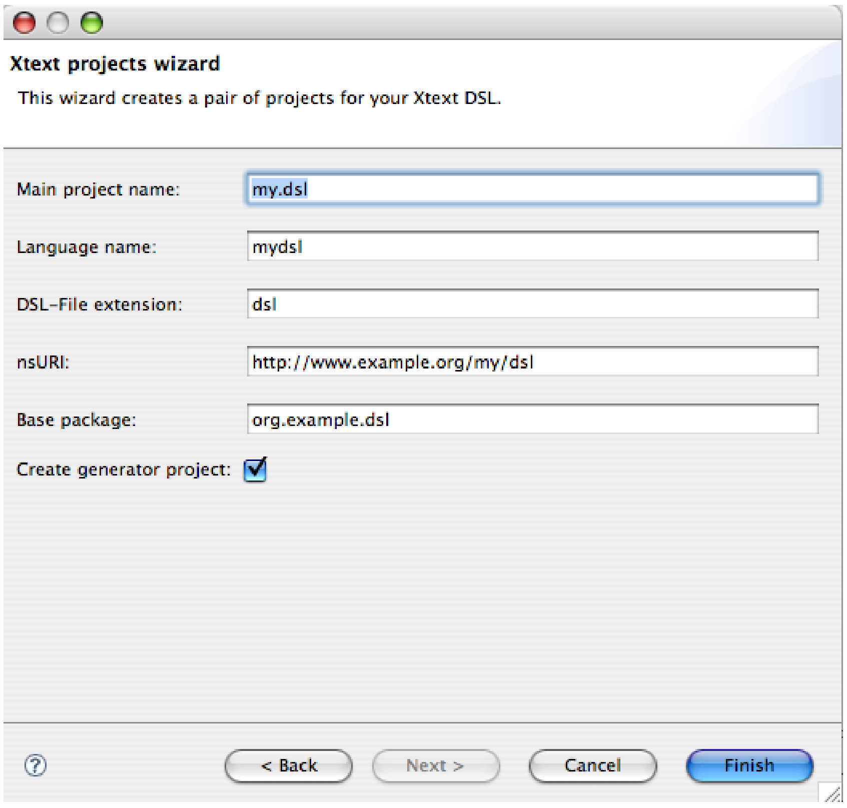


Figure 2.2. Create Xtext projects


Xtext projects wizard
This wizard creates a pair of projects for your Xtext DSL.

Main project name: my.dsl
Language name: mydsl
DSL-File extension: dsl
nsURI: http://www.example.org/my/dsl
Base package: org.example.dsl
Create generator project: ✓

Figure 2.3. Xtext wizard dialog

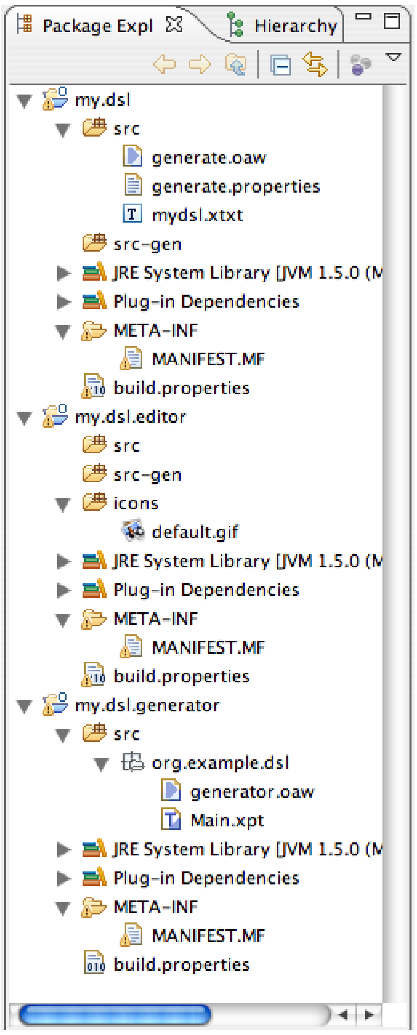
The wizard dialog lets you specify a number of properties used for different things. See the Xtext reference documentation for detailed information about what the different properties mean. For the moment just ensure that everything looks like shown in the screenshot above (i.e. stay with the defaults) and click "Finish".

The wizard generates three projects. The first one (`my.dsl`) is the language project. Therein we'll define the grammar and Xtext's generator will place the meta model and the parser in it.

The second one is named `my.dsl.editor` and contains the Eclipse text editor for our DSL. For now it is empty because, we haven't defined a DSL and started the generator so far.

The third project (`my.dsl-generator`) is called the generator project. Actually this is not directly related to Xtext but to oAW in general. That means that the Xtext generator doesn't generate a single file into this project. However, the wizard has placed a workflow file using the DSL parser (which we will generate in a second) as well as a default Xpand template. So we don't need to do any configuration manually.

Your navigator should look similar to the one in this screenshot:

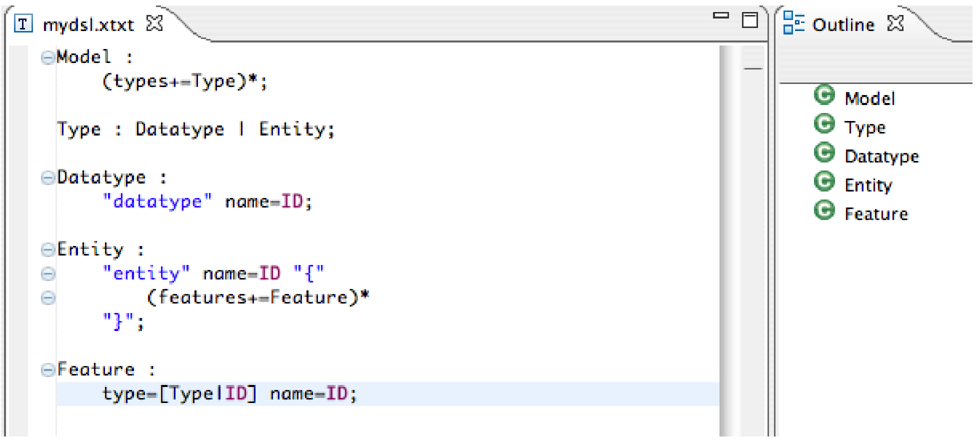


```
my.dsl
  src
    generate.oaw
    generate.properties
    mydsl.xtxt
  src-gen
  JRE System Library [JVM 1.5.0 (M
  Plug-in Dependencies
  META-INF
    MANIFEST.MF
  build.properties
my.dsl.editor
  src
  src-gen
  icons
    default.gif
  JRE System Library [JVM 1.5.0 (M
  Plug-in Dependencies
  META-INF
    MANIFEST.MF
  build.properties
my.dsl.generator
  src
    org.example.dsl
      generator.oaw
      Main.xpt
  JRE System Library [JVM 1.5.0 (M
  Plug-in Dependencies
  META-INF
    MANIFEST.MF
  build.properties
```

Figure 2.4. Package explorer

2.3.2. Defining the grammar

The wizard created and automatically opened an Xtext grammar file (`mydsl.xtxt`). Therein we have to specify the grammar for our textual DSL. Using Xtext's grammar language one defines the abstract syntax (i.e. the meta model) and the conrete syntax of the the language. This allows for very short turn-arounds when refactoring and / or improving the DSL.



```
Model :
    (types+=Type)*;

Type : Datatype | Entity;

Datatype :
    "datatype" name=ID;

Entity :
    "entity" name=ID "{"
        (features+=Feature)*
    "}";

Feature :
    type=[Type|ID] name=ID;
```

Figure 2.5. Create new Ecore model

The root element of all expressions made in our new DSL is called a `Model`. The is the name of the parser rule which is invoked for each textual model to be parsed.

The parser rule `Model` creates and returns an instance of the corresponding meta model element (also called '`Model`'). A `Model` just consists of a list of `types` (rule *Type*). In the model the list of types can be accessed through the reference `types`. When it comes to code generation one can evaluate expressions such as '`myModel.types`' to get the types of a model.

A `Type` corresponds to an abstract meta type, because it just refers to two other rules (without assigning the result to a property like `Model` does). So the list of *Types* consists of `Datatypes` and/or `Entities`.

A `Datatype` starts with keyword `"datatype"` followed by an identifier (`ID`). The value of the identifier is assigned to the `Datatype`'s property `name`. `ID` is a built-in rule and is similar to a Java identifier (i.e. a word starting with a letter followed by alphanumerical characters and/or underscores).

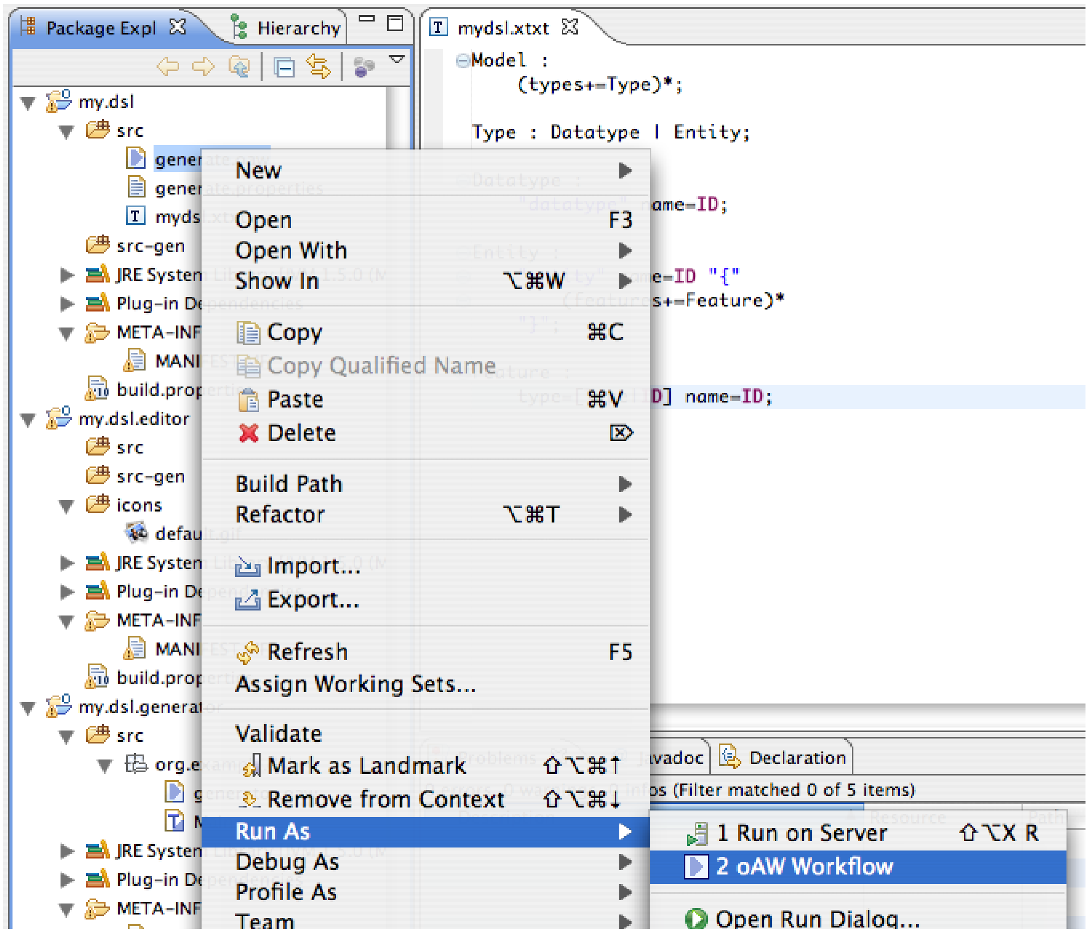
An `Entity` starts with keyword `"entity"` followed by an identifier (`ID`) which is assigned to the property `name` as well. In addition an entity contains declarations of owned features. The list of declarations is assigned to the reference called '`features`' and it is surrounded by curly brackets (`"{"` and `"}"`).

Last but not least a `Feature` consists of an Identifier (`ID`) which refers to a `Type` and another identifier which specifies the name of the `Feature`.

Make sure to read the reference documentation in order understand how a metamodel is derived from a grammar and how the linking for cross references actually works.

2.3.3. Starting the generator

Now that we have defined an Xtext grammar for our simple DSL we can start Xtext's generator by right clicking the workflow file (`generate.oaw`). It will create the meta model and the parser as well as fill the editor project with the needed artifacts.



```
Model :
    (types+=Type)*;

Type : Datatype | Entity;
```

Figure 2.6. Starting the Xtext generator

2.3.4. Starting a runtime workbench

We now can start a so called runtime workbench in order to see our newly defined DSL and it's editor in action. To do so click the "Debug..."-Action in the toolbar like it is shown in the next screenshot. Select the entry called "Open Debug Dialog...".

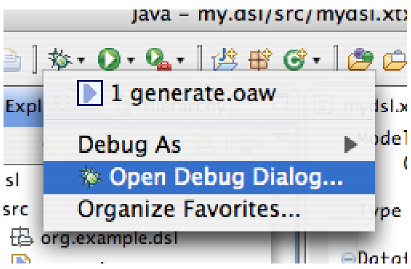
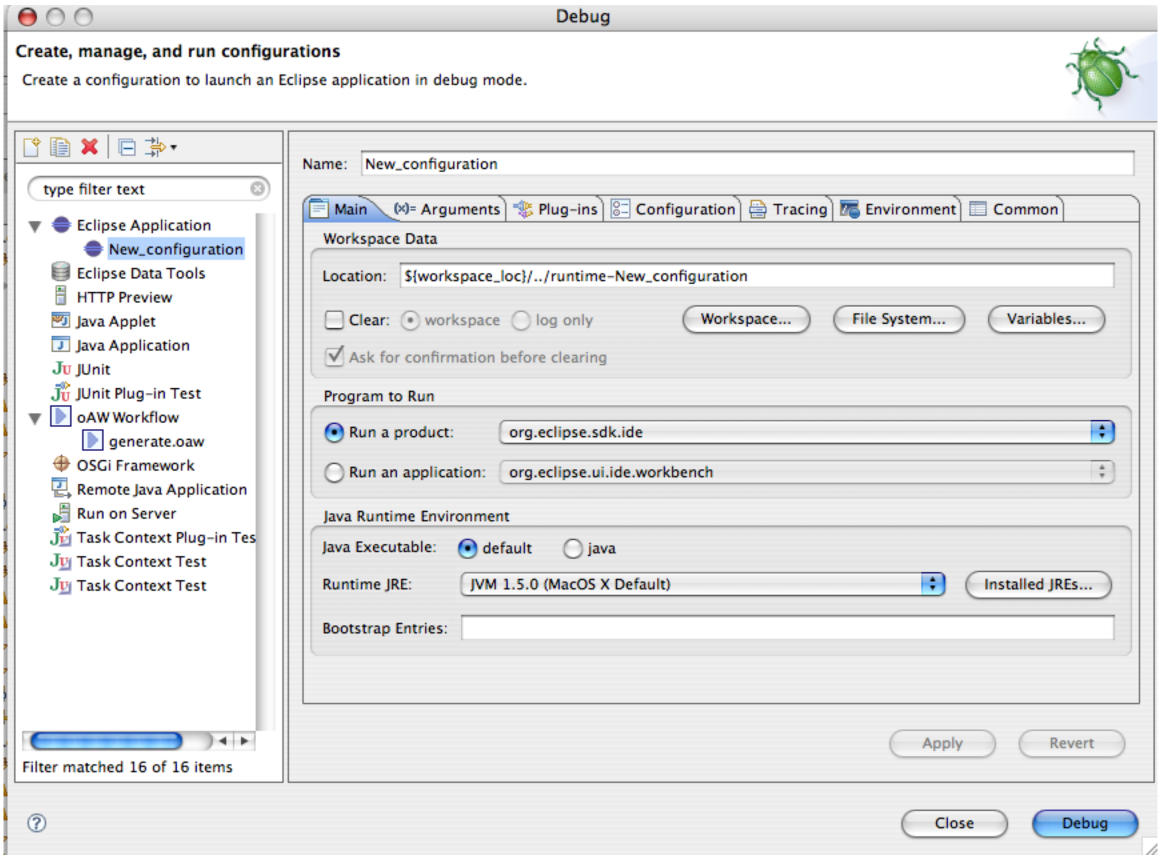


Figure 2.7. Starting a runtime workbench



Debug

Create, manage, and run configurations

Create a configuration to launch an Eclipse application in debug mode.

type filter text

- Eclipse Application
  - New_configuration
- Eclipse Data Tools
- HTTP Preview
- Java Applet
- Java Application
- JUnit
- JUnit Plug-in Test
- oAW Workflow
  - generate.oaw
- OSGi Framework
- Remote Java Application
- Run on Server
- Task Context Plug-in Tes
- Task Context Test
- Task Context Test

Filter matched 16 of 16 items

Name: New_configuration

Main | Arguments | Plug-ins | Configuration | Tracing | Environment | Common

Workspace Data

Location: ${workspace_loc}/../runtime-New_configuration

Clear: (●) workspace ( ) log only — Workspace... File System... Variables...

[✓] Ask for confirmation before clearing

Program to Run

(●) Run a product: org.eclipse.sdk.ide

( ) Run an application: org.eclipse.ui.ide.workbench

Java Runtime Environment

Java Executable: (●) default ( ) java

Runtime JRE: JVM 1.5.0 (MacOS X Default) — Installed JREs...

Bootstrap Entries:

Apply Revert

Close Debug

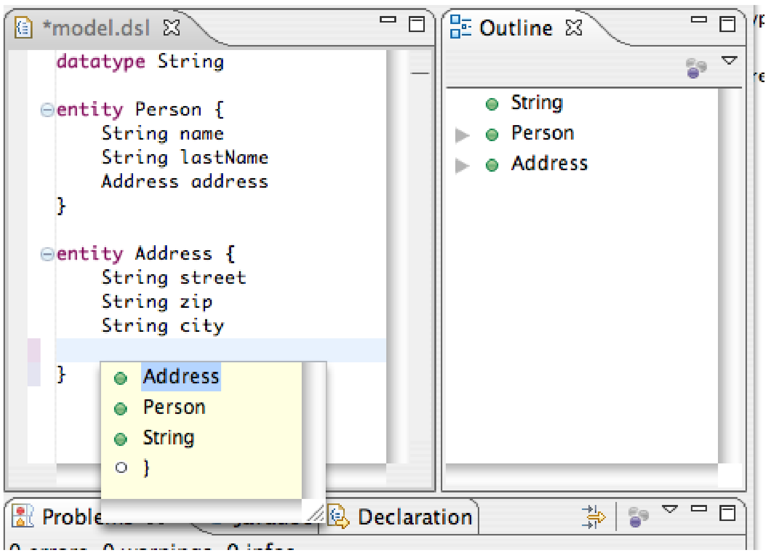
Figure 2.8. Run/debug configurations dialog

When the dialog opens select "Eclipse Application" on the left and create a new configuration by clicking the "new" icon (the upper left icon). Leave everything as it's initially configured and press "Debug".

2.4. Refining the DSL

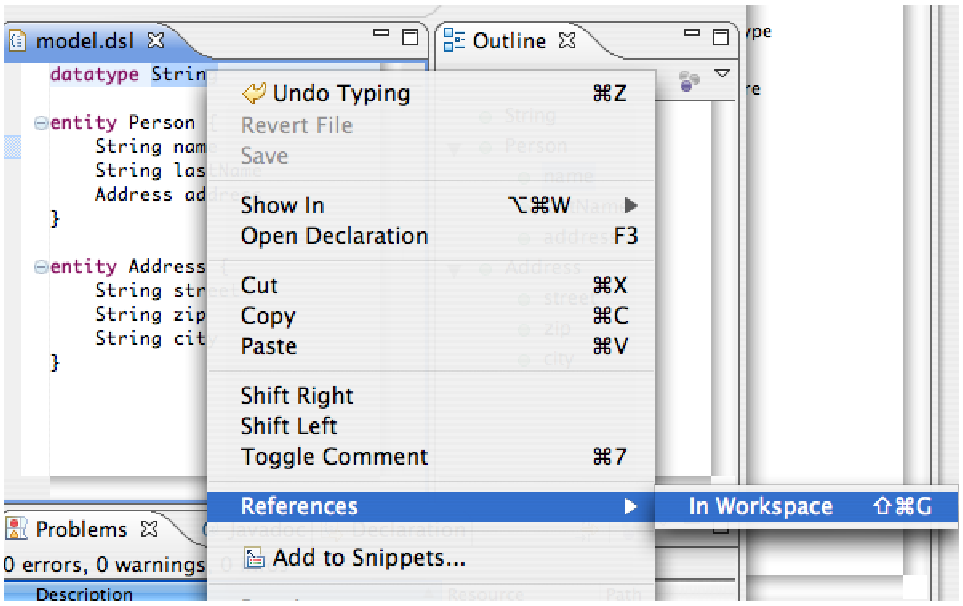
The generated editor already provides a lot of default funtionality which has only been derived from the grammar.

Some of them are code completion, "Got To Declaration", "Find References", outline view, error marker support and folding as shown in the following screenshots:



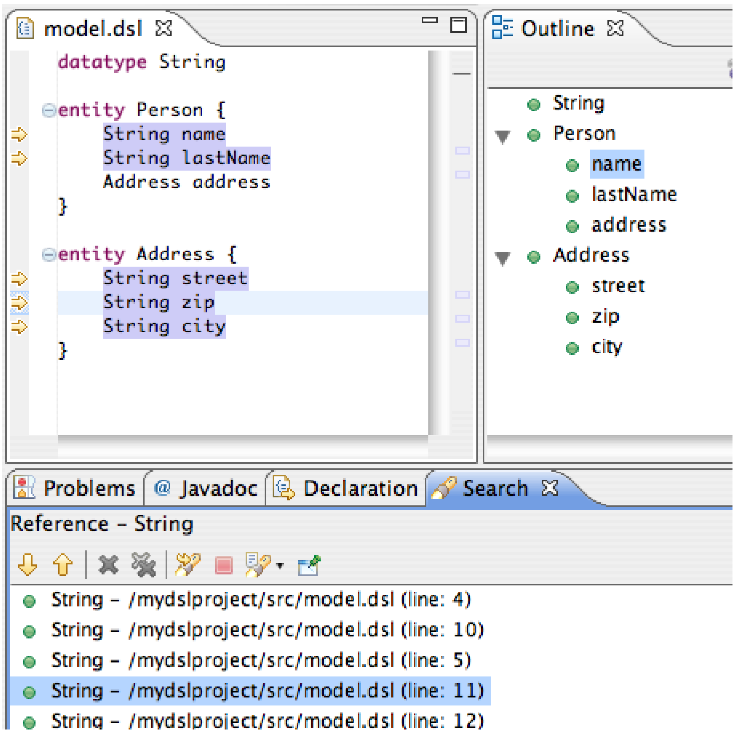
```
datatype String

entity Person {
    String name
    String lastName
    Address address
}

entity Address {
    String street
    String zip
    String city

}
```

Figure 2.9. Code Completion



```
datatype Strin

entity Person
    String nam
    String las
    Address ad
}

entity Address
    String str
    String zip
    String cit
}
```

Figure 2.10. Find References (Action)

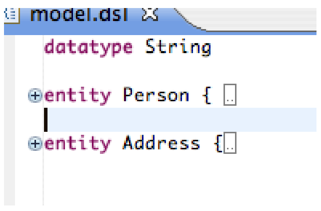


```
datatype String

entity Person {
     String name
     String lastName
     Address address
}

entity Address {
     String street
     String zip
     String city
}
```

```
String
Person
  name
  lastName
  address
Address
  street
  zip
  city
```

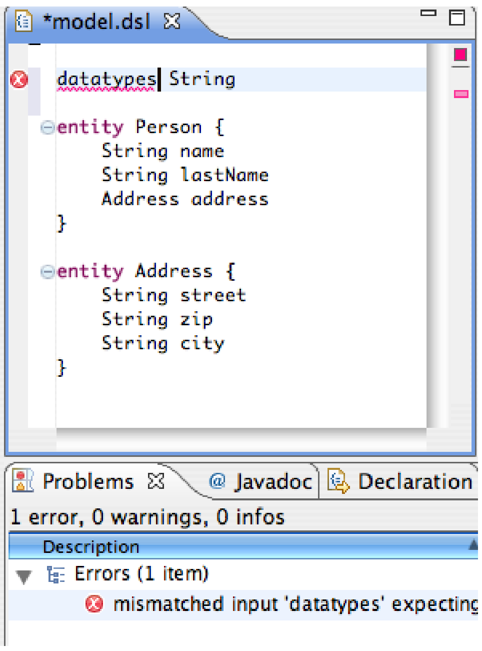
```
Reference - String
String - /mydslproject/src/model.dsl (line: 4)
String - /mydslproject/src/model.dsl (line: 10)
String - /mydslproject/src/model.dsl (line: 5)
String - /mydslproject/src/model.dsl (line: 11)
String - /mydslproject/src/model.dsl (line: 12)
```

Figure 2.11. Find References (result)



```
datatype String

entity Person { 

entity Address {
```

Figure 2.12. Folding



```
datatypes String

entity Person {
     String name
     String lastName
     Address address
}

entity Address {
     String street
     String zip
     String city
}
```

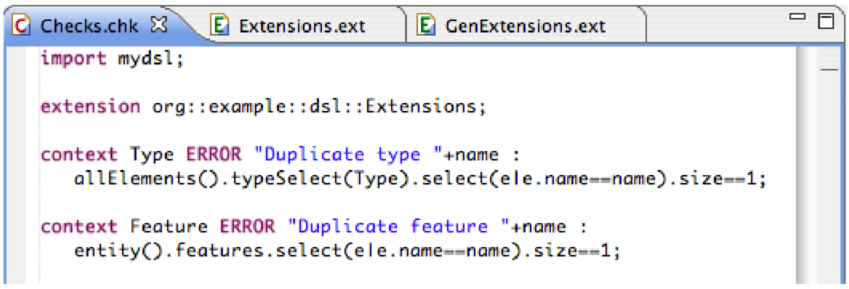
```
1 error, 0 warnings, 0 infos
Errors (1 item)
  mismatched input 'datatypes' expecting
```

Figure 2.13. Errors according to the grammar (i.e. syntax errors)

2.4.1. Validation with Check

The most important thing every DSL designer should do in addition to defining the grammar is to specify so called checks. A check (also called invariant) is expressed in oAW's Check language and is a declarative constraint for all model elements of a certain type. There are some built-in checks Xtext derives from the grammar such as verifying that a referenced element (in our example the reference from Feature.type to Type) could found. We can't and don't want to add all the checks to the grammar because it would get too complex. Instead the Xtext generator has created an empty check file for us where we are supposed to add our semantic constraints.

Let's ensure that each Type has a unique name and within an Entity each Feature has a unique name as well:



```
import mydsl;

extension org::example::dsl::Extensions;

context Type ERROR "Duplicate type "+name :
   allElements().typeSelect(Type).select(ele.name==name).size==1;

context Feature ERROR "Duplicate feature "+name :
   entity().features.select(ele.name==name).size==1;
```

Figure 2.14. Validating the model with Check

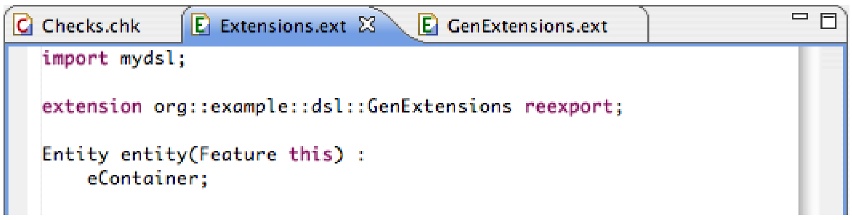
The first thing you usually do in a check file is to import the used meta models (`import mydsl`). The next line (`extension org::example::dsl::Extensions`) imports an extension file. Extension files contain so called extensions, which are essentially functions.

The syntax of a check starts with the keyword "`context`" followed by the meta type (e.g. `Type`) we want to apply the constraint to. Then one has to specify whether the severity is ERROR or WARNING using the appropriate keyword. A message for the user follows. Note that you can use the model element which is actually checked through the imlied 'this' variable. This means we could have written `"Duplicate type "+this.name` instead.

The condition which should hold (i.e. evaluate to true) for all instances of the given type is separated by a colon. The expressions used here (and in the message) are oAW expressions. See the reference documentation of the core languages (Check is one of them) for details.

We use two extensions here. The first one is called `allElements()` and has been generated by Xtext. It returns a list of all model elements containd in the model. `typeSelect(Type)` selects all elements which are of type Type. From that list we select all elements which have the same name as the actually checked model element. The constraints ensure that the size of the reulted list is equal to 1 (i.e. the resulted list only containes the currently checked model element).

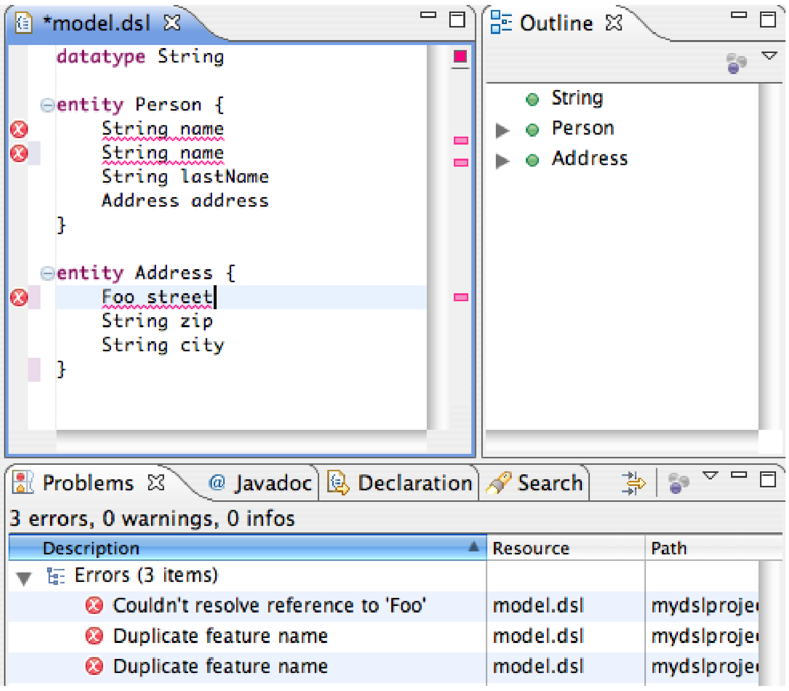
The second extension is used in the check for features. Basically the condition is very similar to the one we discussed before. The only difference is that we don't want to check whether the name is unique within the whole model but within all features of the current feature's entity. To access the feature's entity we have defined an extension '`entity()`' in the file `org/example/dsl/Extension.ext` like so:



```
import mydsl;

extension org::example::dsl::GenExtensions reexport;

Entity entity(Feature this) :
    eContainer;
```

Figure 2.15. Defining extensions

Note that we reexport all extenions from `GenExtensions` here. That's why we can refer to '`allElements()`' from within the check file. We can now start the runtime workbench again without starting Xtext's generator once more because we didn't change the grammar file. Try to break one of the constraints:



```
datatype String

entity Person {
    String name
    String name
    String lastName
    Address address
}

entity Address {
    Foo street
    String zip
    String city
}
```

3 errors, 0 warnings, 0 infos

Description	Resource	Path
Errors (3 items)		
Couldn't resolve reference to 'Foo'	model.dsl	mydslproje
Duplicate feature name	model.dsl	mydslproje
Duplicate feature name	model.dsl	mydslproje

Figure 2.16. Breaking constraints

The constraints are not only checked within the editor but are checked when invoking the parser from oAW's workflow engine as well.

There are more things we could do to enhance the editor (e.g. outline view, code completion or navigation). Have a look at the reference documentation to see how this works.

2.5. Generating code

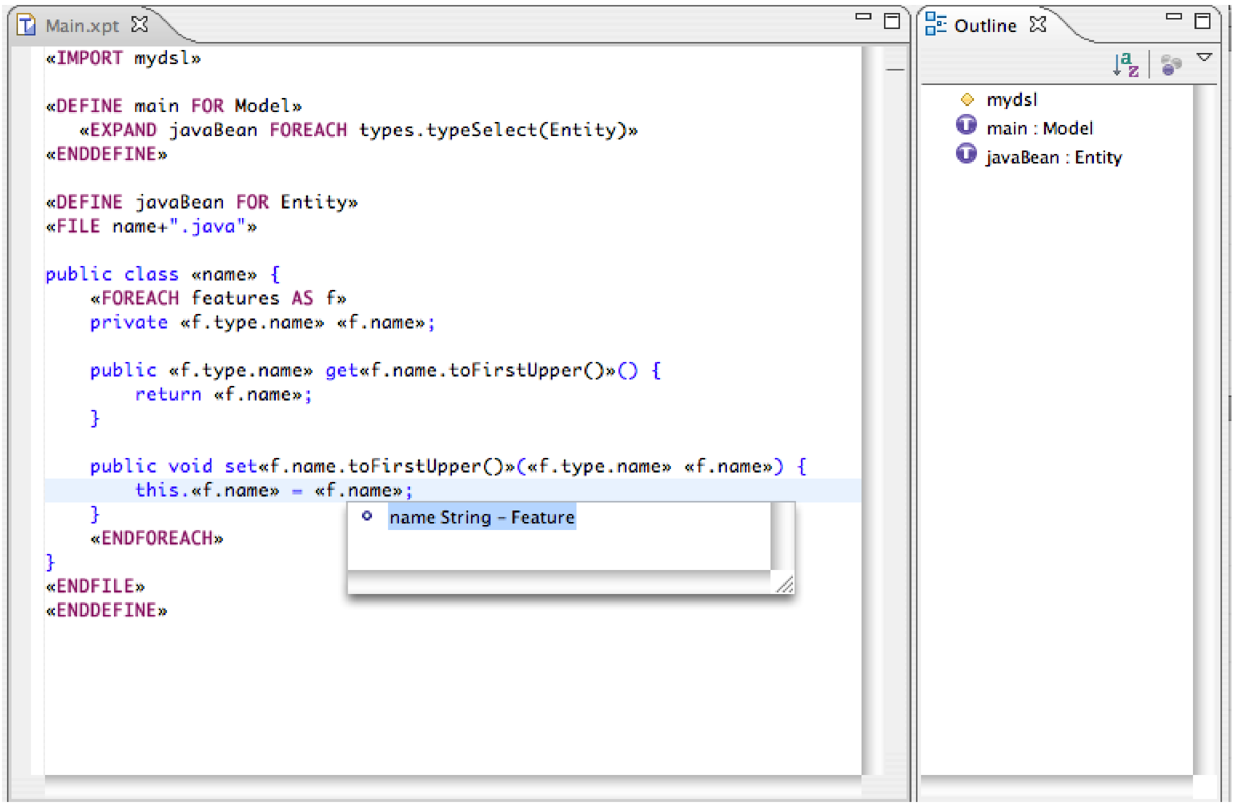
Now that we have a DSL we may want to do something useful with it. DSLs are essentially small programming languages. A programming language has to be understandable by a computer. There are basically two ways to make a language "understandable" by a computer. The first one is to write a compiler which transforms expressions made in one language into another language which is already understandable by a computer. For example a Java compiler transforms Java programs to ByteCode programms. ByteCode is understandable because there are VMs which translate expressions in Java ByteCode into more native instructions. This is usually done at runtime. Translating a language at runtime is called interpretation (ignoring special cases like Just-in-Time compilation here).

With Xtext models one can either create a compiler (a.k.a. generator) or an interpreter. Although there are good reasons for both approaches we will just discuss how one creates a generator in this tutorial.

2.5.1. Code generation with Xpand

The Xtext wizard already created a generator project for us. We're going to write an Xpand template which generates simple JavaBeans from our entities. It's assumed that there is a Java datatype corresponding to the datatypes used in the models (e.g. `String`). So we don't need to care about mapping data types.

So just open the Xpand template (`Main.xpt`) and and modifiy it like this:



```
«IMPORT mydsl»

«DEFINE main FOR Model»
   «EXPAND javaBean FOREACH types.typeSelect(Entity)»
«ENDDEFINE»

«DEFINE javaBean FOR Entity»
«FILE name+".java"»

public class «name» {
    «FOREACH features AS f»
    private «f.type.name» «f.name»;

    public «f.type.name» get«f.name.toFirstUpper()»() {
        return «f.name»;
    }

    public void set«f.name.toFirstUpper()»(«f.type.name» «f.name») {
        this.«f.name» = «f.name»;
    }
    «ENDFOREACH»
}
«ENDFILE»
«ENDDEFINE»
```

Figure 2.17. Xpand template

The definition main is invoked from the workflow file. It's declared for elements of type `mydsl::Model`, which corresponds to the root node of our DSL models. Within this definition another definition (`javaBean`) is called (`<<EXPAND javaBean...`) for each model element (`...FOREACH...`) contained in `Model`'s reference '`types`' which is of type `Entity` (`typeSelect(Entity)`).

The definition javaBean is declared for elements of type Entity. Therein we open a file (<<FILE ...). The path/name of the file is defined through an expression. In this case it corresponds to the name of the entity suffixed with '.java'. It's going to be generated into the src-gen directory directly.

All text contained between <<FILE ...>> and <<ENDFILE>> will go to the new file. Xpand provides control statements (FOR, IF, ELSEIF,...) as well as evaluation of expression in order to create the desired code. See the core languages reference documentation for details.

2.6. Installing everything into Eclipse

Now we've defined a DSL and a corresponding Generator. We don't need to use it in Eclipse - you can run the generator from ant, maven, command line, etc. as well - we'll now show you how to install everything into Eclipse in order to start a new project based on your DSL and generator.

Right click on any project in the navigator view. Choose 'export'.

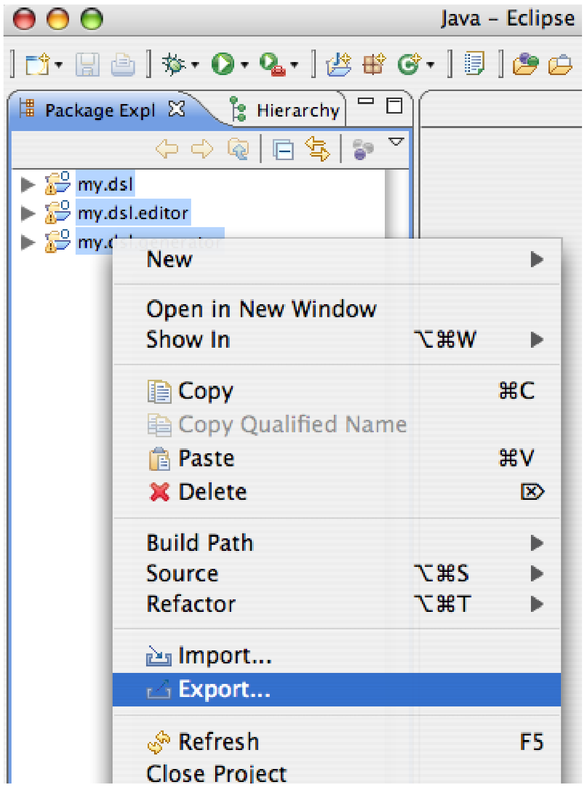
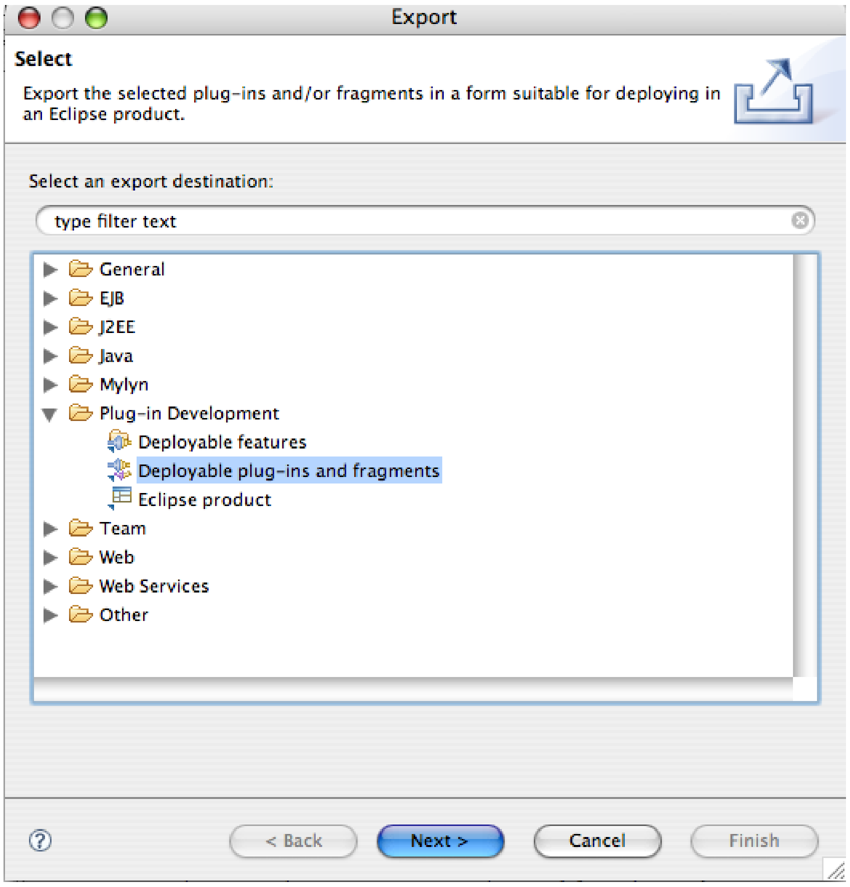


Figure 2.18. Export Plug-ins 1

Choose "Deployable plug-ins and fragments".



Select

Export the selected plug-ins and/or fragments in a form suitable for deploying in an Eclipse product.

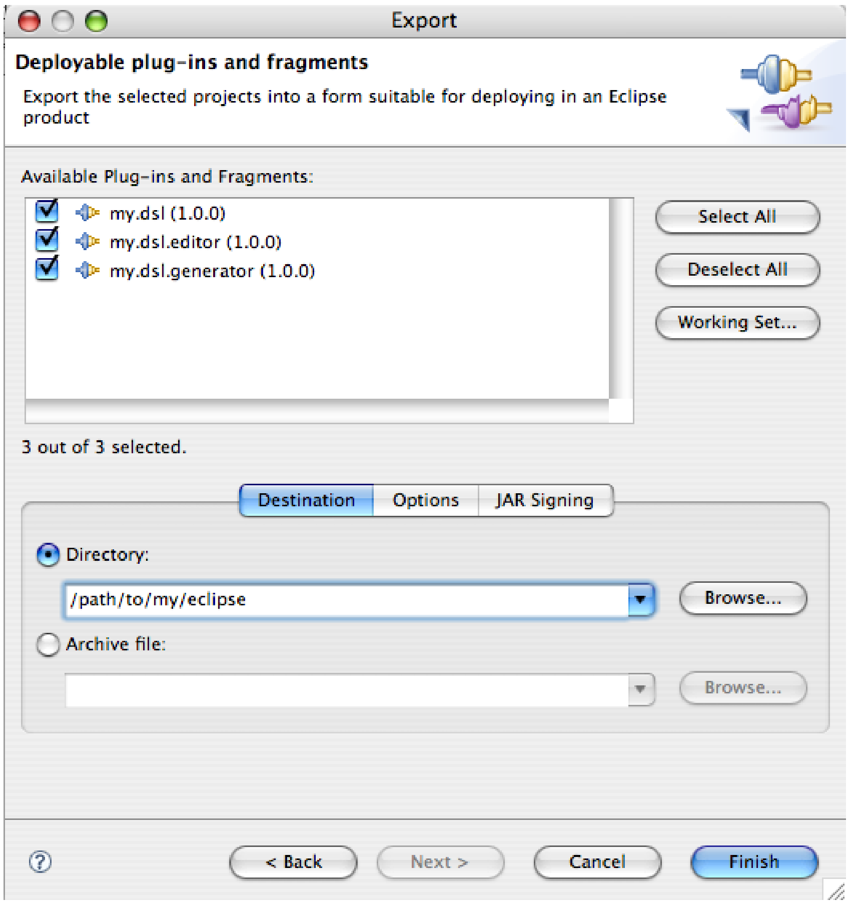
Select an export destination:

type filter text

- General
- EJB
- J2EE
- Java
- Mylyn
- Plug-in Development
  - Deployable features
  - Deployable plug-ins and fragments
  - Eclipse product
- Team
- Web
- Web Services
- Other

Figure 2.19. Export Plug-ins 2

Choose the directory where you've installed Eclipse, mark all three projects and click the "Finish"-button.


Export

Deployable plug-ins and fragments

Export the selected projects into a form suitable for deploying in an Eclipse product

Available Plug-ins and Fragments:

- [✓] my.dsl (1.0.0)
- [✓] my.dsl.editor (1.0.0)
- [✓] my.dsl.generator (1.0.0)

3 out of 3 selected.

[✓ Directory:] /path/to/my/eclipse

Archive file:

Figure 2.20. Export Plug-ins 3

When the export process has finished restart your workbench. Now choose a different workspace. Within the new workspace you can create a new 'mydsl' project using the generated wizard.

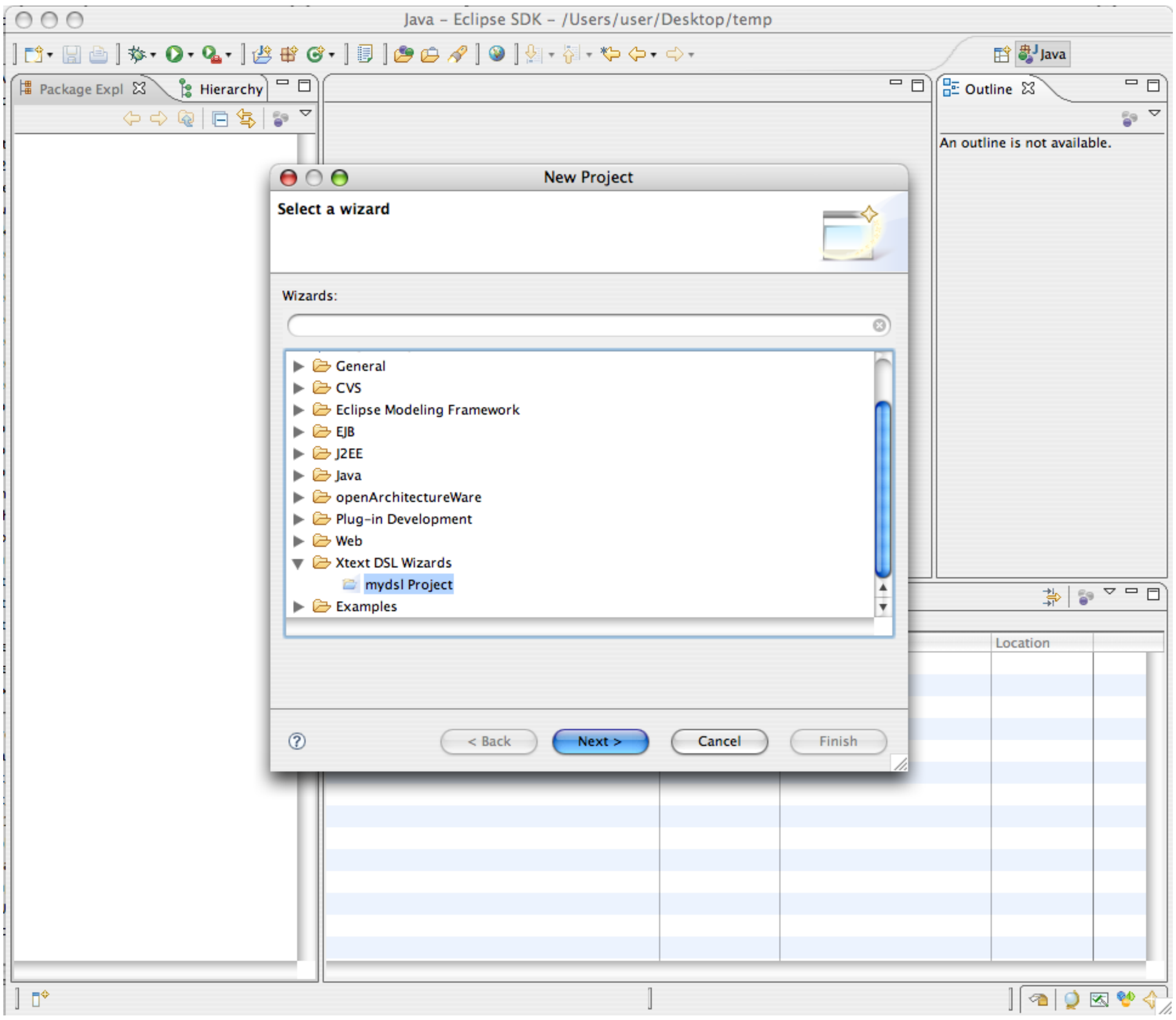
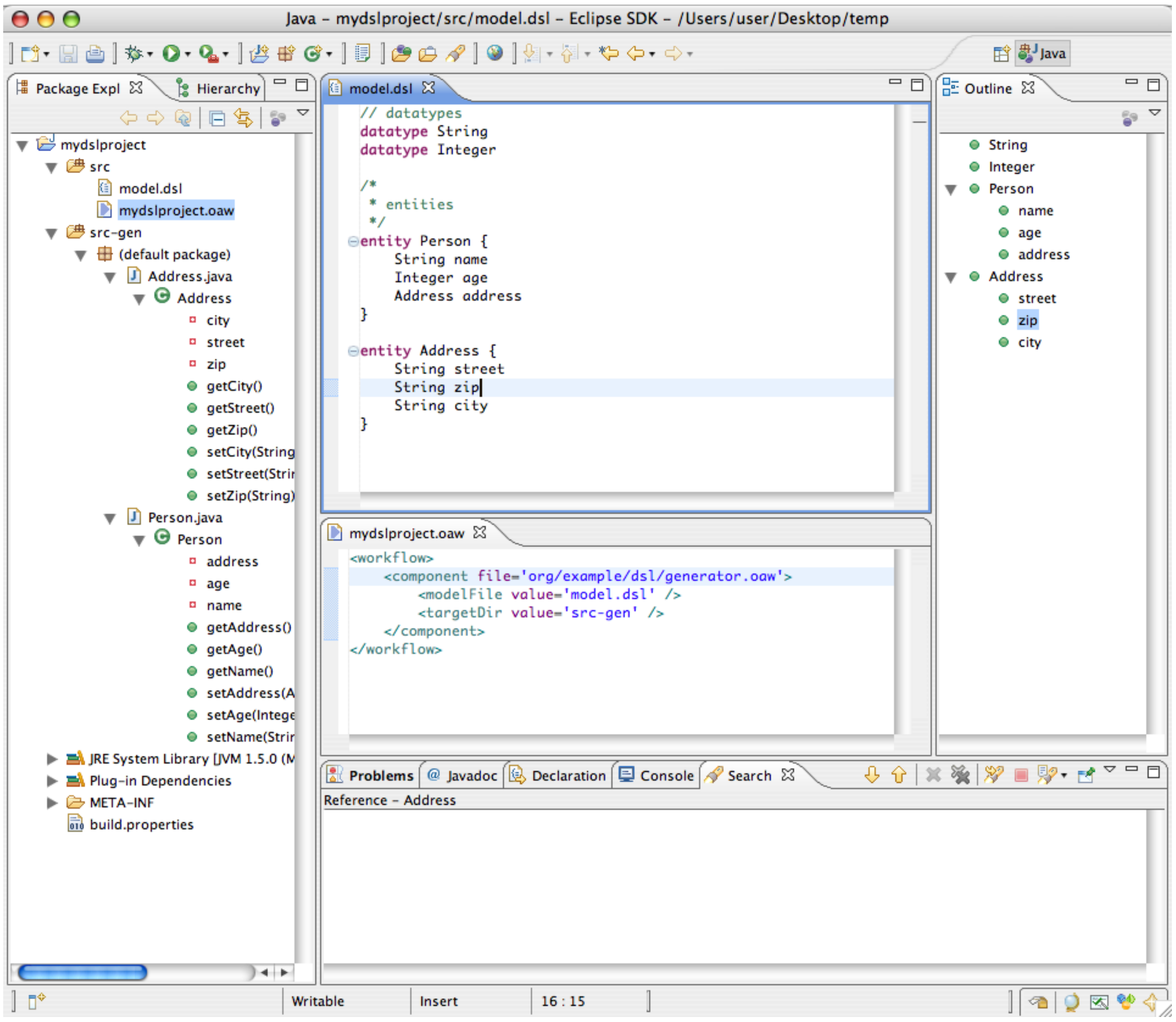


Figure 2.21. New DSL project

The wizard creates an Eclipse plug-in project containing the needed dependencies to the dsl bundle, the generator bundle and the oAW bundles. It also generates a workflow which invokes the workflow from our generator as well as an empty model file. Let's fill the model file with some information.

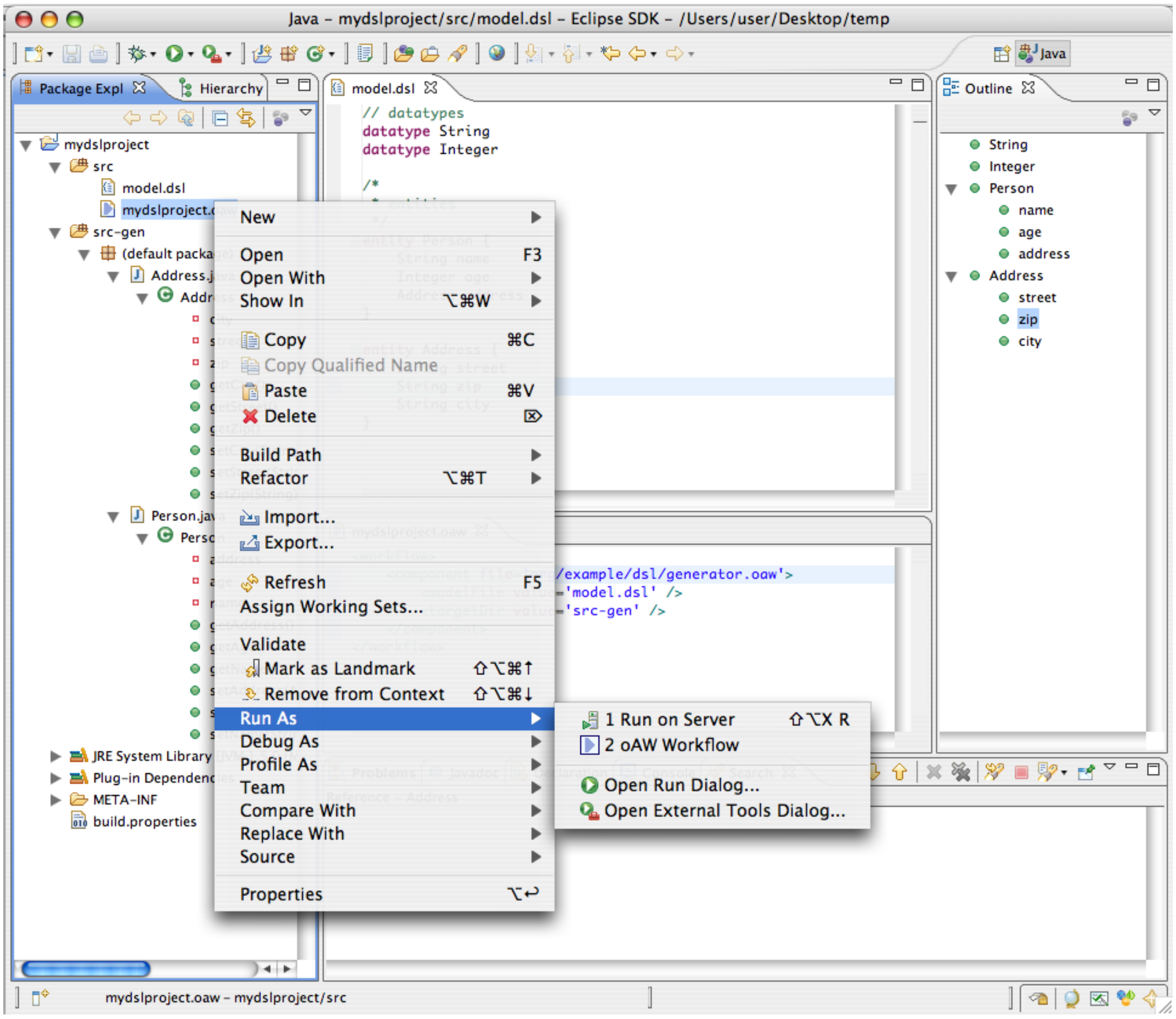


```
// datatypes
datatype String
datatype Integer

/*
 * entities
 */
entity Person {
    String name
    Integer age
    Address address
}

entity Address {
    String street
    String zip
    String city
}
```

```
<workflow>
    <component file='org/example/dsl/generator.oaw'>
        <modelFile value='model.dsl' />
        <targetDir value='src-gen' />
    </component>
</workflow>
```

Figure 2.22. Textual modelling

Now we can run the workflow by right clicking it. Choose `Run As->oAW Workflow`.

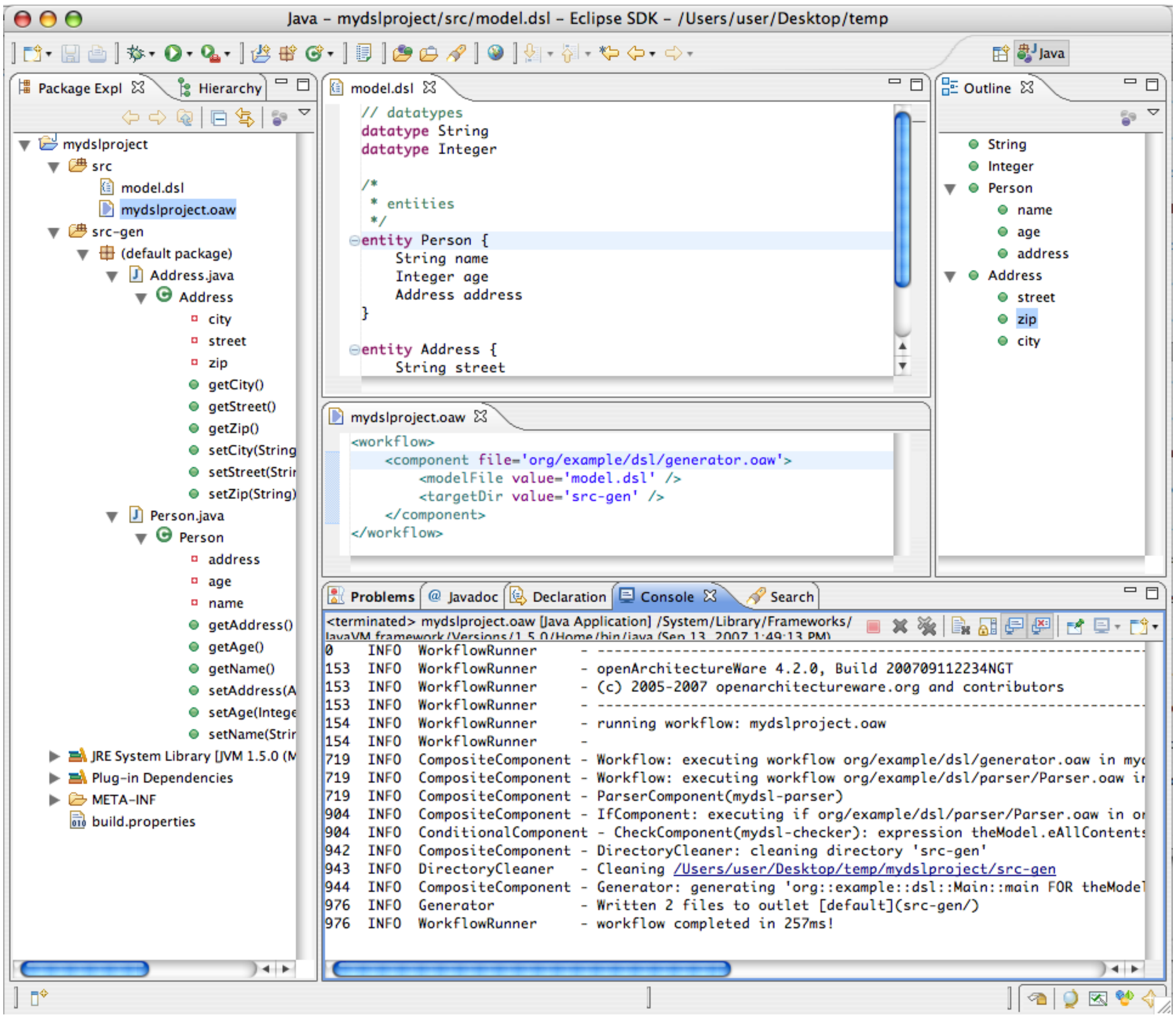


```
// datatypes
datatype String
datatype Integer

/*
```

```
/example/dsl/generator.oaw'>
='model.dsl' />
='src-gen' />
```

Figure 2.23. Start the workflow

The generator finished successfully and the src-gen folder contains the generated Java classes.



model.dsl

```
// datatypes
datatype String
datatype Integer

/*
 * entities
 */
entity Person {
    String name
    Integer age
    Address address
}

entity Address {
    String street
```

mydslproject.oaw

```
<workflow>
    <component file='org/example/dsl/generator.oaw'>
        <modelFile value='model.dsl' />
        <targetDir value='src-gen' />
    </component>
</workflow>
```

```
<terminated> mydslproject.oaw [Java Application] /System/Library/Frameworks/
JavaVM.framework/Versions/1.5.0/Home/bin/java (Sep 13, 2007 1:49:13 PM)
0    INFO  WorkflowRunner      - -----------------------------------------------------------------
153  INFO  WorkflowRunner      - openArchitectureWare 4.2.0, Build 200709112234NGT
153  INFO  WorkflowRunner      - (c) 2005-2007 openarchitectureware.org and contributors
153  INFO  WorkflowRunner      - -----------------------------------------------------------------
154  INFO  WorkflowRunner      - running workflow: mydslproject.oaw
154  INFO  WorkflowRunner      -
719  INFO  CompositeComponent - Workflow: executing workflow org/example/dsl/generator.oaw in myc
719  INFO  CompositeComponent - Workflow: executing workflow org/example/dsl/parser/Parser.oaw ir
719  INFO  CompositeComponent - ParserComponent(mydsl-parser)
904  INFO  CompositeComponent - IfComponent: executing if org/example/dsl/parser/Parser.oaw in or
904  INFO  ConditionalComponent - CheckComponent(mydsl-checker): expression theModel.eAllContents
942  INFO  CompositeComponent - DirectoryCleaner: cleaning directory 'src-gen'
943  INFO  DirectoryCleaner    - Cleaning /Users/user/Desktop/temp/mydslproject/src-gen
944  INFO  CompositeComponent - Generator: generating 'org::example::dsl::Main::main FOR theModel
976  INFO  Generator           - Written 2 files to outlet [default](src-gen/)
976  INFO  WorkflowRunner      - workflow completed in 257ms!
```

Figure 2.24. Workflow completed

That's it for now. Feel free to play around with this small example. If you like it I'ld propose you have a look at the reference documentation and try to create your own DSL.

Have fun!

Chapter 3. oAW 4 Eclipse Integration

3.1. Introduction

This document describes the various functionalities that the *openArchitectureWare* plugins contribute to the Eclipse installation. It is intended as user instruction for the work with Eclipse. You need to read other documentation to understand the *openArchitectureWare* framework itself.

3.2. Installation

It is assumed that you already have installed the oAW core and the oAW plugin feature from the updatesite as described in the *Installation documentation*.

There are some more eclipse plugins available that belong to special sub projects, such as the *Recipe* framework. They are not subject of this document and will be described in it's specific documentation.

3.3. Overview

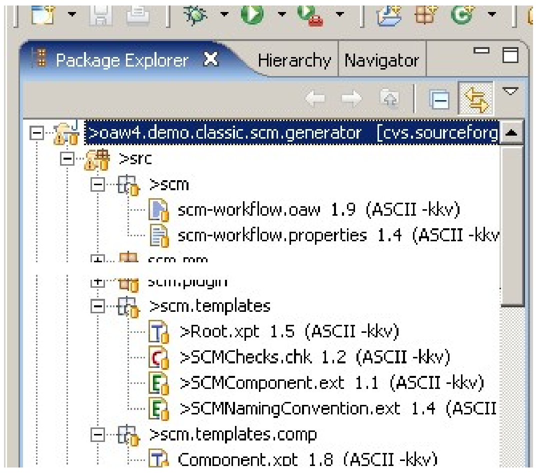
The openArchitectureWare core plugins provide editors for the different languages and a launch shortcut to start workflow files. Let's first have a look at the different oAW specific files.

3.4. File decorations

When you open Eclipse and import a project into the workspace you can see several file decorating images.

There are specific images for

- Workflow files (`.oaw` extension)
- Xpand2 template files (`.xpt` extension)
- Extension files (`.ext` extension)
- Check files (`.chk` extension)

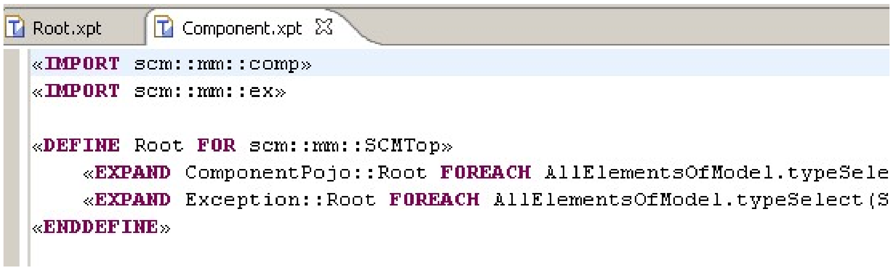

Package Explorer
Hierarchy
Navigator
>oaw4.demo.classic.scm.generator [cvs.sourceforg
>src
>scm
scm-workflow.oaw 1.9 (ASCII -kkv)
scm-workflow.properties 1.4 (ASCII -kkv
scm.mm
scm.plugin
>scm.templates
>Root.xpt 1.5 (ASCII -kkv)
>SCMChecks.chk 1.2 (ASCII -kkv)
>SCMComponent.ext 1.1 (ASCII -kkv)
>SCMNamingConvention.ext 1.4 (ASCII
>scm.templates.comp
Component.xpt 1.8 (ASCII -kkv)

3.5. Editors

When you double clip on one of the above mentioned file types, special editors will open that provide appropriate syntax coloring.

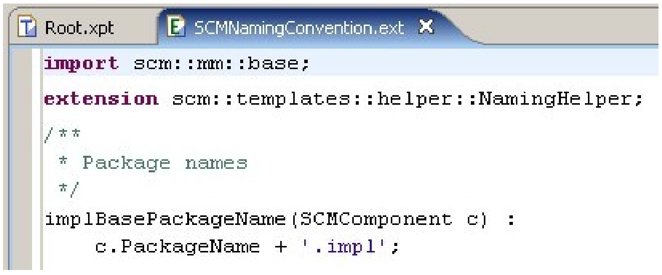
3.5.1. Syntax coloring

Here are examples for the Xpand editor:



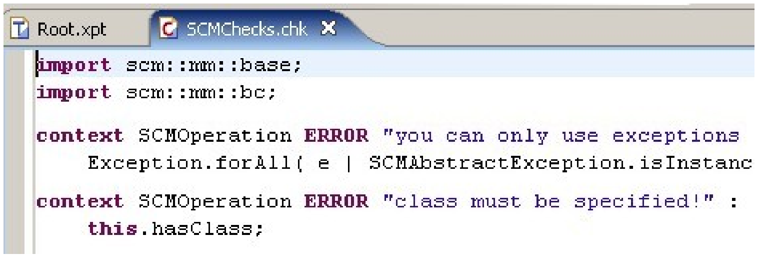
```
«IMPORT scm::mm::comp»
«IMPORT scm::mm::ex»

«DEFINE Root FOR scm::mm::SCMTop»
    «EXPAND ComponentPojo::Root FOREACH AllElementsOfModel.typeSele
    «EXPAND Exception::Root FOREACH AllElementsOfModel.typeSelect(S
«ENDDEFINE»
```

for the Extensions editor:



```
import scm::mm::base;

extension scm::templates::helper::NamingHelper;

/**
 * Package names
 */
implBasePackageName(SCMComponent c) :
    c.PackageName + '.impl';
```

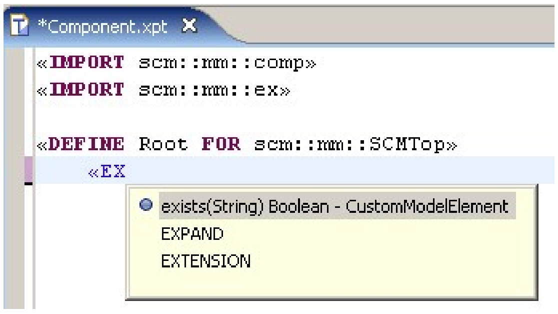
and for Check editor:



```
import scm::mm::base;
import scm::mm::bc;

context SCMOperation ERROR "you can only use exceptions
    Exception.forAll( e | SCMAbstractException.isInstanc

context SCMOperation ERROR "class must be specified!" :
    this.hasClass;
```

3.5.2. Code completion

The Editors provide extensive code completion support by pressing **Ctrl + Space** similar to what is known from the Java editor. Available types, properties and operation, as well as extensions from `.ext`-Files will be found. The Xpand editor provides additionally support for the Xpand language statements.



```
«IMPORT scm::mm::comp»
«IMPORT scm::mm::ex»

«DEFINE Root FOR scm::mm::SCMTop»
    «EX
```

3.5.3. Xpand tag delimiter creation support

In the Xpand editor there is an additional keystroke available to create the opening and closing tag brackets, the guillemots (« and »).

Ctrl + < creates «

and

Ctrl + > creates »

3.6. Preference pages

3.6.1. Meta model contributors

The openArchitectureWare framework version 4 supports several types of meta metamodels.

From older versions the classic UML metamodels may be known. Currently also JavaBeans metamodels and EMF based metamodels are supported out of the box.

Additional Metamodel-contributors can be registered through an extension point.

The editors need to know with what kind of metamodels you are working. Therefore one can configure the metamodel contributors on workspace and on project level.

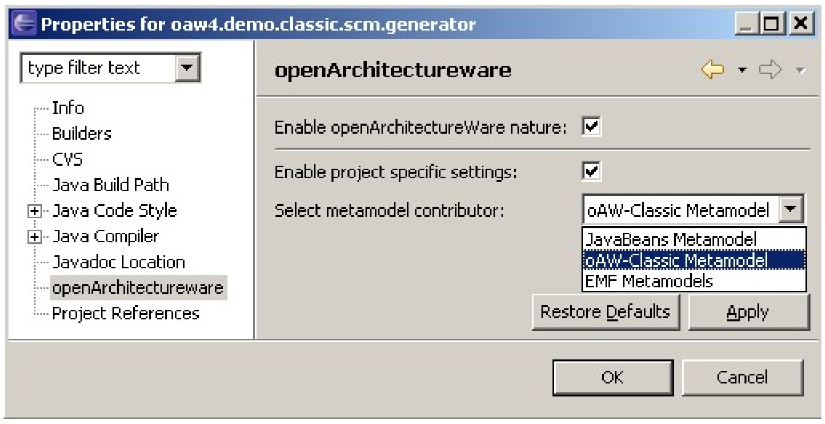
3.6.2. Global preferences

If you work always with the same type of metamodels, you can specify the metamodel contributors in the global preference page. It is available under Windows --> Preferences in the *openArchitectureWare* section.

3.6.3. Preferences per project

In the project property page there is also an *openArchitectureWare* section available.

Therein you can enable the openArchitectureWare Nature (see below) and set project specific metamodel contributor settings.


Properties for oaw4.demo.classic.scm.generator

openArchitectureware

Enable openArchitectureWare nature: ✓

Enable project specific settings: ✓

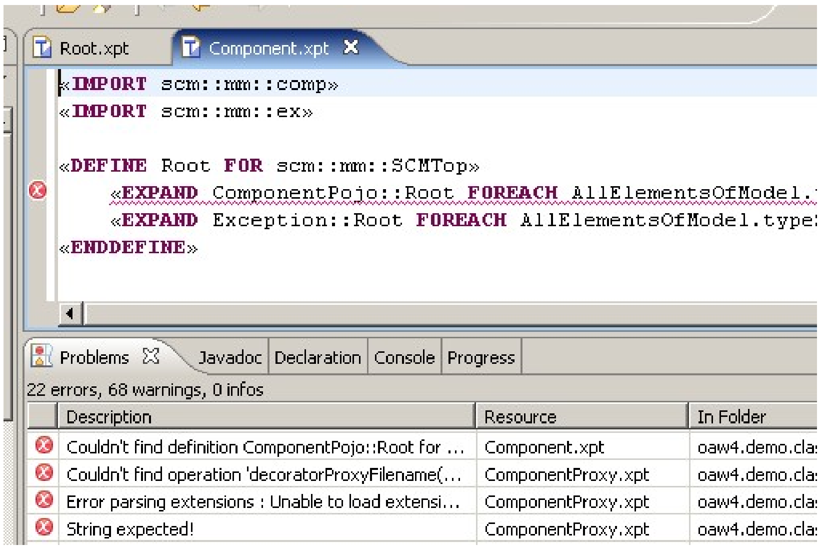
Select metamodel contributor: oAW-Classic Metamodel

3.7. oAW Nature and oAW Builder

You have seen in the last screenshot, that you can switch the *openArchitectureWare* nature on. If you do so, you enable analysation support for all oAW specific file types in that project.

3.7.1. Problem markers

During the build process all found problems are marked in the editors as well as listed in the *Problems* view.



```
«IMPORT scm::mm::comp»
«IMPORT scm::mm::ex»

«DEFINE Root FOR scm::mm::SCMTop»
    «EXPAND ComponentPojo::Root FOREACH AllElementsOfModel.
    «EXPAND Exception::Root FOREACH AllElementsOfModel.type
«ENDDEFINE»
```

22 errors, 68 warnings, 0 infos

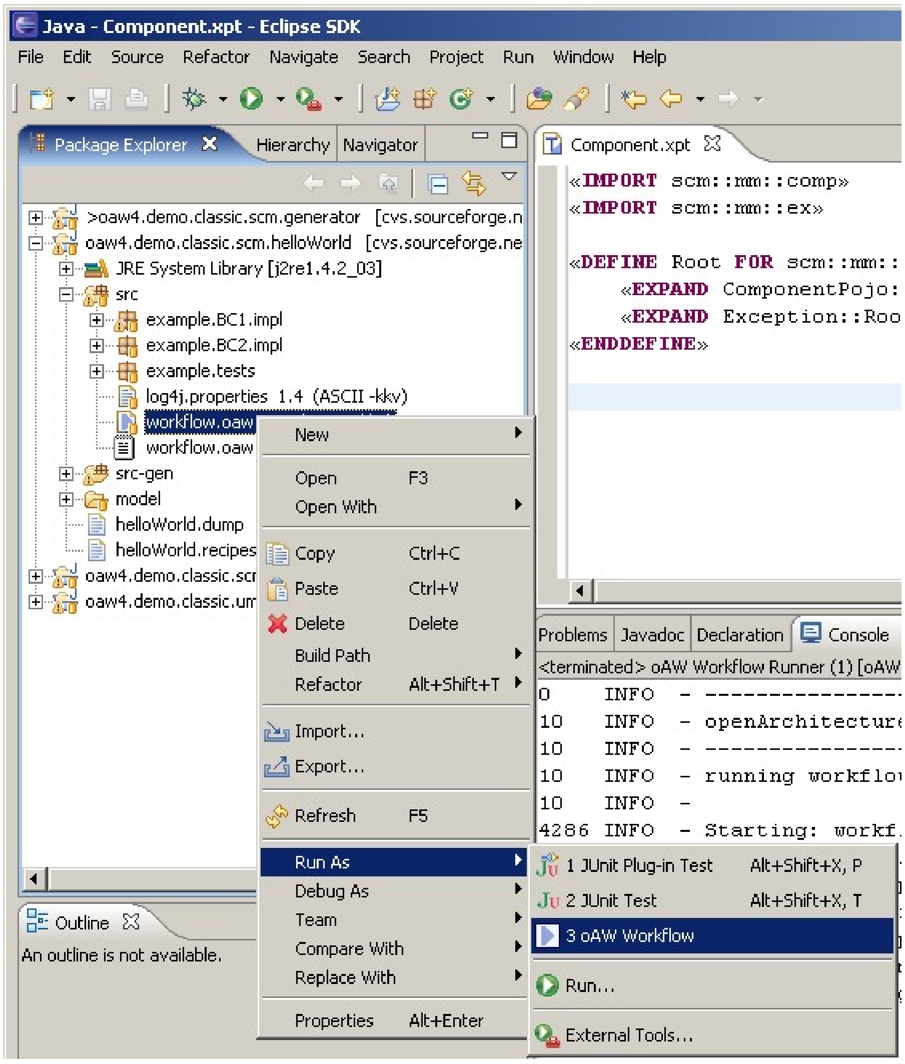
Description	Resource	In Folder
Couldn't find definition ComponentPojo::Root for ...	Component.xpt	oaw4.demo.cla
Couldn't find operation 'decoratorProxyFilename(...	ComponentProxy.xpt	oaw4.demo.cla
Error parsing extensions : Unable to load extensi...	ComponentProxy.xpt	oaw4.demo.cla
String expected!	ComponentProxy.xpt	oaw4.demo.cla

In the current implementation analysations take place when *Eclipse* runs an incremental or full build. That means, problem markers are actualized, when a file is saved for instance. If you are in doubt about the actuality of problem markers, you should clean your project and let it rebuild again.

Note, that if you change signatures of e.g. extensions the referencing artifacts (Xpand templates, etc.) are not analysed automatically.

3.8. Running a workflow

You can start a workflow by right clicking on a workflow file `(*.oaw)` and selecting Run As --> oAW Workflow.



```
«IMPORT scm::mm::comp»
«IMPORT scm::mm::ex»

«DEFINE Root FOR scm::mm::
    «EXPAND ComponentPojo:
    «EXPAND Exception::Roo
«ENDDEFINE»
```

```
<terminated> oAW Workflow Runner (1) [oAW
0    INFO  - ---------------
10   INFO  - openArchitecture
10   INFO  - ---------------
10   INFO  - running workflo
10   INFO  -
4286 INFO  - Starting: workf.
```

Because it is a normal launch configuration, you could run or even debug it using the normal Eclipse functionality.

Chapter 4. Migration

This chapter describes how to migrate between the various versions of oAW.

4.1. Migrate from oAW 4.1.2 to oAW 4.2

Here's what you need to do when migrating from oAW 4.1.2 to oAW 4.2:

4.1.1. Plugin-Dependencies

`org.openarchitectureware.core.check` has been merged with `org.openarchitectureware.core.expressions`. So this dependency can simply be removed. Remove plugin dependencies to all `org.openarchitectureware.core.*` plugins and add a dependency to the new `org.openarchitectureware.dependencies` plugin. This plugin bundles all dependent plugins and reexports these.

4.1.2. Xtext

Although we have many cool new features in Xtext from oAW 4.2, we needed to rework most of the API. This is a step by step migration tutorial. Please use the Xtext forum if you have any trouble migrating to the latest version.

4.1.2.1. Migrating the grammar

The grammar language has changed a bit.

1. The 'Abstract' keyword has been removed. All you need to do is remove it from your grammar.
2. The boolean assignment operator (prior it was '?') conflicted with the optional cardinality. So we changed it to '?='.

4.1.2.2. Migrating the core project

Within the main project the 'Extensions.ext' and 'Check.chk' files have been added. They replace the old '[langname]Checks.ch' resp. '[langname]Extensions.ext' files. You just have to copy and paste the content from the old files to the new ones. (start the generator once if you don't see the new files).

4.1.2.3. Migrating the editor

The editor project has some more changes:

1. The ...Plugin class as well as the ...Editor class names start with a capital (rename them if necessary).
2. The method getPlugin() in the ...Editor class is public now.
3. The content of the [langname]EditorExtensions.ext has been separated into several files.
4. The label() and image() extensions can be copy and pasted to EditorExtension.ext.
5. The content assist logic is contained in ContentAssist.ext.

Although your old projects should work now it's recommended to read the updated Xtext reference documentation.

Part II. Reference

Chapter 5. Workflow Reference

5.1. Introduction

The oAW4 workflow engine is a declarative configurable generator engine. It provides a simple, XML based configuration language with which all kinds of generator workflows can be described. A generator workflow consists of a number of so-called workflow components that are executed sequentially in a single JVM.

5.2. Workflow components

At the heart of the workflow engine lies the WorkflowComponent. A WorkflowComponent represents a part of a generator process. Such parts are typically model parsers, model validators, model transformers and code generators. oAW 4 ships with different WorkflowComponents which should be used where suitable, but you can also implement your own. The only thing you have to do is to implement the `org.openarchitectureware.workflow.WorkflowComponent` interface:

```
public interface WorkflowComponent {

 /**
  * @param ctx
  *   current workflow context
  * @param monitor
  *   implementors should provide some feedback about the progress
  *   using this monitor
  * @param issues
  */
 public void invoke(WorkflowContext ctx, ProgressMonitor monitor, Issues issues);

 /**
  * Is called by the container after configuration so the
  * component can validate the configuration before invocation.
  *
  * @param issues -
  * implementors should report configuration issues to this.
  */
  public void checkConfiguration(Issues issues);

}
```

The `invoke()` operation performs the component's actual work. `checkConfiguration` is used to check whether the component is configured correctly before the workflow starts. More on these two operations later.

A workflow description consists of a list of configured WorkflowComponents.

Here's an example:

```
<workflow>
   <component class="my.first.WorkflowComponent">
      <aProp value="test"/>
   </component>
   <component class="my.second.WorkflowComponent">
      <anotherProp value="test2"/>
   </component>
   <component class="my.third.WorkflowComponent">
      <prop value="test"/>
   </component>
```

```
</workflow>
```

The workflow shown above consists of three different workflow components. The order of the declaration is important! The workflow engine will execute the components in the specified order. To allow the workflow engine to instantiate the workflow component classes, WorkflowComponent implementations must have a default constructor.

5.2.1. Workflow

A workflow is just a composite implementation of the `WorkflowComponent` interface. The `invoke` and `checkConfiguration` methods delegate to the contained workflow components.

The Workflow class declares an `adder()` method

```
public void addComponent(WorkflowComponent comp)</para>
```

which is used by the workflow factory in order to wire up a workflow (see next section 'Workflow Configuration').

5.2.2. Workflow Components with IDs

If you want your workflow components to have an ID (so that you can recognize its output in the log) you have to implement the interface `WorkflowComponentWithID` and the `setID()` and `getID()` operations. Alternatively, you can also extend the base class `AbstractWorkflowComponent`, which handles the ID setter/getter for you.

5.2.3. More convenience

There is another base class for workflow components called `AbstractWorkflowComponent2`. Its main feature is that it has a property called skipOnErrors. If set to `true`, it will not execute if the workflow's issues collection contains errors. This is convenient if you want to be able to skip code generation when the preceding model verification finds errors. Note that instead of implementing `invoke(...)` and `checkConfiguration(...)`, subclasses of `AbstractWorkflowComponent2` have to implement `invokeInternal(...)` and `checkConfigurationInternal(...)`. This is necessary to allow the framework to intercept the invocation and stop it when there are errors in the workflow.

5.3. Workflow Configuration

A workflow is wired up using an XML configuration language based on the dependency injection pattern (DI). Here is an example (not working, just an example!):

```
<workflow>
 <property name='genPath' value='/home/user/target'/>
 <property name='model' value='/home/user/model.xmi'/>
 <component class='oaw.emf.XmiReader'>
  <model value='${model}'/>
 </component>
 <component class='oaw.xpand2.Generator'>
  <outlet>
   <path value='${genPath}'/>
  </outlet>
 </component>
</workflow>
```

The root element is named *workflow*, then there are some property declarations followed by the declaration of two components.

Here is a tree representation of the resulting Java object graph:

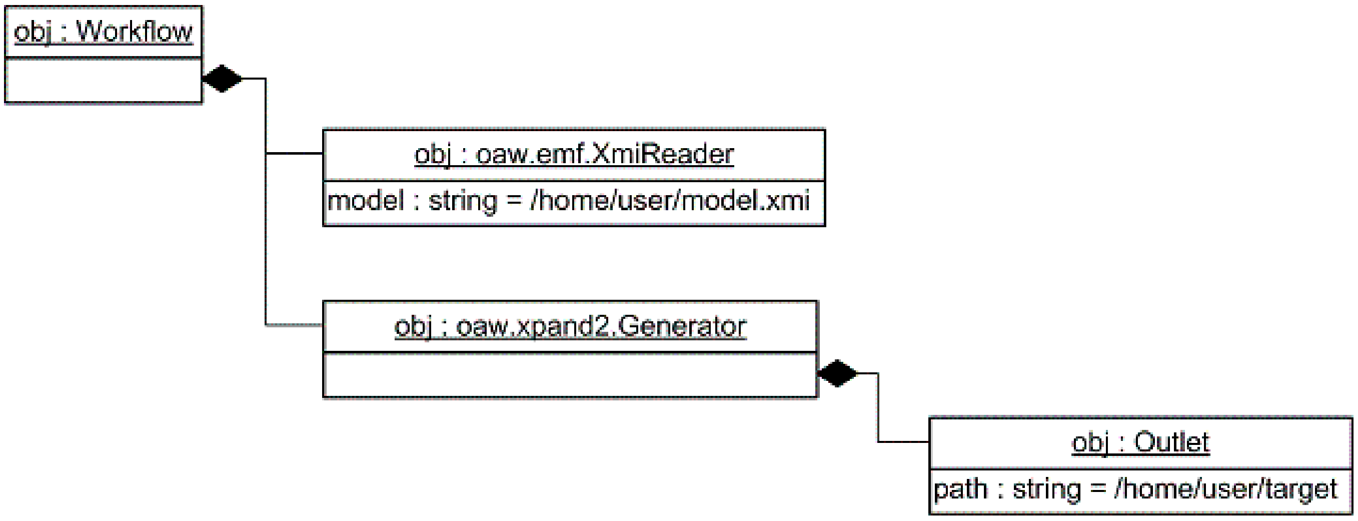

obj : Workflow
obj : oaw.emf.XmiReader
model : string = /home/user/model.xmi
obj : oaw.xpand2.Generator
obj : Outlet
path : string = /home/user/target

Figure 5.1. Java Object Graph

The configuration language expresses four different concepts:

5.3.1. Properties

Borrowing from Apache Ant, we use the concept of properties. Properties can be declared anywhere in a workflow file. They will be available after declaration.

We have two different kinds of properties

1. simple properties

2. property files

Here is an example:

```
<workflow>
 <property name='baseDir' value='./'/>
 <property file='${baseDir}/my.properties'/>
 <component
  class='my.Comp'
  srcDir='${baseDir}'
  modelName='${model}'
  pathToModel='${pathToModel}'/>
</workflow>
```

First there is a simple property baseDir with the value "." defined. This property can be used in any attributes in the workflow file. The second property statement imports a property file. Property files use the well-known Java properties file syntax. There is one feature we added: You can use previously declared properties inside the properties file.

Example:

```
model = myModel
```

```
pathToModel = ${baseDir}/${model}.xmi
```

5.3.1.1. Components

The wired up object graph consists of so called components (A workflow component is a special kind of a component). A component is declared by an XML element. The name represents the property of the parent component holding this component.

Example:

```
<component class='MyBean'>
 <bean class='MyBean'/>
</component>
```

The Java class MyBean needs to have a corresponding property accessor. E.g.:

```
public class MyBean {
 ...
 public void setBean(MyBean b) {
  bean = b;
 }
 ...
}
```

There are currently the following possibilities for declaring the property accessors:

5.3.1.1.1. Accessor methods

As we have seen, one possibility for declaring a dependency is to declare a corresponding setter Method.

```
public void set<propertyname>(<PropertyType>; e)
```

If you want to set multiple multiple values for the same property, you should define an adder method.

```
public void add<propertyname>(<PropertyType> e)
```

In some cases you may want to have key value pairs specified. This is done by providing the following method:

```
public void put(Object k,Object v)
```

5.3.1.2. Component creation

The corresponding Java class (specified using the class attribute) needs to have a default constructor declared. If the class attribute is omitted, the Java class determined from the accessor method will be used. For the preceding example we could write...

```
<component class='MyBean'>
 <bean/>
</component>
```

...because the setter method uses the MyBean type as its parameter type. This is especially useful for more complex configurations of workflow components.

Note that we will probably add factory support in the future.

5.3.1.3. References

A component can have an attribute id. If this is the case we can refer to this component throughout the following workflow configuration.

Example:

```
<workflow>
 <component class='my.Checker'>
  <metaModel id='mm' class='my.MetaModel'
   metaModelPackage='org.oaw.metamodel'/>
 </component>
 <component class='my.Generator'>
  <metaModel idRef='mm'/>
 </component>
 ...
</workflow>
```

In this example an object with the id *mm* (an instance of *my.MetaModel*), is first declared and then referenced using the attribute idRef. Note that this object will only be instantiated once and then reused. It is not allowed to specify any other attributes besides idRef for object references.

5.3.1.4. Simple Parameters

Elements with only one attribute value are simple parameters. Simple parameters may not have any child elements.

Example:

```
<workflow>
 <component class='my.Checker' myParam='foo'>
  <anotherParam value='bar'/>
 </component>
```

As you can see, there are two ways to specify a simple paramter.

1. using an XML attribute

2. using a nested XML element with an attribute value

Both methods are equivalent, although declaring an attribute way saves a few keystrokes. However, the attributes class, id and file are reserved so they cannot be used.

Parameters are injected unsing the same accessor methods as described for components. The only difference is that they are not instantiated using a default constructor but instead using a so called converter.

5.3.1.4.1. Converters

There are currently converter implementations registered for the following Java types:

1. Object

2. String

3. String[] (uses s.split(','))

4. Boolean (both primitive and wrapper)
5. Integer (both primitive and wrapper)

5.3.1.5. Including other workflow files (a.k.a cartridges)

If an element has a property file it is handled as an inclusion. Using an inclusion one can inject a graph described in another workflow file. Here is an example:

file 1: mybean.oaw

```
<anyname class='MyClass'/>
```

file 2: workflow.oaw

```
<comp class='MyBean'>
 <bean file='mybean.oaw'/>
</comp>
```

One can pass properties and components into the included file in the usual way.

file 1: mybean.oaw

```
<anyname class='MyClass' aProp='${myParam}'>
 <bean idRef='myComponent'/>
</anyname>
```

file 2: workflow.oaw

```
<comp class='MyBean'>
 <bean file='mybean.oaw'>
  <myParam value='foo'/>
  <myComponent class='MyBean'/>
 </bean>
</comp>
```

As you can see simple parameters are mapped to properties in the included workflow file and components can be accessed using the idRef attribute.

Properties defined in the included workflow description will be overwritten by the passed properties.

The root element of a workflow description can have any name, because there is no parent defining an accessor method. Additionally you have to specify the attribute class for a root element. There is only one exception: If the root element is named workflow the engine knows that it has to instantiate the type `org.openarchitectureware.Workflow`. Of course you can specify your own subtype of `org.openarchitectureware.Workflow` using the class attribute (if you need to for any reason).

5.3.1.6. InheritAll Feature

If you don't want to explicitely pass the parameters to an included workflow description, you can use the inheritAll attribute. This will make all the properties and beans that are visible to the actual workflow file also visible to the included workflow file.

```
<component file="my/included/workflow.oaw" inheritAll="true"/>
```

5.3.2. Component Implementation and Workflow Execution

This section describes how to implement workflow components, how they can communicate with each other and how the workflow execution can be controlled.

5.3.2.1. The Workflow Context

Workflow components have to communicate among each other. For example, if an XMIReader component reads a model that a constraint checker component wants to check, the model must be passed from the reader to the checker. The way this happens is as follows. In the invoke operation, a workflow component has access to the so-called workflow context. This context contains any number of named slots. In order to communicate, two components agree on a slot name, the first component puts an object into that slot and the second component takes it from there. Basically, slots are named variables global to the workflow. The slot names are configured from the workflow file. Here is an example:

```
<?xml version="1.0" encoding="windows-1252"?>
<workflow>
 <property file="workflow.properties"/>

 <component id="xmiParser"
  class="org.openarchitectureware.emf.XmiReader">
  <outputSlot value="model"/>
 </component>

 <component id="checker" class="datamodel.generator.Checker">
  <modelSlot value="model"/>
 </component>
</workflow>
```

As you can see, both these workflow components use the slot named *model*. Below is the (abbreviated) implementation of the `XmiReader`. It stores the model data structure into the workflow context in the slot whose name was configured in the workflow file.

```
public class XmiReader implements WorkflowComponent {

 private String outputSlot = null;

 public void setOutputSlot(String outputSlot) {
  this.outputSlot = outputSlot;
 }

 public void invoke(WorkflowContext ctx, ProgressMonitor monitor,
  Issues issues) {
  Object theModel = readModel();
  ctx.put( outputSlot, theModel );
 }

}
```

The checker component reads the model from that slot:

```
public class Checker implements WorkflowComponent {

 private String modelSlot;

 public final void setModelSlot( String ms ) {
  this.modelSlot = ms;
 }
 public final void invoke(WorkflowContext ctx,
  ProgressMonitor monitor, Issues issues) {

  Object model = ctx.get(modelSlot);
  check(model);
 }
}
```

5.3.2.2. Issues

Issues provide a way to report errors and warnings. There are two places where issues are used in component implementations:

1. Inside the checkConfiguration operation, you can report errors or warnings. This operation is called before the workflow starts running.

2. Inside the invoke operation, you can report errors or warnings that occur during the execution of the workflow. Typical examples are constraint violations.

The Issues API is pretty straightforward: you can call addError and addWarning. The operations have three parameters: the reporting component, a message as well as the model element that caused the problem, if there is one. The operations are also available in a two-parameter version, omitting the first (reporting component) parameter.

5.3.2.3. Controlling the Workflow

There is an implicit way of controlling the workflow: if there are errors reported from any of the checkConfiguration operations of any workflow component, the workflow will not start running!

There is also an explicit way of terminating the execution of the workflow: if any invoke operation throws a `WorkflowInterruptedException` (a runtime exception) the workflow will terminate immediately.

5.3.2.3.1. Workflow AO

It is sometimes necessary to enhance existing workflow component declarations with additional properties. This is exemplified in the Template AOP example. To implement such an Advice Component, you have to extend the AbstractWorkflowAdvice class. You have to implement all the necessary getters and setters for the properties you want to be able to specify for that advice; also you have to implement the weave() Operation. In this operation, which takes the advised component as a parameter, you have to set the advised parameters:

```
public class GeneratorAdvice extends AbstractWorkflowAdvice {

 private String advices;

 public String getAdvices() {
  return advices;
 }

 public void setAdvices(String advices) {
  this.advices = advices;
 }

 @Override
 public void weave(WorkflowComponent c) {
  Generator gen = (Generator)c;
  gen.setAdvices(advices);
 }

}
```

In the workflow file things are straight forward: You have to specify the advice's component class to be the advice component, and use the special property adviceTarget to identify the target component:

```
<workflow>

 <cartridge file="workflow.oaw"/>
  <component adviceTarget="generator"
   class="oaw.xpand2.GeneratorAdvice">
   <advices value="templates::Advices"/>
  </component>
 </workflow>
```

5.3.3. Invoking a workflow

If you have described your generator process in a workflow file, you might want to run it :-) There are different possibilities for doing so.

5.3.3.1. Starting the WorkflowRunner

The class org.openarchitectureware.workflow.WorkflowRunner is the main entry point if you want to run the workflow from the command line. Take a look at the following example:

```
java org.openarch..WorkflowRunner path/workflow.oaw
```

You can override properties using the -p option:

```
java org.openarch..WorkflowRunner -pbasedir=/base/ path/workflow.oaw
```

5.3.3.2. Starting with Ant

We also have an Ant task. Here's an example:

```
 <target name='generate'>
  <taskdef name="workflow" classname="org.openarchitectureware.workflow.ant.WorkflowAntTask"/>
   <workflow file='path/workflow.oaw'>
    <param name='baseDir' value='/base/'/>
   </workflow>
   ...
  </target>
```

The Workflow ant task extends the Java ant task. Therefore, you have all the properties known from that task (classpath, etc.).

5.3.3.3. Starting from you own code

You can also run the generator from your own application code. Two things to note:

1. the contents of the properties map override the properties defined in the workflow.
2. The slotContents map allows you to fill stuff into the workflow from your application. This is a typical use case: you run oAW from within your app because you already have a model in memory.

```
String wfFile = "somePath\\workflow.oaw";
Map properties = new HashMap();
Map slotContents = new HashMap();
new WorkflowRunner().run(wfFile ,
 new NullProgressMonitor(), properties, slotContents)
```

5.3.3.4. Starting from Eclipse

You can also run a workflow file from within Eclipse, if you have installed the oAW plugins. Just right-click on the workflow file (whatever.oaw) and select Run As -> oAW Workflow. See the plugin documentation for details.

Chapter 6. Xtend/ Xpand/ Check Reference

6.1. Introduction

The oAW4 generator framework provides textual languages, that are useful in different contexts in the MDSD process (e.g. checks, extensions, code generation, model transformation). Each oAW language (Check, Xtend and Xpand) is built up on a common expression language and type system. Therefore they can operate on the same models, metamodels and meta-metamodels and you don't need to learn the syntax again and again, because it is always the same.

The expressions framework provides a uniform abstraction layer over different meta-meta models (e.g. EMF's Ecore, Eclipse's UML, JavaBeans, XML Schema etc.). Additionally, it offers a powerful, statically typed expressions language, which is used in the various textual languages.

6.2. Type System

The abstraction layer on API basis is called a type system. It provides access to built-in types and different registered metamodel implementations. These registered metamodel implementations offer access to the types they provide. The first part of this documentation describes the type system. The expression sub-language is described afterwards in the second part of this documentation. This differentiation is necessary because the type system and the expression language are two different things. The type system is a kind of reflection layer, that can be extended with metamodel implementations. The expression language defines a concrete syntax for executable expressions, using the type system.

The Java API described here is located in the `org.openarchitectureware.type` package and is a part of the subproject `core-expressions`.

6.2.1. Types

Every object (e.g. model elements, values, etc.) has a type. A type contains properties and operations. In addition it might inherit from other types (multiple inheritance).

6.2.1.1. Type Names

Types have a simple Name (e.g. `String`) and an optional namespace used to distingish between two types with the same name (e.g. `my::metamodel`). The delimiter for name space fragments is a double colon „`::`“. A fully qualified name looks like this:

```
my::fully::qualified::MetaType
```

The namespace and name used by a specific type is defined by the corresponding `MetaModel` implementation. The `EmfMetaModel`, for instance, maps `EPackages` to namespace and `EClassifiers` to names. Therefore, the name of the Ecore element `EClassifier` is called:

```
ecore::EClassifier
```

If you don't want to use namespaces (for whatever reason), you can always implement your own metamodel and map the names accordingly.

6.2.1.2. Collection Type Names

The built-in type system also contains the following collection types: `Collection`, `List` and `Set`. Because the expressions language is statically type checked and we don't like casts and `ClassCastExceptions`, we introduced the concept of *parameterized types*. The typesystem doesn't support full featured generics, because we don't need them.

The syntax is:

```
Collection[my::Type]
List[my::Type]
Set[my::Type]
```

6.2.1.3. Features

Each type offers features. The type (resp. the metamodel) is responsible for mapping the features. There are three different kinds of features:

- Properties
- Operations
- StaticProperties

Properties are straight forward: They have a name and a type. They can be invoked on instances of the corresponding type. The same is true for *Operations*. But in contrast to properties, they can have parameters. *StaticProperties* are the equivalent to enums or constants. They must be invoked statically and they don't have parameters.

6.2.2. Built-In Types

As mentioned before the expressions framework has several built-in types, that define operations and properties. In the following, we'll give a rough overview of the types and their features. We won't document all of the operations here, because the built-.in types will evolve over time and we want to derive the documentation from the implementation (model-driven :-)). For a complete reference consult the generated API documentation (http://www.openarchitectureware.org/api/built-ins/).

6.2.2.1. `Object`

`Object` defines a couple of basic operations, like equations. Every type has to extend `Object`!

6.2.2.2. `Void`

The `Void` type can be specified as the return type for operations, although it's not recommended, because whenever possible expressions should be free of side effects whenever possible.

6.2.2.3. Simple types (Datatypes)

The type system doesn't have a concept data type. Data types are just types. As in OCL, we support the following types: `String`, `Boolean`, `Integer`, `Real`.

- `String`: A rich and convenient `String` library is especially important for code generation. The type system supports the '+' operator for concatenation, the usual `java.lang.String` operations (`length()`, etc.) and some special operations (like `toFirstUpper()`, `toFirstLower()`, regular expressions, etc. often needed in code generation templates).

- `Boolean`: `Boolean` offers the usual operators (Java syntax): &&, ||, !, etc.
- `Integer` and `Real`: `Integer` and `Real` offer the usual compare operators (<,>,<=,>=) and simple arithmetics (+,-,*,/). Note that *`Integer` extends `Real`* !

6.2.2.4. Collection types

The type system has three different Collection types. `Collection` is the base type, it provides several operations known from `java.util.Collection`. The other two types (`List`, `Set`) correspond to their `java.util` equivalents, too.

6.2.2.5. Types types

The type system describes itself, hence, there are types for the different concepts. These types are needed for reflective programming. To avoid confusion with meta types with the same name (it's not unusual to have a meta type called `Operation`, for instance) we have prefixed all of the types with the namespace `oaw`. We have:

- `oaw::Type`
- `oaw::Feature`
- `oaw::Property`
- `oaw::StaticProperty`
- `oaw::Operation`

6.2.3. MetaModel-Implementations (aka Meta Meta Model)

By default the type system only knows the built-in types. In order to register your own meta types (e.g. `Entity` or `State`), you need to register a respective MetaModel implementation with the type system. Within a MetaModel implementation the oAW typesystem elements (Type, Property, Operation) are mapped to an arbitrary other typesystem (Java reflections, Ecore or XML Schema).

6.2.3.1. Example JavaMetaModel

For instance, if you want to have the following JavaBean act as a Metatype (i.e. Your model contains instances of the type):

```
public class Attribute {
   private String name;
   private String type;
   public String getName() {
      return name;
   }
   public void setName(String name) {
      this.name = name;
   }
   public String getType() {
      return type;
   }
   public void setType(String type) {
      this.type = type;
   }
}
```

You need to use the `JavaMetaModel` implementation which uses the ordinairy Java reflection layer in order to map access to the model.

So if you have the following expression in e.g. Xpand:

```
myattr.name.toFirstUpper()
```

and `myattr` is the name of a local variable pointing to an instance of `Attribute`. The oaw typesystem asks the metamodel implementations if they 'know' a type for the instance of Attribute. If you have the `JavaMetaModel` registered it will return an `oaw::Type` which maps to the underlying Java class. When the type is asked if it knows a property '`name`', and it will inspect the Java class using the Java reflection API.

The JavaMetaModel implementation shipped with oaw can be configured with a strategy [GOF95-Pattern] in order to control or change the mapping. For instance, the JavaBeansStrategy maps getter and setter methods to simple properties, so we would use this strategy for the example above.

6.2.3.2. Eclipse IDE MetaModelContributors

You should know that for each `Metamodel` implementation you use at runtime, you need to have a so called `MetamodelContributor` extension for the plugins to work with. If you just use one of the standard Metamodel implementations (EMF, UML2 or Java) you don't have to worry about it, since oaw is shipped with respective MetamodelContributors (see the corresponding docs for details). If you need to implement your own `MetamodelContributor` you should have a look at the Eclipse plug-in reference doc.

6.2.3.3. Configuring Metamodel implementations with the workflow

You need to configure your oaw language components with the respective metamodel implementations.

A possible configuation of the `Xpand2` generator component looks like this:

```
<component class="oaw.xpand2.Generator">
   <metaModel class="oaw.type.emf.EmfMetaModel">
      <metaModelPackage value="my.generated.MetaModel1Package"/>
   </metaModel>
   <metaModel class="oaw.type.emf.EmfMetaModel">
      <metaModelFile value="my/java/package/metamodel2.ecore"/>
   </metaModel>
   ...
</component>
```

In this example the `EmfMetaModel` implementation is configured two times. This means that we want to use two metamodels at the same time, both based on EMF. The metaModelPackage property is a property that is specific to the `EmfMetaModel` (located in the `core.emftools` project). It points to the generated `EPackage` interface. The second metamodel is configured using the ecore file. You don't need to have a generated Ecore model for oaw in order to work. The `EmfMetaModel` works with dynamic EMF models just as it works with generated EMF models.

6.2.4. Using different MetaModel implementations (aka MetaMetaModels)

With oAW you can work on different kinds of Model representations at the same time in a transparent manner. One can work with EMF models, XML DOM models, and simple JavaBeans in the same Xpand-Template. You just need to configure the respective MetaModel implementations.

If you want to do so you need to know how the type lookup works. Let's assume that we have an EMF metamodel and a model based on some Java classes. Then the following would be a possible configuration:

```
<component class="oaw.xpand2.Generator">
   <metaModel class="oaw.type.impl.java.JavaMetaModel"/>
   <metaModel class="oaw.type.emf.EmfMetaModel">
      <metaModelFile value="my/java/package/metamodel.ecore"/>
   </metaModel>

   ...
</component>
```

When the oaw runtime needs to access a property of a given object, it asks the metamodels in the configured order. Let's assume that our model element is an instance of the Java type `org.eclipse.emf.ecore.EObject` and it's a dynamic instance of an EMF EClass `MyType`.

We have *three* Metamodels:

1. Built-Ins (always the first one)
2. JavaMetaModel
3. EMFMetaModel – metamodel.ecore

The first one will return the type `Object` (not `java.lang.Object` but oaw's `Object`). At this point the type Object best fits the request, so it will act as the desired type.

The second metamodel returns an oaw type called `oaw::eclipse::emf::ecore::EObject` The typesystem will check if the returned type is a specialization of the current 'best-fit' type (`Object`). It is, because it extends `Object` (Every meta type has to extend `Object`). At this time the typesystem assumes `oaw::eclipse::emf::ecore::EObject` to be the desired type.

The third metamodel will return `metamodel::MyType` which is the desired type. But unfortunately it doesn't extend `org::eclipse::emf::ecore::EObject` as it has nothing to do with those Java types. Instead it extends `emf::EObject` which extends `Object`.

We need to swap the configuration of the two metamodels to get the desired type.

```
<component class="oaw.xpand2.Generator">
   <metaModel class="oaw.type.emf.EmfMetaModel">
      <metaModelFile value="my/java/package/metamodel.ecore"/>
   </metaModel>
   <metaModel class="oaw.type.impl.java.JavaMetaModel"/>

   ...
</component>
```

6.3. Expressions

The oAW expression sub language is a syntactical mixture of Java and OCL. This documentation provides a detailed description of each available expression. But let's start with some simple examples.

Accessing a property:

```
myModelElement.name
```

Accessing an operation:

```
myModelElement.doStuff()
```

simple arithmetic:

```
1 + 1 * 2
```

boolean expressions (just an example:-)):

```
!('text'.startsWith('t') && ! false)
```

6.3.1. Literals and special operators for built-in types

There are several literals for built-in types:

6.3.1.1. `Object`

There are naturally no literals for object, but we have two operators:

equals:

```
obj1 == obj2
```

not equals:

```
obj1 != obj2
```

6.3.1.2. `Void`

The only possible instance of `Void` is the `null` reference. Therefore, we have one literal:

```
null
```

6.3.1.3. Type literals

The literal for types is just the name of the type (no '.class' suffix, etc.). Example:

```
String // the type string
my::special::Type // evaluates to the type 'my::special::Type'
```

6.3.1.4. StaticProperty literals

The literal for static properties (aka enum literals) is correlative to type literals:

```
my::Color::RED
```

6.3.1.5. `String`

There are two different literal syntaxes (with the same semantics):

```
S'a String literal'
"a String literal" // both are okay
```

For Strings the expression sub-language supports the plus operator that is overloaded with concatenation:

```
'my element '+ ele.name +' is really cool!'
```

Note, that multi-line Strings are supported.

6.3.1.6. `Boolean`

The boolean literals are:

```
true
false
```

Operators are:

```
true && false // AND
true || false // OR
! true        // NOT
```

6.3.1.7. `Integer` and `Real`

The syntax for integer literals is as expected:

```
// integer literals
3
57278
// real literals
3.0
0.75
```

Additionally, we have the common arithmetic operators:

```
3 + 4  // addition
4 – 5  // subtraction
2 * 6  // multiplication
3 / 64 // divide
// Unary minus operator
- 42
- 47.11
```

Furthermore, the well known compare operators are defined:

```
4 > 5 // greater than
4 < 5 // smaller than
4 >= 23 // greater equals than
4 <= 12 // smaller equals than
```

6.3.1.8. Collections

There is a literal for lists:

```
{1,2,3,4} // a list with four integers
```

There is no other special concrete syntax for collections. If you need a set, you have to call the `toSet()` operation on the list literal:

```
{1,2,4,4}.toSet() // a set with 3(!) integers
```

6.3.2. Special Collection operations

Like OCL, the oAW expression sub-language defines several special operations on collections. Those operations are not members of the type system, therefore you can't use them in a reflective manner!

6.3.2.1. `select`

Sometimes an expression yields a large collection, but onje is only interested in a special subset of the collection. The expression sub-language has special constructs to specify a selection out of a specific collection. These are the `select` and `reject` operations. The select specifies a subset of a collection. A `select` is an operation on a collection and is specified as follows:

```
collection.select( v | boolean-expression-with-v )
```

Select returns a sublist of the specified collection. The list contains all elements for which the evaluation of boolean-expression-with-v results in true. Example:

```
{1,2,3,4}.select(i|i>=3) // returns {3,4}
```

6.3.2.2. `typeSelect`

A special version of a select expression is `typeSelect`. Rather than providing a boolean expression a class name is here provided.

```
collection.typeSelect( classname )
```

`typeSelect` returns that sublist of the specified collection, that contains only objects which are an instance of the specified class (also inherited).

6.3.2.3. `reject`

The `reject` operation is similar to the `select` operation, but with `reject` we get the subset of all the elements of the collection for which the expression evaluates to `false`. The `reject` syntax is identical to the `select` syntax:

```
collection.reject( v | boolean-expression-with-v )
```

Example:

```
{1,2,3,4}.reject(i|i>=3) // returns {1,2}
```

6.3.2.4. `collect`

As shown in the previous section, the `select` and `reject` operations always result in a sub- collection of the original collection. Sometimes one wants to specify a collection which is derived from another collection, but which contains objects not in the original collection (it is not a sub-collection), we can use a `collect` operation. The `collect` operation uses the same syntax as the `select` and `reject` and is written like this:

```
collection.collect( v | expression-with-v )
```

`collect` again iterates over the target collection and evaluates the given expression on each element. In contrast to `select`, the evaluation result is collected in a list. When an iteration is finished the list with all results is returned. Example:

```
namedElements.collect(ne|ne.name) // returns a list of strings
```

6.3.2.5. Shorthand for `collect` (and more than that)

As navigation through many objects is very common, there is a shorthand notation for collect that makes the expressions more readable. Instead of

```
self.employee.collect(e|e.birthdate)
```

one can also write:

```
self.employee.birthdate
```

In general, when a property is applied to a collection of Objects, it will automatically be interpreted as a `collect` over the members of the collection with the specified property.

The syntax is a shorthand for `collect`, if the feature does not return a collection itself. But sometimes we have the following:

```
self.buildings.rooms.windows // returns a list of windows
```

This syntax works, but one cannot express it using the collect operation in an easy way.

6.3.2.6. `forAll`

Often a boolean expression has to be evaluated for all elements in a collection. The `forAll` operation allows specifying a Boolean expression, which must be true for all objects in a collection in order for the `forAll` operation to return `true`:

```
collection.forAll( v | boolean-expression-with-v )
```

The result of `forAll` is `true` if `boolean-expression-with-v` is `true` for all the elements contained in a collection. If `boolean-expression-with-v` is `false` for one or more of the elements in the collection, then the `forAll` expression evaluates to `false`.

Example:

```
{3,4,500}.forAll(i|i<10) // evaluates to false (500 < 5 is false)
```

6.3.2.7. `exists`

Often you will need to know whether there is at least one element in a collection for which a boolean is `true`. The exists operation allows you to specify a Boolean expression which must be `true` for at least one object in a collection:

```
collection.exists( v | boolean-expression-with-v )
```

The result of the exists operation is `true` if `boolean-expression-with-v` is `true` for at least one element of collection. If the `boolean-expression-with-v` is `false` for all elements in collection, then the complete expression evaluates to `false`.

Example:

```
{3,4,500}.exists(i|i<10) // evaluates to true (e.g. 3 < 5 is true)
```

6.3.2.8. `sortBy`[1]

If you want to sort a list of elements, you can use the higher order function `sortBy`. The list you invoke the `sortBy` operation on is sorted by the results of the given expression.

Example:

```
myListOfEntity.sortBy(entity|entity.name)
```

In the example the list of entities is sorted by the name of the entities. Note that there is no such `Comparable` type in oaw. If the values returned from the expression are instances of `java.util.Comparable` the `compareTo` method is used, otherwise `toString()` is invoked and the the result is used.

More Examples - the following expression return `true`:

```
{'C','B','A'}.sortBy(e|e) == {'A','B','C'}
{'AAA','BB','C'}.sortBy(e|e.length) == {'C','BB','AAA'}
{5,3,1,2}.sortBy(e|e) == {1,2,3,5}
{5,3,1,2}.sortBy(e|e-2*e) == {5,3,2,1}
...
```

6.3.3. If expression

There are two different „flavours“ of conditional expressions. The first one is the so-called *if expression*. Syntax:

```
condition ? thenExpression : elseExpression
```

Example:

```
name != null ? name : 'unknown'
```

6.3.4. `switch` expression

The other one is called *switch expression*. Syntax:

```
switch (expression) {
   (case expression : thenExpression)*
   default : catchAllExpression
}
```

The default part is mandatory, because `switch` is an expression, therefore it needs to evaluate to something in any case. Example:

```
switch (person.name) {
   case 'Hansen' : 'Du kanns platt schnacken'
   default : 'Du kanns mi nech verstohn!'
}
```

There is an abbreviation for *Boolean* expressions:

[1]since 4.1.2

```
switch {
   case booleanExpression : thenExpression
   default : catchAllExpression
}
```

6.3.5. Chain expression

Expressions and functional languages should be free of side effects as far as possible. But sometimes there you need invocations that do have side effects. In some cases expressions even don't have a return type (i.e. the return type `Void`). If you need to call such operations, you can use the chain expression. Syntax:

```
anExpr ->
anotherExpr ->
lastExpr
```

Each expression is evaluated in sequence, but only the result of the last expression is returned. Example:

```
pers.setName('test') ->
pers
```

This chain expression will set the `name` of the person first, before it returns the person object itself.

6.3.6. `create` expression

The `create` expression is used to instantiate new objects of a given type:

```
new TypeName
```

6.3.7. `let` expression

The `let` expression lets you define local variables. Syntax is as follows:

```
let v = expression in expression-with-v
```

This is especially useful together with a chain- and a create expressions. Example:

```
let p = new Person in
   p.name('John Doe') ->
   p.age(42) ->
   p.city('New York') ->
   p
```

6.3.8. 'GLOBALVAR' expression

Sometimes you don't want to pass everything down the call stack by parameter. Therefore, we have the `GLOBALVAR` expression. There are two things you need to do, to use global variables within one of the openArchitetcureWare languages (Check, Xtend or Xpand).

6.3.8.1. Using GLOBALVARS to configure workflows

Each workflow component using the expression framework (Xpand, Check and Xtend) can be configured with global variables. Here is an example:

```
<workflow>
   .... stuff
   <component class="oaw.xpand2.Generator">
      ... usual stuff (see ref doc)
      <globalVarDef name="MyPSM" value="slotNameOfPSM"/>
      <globalVarDef name="ImplClassSuffix" value="'Impl'"/>
   </component>
</workflow>
```

If you have injected global variables into the respective component, you can call them using the following syntax:

```
GLOBALVAR ImplClassSuffix
```

Note, we don't have any static typeinformation. Therefore `Object` is assumed. So you have to down cast the global var to the intended type:

```
((String) GLOBALVAR ImplClassSuffix)
```

It is good practice to type it once, using an Extension and then always refer to that extension:

```
String implClassSuffix() : GLOBALVAR ImplClassSuffix;
// usage of the typed global var extension
ImplName(Class c) :
   name+implClassSuffix();
```

6.3.9. Multi methods (multiple dispatch)

The expressions language supports multiple dispatching. This means that when there is a bunch of overloaded operations, the decision which operation has to be resolved is based on the dynamic type of all parameters (the implicit '`this`' included).

In Java only the dynamic type of the 'this' element is considered, for paramters the static type is used. (this is called single dispatch)

Here is a Java example:

```
class MyClass {
   boolean equals(Object o) {
      if (o instanceof MyClass) {
         return equals((MyClass)o);
      }
      return super.equals(o);
   }
   boolean equals(MyType mt) {
      //implementation...
   }
}
```

The method `equals(Object o)` must not been overwritten, if Java would support multiple dispatch.

6.3.10. Casting

The expression language is statically type checked. Allthough there are many concepts that help the programmer to have really good static type information, sometimes one knows more about the real type than the system. To explicitely give the system such an information casts are available. *Casts are 100% static, so you don't need them if you never statically typecheck your expressions!*

The syntax for casts is very Java-like:

```
((String)unTypedList.get(0)).toUpperCase()
```

6.4. Xtend

Like the expressions sub language that summarizes the syntax of expressions for all the other textual languages delivered with the openArchitectureWare framework, there is another commonly used language called Xtend.

This language provides the possibility to define rich libraries of independent operations and no-invasive metamodel extensions based on either Java methods or oAW expressions. Those libraries can be referenced from all other textual languages, that are based on the expressions framework.

6.4.1. Extend files

An extend file must reside in the Java class path of the used execution context. Additionally it's file extension must be `*.ext`. Let's have a look at an extend file.

```
import my::metamodel;extension other::ExtensionFile;

/**
  * Documentation
  */
anExpressionExtension(String stringParam) :
 doingStuff(with(stringParam))
;

/**
  * java extensions are just mappings
  */
String aJavaExtension(String param) : JAVA
 my.JavaClass.staticMethod(java.lang.String)
;
```

The example shows the following statements:

1. import statements
2. extension import statements
3. expression or java extensions

6.4.2. Comments

We have single- and multi-line comments. The syntax for single line comments is:

```
// my comment
```

Multi line comments are written like this:

```
/* My multi line comment */
```

6.4.3. Import Statements

Using the import statement one can import name spaces of different types.(see expressions framework reference documentation).

Syntax is:

```
import my::imported::namespace;
```

Extend does not support static imports or any similar concept. Therefore, the following is incorrect syntax:

```
import my::imported::namespace::*; // WRONG!import my::Type; // WRONG!
```

6.4.4. Extension Import Statement

You can import another extend file using the extension statement. The syntax is:

```
extension fully::qualified::ExtensionFileName;
```

Note, that no file extension (`*.ext`) is specified.

6.4.4.1. Reexporting Extensions

If you want to export extensions from another extension file together with your local extensions, you can add the keyword 'reexport' to the end of the respective extension import statement.

```
extension fully::qualified::ExtensionFileName reexport;
```

6.4.5. Extensions

The syntax of a simple expression extension is as follows:

```
ReturnType extensionName(ParamType1 paramName1, ParamType2...): expression-using-params;
```

Example:

```
String getterName(NamedElement ele) : 'get'+ele.name.firstUpper();
```

6.4.5.1. Extension Invocation

There are two different ways of how to invoke an extension. It can be invoked like a function:

```
getterName(myNamedElement)
```

The other way to invoke an extension is through the "member syntax":

```
myNamedElement.getterName()
```

For any invocation in member syntax, the target expression (the member) is mapped to the first parameter. Therefore, both syntax forms do the same thing.

It's important to understand that extensions are not members of the type system, hence, they are not accessible through reflection and you cannot specialize or overwrite operations using them.

The expression evaluation engine first looks for an appropriate operation before looking for an extension, in other words operations have higher precedence.

6.4.5.2. Type Inference

For most extensions, you don't need to specify the return type, because it can be derived from the specified expression. The special thing is, that the static return type of such an extension depends on the context of use!

For instance, if you have the following extension

```
asList(Object o): {o};
```

the invocation of

```
asList('text')
```

has the static type List[String]. This means you can call

```
asList('text').get(0).toUpperCase()
```

The expression is statically type safe!

There is always a return value, whether you specify it or not, even if you specify explicitely 'Void'.

See the following example.

```
modelTarget.ownedElements.addAllNotNull(modelSource.contents.duplicate())
```

In this example duplicate() dispatches polymorphicly. Two of the extentions might look like:

```
Void duplicate(Realization realization):
   realization.Specifier().duplicate()->
   realization.Realizer().duplicate()
;

create target::Class duplicate(source::Class):
   ...
;
```

If a 'Realisation' is contained in the 'contents' list of 'modelSource', the 'Realizer' of the 'Realization' will be added to the 'ownedElements' list of the 'modelTarget'. If you do not want to add in the case that the contained element is a 'Realization' you might change the extention to:

```
Void duplicate(Realization realization):
   realization.Specifier().duplicate()->
   realization.Realizer().duplicate() ->
   {}
;
```

6.4.5.3. Recursion

There is only one exception: For recursive extensions the return type cannot be inferred, therefore you need to specify it explicitely:

```
String fullyQualifiedName(NamedElement n) : n.parent == null ? n.name :
   fullyQualifiedName(n.parent)+'::'+n.name
;
```

Recursive extensions are non-deterministic in a static context, therefore it is necessary to specify a return type.

6.4.5.4. Cached Extensions

If you call an extension without side effects very often, you would like to cache the result for each set of parameters, in order improve the performance. You can just add the keyword 'cached' to the extension in order to acieve this:

```
cached String getterName(NamedElement ele) :
   'get'+ele.name.firstUpper()
;
```

The getterName will be computed only once for each NamedElement.

6.4.5.5. Private Extensions

By default all extensions are public, i.e. they are visible from outside the extension file. If you want to hide extensions you can add the keyword 'private' in front of them:

```
private internalHelper(NamedElement ele) :
   // implementation....
;
```

6.4.6. Java Extensions

In some rare cases one does want to call a Java method from inside an expression. This can be done by providing a Java extension:

```
Void myJavaExtension(String param) :
   JAVA my.Type.staticMethod(java.lang.String)
;
```

The signature is the same as for any other extension. The implementation is redirected to a public static method in a Java class.

It's syntax is:

```
JAVA fully.qualified.Type.staticMethod(my.ParamType1,
                                       my.ParamType2,
                                       ...)
;
```

Note that you cannot use any imported namespaces. You have to specify the type, its method and the parameter types in a fully qualified way.

Example:

If you have defined the following Java extension:

```
Void dump(String s) :
   JAVA my.Helper.dump(java.lang.String)
;
```

and you have the following Java class:

```
package my;
```

```
public class Helper {
   public final static void dump(String aString) {
      System.out.println(aString);
   }
}
```

the expressions

```
dump('Hello world!')
'Hello World'.dump()
```

both result are invoking the Java method void dump(String aString)

6.4.7. Create Extensions (Model Transformation)

Since Version 4.1 the Xtend language supports additional support for model transformation. The new concept is called 'create extension' and is explained a bit more comprehensive as usual.

Elements contained in a model are usually referenced multiple times. Consider the following model structure

```
    P
   / \
  C1 C2
   \ /
    R
```

A package P contains two classes C1 and C2. C1 contains a reference R of type C2 (P references C2).

We could write the following extensions in order to transform an Ecore (EMF) model to our metamodel (Package, Class, Reference).

```
toPackage(EPackage x) :
   let p = new Package :
      p.ownedMember.addAll(x.eClassifiers.toClass()) ->
      p;

toClass(EClass x) :
   let c = new Class :
      c.attributes.addAll(x.eReferences.toReference()) ->
      c;

toReference(EReference x) :
   let r = new Reference :
      r.setType(x.eType.toClass()) ->
      r;
```

For an ecore model of the structure from above, the result would be:

```
    P
   / \
  C1 C2
  |
  R - C2
```

What happend? The C2 class has been created 2 times (one time for the package containment and another time for the Reference's reference). We can solve the problem by adding the 'cached' keyword to the second extension:

```
cached toClass(EClass x) :
   let c = new Class :
      c.attributes.addAll(c.eAttributes.toAttribute()) ->
      c;
```

The process goes like this:

1. start create P
    a. start create C1 (contained in P)
        i. start create R (contained in C1)
            A. start create C2 (referenced from R)
            B. end (result C2 is cached)
        ii. end R
    b. end C1
    c. start get cached C2 (contained in P)
2. end P

So this works very well. We will get the intended structure. But what about circular dependencies? For instance, C2 could contain a Reference R2 of type C1 (bidirectional references):

The transformation would occurr like this:

1. start create P
    a. start create C1 (contained in P)
        i. start create R (contained in C1)
            A. start create C2 (referenced from R)
                I. start create R2 (contained in C2)
                    1. start create C1 (referenced from R1)... OOPS!

C1 is already in creation and will not complete until the stack is reduced. Deadlock! The problem is that the cache caches the return value, but C1 was not returned so far, because it is still in construction. The solution: create extensions

The syntax is as follows:

```
create Package toPackage(EPackage x) :
   this.classifiers.addAll(x.eClassifiers.toClass());

create Class toClass(EClass x) :
   this.attributes.addAll(x.eReferences.toReference());

create Reference toReference(EReference x) :
   this.setType(x.eType.toClass());
```

This is not only a shorter syntax but it also has the needed semantics: The created model element will be added to the cache before evaluating the body. The return value is always the reference to the created and maybe not completely initialized element.

6.4.8. Calling Extensions From Java

The previous section showed how to implement Extensions in Java. This section shows how to call Extensions from Java.

```
// setup
XtendFacade f = XtendFacade.create("my::path::MyExtensionFile");

// use
f.call("sayHello",new Object[]{"World"});
```

The called extension file looks like this:

```
sayHello(String s) :
   "Hello " + s;
```

This example uses only features of the BuiltinMetaModel, in this case the „+“ feature from the StringTypeImpl.

Here is another example, that uses the JavaBeansMetaModel strategy. This strategy provides as additional feature the access to properties using the getter and setter methods.

For more information about type systems see the Expressions Reference Documentation.

We have one JavaBean-like meta model class:

```
package mypackage;
public class MyBeanMetaClass {
   private String myProp;
   public String getMyProp() { return myProp; }
   public void setMyProp(String s) { myProp = s;}
}
```

Additional to the already builtin metamodel type system, we register the JavaMetaModel with the JavaBeansStrategy for our facade. Now we can use also this strategy in our extension:

```
// setup facade

XtendFacade f = XtendFacade.create("myext::JavaBeanExtension");

// setup additional type system
JavaMetaModel jmm =
   new JavaMetaModel("JavaMM", new JavaBeansStrategy());

f.registerMetaModel(jmm);

// use the facade
MyBeanMetaClass jb = MyBeanMetaClass();
jb.setMyProp("test");
f.call("readMyProp", new Object[]{jb}));
```

The called extension file looks like this:

```
import mypackage;

readMyProp(MyBeanMetaClass jb) :
   jb.myProp
;
```

6.4.9. WorkflowComponent

With the additional support for model transformation it makes sense to invoke Xtend within a workflow. A typical workflow configuration of the Xtend component looks like this:

```
<component class="oaw.xtend.XtendComponent">
   <metaModel class="oaw.type.emf.EmfMetaModel">
      <metaModelFile value="metamodel1.ecore"/>
   </metamodel>
   <metaModel class="oaw.type.emf.EmfMetaModel">
      <metaModelFile value="metamodel2.ecore"/>
   </metaModel>
   <invoke value="my::example::Trafo::transform(inputSlot)"/>
   <outputSlot value="transformedModel"/>
</component>
```

Note that you can mix and use any kinds of metamodels (not only EMF metamodels).

6.4.10. Aspect-Oriented Programming in Xtend (since 4.2)

Using the workflow engine it is now possible to package (e.g. zip) a written generator and deliver it as a kind of black box. If you want to use such a generator but need to change some things without modifiying any code, you can make use of Xtend's around advices.

The following advice is weaved around every invokation of an extensions which name starts with 'my::generator::':

```
around my::generator::*(*) :
 log('Invoking ' + ctx.name) -> ctx.proceed()
;
```

Around advices let you change behaviour in an non-invasive way (you don't need to touch the packaged extensions).

6.4.10.1. Join Point and Point Cut Syntax

AOP is basically about weaving code into different points inside the call graph of a software module. Such points are called Join Points. In Xtend the join points are the extenion invocations (Note that Xpand offers a simliar feature, see the Xpand documentation).

One specifies on which join points the contributed code should be executed by specifying something like a 'query' on all available join points. Such a query is called a point cut.

```
around [pointcut] :
   expression;
```

A pointcut consists of a fully qualified name and a list of parameter declarations.

6.4.10.1.1. Extensions Name

The extension name part of a point cut must match the fully qualified name of the join point's definition. Such expressions are case sensitive. The asterisk character is used to specify wildcards. Some examples:

```
my::Extension::definition // extensions with the specified name
org::oaw::* //extensions prefixed with 'org::oaw::'
*Operation* // extensions containing the word 'Operation' in it.
* // all extensions
```

WARNING!

BE CAREFUL WHEN USING THE WILCARD, AS YOU WILL GET AN ENDLESS RECURSION IF YOU WEAVE AN EXTENSION WHICH IS CALLED INSIDE THE ADVICE!

6.4.10.1.2. Parameter Types

The parameters of the extensions we want to add our advice to can also be specified in the point cut. The rule is that the type of the specified parameter must be the same or a super type of the corresponding parameter type (the dynamic type at runtime!) of the definition to be called.

Additionally one can set the wildcard at the end of the parameter list to specify that there might be none or more parameters of any kind.

Some examples:

```
my::Templ::extension() // extension without parameters
my::Templ::extension(String s) // extension with exactly one parameter of type String
my::Templ::extension(String s,*) // templ def with one or more parameters,
                                 // where the first parameter is of type String
my::Templ::extension(*) // templ def with any number of parameters
```

6.4.10.1.3. Proceeding

Inside an advice you might want to call the underlying definition. This can be done using the implicit variable ctx, which is of the type xtend::AdviceContext and provides an operation proceed() which invokes the underlying definition with the original parameters (Note that you might have changed any mutable object in the advice before).

If you want to control what parameters are to be passed to the definition you can use the operation proceed(List[Object] params). There is no type checking here!

Additionally there are some inspection properties (like name, paramTypes, etc.) available.

6.4.10.2. Workflow configuration

To weave the defined advices into the different join points you need to configure the XtendComponent with the qualified names of the Extension files containing the advices.

Example:

```
<component class="oaw.xtend.XtendComponent">
```

```
   <metaModel class="oaw.type.emf.EmfMetaModel">
      <metaModelFile value="metamodel1.ecore"/>
   </metamodel>
   <metaModel class="oaw.type.emf.EmfMetaModel">
      <metaModelFile value="metamodel2.ecore"/>
   </metaModel>

   <invoke value="my::example::Trafo::transform(inputSlot)"/>
      <outputSlot value="transformedModel"/>
   <value="my::Advices,my::Advices2"/>
</component>
```

6.4.10.3. Model-to-Model transformation with Xtend

This example uses Eclipse EMF as the basis for model-to-model transformations.It builds on the *emfExample* documented elsewhere. Please read and install the *emfExample* first.

The idea in this example is to transform the data model introduced in the EMF example into itself. This might seem boring, but the example is in fact quite illustrative.

6.4.10.4. Workflow

By now you should know the role and structure of workflow files. Therefore, the interesting aspect of the workflow file below is the *XtendComponent*.

```
<workflow>
   <property file="workflow.properties"/>
      ...
   <component class="oaw.xtend.XtendComponent">
      <metaModel class="oaw.type.emf.EmfMetaModel">
         <metaModelPackage value="data.DataPackage"/>
      </metaModel>
      <invoke value="test::Trafo::duplicate(rootElement)"/>
      <outputSlot value="newModel"/>
   </component>
   ...
</workflow>
```

As usual, we have to define the metamodel that should be used, and since we want to transform a data model into a data model, we need to specify only the `data.DataPackage` as the metamodel.

We then specify which function to invoke for the transformation. The statement `test::Trafo::duplicate(rootElement)` means to invoke:

- the `duplicate` function taking the contents of the `rootElement` slot as a parameter
- the function can be found in the `Trafo.ext` file
- and that in turn is in the classpath, in the `test` package

6.4.10.5. The Transformation

The transformation, as mentioned above, can be found in the `Trafo.ext` file in the `test` package in the `src` folder. Let's walk through the file.

So, first we import the metamodel.

```
import data;
```

The next function is a so-called `create` extension. Create extensions, as a sideeffect when called, create an instance of the type given after the `create` keyword. In our case, the `duplicate` function creates an instance of `DataModel`. This newly created object can be referrred to in the transformation by `this` (which is why `this` is specified behind the type). Since `this` can be ommitted, we don't have to mention it explicitly in the transformation.

The function also takes an instance of `DataModel` as its only parameter. That object is referred to in the transformation as `s`. So, this function sets the name of the newly created `DataModel` to be the name of the original one, and then adds duplicates of all entities of the original one to the new one. To create the duplicates of the entities, the `duplicate()` operation is called for each `Entity`. That is the next function in the transformation.

```
create DataModel this duplicate(DataModel s):
   entity.addAll( s.entity.duplicate() ) ->
   setName(s.name);
```

The duplication function for Entities is also a create Extension, this time it creates a new Entity for each old Entity passed in. Again, it copies the name and adds duplicates of the attributes and references to the new one.

```
create Entity this duplicate(Entity old):
   attribute.addAll( old.attribute.duplicate() ) ->
   reference.addAll( old.reference.duplicate() ) ->
   setName( old.name );
```

The function that copies the attribute is rather straight forward, ... but ...

```
create Attribute this duplicate(Attribute old):
   setName( old.name ) ->
   setType( old.type );
```

... the one for the references is more interesting. Note that a reference, while being owned by some Entity, also references another Entity as its target. So how do you make sure you don't duplicate the target twice? Xtend provides explicit support for this kind of situation. *Create extensions are only executed once per tuple of parameters!* So if, for example, the Entity behind the target reference had already been duplicated by calling the duplicate function with the respective parameter, the next time it will be called *the exact same object will be returned*. This is very useful for graph transformations.

```
create EntityReference this duplicate(EntityReference old):
   setName( old.name ) ->
   setTarget( old.target.duplicate() );
```

For more information about the Xtend language please see the Xtend Reference documentation.

6.5. Xpand2

The *openArchitectureWare* framework contains a special language called *Xpand* that is used in templates to control the output generation. This documentation describes the general syntax and semantics of the *Xpand* language.

Typing the guillemets (« and ») used in the templates is supported by the Eclipse editor: which provides keyboard shortcuts with **Ctrl**+< and **Ctrl**+>.

6.5.1. Template files and encoding

Templates are stored in files with the extension `xpt`. Template files must reside on the Java classpath of the generator process.

Almost all characters used in the standard syntax are part of *ASCII* and should therefore be available in any encoding. The only limitation are the tag brackets (guillemets), for which the characters « (Unicode `00AB`) and » (Unicode `00BB`) are used. So for reading templates an encoding should be used that supports these characters (e.g. `ISO-8859-1` or `0UTF-8`).

Names of properties, templates, namespaces etc. must only contain letters, numbers and underscores.

6.5.2. General structure of template files

Here is a first example of a template.

```
«IMPORT meta::model»
«EXTENSION my::ExtensionFile»

«DEFINE javaClass FOR Entity»
   «FILE fileName()»
      package «javaPackage()»;

      public class «name» {
         // implementation
      }
   «ENDFILE»
«ENDDEFINE»
```

A template file consists of any number of IMPORT statements, followed by any number of EXTENSION statements, followed by one or more DEFINE blocks (called definitions).

6.5.3. Statements of the Xpand language

6.5.3.1. IMPORT

If you are tired of always typing the fully qualified names of your types and definitions, you can import a namespace using the IMPORT statement.

```
«IMPORT meta::model»
```

This one imports the namespace `meta::model`. If your template contains such a statement, you can use the unqualified names of all types and template files contained in that namespace. This is similar to a Java import statement `import meta.model.*`.

6.5.3.2. EXTENSION

Metamodels are typically described in a structural way (graphical, or hierarchical, etc.) . A shortcoming of this, is that it's difficult to specify additional behaviour (query operations, derived properties, etc.). Also, it's a good idea not to pollute the meta model, with target platform specific information (e.g. Java type names, packages, getter and setter names, etc.).

Extensions provide a flexible and convenient way of defining additional features of meta classes. You do this by using the *Extend* language. (See the corresponding reference documentation for details)

An EXTENSION import points to the *Extend* file containing the required extensions:

```
«EXTENSION my::ExtensionFile»
```

Note that extension files have to reside on the Java classpath, too. Therefore they use the same namespace mechanism (and syntax) as types and template files.

6.5.3.3. DEFINE

The central concept of *Xpand* is the DEFINE block, also called a template. This is the smallest identifiable unit in a template file. The tag consists of a name, an optional comma separated parameter list as well as the name of the meta model class for which the template is defined.

```
«DEFINE templateName(formalParameterList) FOR MetaClass»
   a sequence of statements
«ENDDEFINE»
```

To some extent templates can be seen as special methods of the meta class – there is always an implicit *this* parameter which can be used to address the "underlying" model element; in our example above, this model element is "MetaClass".

As in Java a formal parameter list entry consists of the type followed by the name of that parameter.

The body of a template can contain a sequence of other statements including any text.

A full parametric polymorphism is available for templates. If there are two templates with the same name that are defined for two meta classes which inherit from the same super class, *Xpand* will use the corresponding subclass template in case the template is called for the super class. Vice versa the super class’s template would be used in case a subclass template is not available. Note that this not only works for the target type, but for all parameters. Technically, the target type is handled as the first parameter.

So, assume you have the following metamodel:

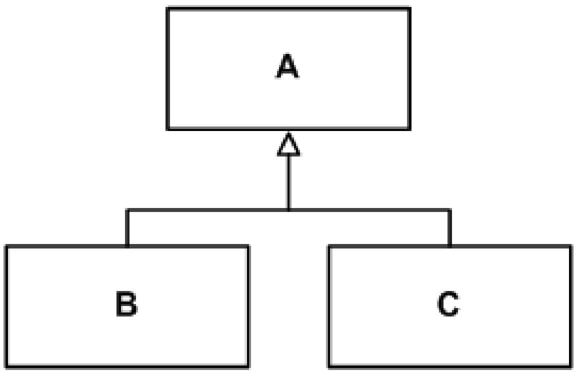


Figure 6.1. Sample metamodel

Assume further, you'd have a model which contains a collection of `A`, `B` and `C` instances in the property `listOfAs`. You can then write the following template:

```
«DEFINE someOtherDefine FOR SomeMetaClass»
   «EXPAND implClass FOREACH listOfAs»
«ENDDEFINE»
```

```
«DEFINE implClass FOR A»
   // this is the code generated for the super class A
«ENDDEFINE»

«DEFINE implClass FOR B»
   // this is the code generated for the subclass B
«ENDDEFINE»

«DEFINE implClass FOR C»
   // this is the code generated for the subclass C
«ENDDEFINE»
```

So for each `B` in the list, the template defined for `B` is executed, for each `C` in the collection the template defined for *C* is invoked, and for all others (which are then instances of `A`) the default template is executed.

6.5.3.4. FILE

The `FILE` statement redirects the output generated from its body statements to the specified target.

```
«FILE expression [outletName]»
   a sequence of statements
«ENDFILE»
```

The target is a file in the file system whose name is specified by the expression (relative to the specified target directory for that generator run). The expression for the target specification can be a concatenation (using the + operator). Additionally you can specify an identifier (a legal Java identifier) for the name of the outlet. (See the configuration section for a description of outlets).

The body of a `FILE` statement can contain any other statements. Example:

```
«FILE InterfaceName + ".java"»
   package «InterfacePackageName»;

   /* generated class! Do not modify! */
   public interface «InterfaceName» {
      «EXPAND Operation::InterfaceImplementation FOREACH  Operation»
   }
«ENDFILE»


«FILE ImplName + ".java" MY_OUTLET»
   package «ImplPackageName»;

   public class «ImplName» extends «ImplBaseName»
                           implements «InterfaceName» {
   //TODO: implement it
   }
«ENDFILE»
```

6.5.3.5. EXPAND

The `EXPAND` statement "expands" another `DEFINE` block (in a separate variable context), inserts its output at the current location and continues with the next statement. This is similar in concept to a subroutine call.

```
«EXPAND definitionName [(parameterList)]
   [FOR expression | FOREACH expression [SEPARATOR expression] ]»
```

The various alternative syntaxes are explained below.

6.5.3.5.1. Names

If the *definitionName* is a simple unqualified name, the corresponding `DEFINE` block must be in the same template file.

If the called definition is not contained in the same template file, the name of the template file must be specified. As usual, the double colon is used to delimit namespaces.

```
«EXPAND TemplateFile::definitionName FOR myModelElement»
```

Note, that you would need to import the namespace of the template file (if there is one). For instance, if the template file resides in the java package `my.templates`, there are two alternatives. You could either write

```
«IMPORT my::templates»
...
«EXPAND TemplateFile::definitionName FOR myModelElement»
```

or

```
«EXPAND my::templates::TemplateFile::definitionName
        FOR myModelElement»
```

6.5.3.6. FOR vs. FOREACH

If `FOR` or `FOREACH` is omitted the other template is called `FOR this`.

```
«EXPAND TemplateFile::definitionName»
```

equals

```
«EXPAND TemplateFile::definitionName FOR this»
```

If `FOR` is specified, the definition is executed for the result of the target expression.

```
«EXPAND myDef FOR entity»
```

If `FOREACH` is specified, the target expression must evaluate to a collection type. The other definition is executed for each element of that collection.

```
«EXPAND myDef FOREACH entity.allAttributes»
```

6.5.3.6.1. Specifying a Separator

If a definition is to be expanded `FOREACH` element of the target expression it's possible to specify a `SEPARATOR` expression:

```
«EXPAND paramTypeAndName FOREACH params SEPARATOR ″,″»
```

The result of the separator expression will be written to the output between each evaluation of the target definition (not *after* each one, but rather only in *between* two elements. This comes in handy for things such as comma-separated parameter lists).

An `EvaluationException` will be thrown if the specified target expression cannot be evaluated to an existing element of the instantiated model or no suitable `DEFINE` block can be found.

6.5.3.7. FOREACH

This statement expands the body of the `FOREACH` block for each element of the target collection that results from the expression. The current element is bound to a variable with the specified name in the current context.

```
«FOREACH expression AS variableName [ITERATOR iterName] [SEPARATOR expression]»
   a sequence of statements using variableName to access the
   current element of the iteration
«ENDFOREACH»
```

The body of a `FOREACH` block can contain any other statements; specifically `FOREACH` statements may be nested. If `ITERATOR` name is specified, an object of the type *xpand2::Iterator* (see API doc for details) is accessible using the specified name. The `SEPARATOR` expression works in the same way as the one for `EXPAND`.

Example:

```
«FOREACH {'A','B','C'} AS c ITERATOR iter SEPARATOR ','»
   «iter.counter1» : «c»
«ENDFOREACH»
```

The evaluation of the above statement results in the following text:

```
1 : A,
2 : B,
3 : C
```

6.5.3.8. IF

The `IF` statement supports conditional expansion. Any number of `ELSEIF` statements are allowed. The `ELSE` block is optional. Every `IF` statement must be closed with an `ENDIF`. The body of an `IF` block can contain any other statement, specifically, `IF` statements may be nested.

```
«IF expression»
   a sequence of statements
[ «ELSEIF expression» ]
   a sequence of statements ]
[ «ELSE»
   a sequence of statements ]
«ENDIF»
```

6.5.3.9. PROTECT

Protected Regions are used to mark sections in the generated code that shall not be overridden again by the subsequent generator run. These sections typically contain manually written code.

```
«PROTECT CSTART expression CEND expression ID expression (DISABLE)?»
   a sequence of statements
«ENDPROTECT»
```

The values of CSTART and CEND expressions are used to enclose the protected regions marker in the output. They should build valid comment beginning and end strings corresponding to the generated target language (e.g. *"/*"* and *"*/"* for Java). The following is an example for Java:

```
«PROTECT CSTART „/*“ CEND „*/“ ID ElementsUniqueID»
   here goes some content
```

```
«ENDPROTECT»
```

The `ID` is set by the `ID` expression and must be globally unique (at least for one complete pass of the generator).

Generated target code looks like this:

```
public class Person {
/*PROTECTED REGION ID(Person) ENABLED START*/
   this pr is enabled, therefore the contents will always be
   preserved. If you want to get the default contents from the
   template you must remove the ENABLED keyword (or even remove
   the whole file :-))
/*PROTECTED REGION END*/
}
```

Protected regions are generated in enabled state by default. Unless you manually disable them, by removing the `ENABLED` keyword, they will always be preserved.

If you want the generator to generate disabled protected regions, you need to add the `DISABLE` keyword inside the declaration:

```
«PROTECT CSTART '/*' CEND '*/' ID this.name DISABLE»
```

6.5.3.10. LET

`LET` lets you specify local variables. :-)

```
«LET expression AS variableName»
   a sequence of statements
«ENDLET»
```

During the expansion of the body of the `LET` block, the value of the expression is bound to the specified variable. Note that the expression will only be evaluated once, independent from the number of usages of the variable within the `LET` block. Example:

```
«LET packageName + "." + className AS fqn»
   the fully qualified name is: «fqn»;
«ENDLET»
```

6.5.3.11. ERROR

The `ERROR` statement aborts the evaluation of the templates by throwing an `XpandException` with the specified message.

```
«ERROR expression»
```

Note that you should use this facility very sparingly, since it is better practice to check for invalid models using constraints on the metamodel, and not in the templates.

6.5.3.12. Comments

Comments are only allowed outside of tags.

```
«REM»
   text comment
```

```
«ENDREM»
```

Comments may not contain a REM tag, this implies that comments are not nestable. A comment may not have a white space between the REM keyword and its brackets. Example:

```
«REM»«LET expression AS variableName»«ENDREM»
   a sequence of statements
«REM»  «variableName.stuff»
«ENDLET»«ENDREM»
```

6.5.3.13. Expression Statement

Expressions support processing of the information provided by the instantiated meta model. *Xpand* provides powerful expressions for selection, aggregation, and navigation. Xpand uses the expressions sub language in almost any statement that we have seen so far. The expression statement just evaluates the contained expression and writes the result to the output (using `java.lang.Object`'s `toString()` method). Example:

```
public class «this.name» {
```

All expressions defined by the oAW expressions sub language are also available in *Xpand*. You can invoke imported extensions. (See the *Expressions* and *Extend Language Reference* for more details).

6.5.3.14. Controlling generation of white space

If you want to omit the output of superfluous whitespace you can add a minus sign just before any closing bracket. Example:

```
«FILE InterfaceName + ".java"-»
«IF hasPackage-»
package «InterfacePackageName»;
«ENDIF-»
...
«ENDFILE»
```

The generated file would start with two new lines (one after the FILE and one after the IF statement) if the minus characters had not been set.

In general: If a statement (or comment) ends with such a minus all preceding whitespace up to the newline character (excluded!) is removed. Additionally all following whitespace including the first newline character (\r\n is handled as one character) is also removed.

6.5.4. Aspect-Oriented Programming in Xpand

Using the workflow engine it is now possible to package (*e.g.* zip) a written generator and deliver it as a kind of black box. If you want to use such a generator but need to change some small generation stuff, you can make use of the `AROUND` aspects.

```
«AROUND qualifiedDefinitionName(parameterList)? FOR type»
   a sequence of statements
«ENDAROUND»
```

`AROUND` lets you add templates in an non-invasive way (you don't need to touch the generator templates). Because aspects are invasive, a template file containing `AROUND` aspects must be wrapped by configuration (see next section).

6.5.4.1. Join Point and Point Cut Syntax

AOP is basically about weaving code into different points inside the call graph of a software module. Such points are called *Join Points*. In Xpand there is only one join point so far: a call to a definition.

You specify on which join points the contributed code should be executed by specifying something like a 'query' on all available join points. Such a query is called a *point cut*.

```
«AROUND [pointcut]»
   do stuff
«ENDAROUND»
```

A pointcut consists of a fully qualified name, parameter types and the target type.

6.5.4.1.1. Definition Name

The definition name part of a point cut must match the fully qualified name of the join point's definition. Such expressions are case sensitive. The asterisk character is used to specify wildcards.

Some examples:

```
my::Template::definition // definitions with the specified name
org::oaw::* // definitions prefixed with 'org::oaw::'
*Operation* // definitions containing the word 'Operation' in it.
*           // all definitions
```

6.5.4.1.2. Parameter Types

The parameters of the definitions we want to add our advice to can also be specified in the point cut. The rule is that the type of the specified parameter must be the same or a super type of the corresponding parameter type (the dynamic type at runtime!) of the definition to be called.

Additionally one can set the wildcard at the end of the parameter list to specify that there might be none or more parameters of any kind.

Some examples:

```
my::Templ::def() // templ def without parameters
my::Templ::def(String s) // templ def with exactly one parameter
                         // of type String
my::Templ::def(String s,*) // templ def with one or more parameters,
                           // where the first parameter is of type String
my::Templ::def(*) // templ def with any number of parameters
```

6.5.4.1.3. Target Type

Finally we have to specify the target type. This is straightforward:

```
my::Templ::def() FOR Object// templ def for any target type
my::Templ::def() FOR Entity// templ def objects of type Entity
```

6.5.4.2. Proceeding

Inside an advice you might want to call the underlying definition. This can be done using the implicit variable *targetDef*, which is of the type xpand2::Definition and provides an operation *proceed()* which invokes the underlying definition with the original parameters (Note that you might have changed any mutable object in the advice before).

If you want to control what parameters are to be passed to the definition you can use the operation *proceed(Object target, List params)*. There is no type checking here!

Additionally there are some inspection properties (like name, paramTypes, etc.) available.

6.5.5. Generator Workflow Component

This section describes the workflow component that is provided to perform the code generation, i.e. run the templates. You should have a basic idea of how the workflow engine works. (see *Workflow Reference*). A simple generator component configuration could look as follows:

```
<component class="oaw.xpand2.Generator">
   <fileEncoding value="ISO-8859-1"/>
   <metaModel class="oaw.type.emf.EmfMetaModel">
       <metaModelPackage value="org.eclipse.emf.ecore.EcorePackage"/>
   </metaModel>
   <expand value="example::Java::all FOR myModel"/>

   <!-- aop configuration -->
   <advices value='example::Advices1, example::Advices2'/>

   <!--  output configuration -->
   <outlet path='main/src-gen'/>
   <outlet name='TO_SRC' path='main/src' overwrite='false'/>
   <beautifier class="oaw.xpand2.output.JavaBeautifier"/>
   <beautifier class="oaw.xpand2.output.XmlBeautifier"/>

   <!-- protected regions configuration -->
   <prSrcPathes value="main/src"/>
   <prDefaultExcludes value="false"/>
   <prExcludes value="*.xml"/>
</component>
```

Let's go through the different properties one by one.

6.5.5.1. Main configuration

The first thing to note, is that the qualified Java name of the component is `org.openarchitectureware.xpand2.Generator2`. One can use the shortcut `oaw` instead of a preceding `org.openarchitectureware`. The workflow engine will resolve it.

6.5.5.2. Encoding

For *Xpand* it's important to have the file encoding in mind, because of the guillemet characters used to delimit keywords and property access. The `fileEncoding` property specifies the file encoding to use for reading the templates, reading the protected regions and writing the generated files. This property defaults to the default file encoding of your JVM.

6.5.5.3. Metamodel

The property `metaModel` is used to tell the generator engine on which metamodels the xpand templates should be evaluated. One can specify more than one metamodel here. Metamodel implementations are required by the expression framework (see *Expression Language Reference*) used by Xpand2. In the example above we configured the Ecore metamodel using the *EMFMetaModel* implementation shipped with the core part of the *openArchitectureWare* 4 release.

A mandatory configuration is the `expand` property. It expects a syntax similar to that of the `EXPAND` statement (described above). The only difference is that we omit the `EXPAND` keyword because we write it as the property's name. Examples:

```
<expand value="Template::define FOR mySlot"/>
```

or:

```
<expand value="Template::define('foo') FOREACH {mySlot1,mySlot2}"/>
```

The expressions are evaluated using the workflow context. Each slot is mapped to a variable. For the examples above the workflow context needs to contain elements in the slots `'mySlot'`, `'mySlot1'` and `'mySlot2'`. It's also possible to specify some complex expressions here. If, for instance, the slot `myModel` contains a collection of model elements one could write:

```
<expand value="Template::define FOREACH myModel.typeSelect(Entity)"/>
```

This selects all elements of type *Entity* contained in the collection stored in the `myModel` slot.

6.5.5.4. Output configuration

The second mandatory configuration is the specification of so called outlets (a concept borrowed from AndroMDA). Outlets are responsible for writing the generated files to disk . Example:

```
<component class="oaw.xpand2.Generator2">
   ...
   <outlet path='main/src-gen'/>
   <outlet name='TO_SRC' path='main/src' overwrite='false'/>
   ...
</component>
```

In the example there are two outlets configured. The first one has no name and is therefore handled as the default outlet. Default outlets are triggered by omitting an outlet name:

```
«FILE 'test/note.txt'»
# this goes to the default outlet
«ENDFILE»
```

The configured base path is 'main/src-gen', so the file from above would go to 'main/src-gen/test/note.txt'.

The second outlet has a `name` ('TO_SRC') specified. Additionally the flag `overwrite` is set to false (defaults to true). The following Xpand fragment

```
«FILE 'test/note.txt' TO_SRC»
# this goes to the TO_SRC outlet
«ENDFILE»
```

would cause the generator to write the contents to 'main/src/test/note.txt' if the file does not already exist (the overwrite flag).

Another option called `append` (defaults to `false`) causes the generator to append the generated text to an existing file. If `overwrite` is set to false this flag has no effect.

6.5.5.5. Beautifier

Beautifying the generated code is a good idea. It's very important, that generated code look good, because developers should be able to understand it. On the other hand template files should look good, too. It is thus best practice to write nice looking template files and not to care how the generated code looks – and then you run a beautifier over the generated code to fix that problem. Of course, if a beautifier is not available, or if white space has syntactical meaning (as in Python), you would have to write your templates with that in mind (using the minus character before closing brackets as described in a preceding section).

The *Xpand* workflow component can be configured with multiple beautifiers:

```
<beautifier
   class="org.openarchitectureware.xpand2.output.JavaBeautifier"/>
<beautifier
   class="org.openarchitectureware.xpand2.output.XmlBeautifier"/>
```

These are the two beautifiers delivered with *Xpand*. If you want to use your own beautifier, you would just need to implement the following Java interface:

```
package org.openarchitectureware.xpand2.output;

public interface PostProcessor {
   public void beforeWriteAndClose(FileHandle handle);
   public void afterClose(FileHandle handle);
}
```

The `beforeWriteAndClose` method is called for each `ENDFILE` statement.

6.5.5.5.1. JavaBeautifier

The JavaBeautifier is based on the Eclipse Java formatter provides base beautifying for Java files.

6.5.5.5.2. XmlBeautifier

The XmlBeautifier is based on dom4j and provides a single option `fileExtensions` (defaults to ".xml, .xsl, .wsdd, .wsdl") used to specify which files should be pretty printed.

6.5.5.6. Protected Region Configuration

Finally you need to configure the protected region resolver, if you want to use protected regions.

```
<prSrcPaths value="main/src"/>
<prDefaultExcludes value="false"/>
<prExcludes value="*.xml"/>
```

The *prSrcPaths* property points to a comma-separated list of directories. The protected region resolver will scan these directories for files containing activated protected regions.

There are several file names which are excluded by default:

```
RCS, SCCS, CVS, CVS.adm, RCSLOG, cvslog.*, tags, TAGS, .make.state, .nse_depinfo, *~, #*,
.#*, ',*', _$*,*$, *.old, *.bak, *.BAK, *.orig, *.rej, .del-*, *.a, *.olb, *.o, *.obj,
 *.so, *.exe, *.Z,* .elc, *.ln, core, .svn
```

If you don't want to exclude any of these, you must set `prDefaultExcludes` to false.

```
<prDefaultExcludes value="false"/>
```

If you want to add additional excludes, you should use the prExcludes property.

```
<prExcludes value="*.xml,*.hbm"/>
```

Note: It's bad practice to mix generated and non-generated code in one artifact... Instead of using protected regions, you should try to leverage the target language's extension features (inheritance, inclusion, references, etc.) wherever possible. It is very rare that the use of protected regions is an appropriate solution.

6.5.6. Example for AOP and Xpand

This example shows how to use aspect oriented programming techniques in Xpand templates. It is applicable to EMF based and Classic systems. However, we explain the idea based on the *emfExample* – hence you should read that before.

6.5.7. The Problem

There are many circumstances when template-AOP is useful. Here are two examples:

Scenario 1: Assume you have a nice generator that generates certain artefacts. The generator (or cartridge) might be a third-party product, delivered in a single JAR file. Still you might want to adapt certain aspects of the generation process – *without modifying the original generator*.

Scenario 2: You are building a family of generators that can generate variations of the generate code, e.g. implementations for different embedded platforms. In such a scenario, you need to be able to express those differences (variabilities) sensibly without creating a non-understandable chaos of *if* statements in the templates.

6.5.8. Example

To illustrate the idea of extending a generator without "touching" it, let's create a new project called `oaw4.demo.emf.datamodel.generator-aop`. The idea is that it will "extend" the original `oaw4.demo.emf.datamodel.generator` project introducedin the *emfExample*. So this new projects needs to have a project dependency to the former one.

6.5.8.1. Templates

An AO system always needs to define a joinpoint model; this is, you have to define, at which locations of a (template) program you can add additional (template) code. In Xpand, the joinpoints are simply templates (i.e. *DEFINE .. ENDDEFINE*) blocks. An "aspect template" can be declared *AROUND* previously existing templates. If you take a look at the `oaw4.demo.emf.datamodel.generator` project's source folder, you can find the `Root.xpt` template file. Inside, you can find a template called `Impl` that generates the implementation of the Java Bean.

```
«DEFINE Entity FOR data::Entity»
   «FILE baseClassFileName() »
      // generated at «timestamp()»
      public abstract class «baseClassName()» {
         «EXPAND Impl»
      }
   «ENDFILE»
«ENDDEFINE»
```

```
«DEFINE Impl FOR data::Entity»
   «EXPAND GettersAndSetters»
«ENDDEFINE»

«DEFINE Impl FOR data::PersistentEntity»
   «EXPAND GettersAndSetters»
    public void save() {

   }
«ENDDEFINE»
```

What we now want to do is as follows: Whenever the *Impl* template is executed, we want to run an additional template that generates additional code (for example, some kind of meta information for frameworks ... the specific code is not important for the example here).

So, in our new project, we define the following template file:

```
«AROUND Impl FOR data::Entity»
   «FOREACH attribute AS a»
      public static final AttrInfo «a.name»Info = new AttrInfo(
         "«a.name»", «a.type».class );
   «ENDFOREACH»
   «targetDef.proceed()»
«ENDAROUND»
```

So, this new template "wraps around" the exiting template called `Impl` It first generates additional code and then forwards the execution to the original template using `targetDef.proceed()`. So, in effect, this is a *BEFORE* advice. Moving the proceed statement to the beginning makes it an *AFTER* advice, ommitting it makes it an override.

6.5.8.2. Workflow File

Let's take a look at the workflow file to run this generator.

```
<workflow>
   <cartridge file="workflow.oaw"/>
   <component adviceTarget="generator"
              id="reflectionAdvice"
              class="oaw.xpand2.GeneratorAdvice">
      <advices value="templates::Advices"/>
   </component>
</workflow>
```

Mainly what we do here is to call the original workflow file. It is available from the classpath. After this cartridge call, we define an additional workflow component, a socalled advice component. It specifies *generator* as it's *adviceTarget*. That means that all the properties we define inside this advice component will instead be added to the component referenced by name in the *adviceTarget*, in our case the generator. So, in effect, we add the <advices value="templates::Advices" /> to the original generator component (without invasively modifying its own definition! This contributes the advice templates to the generator.

6.5.8.3. Running the new generator

Running the generator produces the following code:

```
public abstract class PersonImplBase {
   public static final AttrInfo
      nameInfo = new AttrInfo("name", String.class);
   public static final AttrInfo
      name2Info = new AttrInfo("name2", String.class);
   private String name;
   private String name2;

   public void setName(String value) {
      this.name = value;
   }

   public String getName() {
      return this.name;
   }

   public void setName2(String value) {
      this.name2 = value;
   }

   public String getName2() {
      return this.name2;
   }
}
```

6.5.9. More AO

In general, the syntax for the *AROUND* construct is as follows:

```
<<AROUND fullyQualifiedDefinitionNameWithWildcards
      (Paramlist (*)?) FOR TypeName>>
   do Stuff
<<ENDAROUND>>
```

Here are some examples:

```
<<AROUND *(*) FOR Object>>
```

matches all templates

```
<<AROUND *define(*) FOR Object>>
```

matches all templates with *define* at the end of it's name and any number of parameters

```
<<AROUND org::oaw::* FOR Entity>>
```

matches all templates with namespace *org::oaw::* that do not have any parameters and whose type is Entity or a subclass

```
<<AROUND *(String s) FOR Object>>
```

matches all templates that have exactly one `String` parameter

```
<<AROUND *(String s,*) FOR Object>>
```

matches all templates that have at least one `String` parameter

```
<<AROUND my::Template::definition(String s) FOR Entity>>
```

matches exactly this single definition

Inside an *AROUND*, there's the variable *targetDef*, which has the type `xpand2::Definition`. On this variable you can call proceed, and also query a number of other things:

```
<<AROUND my::Template::definition(String s) FOR String>>
   log('invoking '+<<targetDef.name>>+' with '+this)
   <<targetDef.proceed()>>
<<ENDAROUND>>
```

6.6. Built-in types API documentation

6.6.1. `Object`

Super type: none

Table 6.1. Properties

Type	Name	Description
`oaw::Type`	`metaType`	returns this object's meta type.

Table 6.2. Operations

Return type	Name	Description
`Boolean`	`<` (`Object`)	
`Boolean`	`!=` (`Object`)	
`Boolean`	`>=` (`Object`)	
`Boolean`	`<=` (`Object`)	
`Boolean`	`>` (`Object`)	
`Integer`	`compareTo` (`Object`)	Compares this object with the specified object for order. Returns a negative integer, zero, or a positive integer as this object is less than, equal to, or greater than the specified object.
`Boolean`	`==` (`Object`)	
`String`	`toString` ()	returns the String representation of this object. (Calling Java's toString() method)

6.6.2. `String`

Super type: `Object`

Table 6.3. Properties

Type	Name	Description
`Integer`	`length`	the length of this string

Table 6.4. Operations

Return type	Name	Description
`String`	`toUpperCase` ()	Converts all of the characters in this String to upper case using the rules of the default locale (from Java)
`String`	`toLowerCase` ()	Converts all of the characters in this String to lower case using the rules of the default locale (from Java)
`List`	`split` (`String`)	Splits this string around matches of the given regular expression (from Java 1.4)
`String`	`trim` ()	Returns a copy of the string, with leading and trailing whitespace omitted. (from Java 1.4)
`String`	`+` (`Object`)	concatenates two strings
`String`	`replaceAll` (`String`, `String`)	Replaces each substring of this string that matches the given regular expression with the given replacement.
`String`	`subString` (`Integer`, `Integer`)	Tests if this string ends with the specified prefix.
`Boolean`	`endsWith` (`String`)	Tests if this string ends with the specified prefix.
`Integer`	`asInteger` ()	Returns an Integer object holding the value of the specified String (from Java 1.5)
`Boolean`	`contains` (`String`)	Tests if this string contains substring.
`String`	`toFirstUpper` ()	Converts the first character in this String to upper case using the rules of the default locale (from Java)
`String`	`toFirstLower` ()	Converts the first character in this String to lower case using the rules of the default locale (from Java)
`String`	`replaceFirst` (`String`, `String`)	Replaces the first substring of this string that matches the given regular expression with the given replacement.
`Boolean`	`startsWith` (`String`)	Tests if this string starts with the specified prefix.
`List`	`toCharList` ()	splits this String into a List[String] containing Strings of length 1
`Boolean`	`matches` (`String`)	Tells whether or not this string matches the given regular expression. (from Java 1.4)

6.6.3. `Integer`

Super type: `Real`

Table 6.5. Operations

Return type	Name	Description
`Boolean`	`<=` (`Object`)	
`Integer`	`+` (`Integer`)	
`Integer`	`*` (`Integer`)	
`Boolean`	`>` (`Object`)	
`List`	`upTo` (`Integer`, `Integer`)	returns a List of Integers starting with the value of the target expression, up tothe value of the first parameter, incremented by the second parameter. E.g. '1.upTo(10, 2)' evaluates to {1,3,5,7,9}
`Boolean`	`!=` (`Object`)	
`Integer`	`/` (`Integer`)	
`Integer`	`-` ()	
`List`	`upTo` (`Integer`)	returns a List of Integers starting with the value of the target expression, up tothe value of the specified Integer, incremented by one. e.g. '1.upTo(5)' evaluates to {1,2,3,4,5}
`Boolean`	`<` (`Object`)	
`Integer`	`-` (`Integer`)	
`Boolean`	`==` (`Object`)	
`Boolean`	`>=` (`Object`)	

6.6.4. `Boolean`

Super type: `Object`

Table 6.6. Operations

Return type	Name	Description
`Boolean`	`!` ()	

6.6.5. `Real`

Super type: `Object`

Table 6.7. Operations

Return type	Name	Description
`Boolean`	`==` (`Object`)	
`Boolean`	`!=` (`Object`)	
`Boolean`	`<=` (`Object`)	
`Real`	`/` (`Real`)	
`Boolean`	`<` (`Object`)	
`Real`	`*` (`Real`)	
`Boolean`	`>` (`Object`)	
`Real`	`-` ()	
`Real`	`-` (`Real`)	
`Boolean`	`>=` (`Object`)	
`Real`	`+` (`Real`)	

6.6.6. `Collection`

Super type: `Object`

Table 6.8. Properties

Type	Name	Description
`Integer`	`size`	returns the size of this Collection
`Boolean`	`isEmpty`	returns true if this Collection is empty

Table 6.9. Operations

Return type	Name	Description
`Collection`	`remove` (`Object`)	removes the specified element from this Collection if contained (modifies it!). returns this Collection.
`Set`	`toSet` ()	converts this collection to Set
`List`	`toList` ()	converts this collection to List
`Boolean`	`containsAll` (`Collection`)	returns true if this collection contains each element contained in the specified collection. otherwise false. returns this Collection.
`Collection`	`removeAll` (`Object`)	removes all elements contained in the specified collection from this Collection if contained (modifies it!). returns this Collection.
`Collection`	`addAll` (`Collection`)	adds all elements to the Collection (modifies it!). returns this Collection.
`String`	`toString` (`String`)	concatenates each contained element (using toString()), separated by the specified String.
`Boolean`	`contains` (`Object`)	returns true if this collection contains the specified object. otherwise false. returns this Collection.
`Set`	`intersect` (`Collection`)	returns a new Set, containing only the elements contained in this and the specified Collection
`Set`	`without` (`Collection`)	returns a new Set, containing all elements from this Collection without the elements from specified Collection
`List`	`flatten` ()	returns a flatten List.
`Set`	`union` (`Collection`)	returns a new Set, containing all elements from this and the specified Collection
`Collection`	`add` (`Object`)	adds an element to the Collection (modifies it!). returns this Collection.

6.6.7. `List`

Super type: `Collection`

Table 6.10. Operations

Return type	Name	Description
`Object`	`last` ()	
`Object`	`first` ()	
`Integer`	`indexOf` (`Object`)	
`Object`	`get` (`Integer`)	
`List`	`withoutLast` ()	
`List`	`withoutFirst` ()	

6.6.8. `Set`

Super type: `Collection`

6.6.9. `oaw::Type`

Super type: `Object`

Table 6.11. Properties

Type	Name	Description
`String`	`name`	
`Set`	`superTypes`	
`Set`	`allProperties`	
`Set`	`allFeatures`	
`Set`	`allOperations`	
`Set`	`allStaticProperties`	
`String`	`documentation`	

Table 6.12. Operations

Return type	Name	Description
`oaw::Property`	`getProperty` (`String`)	
`oaw::Operation`	`getOperation` (`String`, `List`)	
`oaw::StaticProperty`	`getStaticProperty` (`String`)	
`oaw::Feature`	`getFeature` (`String`, `List`)	
`Boolean`	`isAssignableFrom` (`oaw::Type`)	
`Boolean`	`isInstance` (`Object`)	
`Object`	`newInstance` ()	

6.6.10. `oaw::Feature`

Super type: `Object`

Table 6.13. Properties

Type	Name	Description
`oaw::Type`	`owner`	
`oaw::Type`	`returnType`	
`String`	`documentation`	
`String`	`name`	

6.6.11. `oaw::Property`

Super type: `oaw::Feature`

Table 6.14. Operations

Return type	Name	Description
`Void`	`set` (`Object`, `Object`)	
`Object`	`get` (`Object`)	

6.6.12. `oaw::Operation`

Super type: `oaw::Feature`

Table 6.15. Operations

Return type	Name	Description
`Object`	`evaluate` (`Object`, `List`)	
`List`	`getParameterTypes` ()	

6.6.13. `oaw::StaticProperty`

Super type: `oaw::Feature`

Table 6.16. Operations

Return type	Name	Description
`Object`	`get` ()	returns the static value

6.6.14. `Void`

Super type: `Object`

6.6.15. `xtend::AdviceContext`

Super type: `Object`

Table 6.17. Properties

Type	Name	Description
`List`	`paramNames`	
`String`	`name`	
`List`	`paramTypes`	
`List`	`paramValues`	

Table 6.18. Operations

Return type	Name	Description
`Object`	`proceed` ()	
`Object`	`proceed` (`List`)	

6.6.16. `xpand2::Definition`

Super type: `Object`

Table 6.19. Properties

Type	Name	Description
`List`	`paramNames`	
`List`	`paramTypes`	
`oaw::Type`	`targetType`	
`String`	`name`	

Table 6.20. Operations

Return type	Name	Description
`String`	`toString` ()	
`Void`	`proceed` (`Object`, `List`)	
`Void`	`proceed` ()	

6.6.17. `xpand2::Iterator`

Super type: `Object`

Table 6.21. Properties

Type	Name	Description
`Boolean`	`firstIteration`	
`Boolean`	`lastIteration`	
`Integer`	`counter1`	
`Integer`	`elements`	
`Integer`	`counter0`	

Chapter 7. Xtext Reference (from oAW 4.2)

7.1. Introduction

Does this sound familiar to you?

Oh, I need to rename this misspelled property within our domainmodel. Ok, so let's startup this big UML monster... and by the way let's get a new cup of coffee. Cool, it has been started up already. Grabbing the mouse, clicking through the different diagrams and graph visualizations... Ahhh, there is the name of the property right down there in the properties view. Let's change it, export it to XMI (...drinking coffee), starting the oAW generator (in a jiffy ;-)). Oh, it's not allowed for the property to be named that way, a constraint says that properties names should start with a lower case letter. Ok, let's change that and again reexport...

Some moments later, everything seems to works (tests are green). Ok let's check it in!

Oh someoneelse has also modified the model! Aaarrrgggh....

Think of this:

Want to change a properties name? Ok, open the respective text file, rename the properties name and save it. The editor complains about a violated constraint. Ok fix the issue, save again and generate. Check the changes into SVN (CVS). Oh there is a conflict, ok, let's simply merge it using Diff.

And now? Let's have a cup of coffee :-)

Xtext is a textual DSL development framework. Providing the ability to describe your DSL using a simple EBNF notation. Xtext will create a parser, a metamodel and a specific Eclipse texteditor for you!

7.2. Installation

Xtext is contained in the openArchitectureWare SDK. The easiest way to install is to download and unzip the "Eclipse 3.3 for RCP/Plug-in Developers" from eclipse's download site (http://www.eclipse.org/downloads/).

Afterwards download the org.openarchitectureware.all_in_one_feature-4.2.0.*.zip release and extract it to the directory where you have unziped the Eclipse release (i.e. the Eclipse installation dir).

Make sure that you start Eclipse with a Java VM Version greater than 5.0.

7.3. Getting started

You should have a look at the Xtext tutorial screencast (TODO link to screencast). This will give you a good overview of how Xtext basically works. Come back to this document to find out about additional details.

7.4. The Grammar Language

At the heart of Xtext lays its grammar language. It's a lot like an extended Backus-Naur-Form but it not only describes the concrete syntax, but also the abstract syntax (metamodel).

A grammar file consists of a list of so called *Rules*.

7.4.1. Example

This is an example for a *Rule* describing something called an entity :

```
Entity :
  "entity" name=ID "{"
    (features+=Feature)+
  "}"
```

Entity is both the name of the rule and the name of the metatype corresponding to this rule. After the colon the description of the rule is following. A description is made up of *tokens*. The first token is a *KeywordToken* which says that a description of an entity starts with the keyword *entity*. A so called *Assignment* follows (name=ID).

The left hand refers to a property of the Metatype (in this case it's the property *name* of type *Entity*). The left hand side is a call to the built-in token ID. Which means Identifier and allows character sequences of the form ('a-zA-Z_' ('a-zA-Z_0-9)*). The parser will assign ('=') the Identifier to the specified property (name).

Then (enclosed in curly brackets ("{" and "}" both are essentially keyword tokens)) one or more features can be declared (*(features+=Feature)+*). This one again is an assignment. This time the token points to another rule (called *Feature*) and each feature is added (note += operator) to the Entity's reference called *features*.

The Feature rule itself could be described like this:

```
Feature :
  type=ID name=ID ";"
```

so that the following description of an entity would be valid according to the grammar:

```
entity Customer {
  String name;
  String street;
  Integer age;
  Boolean isPremiumCustomer;
}
```

Note, that the types (String, Integer, Boolean) used in this description of a customer, are simple identifiers, they don't have been mapped to e.g. Java types or something else. So according to the grammar this would also be valid, so far:

```
entity X {
  X X;
  X X;
  X X;
  cjbdlfjerifuerfijerf dkjdhferifheirhf;
}
```

7.4.2. How the parsers work in general

As stated before the grammar is not only used as input for the parser generator but it is also used to compute a meta model for your DSL. We will first talk about how an Xtext parser works in general, before we look at how a meta model is beeing constructed.

The parsing of text is devided in two separate tasks the lexing and the parsing.

The lexer is responsible of creating a sequence of tokens from a character stream. Such tokens are identifiers, keywords, whitespace, comments, operators, etc. Xtext comes with a set of built-in lexer rules which can be extended or overwritten if necessary. You have already seen some of them (e.g. ID).

The parser get's the stream of tokens and creates a parse tree out of them. The type rules from the example are essentially parser rules.

Now let's have a look at how the meta model is constructed.

7.4.3. Type Rules

We've already seen how the Type Rules works in general. The rule's name is used as the name of the meta type generated by Xtext.

7.4.3.1. Assignment tokens / Properties

Each assignment token within an Xtext grammar is not only used to create a corresponding assignment action in the parser but also to compute the properties of the current meta type.

Properties can refer to the simple types such as String, Boolean or Integer as well as to other complex meta types (i.e. other rules). It depends on the assignment operator and the type of the token on the right what the type actually is.

There are three different assignment operators:

- Standard assignment '=' : The type will be computed from the token on the right.
- Boolean assignment '?=' : The type will be Boolean
- Add assignment '+=' : The type will be List. The list's inner type depends on the type returned by the token on the right.

Example:

```
Entity :
  (isAbstract?="abstract")? "entity" name=ID "{"
     (features+=Feature)*
  "}";
```

The meta type entity will have three properties:

1) Boolean isAbstract

2) String name

3) List[Feature] features

7.4.3.2. Cross References

Parsers construct parse trees not graphs. This means that the outcome of a parser has no crossreferences only so called containment references (Composition).

In order to get cross links in your model, one usually has to add third task : the linking. However, Xtext supports specifying the linking information in the grammar, so that the meta model contains cross references and the generated linker links the model elements automatically (for most cases). Linking semantic can be arbritrary complex. Xtext generates a default semantic (find by id) which can be selektively overwritten. We will see how this can be done later in this document.

Let's concentrate on what the grammar language supports:

```
Entity :
  "entity" name=ID ("extends" superType=[Entity])?
  "{"
     (features+=Feature)*
  "}";
```

Have a look at the optional extends clause. Therein the rule name on the right is surrounded by squared paranthesis. That's it.

By default the parser expects an ID to point to the refered element. If you want to refer with another klind of token you can optionally specifiy it sepearted by a vertical bar:

```
 ... ("extends" superType=[Entity|MyComplexTokenRule])? ...
```

Where MyComplexTokenRule must be either a NativeLexerRule or a StringRule (explaination follows).

7.4.3.3. Meta Type Inheritance

We've seen how to define simple concrete meta types it's features. One can also define type hierarchies using Xtext's grammar language. Sometimes you want to abstract rules, in order to let a feature contain elements of different types.

We have seen the Feature rule in the example. If you would like to have two different kinds of Feature (e.g. Attribute and Reference) you could create an abstract type rule like this:

```

Feature :
  Attribute | Reference;

Attribute :
  type=ID name=ID ";";

Reference :
  "ref" (containment?"+")? type=ID name=ID ("<->" oppositeName=ID)? ";";

```

The transformation creating the meta model automatically normalizes the type hierarchy. This means that properties defined in all subtypes will automatically be moved to the common super type. In this case the abstract type 'Feature' would be created containing the two features (*name* and *type*). Attribute and Reference would be subtypes of Feature inheriting those properties.

It is also possible to define concrete supertypes like this:

```
Feature :
  type=ID name=ID ";" | Reference;

Reference :
  "ref" (containment?"+")? type=ID name=ID ("<->" oppositeName=ID)? ";";
```

In this case Feature wouldn't be abstract but would be the supertype of Reference.

If you need multiple inheritance you can simply add an abstract rule. Such a rule must not be called from anothe rule.

Example:

```
Model : TypeA TypeA TypeC;

TypeA : "A" | TypeB;
TypeB : "B";
TypeC : "C";

CommonSuper : TypeB | TypeC; // just for the typehierarchy
```

The resulting type hierarchy will look like this:

- Model

- TypeA

- TypeB extends TypeA, CommonSuper

- TypeC extends CommonSuper

- CommonSuper

7.4.4. Enum Rule

The enum rule is used to define enumerations. For example if you would like to hardwire the possible datatypes for attributes into the language you could just write:

```
Attribute :
  type=DataType name=ID ";";

Enum DataType :
  String="string"|Integer="int"|Boolean="bool";
```

So that this would be valid:

```
entity Customer {
  string name;
  string street;
  int age;
  bool isPremiumCustomer;
}
```

but this would not

```
entity Customer {
  X name; // type X is not known
  String street; // type String is not known (case sensitivity!)
}
```

7.4.5. String Rule

Xtend provides built-in Tokens (we have already seen the

IdentifierToken
and the

KeywordToken
). Sometimes this is not sufficient, so we might want to create our own Tokens. Therefore we have the so called

String Rule
, which is implemented as a parser rule (it's not a lexer rule!).

Example

```
String JavaIdentifier :
  ID ("." ID)*;
```

The contents of the String Rule is simply concatenated and returned as a string. One can refer to a String Rule in the same manner we refere to any other rule.

So just for the case you want to declare datatypes using your DSL and therein specify how it is mapped to Java (not Platform independent, i know, but expressive and pragmatic), you could do so using the following rules.

```
Attribute :
  type=DataType name=ID ";";

DataType :
  "datatype" name=ID "mappedto" javaType=JavaIdentifier;

String JavaIdentifier :
  ID ("." ID)*;
```

A respective model could look like this:

```
entity Customer {
  string name;
  string street;
  int age;
  bool isPremiumCustomer;
}

datatype string mappedto java.util.String
datatype int mappedto int
datatype bool mappedto boolean
```

You could of course point to a custom typemapping implementation, if you need to support multiple platforms (like e.g. SQL, WSDL, Java,...). Additionally you should consider to define the datatypes in a separate file, so the users of your DSL can import and use them.

7.5. Lexer Rules

As mentioned before we Xtext provides some common built-in lexer rules. Let's start with the two simplest.

7.5.1. Keyword Token

All static characters or words (keywords) can be specified directly in the grammar using the usual string literal syntax. We never need the value of keyword because we know it (it's static). But sometimes there are optional keywords like e.g. the modifiers in Java. The existence of a keyword can be assigned using the boolean assignment operator "?". However, if you want to assign the value of the keyword to a property just use the assignment operator '='.

Example:

```
Entity :
  (abstract?"abstract")? "entity" name=ID ("<" extends=ID)?
  "{"
    (features+=Feature)*
  "}";
```

With this the type

Entity
will have the boolean property

abstract
, which is set to true if the respective keyword has been specified for an entity. (I've added the extends part, because an abstract entity wouldn't make sense without inheritance).

Note that operators such as '<' in the example are keywords, too.

7.5.2. Identifier Token

We also have seen the identifier token (ID). This is the token rule expressed in Antlr grammar syntax:

```
('^')?('a'..'z'|'A'..'Z'|'_') ('a'..'z'|'A'..'Z'|'_'|'0'..'9')*
```

So an identifier is a word starting with a character or underscore followed by optionally additional characters, underscores or digits. The return value of the Identifier token is a String. So if you use the usual assignment operator „=“, the feature the value is assigned to will be of type String. You could also use the boolean operator and the type will be Boolean.

If an identifier conflicts with a keyword or another lexer rule, it can be escaped with the '^' character.

7.5.3. String Token

There is also a built-in String Token. Here is an example:

```
Attribute :
   type=DataType name=ID (description=STRING)? ";";
```

With this one can optionally specify a description for an entity like this:

```
entity Customer {
  string name ;
  string street "should include the street number, too.";
  int age;
  bool isPremiumCustomer;
}
```

By default the two string literal syntaxes "my text" and 'my text' are supported. Note that unlike in Java also multiline strings are supported:

```
entity Customer {
  string name ;
  string street "should include the street number, too.
                 And if you don't want to specify it, you
                 should consider specifying it somewhere else.";
  int age;
  bool isPremiumCustomer;
}
```

7.5.4. Integer Token

Sometimes you want to assign Integers. Xtext supports it with the built-in lexer rule INT.

```
Index:
  "#" index=INT;
```

The default pattern is :

```
('-')?('0'..'9')+
```

It can be overwritten (see next section), but you have to take car that the coercion (*Integer.valueOf(String)* is used) works.

7.5.5. Comments

There are two different kinds of comments automatically available in any Xtext language.

```
// single-line comments and

/*
  mutli-line comments
*/
```

Note that those comments are ignored by the language's parser by default (i.e. they are not contained in the AST returned from the parser).

If you don't want ignored comments, or you ant to have a different syntax you need to overwrite the default implementation (name is SL_COMMENT resp. ML_COMMENT).

7.5.6. Whitespace

Every textual model contains whitespace. As most languages simply ignore whitespace, Xtext does so by default, too. If you want to have semantic whitespace in your language (like e.g. python), you have to overwrite the builtin whitespace rule (name is WS).

7.5.7. Native rules / Overwriting built-in lexer rules

If you want to overwrite one or more of the built-in lexer rules or add an additional one, the so called native rule is your friend.

Example:

```
// overwriting SL_COMMENTS we don't want Java syntax (//) but bash syntax (#)
Native SL_COMMENT :
  "'#' ~('\n'|'\r')* '\r'? '\n' {$channel=HIDDEN;}";

// fully qualified names as a lexer rule
Native FQN :
  "ID ('.' ID)*";
```

The syntax is :

```
"Native" ID ":"
   STRING // The string contains a valid ANTLR 3 lexer rule expression (see http://www.antlr.org/wiki/display/AN
   ";"
```

7.6. The generator

It's assumed that you've used the Xtext Projects Wizard and that you have successfully written an Xtext grammar file describing your little language. Next up you need to start Xtext's generator in order to get a parser, a metamodel and an editor. To do so just right-click the workflow file `(*.oaw)` located next to the grammar file and choose "Run As" -> "Run Workflow" (in Eclipse, of course). The generator will read the grammar file in and create a bunch of files. Some of them located in the `src-gen` directories others located in the `src` directory.

*IMPORTANT : You should now (after first generation) open the *.properties file and set the "overwritePluginRes=true" option to false!*

7.6.1. Configuring the generator

The generator can be configured with the following properties definied in `generate.properties`:

property name (default)	description
grammar	The grammar file to generate the code from.
debug.grammar (false)	Specifies whether a debug grammar should be generated. A debug grammar is an antlr grammar without any action code, so it can be interpreted within Antlrworks.
language.name	The name of the DSL. Is used throughout the generated code
language.nsURI ("http://www.oaw.org/xtext/dsl/${language.name}")	A unique URI used within the derived ecore package.
language.fileextension ("${language.name}")	The file extension the generated editor is configured for.
overwrite.pluginresources ("false")	If this is set to true the plugin resources (META-INF/MANIFEST.MF, plugin.xml) will be overwritten by the generator!!!
wipeout.src-gen ("true")	Specifies whether the src-gen folders should be deleted before generation.
generator.project.name ("")	If this property is set to something, a project wizard will be generated referencing the generator project.
workspace.dir	The root of the workspace.
core.project.name	name of the main project
core.project.src ("src/")	src folder of the main project
core.project.src.gen ("src-gen/")	src-gen folder of the main project
editor.generate ("true")	should an editor be generated at all
editor.project.name ("${core.project.name}.editor")	name of the editor project
editor.project.src ("${core.project.src}")	src folder of the editor project
editor.project.src.gen ("${core.project.src.gen}")	src-gen folder of the editor project

7.6.2. Generated and manual code

Any textual artifacts located in the `src` dir (of any project) will always stay untouched. The generator just creates them the first time when they don't exist.

Files generated to the `src-gen` directory should never be touched! The whole directory will be wiped out the next time one starts the generator.

7.6.3. The different projects and artifacts

Xtext generates artifact into two different projects.

7.6.3.1. The main project

The name of the main project can be specified in the wizard. This project contains the main language artifacts and is 100% eclipse independent. The default locations of the most important resources are:

Location	Description
src/[dslname].xtxt	The grammar file, containing the grammar rules describing your DSL
src/generate.oaw	The workflow file for the Xtext generator.
src/generator.properties	Properties passed to the Xtext generator
src/[base.package.name]/Checks.chk	The Check-file used by the parser and within the editor. Used to add semantic constraints to your language.
src-gen/[base.package.name]/ GenChecks.chk	The generated Check-file contains checks automatically derived from the grammar.
src/[base.package.name]/ Extensions.ext	The Extension-file is used (imported) by all aother extensions and check files. It reexports the extensions from `GenExtensions.ext` (contained in src-gen/). You can specify (use more conrete parameter types) or overwrite (use the same signature) the extensions from `GenExtensions.ext` here.
src-gen/[base.package.name]/ GenExtensions.ext	generated extensions (reexported by `Extensions.ext`).
src/[base.package.name]/Linking.ext	Used by `Linker.ext` from *`src-gen/[base.package.name]/parser/Linker.ext`* Default linking semantic is generated in `GenLinking.ext` (src.gen/) and can be overwritten here.

src-gen/[base.package.name]/ GenLinking.ext	Contains the default linking semantic for each cross reference.
	
	Example:
	
	`Void link_featureName(my::MetaType this) :`
	`   (let ents = this.allElements().typeSelect(my::ReferredType) :`
	`   this.setFeatureName(ents.select(e|e.id()`
	`     == this.parsed_featureName).first()) );`
	
	This is:
	
	Get all instances of the referred type using the *allElements()* extension. Select the first one where the *id()* equals the parsed value (by default an identifier).
	
	Both extensions, *id()* and *allElements()*) can be overwritten or specialized in the `Extensions.ext` file. The *link_[featurename]()* extension can be overwritten in `Linking.ext`

src-gen/[base.package.name]/ [dslname].ecore	Metamodel derived from the grammar
src-gen/[base.package.name]/parser/ *	Generated Antlr parser artifacts

7.6.3.2. The editor project

The name of the editor project is derived from the main project's name by appending the suffix `.editor` to it. The editor project contains the Eclipse Texteditor specific informations. Note that it uses a generic xtext.editor plugin, which does most of the job. These are the most important resources:

Location	Description
src/[base.package.name]/ [dslname]EditorExtensions.ext	The Xtend-file is used by the outline view. If you want to customize the labels of the outline view, you can do that here.
src-gen/[base.package.name]/ [dslname]Utilities.java	Contains all the important DSL-specific information. You should subclass it in order to overwrite the default behaviours.
src/[base.package.name]/ [dslname]EditorPlugin.java	If you have sublcassed the *Utilities class, make sure to change the respective instantiation here.

7.6.3.3. The generator project

The name of the generator project is derived from the main project's name by appending the suffix `.generator` to it. The generator project is intended to contain all needed generator resources such as Xpand templates, platform-specific Xtend files etc..

These are the most important resources:

Location	Description
src/[base.package.name]/ generator.oaw	The generators workflow preconfigured with the generated DSL parser and the Xpand component. As this is just a proposal, feel free to change/add the workflow as you see fit.
src-gen/[base.package.name]/ Main.xpt	The proposed td Xpand template file.

7.7. Pimping the editor

The generated editor supports a number of features known from other eclipse editors. Although most of them have a decent default implementation, we will see how to tweak and enhance each of them.

7.7.1. Code Completion

Code Completion is controlled using oAW extensions. The default implementation provides keyword proposals as well as proposals for cross references.

Have a look at the extension file `ContentAssist.ext`. Therein a comment describes how to customize the default behaviour:

```
/*
 * There are two types of extensions one can define
 *
 * 1) completeMetaType_feature(ModelElement ele, String prefix)
 * This one is called for assignments only. It gets the underlying Modelelement and the current
 * prefix passed in.
 *
 * 2) completeMetaType(xtext::Element grammarEle, ModelElement ele, String prefix)
 * This one gets the grammarElement which should be completed passed in as the first parameter.
 * an xtext::Element can be of the following types :
 *  - xtext::RuleName (a call to a lexer rule (e.g. ID)),
 *  - xtext::Keyword,
 *  - xtext::Assignment
 *
 * Overwrite rules are as follows:
 * 1) if the first one returns null for a given xtext::Assignment or does not exist the second one
 *    is called.
 * 2) if the second one returns null for a given xtext::Keyword or does not exist a default keyword
 *    proposal will be added.
 *
 * Note that only propals with wich match (case-in-sensitive) the current prefix will be proposed
 * in the editor
 */
```

7.7.2. Navigation

The implementation for the navigation actions is implemented via extensions, too. As for Code completion the same pattern applies: There is a `GenNavigation.ext` extension file in the `src-gen` folder which can be overwritten or specialized using the `Navigation.ext` file in the `src` folder (reexporting the generated extensions).

There are two different Actions supported by Xtext:

7.7.2.1. Find References

This action ca be invoked via [CTRL]+[SHIFT]+G or use the corresponding action int context menu. The default implementation returns the crossreferences for a modelelement.

The signature to overwrite / specialize is:

```
List[UIContentNode] findReferences(String s, Object grammarelement, Object element) : ...;
```

A UIContentNode is a meta class used by xtext. An UIContentNode represents an element visualized in eclipse.

Here is the declaration of UIContentNode (pseudo code):

```
package tree;


eclass UIContentNode {
   UIContentNode parent;
   UIContentNode[] children;
   String label;
   String image;
   emf::EObject context;
}
```

A content node can have children and / or a parent (the tree structure is not used for find references). The label is used for the label in eclipse and the image points to an image relative to the icons folder in the editor project. The icon instances are automatically cached and managed.

The context points to the actual model element. This is used to get the file, line and offset of the declaration. If you don't fill it you cannot click on the item in order to get to it.

7.7.2.2. Go to Declaration

This action can be invoked via F3 as well as by holding CTRL, hovering over an identifier and left click the mouse.

The default implementation goes to the declaration of a crossreference. You can implement or overwrite this action for all grammar elements.

```
emf::EObject findDeclaration(String identifier, emf::EObject grammarElement,
   emf::EObject modelElement) : ...;
```

Have a look at the generated extensions to see how it works.

7.7.3. Outline View

The outline view is constructed using a tree of UIContentNode (see above).

Each time the outline view is created the following extension is called:

```
UIContentNode outlineTree(emf::EObject model)
```

It is expected to be declared in `Outline.ext` which by default exports a generic implementation from `GenOutline.ext` (the same pattern again).

You can either reuse the generic extension and just provide a *label()* and *image()* extension for your model elements (should be added in `EditorExtensions.ext`).

However, if you want to control the structure of the outline tree you can overwrite the extension *outlineTree(emf::EObject model)* in `Outline.ext`.

7.7.4. Syntax Highlighting

The default syntax highlighting distincts between comments, string literals, keywords and the rest.

If you just want to specify which words to be coloured as keywords you can extend the [basepackage.][Languagename]Utilities.java class from the editor plugin. You need to overwrite the following method (DON'T CHANGE IT DIRECTLY, BECAUSE IT WILL BE OVERWRITTEN THE NEXT TIME YOU START THE GENERATOR!).

```
public String[] allKeywords()
```

Each String returned by the method represents a keyword.

The utiltities method is created within the [LanguageName]EditorPlugin.java. So make sure that you change the following lines, too :

```
   // OLD -> private MyLangUtilities utilities = new MyLangUtilities();
   private MyCustomUtilities utilities = new MyCustomUtilities();
   public LanguageUtilities getUtilities() {
      return utilities;
   }
```

If you want to change the syntax of comments and string literals you have to provide an alternative implementation of GeneratedPartitionScanner.

Don't touch the class directly but, use the Utilities method to return a different instance.

7.8. Cookbook

This part of the documentation deals with the discussion and solution of different requirements and problems.

7.8.1. Modeling In Multiple Files

If you have uge models or want to separate parts of your models from others for other reasons (e.g. provide a kind of library). You need to tweak Xtext a bit, because there is no first class support for this as for now. However, Xtext has a built-in registry where you can get parsed models by name.

7.8.1.1. The Registry

Xtext automatically manages a built-in registry. That is it caches parsed models by there filename and provides an API (both Java and Xtend) to access cached models.

The registry is contained in the org.openarchitectureware.xtext.core.base bundle. The Java API sonsists of a handful of static methods from org.openarchitectureware.xtext.registry.Registry.java. The extensions are contained in org.openarchitectureware.xtext.registry.Reg.ext. This part of the framework will definitely be enhanced in te future so expect API changes here.

7.8.1.2. Using the Registry

All you have to do is to declare some kind of import statemnent in our DSL and overwrite the allElements() extension from GenExtensions.ext.

Here is an example:

```
MyModel :
   (imports+=Import)*
   (types+=Type)*;

Import :
   "import" name=ID;

Type : ...
```

Overwrite the allElements extension in Extensions.ext to something like this:

```
 extension mydsl::GenExtensions reexport;
 extension org::openarchitectureware::xtext::registry::Reg;

 allElements(emf::EObject this) :
    wholeModel().union(
       (((MyModel)eRootContainer)
        .imports                   // for each import
        .getRootNode(i)            // get the root from the registry
        .wholeModel()              // get the whole model as a list
    );

 wholeModel(emf::EObject this) :
    {eRootContainer}.union(eRootContainer.eAllContents);
```

As the allElements() extension is used everywhere the imported model elements will automatically be available for code completion, navigation, checking, etc.

Chapter 8. UML2 Adapter

8.1. Introduction

The UML2Adapter for oAW is available since version 4.1. It is based upon Eclipse's UML2 2.0 framework and provides a type mapping from the UML 2.1 metamodel implementation to the oAW type system. Hence one can access the whole UML2 metamodel from Check, Xtend and Xpand. Additionally and more important the adapter dynamically maps stereotypes applied to model elements to oAW types and TaggedValues to oAW properties. You don't have to implement additional Java classes anymore. Just export your models and applied profiles. That's all!

8.2. Installation

First you need to install the UML2 feature from eclipse.org.

http://download.eclipse.org/tools/uml2/updates/site-interim.xml

The oAW uml2adapter is available from the oAW updatesite:

http://www.openarchitectureware.org/updatesite/milestone/site.xml

(Go to the project's homepage and find the current location if either of the sites don't work)

Restart your Eclipse workbench when Eclipse asks you to do so.

8.3. Setting up Eclipse

You need to configure your project (or the whole workspace) to use the UML2Adapter.

Right click on the project and choose 'properties' from the pop-up menu. Therein open the 'openArchitectureWare'-tab, activate the checkboxes (nature and specific metamodel contributors) and add the UMLProfiles metamodel contributor.

8.3.1. Profiles in Eclipse

If you want Eclipse to register (be aware of) your specific profile in order to provide static type checking and code completion in the editors, the profiles (*.profile.uml or *.profile.uml2) need to be on the project's classpath (e.g. are contained in a src folder)

8.4. Runtime Configuration

At runtime you just need the org.openarchitectureware.uml2.adapter-4.1.0...jar. You can use Eclipse's dependency mechanism from the PDE (as described in the installation section on the getting started page), or copy or reference the respective jar directly. It doesn't matter, you just have to take care that it is on the classpath.

8.4.1. Workflow

If you have written some Check, Xtend or Xpand files and now want to execute them you have to provide the right configuration.

You need to configure the UML2 metamodel and a profile metamodel *for each profile* you used directly. A typical configuration looks like this:

```
<workflow>
   <bean class="oaw.uml2.Setup" standardUml2Setup="true"/>
   <component class="oaw.emf.XmiReader">
      ...
   </component>
   <component class="oaw.xpand2.Generator">
      <metaModel class="oaw.uml2.UML2MetaModel"/>
      <metaModel class="oaw.uml2.profile.ProfileMetaModel">
         <profile value="myProfile.profile.uml2"/>
      </metaModel>
      ...
   </component>
<workflow>
```

*!!Note the bean configuration in the second line. It statically configures the XmiReader to use the right factories for *.uml and *.uml2 files. This is very important!!*

If you are invoking several oAW components, you should use the id / idRef mechanism:

```
<workflow>
   <bean class="oaw.uml2.Setup" standardUml2Setup="true"/>
   <component class="oaw.emf.XmiReader">
      ...
   </component>
   <component class="oaw.xpand2.Generator">
      <metaModel id="uml" class="oaw.uml2.UML2MetaModel"/>
      <metaModel id="profile"
                 class="oaw.uml2.profile.ProfileMetaModel">
         <profile value="myProfile.profile.uml"/>
      </metaModel>
      ...
   </component>
   <component class="oaw.xpand2.Generator">
      <metaModel idRef="uml"/>
      <metaModel idRef="profile"/>
      ...
   </component>
```

Chapter 9. UML2 Example

9.1. Setting up Eclipse

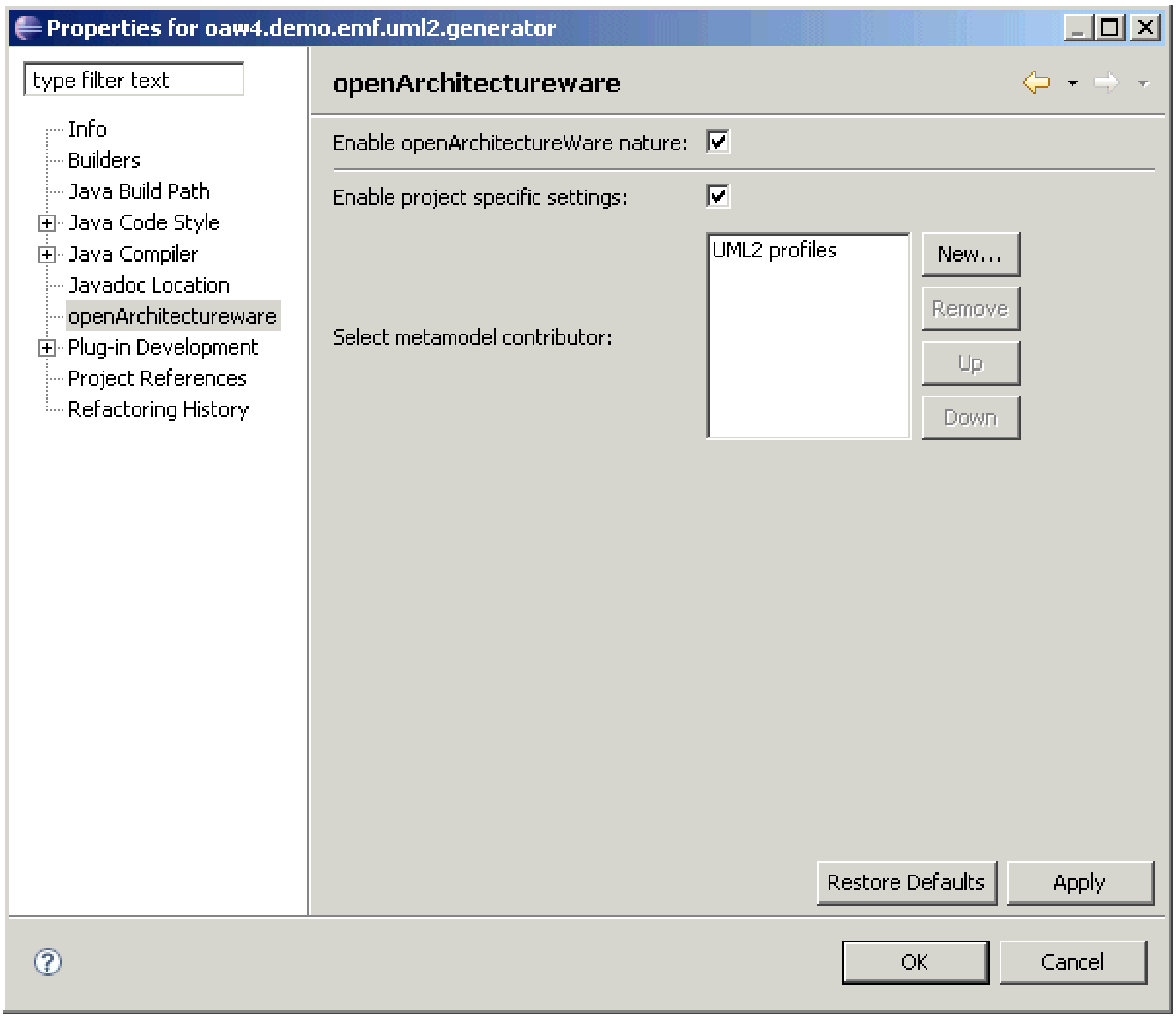
Before you can use oAW with Eclipse UML2, you first have to install the UML2 plugins into your Eclipse installation.

9.2. Setting up the project

Create a new openArchitectureWare plugin project. You have to add the following dependencies to the manifest file:

- org.openarchitectureware.uml2.adapter

To tell the oAW Eclipse plugins that this project is a UML2 specific one, you need to specify that in the oAW preferences. Open the project properties, select the openArchitectureWare tab and select the UML2 profiles metamodel.


Properties for oaw4.demo.emf.uml2.generator

openArchitectureware

Enable openArchitectureWare nature: ✓

Enable project specific settings: ✓

Select metamodel contributor: UML2 profiles

Figure 9.1. Configure UML2 profiles metamodel

Note, that if you want to transform an UML2 model into a normal EMF model, you need to add the UML2 metamodel and the EMF metamodels. The order is important! The UML2 profiles entry must be first in the list.

9.3. Creating a UML2 Model

You start by defining a uml2 model, i.e. an instance of the UML2 metamodel. In the new Java project, in the source folder, you create a UML2 model that you should call `example.uml`.

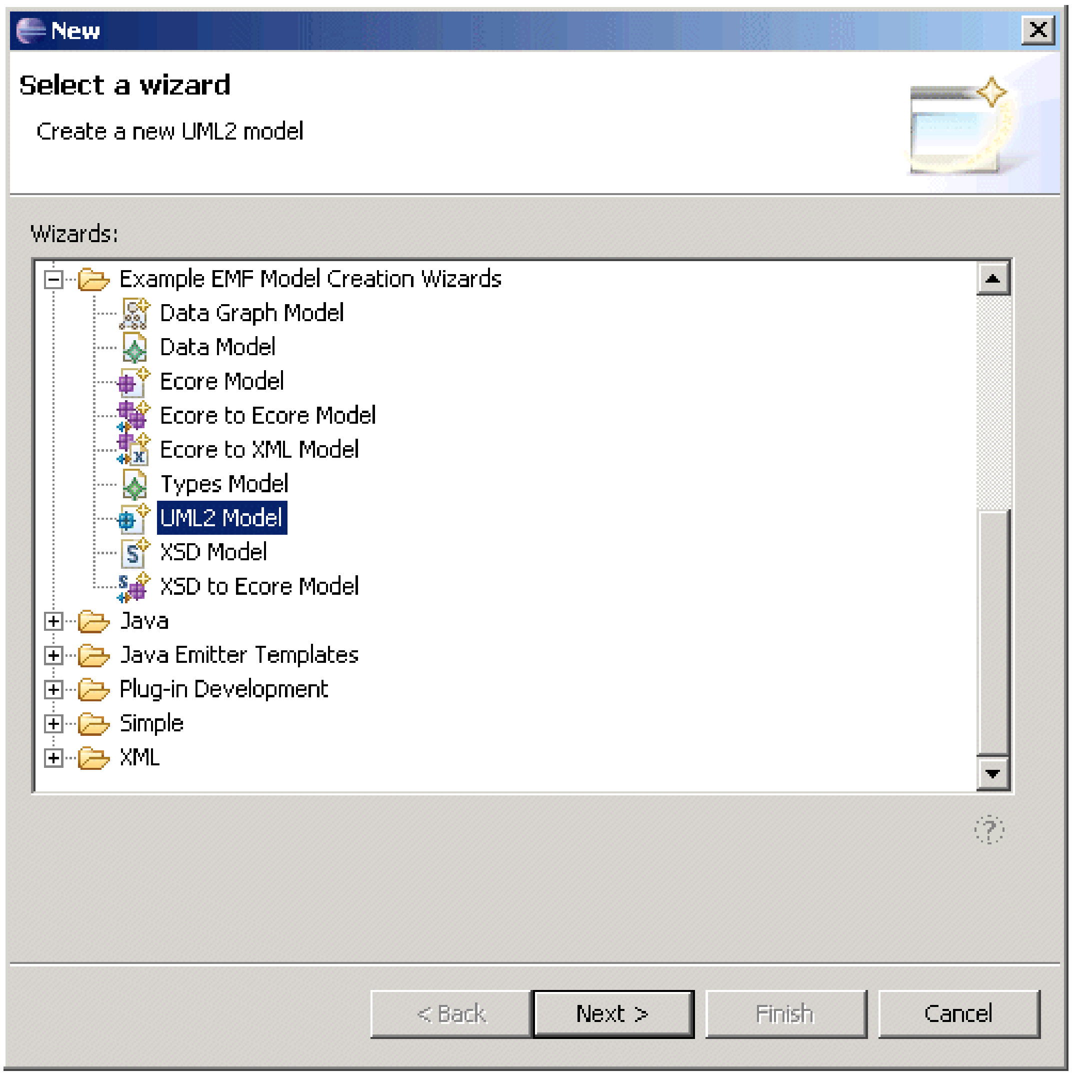
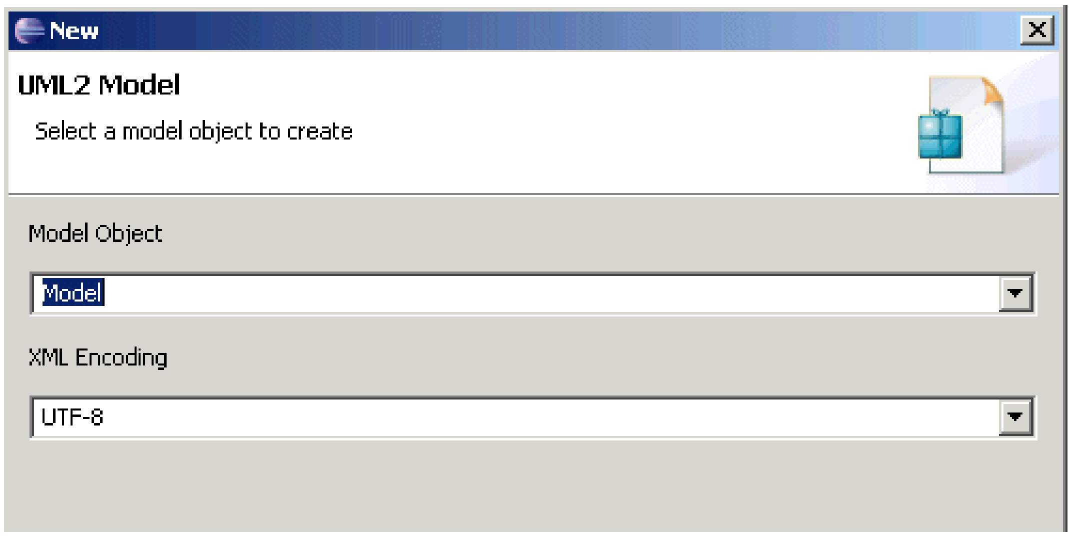


Figure 9.2. Creating a new UML2 model

You then have to select the model object. Make sure its a *Model*, not a *Profile*.


New

UML2 Model

Select a model object to create

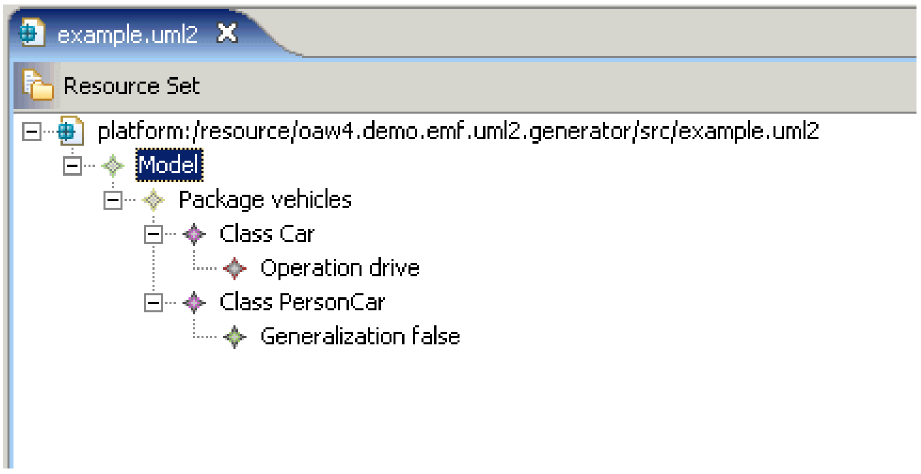
Model Object: Model

XML Encoding: UTF-8

Figure 9.3. Selecting the Model object

9.3.1. Modelling the content

You should then build a model that looks somewhat like this:


example.uml2

Resource Set

```
platform:/resource/oaw4.demo.emf.uml2.generator/src/example.uml2
  Model
    Package vehicles
      Class Car
        Operation drive
      Class PersonCar
        Generalization false
```

Figure 9.4. Example model

By the way, if you rename the `.uml` file to `.ecore`, you can edit the model using the ecore editors. To inspect the model, they provide a somewhat better view, so you might try!

9.4. Code generation

9.4.1. Defining the templates

Inside the source folder of our project, create a `templates` package. Inside that package folder, create a template file `Root.xpt` that has the following content. First, we define the entry template that is called `Root`. Since we expect a UML model element to be the top element to the model, we define it for `uml::Model`. Note the use of the uml Namespace prefix, as defined in the UML2 metamodel. Inside that template, we iterate over all owned elements of the model and expand a template for the packages defined in it.

```
«DEFINE Root FOR uml::Model»
```

```
«EXPAND PackageRoot FOREACH ownedElement»
«ENDDEFINE»
```

In the package template, we again iterate over all owned elements and call a template that handles classes. At this point we expect that only classes are in that package.

```
«DEFINE PackageRoot FOR uml::Package»
 «EXPAND ClassRoot FOREACH ownedType»
«ENDDEFINE»
```

This template handles classes. It opens a file that has the same name as the class, suffixed by `.java`. Into that file, we generate an empty class body.

```
«DEFINE ClassRoot FOR uml::Class»
 «FILE name+".java"»
  public class «name» {}
 «ENDFILE»
«ENDDEFINE»
```

9.4.2. Defining the workflow

In order to generate code, we need a workflow definition. Here is the workflow file; you should put it into the source folder. The file should be generally understandable if you read the oAW EMF Example docs.

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<workflow>
```

You need to setup the UML2 stuff (registering URI maps, Factories, etc.). This can be done declaring a bean in before of the `XmiReader` component:

```
 <bean class="oaw.uml2.Setup" standardUML2Setup="true"/>
 <component class="oaw.emf.XmiReader">
  <modelFile value="example.uml"/>
  <outputSlot value="model"/>
 </component>
```

The `XmiReader` reads the model and stores the content (a list containing the model element) in a slot named '`model`'. As usual, you might want to clean the target directory.

```
 <component id="dirCleaner"
  class="oaw.workflow.common.DirectoryCleaner"
  directories="src-gen"/>
```

and in the generator we also configure the EMF meta model for oAW, together with the UML2 metamodel package, because the UML2 metamodel refers to it.

```
 <component id="generator" class="oaw.xpand2.Generator"
  skipOnErrors="true">
  <metaModel class="oaw.type.emf.EmfMetaModel">
   <metaModelPackage  value="org.eclipse.emf.ecore.EcorePackage"/>
  </metaModel>
  <metaModel class="oaw.uml2.UML2MetaModel"/>
  <expand value="templates::Root::Root FOR model"/>
  <outlet path="src-gen/">
   <postprocessor class="oaw.xpand2.output.JavaBeautifier"/>
  </outlet>
 </component>
```

If you run the workflow (by right clicking on the .oaw file and select *Run As -> oAW Workflow* the two Java classes should be generated.

9.5. Profile Support

openArchitectureWare 4 is shipped with a special UML2Profiles metamodel implementation. The implementation maps Stereotypes to Types and Tagged Values to simple properties. It also supports Enumerations defined in the profile and Stereotype hierarchies.

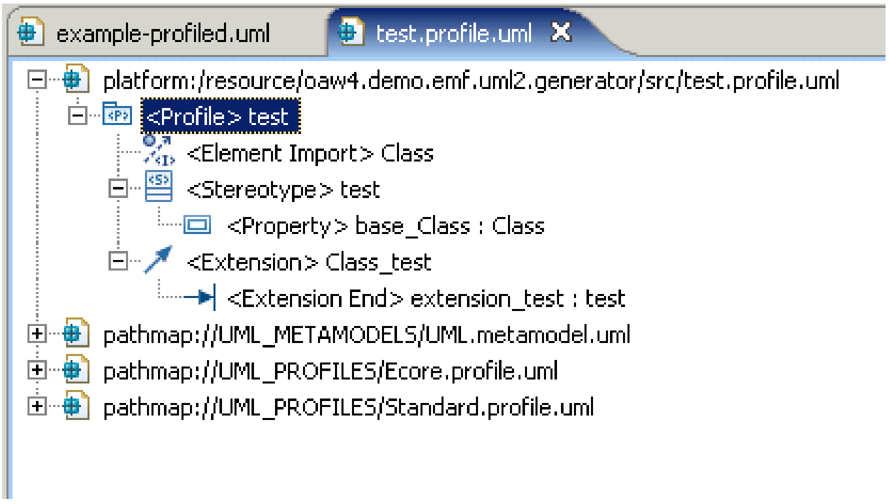
9.5.1. Defining a Profile

To define a profile, you can use a variety of UML2-based modelling tools. Assuming they do actually correctly create profile definitions (which is not always the case, as we had to learn painfully), creating a profile and exporting it correctly is straight forward.

In this section, we explain the "manual way", which is good for explaining what happens, but completely useless for practical use. You don't want to build realisitically-sized models using the mechanisms explained below.

You start be creating a new UML2 file (as shown above). In the example we'll call it `test.profile.uml`. The root element, however, will be a *Profile*, not a *Package*. Don't forget to actually assign a name to the profile! It should be test, too.

As a child of that *Profile*, you then create a *Packaged Element Stereotype* (you'll have to scroll a bit in the *Add Child* menu....). For the sake of example, we'll call it test, too. In our case, we want to make the stereotype be applicable to UML classes – they are defined as part of the UML2 metamodel. So we have to import that metamodel first. So what you do is to select your profile object, and then go to the UML2 Editor menu (in the Eclipse menu bar) and select *Profile -> Reference Metaclass*. Select `uml::Class`. You can then select your stereotype, and select *Stereotype -> Create Extension* from the UML2 Editor menu. Select `uml::Class`. This should lead to the following model. Save it, you're done with the profile definition.

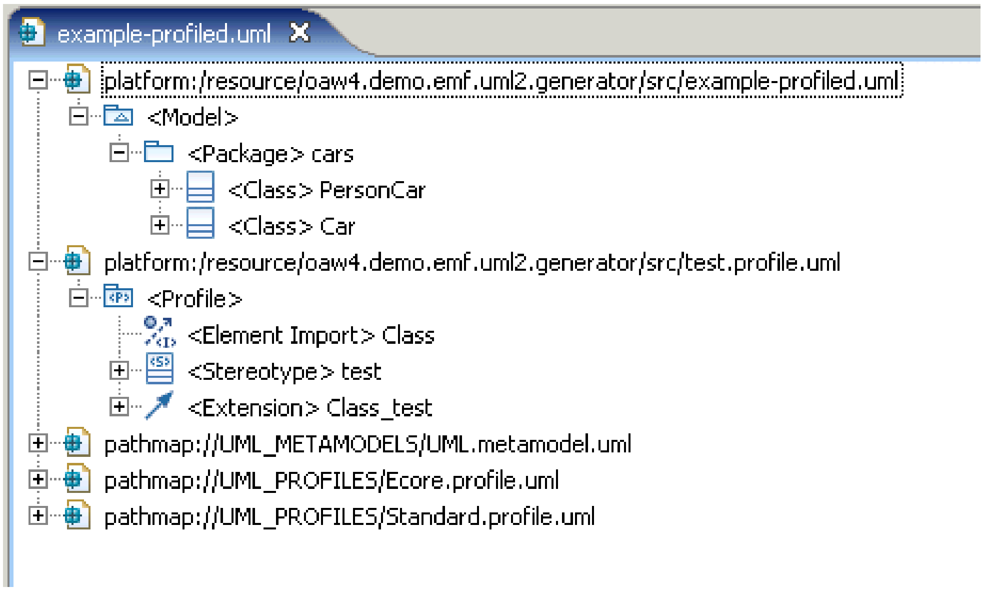


```
platform:/resource/oaw4.demo.emf.uml2.generator/src/test.profile.uml
  <Profile> test
    <Element Import> Class
    <Stereotype> test
      <Property> base_Class : Class
    <Extension> Class_test
      <Extension End> extension_test : test
pathmap://UML_METAMODELS/UML.metamodel.uml
pathmap://UML_PROFILES/Ecore.profile.uml
pathmap://UML_PROFILES/Standard.profile.uml
```

Figure 9.5. Modelling a Profile

9.5.2. Applying the Profile

To make any use of the profile, we have to apply it to some kind of model. To do that, we copy the `example.uml` model to a `example-profiled.uml`. We then open that file and load a resource, namely the profile we just defined. This then looks somewhat like this:



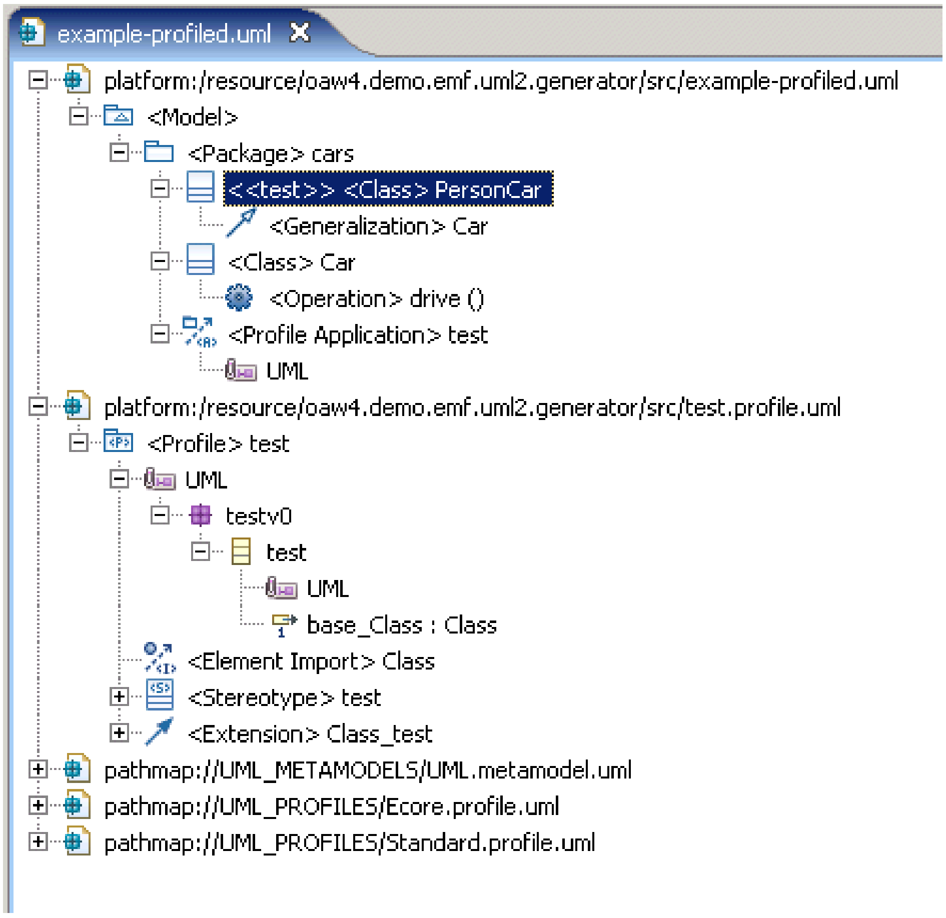
```
example-profiled.uml
platform:/resource/oaw4.demo.emf.uml2.generator/src/example-profiled.uml
    <Model>
        <Package> cars
            <Class> PersonCar
            <Class> Car
platform:/resource/oaw4.demo.emf.uml2.generator/src/test.profile.uml
    <Profile>
        <Element Import> Class
        <Stereotype> test
        <Extension> Class_test
pathmap://UML_METAMODELS/UML.metamodel.uml
pathmap://UML_PROFILES/Ecore.profile.uml
pathmap://UML_PROFILES/Standard.profile.uml
```

Figure 9.6. Loading the Profile

Now, to make the following stuff work, you first have to select the profile and select the *Profile* -> *Define* operation from the UML2 Editor menu. This creates all kinds of additional model elements, about which you shouldn't care for the moment.

Now, finally, you can select your cars package (the one from the example model) and select *Package* -> *Apply Profile* from the UML2 Editor menu. Select your test profile to be applied.

For the purpose of this example, you should now apply the test stereotype to the `PersonCar` class. Select the class, and the select *Element* -> *Apply Stereotype* from the UML2 Editor menu. This should result in the following model:


example-profiled.uml

platform:/resource/oaw4.demo.emf.uml2.generator/src/example-profiled.uml
<Model>
<Package> cars
<<test>> <Class> PersonCar
<Generalization> Car
<Class> Car
<Operation> drive ()
<Profile Application> test
UML
platform:/resource/oaw4.demo.emf.uml2.generator/src/test.profile.uml
<Profile> test
UML
testv0
test
UML
base_Class : Class
<Element Import> Class
<Stereotype> test
<Extension> Class_test
pathmap://UML_METAMODELS/UML.metamodel.uml
pathmap://UML_PROFILES/Ecore.profile.uml
pathmap://UML_PROFILES/Standard.profile.uml

Figure 9.7. Defining the Profile

9.5.3. Generating Code

Note that all the stuff above was not in any way related to oAW, it was just the "bare bones" means of creating and applying a profile to a UML2 model

There are two things we have to change: The workflow (specifically, the configuration of the generator component) needs to know about the profile, and the template needs to generate different code if a class has the test stereotype applied. Let's look at the second aspect first. Here's the modified template (in `RootWithProfile.xpt`):

```
«DEFINE Root FOR uml::Model»
 «EXPAND PackageRoot FOREACH (List[uml::Package])ownedElement»
«ENDDEFINE»

«DEFINE PackageRoot FOR uml::Package»
 «EXPAND ClassRoot FOREACH (List[uml::Class])ownedType»
«ENDDEFINE»

«DEFINE ClassRoot FOR uml::Class»
«FILE name+".java"»
 public class «name» {}
«ENDFILE»
«ENDDEFINE»

«DEFINE ClassRoot FOR test::test»
«FILE name+".java"»

public class «name» {} // stereotyped
«ENDFILE»
```

```
«ENDDEFINE»
```

As you can see, the stereotype acts just like a type, and even the polymorphic dispatch between the base type (`uml::Class`) and the stereotype works.

Adapting the workflow file is also straight forward (workflowWithProfile.oaw), here's the modified generator component:

```
<component id="generator" class="oaw.xpand2.Generator"
skipOnErrors="true">
 <metaModel class="oaw.type.emf.EmfMetaModel"
  metaModelPackage="org.eclipse.emf.ecore.EcorePackage"/>
 <metaModel class="oaw.uml2.UML2MetaModel"/>
 <metaModel id="profile"
  class="oaw.uml2.profile.ProfileMetaModel">
  <profile value="test.profile.uml"/>
 </metaModel>
 <expand
  value="templates::RootWithProfile::Root FOR model"/>
  <outlet path="src-gen">
   <postprocessor class="oaw.xpand2.output.JavaBeautifier"/>
  </outlet>
</component>
```

The only thing we have to do is add a new metamodel that refernces the profile we just created.

Chapter 10. GMF2 Adapter

10.1. Introduction

The GMF-Adapter integrates the oAW-Check language with GMF2

10.2. Installation

First you need to install the GMF from eclipse.org.

http://download.eclipse.org/modeling/gmf/downloads/drops/R-2.0-200706210000/index.php

The oAW gmfadapter is available from the oAW updatesite:

http://www.openarchitectureware.org/updatesite/milestone/site.xml

(Go to the project's homepage and find the current location if either of the sites don't work)

Restart your Eclipse workbench when Eclipse asks you to do so.

10.3. Setting up Eclipse

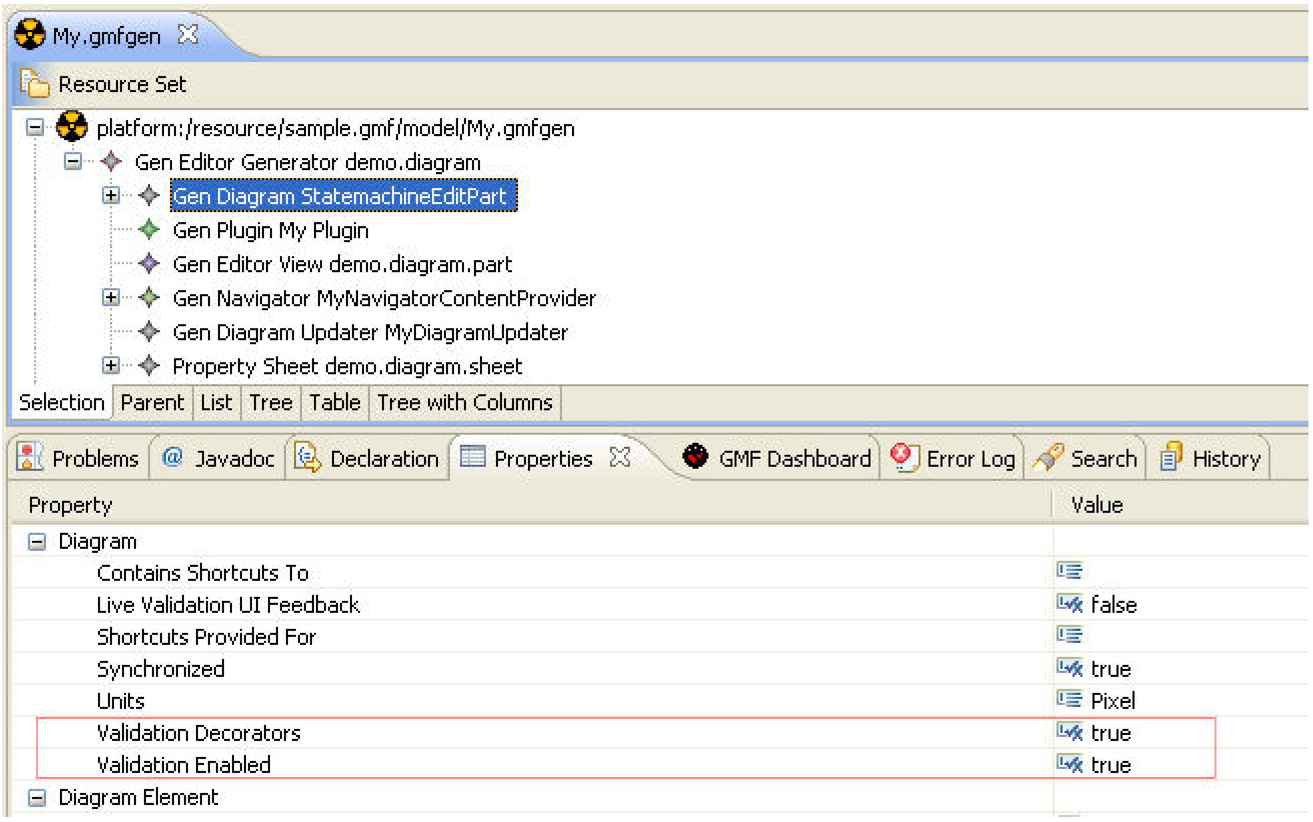
You need to import one project into your workspace It is called "org.openarchitectureware.adapter.gmf2". You can do that using the import wizard. Do a right click in the Project Explorer and choose Import... Now select "Plug-ins and Fragments" from the Plug-in development section. Import the bundle as a project with source folders.

10.4. Setting up GMF

10.4.1. Setting validation options

Next, open your .gmfgen file and set the following properties in the your GenDiagram Element:

- Set *Validation Decorators* in the section "Diagram" to *true*
- Set *Validation Enabled* in the section "Diagram" to */org.openarchitectureware.adapter.gmf2/templates*



My.gmfgen

Resource Set

```
⊟ platform:/resource/sample.gmf/model/My.gmfgen
   ⊟ Gen Editor Generator demo.diagram
      ⊞ Gen Diagram StatemachineEditPart
        Gen Plugin My Plugin
        Gen Editor View demo.diagram.part
      ⊞ Gen Navigator MyNavigatorContentProvider
        Gen Diagram Updater MyDiagramUpdater
      ⊞ Property Sheet demo.diagram.sheet
```

Selection | Parent | List | Tree | Table | Tree with Columns

Problems | Javadoc | Declaration | Properties | GMF Dashboard | Error Log | Search | History

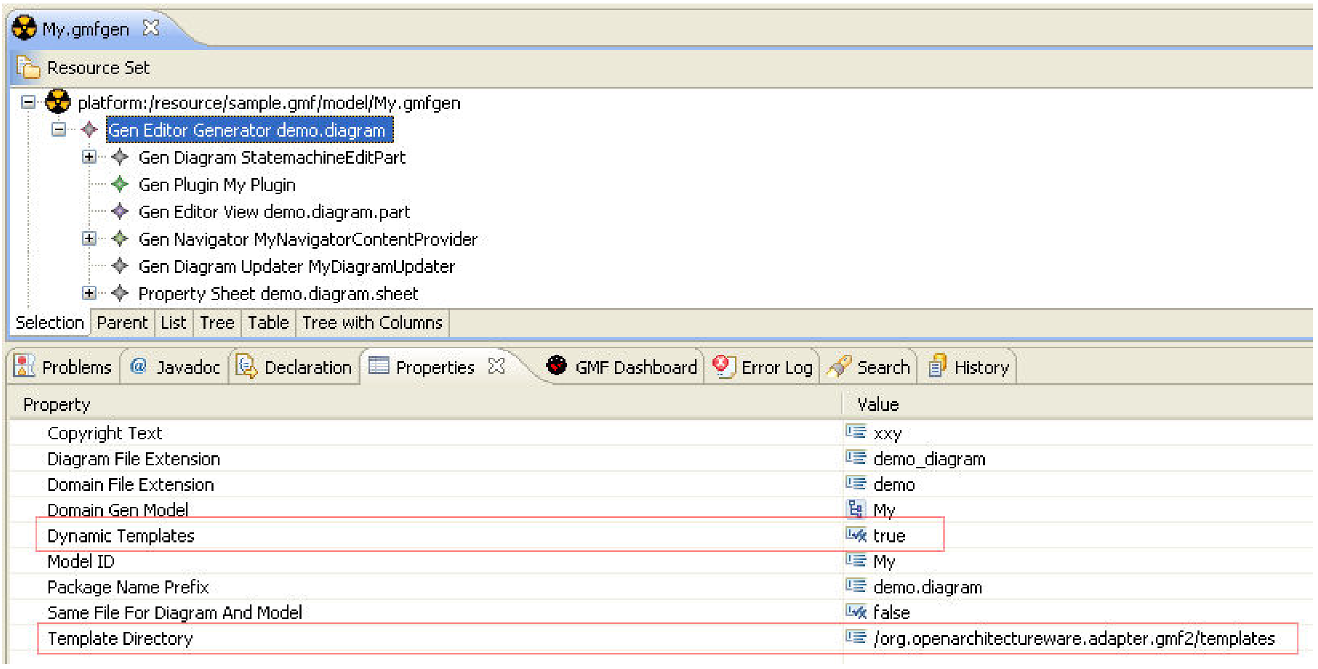
Property	Value
⊟ Diagram	
Contains Shortcuts To	
Live Validation UI Feedback	false
Shortcuts Provided For	
Synchronized	true
Units	Pixel
Validation Decorators	true
Validation Enabled	true
⊟ Diagram Element	

Figure 10.1. Validation settings

10.4.2. Setting template options

Now, select your Gen Editor Generator and set the following properties:

- Set *Dynamic Templates* to *true*
- Set *Template Directory* in the section "Diagram" to *true*



My.gmfgen

Resource Set

```
⊟ platform:/resource/sample.gmf/model/My.gmfgen
   ⊟ Gen Editor Generator demo.diagram
      ⊞ Gen Diagram StatemachineEditPart
        Gen Plugin My Plugin
        Gen Editor View demo.diagram.part
      ⊞ Gen Navigator MyNavigatorContentProvider
        Gen Diagram Updater MyDiagramUpdater
      ⊞ Property Sheet demo.diagram.sheet
```

Selection | Parent | List | Tree | Table | Tree with Columns

Problems | Javadoc | Declaration | Properties | GMF Dashboard | Error Log | Search | History

Property	Value
Copyright Text	xxy
Diagram File Extension	demo_diagram
Domain File Extension	demo
Domain Gen Model	My
Dynamic Templates	true
Model ID	My
Package Name Prefix	demo.diagram
Same File For Diagram And Model	false
Template Directory	/org.openarchitectureware.adapter.gmf2/templates

Figure 10.2. Template settings

10.4.3. Loading the extension model

Right-click into the gmfgen editor and choose the "Add extension model..." action. Browse your file system and got to your eclipse installation directory. Navigate to plugins/org.openarchitectureware.adapter.gmf2.extensionmodel_1.0.0\model and choose oawGmfExtension.ecore. Select the CheckContainer when asked for the Root Class

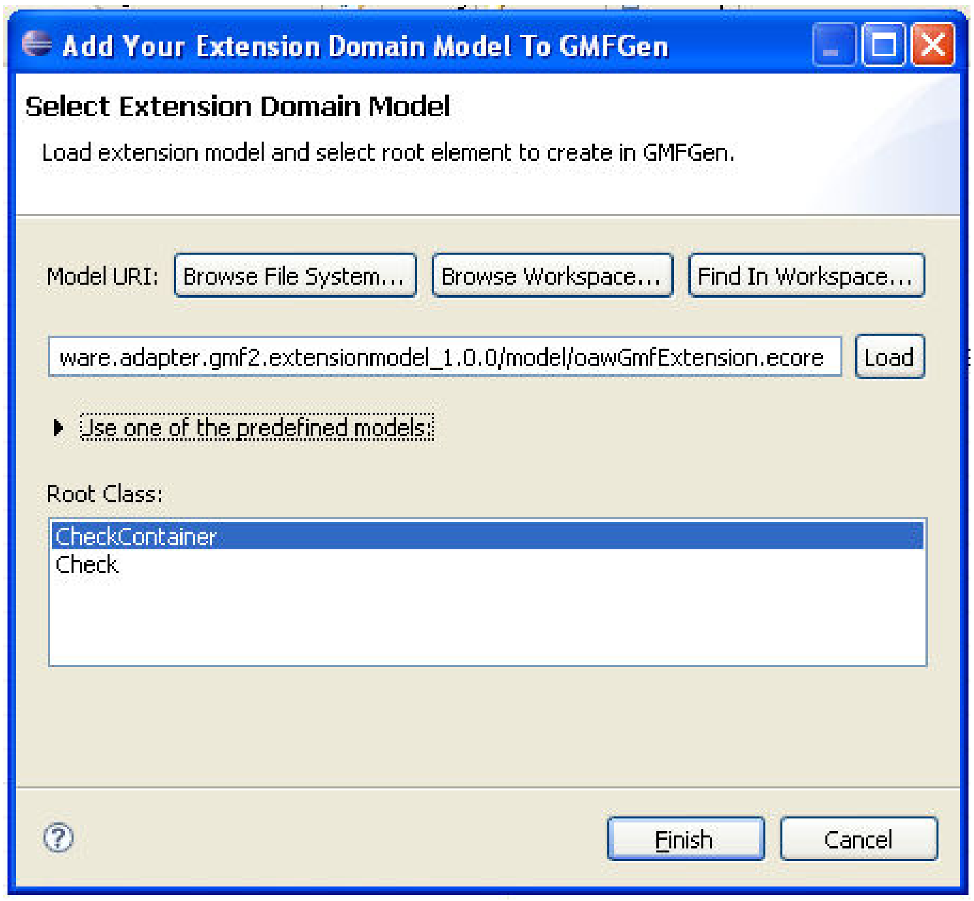
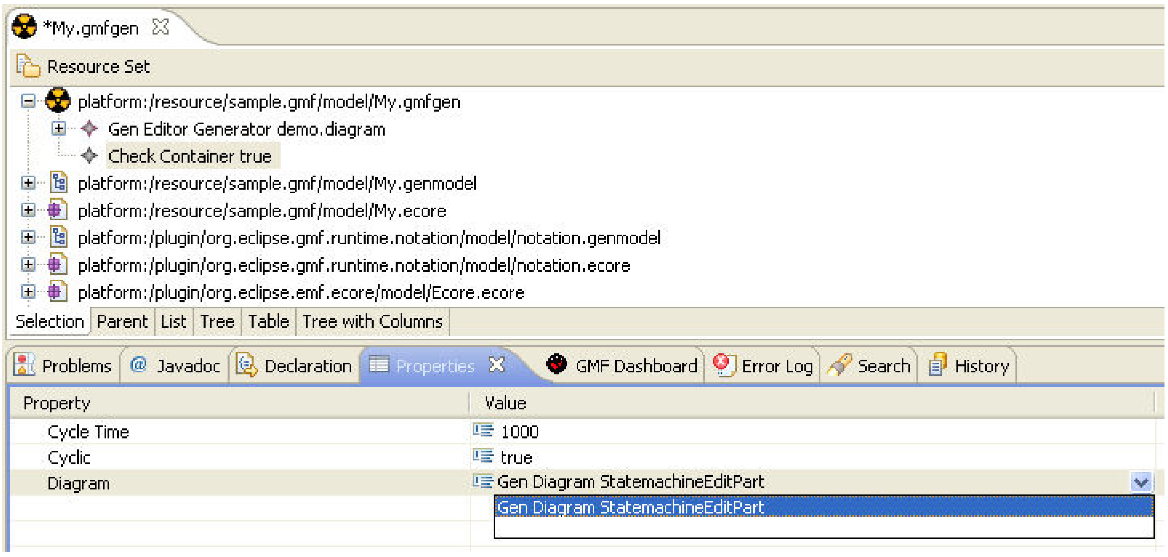

Add Your Extension Domain Model To GMFGen
Select Extension Domain Model
Load extension model and select root element to create in GMFGen.
Model URI:
Browse File System...
Browse Workspace...
Find In Workspace...
ware.adapter.gmf2.extensionmodel_1.0.0/model/oawGmfExtension.ecore
Load
Use one of the predefined models:
Root Class:
CheckContainer
Check
Finish
Cancel

Figure 10.3. Adding the extension model

In the CheckContainer element you have to set the diagram from your gmfgen. Normally there is just one to select. You can also choose whether you'd like to run the validation in a cyclic mode or not. The cycle time attribute is the time in ms. Default is one second

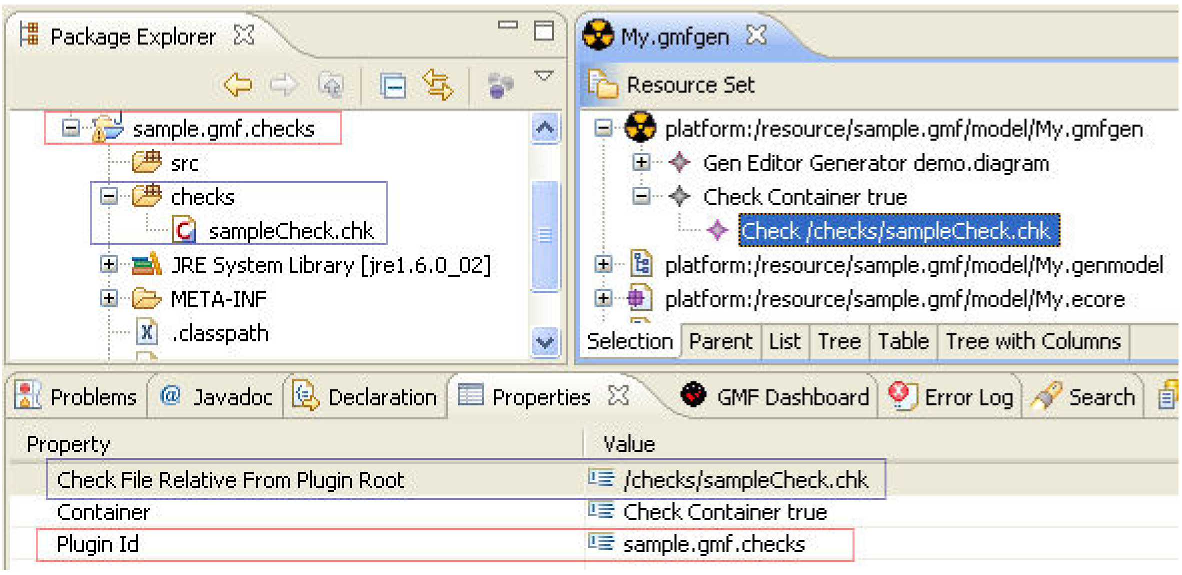


```
*My.gmfgen
Resource Set
platform:/resource/sample.gmf/model/My.gmfgen
    Gen Editor Generator demo.diagram
    Check Container true
platform:/resource/sample.gmf/model/My.genmodel
platform:/resource/sample.gmf/model/My.ecore
platform:/plugin/org.eclipse.gmf.runtime.notation/model/notation.genmodel
platform:/plugin/org.eclipse.gmf.runtime.notation/model/notation.ecore
platform:/plugin/org.eclipse.emf.ecore/model/Ecore.ecore
```

Property	Value
Cycle Time	1000
Cyclic	true
Diagram	Gen Diagram StatemachineEditPart

Figure 10.4. Setting properties on the CheckContainer element

Finally you can add a list of Check Elemens. In each of them you have to specify the plugin ID and the relative path to the check file from the plugin root



```
Package Explorer
sample.gmf.checks
    src
    checks
        sampleCheck.chk
    JRE System Library [jre1.6.0_02]
    META-INF
    .classpath
```

```
My.gmfgen
Resource Set
platform:/resource/sample.gmf/model/My.gmfgen
    Gen Editor Generator demo.diagram
    Check Container true
        Check /checks/sampleCheck.chk
platform:/resource/sample.gmf/model/My.genmodel
platform:/resource/sample.gmf/model/My.ecore
```

Property	Value
Check File Relative From Plugin Root	/checks/sampleCheck.chk
Container	Check Container true
Plugin Id	sample.gmf.checks

Figure 10.5. Adding a new check file

For more information on checks, please refer to the Check documentation Chapter 6, *Xtend/ Xpand/ Check Reference*

Chapter 11. RSM/RSA Adapter

11.1. Introduction

The IBM Rational Software Architect / Modeler (RSA/RSM) is a uml modeling tool. It's based on Eclipse and the Eclipse's UML 2.0 project. The uml models stored in a special file format. These model files have the file extension `.emx`, uml profiles are stored in files with the extension `.epx`. The files from version 6.0 of RSA/RSM can be opened with a special API only. With the introduction of version 7.0 the models and profiles can be opened directly with the UML2 2.0 framework.

Usually RSA/RSM profiles are deployed in plugins, the referenced to these profiles are written with a special URI called pathmap (people working with Rational Rose might know this).

The RSA/RSM adapter brings the functionality of the UML2 adapter written by Sven to RSA/RSM. The adapter for oAW is available since version 4.1. It is based upon Eclipse's UML2 2.0 framework and provides a type mapping from the UML 2.1 metamodel implementation to the oAW type system. Hence one can access the whole UML2 metamodel from Check, Xtend and Xpand. Additionally and more important the adapter dynamically maps stereotypes, stored in RSA/RSM specific model files (`.epx`), which are applied to model elements to oAW types and stereotype properties (TaggedValues) to oAW properties. You don't have to implement additional Java classes anymore. Just export your models and applied profiles. That's all!

11.2. Installation

Using the RSA/RSM adapter with Eclipse, you first need to install the UML2 feature from Eclipse.org.

http://download.eclipse.org/tools/uml2/updates/site-interim.xml

The oAW uml2adapter is available from the oAW updatesite:

http://www.openarchitectureware.org/updatesite/milestone/site.xml

(Go to the project's homepage and find the current location if either of the sites don't work)

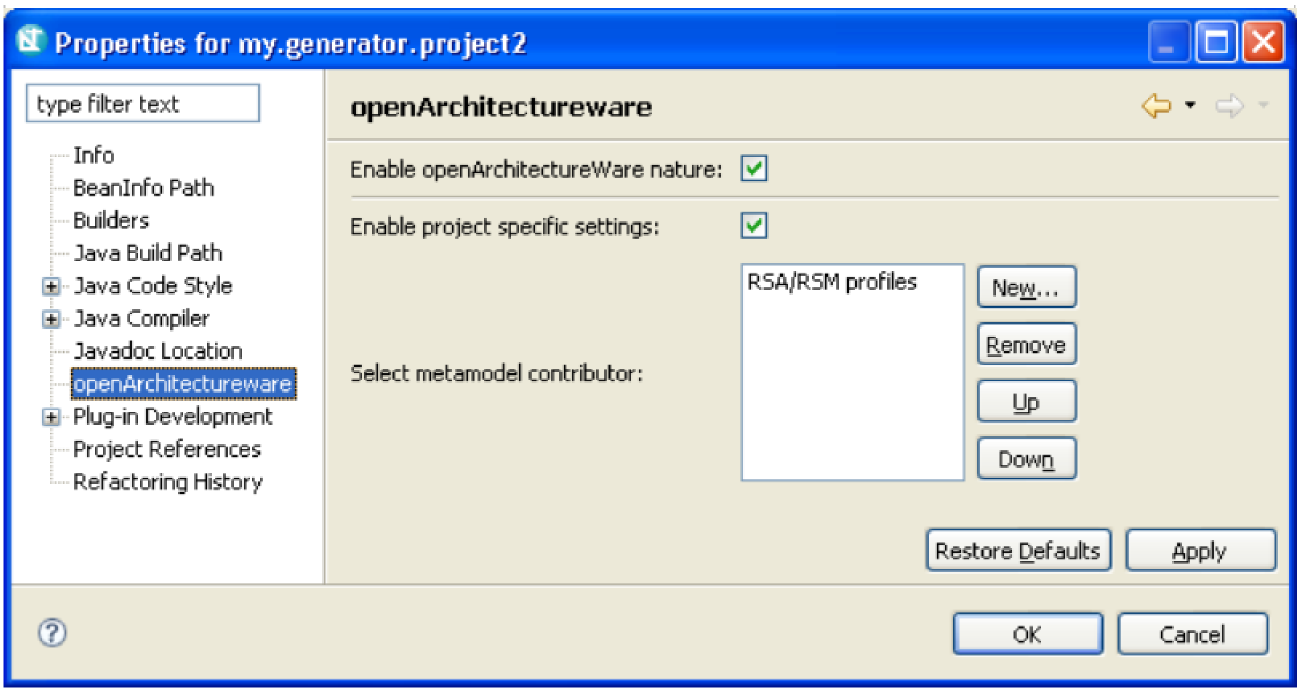
Restart your Eclipse workbench when Eclipse asks you to do so.

11.3. Setting up IBM Rational Software Architect / Modeller

You need to configure your project (or the whole workspace) to use the RSA/RSM adapter.

Right click on the project and choose 'properties' from the pop-up menu. Open the 'openArchitectureWare'-tab, activate the checkboxes (nature and specific metamodel contributors) and add the RSA/RSM Profiles metamodel contributor.

All profiles installed in plugins using the `com.ibm.xtools.uml2.msl.UMLProfiles` extension point, are added as metamodels (for more information about creating your own profiles with RSA/RSM see help for „Extending Rational Software Modeler functionality“) .



Enable openArchitectureWare nature: ✓

Enable project specific settings: ✓

Select metamodel contributor: RSA/RSM profiles

Figure 11.1. Project properties with RSA/RSM profiles added

11.3.1. Runtime Configuration

At runtime you just need the org.openarchitectureware.rsdp.adapter-4.1.0.jar. You can use Eclipse's dependency mechanism from the PDE (as described in the installation section on the getting started page), or copy or reference the respective jar directly. It doesn't matter, you just have to take care that it is on the classpath.

11.3.2. Workflow using profiles from plugins

If you have written some Check, Xtend or Xpand files and now want to execute them you have to provide the right configuration.

You need to configure the UML2 metamodel and a profile metamodel for each profile you used directly. A typical configuration looks like this:

```
<workflow>
  <property
    name="umlmda.profile.plugin.path"
    value="C:/winapp/eclipse/v3.2/UMLMDA/eclipse/plugins/org.umlmda.u
ml2.profile_2.0.0"/>
  <!-- initializes resourcemaps, urimaps, etc. -->
  <component
     class="org.openarchitectureware.rsdp.workflow.RSASetup" >
    <pathMapEntry>
      <alias value="UMLMDA_PROFILE"/>
      <path value="${umlmda.profile.plugin.path}/profiles"/>
    </pathMapEntry>
    <init value="true"/>
  </component>
  <component class="oaw.emf.XmiReader">
     ...
  </component>
  <component class="oaw.xpand2.Generator">
    <metaModel class="oaw.uml2.UML2MetaModel"/>
    <metaModel class="oaw.uml2.profile.ProfileMetaModel">
      <profile value="pathmap://UMLMDA_PROFILE/UMLMDAProfile.epx"/>
    </metaModel>
        ...
  </component>
<workflow>
```

11.3.3. Workflow using profiles from workspace projects

If the RSA/RSM profiles are installed in a workspace project rather in a plugin, it can be accessed with a workflow below:

```
<workflow>
  <property
    name="umlmda.profile.project.path"
    value="C:/devel/umlmda.rsm7/org.umlmda.uml2.profile"/>
  <!-- initializes resourcemaps, urimaps, etc. -->
  <component
    class="org.openarchitectureware.rsdp.workflow.RSASetup" >
    <umlExtensionProject
      class="org.openarchitectureware.rsdp.workflow.UmlExtensionProje
ct">
      <projectName value="UMLMDAProfile"/>
      <path value="${umlmda.profile.project.path}"/>
    </umlExtensionProject>
    <init value="true"/>
  </component>
  <component class="oaw.emf.XmiReader">
    <modelFile value="${model}"/>
    <outputSlot value="model"/>
   </component>
  <component class="oaw.xpand2.Generator" skipOnErrors="true">
    <metaModel class="oaw.type.emf.EmfMetaModel"
      metaModelPackage="org.eclipse.emf.ecore.EcorePackage"/>
    <metaModel class="oaw.uml2.UML2MetaModel"/>
    <metaModel class="oaw.uml2.profile.ProfileMetaModel">
      <profile
        value="file://${umlmda.profile.project.path}/profiles/UMLMDAP
rofile.epx"/>
    </metaModel>
    ...
  </component>
```

11.3.4. Future enhancements

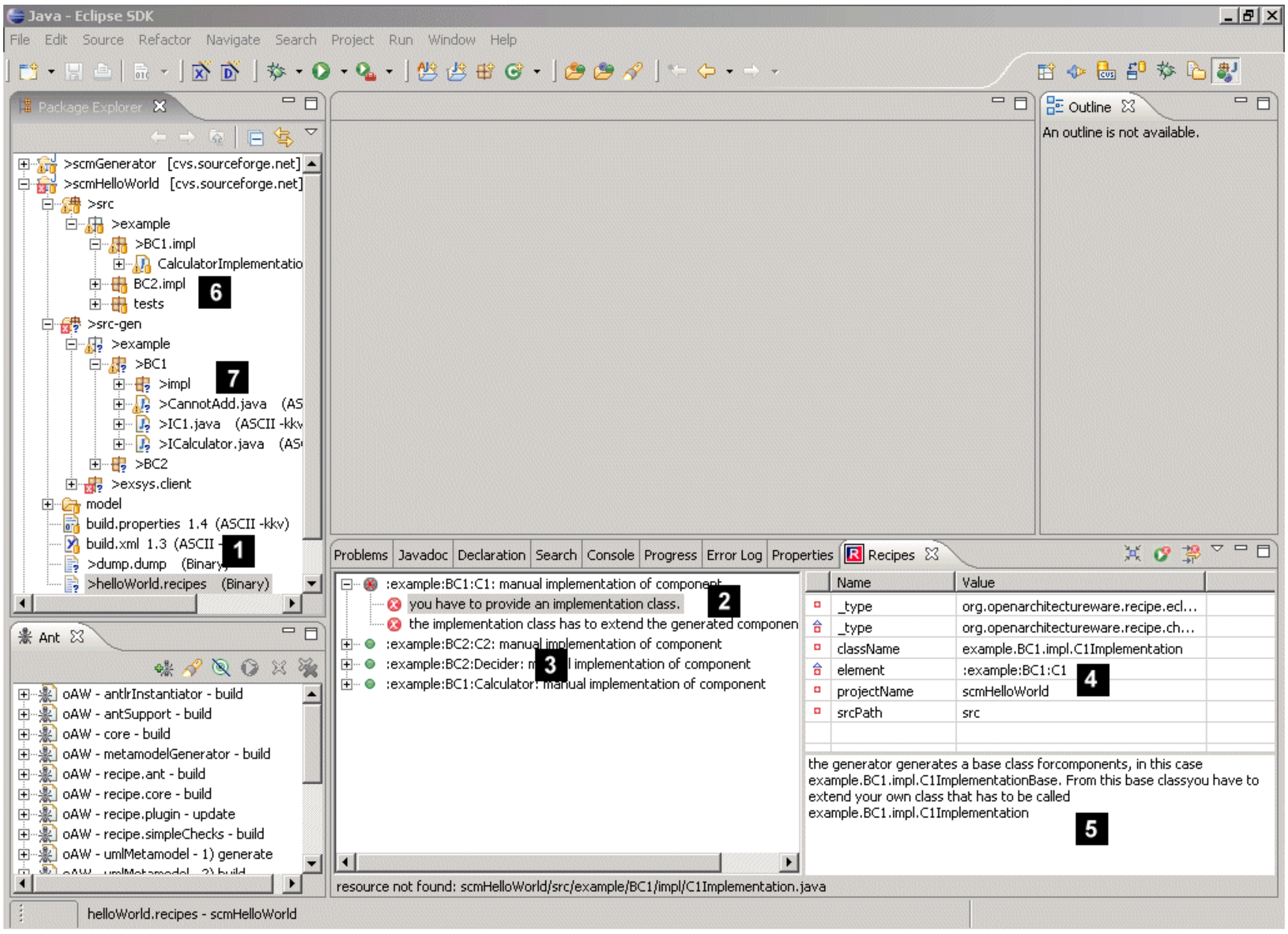
The next version of the RSA/RSM adapter will support profiles found in the classpath of the generator project. In addition profiles can be added more selectively.

Chapter 12. Recipe Framework

12.1. Introductory Example and Plugin

Currently it not feasible in MDSD to generate 100% of an application. Usually, you generate some kind of implementation skeleton into which developers integrate their own manually written code. For example, the generator generates an abstract base class, from which developers extend their implementation classes – which contains the application logic.

The screenshot above shows an example – and also illustrates the use of the Recipe Plugin. Let’s look at the various items in the screenshot.


Java - Eclipse SDK
File Edit Source Refactor Navigate Search Project Run Window Help
Package Explorer
>scmGenerator [cvs.sourceforge.net]
>scmHelloWorld [cvs.sourceforge.net]
>src
>example
>BC1.impl
CalculatorImplementatio
BC2.impl
tests
>src-gen
>example
>BC1
>impl
>CannotAdd.java (AS
>IC1.java (ASCII -kkv
>ICalculator.java (AS
>BC2
>exsys.client
model
build.properties 1.4 (ASCII -kkv)
build.xml 1.3 (ASCII
>dump.dump (Binary
>helloWorld.recipes (Binary)
Ant
oAW - antlrInstantiator - build
oAW - antSupport - build
oAW - core - build
oAW - metamodelGenerator - build
oAW - recipe.ant - build
oAW - recipe.core - build
oAW - recipe.plugin - update
oAW - recipe.simpleChecks - build
oAW - umlMetamodel - 1) generate
Outline
An outline is not available.
Problems Javadoc Declaration Search Console Progress Error Log Properties Recipes
1
2
3
4
5
6
7

:example:BC1:C1: manual implementation of component
you have to provide an implementation class.
the implementation class has to extend the generated componen
:example:BC2:C2: manual implementation of component
:example:BC2:Decider: manual implementation of component
:example:BC1:Calculator: manual implementation of component

Name	Value
_type	org.openarchitectureware.recipe.ecl...
_type	org.openarchitectureware.recipe.ch...
className	example.BC1.impl.C1Implementation
element	:example:BC1:C1
projectName	scmHelloWorld
srcPath	src

the generator generates a base class forcomponents, in this case example.BC1.impl.C1ImplementationBase. From this base classyou have to extend your own class that has to be called example.BC1.impl.C1Implementation

resource not found: scmHelloWorld/src/example/BC1/impl/C1Implementation.java

helloWorld.recipes - scmHelloWorld

Figure 12.1. Recipe Example

1. The generator creates a so-called `.recipes` file. How this file is created will be shown below. The recipe file contains the checks that need to be executed on the code base. In the context menu of a `.recipes` file you’ll find an item called Open Recipe File that opens the checks in the respective browser. Note that the file has to have a `.recipes` extension – otherwise the plugin will not open the file!

2. Here you can see failed checks. The messages tell you that you have to write the implementation class, and (the second item) you’ll have to make sure it extends from the generated base class.

3. Here you can see a check that worked well.

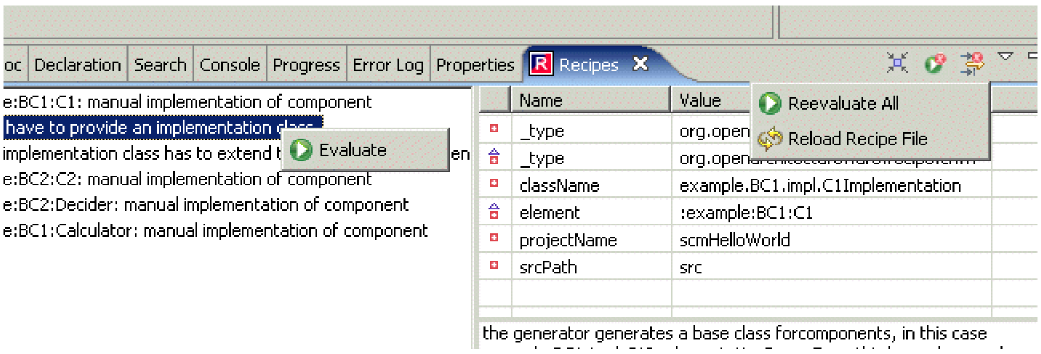
4. Each check contains a number of parameters; the table shows the parameters of the selected check. For example the name of the class to be generated, the one from which you have to inherit, etc. This is basically for your information. If you double-click on a certain row, the value of the parameter is copied to the clipboard – and you can past it to wherever you need.

5. Here you can see a descriptive text that explains what you have to do in order to fix the failed check.

6. Here is the manually written code (in the src folder). You can see the class `CalculatorImplementation` – this is why the check that verifies its presence is successful. There is no `C1Implementation` why the check that checks its presence fails.

7. This is the generated code folder (`src-gen`). It contains the generated base classes.

There are a couple of options to work with those recipes, as shown in the next illustration.



e:BC1:C1: manual implementation of component
have to provide an implementation class
implementation class has to extend t
e:BC2:C2: manual implementation of component
e:BC2:Decider: manual implementation of component
e:BC1:Calculator: manual implementation of component

	Name	Value
	_type	org.open
	_type	org.open
	className	example.BC1.impl.C1Implementation
	element	:example:BC1:C1
	projectName	scmHelloWorld
	srcPath	src

the generator generates a base class forcomponents, in this case

Figure 12.2. Using the Recipe plugin

If you right-click on a check in the treeview, you can reevaluate the check explicity. The buttons at the top right of the view has three buttons: the first on collapses the tree view. The “play button with the small red cross” re-evaluates all the failed checks – and only those! The third button is a filter button; if selected, the tree view hides the checks that are ok. In the view’s drop down menu (activated with the small downward-pointing triangle) there are two entries: the green run-button labelled “reevaluate all” reevaluates all checks, even those that have been successful before. And finally, the reload button reloads the recipe file, and reevaluates everything.

There are two important automation steps:

- First of all, you should make sure that when you run the generator – typically through an ant file – the workspace will be refreshed after the ant run (you can configure this in Eclipse). If you do this, the view will automatically reload the recipe file and reevaluate all the checks.

- There are certain kinds of checks that automatically re-evaluate if the workspace changes. This means that, for example, if you add the implementation class in the above example, as soon as you save the class file, the check will evaluate to true. The question which checks will be evaluated automatically has to be defined in the check definition – see below.

12.1.1. Installing the Plugin

There are two steps. The first one installs the plugin itself, i.e. the Recipe Browser View, etc. The respective plugin is org.openarchitectureware.recipe. As usual you install it by copying it into the Eclipse plugin directory or just downloading it from the oAW update site. If the plugin is installed in this way, it can only evaluate the (relatively trivial) checks in the `recipe.simpleChecks` project. To check useful things, you'll have to extend the plugin – you have to contribute the checks that should be executed. For this purpose, the `org.openarchitectureware.recipe` plugin provides the `check` extension point. A number of useful checks that can be evaluated in Eclipse are contained in the `org.openarchitectureware.recipe.eclipseChecks` plugin. You should install that one, too. It also comes automatically from the update site.

In general, this means: whenever you develop your own checks and want to evaluate them in Eclipse, you have to contain them in a plugin and extend the above-mentioned extension point. Otherwise it will not work.

12.1.2. Referencing the JAR files

In order for the workflow to find the recipe JARs, they need to be on the classpath. The easiest way to achieve that is to make your generator project a plugin project and reference the recipe plugins in the plugin dependencies (all the oAW plugins with recipe in their name). This will update your classpath and add the necessary JARs. If, for some reason, you don't want your projects to be plugins, you have to reference the JAR files of the above mentioned plugins manually.

12.2. Executing Recipe Checks

12.2.1. Running Checks within your workflow

You have to write a workflow component that creates the recipes. Your custom workflow component has to extend the `RecipeCreationComponent` base class and overwrite the `createRecipes()` operation. The operation has to return the collection of recipes that should stored into the recipe file. In the workflow file, you then have to configure this component with the name of the application project in Eclipse, the souce path where the manually write code can be found and the name of the recipe file to be written.

Please take a look a the emfHelloWorld example. It contains an extensive example of how to use the recipes in oAW 4.

12.2.2. Running Checks within Ant

You can also check the recipes using ant. Of course you cannot use those nice and cool interactive checks – and you also can't use Eclipse-based checks. They can be in the recipes file, since the ant tasks skips them automatically. The following piece of ant code shows how to run the checks – should be self-explanatory. Note that you have to use all the jar files from the recipe.ant project.

```
<?xml version="1.0" encoding="ISO-8859-1" ?>
<project name="scm - hello world - generate" default="generate">
   <property file="build.properties" />
   <path id="ant.runtime.classpath">
      <pathelement location="${GENROOT}" />
      <fileset dir="${GENROOT}" includes="*.jar"/>
      <fileset dir="${OAWROOT}/dist" includes="*.jar"/>
      <fileset dir="${RECIPE.CORE.DIR}/dist" includes="*.jar"/>
      <fileset dir="${RECIPE.SIMPLECHECKS.DIR}/dist" includes="*.jar"/>
      <fileset dir="${RECIPE.ANT.DIR}/dist" includes="*.jar"/>
      <fileset dir="${RECIPE.ANT.DIR}/lib" includes="*.jar"/>
      <fileset dir="${RECIPE.ECLIPSECHECKS.DIR}" includes="*.jar"/>
   </path>
   <target name="check" depends="">
```

```
      <taskdef name="check"
         classname="org.openarchitectureware.recipe.ant.RecipeCheckTask">
         <classpath refid="ant.runtime.classpath" />
      </taskdef>
      <check recipeFile="L:/workspace/xy/helloWorld.recipes"/>
   </target>
</project>
```

The checks use log4j logging to output the messages. So you can set the log level using the log4j.properties file. The following output shows all the checks being successful:

```
Buildfile: l:\exampleWorkspace-v4\scmHelloWorld\build.xml
check:
    [check] 0    INFO  - checking recipes from file:
          L:/runtime-EclipseApplication/xy/helloWorld.recipes
BUILD SUCCESSFUL
Total time: 1 second
```

If you set the log level to DEBUG, there’s more; you can see that all the Eclipse checks are skipped.

```
Buildfile: l:\exampleWorkspace-v4\scmHelloWorld\build.xml
check:
    [check] 0    INFO  - checking recipes from file: L:/runtime-
            EclipseApplication/xy/helloWorld.recipes
    [check] 60   DEBUG - [skipped] resource exists exists –
            skipped - mode was batch only.
    [check] 70   DEBUG - [skipped] resource exists exists –
            skipped - mode was batch only.
    [check] 70   DEBUG - [skipped] resource exists exists –
            skipped - mode was batch only.
    [check] 80   DEBUG - [skipped] resource exists exists –
            skipped - mode was batch only.
    [check] 80   DEBUG - [skipped] resource exists exists --
            skipped - mode was batch only.
    [check] 90   DEBUG - [skipped] resource exists exists –
            skipped - mode was batch only.
    [check] 90   DEBUG - [skipped] resource exists exists –
            skipped - mode was batch only.
    [check] 90   DEBUG - [skipped] resource exists exists –
            skipped - mode was batch only.
BUILD SUCCESSFUL
Total time: 1 second
```

If there are errors, they will be output as a ERROR level message.

12.2.3. Implementing your own Checks

12.2.3.1. Hello World

The following piece of code is the simplest check you could possibly write:

```
package org.openarchitectureware.recipe.checks.test;

import org.openarchitectureware.recipe.core.AtomicCheck;
import org.openarchitectureware.recipe.eval.EvaluationContext;

public class HelloWorldCheck extends AtomicCheck {
  private static final long serialVersionUID = 1L;
  public HelloWorldCheck() {
    super( "hello world", "this check always succeeds" );
  }

  public void evaluate(EvaluationContext c) {
    ok();
  }
}
```

A couple of notes:

- You can define any kind of constructor you want – passing any parameters you like. You *have* to pass at least two parameters to the super constructor: the first one is the name, a short name, of the check. The second parameter is the somewhat longer message. You can call `setLongDescription()` if you want to set the explanatory text.
- You can pass a third parameter to the super constructor: and that is one of the two constants in `EvalTrigger`. By default, the `EvalTrigger.ON_REQUEST` is used which means that the check is only evaluated upon explicit request. If you pass `EvalTrigger.ON_CHANGE`, the check will be automatically re-evaulated if the Eclipse workspace changes.
- You should define a serial version uid since Java serialization is used for the recipe file.
- In the `evaluate()` method you do the check itself. We will explain more on that later.

12.2.3.2. More sensible Checks

More sensible checks distinguish themselves in two respects:

- First, you'll typically pass some parameters to the constructor which you'll store in member variables and then use in the `evaluate()` operation.
- You can store parameters for display in the table view in the plugin. You can use the setParameter(name, value)`setParameter( name, value )` operation for that. More on that below.
- The evaluation will contain a certain business logic.

An example:

```
public void evaluate(EvaluationContext c) {
   if ( something is not right ) {
      fail( "something has gone wrong");
   }
   if ( some condition is met ) {
      ok();
   }
```

By the way, you don't need to care about the EvaluationContext. Its only needed by the framework.

12.2.3.3. Eclipse Checks

Eclipse checks are a bit special. If the check were implemented in the way described above, you'd have a lot of dependencies to all the Eclipse plugins/jars. You'd have these dependencies as soon as you'd instantiate the check – i.e. also in the generator when you configure the check. In order to avoid this, we have to decouple the configuration of a check in the generator and its evaluation later in Eclipse:

1. During configuration we don't want any Eclipse dependencies since we don't want to "import" half of Eclipse into out ant-based code generator

2. However, when evaluating the check we obviously need the Eclipse dependencies, otherwise we couldn't take advantage of Eclipse-based checks in the first place.

An Eclipse check is thus implemented in the following way. First of all, our check has to extend the `EclipseCheck` base class.

```
public class ResourceExistenceCheck extends EclipseCheck {
```

Again, we add a serial version uid to make sure deserialization will work.

```
private static final long serialVersionUID = 2L;
```

In the constructor we decide whether we want to have this check evaluated whenever the Eclipse workspace changes (`EvalTrigger.ON_CHANGE`) or not. We also store some of the parameters in the parameter facility of the framework. Note that we *do no implement the `evaluate()`* operation!

```
   public ResourceExistenceCheck( String message,
          String projectName, String resourceName ) {
      super( "resource exists exists", message, EvalTrigger.ON_CHANGE );
      setProjectName( projectName );
      setResourceName( resourceName );
   }

   private void setProjectName(String projectName) {
      setParameter( "projectName", projectName );
   }

   private void setResourceName(String resourceName) {
      setParameter( "resourceName", resourceName );
   }
```

In order to provide the evaluation functionality, you have to implement an `ICheckEvaluator`. *It has to have the same qualified name as the Check itself, postfixed with Evaluator*. During the evaluation of the check, the class is loaded dynamically based on its name. A wrong name will result in a runtime error during evaluation the Eclipse Plugin.

```
public class ResourceExistenceCheckEvaluator
implements ICheckEvaluator {

public void evaluate( AtomicCheck check ) {
   String projectName =
       check.getParameter("projectName").getValue().toString();
   String resourceName =
      check.getParameter("resourceName").getValue().toString();
   IWorkspace workspace = ResourcesPlugin.getWorkspace();
   IResource project =
        workspace.getRoot().getProject(projectName);
   if ( project == null )
      check.fail("project not found: "+projectName);
   IFile f = workspace.getRoot().getFile(
      new Path(projectName+"/"+resourceName) );
   String n = f.getLocation().toOSString();
   if ( !f.exists() ) check.fail(
      "resource not found: "+projectName+"/"+resourceName);
      check.ok();}
```

When implementing the evaluator, you can basically do the same things as in the `evaluate()` operation in normal checks. However, in order to set the `ok()` or `fail(“why”)` flags, you have to call the respective operations on the check passed as the parameter to the operation.

12.2.3.4. Making checks available to the Eclipse plugin

In order to allow the Eclipse runtime to execute your checks, it has to find the respective classes when deserializing the recipe file. This is a bit tricky in Eclipse, since each plugin has its own classloader. So assume you want to define your own checks and want to use them in Eclipse; what you have to do is: implement your own plugin that extends a given extension point in the Recipe Browser plugin. The following XML is the plugin descriptor of the *org.openarchitectureware.recipe.eclipseChecks.plugin.EclipseChecksPlugin*, a sample plugin that comes with the recipe framework and provides a number of Eclipse-capable checks.

```
<?xml version="1.0" encoding="UTF-8"?>
<?eclipse version="3.0"?>
<plugin
   id="org.openarchitectureware.recipe.eclipseChecks"
   name="%plugin_name"
   version="4.0.0"
   provider-name="%provider_name"
   class="org.openarchitectureware.recipe.\
   eclipseChecks.plugin.EclipseChecksPlugin">
```

Here we now define the jar file that contains our checks (will be important below!)

```
   <runtime>
      <library name="oaw-recipe-eclipsechecks.jar">
         <export name="*"/>
      </library>
   </runtime>
```

The required plugins mainly depend on the implementations of the CheckEvaluators, of course, however, you have to make sure the dependencies contains the *org.openarchitectureware.recipe* plugin, since you’re going to extend an extension point defined therein.

```
   <requires>
      <import plugin="org.eclipse.ui"/>
      <import plugin="org.eclipse.core.runtime"/>
      <import plugin="org.eclipse.core.resources"/>
      <import plugin="org.openarchitectureware.recipe"/>
      <import plugin="org.eclipse.jdt.core"/>
   </requires>
```

This is the important line: here you specify that you extend the *check* extension point of the Recipe Browser Plugin. If you don’t do this, deserialization of the recipe file will fail and you’ll get nasty errors. And yes, you need the dummy element; otherwise the class loading "magic" will not work.

```
   <extension point="org.openarchitectureware.recipe.check”>
      <dummy/>
   </extension>
</plugin>
```

When you need to use the checks outside of Eclipse (e.g. in the generator for configuration/serialization purposes) you just add the plugin’s jar to your generator classpath. You *don’t* need all the Eclipse plugin’s jars referenced in the requires section, since these things will only be used during evaluation!

12.2.4. Framework components

Component	Plugin	Depends on	Description
recipe.core	Yes	-	Framework core. Needed whenever you do anything with recipes
recipe.ant	Yes	recipe.core	Contains the ant task to check recipes. Needed only for recipe evaluation in ant
recipe.simpleChecks	Yes	recipe.core	Contains a number of (more or less useful) sample checks
recipe.plugin	Yes	recipe.core	Contains the Eclipse Recipe Browser view
recipe.eclipsechecks.plugin	Yes	recipe.core	Contains the pre-packaged Eclipse checks.

12.2.5. List of currently available Checks

This table contains a list of all currently available checks. We are working on additional ones. Contributions are always welcome! This list might thus not always be up to date – just take a look at the code to find out more.

Type	Classname	Purpose
Batch	*org.openarchitectureware.recipe.checks. file.FileExistenceCheck*	Checks whether a given file exists
Batch	*org.openarchitectureware.recipe.checks. file.FileContentsCheck*	Checks whether a given substring can be found in a certain file
Eclipse	*org.openarchitectureware.recipe. eclipseChecks.checks. JavaClassExistenceCheck*	Checks whether a given Java class exists
Eclipse	*org.openarchitectureware.recipe. eclipseChecks.checks. JavaSupertypeCheck*	Checks whether a given Java class extends a certain superclass
Eclipse	*org.openarchitectureware.recipe. eclipseChecks.checks. ResourceExistenceCheck*	Checks whether a given Eclipse Workspace Resource exists

Chapter 13. UML2Ecore Reference

13.1. What's this?

Building meta models with EMF's internal tools is tedious. Using the tree view based editors doesn't scale. Once you're at more than, say, 30 metaclasses, things become hard to work with. The same is true for GMF's Ecore editor. Since you cannot easily factor a large meta model into several diagrams, the diagram get cluttered and layouting becomes almost impossible.

One way to solve this problem is to use UML tools to draw the meta model and then transform the UML model into an Ecore instance.

The oAW uml2ecore utiliy transforms a suitably structured Eclipse UML2 model (which can be created using various tools) into an ecore file.

Note that this tool also serves as a tutorial for writing model-to-model transformations. This aspect, however, is documented elsewhere. This document only shows how to use the uml2ecore tool.

13.2. Setting up Eclipse

You need an installation of oAW 4.1 including the UML2 support. Run the UML2 example (available for download on the oAW download page) to verify that you have all the UML2 stuff installed.

The only additional thing required is that you install the uml2ecore plugin into your Eclipse installation. The plugin is part of the oAW 4.1.2 distribution.

13.3. UML Tool Support

Of course you could use UML2's supplied tree editors for drawing the UML2 model that should be transformed into Ecore. However, this is useless, since then you're back to square one: tree editors. So you need to use an UML tool that is able to export the model in the *Eclipse UML2 2.0* format. For example, MagicDraw 11.5 (or above) can do that; this tool (MD11.5) is also the one we tested the uml2ecore utility with.

Note that we do not use any profiles in the uml2ecore utiliy. Although using profiles might make the metamodel a bit more expressive, we decided not to use a specific profile, to reduce the potential for compatibility problems (with the various tools).

13.4. Setting up your meta model project

You should first create a new Generator project (select *File->New->Other->openArchitectureWare/Generator Project*).

Then open your UML2 tool of choice (we'll use MagicDraw here) and draw a class diagram that resembles your metamodel. Here's the one we've drawn as an example for this document:

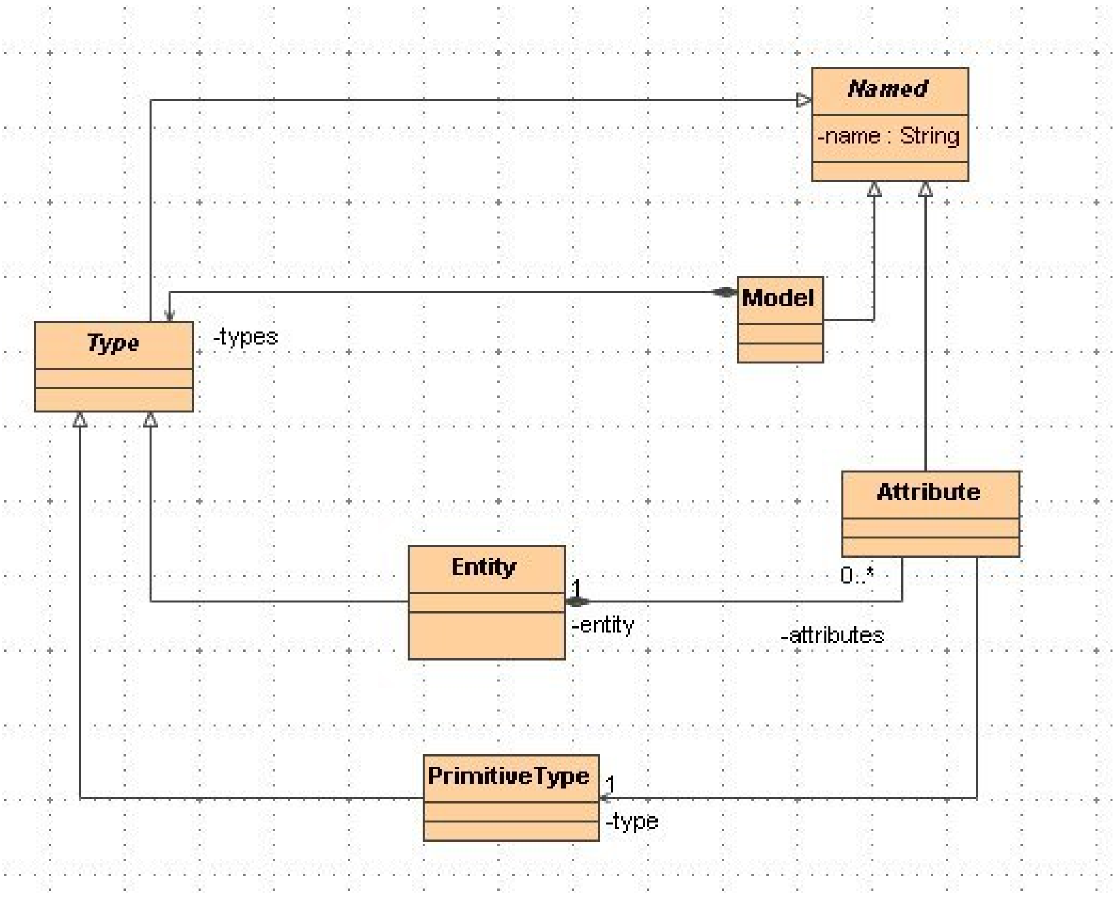


Figure 13.1. UML2Ecore sample metamodel - class diagram

This is the usual meta model for entities and such. Nothing special. Also, the name of the model defines the name of the ecore metamodel; here's the MagicDraw tree view to illustrate this:

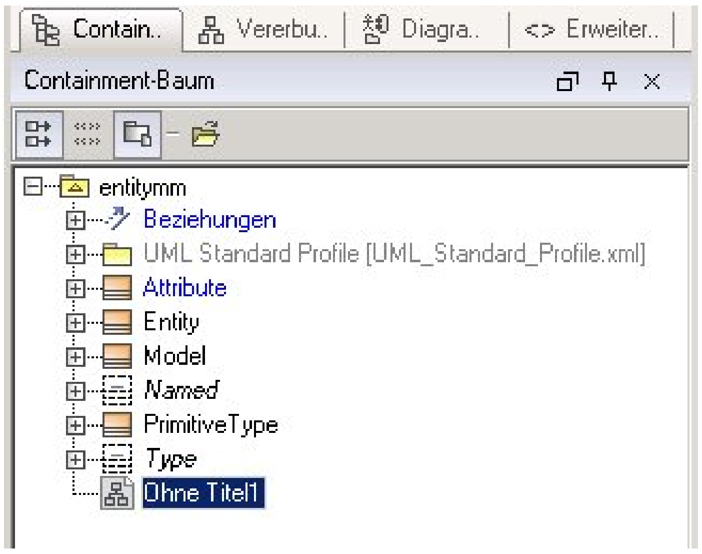


Figure 13.2. UML2Ecore sample metamodel - MagicDraw containment tree

You now have to save/export this model in EclipseUML2 format. In MagicDraw, you do this by selecting *File->Export->Eclipse UML2*. The exported files have to be in the *root of the src folder* in the metamodel project created above! This is how the project looks like after this step, assuming you'd called your model `entity.uml2`:

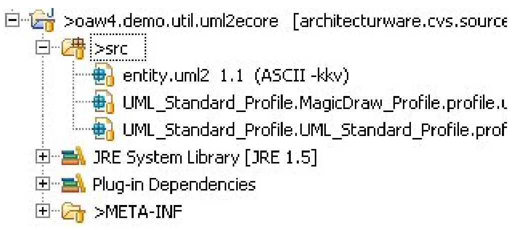

>oaw4.demo.util.uml2ecore [architecturware.cvs.source
>src
entity.uml2 1.1 (ASCII -kkv)
UML_Standard_Profile.MagicDraw_Profile.profile.u
UML_Standard_Profile.UML_Standard_Profile.prof
JRE System Library [JRE 1.5]
Plug-in Dependencies
>META-INF

Figure 13.3. Project layout

Before you can actually run the generator, you have to make sure that your project has a plugin dependency to the uml2ecore plugin. Double-Click on the plugin's manifest file, select the *Dependencies* tab and click add. Select the `org.openarchitectureware.uml2ecore` plugin. The result looks like this:

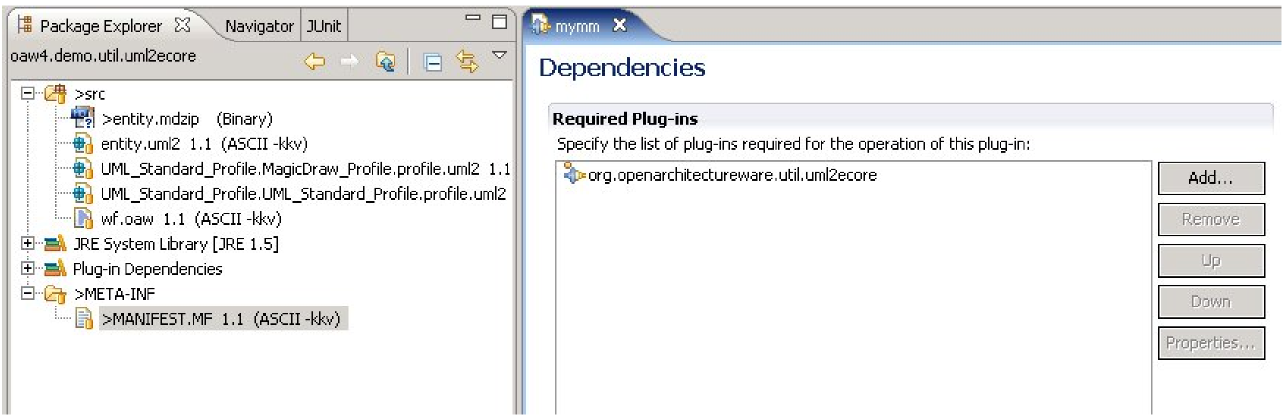

Package Explorer
Navigator
JUnit
oaw4.demo.util.uml2ecore
>src
>entity.mdzip (Binary)
entity.uml2 1.1 (ASCII -kkv)
UML_Standard_Profile.MagicDraw_Profile.profile.uml2 1.1
UML_Standard_Profile.UML_Standard_Profile.profile.uml2
wf.oaw 1.1 (ASCII -kkv)
JRE System Library [JRE 1.5]
Plug-in Dependencies
>META-INF
>MANIFEST.MF 1.1 (ASCII -kkv)
mymm
Dependencies
Required Plug-ins
Specify the list of plug-ins required for the operation of this plug-in:
org.openarchitectureware.util.uml2ecore
Add...
Remove
Up
Down
Properties...

Figure 13.4. Dependencies

In the current version, you also need a dependency to the `org.openarchitectureware.util.stdlib` project. Later versions of the `uml2ecore` plugin will reexport that dependency, so that you will not need to add it you your projects manually.

13.5. Invoking the Generator

As usual, you have to write a workflow file. It also has to reside in your project's source folder. Here's how it looks:

```
<?xml version="1.0"?>
<workflow>
<cartridge
 file="org/openarchitectureware/util/uml2ecore/uml2ecoreWorkflow.oaw"
    uml2ModelFile="org/openarchitectureware/uml2ecore/test/data/entity.uml2"
    outputPath="out"
    nsUriPrefix="http://www.openarchitectureware.org"
    includedPackages="Data"
    addNameAttribute="false"/>
</workflow>
```

As you might expect, it simply calls a cartridge supplied by uml2ecore plugin. You have to define the following properties:

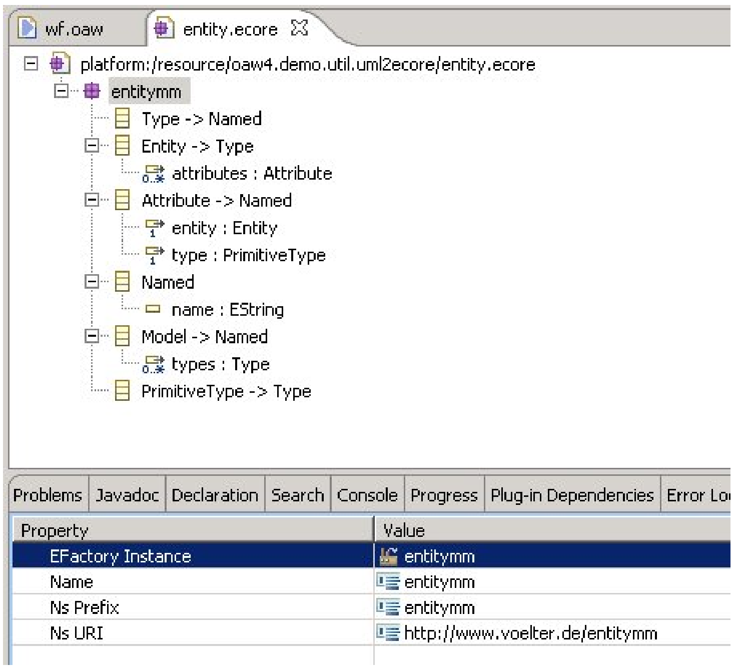
Table 13.1. UML2Ecore - Cartridge properties

Property	Description
`uml2ModelFile`	the is the name of your UML2 file that contains the model; as usual, the file is looked for in the classpath (that's why you had to move it into the source folder)
`addNameAttribute`	`true/false`, the determines whether automatic namespace management and naming is turned on (see the end of this document). For the simple example, please set the value to be false.
`nsUriPrefix`	the nsUriPrefix is used to assemble the namespace URI. The name of the meta model, as well as the nsPrefix, will be derived from the UML model name; so in our example, the nsPrefix and the name of the generated EPackage will be enttymm. The complete namespace URL also required by Ecore is created by concatenating the nsUriPrefix given here, and the name. The resulting namespace URL in the example will thus be http://www.voelter.de/entitymm.
`includedPackages`	determines which packages the transformer should consider when transforming the model; note that the contents of all the packages will be put into the root `EPackage`.
`outputPath`	determines where the resulting files are written to.
`resourcePerToplevelPackage`	It set to true, the generator will write a separate ecore file for each of the top level packages in you UML model. Useful for modularizing meta models (see the end of this chapter).
`nameUnnamedNavigableAssociationEnds`	If set to true all unnamed navigable association ends will be initialized with the name of the target type.

You can now run this workflow by selecting *Run As -> oAW Workflow*. The name of the generated Ecore file will correspond to the name of the root Model element in the UML model.

13.6. The generated Model

Here's a screenshot of the generated model:



```
platform:/resource/oaw4.demo.util.uml2ecore/entity.ecore
  entitymm
    Type -> Named
    Entity -> Type
      attributes : Attribute
    Attribute -> Named
      entity : Entity
      type : PrimitiveType
    Named
      name : EString
    Model -> Named
      types : Type
    PrimitiveType -> Type
```

Property	Value
EFactory Instance	entitymm
Name	entitymm
Ns Prefix	entitymm
Ns URI	http://www.voelter.de/entitymm

Figure 13.5. Generated Ecore model

The generator also creates a constraints file (called `entitymmConstraints.chk`) which contains a number of constraints; currently these are specifically the checks for the minimum multiplicity in references (an error is reported if the minimum multiplicity is one, but the reference is null or empty, respectively). You can integrate the generated constraints file into your workflow using the usual approach.

13.7. Naming

It is often the case the basically all model elements in a model should have a name. It might not always be necessary from a domain perspective, but it's really useful for debugging. Of course, you can add a superclass called `Named` with a single attribute `name` to all you classes. However, if you set the *`addNameAttribute`* parameter to be true when calling the uml2ecore cartridge, every class which does not inherit from another class gets an additioal `name` attribute. Also, constraints that make sure that names within a namespace (i.e. a containement reference) are unique.

uml2ecore also comes with a utility extension called `org::openarchitectureware::util::stdlib::naming` that can calculate the `namespace()` and the `qualifiedName()` for every model element that has a name.

Another convenience is the parameter *`nameUnnamedNavigableAssociationEnds`*. Often you specify a relationship between two metaclasses and give the target end the name of the target metaclass. Let's say you specify an association from metaclass `Application` to `Component`. It is likely that the target end will be called `component`. By setting the parameter to true all unnamed navigable association ends will get the name of the target class. If there is more than one unnamed association only the first one will be modified. This would lead to a failing constraint afterwards, since at least after this modification all navigable association ends must be named.

13.8. Modularizing the meta model file

You can modularize the meta model. If you specify the *`resourcePerToplevelPackage="true"`* parameter to the cartridge call, you'll get a separate ecore file for each top level package, as well as a separate constraint check file.

Chapter 14. "Classic" Reference

14.1. Available UML Tool Adapters

Table 14.1. Available UML tool adapters

UML Tool	Adapter Class [a]	Mapping File
ArgoUML	`argouml.ArgoUMLAdapter`	`argouml_xmi12_all.xml`
ARIS	`aris.ARISAdapter`	`aris_xmi11_all.xml`
Artisan	`artisan.ArtisanAdapter`	`artisan_xmi13_all.xml`

Enterprise Architect
 	
2.5
 	
4.x
 	
5.x
	`ea.EAAdapter`	`ea25_xmi11_all.xml`
		
		`ea41_xmi12_all.xml`
		
		`ea5_xmi11_all.xml`

Enterprise Architect 6.1	`EA61UnisysXmi12Adapter,`
	`EA61Xmi12Adapter`
		`ea61_unisys_xmi12_cls.xml,`
		`ea61_xmi12_cls.xml`

MID Innovator	`innovator.InnovatorAdapter`	`innovator_xmi11_all.xml`
MagicDraw 8 -9	`magicdraw.MagicDrawAdapter12`	`magicdraw_xmi12_all.xml`
MagicDraw 10 - 12	`magicdraw_MagicDrawAdapter21`	`magicdraw_xmi21_all.xml`
Metamill	`metamill.MetamillAdapter`	`metamill31_xmi12_all.xml`
Poseidon 1.6	`poseidon.PoseidonAdapter`	`poseidon16_xmi12_all.xml`
Poseidon 2.x	`poseidon.PoseidonAdapter`	`poseidon20_xmi12_all.xml`
Poseidon 3.0	`poseidon.PoseidonAdapter`	`poseidon30_xmi12_all.xml`
Poseidon 3.1	`poseidon.PoseidonAdapter`	`poseidon31_xmi12_all.xml`
Poseidon 4	`poseidon.PoseidonAdapter`	`poseidon40_xmi12_all.xml`
Poseidon 5	`poseidon.PoseidonAdapter`	`poseidon40_xmi12_all.xml`
Rational Rose/Unisys Plugin 1.3.2 XMI 1.0	`rose.RoseAdapter`	`rose_unisys132_xmi10_all.xml`
Rational Rose/Unisys Plugin 1.3.2 XMI 1.1	`rose.RoseAdapter`	`rose_unisys132_xmi11_all.xml`
Rational Rose/Unisys Plugin 1.3.4/1.3.6 XMI 1.1	`rose.RoseAdapter`	`rose_unisys134_xmi11_all.xml`
Star UML	`staruml.StarUMLAdapter`	`staruml_xmi11_all.xml`
Together	`together.TogetherAdapter`	`together_xmi11_all.xml`
XDE	`xde.XdeAdapter`	`xde2_xmi11_all.xml`

[a]Package Prefix: `org.openarchitectureware.core.frontends.xmi.toolsupport.uml`

14.2. The Classic UML Metamodel

14.2.1. Core and Class Diagram Support

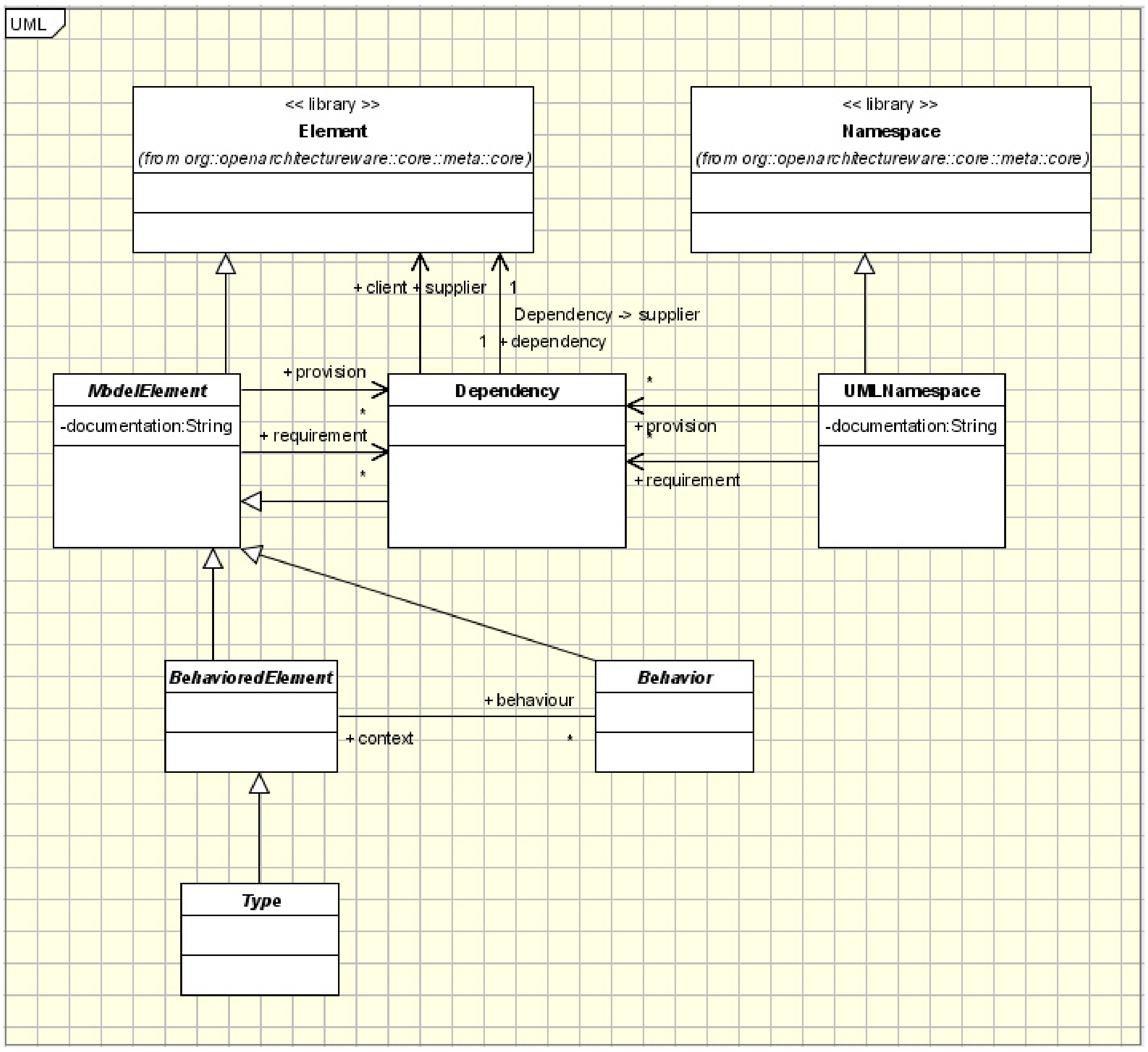


Figure 14.1. Core Elements

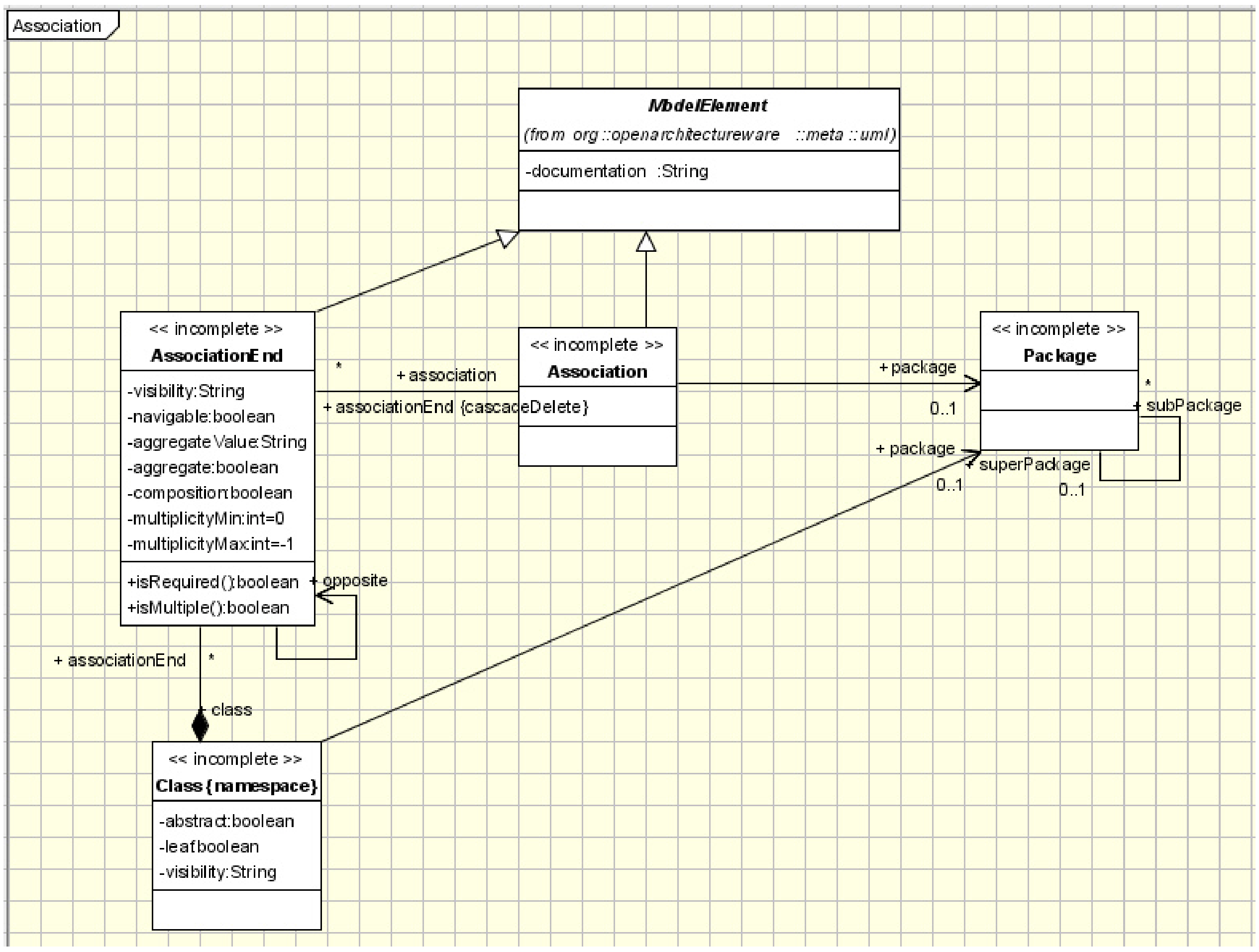


Figure 14.2. Associations

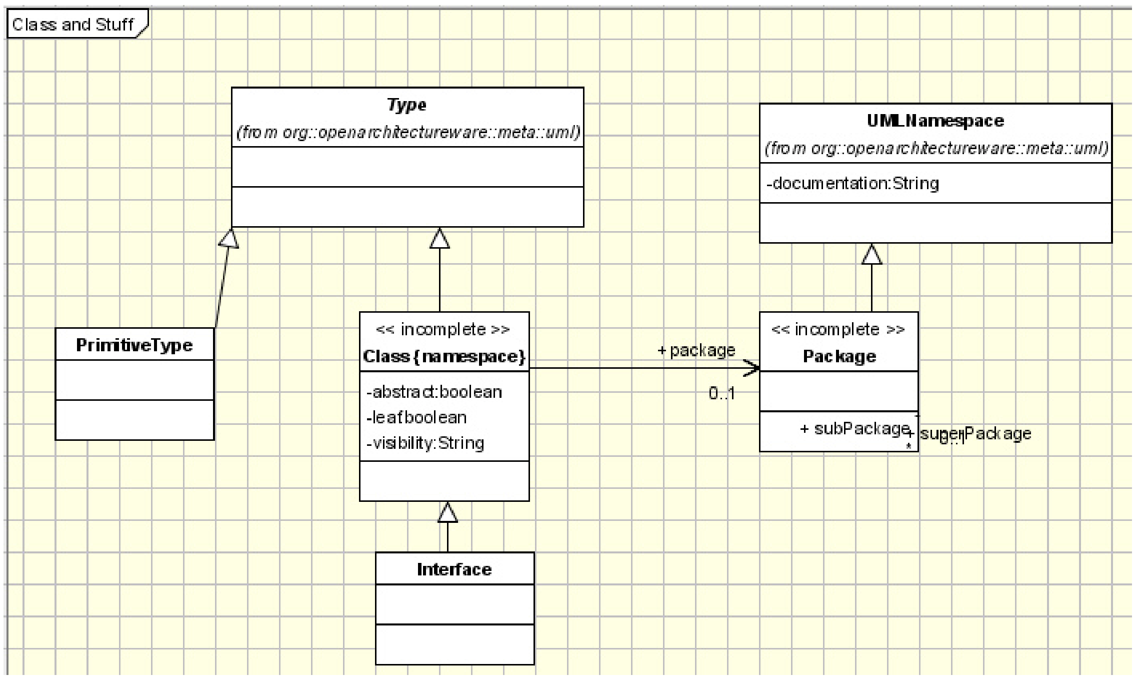


Figure 14.3. Class, Types, Package

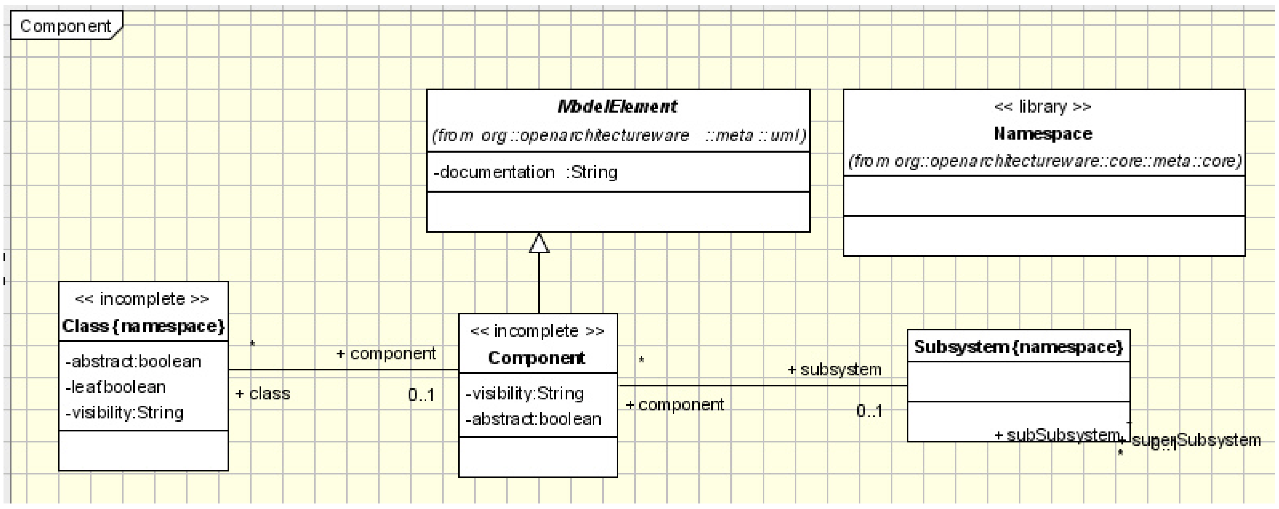


Figure 14.4. Components

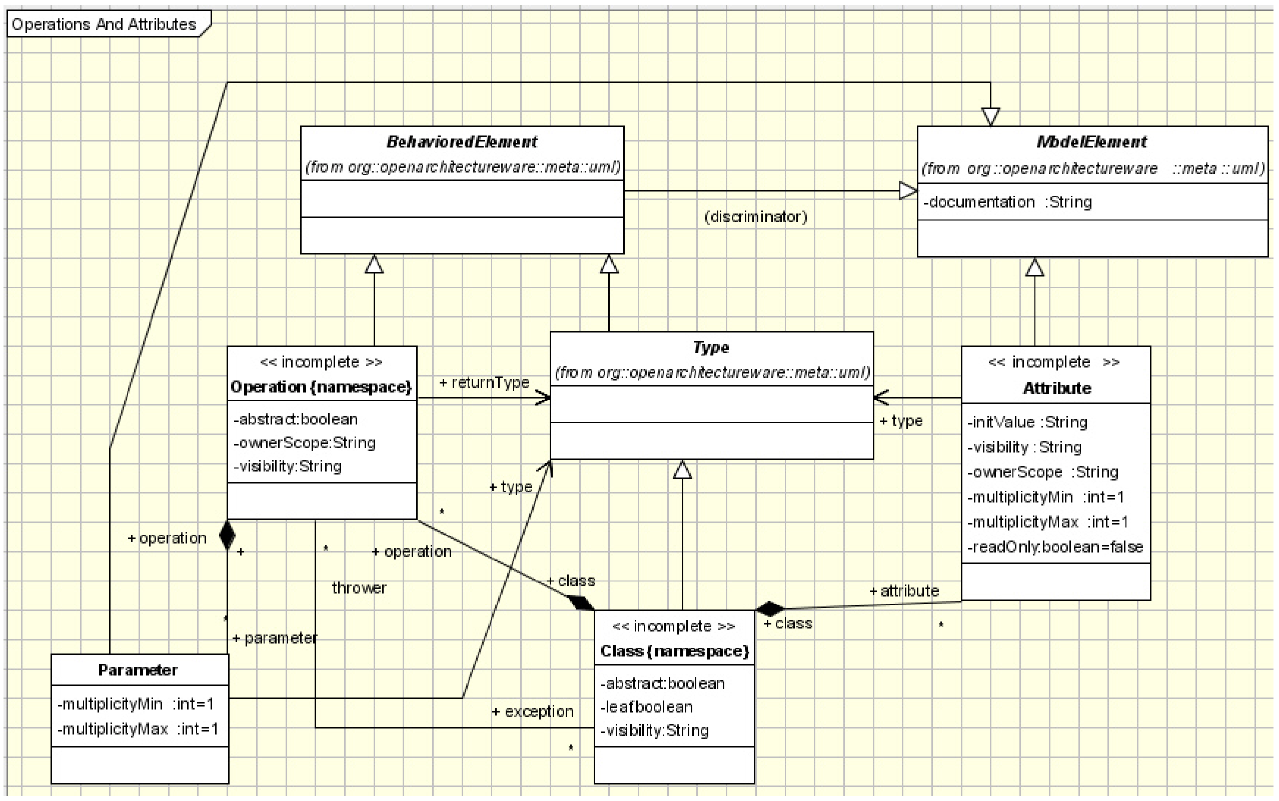


Figure 14.5. Operations and Attributes

14.2.2. Statechart Support

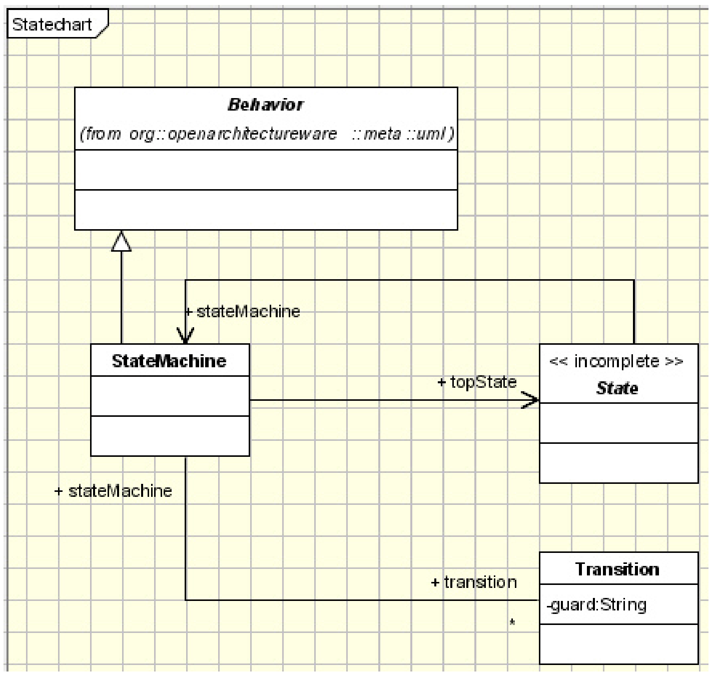


Figure 14.6. State Charts

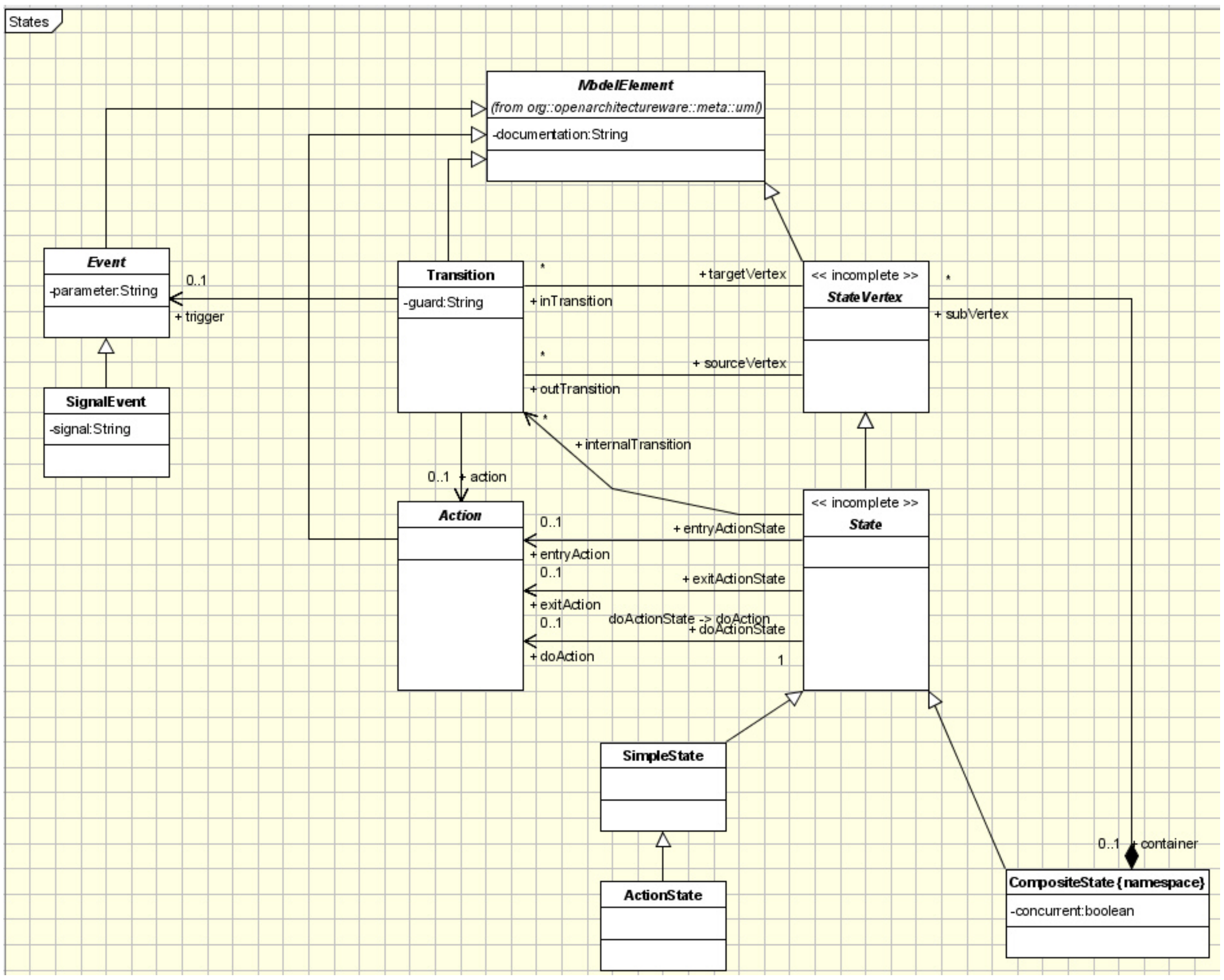


Figure 14.7. States Main

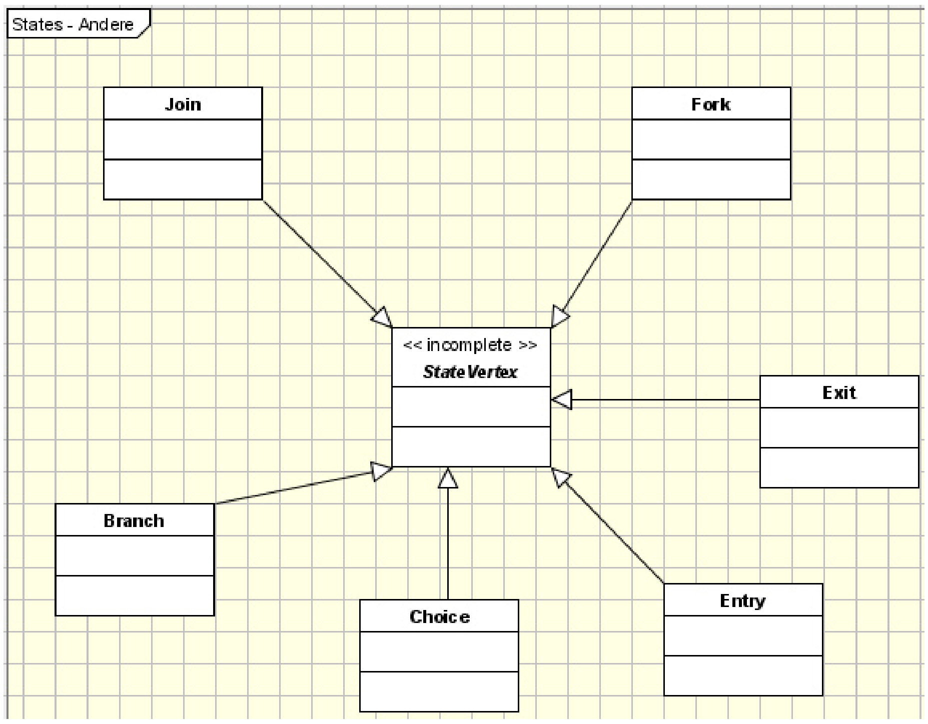


Figure 14.8. StateVertex Subtypes

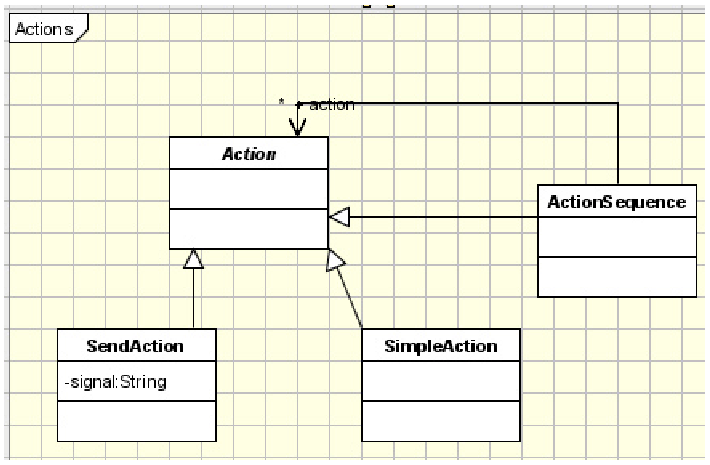


Figure 14.9. Actions

14.2.3. Activity Diagram Support

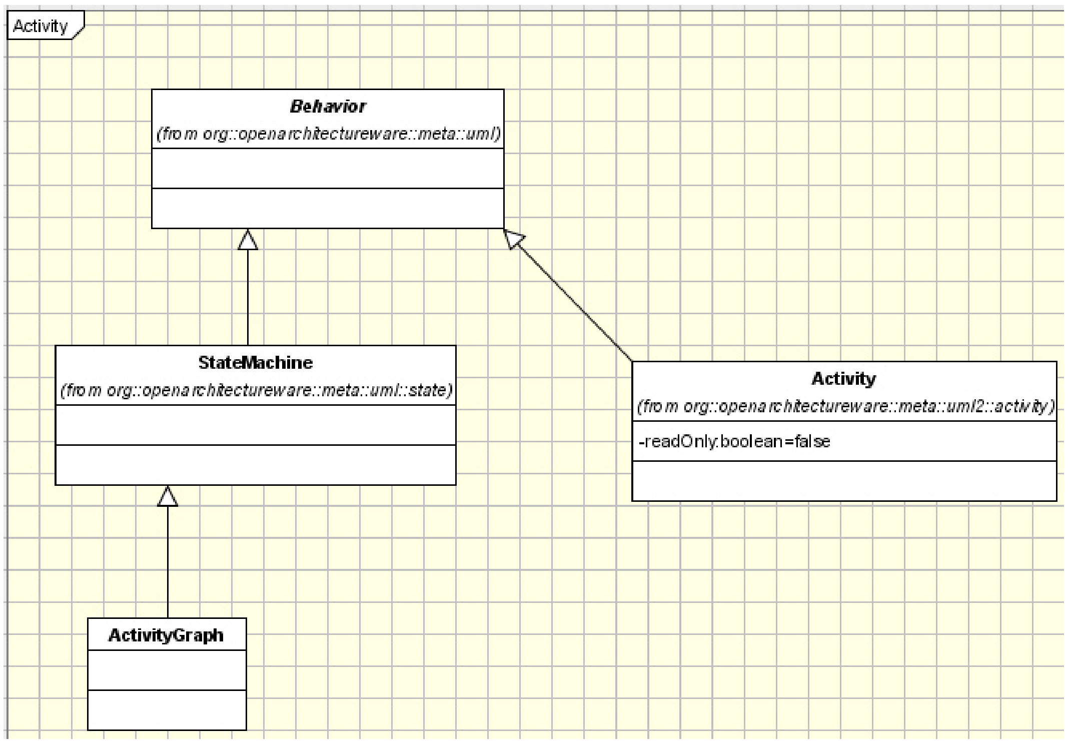

Activity
Behavior
(from org::openarchitectureware::meta::uml)
StateMachine
(from org::openarchitectureware::meta::uml::state)
Activity
(from org::openarchitectureware::meta::uml2::activity)
-readOnly:boolean=false
ActivityGraph

Figure 14.10. Activity

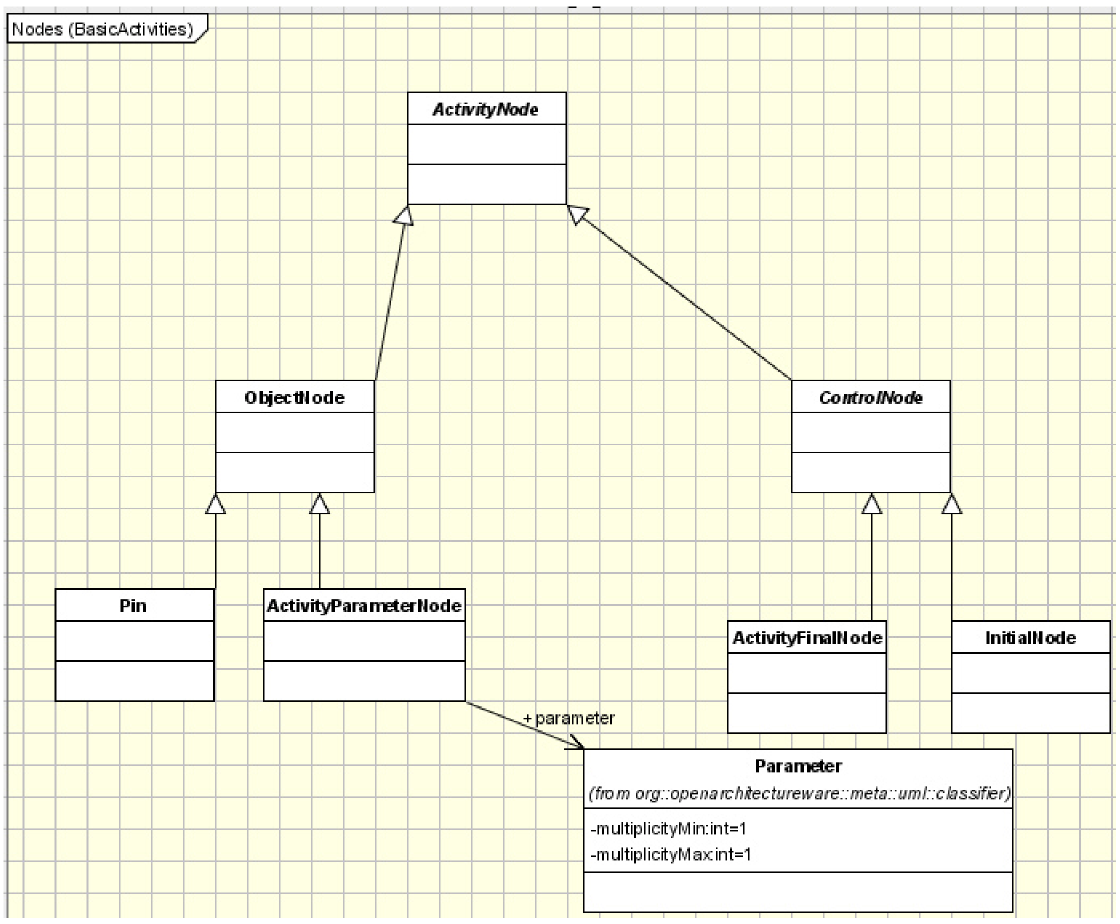


Figure 14.11. Nodes (Basic Activities)

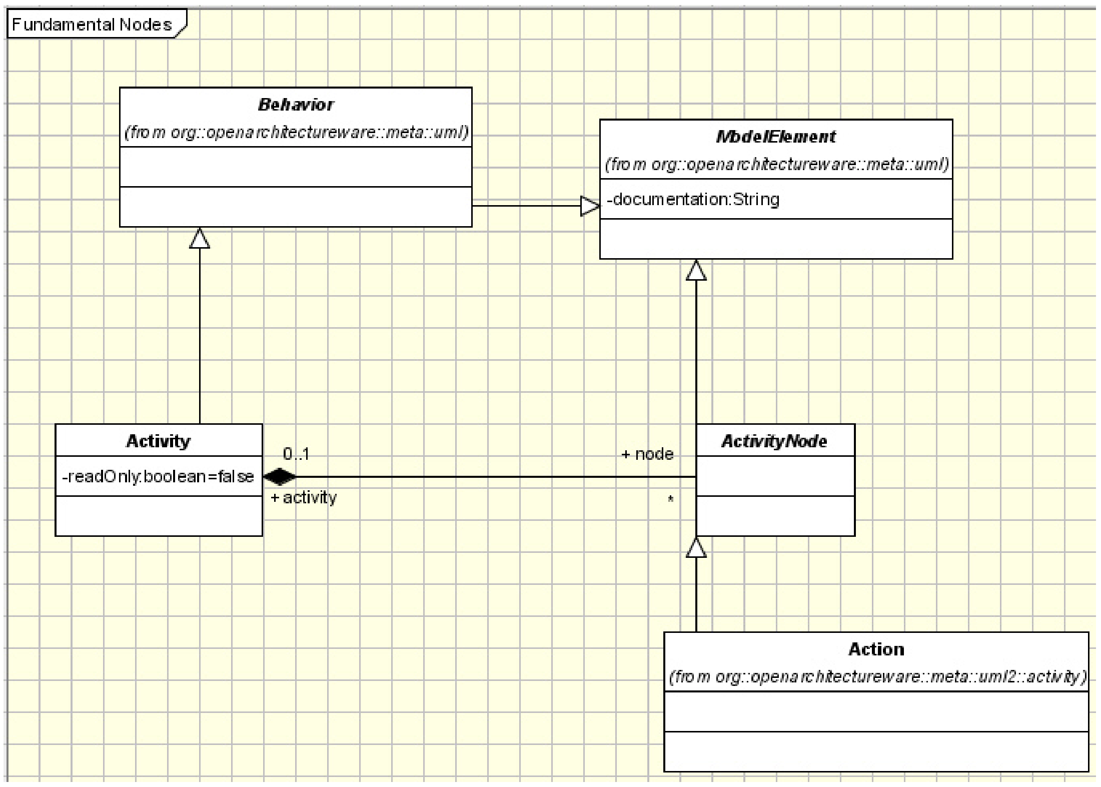

Fundamental Nodes
Behavior
(from org::openarchitectureware::meta::uml)
ModelElement
(from org::openarchitectureware::meta::uml)
-documentation:String
Activity
-readOnly:boolean=false
0..1
+ activity
+ node
*
ActivityNode
Action
(from org::openarchitectureware::meta::uml2::activity)

Figure 14.12. Fundamental Nodes

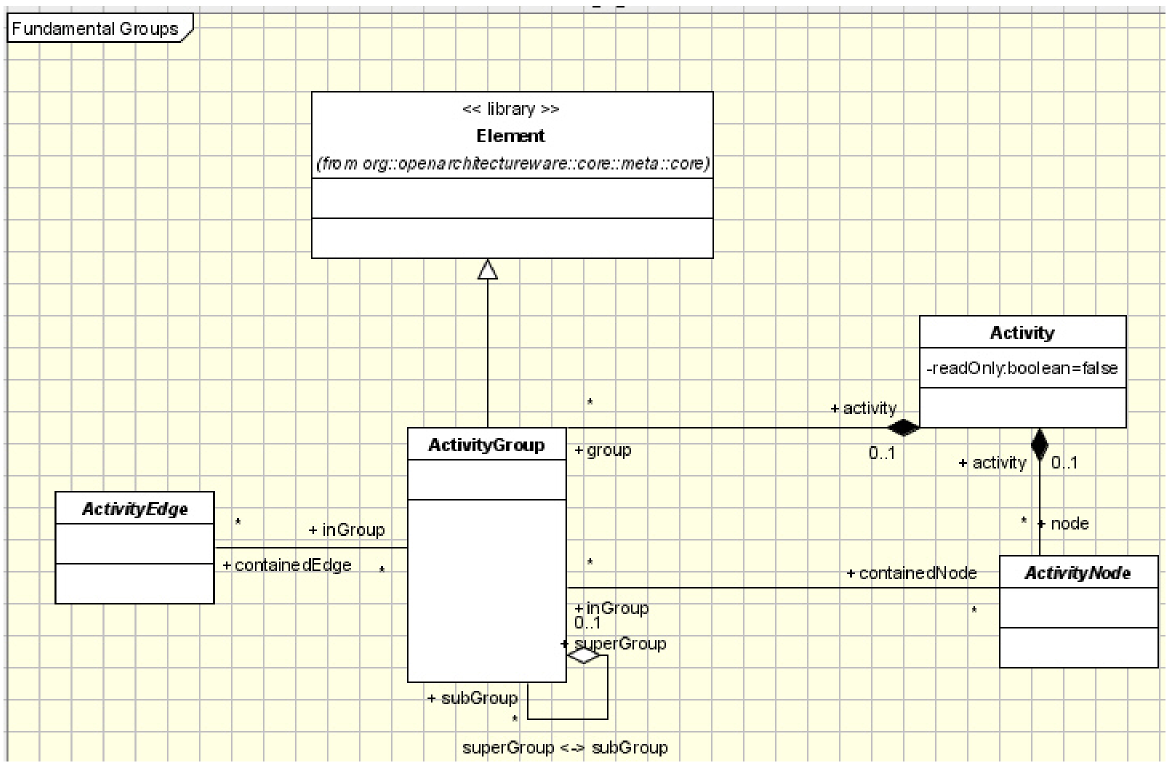


Figure 14.13. Fundamental Groups

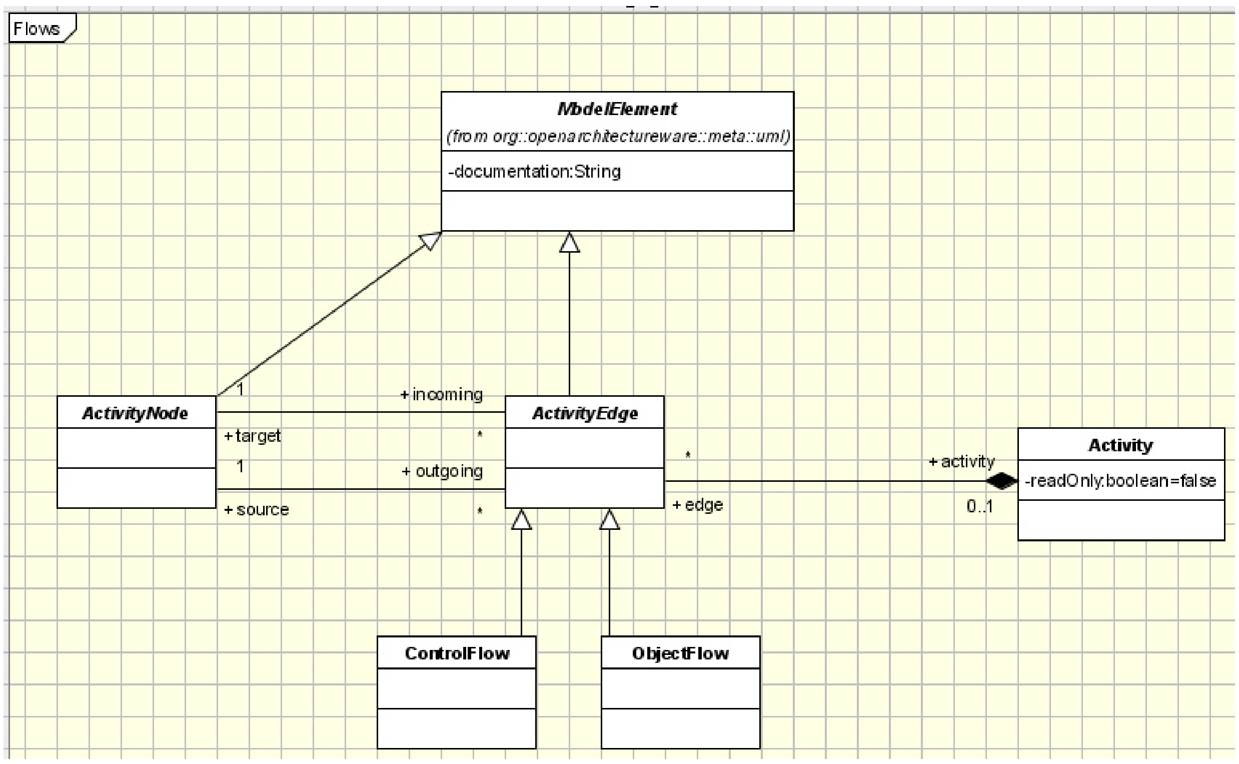


Figure 14.14. Flows

Chapter 15. Classic UML Tutorial

15.1. Introduction

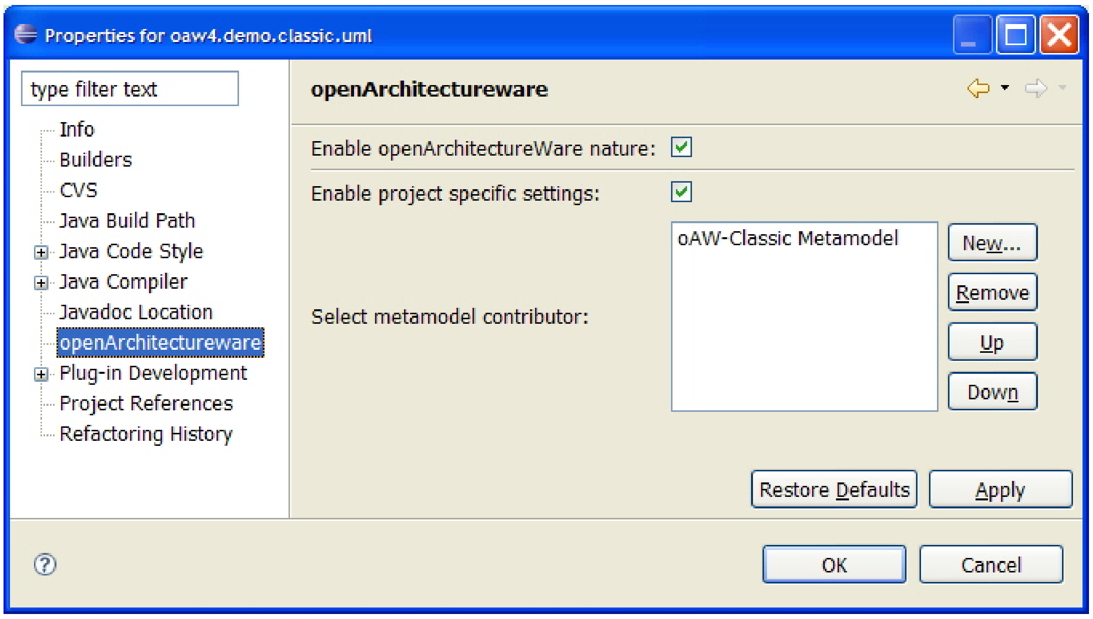
This example shows the usage of openArchitectureWare 4 with integration of an UML tool. In openArchitectureWare 4 we call this "Classic" style, as the underlying metamodel has to be the "Classic" UML metamodel that was introduced by oAW 3. For the example Magic Draw 11.5 Community Edition is used, but the example can easily be adapted to any supported UML tool. It is strongly recommended to work through this tutorial with MagicDraw to minimize environmental problems!

15.2. Installing the sample

Make sure that you installed the openArchitectureWare feature properly in your Eclipse environment.

openArchitectureWare depends on EMF, so check that you have installed it. If you need further information on oAW installation please look at http://www.openarchitectureware.org/staticpages/index.php/documentation.

Instead of working through this tutorial you can also install the packaged example by downloading the `oaw-samples-classic-uml-4.x.x` package. It contains one Eclipse project, which you have to import into your workspace. To make the projects compile and run, you may have to define to use the *oAW-Classic Metamodel* in the project properties:


Properties for oaw4.demo.classic.uml

openArchitectureware

Enable openArchitectureWare nature: ✓

Enable project specific settings: ✓

Select metamodel contributor: oAW-Classic Metamodel

Figure 15.1. Configure oAW-Classic Metamodel

15.3. Example overview

The purpose of this tutorial is to demonstrate the very simplest way to use oAW4 in combination with an (non EMF UML2 capable) UML tool to create code from a model that contains some classes. The project is really simple, so it is the right place to start when you are new to openArchitectureWare 4 and want to use UML tools like MagicDraw, Poseidon, Rational Rose etc.

In this example we want to generate code from this model:

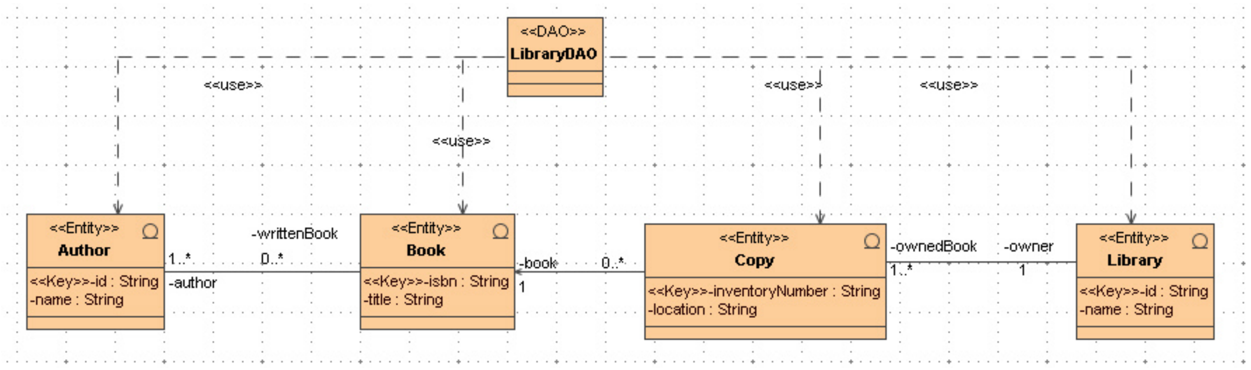
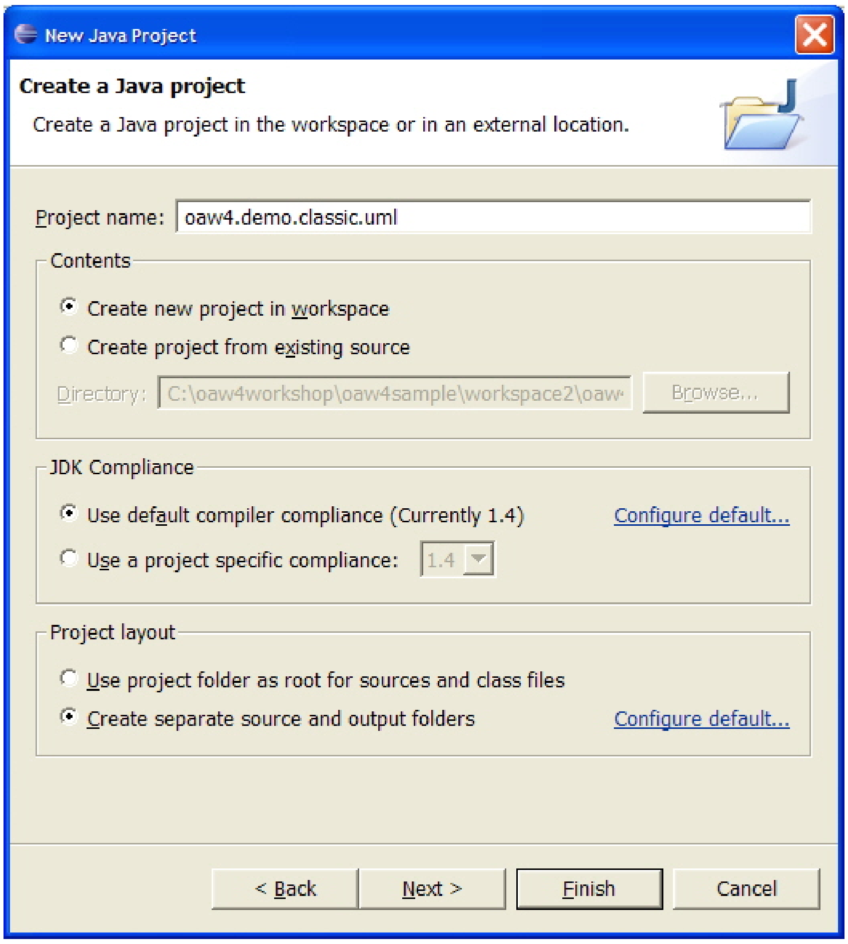


Figure 15.2. Example Model

As a result we want to create some JavaBean style classes which have properties with getter/setter methods.

15.4. Setting up the project

Create a new Java Project called `oaw4.demo.classic.uml` and select the option to create seperate source and output folders.


New Java Project

Create a Java project

Create a Java project in the workspace or in an external location.

Project name: oaw4.demo.classic.uml

Contents

[✓ Create new project in workspace]

Create project from existing source

Directory: C:\oaw4workshop\oaw4sample\workspace2\oaw

JDK Compliance

[✓ Use default compiler compliance (Currently 1.4)]

Use a project specific compliance: 1.4

Project layout

Use project folder as root for sources and class files

[✓ Create separate source and output folders]

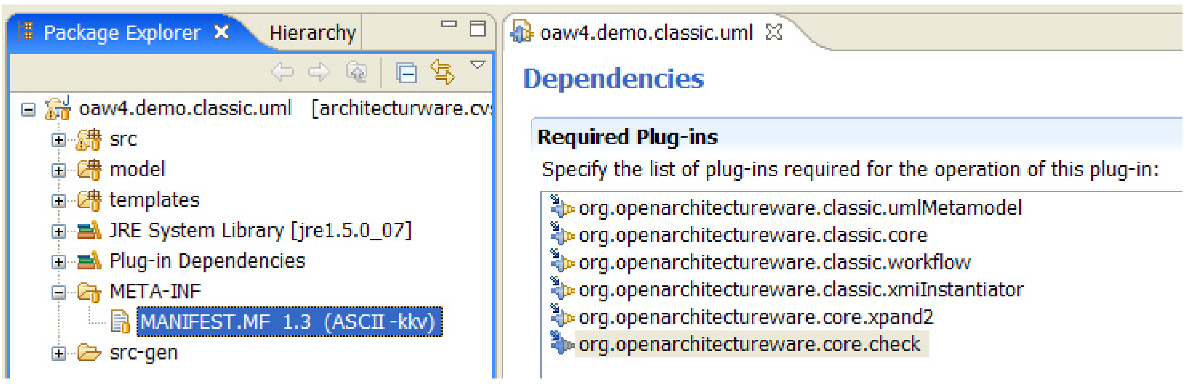
Figure 15.3. Creating the tutorial project

Afterwards select from the context menu PDE tools -> Convert Projects to Plug-in Projects, since we want to define our dependencies via Eclipse Plug-In dependencies.

Alternatively you could create a Plug-In project instead of these both steps.

15.5. Defining Dependencies

In the new project there is now a `META-INF/MANIFEST.MF`. Open it, go to the Dependencies page and add the following dependencies:



Specify the list of plug-ins required for the operation of this plug-in:

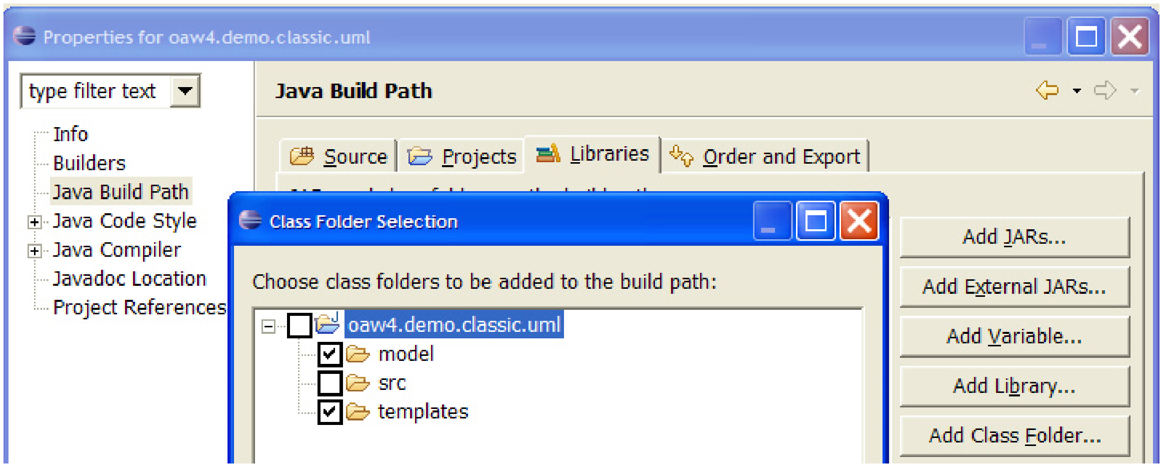
- org.openarchitectureware.classic.umlMetamodel
- org.openarchitectureware.classic.core
- org.openarchitectureware.classic.workflow
- org.openarchitectureware.classic.xmiInstantiator
- org.openarchitectureware.core.xpand2
- org.openarchitectureware.core.check

Figure 15.4. Defining plug-in dependencies for oAW Classic

- `org.openarchitectureware.classic.umlMetamodel`: The classic UML metamodel classes
- `org.openarchitectureware.classic.core`: Framework classes for oAW classic
- `org.openarchitectureware.classic.workflow`: oAW classic workflow components and cartridges
- `org.openarchitectureware.classic.xmiInstantiator`: Parser component for UML tools
- `org.openarchitectureware.classic.libraries`: Required 3rd party libraries
- `org.openarchitectureware.core.xpand2`: The Xpand template engine
- `org.openarchitectureware.core.check`: oAW language Check for defining constraints

15.6. Create source folders

Create two folders `model` and `templates` in the project root (not in `src`!) and add this folders as classpath folders in the project properties dialog, Libraries tab. By doing this the model and the templates can be found in the project's classpath without placing the files in the source folder.



Choose class folders to be added to the build path:

- [ ] oaw4.demo.classic.uml
  - [✓] model
  - [ ] src
  - [✓] templates

Figure 15.5. Creating source folders

15.7. Create the model

This section explains how to create the model from scratch using MagicDraw 10/11. If you are using another UML tool this is a guideline to create the model, but the tool can differ in some details. You can skip this section if you have MagicDraw, downloaded the sample project and use the model from the sample project.

Start your UML Tool and create the model from the screenshot above. You have to create the Stereotypes `Entity` and `Key`.

To define the model above follow these steps:

1. Create the stereotype `Entity` with base class `Class`.
2. Create the stereotype `Key` with base class `Property`.
3. Create the stereotype `DAO` with base class `Class`.
4. Create a package structure in your project: `oaw4 / demo / classic / uml / entity`
5. Create a class diagramm in the package `entity`
6. Create a class `Author`
   a. Assign the stereotype `Entity`
   b. Create an attribute `id` of type `String`. Please select for String the datatype from your model, *not from UML Standard Profile*! Assign the stereotype `Key` for this attribute.
   c. Create an attribute `name` of type `String`.
7. Create the class `Book` with stereotype `Entity`. The `Key` attribute is `isbn` of type `String`. The second attribute is the `title`.
8. Draw an association between these two classes.
   a. The association end at class `Author` is named `author`, is navigable and the multiplicity is *1..**.
   b. The other association end is `writtenBook` with multiplicity *0..** and is navigable.
9. Create the class `Copy` of stereotype `Entity`
   a. The `Key` attribute is `inventoryNumber` of type `String`.
   b. Add attribute `location` of type `String`.
10. Draw a *directed* association from `Copy` to `Book`
    a. The association end at class `Book` is named `book`, is navigable, with multplicity *1*.
    b. The opposite end at `Copy` is unnamed, not navigable and multiplicity *0..**
11. Create the class `Library` of stereotype `Entity`
    a. The `Key` attribute is `id` of type `String`.

b. The library has a `String` attribute `name`

12. Draw an association from `Library` to `Copy`

a. The association end at class `Library` is named `owner`, is navigable, the multiplicity is *1*.

b. The association end at class `Book` is named `ownedBook`, is navigable and the multiplicity is *1..**.

Save your model packed format in the model folder of your project and give the file the name `AuthorBookExampleMD11.mdzip`. The tool adapter will automatically recognize that it is zipped and read the appropriate ZIP entry.

Create a subfolder `model/md11`. From the `profiles` directory of your MagicDraw installation copy the `UML_Standard_Profile.xml` to there.

15.8. Defining the metamodel

Models are instances of a *Metamodel*. In order to get openArchitectureWare to do something useful it needs to know the used metamodel. Using oAW „Classic“ the metamodel is implemented by metaclasses. In UML they are represented in the model by stereotypes.

The recently defined model already uses the stereotypes `DAO`, `Entity` and `Key`. Entities are some kind of business objects, which have some attributes. They are represented in UML as classes. Exactly one attribute is a special one: a `Key` attribute. `DAOs` are classes which manage `Entities`. We want to express this relationship by using a dependency from `DAO` to `Entity` in our model.

In UML this metamodel looks like this:

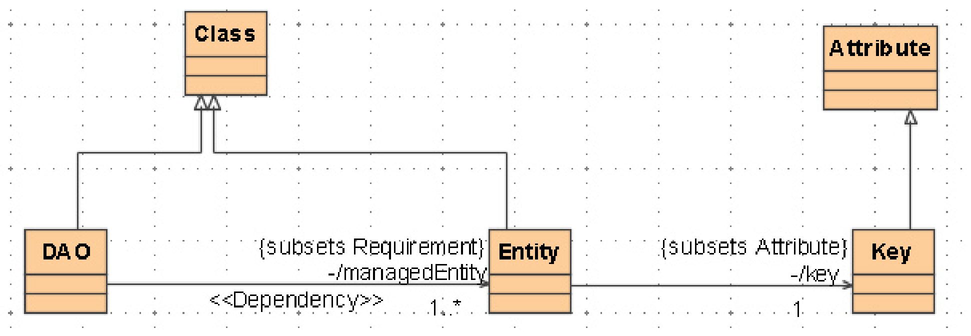


Figure 15.6. Tutorial Metamodel

We have to provide the metaclasses that make up our DSL. The base metaclasses `Class` and `Attribute` are provided by openArchitectureWare within the package `org.openarchitectureware.meta.uml` and its subpackages.

15.8.1. Defining the metaclasses

Create a package `oaw4.demo.classic.uml.meta`. This package will contain our metaclasses which realize the UML profile we want to use. As you can see from the model above we use the Stereotypes `Entity`, `Key` and `DAO`. For these Stereotypes we need metaclasses.

Metaclasses are derived from UML metaclasses. oAW4 provides implementation classes for UML metaclasses. For example an `Entity` is represented by classes, so the right metaclass to extend is `Class`, while `Keys` are a specialization from `Attribute`.

In the simplest case you will only have to create the classes `Entity`, `Key` and `DAO` and derive them from the base metaclasses `Class` and `Attribute` defined in package `org.openarchitecture.meta.uml.classifier`:

```
package oaw4.demo.classic.uml.meta;

public class Entity extends org.openarchitectureware.meta.uml.classifier.Class {
   // nothing to do in the simplest case
}
```

```
package oaw4.demo.classic.uml.meta;

public class Key extends org.openarchitectureware.meta.uml.classifier.Attribute {
}
```

```
package oaw4.demo.classic.uml.meta;

public class DAO extends org.openarchitectureware.meta.uml.classifier.Class {
}
```

15.8.2. Metamappings

By now the generator will not know that the stereotype `<<Entity>>` has to be mapped to the metaclass `oaw4.demo.classic.uml.meta.Entity`. By default these elements are mapped to their UML base classes, in case of `Entity` this is `Class`.

To map stereotypes to metaclasses a xml file has to be created, called the *metamapping file*.

Create the file `metamappings.xml` in your source folder:

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE MetaMap SYSTEM "http://www.openarchitectureware.org/dtds/metamap.dtd">

<MetaMap>
   <Mapping>
      <Map>Entity</Map>
      <To>oaw4.demo.classic.uml.meta.Entity</To>
   </Mapping>
   <Mapping>
      <Map>DAO</Map>
      <To>oaw4.demo.classic.uml.meta.DAO</To>
   </Mapping>
   <Mapping>
      <Map>Key</Map>
      <To>oaw4.demo.classic.uml.meta.Key</To>
   </Mapping>
</MetaMap>
```

15.9. Log4j configuration

Later when running the generator you would like to see some output messages. Therefore you have to define a `log4j.properties`. Create this file in the source folder:

```
# Set root logger level to INFO and its only appender to A1.
```

```
log4j.rootLogger=INFO, A1

# A1 is set to be a ConsoleAppender.
log4j.appender.A1=org.apache.log4j.ConsoleAppender

# A1 uses PatternLayout.
log4j.appender.A1.layout=org.apache.log4j.PatternLayout
log4j.appender.A1.layout.ConversionPattern=%-4r %-5p %m%n
```

15.10. Creating the generator workflow and the first template

15.10.1. The workflow script

The next step is to create a workflow script. The workflow has to accomplish the following tasks:

- Initialize the environment for using the „classic“ metamodel
- Parse the tool-specific xmi file and instantiate the metamodel
- Initialize all instantiated elements
- Run the generator to create code
- Tear-down: Print messages collected through the generator run

For all these tasks pre-defined workflow-scripts and components can be included in the workflow. The following workflow script does all these tasks and should fit for the first steps. Later on you may need to customize the workflow script to integrate further components like model modifiers. Therefore the script itself is not bundled as a cartridge.

```
<?xml version="1.0" encoding="UTF-8"?>
<workflow>
   <property file="workflow.properties"/>

   <cartridge file="org/openarchitectureware/workflow/oawclassic/classicstart.oaw">
      <metaEnvironmentSlot value="me"/>
      <instantiatorEnvironmentSlot value="ie"/>
   </cartridge>

   <component class="org.openarchitectureware.core.frontends.xmi.workflow.XMIInstantiator">
      <instantiatorEnvironmentSlot value="ie"/>
      <modelFile value="${model.xmi}"/>
      <xmlMapFile value="${toolMappingFile}"/>
      <metaMapFile value="${metaMapFile}"/>
      <toolAdapterClassname value="${toolAdapterClassname}"/>
      <moduleFile value="${moduleFile}"/>
   </component>

   <cartridge file="org/openarchitectureware/workflow/oawclassic/classicinit.oaw">
      <metaEnvironmentSlot value="me"/>
   </cartridge>

   <component id="dirCleaner"
      class="org.openarchitectureware.workflow.common.DirectoryCleaner">
      <directories value="${srcGenPath}"/>
   </component>

   <component id="generator" class="org.openarchitectureware.xpand2.Generator">
      <metaModel class="org.openarchitectureware.type.impl.java.JavaMetaModel">
         <typeStrategy
```

```
            class="org.openarchitectureware.type.impl.oawclassic.OAWClassicStrategy"
            convertPropertiesToLowerCase="false"/>
      </metaModel>
      <expand value="Root::Root FOREACH me.getElements('Model')"/>
      <genPath value="${srcGenPath}/"/>
      <srcPath value="${srcGenPath}/"/>
      <beautifier class="org.openarchitectureware.xpand2.output.JavaBeautifier"/>
      <beautifier class="org.openarchitectureware.xpand2.output.XmlBeautifier"/>
      <fileEncoding value="ISO-8859-1"/>
   </component>

   <cartridge file="org/openarchitectureware/workflow/oawclassic/classicfinish.oaw">
      <instantiatorEnvironmentSlot value="ie"/>
      <dumpfile value="${dumpfile}"/>
   </cartridge>

</workflow>
```

15.10.2. Workflow Properties

The workflow includes a properties file in which the concrete configuration is stored. Create the file `workflow.properties` like this:

```
# Note: all paths must be found in the classpath!
# the metamappings file
metaMapFile = metamappings.xml

# model.xmi: name of the XMI export
# toolMappingFile: tool mapping file to use
# toolAdapterClassname: tool adapter implementation
# moduleFile: profile files

# MagicDraw 10
model.xmi = AuthorBookExampleMD10.mdzip
toolMappingFile = magicdraw_xmi21_all.xml
toolAdapterClassname =
   org.openarchitectureware.core.frontends.xmi.toolsupport.uml.magicdraw.MagicDrawAdapter21
moduleFile =
   magicdraw/md10/UML_Standard_Profile.xml

#model.xmi = AuthorBookExampleMD11.mdzip
#toolMappingFile = magicdraw_xmi21_all.xml
#toolAdapterClassname =
   org.openarchitectureware.core.frontends.xmi.toolsupport.uml.magicdraw.MagicDrawAdapter21
#moduleFile = magicdraw/md11/UML_Standard_Profile.xml

# path to create the generated output to
srcGenPath = src-gen
# path where the dump file is created
dumpfile = bin/dump
```

15.10.2.1. Setting up for use with other UML tools

This configuration file is designed for use with MagicDraw. Other UML tools can be easily configured by changing the properties *`model.xmi`*, *`toolAdapterClassname`*, *`toolMappingFile`* and *`moduleFile`*. The property *`moduleFile`* specifies additional modules to load and merge, which is currently only evaluated by the MagicDraw adapter.

The existing tool adapter classes and mapping files can be found beneath the package

`org/openarchitectureware/core/frontends/xmi/toolsupport/uml/<TOOL>`

For example, to set up this project for Poseidon 4/5 the appropriate settings are:

```
toolAdapterClassname =
   org.openarchitectureware.core.frontends.xmi.toolsupport.uml.poseidon.PoseidonAdapter
toolMappingFile = poseidon40_xmi12_all.xml
```

15.10.3. Create the root template

In the workflow the generator has been configured to start with the this definition:

```
<expand value="Root::Root FOREACH me.getElements('Model')"/>
```

This means that the generator will look for a template file `Root.xpt` in the classpath where a definition named `Root` is found for all elements that are selected by the expression `me.getElements('Model')`. In case of UML models there exists solely one element of type `Model` that will be selected.

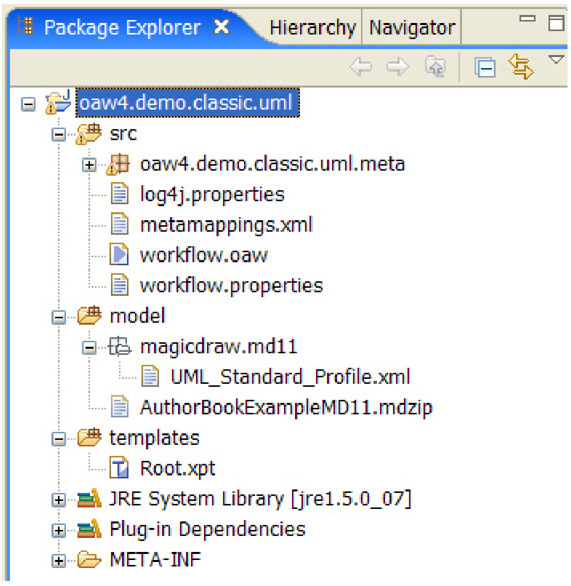
Now create the file Root.xpt in the templates folder. Remember: We have configured our Eclipse project that the folder templates is a classpath folder. You will see that the new file is recognized as an oAW template file, as it has a template file icon:

For the beginning the template will be simple:

```
«IMPORT org::openarchitectureware::core::meta::core»

«DEFINE Root FOR Model»
«ENDDEFINE»
```

This template contains only an empty definition for Model elements. The namespace of the `Model` metaclass must be known for the generator, so we import the corresponding package. Otherwise we would have to fully qualify `Model`. As you could expect this template does not really do anything yet.

At this time your project structure should look like this:



15.11. Execute the workflow

We have not defined anything useful in our template yet. However, we now execute the workflow to prove that everything is right configured. Execute the workflow by selecting `workflow.oaw` and select *Run As -> oAW Workflow* from the context menu. The output should be like this:

```
0    INFO  --------------------------------------------------------------------------------
0    INFO  openArchitectureWare v4 -- (c) 2005, 2006 openarchitectureware.org and contributors
0    INFO  --------------------------------------------------------------------------------
0    INFO  running workflow:
              C:/dev/ide/workspace/oaw-v4-projects/oaw4.demo.classic.uml/src/workflow.oaw
0    INFO
540  INFO  Starting: workflow org/openarchitectureware/workflow/oawclassic/classicstart.oaw
540  INFO  Starting: org.openarchitectureware.workflow.oawclassic.ClassicOAWSetup
561  INFO  classic oAW environment is set up;
              instantiator environment in: ie, meta environment in me
561  INFO  Starting: org.openarchitectureware.core.frontends.xmi.workflow.XMIInstantiator
561  INFO  Loading XMI from: AuthorBookExampleMD10.mdzip using map: magicdraw_xmi21_all.xml
              and metamap: metamappings.xml
571  INFO  Starting mapping instantiator ...
571  INFO
581  INFO  Parsing metamap metamappings.xml ...
721  INFO  Parsing of metamap took 0.14s
721  INFO
1692 INFO  Parsing design AuthorBookExampleMD10.mdzip ...
1702 INFO  Loading model...
2163 INFO  Initializing XMI support for XMI version 2.1
2163 INFO  Scanning for referenced modules...
2183 INFO  Found reference to module 'UML_Standard_Profile.xml'
2193 INFO  Model loaded in 0.491s
2193 INFO
2193 INFO  Loading modules...
2984 INFO  Scanning for referenced modules...
3064 INFO  Modules loaded in 0.871s
3064 INFO
3074 INFO  Merging...
3114 INFO  Modules merged in 0.04s
3114 INFO
3234 INFO  Parsed design in 1.542s
3234 INFO
3234 INFO  Loading extensions...
3304 INFO  Extensions loaded in 0.07s
3304 INFO
3304 INFO  Loading design...
3314 WARN  ignoring node 65973 (ownedMember): cannot coerce to ModelElement
3314 WARN  ignoring node 66017 (ownedMember): cannot coerce to ModelElement
3314 WARN  ignoring node 66061 (ownedMember): cannot coerce to ModelElement
3314 WARN  ignoring node 66119 (ownedMember): cannot coerce to ModelElement
3314 WARN  ignoring node 68759 (ownedMember): cannot coerce to ModelElement
3314 WARN  ignoring node 70438 (ownedMember): cannot coerce to ModelElement
3324 WARN  ignoring node 65945 (ownedMember): cannot coerce to ModelElement
3334 WARN  ignoring node 65952 (ownedMember): cannot coerce to ModelElement
3334 WARN  ignoring node 65959 (ownedMember): cannot coerce to ModelElement
3334 WARN  ignoring node 65966 (ownedMember): cannot coerce to ModelElement
3405 INFO  Design loaded in 0.101s
3405 INFO
3405 INFO  Applying tool specific design modifications...
3415 INFO  Design modified in 0.01s
3415 INFO
3415 INFO  Instantiating metamodel...
3485 WARN  <<Model>> [no Name@27940994]: ignoring value for nonexisting property Documentation =
[Author:Karsten.
Created:27.02.06 08:47.
Title:.
Comment:.
]
3525 INFO  Metamodel instantiated in 0.1s
3525 INFO
3525 INFO  Instantiated design in 2.954s
3525 INFO
3525 INFO  MetaModel Summary
3525 INFO  -----------------
3525 INFO
3525 INFO  3x Association (org.openarchitectureware.meta.uml.classifier.Association)
3525 INFO  6x AssociationEnd (org.openarchitectureware.meta.uml.classifier.AssociationEnd)
3525 INFO  4x Attribute (org.openarchitectureware.meta.uml.classifier.Attribute)
3525 INFO  1x DAO (oaw4.demo.classic.uml.meta.DAO)
3525 INFO  4x Entity (oaw4.demo.classic.uml.meta.Entity)
3525 INFO  4x Key (oaw4.demo.classic.uml.meta.Key)
3525 INFO  1x Model (org.openarchitectureware.core.meta.core.Model)
3525 INFO  7x Package (org.openarchitectureware.meta.uml.classifier.Package)
3525 INFO  12x PrimitiveType (org.openarchitectureware.meta.uml.classifier.PrimitiveType)
3525 INFO
3525 INFO  Starting: workflow org/openarchitectureware/workflow/oawclassic/classicinit.oaw
3525 INFO  Starting: org.openarchitectureware.workflow.oawclassic.ModelInitializer
3525 INFO  initializing model elements (calling initializeModelElements)
3535 INFO  Starting: org.openarchitectureware.workflow.oawclassic.ModelChecker
3535 INFO  checking model elements (calling checkConstraints)
3545 INFO  Starting: org.openarchitectureware.check.CheckComponent
3765 INFO  Starting: dirCleaner [org.openarchitectureware.workflow.common.DirectoryCleaner]
3765 INFO  Cleaning C:\dev\ide\workspace\oaw-v4-projects\oaw4.demo.classic.uml\src-gen
3875 INFO  Starting: generator [org.openarchitectureware.xpand2.Generator]
3915 INFO  Starting: workflow org/openarchitectureware/workflow/oawclassic/classicfinish.oaw
3915 INFO  Starting: org.openarchitectureware.workflow.oawclassic.MessageOutput
3915 INFO  Starting: org.openarchitectureware.workflow.oawclassic.DumpWriter
3915 INFO  writing dump to: bin/dump
3925 INFO  workflow completed in 3385ms!
```

Congratulations! You have just set up the whole environment to get openArchitectureWare running. Now let's do the interesting stuff!

15.12. Looping through the model

Later on we want to do something with the elements contained in our model. A common pattern in the Root template when using UML models is to loop through the model to find the elements that should be expanded. A model is an instance of `Namespace` and all elements directly contained by the model can be accessed through the association `OwnedElement`. The owned elements can be of various types: Classes, Packages, Datatypes and so on. Packages are also instances of `Namespace`, so they also have a `OwnedElement` association.

We use the feature to recursively resolve any element contained in the model tree. Now extend the `Root.xpt` template file:

```
«IMPORT org::openarchitectureware::core::meta::core»
«IMPORT org::openarchitectureware::meta::uml::classifier»
«DEFINE Root FOR Model»
   «EXPAND Root FOREACH OwnedElement»
«ENDDEFINE»

«DEFINE Root FOR Package»
   «EXPAND Root FOREACH OwnedElement»
«ENDDEFINE»
```

```
«DEFINE Root FOR Object»«ENDDEFINE»
```

Note that we have added a new `IMPORT` statement, because the metaclass `Package` is in package `org.openarchitectureware.meta.uml.classifier`.

First the definition `Root` FOR `Model` will be called by the generator. This will call the definition named `Root` for all elements, that the `Model` instance contains. Look at the last definition: This is a catcher for all elements that are found while traversing through the tree that are not of any handled type.

When the model contains `Package` instances the definition `Root FOR Package` will be called for these instances. This is polymorphism at work! When the package contains subpackages, the definition is called recursively.

15.13. Creating a template for JavaBeans

As we want to create JavaBean style classes from the entities in our model we now want to create the template file for this. Create a new folder java within the folder `templates` create the file `JavaBean.xpt` there.

For a first step this template will simply create a file with the name of the class.

```
«IMPORT org::openarchitectureware::meta::uml::classifier»

«DEFINE BeanClass FOR Class»
   «FILE NameS+".java"»
      public class «Name» {
      }
   «ENDFILE»
«ENDDEFINE»
```

Note that we have named the definition `BeanClass` and it is defined for elements of type `Class`. So this template will not only fit for elements of type `Entity`, but can be used for any class.

In the `FILE` statement we access the name of the current element by property `NameS`. This is specific to the oAW classic metamodel. The property `NameS` returns the name of the element as String. The property `Name` itself is of type `Object` for backward compatibility. But in templates we usually want the name as a String object.

15.14. Calling the `JavaBean` template from `Root.xpt`

By now this template is not called. We have to extend the `Root.xpt` template file. Add a definition `Root` defined for `Entity`. We also have to add a new `IMPORT`, so that oAW can resolve `Entity`.

```
«IMPORT oaw4::demo::classic::uml::meta»

...

«DEFINE Root FOR Entity»
«EXPAND java::JavaBean::BeanClass»
«ENDDEFINE»
```

As you remember while looping through the model for each element in the model tree a definition called `Root` is called. Before adding this we had a definition for Packages, Models and all other objects. Now when evaluating elements of type `Entity` this definition matches. In this definition we call the definition named `BeanClass` from the template file `JavaBean.xpt`. As the template `JavaBean.xpt` is defined in the package `java` we also have to qualifiy this namespace. As an alternative we could import the namespace `java`. The definition is (implicitely) called for the current element, which is of course an `Entity`.

15.15. The first generated code

Run the generator again (as a shortcut you could type **Ctrl**+**F11**). Now your project should contain the folder `src-gen`, which contains four files: `Author.java`, `Book.java`, `Copy.java` and `Library.java`.

Open `Author.java`. It does only contain the class definition, since the template was that simple.

```
public class Author {
}
```

15.16. Defining property declarations and accessor methods

Now we want to extend the JavaBean template to create instance variables, property getters and setters. Generating declarations for instance variables as well as their getter and setter methods is a very recurring task for attributes, so we want this in a central template file.

Create the file `Attribute.xpt` in folder `java`.

```
«IMPORT org::openarchitectureware::meta::uml::classifier»

«DEFINE PropertyDeclaration FOR Attribute»
private «Type.NameS» «NameS»;
«ENDDEFINE»

«DEFINE Getter FOR Attribute»
public «Type.NameS» get«NameS.toFirstUpper()» () {
   return this.«NameS»;
}
«ENDDEFINE»

«DEFINE Setter FOR Attribute»
public void set«NameS.toFirstUpper()» («Type.NameS» «NameS») {
   this.«NameS» = «NameS»;
}
«ENDDEFINE»
```

Of course we also have to call these templates from our `JavaBean` template. We want to call the templates `PropertyDeclaration`, `Getter` and `Setter` for each attribute a class has. So open your `JavaBean.xpt` template and extend it like follows:

```
«IMPORT org::openarchitectureware::meta::uml::classifier»

«DEFINE BeanClass FOR Class»
«FILE NameS+".java"»
public class «Name» {
   «EXPAND Attribute::PropertyDeclaration FOREACH Attribute»
   «EXPAND Attribute::Getter FOREACH Attribute»
   «EXPAND Attribute::Setter FOREACH Attribute»
}
«ENDFILE»
«ENDDEFINE»
```

Once again run the generator. Now your generated files have properties!

```
public class Author {
   private String id;
   private String name;
   public String getId() {
      return this.id;
   }

   public String getName() {
      return this.name;
   }

   public void setId(String id) {
      this.id = id;
   }

   public void setName(String name) {
      this.name = name;
   }
}
```

15.17. Using Extensions

A very powerful new feature of openArchitectureWare 4 are extensions. With extensions the Xpand template engine can be extended with functions without the need to modify the metamodel [1]. A very common use of extensions are the use of naming conventions, navigation, computation of package, path and filenames for artifacts etc.

openArchitectureWare extensions are declared in files ending with `.ext`. The declaration of extension functions can be by means of oAW expressions or by calling Java functions. The latter have to be declared public and static.

TODO: Make correct references to other chapters! We will not cover the syntax of expressions very deep, so if you are interested to get more information look at the reference manuals r25_extendReference.pdf and r10_expressionsReference.pdf. Also in the other tutorials you can see more examples for the usage of expressions.

15.17.1. Declaring functions with the Xtend language

For our example we want to use extensions to introduce some naming conventions for instance variables, parameters and the computation of the package and path for classes.

Now create a file `NamingConventions.ext` in the `templates/java` folder. In this extension we declare some functions that are helpful for name conversions [2]:

```
import org::openarchitectureware::meta::uml;
import org::openarchitectureware::meta::uml::classifier;

String asParameter (ModelElement elem) :
   "p"+elem.NameS.toFirstUpper();

String asSetter (ModelElement elem) :
   "set"+elem.NameS.toFirstUpper();

String asGetter (ModelElement elem) :
   "get"+elem.NameS.toFirstUpper();

String asInstanceVar (ModelElement elem) :
```

[1]With openArchitectureWare3 it was needed to code functionality of the metamodel in metaclasses

[2]The functions in the Extension file could be defined for type `Attribute` instead of `ModelElement`, but we want to use these functions for other types later on, too.

```
   elem.NameS.toFirstLower();
```

In extension files import statements for used types are necessary, too. The function declarations are single-lined and can use any expressions, calls of other extension functions included.

Open `Attribute.xpt` and make use of these functions. In template files the usage of extensions must be declared by the `«EXTENSION»` keyword. The modified template file will be this:

```
«IMPORT org::openarchitectureware::meta::uml::classifier»
«EXTENSION java::NamingConventions»

«DEFINE PropertyDeclaration FOR Attribute»
   private «Type.NameS» «asInstanceVar()»;
«ENDDEFINE»

«DEFINE Getter FOR Attribute»
   public «Type.NameS» «asGetter()» () {
      return this.«asInstanceVar()»;
   }
«ENDDEFINE»

«DEFINE Setter FOR Attribute»
public void «asSetter()» («Type.NameS» «asParameter()») {
 this.«asInstanceVar()» = «asParameter()»;
}
«ENDDEFINE»
```

Run the generator and open `Author.java`. The file looks almost the same, since the replacements for instance variables, getter and setter method names are equivalent. The only difference are the parameters for setter methods. They are now prefixed with the character `p`.

```
public void setId(String pId) {
   this.id = pId;
}
```

15.17.2. Calling Java functions as extensions

More complex computations are often easier and more understandable by means of the Java programming language. So the Xtend language allows to define functions by referencing a Java function. The methods that should be called must be declared `public static`.

In our example we miss the declaration of packages, and files are written in the root directory. We now want to declare some functions that help us to compute the full package name of classes, their corresponding path and the fully qualified name.

Create a new package `oaw4.demo.classic.uml.extend` and a class `ClassUtil`. In this class we define a function `getPackageName()` that computes the full package of a Class (remember that we operate on the metamodel's class named `(org.openarchitectureware.meta.uml.classifier.)Class`, not `java.lang.Class`).

```
package oaw4.demo.classic.uml.extend;

import org.openarchitectureware.meta.uml.classifier.Class;
import org.openarchitectureware.meta.uml.classifier.Package;

public class ClassUtil {
   public static String getPackageName (Class cls) {
      String result = "";
      for (Package pck=cls.Package(); pck!=null; pck=pck.SuperPackage()) {
            result = pck.NameS() + (result.length()>0 ? "."+result : "");
        }
        return result;
    }
}
```

We declare this function in `NamingConventions.ext` and two more functions that use it. Add these function declarations:

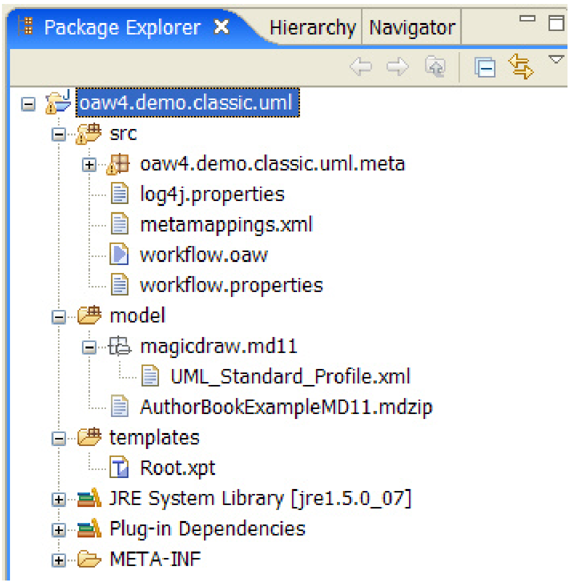
```
String packageName (Class cls) :
   JAVA oaw4.demo.classic.uml.extend.ClassUtil
   .getPackageName(org.openarchitectureware.meta.uml.classifier.Class);

String packagePath (Class cls) :
   packageName(cls).replaceAll("\\.", "/");

String fqn (Class cls) :
   packageName(cls).length>0 ? packageName(cls)+"."+cls.NameS : cls.NameS;
```

The additional functions are used to compute the path to files based on a class and to get the full qualified name of a class. We want to make use of these functions to declare the package, compute the desired file path and to extend from the super class, if a class has one (in our example model this is not the case yet). If no super class exists, the Bean class should declare to implement the `Serializable` interface.

Open the `JavaBean.xpt` template file and modify it like follows:

```
«IMPORT org::openarchitectureware::meta::uml::classifier»
«IMPORT java»
«EXTENSION java::NamingConventions»

«DEFINE BeanClass FOR Class»
«FILE packagePath()+"/"+NameS+".java"»
package «packageName()»;
public class «Name»
   «IF hasSuperClass»extends «SuperClass.fqn()» «ENDIF»
   implements java.io.Serializable {

...
```

Once again run the generator and refresh your `src-gen` folder. Now the classes are generated in the expected directory structure:



```
oaw4.demo.classic.uml
  src
    oaw4.demo.classic.uml.meta
    log4j.properties
    metamappings.xml
    workflow.oaw
    workflow.properties
  model
    magicdraw.md11
      UML_Standard_Profile.xml
    AuthorBookExampleMD11.mdzip
  templates
    Root.xpt
  JRE System Library [jre1.5.0_07]
  Plug-in Dependencies
  META-INF
```

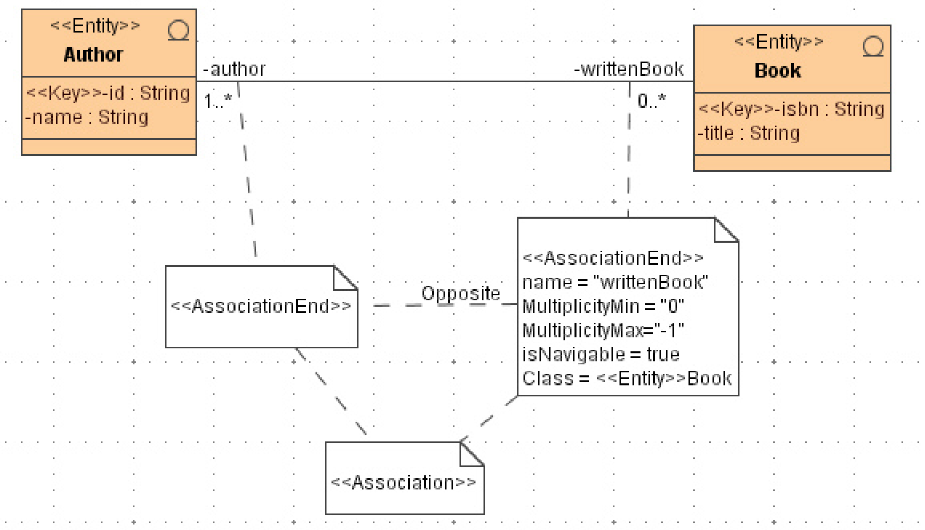
The generated classes now contain the correct `package` statement:

```
package oaw4.demo.classic.uml.entity;

public class Author implements java.io.Serializable {
   ...
```

15.18. Working with associations

In the model we have defined some associations of different kind. In the next step we evaluate these associations and create references, accessor methods and modification methods. As you can see there exists a m:n association between `Author` and `Book`. There exists an association from `Library` to `Copy` with the multiplicity 1:n. The association from `Book` to `Copy` is not navigable. These associations must be handled differently.

Ordinary associations in UML consist of three elements: Two *association ends* and one *association* containing them. From the view of a class a referenced class is at the *opposite* end. Normally it must be considered whether the association, i.e. the opposite association end, to the referenced class is navigable.



Also the templates for associations between classes are very common, so we define them in a central template file `Association.xpt` in the `templates/java` folder.

We want to keep the usage of the association template for the calling class template simple and hide this complex stuff about association ends. So we define simple entry points for `Class` elements. We also make use of further extensions to facilitate template development.

15.18.1. Association Extensions

The extensions for functions used for associations are put into a seperate file. Create the file `templates/java/Associations.ext` with this content:

```
import org::openarchitectureware::meta::uml::classifier;
extension java::NamingConventions;

String fqn (AssociationEnd ae) :
   !ae.isMultiple ? ae.Class.fqn() : "java.util.Collection<"+ae.Class.fqn()+">";

String iterator (AssociationEnd ae) : "java.util.Iterator<"+ae.Class.fqn()+">";
```

As you can see we will create Java 5 style collections for to-many associations. If you don't want to use generics you could easily replace or modify the extension file and all associations will change to your style.

We see in this extension file that other extensions can be referenced using the `extension` keyword. In this case we need the function `fqn()` that was defined for classes. For associations another function `fqn()` is defined, but now for `AssociationEnds`. For to-one associations the fully qualified name of the associated class is returned, for to-many references a generic collection for that class. In the template code classes and association ends will both use the `fqn()` function to print out the referenced type.

15.18.2. Writing a template for associations

Now it is time to write the template for associations. Create the file `Association.xpt`. Now fill in the content, we will explain some statements right after.

```
«IMPORT org::openarchitectureware::meta::uml::classifier»
«EXTENSION java::NamingConventions»
«EXTENSION java::Associations»

«DEFINE ReferenceVariables FOR Class»
   «FOREACH AssociationEnd.Opposite.select(ae|ae.isNavigable) AS ae»
      private «ae.fqn()» «ae.asInstanceVar()»;
   «ENDFOREACH»
«ENDDEFINE»

«DEFINE AccessorMethods FOR Class»
   «EXPAND ToOneAccessorMethods FOREACH
      AssociationEnd.Opposite.select(ae|!ae.isMultiple && ae.isNavigable)»
   «EXPAND ToManyAccessorMethods FOREACH
      AssociationEnd.Opposite.select(ae|ae.isMultiple && ae.isNavigable)»
«ENDDEFINE»

«DEFINE ToOneAccessorMethods FOR AssociationEnd»
   public void «asSetter()» («Class.fqn()» «asParameter()») {
      this.«asInstanceVar()» = «asParameter()»;
   }

   public «Class.fqn()» «asGetter()» () {
      return this.«asInstanceVar()»;
   }
«ENDDEFINE»

«DEFINE ToManyAccessorMethods FOR AssociationEnd»
   public void add«NameS.toFirstUpper()» («Class.fqn()» «asParameter()») {
      this.«asInstanceVar()».add(«asParameter()»);
   }

   public void remove«NameS.toFirstUpper()» («Class.fqn()» «asParameter()») {
      this.«asInstanceVar()».remove(«asParameter()»);
   }

   public «iterator()» «asGetter()» () {
      return this.«asInstanceVar()».iterator();
   }
«ENDDEFINE»
```

At first we see that this template uses both extensions, `NamingConventions` and `Associations`.

Next, a template `ReferenceVariables` is declared. The template makes use of a `FOREACH` loop of a different kind than we saw before. One more specific thing here is the statement

```
«FOREACH AssociationEnd.Opposite.select(ae|ae.isNavigable) ...
```

This returns all *navigable* opposite end of each association end a class has.

The body of the loop declares a reference variable for an association. For both alternatives (to-one and to-many) the function `fqn()` (the one defined for association ends) is called to determine the right type. In our example this should result in the following both declarations:

```
// to-one association (Copy.java)
private oaw4.demo.classic.uml.entity.Library owner;

// to-many association (Author.java)
private java.util.Collection<oaw4.demo.classic.uml.entity.Book> writtenBook;
```

Both types are now expressed by this statement – simple, isn't it?

```
private «ae.fqn()» «ae.asInstanceVar()»;
```

The next template definition is also interesting. The definition `AccessorMethods FOR Class` dispatches to the definitions `ToOneAccessorMethods` or `ToManyAccessorMethods`, depending on the cardinality of the association. To distinguish both types we make use of the select expression which is defined for expression. The statement

```
«EXPAND ToOneAccessorMethods FOREACH
   AssociationEnd.Opposite.select(ae|!ae.isMultiple && ae.isNavigable)»
```

means that the definition `ToOneAccessorMethods` should be expanded for each opposite association end which is not to-many and navigable. So for unnavigable associations no accessor method will be created.

The definitions for the accessor methods have nothing new, so we do not explain them in detail now.

15.18.3. Extending the JavaBeans template

Now we want to use the new templates from the JavaBeans template so that the classes get instance variables for referenced classes and appropriate accessor methods. Modify the template file `JavaBeans.xpt` by adding these two statements to the class definition:

```
public class «Name» «IF hasSuperClass»extends «SuperClass.fqn()» «ENDIF»{
   «EXPAND Attribute::PropertyDeclaration FOREACH Attribute»
   «EXPAND Attribute::Getter FOREACH Attribute»
   «EXPAND Attribute::Setter FOREACH Attribute»
   «EXPAND Association::ReferenceVariables»
   «EXPAND Association::AccessorMethods»
}
```

15.18.4. Generator result

Run the generator again. After successful generation open `Book.java`. This file should have the following contents:

```
package oaw4.demo.classic.uml.entity;

public class Book implements java.io.Serializable {
   private String isbn;
   private String title;
   private java.util.Collection<oaw4.demo.classic.uml.entity.Author> author;

   public String getIsbn () {
      return this.isbn;
   }

   public String getTitle () {
      return this.title;
   }

   public void setIsbn (String pIsbn) {
      this.isbn = pIsbn;
   }

   public void setTitle (String pTitle) {
      this.title = pTitle;
   }

   public void addAuthor (oaw4.demo.classic.uml.entity.Author pAuthor) {
      this.author.add(pAuthor);
   }

   public void removeAuthor (oaw4.demo.classic.uml.entity.Author pAuthor) {
      this.author.remove(pAuthor);
   }

   public java.util.Iterator<oaw4.demo.classic.uml.entity.Author> getAuthor () {
      return this.author.iterator();
   }
}
```

In this file we have a to-many association named `author` to entity `Author`. No code exists for the association to the `Copy` class, since this association is not navigable.

An example for to-one associations can be seen in the `Copy` class:

```
public class Copy implements java.io.Serializable {
   ...
   private oaw4.demo.classic.uml.entity.Library owner;
   ...
   public void setOwner (oaw4.demo.classic.uml.entity.Library pOwner) {
      this.owner = pOwner;
   }

   public oaw4.demo.classic.uml.entity.Library getOwner () {
      return this.owner;
   }
   ...
}
```

The template code is really small, but now you could only have to model classes and their associations and you get the right JavaBeans code from the model. Our JavaBeans template is not specifix for entities, you could use it to generate JavaBeans code for just any modelled class. But we only call this template for classes stereotyped with `<<Entity>>` for now. You remember that the model contains another class `<<DAO>> LibraryDAO` for which no code is generated yet.

15.19. Constraint Checking

It is very important that a generator produces correct output. Therefore the input information must be valid, i.e. the model must be consistent. To prove this the metamodel is enriched by constraints that check the consistence of the model.

15.19.1. Alternatives for implementing constraints

Constraints can be provided in three different ways:

- Overriding the `checkConstraints()` method of the metaclasses.

  The `checkConstraints()` method is only available for metaclasses based on the „classic" metamodel. It is not recommended to use this alternative. This alternative is for backward compatibility; in oAW3 metaclasses usually used this method to check model constraints.

- Using the new *Check* language.

  oAW4 has a new language named Check that can be used to check model constraints. In this example we will focus on this method. You may want to read the reference manual of the Check language r30_checkReference.pdf for more information. TODO: Reference to Check chapter

- Using a third party library, e.g. an OCL library.
  The example t35_oclExample.pdf shows how to integrate an OCL library for model validation. This is out of scope for this example. TODO: Reference to OCL Adapter

We want to implement constraint checks by using the *Check* language. The syntax for check files is similar to those for Extensions, as it uses also the oAW Expressions framework. Check files have the file extension `.chk` and must be found on the classpath.

15.19.2. Constraints to implement in the example

In our example we want to implement the following constraint:

1. Each navigable association end must have a role name.

2. Unnavigable association ends should have no role name.

Constraint 1 must be fulfilled, otherwise an error message should be printed and the generation process should not be started. If constraint 2 is not fulfilled a warn message should be printed, but the generation process should not be stopped.

15.19.3. Creating the Check file

As the constraints that should be implemented are specific for associations the check file should be named `AssociationChecks.chk`. Create this file in `templates/java`.

```
import org::openarchitectureware::meta::uml::classifier;

context AssociationEnd ERROR Class.NameS+"->"+Opposite.Class.NameS+":
   Navigable association ends must have a role name" :
   isNavigable ? !isUnnamed : true;

context AssociationEnd WARNING Class.NameS+"->"+Opposite.Class.NameS+":
   Not navigable association ends should have no role name":
   isNavigable ? true : isUnnamed;
```

The syntax is rather simple. Both constraints should be checked for the metaclass `AssociationEnd`, so the appropriate namespace has to be imported. The expression following the colon is the constraint. If it is not fulfilled the message is printed. When error messages are printed the workflow will be interrupted.

15.19.4. Checking the model

To execute the constraint checks the generator workflow has to be extended. The constraint check is configured by a workflow component `CheckComponent`. Insert this code into `workflow.oaw` right between the cartridge `classicinit.oaw` and the `dirCleaner` component.

```
<component class="org.openarchitectureware.check.CheckComponent">
   <metaModel class="org.openarchitectureware.type.impl.java.JavaMetaModel">
    <typeStrategy class="org.openarchitectureware.type.impl.oawclassic.OAWClassicStrategy"
     convertPropertiesToLowerCase="false"/>
   </metaModel>
   <checkFile value="java::AssociationChecks"/>
   <expression value="me.getElements('ModelElement')"/>
   <abortOnError value="true"/>
</component>
```

Also the constraint checker has to know which metamodel it should use. It is the same configuration as for the Generator component [3].

The `checkFile` property specifies the qualified name of the check file.

Finally, the `expression` property defines for which elements to constraints should be applied. In our case we select *all* elements in the `MetaEnvironment`. However, for our special case it would be satisfactory to select only all elements of type `AssociationEnd`. For larger projects it could be of advantage to select the right subset of elements for improving performance.

15.19.5. Testing the constraints

Start the generator. The generator should run without complaining, because all constraints are fulfilled in the example model for now.

Now open the model; we will change the model in a way that both constraints are not fulfilled.

First, edit the association between `Book` and `Author`. Take the association end named `author` and remove the name. Set the `navigable` flag to `false` for the opposite end named `writtenBooks`.

Save the model and re-run the generator. The generator now produces the expected messages and stops execution, because there is one constraint error and one warning.

```
4316 INFO  Starting: org.openarchitectureware.check.CheckComponent
4667 ERROR Workflow interrupted. Reason: Errors during validation.
4667 WARN  Book->Author: Not navigable association ends should have no role
           name [<<AssociationEnd>> writtenBook]
4667 ERROR Author->Book: Navigable association ends must have a role name [<<AssociationEnd>> ]
```

15.20. Further development of this tutorial

This tutorial is not finished. I plan to extend it to show more basic things about oAW usage. If you have any suggestions let me know them. Some features that will be handled in the future are:

- Extending the metamodel manually

[3] It is possible to declare the used metamodel once and reference it the second time

- Usage of MMUtil functions in metamodel classes
- Generating the metaclasses with the Metamodel Generator
- Demonstration of some oAW expression language features, e.g. collection filter, list operations

Part III. Samples

Chapter 16. Using the Emfatic Ecore Editor

16.1. Introduction

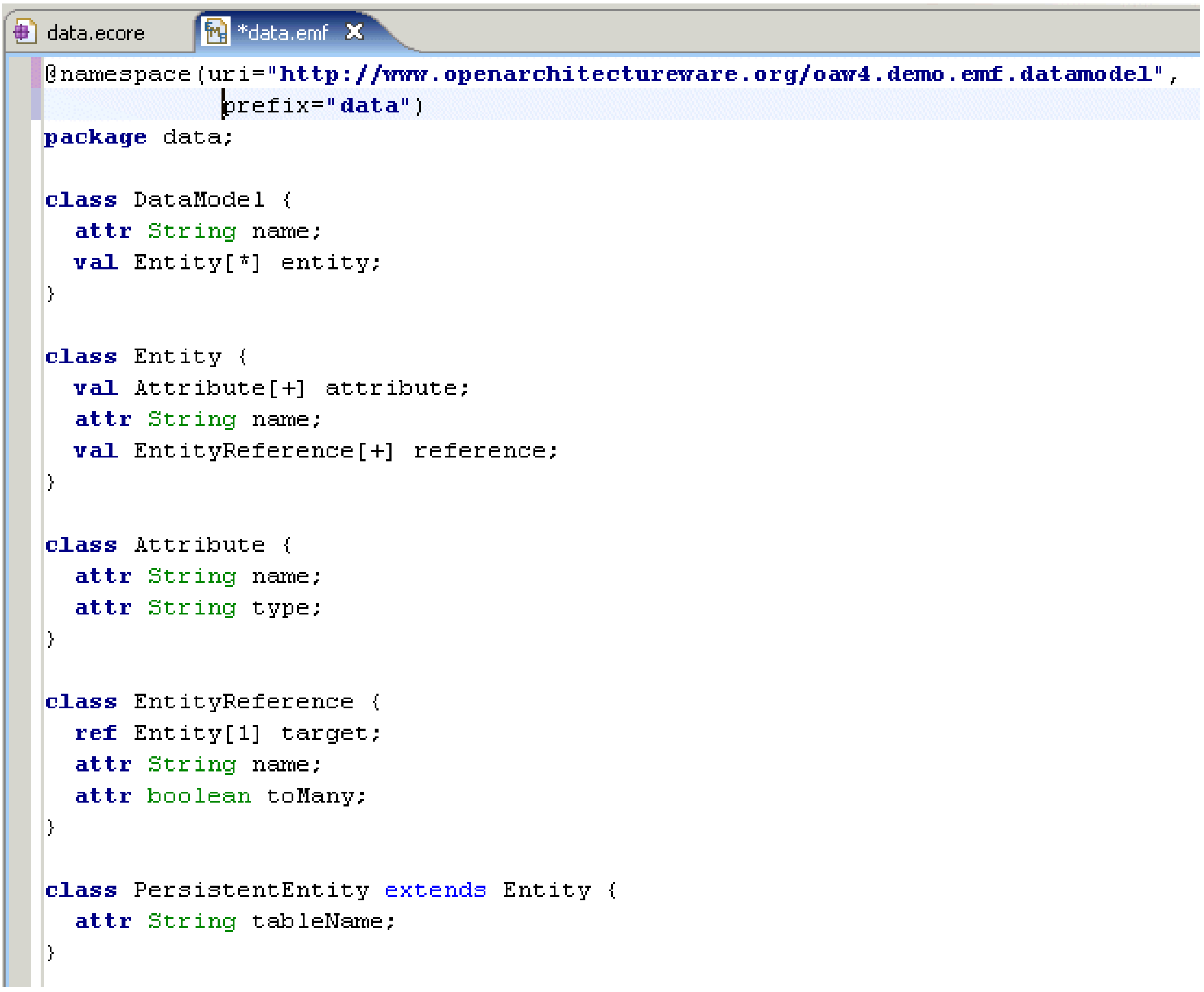
Metamodelling based on EMF's tree views is not a very good solution. A better solution is a textual representation for Ecore models. The IBM Emfatic plugin provides this support.

16.2. Installation

Install the Emfatic plugins from http://www.alphaworks.ibm.com/tech/emfatic.

16.3. Working with Emfatic

If you already have an ecore file (such as our example's `data.ecore`) you can right-click on the file and select the *Generate Emfatic Source* item. The following code is generated from our `data.ecore` file into a file called `data.emf`. After changing the source in the emf file, you can right-click that file and select *Generate Ecore Model* to transfer it back.



```
@namespace(uri="http://www.openarchitectureware.org/oaw4.demo.emf.datamodel",
           prefix="data")
package data;

class DataModel {
  attr String name;
  val Entity[*] entity;
}

class Entity {
  val Attribute[+] attribute;
  attr String name;
  val EntityReference[+] reference;
}

class Attribute {
  attr String name;
  attr String type;
}

class EntityReference {
  ref Entity[1] target;
  attr String name;
  attr boolean toMany;
}

class PersistentEntity extends Entity {
  attr String tableName;
}
```

Figure 16.1. Editing a metamodel with the EMFatic editor.

The syntax should be self-explaining. One remark: To render *containment* relationships, emfatic uses the *val* keyword, not *ref*, see in the screenshot in the Entities attributes, for example.

Chapter 17. EMF State Machine

17.1. Introduction

This example shows how to implement a state machine generator using EMF and openArchitectureWare. Note that the implementation of the state machine in Java is probably the slowest and clumsiest way to implement a state machine. The focus was not on optimizing the performance of the state machien implementation.

This tutorial does not explain too much – it's rather a guide through the example code. We expect that you know how to work with openArchitectureWare and EMF. If that's not the case, you should read and play with the *emfHelloWorld* example first (the tutorial entitled *Generating Code from EMF Models*).

17.2. Installation

You need to have openArchitectureWare 4.2 installed. Please consider http://www.eclipse.org/gmt/oaw/download/ for details.

You can also install the code for the tutorial. It can be downlaoded from the URL above, it is part of the the EMF samples ZIP file. Installing the demos is easy: Just add the projects to your workspace. Note that in the openArchitectureWare preferences (either globally for the workspace, or specific for the sample projects, you have to select *EMF metamodels* for these examples to work.

In the emf examples package, you can find the following three projects:

- `oaw4.demo.emf.statemachine`: contains the metamodel
- `oaw4.demo.emf.statemachine.generator`: contains the code generator
- `oaw4.demo.emf.statemachine.example`: contains an example state machine as well as a manually written unit test

17.3. Metamodel

The metamodel looks more or less as you'd expect from a state machine metamodel. The following is the representation of the metamodel in Emfatic syntax. You can find it in the `oaw4.demo.emf.statemachine/model` package.

```
@namespace(uri="http://oaw/statemachine",
prefix="statemachine")
package statemachine;

abstract class Named {
 attr String name;
}

class State extends AbstractState {
 val Action entryAction;
 val Action exitAction;
}

class StartState extends AbstractState {
}
```

```
class StopState extends AbstractState {
}

class Transition extends Named {
 ref AbstractState[1] target;
 val Action action;
 ref Event event;
}

class Action extends Named {
}

class Event extends Named {
}

class CompositeEvent extends Event {
 val Event[*] children;
}

class StateMachine extends Named {
 val AbstractState[*] states;
 val Event[*] events;
}

abstract class AbstractState extends Named {
 val Transition[*] transition;
}
```

From the .ecore file, you have to generate the implementation classes – as usual with EMF.

17.4. Example Statemachine

In the `oaw4.demo.emf.statemachine.example/src` folder you can find an `example.statemachine` file that contains a simple example state machine. You can view it as an EMF tree view after generating the EMF editors.

To generate code from it, run the example.oaw workflow file right next to it. It looks as follows:

```
<workflow>
 <cartridge file="workflow.oaw">
  <modelFile value="example.statemachine"/>
  <srcGenPath value="src-gen"/>
  <appProject value="oaw4.demo.emf.statemachine.example"/>
  <srcPath value="man-src"/>
 </cartridge>
</workflow>
```

As you can see it only defines a number of parameters and calls another workflow file – the one in the generator project. We'll take a look at it below.

17.4.1. Running the example

... is achieved by running the `example.oaw` file. It creates an implementation of the state machine in the *src-gen* folder in the example project. Take a look at the file to understand the implementation of the state machine.

In the *man-src* folder, there's a manually written subclass that implements the actions referenced from the state machine. There's also a unit test that you can run to verify that it works. It also shows you how to use the generated state machine.

17.5. The Generator

17.5.1. Workflow

The workflow file in `oaw4.demo.emf.statemachine.generator/src` has four steps:

- first it reads the model from the XMI file
- then it verifies a number of constraints
- then it generates the code
- and finally it creates a recipes file

17.5.2. Constraints

A number of constraints are defined. Take a look at their definition in *structure.chk* to learn about the constraints check language.

17.5.3. Transformation

There is a transformation called *trafo.ext* in the `src` folder which adds an emergency stop transition to each state.

17.5.4. Templates

In the `src/templates` folder you can find the code generation templates.

17.5.5. Recipe Creation

In `src/recipe` you there's an *SMRecipeCreator* workflow component that creates recipes for the manual implementation of the state machine.Recipe Creation

17.5.6. Acknowledgements

Thanks to the folks at Rohde & Schwarz Bick Mobilfunk for letting us use this example.

Chapter 18. Model-To-Model with UML2 Example

18.1. Introduction

This tutorial introduces various somewhat advanced topics of working with openArchitecureWare. We don't generate code, we transform models. Specifically, the tutorial covers the following:

- real model-to-model transformations
- how to test m2m transformations
- working with Eclipse UML2 (specifically, transforming away from it)
- using global variables
- implementing JAVA extensions

Note that this tutorial actually documents the *uml2ecore* utility that can be used to transform metamodels drawn with an UML2 tool into an Ecore instance. This tool is available for download as a plugin on the oAW download page.

Please make sure you first read the *u10_uml2ecore* reference. That document explains what to tool does – this is more or less a precondition to making sense *how* the tool does it (which is what this document explains).

Also note that many of the gory details are actually documented as code comments in the various oAW files of the example. So, make sure you have the code available as you read this document.

18.2. Why this example?

In general, we needed an example for real m2m transformations. And obviously, since we already had the *uml2ecore* tool, it makes sense to document this one. Also, including some information of working with UML2 is also important. However, there's one really good reason why looking at this example is important.

If you work with UML2 models, you'll soon realize that the UML2 metamodel is very intricate, non-intuitive and complicated. So it is very good practice to „transform away“ from the UML2 model as early as possible. Especially, if you want to enhance your model using model modifications (remember the emergency-stop feature in the statemachine example?) this approach is recommended. While read access to UML2 models is tedious, write access is almost impossible to get correct, and in some aspects also impossible with generic EMF tools such as oAW.

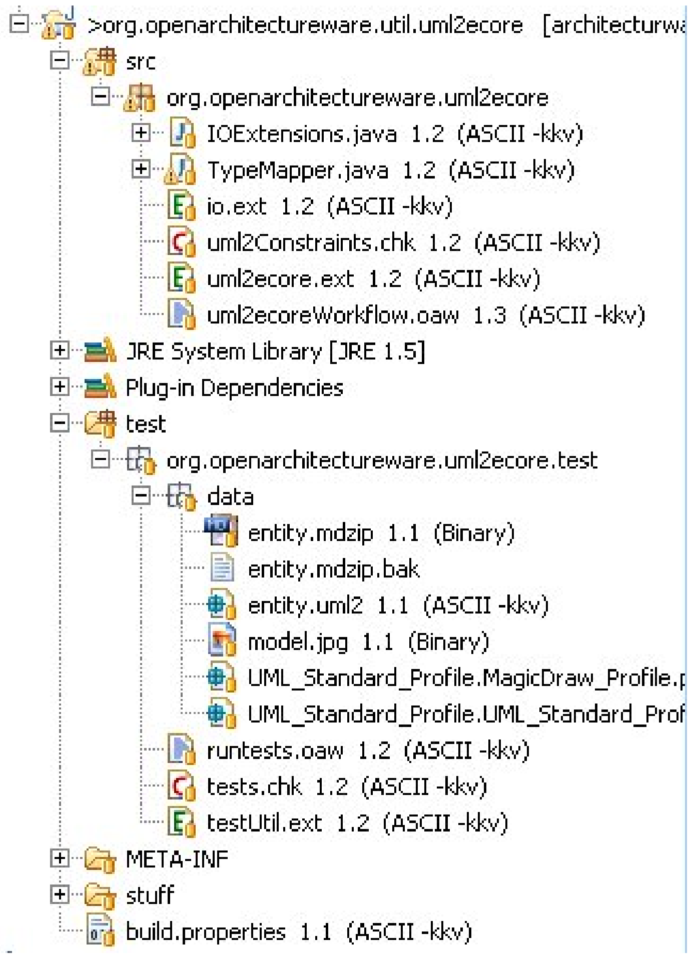
So: if you work with a UML2 model, always begin by transforming into your own domainspecific metamodel.

In this example, we transform into an instance of Ecore in order to get the meta model (since the uml2ecore tool is used for EMF meta modelling in UML tools). So in your application projects, the transformation would not create an instance of Ecore, but an instance of your domain-specific metamodel (which, in turn, might have been created with uml2ecore). The only difference to the example given here is that you'd use as a meta model not Ecore, but rather your own one. This has effects on the meta model declarations in the workflow file; everything else is similar.

18.3. Setting up Eclipse

You need an installation of oAW 4.1 including the UML2 support. Run the UML2 example (available for download on the oAW download page) to verify that you have all the UML2 stuff installed.

Then download the sample code for this tutorial and put the project into your workspace. Should look something like this, then.



```
>org.openarchitectureware.util.uml2ecore  [architecturw
  src
    org.openarchitectureware.uml2ecore
      IOExtensions.java  1.2  (ASCII -kkv)
      TypeMapper.java  1.2  (ASCII -kkv)
      io.ext  1.2  (ASCII -kkv)
      uml2Constraints.chk  1.2  (ASCII -kkv)
      uml2ecore.ext  1.2  (ASCII -kkv)
      uml2ecoreWorkflow.oaw  1.3  (ASCII -kkv)
  JRE System Library [JRE 1.5]
  Plug-in Dependencies
  test
    org.openarchitectureware.uml2ecore.test
      data
        entity.mdzip  1.1  (Binary)
        entity.mdzip.bak
        entity.uml2  1.1  (ASCII -kkv)
        model.jpg  1.1  (Binary)
        UML_Standard_Profile.MagicDraw_Profile.p
        UML_Standard_Profile.UML_Standard_Prof
      runtests.oaw  1.2  (ASCII -kkv)
      tests.chk  1.2  (ASCII -kkv)
      testUtil.ext  1.2  (ASCII -kkv)
  META-INF
  stuff
  build.properties  1.1  (ASCII -kkv)
```

18.4. The Building Blocks of the Transformer

The first thing you should look at (*after* reading the uml2ecore user guide!) is the workflow file. It reads the UML2 model, checks a couple of constraints against it and then invokes the transformation. We then write the result of the transformation out to an `.ecore` file.

`src/org/openarchitectureware/uml2ecore/uml2ecoreWorkflow.oaw`

You could now take a look at the constraints against the UML model. There are currently quite few of them in the code, but at least it shows how to write constraints against UML2 models

`src/org/openarchitectureware/uml2ecore/uml2Constraints.chk`

The transformation itself is located in `uml2ecore.ext`. While the transformation is not too complicated, it is also not trivial and illustrates many of the facettes of the Xtend transformation language.

`src/org/openarchitectureware/uml2ecore/uml2ecore.ext`

To see how global variables are used, take a look at the <globalvar ... /> declaration in the workflow file, as well as the `nsUri()` function in `uml2exore.ext` .

To see JAVA extensions in action, take a look at `io.ext` and `IOExtensions.java`

18.5. Using the transformer

Usage of the transformer can be seen from the uml2ecore user's guide mentioned a couple of times already. However, you can also take a look at the stuff in the testing section.

18.6. Testing an M2M transformation

M2M transformations can become quite intricate, especially if UML2 is involved. Therefore, testing such a transformation is essential. Note that you should resist the the temptation to write tests in the form of generic constraints such as

for each Class in the UML2 model there has to be an EClass in the Ecore model

While this statement is true, it is also on the same level of genericity as the transformation itself. It's therefore not much less complex, and therefore as error prone as the transformation itself

Instead what you should do is the following:

- Define a reference model. This model should contain all the possible alternatives of creating input models, i.e. should cover the complete variability of the meta model.
- Then run the transformation on that reference model
- Finally, write *model-specific* constraints that verify the particular result of the transformation.

So in our example, we have a small meta model modelled in UML using abstract and nonabstract classes, inheritance, attributes, 1:n and 1:1 references, bidirectional and unidirectional. The model, in our case, is drawn with MagicDraw 11.5 and exported as an UML2 model. You find all the model contents in the following location.

```
test/org/openarchitectureware/uml2ecore/test/data
```

Here's a screenshot of the model:

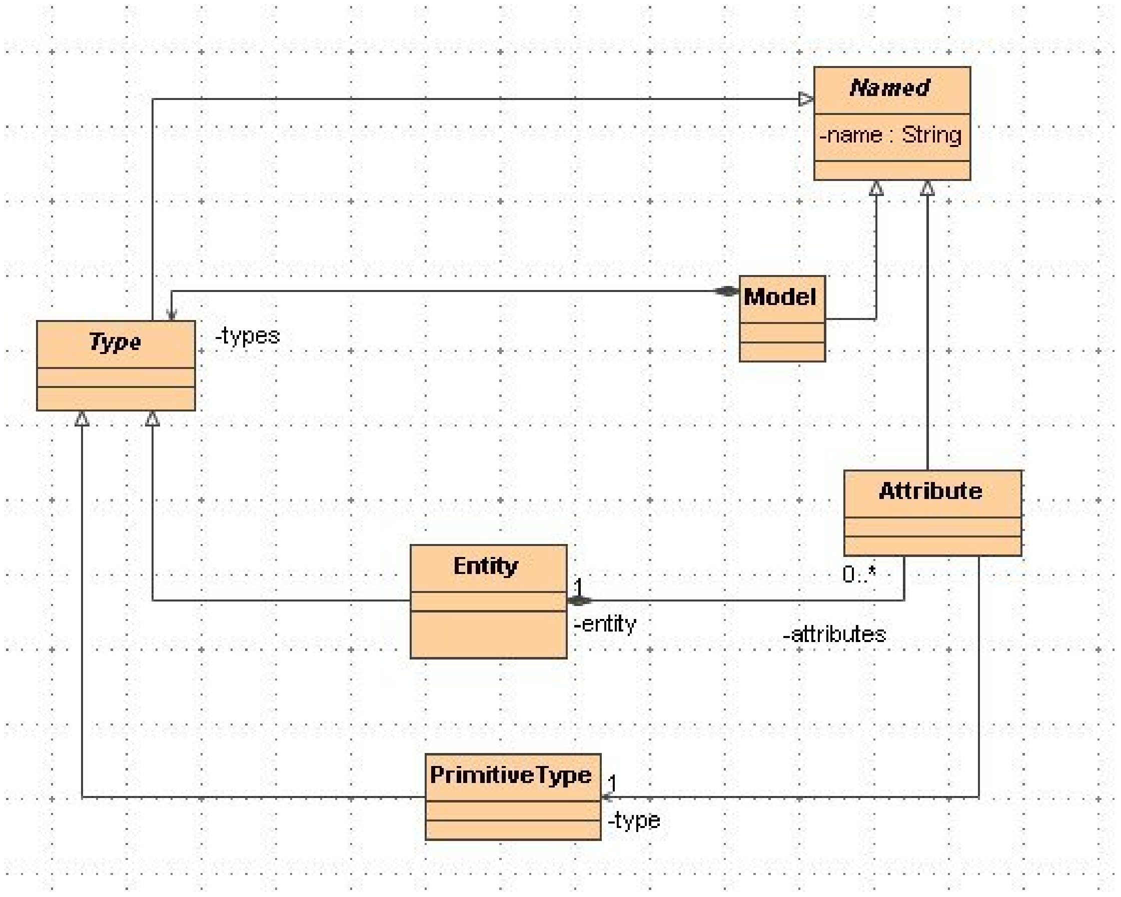


Figure 18.1. Model example

You now run the transformation using a workflow file that looks as follows:

```
test/org/openarchitectureware/uml2ecore/test/runtests.oaw
```

This workflow basically just invokes the transformation just as any other user of the transformation. However, in addition, after the transformation has finished, we validate test-specific constraints. This is what the additional constraint checker component is good for in the above mentioned workflow.

Now comes the point: The test constraints are not generic! Instead they do have knowledge about the input model (which generic constraints don't, they just operate with knowledge about the meta model). So this file contains constraints such as

There has to be a class called Entity in the resulting model.

Or:

There must be an EReference owned by Attribute called type, pointing to the class called PrimitiveType.

Make sure that the constraints – again: coverage! - check all relevant aspects of the transformation.

```
test/org/openarchitectureware/uml2ecore/test/tests.chk
```

Glossary

D

DSL	Domain Specific Language

E

Ecore	Add description here...
EMF	Add description here...

G

GMF	Graphical Modeling Framework.

M

MDA	Add description here...

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