SWG

Introduction to Eclipse and the Eclipse Modeling Framework

Catherine Griffin

Agenda

- Eclipse overview
- Eclipse Modeling Framework overview
- Using the Eclipse Modeling Framework – including demo

SWG

Eclipse Overview

Eclipse Project Aims

- Provide open platform for application development tools
  - Run on a wide range of operating systems
  - GUI and non-GUI
- Language-neutral
  - Permit unrestricted content types
  - HTML, Java, C, JSP, EJB, XML, GIF, …
- Facilitate seamless tool integration
  - At UI and deeper
  - Add new tools to existing installed products
- Attract community of tool developers
  - Including independent software vendors (ISVs)
  - Capitalize on popularity of Java for writing tools

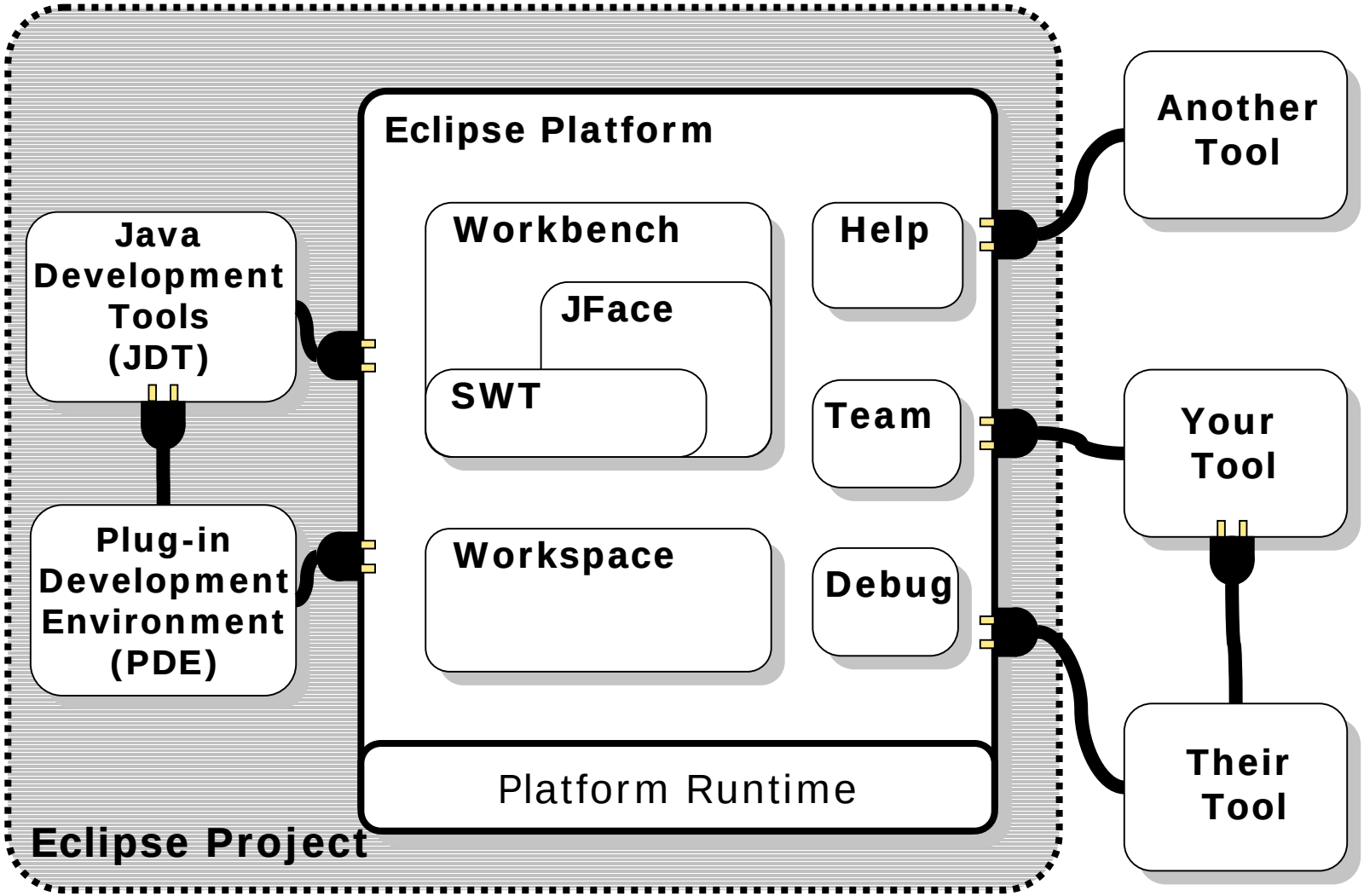
Eclipse Community

- Eclipse is an open source project since November 2000
- February 2004 —Eclipse reorganized into a not-for-profit corporation. Eclipse is now an independent body with a full-time management organization.

- Host site is www.eclipse.org

- Hosts a variety of projects
  - The Eclipse Platform Project
  - The Eclipse Technology Project
  - The Eclipse Tools Project
    - Including Eclipse Modeling Framework, UML 2.0
  - The Eclipse Web Tools Platform Project

Eclipse Overview



What is Eclipse?

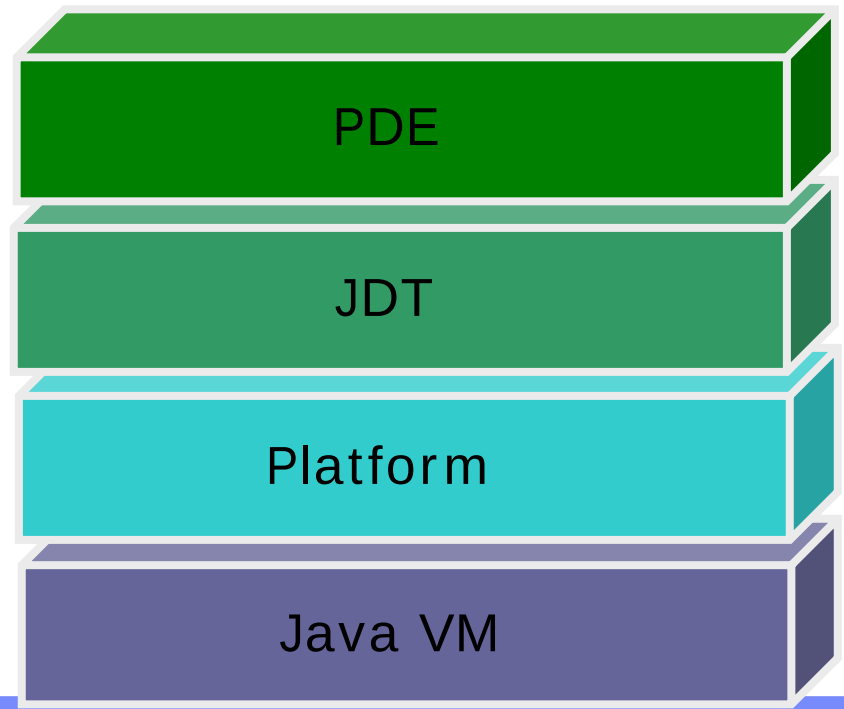
- Eclipse is a universal platform for integrating development tools
- Open, extensible architecture based on plug-ins

Plug-in development environment

Java development tools

Eclipse Platform

Standard Java2 Virtual Machine



Eclipse Plug-in Architecture

- **Plug-in -** smallest unit of Eclipse function
  - Big example: HTML editor
  - Small example: Action to create zip files
- **Extension point** - named entity for collecting “contributions”
  - Example: extension point for workbench preference UI
- **Extension -** a contribution
  - Example: specific HTML editor preferences

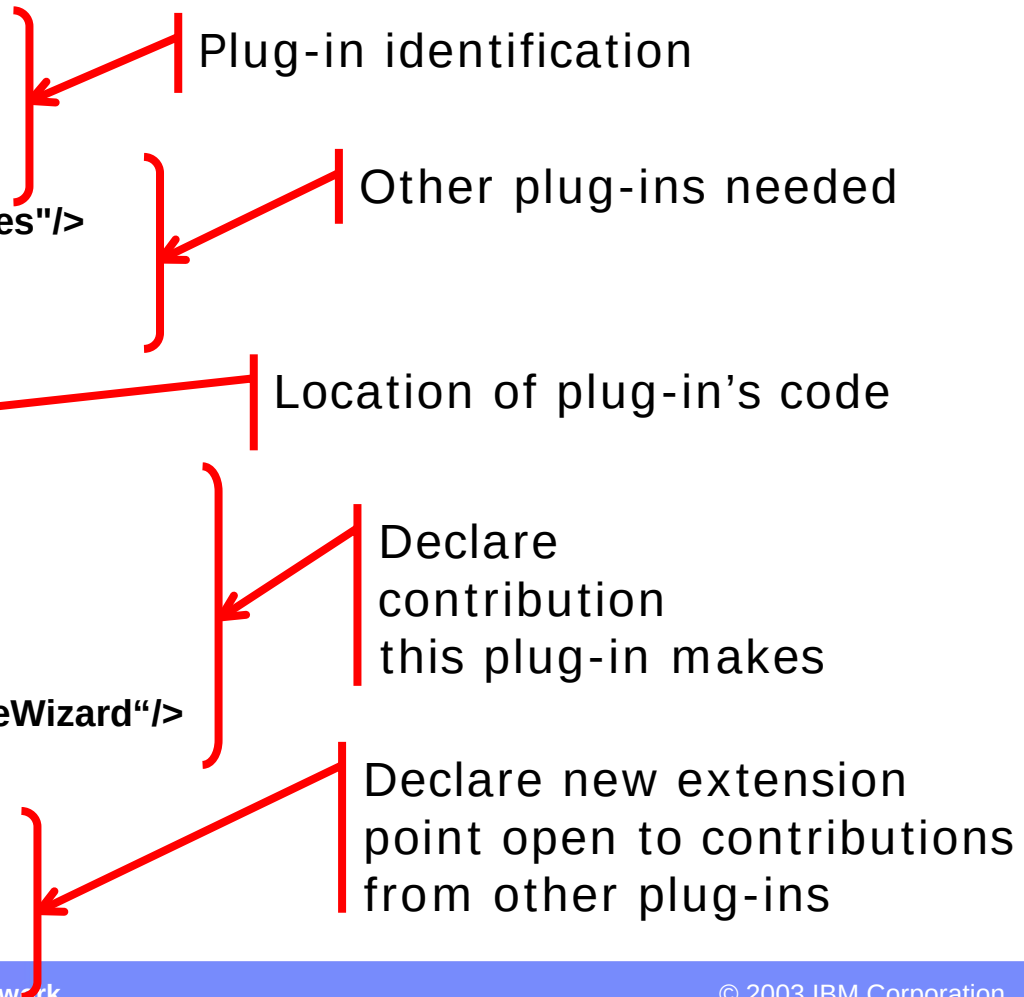
Eclipse Plug-in Architecture

- Each plug-in
  - Contributes to 1 or more extension points
  - Optionally declares new extension points
  - Depends on a set of other plug-ins
  - Contains Java code libraries and other files
  - May export Java-based APIs for downstream plug-ins
  - Lives in its own plug-in subdirectory
- Details spelled out in the **plug-in manifest**
  - Manifest declares contributions
  - Code implements contributions and provides API
  - plugin.xml file in root of plug-in subdirectory

Plug-in Manifest

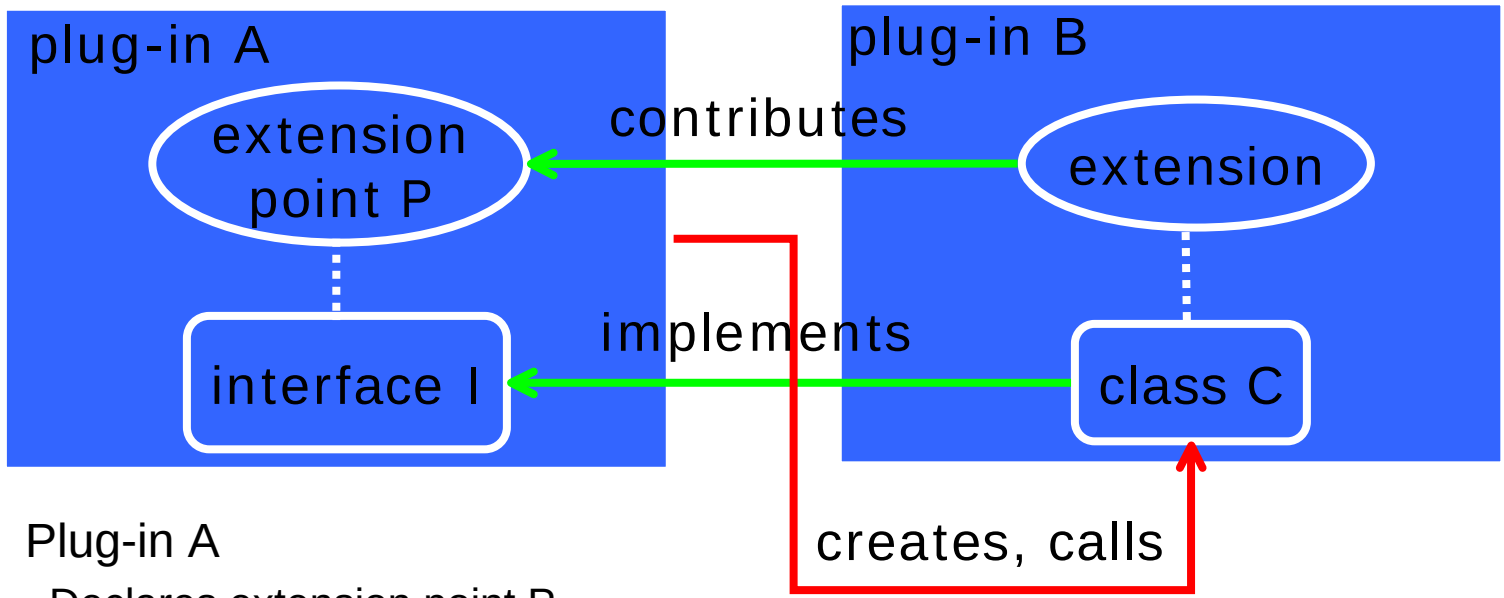
plugin.xml

```
<plugin
    id = “com.example.tool"
    name = “Example Plug-in Tool"
    class = "com.example.tool.ToolPlugin">
 <requires>
    <import plugin = "org.eclipse.core.resources"/>
    <import plugin = "org.eclipse.ui"/>
 </requires>
 <runtime>
    <library name = “tool.jar"/>
 </runtime>
 <extension
    point = "org.eclipse.ui.preferencepages">
   <page id = "com.example.tool.preferences"
     icon = "icons/knob.gif"
     title = “Tool Knobs"
     class = "com.example.tool.ToolPreferenceWizard“/>
 </extension>
 <extension-point
    name = “Frob Providers“
    id = "com.example.tool.frobProvider"/>
</plugin>
```



Eclipse Plug-in Architecture

- Typical arrangement



- Plug-in A
  - Declares extension point P
  - Declares interface I to go with P
- Plug-in B
  - Implements interface I with its own class C
  - Contributes class C to extension point P
- Plug-in A instantiates C and calls its interface I methods

Eclipse Platform Architecture

- Eclipse Platform Runtime is micro-kernel
  - All functionality supplied by plug-ins
- Eclipse Platform Runtime handles start up
  - Discovers plug-ins installed on disk
  - Matches up extensions with extension points
  - Builds global plug-in registry
  - Caches registry on disk for next time

Plug-in Activation

- Each plug-in gets its own Java class loader
  - Delegates to required plug-ins
  - Restricts class visibility to exported APIs
- Contributions processed without plug-in activation
  - Example: Menu constructed from manifest info for contributed items
- Plug-ins are activated only as needed
  - Example: Plug-in activated only when user selects its menu item
  - Scalable for large base of installed plug-ins
  - Helps avoid long start up times

Plug-in Install

- **Features** group plug-ins into installable chunks
  - Feature manifest file
- Plug-ins and features bear version identifiers
  - major . minor . service
  - Multiple versions may co-exist on disk
- Features downloadable from web site
  - Using Eclipse Platform update manager
  - Obtain and install new plug-ins
  - Obtain and install updates to existing plug-ins

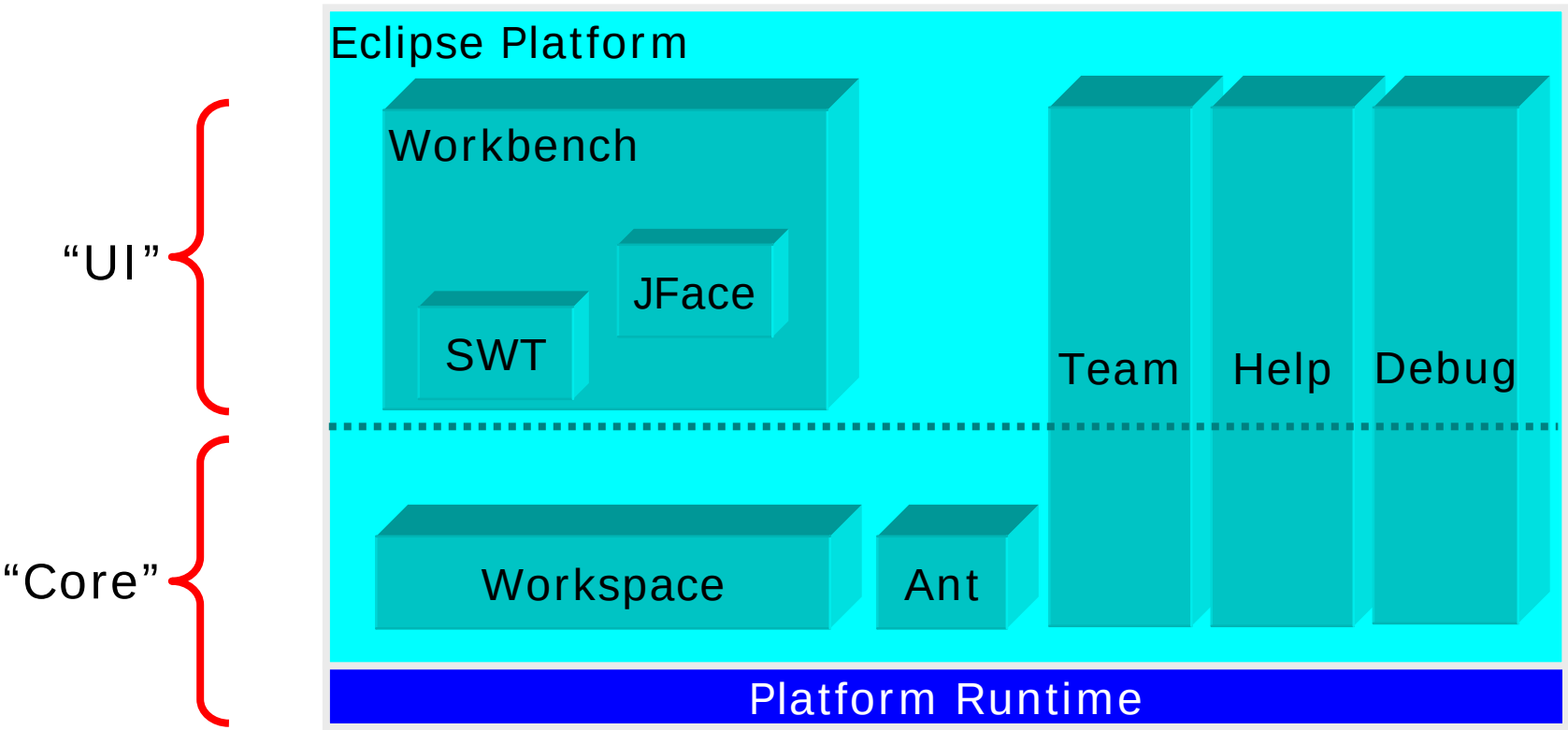
Plug-in Architecture - Summary

- All functionality provided by plug-ins
  - Includes all aspects of Eclipse Platform itself
- Communication via extension points
  - Contributing does not require plug-in activation
- Packaged into separately installable features
  - Downloadable

Eclipse has open, extensible architecture based on plug-ins

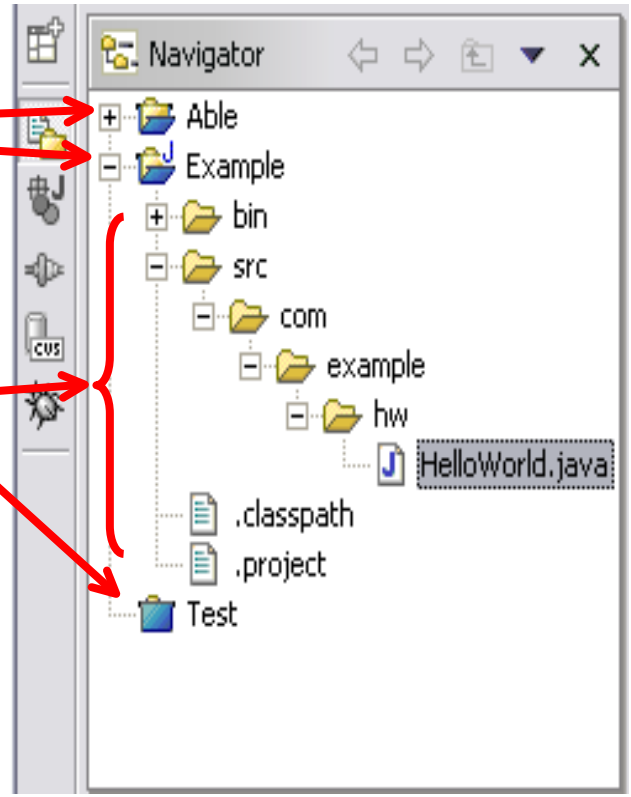
Eclipse Platform

- Eclipse Platform is the common base
- Consists of several key components



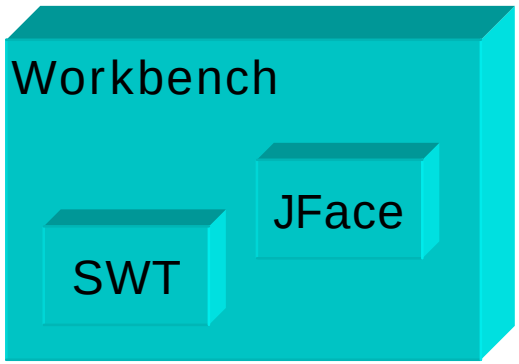
Workspace Component

- Tools operate on files in user's **workspace**
- Workspace holds 1 or more top-level **projects**
- Projects map to directories in file system
- Tree of **folders** and **files**
- {Files, Folders, Projects} termed **resources**



- Tools read, create, modify, and delete resources in workspace
- Plug-ins access via workspace and resource APIs

Workbench Component



- SWT – generic low-level graphics and widget set
- JFace – UI frameworks for common UI tasks
- Workbench – UI personality of Eclipse Platform

SWT

- SWT = Standard Widget Toolkit
- Generic graphics and GUI widget set

  buttons, lists, text, menus, trees, styled text...

- Simple
- Small
- Fast
- OS-independent API
- Uses native widgets where available
- Emulates widgets where unavailable

Why SWT?

- Consensus: hard to produce professional looking shrink-wrapped products using Swing and AWT
- SWT provides
  - Tight integration with native window system
  - Authentic native look and feel
  - Good performance
  - Good portability
  - Good base for robust GUIs
- The proof of the pudding is in the eating…

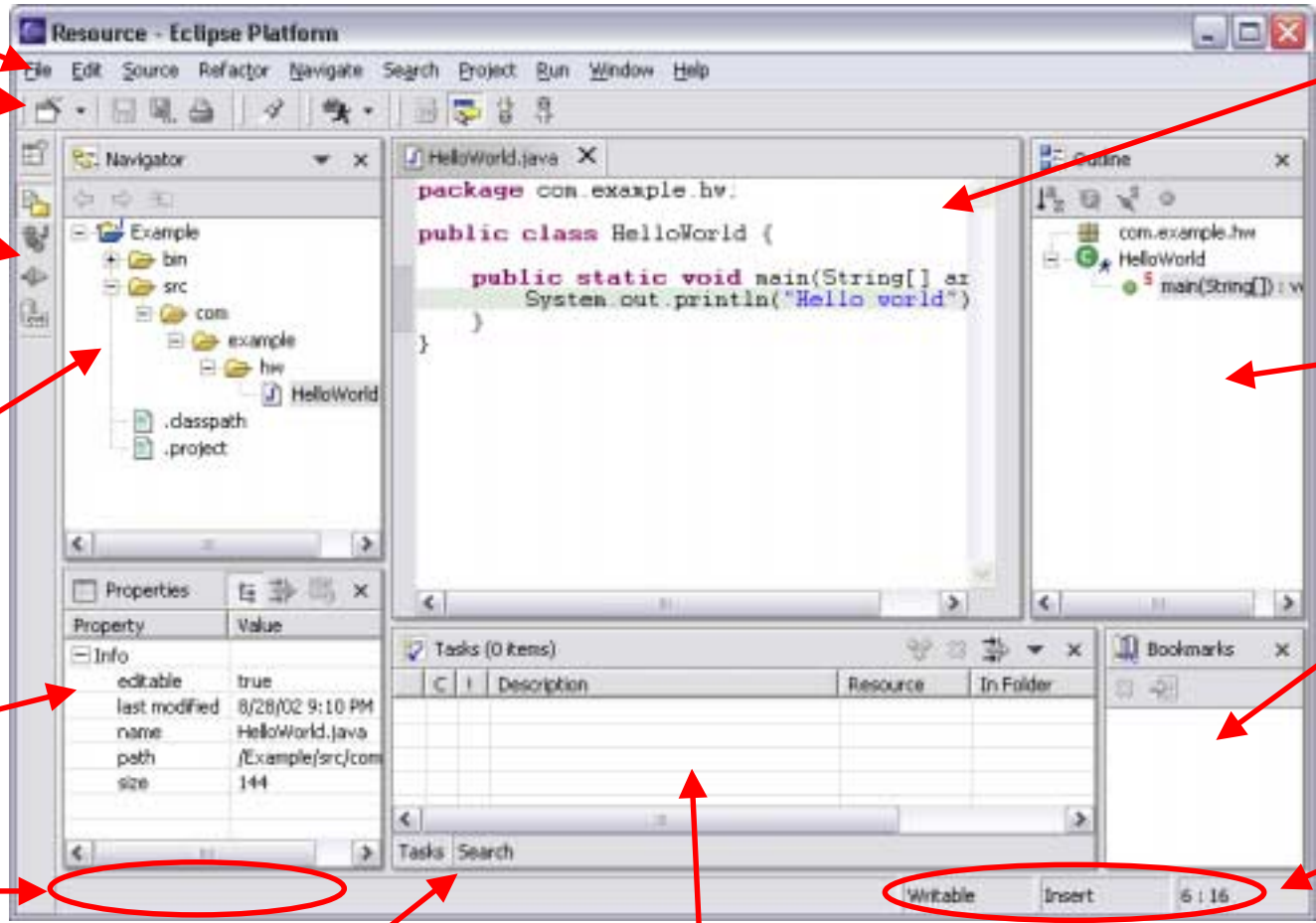
JFace

- JFace is set of UI frameworks for common UI tasks
- Designed to be used in conjunction with SWT
- Classes for handling common UI tasks
- API and implementation are window-system independent

Workbench Component

- Workbench is UI personality of Eclipse Platform
- UI paradigm centered around
  - Editors
  - Views
  - Perspectives

Workbench Terminology



Editors

- Editors appear in workbench editor area
- Contribute actions to workbench menu and tool bars
- Open, edit, save, close lifecycle
- Open editors are stacked

- Extension point for contributing new types of editors
- Example: JDT provides Java source file editor
- Eclipse Platform includes simple text file editor
- Windows only: embed any OLE document as editor
- Extensive text editor API and framework

Views

- Views provide information on some object
- Views augment editors

  Example: Outline view summarizes content
- Views augment other views

  Example: Properties view describes selection

- Extension point for new types of views
- Eclipse Platform includes many standard views

  Resource Navigator, Outline, Properties, Tasks, Bookmarks, Search, …
- View API and framework

  Views can be implemented with JFace viewers

Perspectives

- Perspectives are arrangements of views and editors
- Different perspectives suited for different user tasks
- Users can quickly switch between perspectives
- Task orientation limits visible views, actions
  - Scales to large numbers of installed tools
- Perspectives control
  - View visibility
  - View and editor layout
  - Action visibility
- Extension point for new perspectives
- Eclipse Platform includes standard perspectives
  - Resource, Debug, …
- Perspective API

Eclipse Platform - Summary

- Eclipse Platform is the nucleus of IDE products
- Plug-ins, extension points, extensions
  - Open, extensible architecture
- Workspace, projects, files, folders
  - Common place to organize & store development artifacts
- Workbench, editors, views, perspectives
  - Common user presentation and UI paradigm
- Key building blocks and facilities
  - Help, team support, internationalization, …

Eclipse is a universal platform for integrating development tools

Java Development Tools

- JDT = Java development tools
- State of the art Java development environment

- Built atop Eclipse Platform
  - Implemented as Eclipse plug-ins
  - Using Eclipse Platform APIs and extension points

- Included in Eclipse Project releases
  - Available as separately installable feature
  - Part of Eclipse SDK drops

Plug-in Development Environment

- PDE = Plug-in development environment
- Specialized tools for developing Eclipse plug-ins

- Built atop Eclipse Platform and JDT
  - Implemented as Eclipse plug-ins
  - Using Eclipse Platform and JDT APIs and extension points

- Included in Eclipse Project releases
  - Separately installable feature
  - Part of Eclipse SDK drops

Eclipse 3.0

- Eclipse 3.0 is under development.
- Eclipse 2.1 is the current stable release
- Main changes are:
  - Rich client platform
  - New look and feel
  - SWT enhancements and Swing interoperability
  - Java tools enhancements

Eclipse Operating Environments

- Eclipse Platform currently* runs on
  - Microsoft® Windows® XP (98, ME, NT, 2000, Server 2003)
  - Linux® on Intel x86 - GTK
    - Red Hat Enterprise Linux WS3 x86
    - SuSE Linux 8.2 x86
  - Sun Solaris 8 SPARC – Motif
  - HP-UX 11i hp9000 – Motif
  - IBM® AIX 5L 5.2 on PowerPC – Motif
  - Apple Mac OS® X 10.3 on PowerPC – Carbon
  - QNX® Neutrino® RTOS 6.2.1 - Photon®

*** Eclipse 3.0 – Jan 2004**

Other Operating Environments

- Most Eclipse plug-ins are 100% pure Java
  - Freely port to new operating environment
  - Java2 and Eclipse APIs insulate plug-in from OS and window system
- Gating factor: porting SWT to native window system
- Eclipse Platform also runs “headless”
  - Example: help engine running on server

*** March 2003**

Eclipse Board of Directors – March 2004

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Announced Eclipse Add-In Providers

- Advanced Systems Concepts
- Borland
- Candle Corporation
- CanyonBlue
- Catalyst Systems Corporation
- CollabNet
- Embarcadero Technologies
- ETRI
- Exadel
- Fujitsu
- Genuitec
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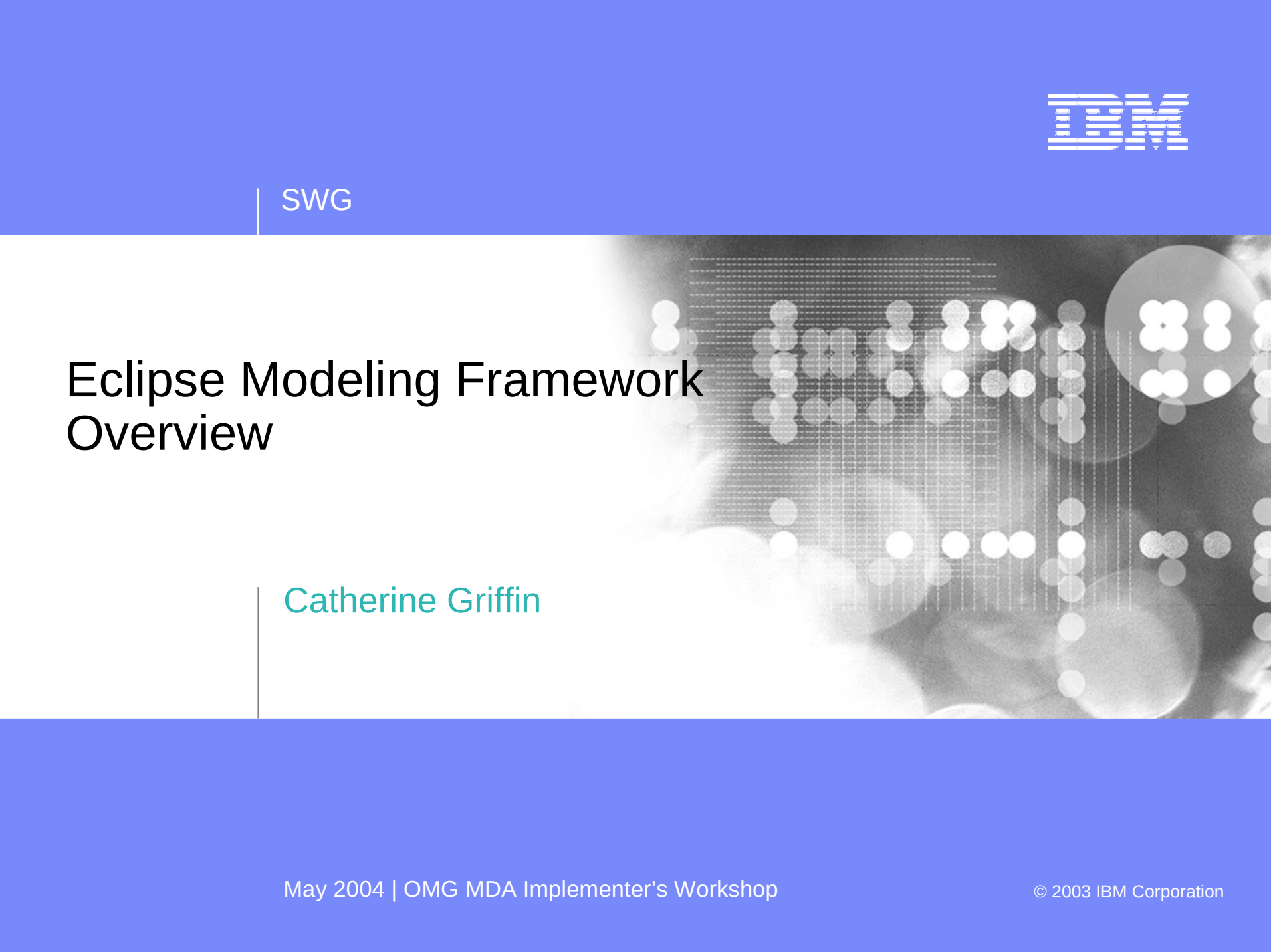
- Wasabi Systems
- webMethods
- Wind River



Eclipse Modeling Framework Overview

Catherine Griffin

EMF History

- Originally based on MOF (Meta Object Facility)
  - From OMG (Object Management Group)
  - Abstract language and framework for specifying, constructing, and managing technology neutral meta-models.
- EMF evolved based on experience supporting a large set of tools
  - Efficient Java implementation of a practical subset of the MOF API
  - To avoid confusion, the MOF-like core meta model in EMF is called **Ecore** instead of MOF
- Foundation for model based WebSphere Studio family product set
  - Example: J2EE model in WebSphere Studio Application Developer
- 2003: MOF 2.0 Specification
  - EMF designers contributed to MOF 2.0
  - EMF is essentially the same as EMOF subset

Who is using EMF today?

- IBM WebSphere Studio product family
- Rational XDE and future tools
- Eclipse based components
  - Hyades Project (testing and logging)
  - RSE (remote file system support)
  - XSD Project (manipulate XML Schemas)
  - UML 2.0
- ISV's
  - TogetherSoft (UML editor and code generation)
  - Ensemble (support for Weblogic servers)
  - Versata (extend J2EE to capture their business rules)
  - Omondo (UML editor tightly coupled to EMF tools

EMF Features

- Meta-model (**Ecore**)
- Template based Java code generation
  - Model implementation
  - Eclipse editor
- XMI2.0 serialization and deserialization
- Reflection APIs
- Change notification
- Dynamic models (no code generation)
- Reusable parts for building Eclipse tools
- .. And more

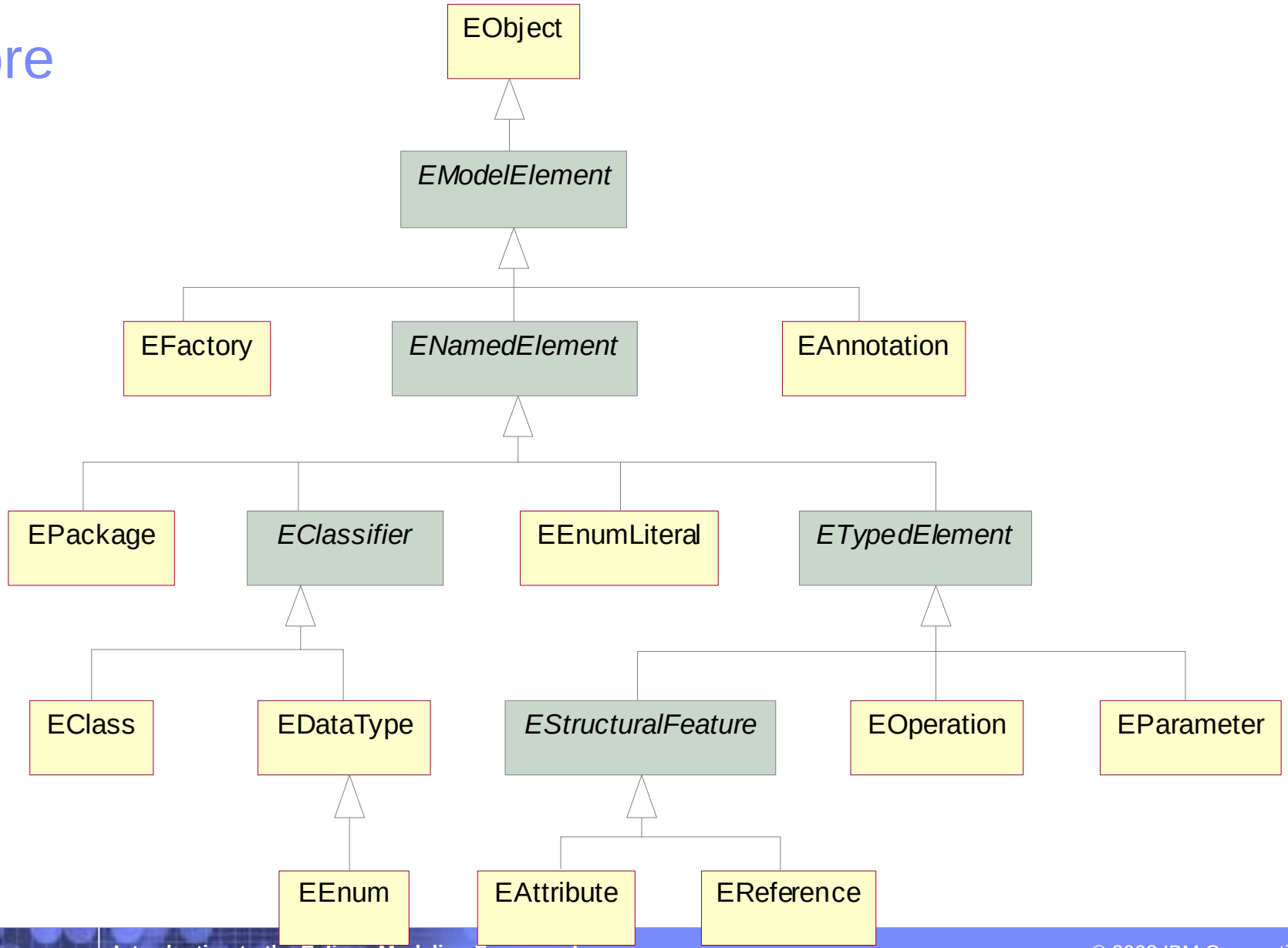
EMF 2.0 Highlights

- MOF 2.0 alignment
  - Changes to Ecore
  - Read/write Ecore as EMOF
- Service Data Objects (SDO) implementation
  - uniform access and manipulation for data from relational databases, XML data sources, Web services, and enterprise information systems
  - JSR 235
- XSD support improvements
- Rose import improvements
  - XSD
  - operation body can be specified
- Change (delta) model
  - Record, apply, and reverse changes

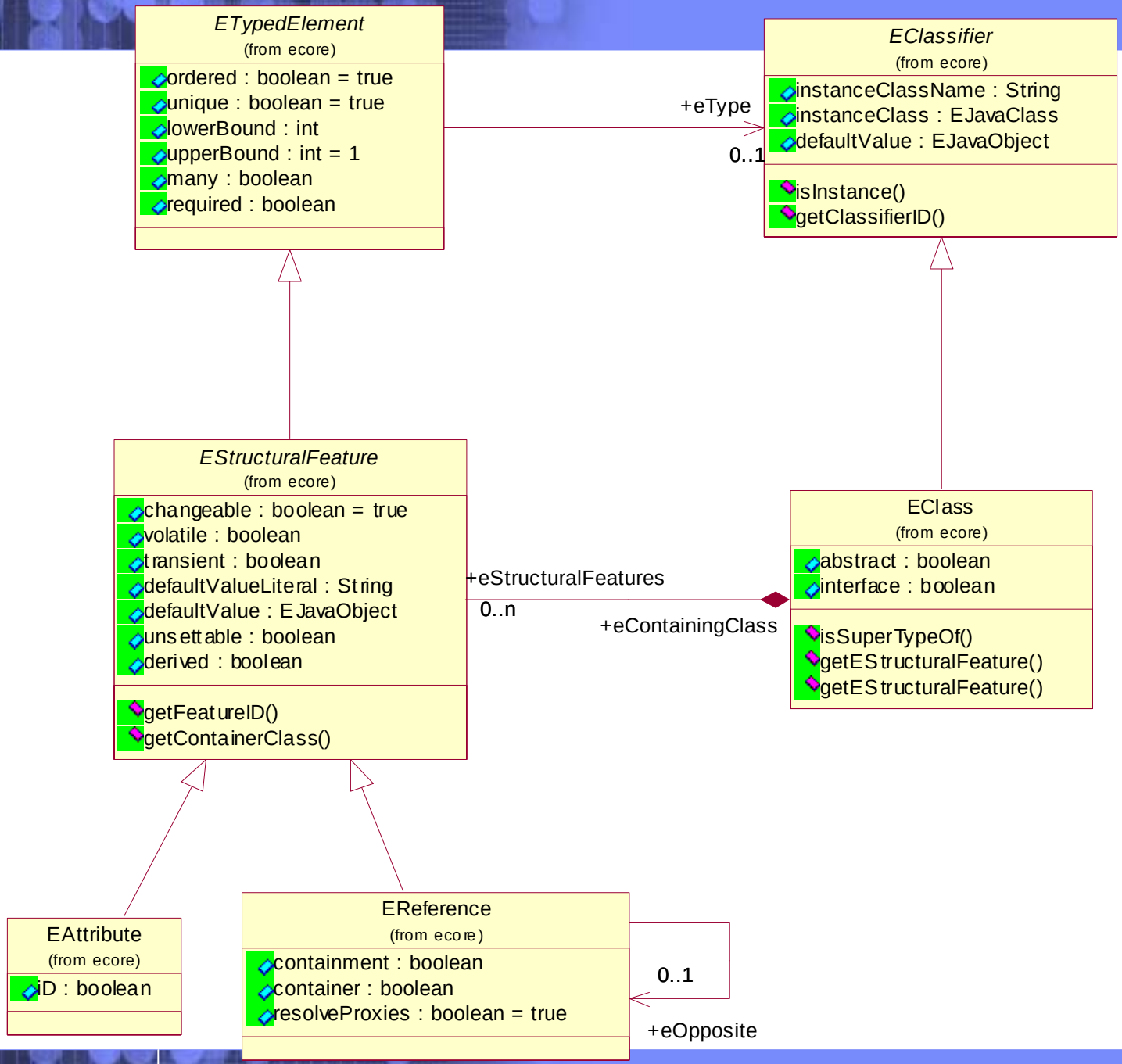
What EMF is not

- No repository concept
- Simple meta-model – no associations, constraints
- Does not implement JMI

Ecore



Ecore



Creating an Ecore model

- Various methods of creating an Ecore model are supported:
  - Rational Rose
  - Java interfaces with added annotations
  - XML Schema
  - EMF Java APIs (write a program)
  - Other tools – e.g.Omondo (UML editor)

Code generation

- EMF generates Java classes to implement your metamodel (defined as an Ecore model)
- Based on easy to modify templates (JET)
- The generated code is efficient, simple and clean
- EMF can also generate a simple Eclipse editor for your model

Customizing generated code

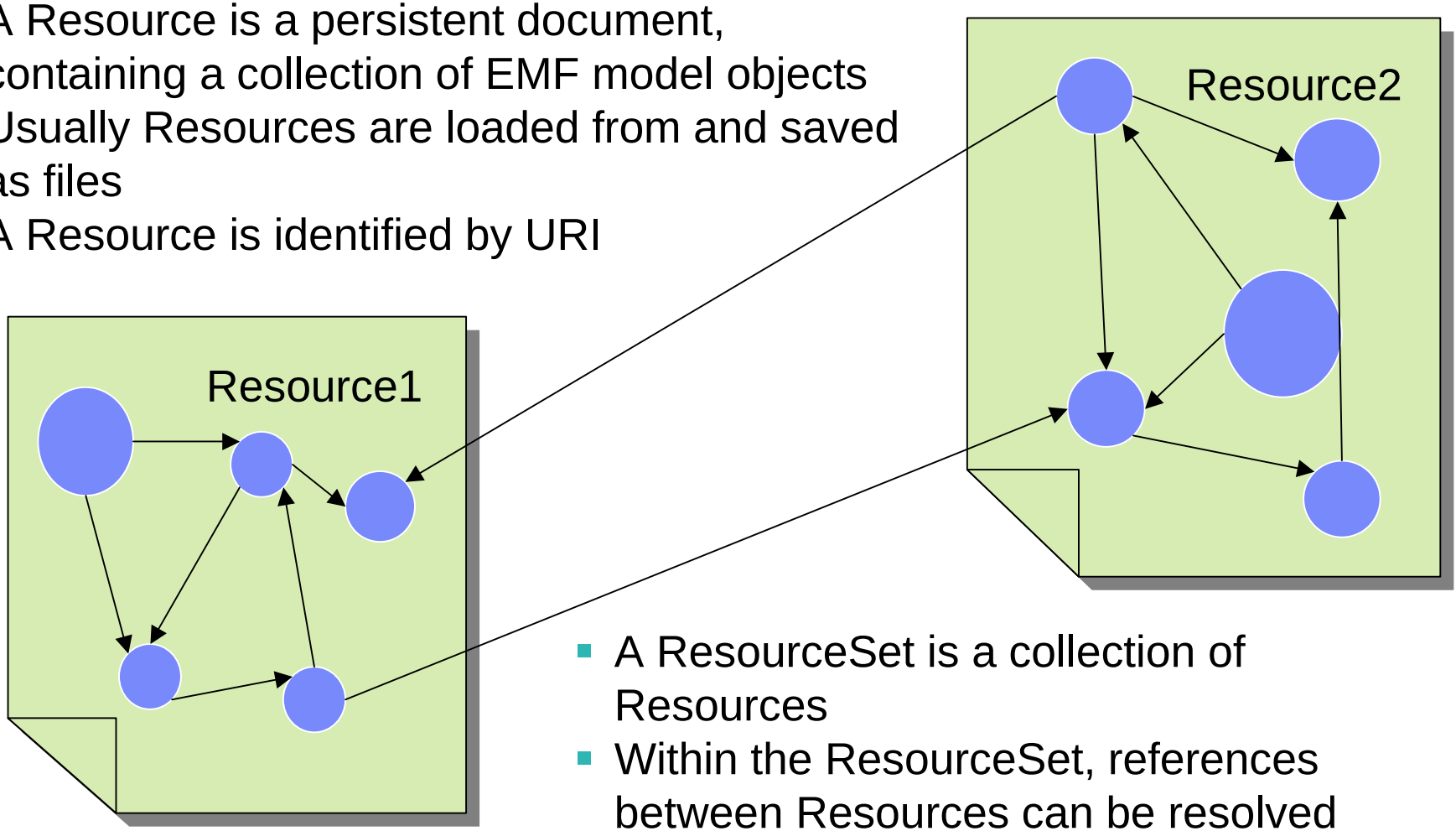
- You can edit the generated code, and your changes will be maintained when the code is re-generated
  - Generated methods have the flag @generated in the method comment
  - If you edit a generated method, either remove the @generated flag or change it to @generated NOT – this will prevent your changes being lost when the code is re-generated
- You can also use different templates for code generation
  - You might want to do this to change the standard file header, or conform to your preferred naming conventions

Loading and Saving EMF Models

- EMF has no repository concept – model instances are usually serialized into files
- By default, models are serialized using XMI2.0
- EMF also supports serialization to XML, for XML schema based models
- If you need to, you can write your own custom serialization/deserialization code

Resources

- A Resource is a persistent document, containing a collection of EMF model objects
- Usually Resources are loaded from and saved as files
- A Resource is identified by URI



- A ResourceSet is a collection of Resources
- Within the ResourceSet, references between Resources can be resolved

XMI1.0 Sample (from Rational Rose Unisys XMI Exporter)

```
<?xml version = '1.0' encoding = 'ISO-8859-1' ?>
<!-- <!DOCTYPE XMI SYSTEM 'UML13.dtd' > -->
<XMI xmi.version = '1.0' timestamp = 'Thu May 29 11:25:05 2003' >
 <XMI.header>
  <XMI.documentation>
   <XMI.exporter>Unisys.JCR.1</XMI.exporter>
   <XMI.exporterVersion>1.3.4</XMI.exporterVersion>
  </XMI.documentation>
  <XMI.metamodel xmi.name = 'UML' xmi.version = '1.3'/>
 </XMI.header>
<XMI.content>
<!-- ==================== XSD    [Model] ==================== -->
<Model_Management.Model xmi.id = 'G.0' >
  <Foundation.Core.ModelElement.name>XSD</Foundation.Core.ModelElement.name>
  <Foundation.Core.ModelElement.visibility xmi.value = "public"/>
  <Foundation.Core.ModelElement.isSpecification xmi.value = "false"/>
  <Foundation.Core.GeneralizableElement.isRoot xmi.value = "false"/>
  <Foundation.Core.GeneralizableElement.isLeaf xmi.value = "false"/>
  <Foundation.Core.GeneralizableElement.isAbstract xmi.value = "false"/>
  <Foundation.Core.Namespace.ownedElement>
    <!-- ==================== XSD::datatypes1    [Package] ==================== -->
    <Model_Management.Package xmi.id = 'S.148.1124.56.1' >
      <Foundation.Core.ModelElement.name>datatypes1</Foundation.Core.ModelElement.name>
      <Foundation.Core.ModelElement.visibility xmi.value = "public"/>
      <Foundation.Core.ModelElement.isSpecification xmi.value = "false"/>
      <Foundation.Core.GeneralizableElement.isRoot xmi.value = "false"/>
....
```

XMI 2.0 Sample (from EMF)

```
<?xml version="1.0" encoding="ASCII"?>
<model_management:Model xmi:version="2.0" xmlns:xmi="http://www.omg.org/XMI" xmlns:xsi="http://www.
  <ownedElement xsi:type="model_management:Package" name="datatypes1" isSpecification="false" isRoo
    <ownedElement xsi:type="core:Association" name="" isSpecification="false" isRoot="false" isLeaf="false"
      <connection name="" isSpecification="false" isNavigable="false" participant="//@ownedElement.5/@own
        <multiplicity>
          <range lower="0" upper="-1"/>
        </multiplicity>
      </connection>
      <connection name="ref1" isSpecification="false" isNavigable="true" participant="//@ownedElement.0/@o
        <multiplicity>
          <range lower="1" upper="-1"/>
        </multiplicity>
      </connection>
    </ownedElement>
    <ownedElement xsi:type="core:Association" name="" isSpecification="false" isRoot="false" isLeaf="false"
      <connection name="" isSpecification="false" isNavigable="false" aggregation="composite" participant="//@
        <multiplicity>
          <range lower="0" upper="-1"/>
        </multiplicity>
      </connection>
      <connection name="aggr1" isSpecification="false" isNavigable="true" participant="//@ownedElement.0
        <multiplicity>
          <range lower="1" upper="1"/>
        </multiplicity>
```

Reflection

- Reflection allows generic access to any EMF model
  - Similar to Java's introspection capability.
  - Every EObject (which is every EMF object) defines a reflection API
- The entire model can be traversed and updated using the EMF reflection API
  - Reflection API's only slightly less efficient than generated implementation

Model Change Notification

- Model change notification is built in to EMF
- Every model object is an EMF **`EObject`**
  - Every `EObject` has built-in notification support
- Changing any object attributes or references will send a notification to all registered listeners
  - Notification bypassed if there are no listeners
  - Notification encoded in the object's `set`*XXX* methods

SWG

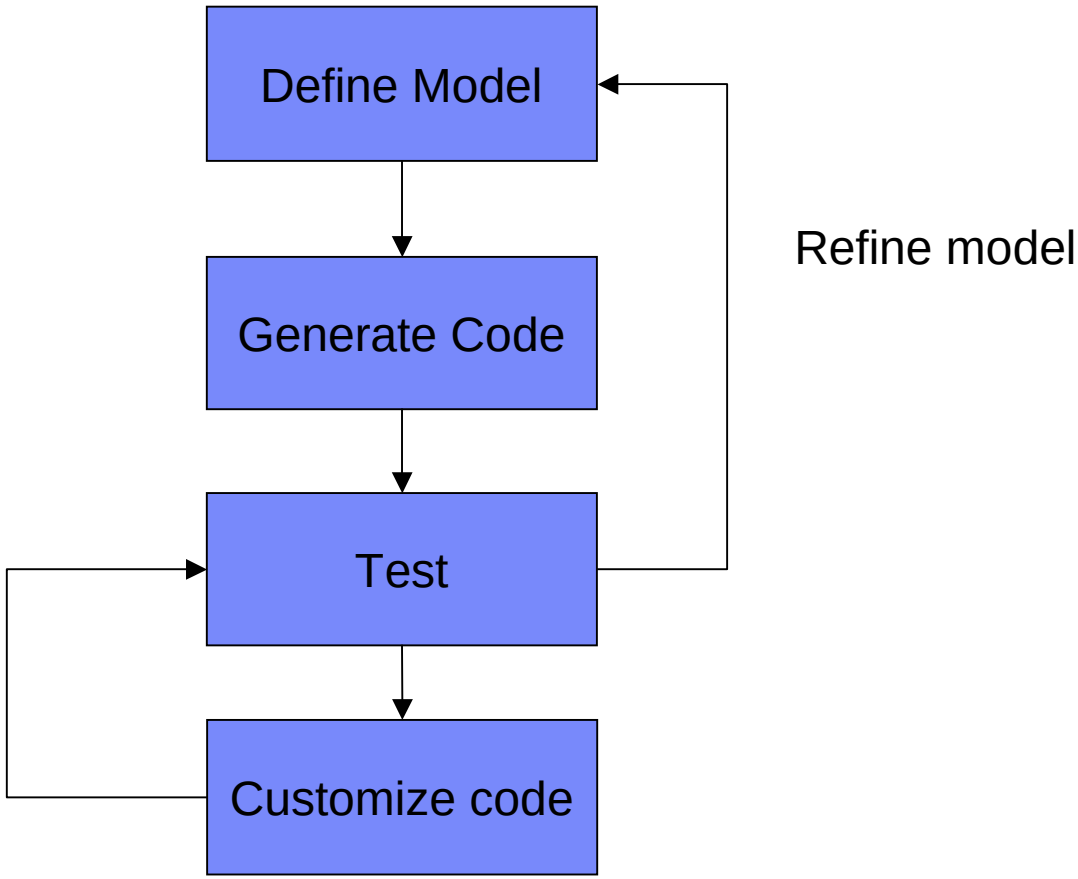
Using the Eclipse Modeling Framework

Catherine Griffin

Installing EMF

1. Download as zip files from http://www.eclipse.org/emf
   - EMF Runtime (you need at least this)
   - Documentation
   - Source
   - XSD Runtime
2. Unzip into the **eclipse** directory
3. Restart eclipse

EMF development process

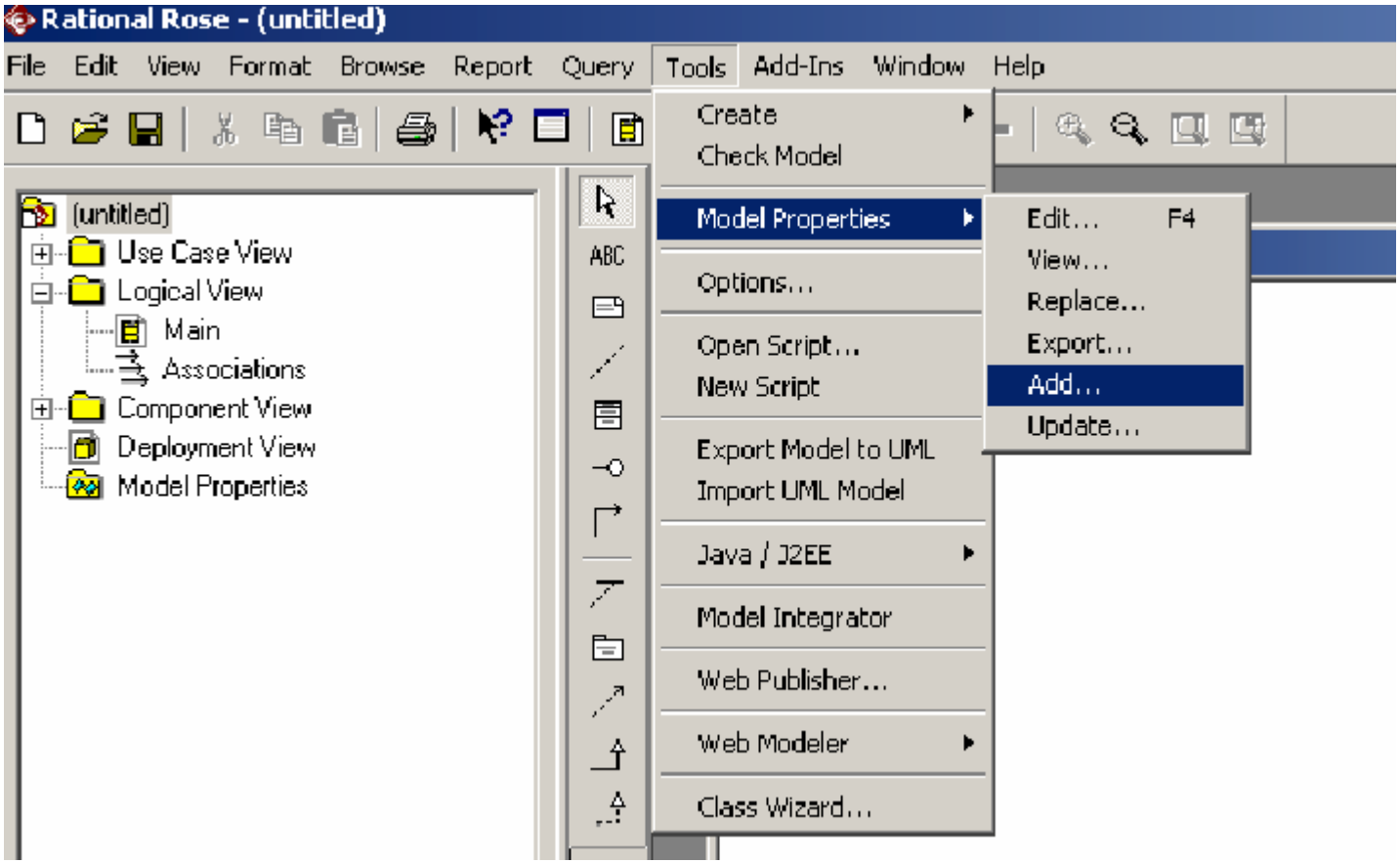


Using Rational Rose to define an Ecore model

- An Ecore model can be defined using a UML class diagram
- There are some Ecore specific properties that you may need to set

  add the Ecore model properties to Rose
- Create one or more top-level packages
- Add sub-packages, classes, associations etc
- Save the model
- Use EMF tools to generate code from the Rose .mdl file

Ecore properties

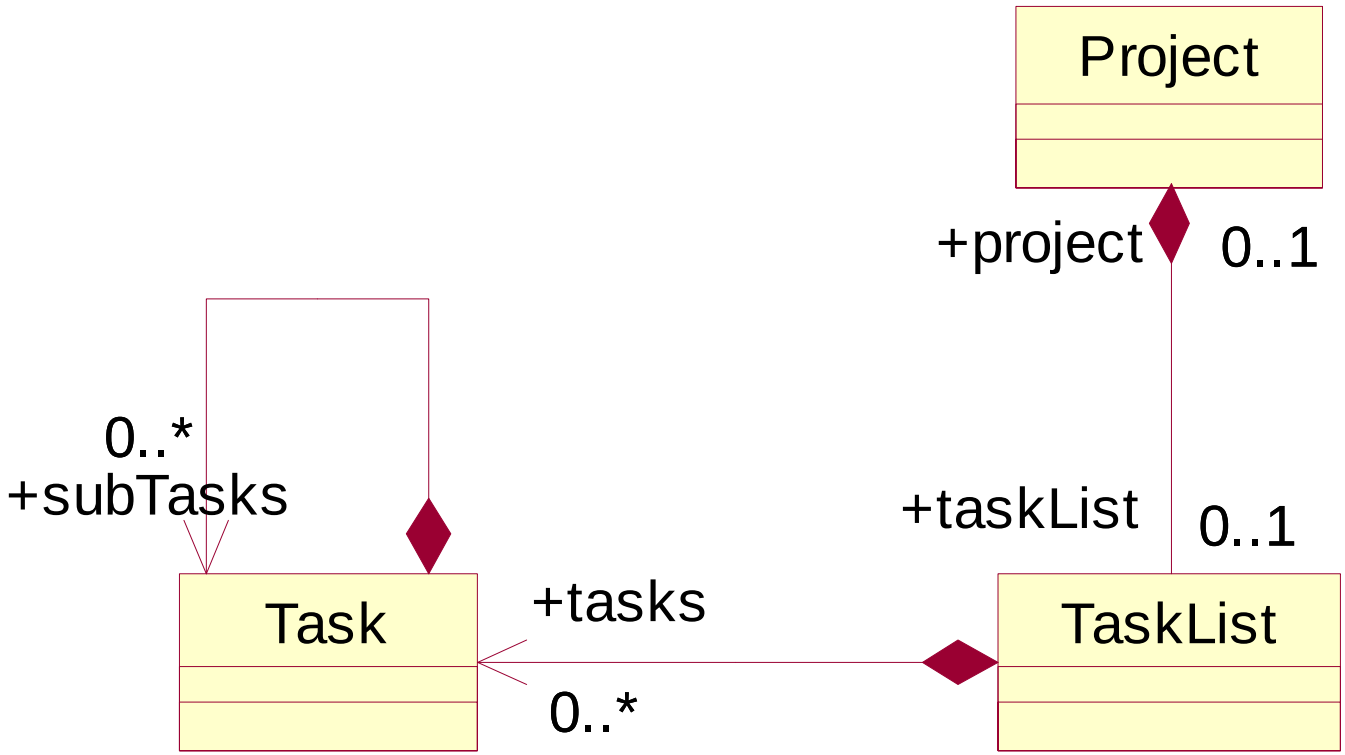


Load the file **ecore.pty** from
eclipse\plugins\org.eclipse.emf.codegen.ecore_x.x.x\rose

Associations

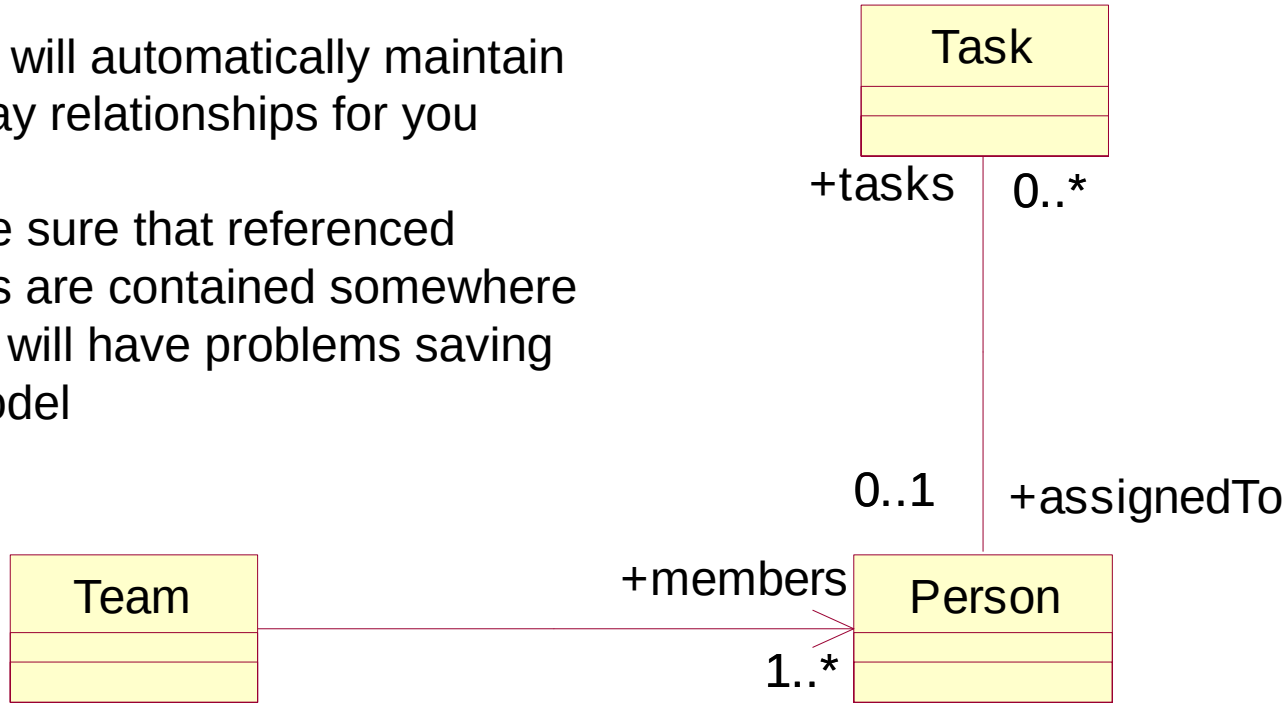
- At least one end must be navigable
- All navigable ends should have role names
- All navigable ends must have multiplicity
- The generated code only distinguishes between ‘many’ and ‘one’ multiplicities (but you can use whatever multiplicities you like)
- Containment should be by value

Containment relations

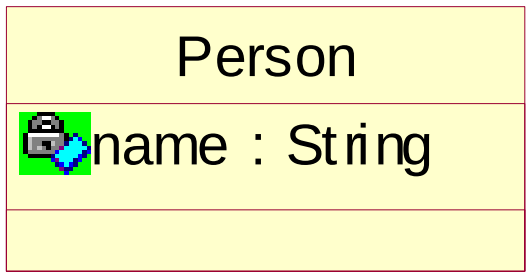


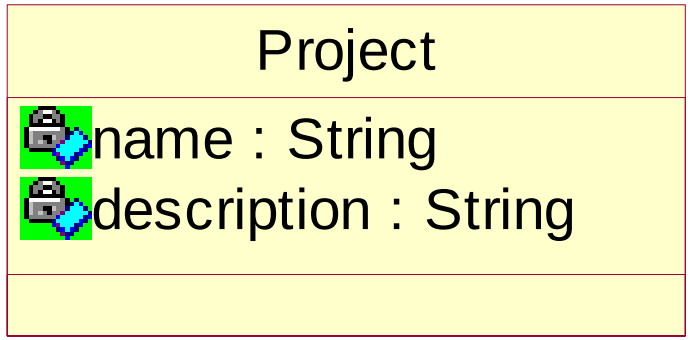
Reference relations

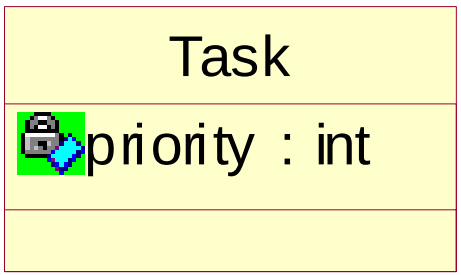
- EMF will automatically maintain two-way relationships for you
- Make sure that referenced objects are contained somewhere or you will have problems saving the model



Attributes



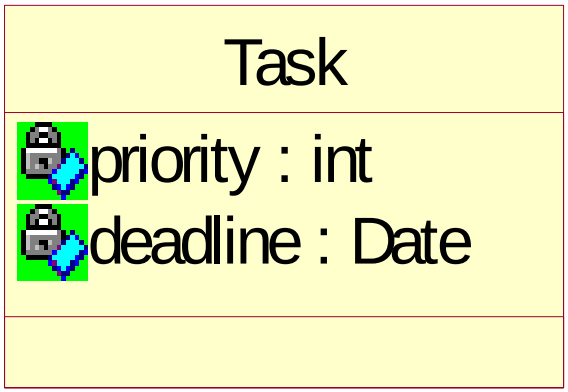


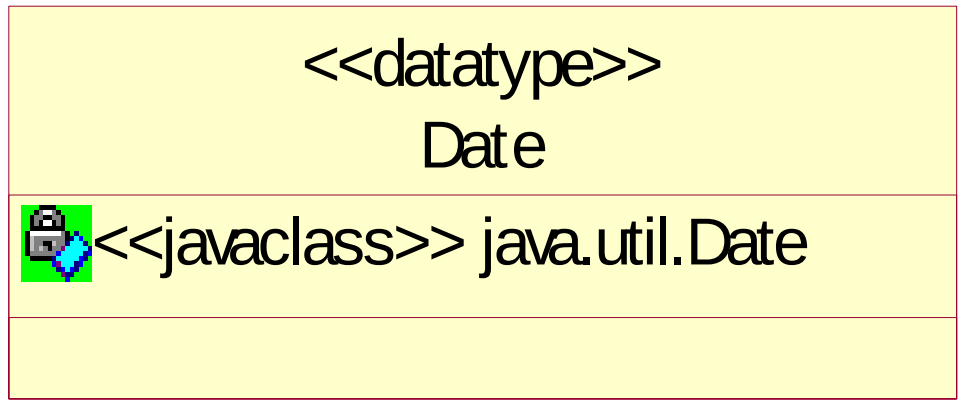


The type of an attribute must be a data type:
- a Java primitive type (boolean, int, char …)
- Java language type (Class, Object, Boolean, String, Integer…)
- an enumeration or data type defined in your model

Multiplicity is specified by a stereotype on the attribute, e.g. <<0..*>>

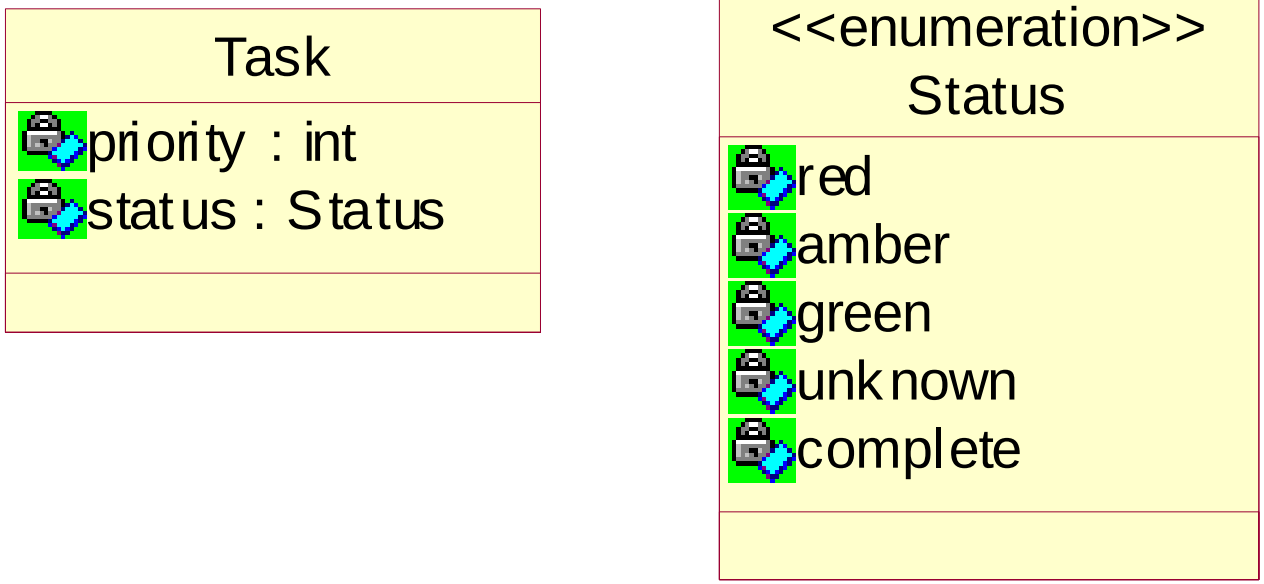
DataTypes



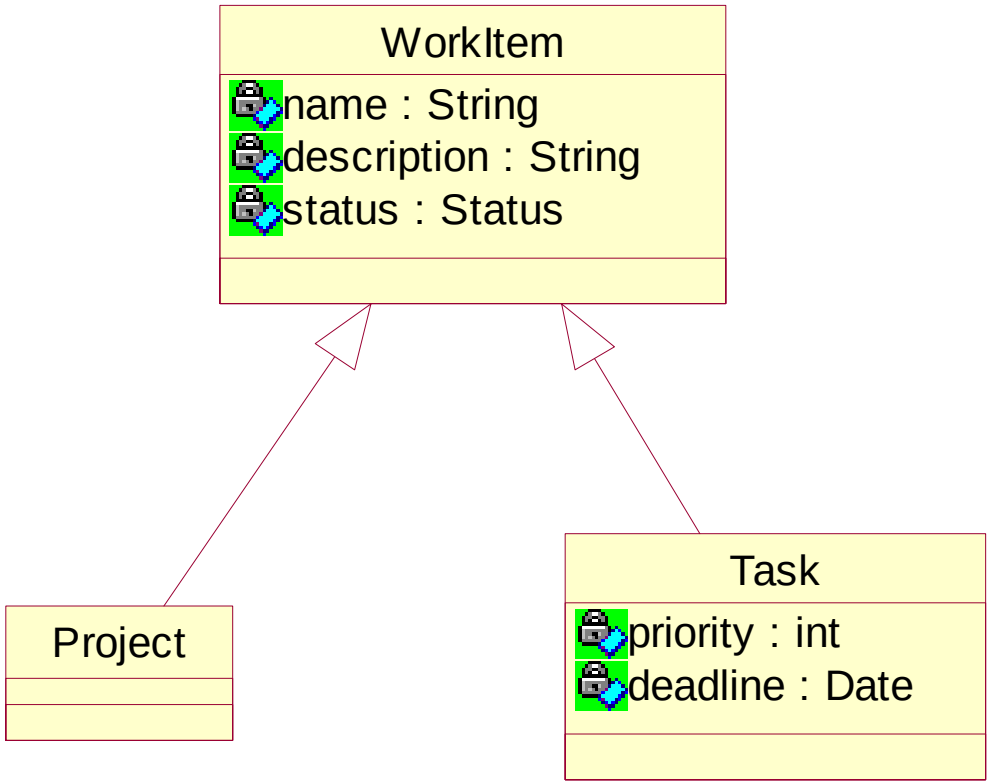


Data type values are serialized as strings in the XMI. It is up to you to ensure this is implemented correctly for any data types you define.
The default behavior uses the Java toString() method to serialize the data, and a constructor with a String argument, or valueOf(String) method, to read it back in.

Enumerations

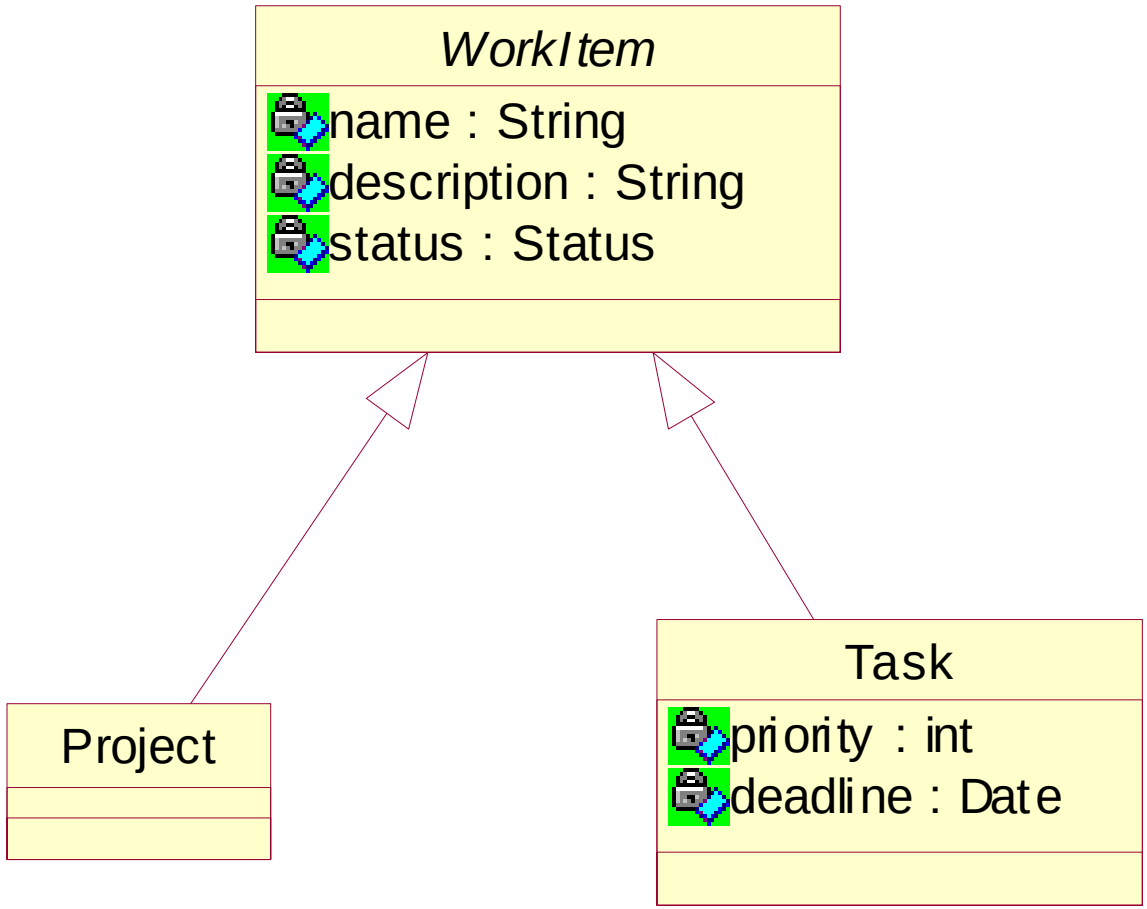


Inheritance



(Multiple inheritance is supported)

Abstract classes

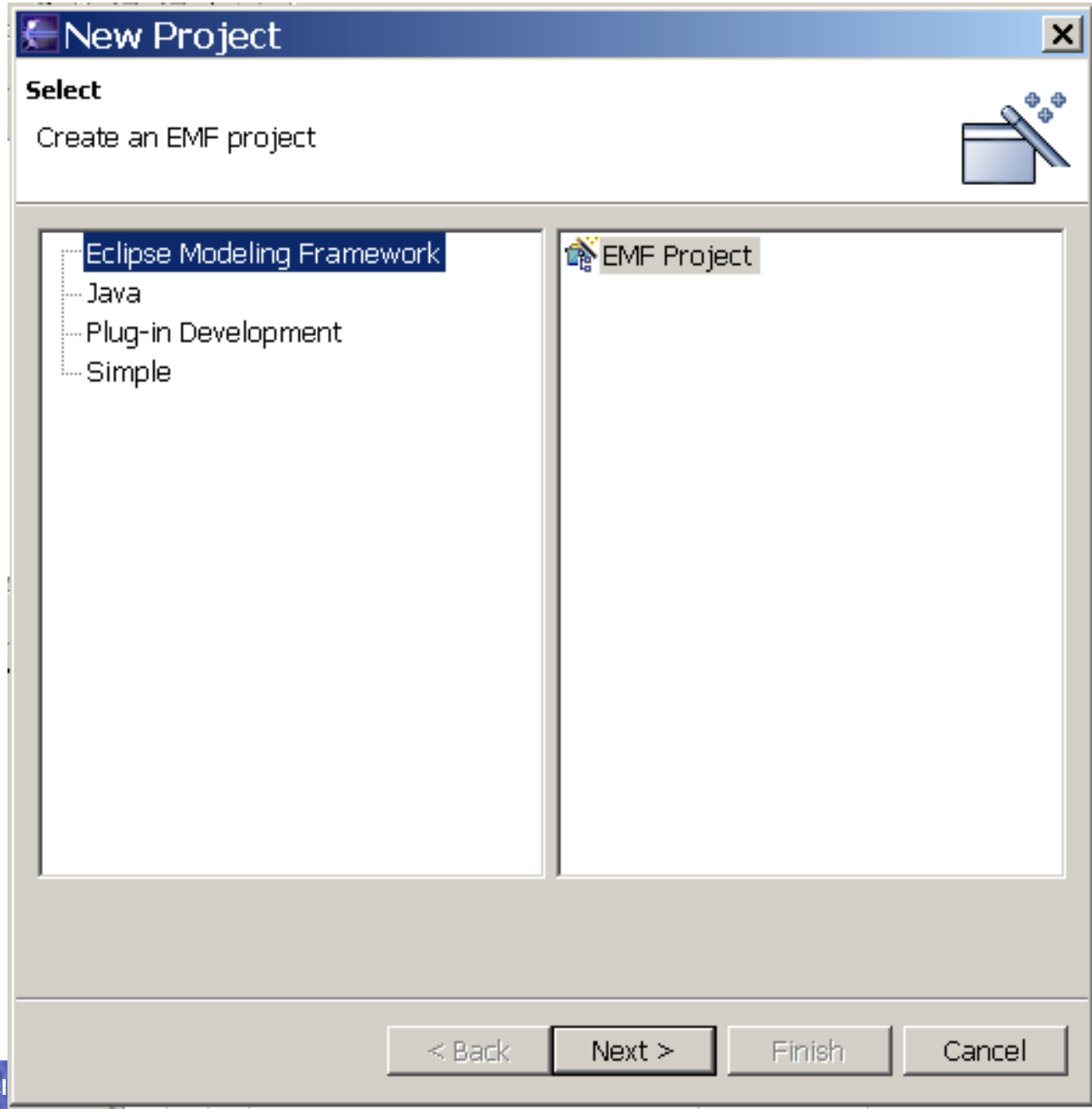


Code generation

- To generate code you need
  - an Ecore model (in one or more .ecore files)
  - a generator model (.genmodel file)
- EMF stores code generation options in this separate genmodel file, which references your Ecore model
- The genmodel file is only used for code generation

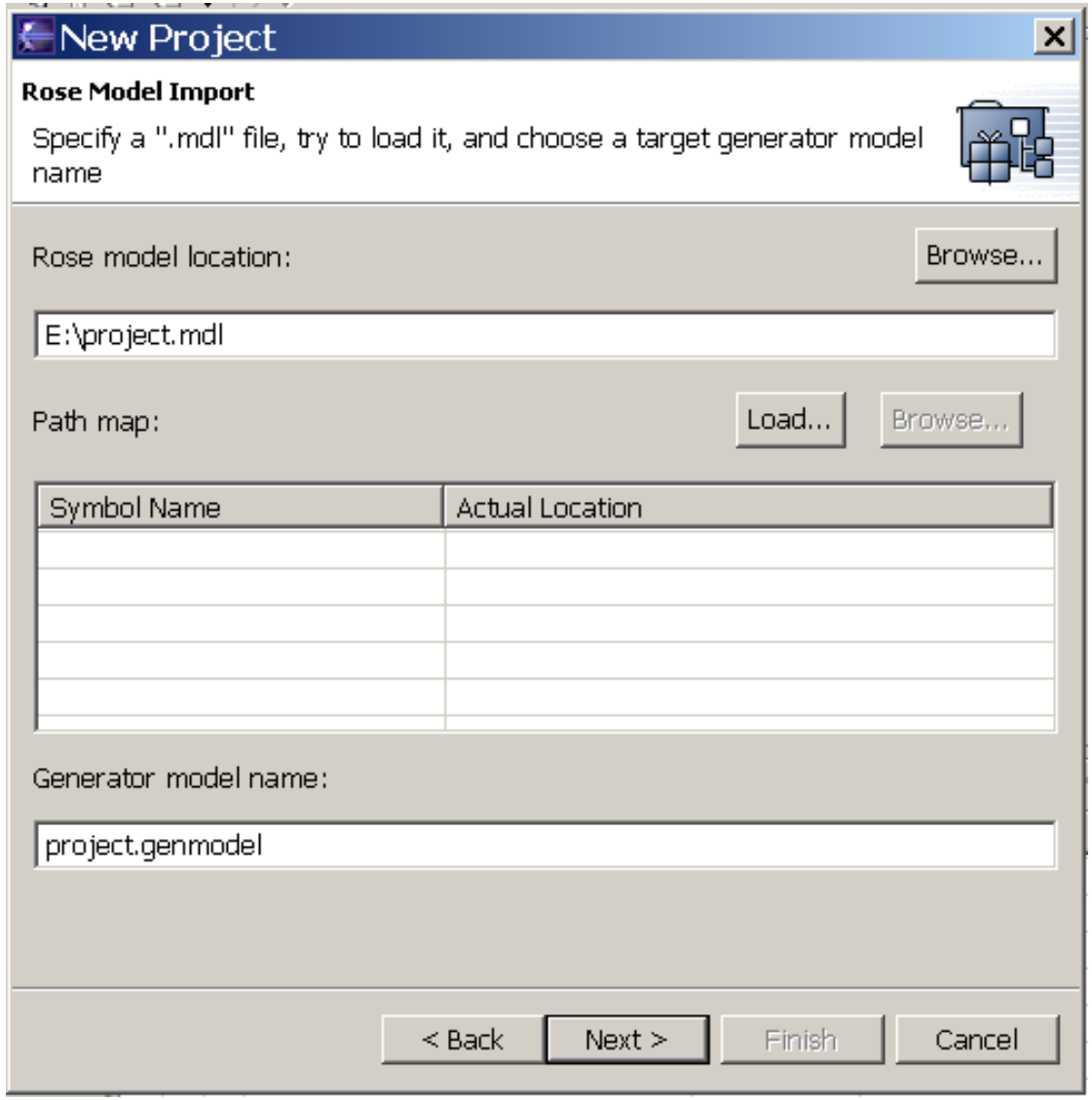
Generating code

1. In Eclipse, select **File > New > Project…**
2. Use the wizard to create a new **EMF Project**
3. Select **Rose class model** as the source to load



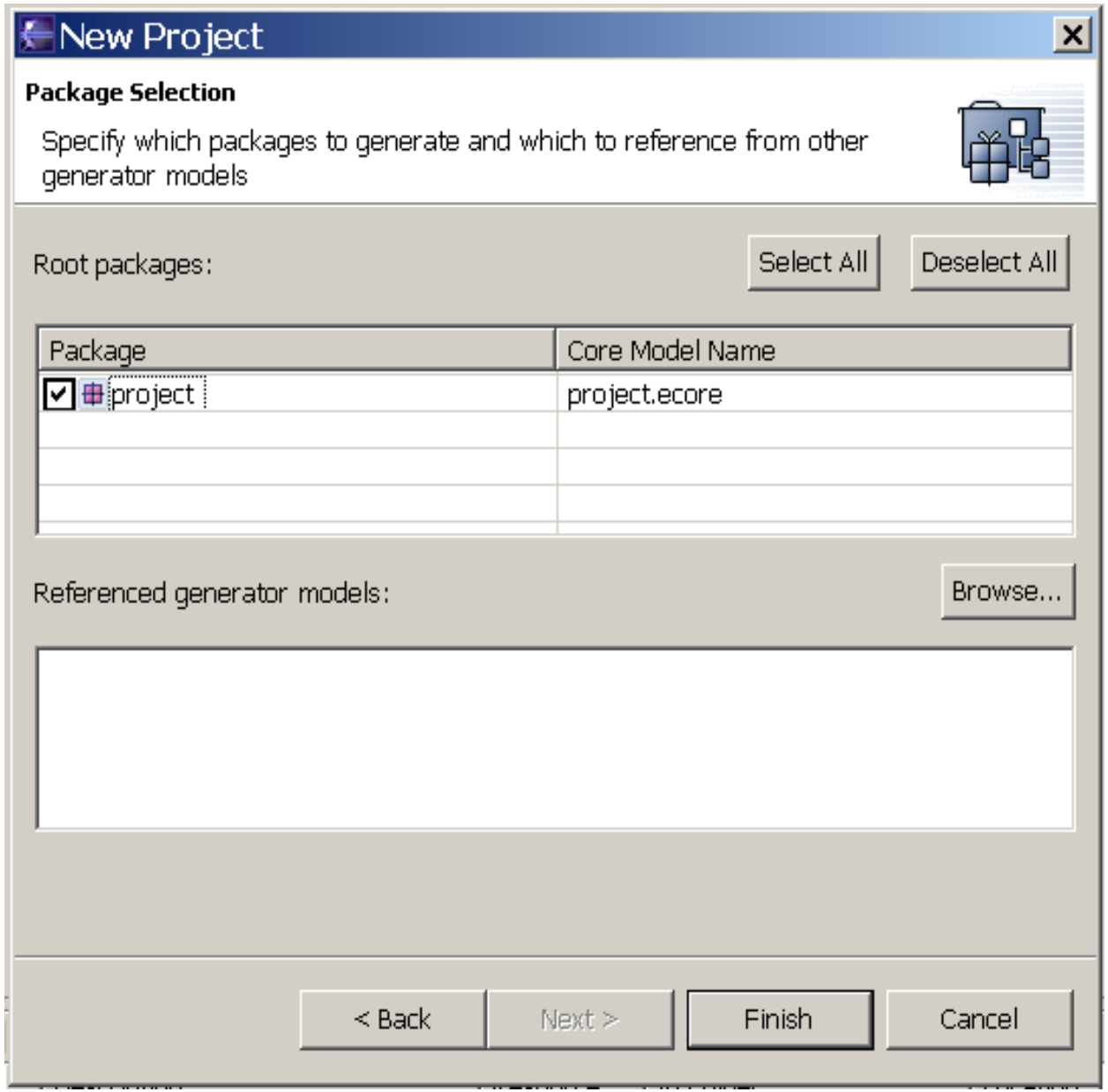
Importing the Rose model

1. Click on **Browse..** and select the Rose .mdl file to load
2. Click **Next >**

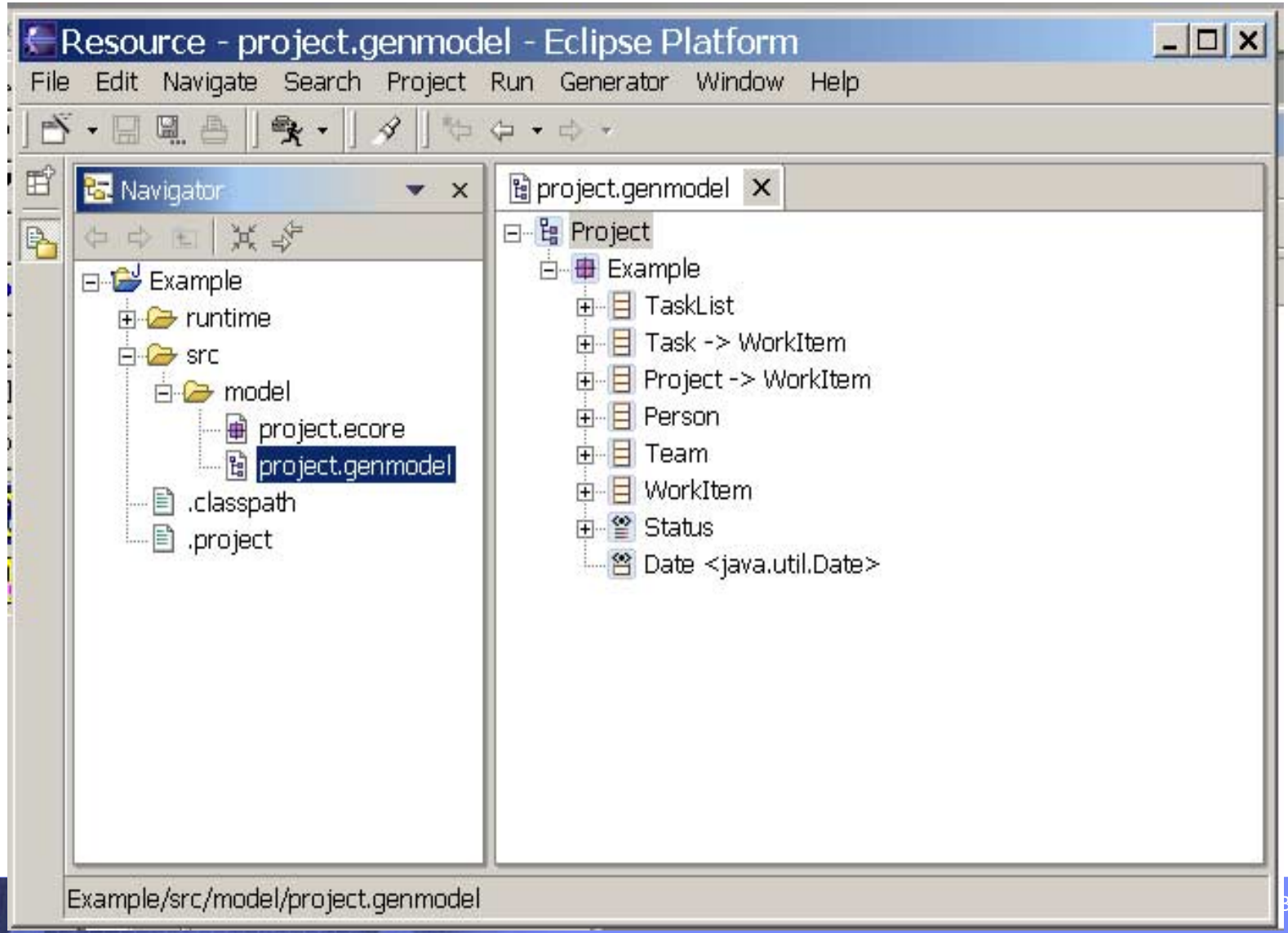


Select packages

1. Make sure the packages that you want to generate code for are selected
2. Click **Finish**
3. A new project is built, containing one or more ecore files and one genmodel file
4. The genmodel is open for editing

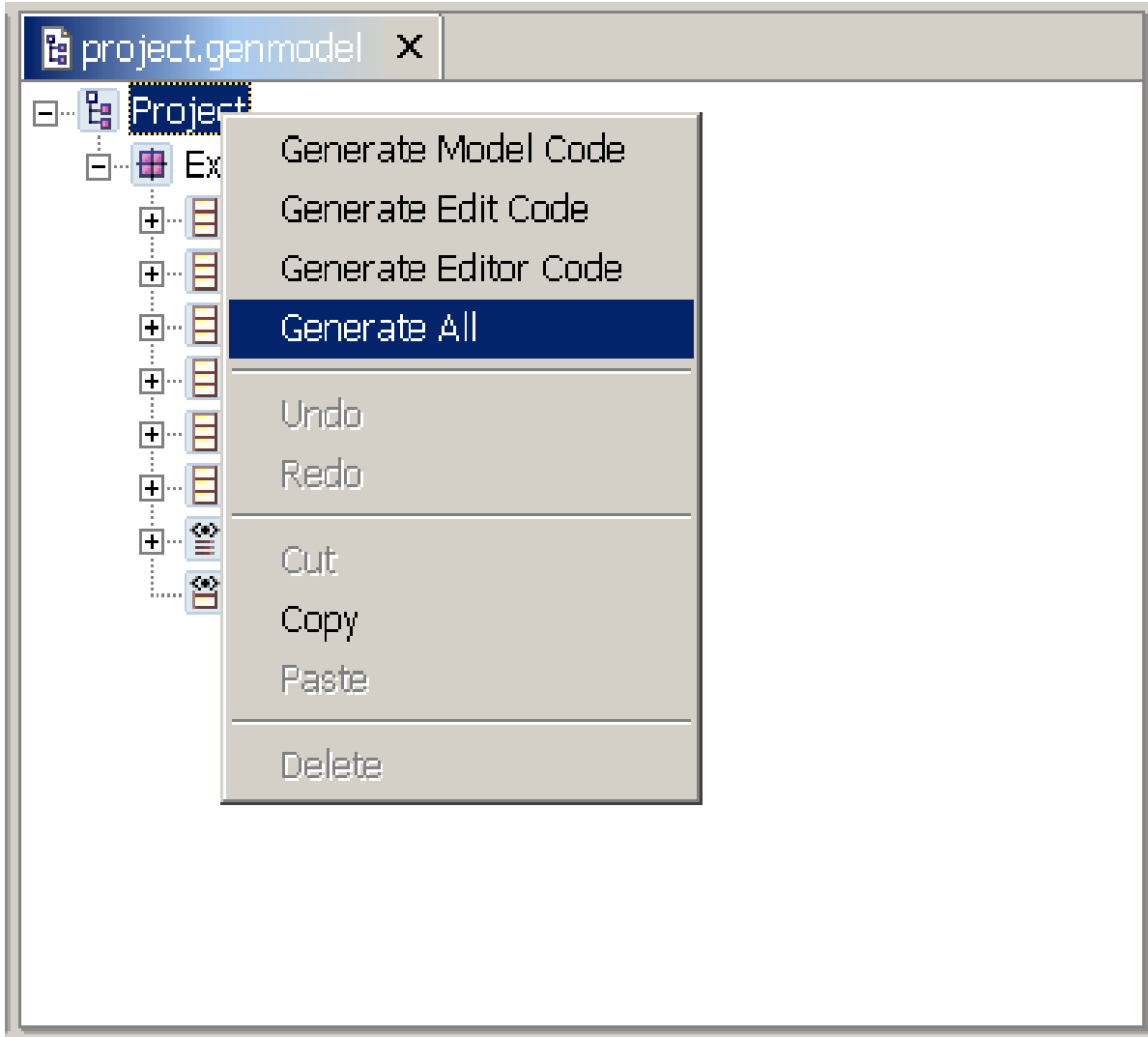


Ready to generate code

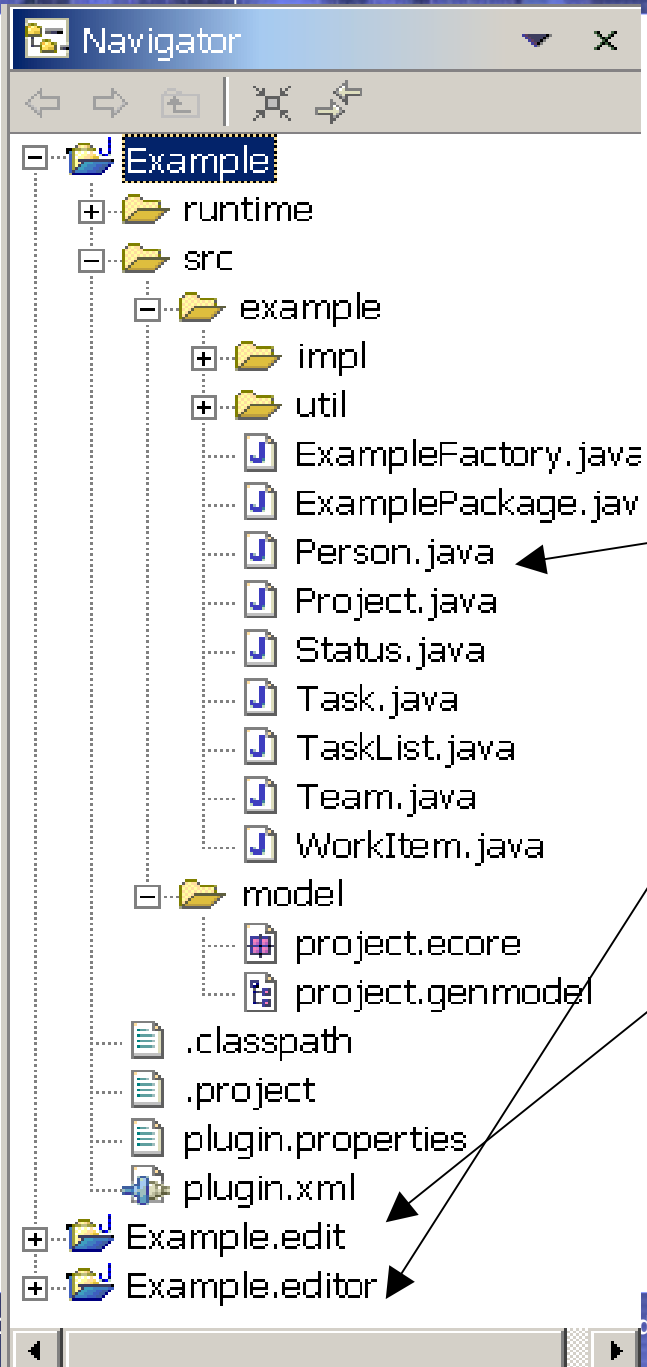


Generating code

1. Right-click on the top tree element to get the popup menu
2. Select **Generate All** to begin code generation



The results



- Code is generated into the current project and two new projects
- The original project contains a generated implementation of your model
- The .editor project contains code for a generated Eclipse editor which will allow you to build instances of your model
- The .edit project contains generated adapters which interface between your model objects and the editor

Understanding the generated model classes

- For each class in your model, there is a corresponding generated
  - Java interface
  - Java implementation class
- For each package, there is a
  - XXXPackage interface and implementation class
  - XXXFactory interface and implementation class

Example of generated interface

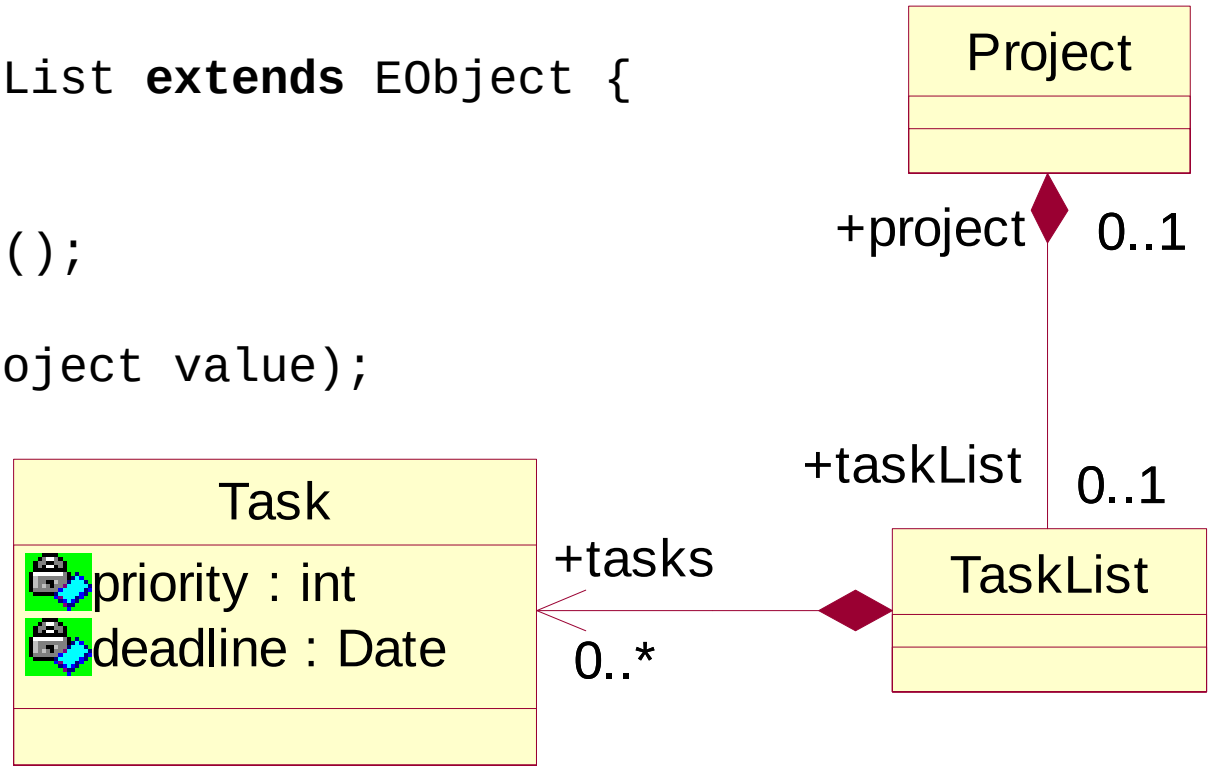
```
package example;
import org.eclipse.emf.common.util.EList;
import org.eclipse.emf.ecore.EObject;

public interface TaskList extends EObject {
   EList getTasks();

   Project getProject();

   void setProject(Project value);

} // TaskList
```



Generated Implementation Classes

- Extend the EMF class EObjectImpl
- Implement the relevant generated interface
- Implement the EMF reflective API
- Where multiple inheritance is used in the model, the generated implementation class extends one super class and implements the relevant interfaces for the rest

Package and Factory Implementation Classes

- These are singletons, to access the instances use

```
XXXPackage.eINSTANCE
XXXFactory.eINSTANCE
```

- Use the Factory to create instances of your model classes, e.g:

```
TaskList t =
  ExampleFactory.eINSTANCE.createTaskList();
```

- Use the Package to access the meta-model definition, e.g:

```
EClass c = ExamplePackage.eINSTANCE.getTaskList();
List attrs = c.getEAttributes();
```

Customizing generated code

- You can edit the generated code – so that your changes are not lost when the code is re-generated, make sure you remove the @generated flag or change it to @generated NOT
- You may need to modify the generated code to implement
  - Operations that are defined in your model
  - Derived attributes or references

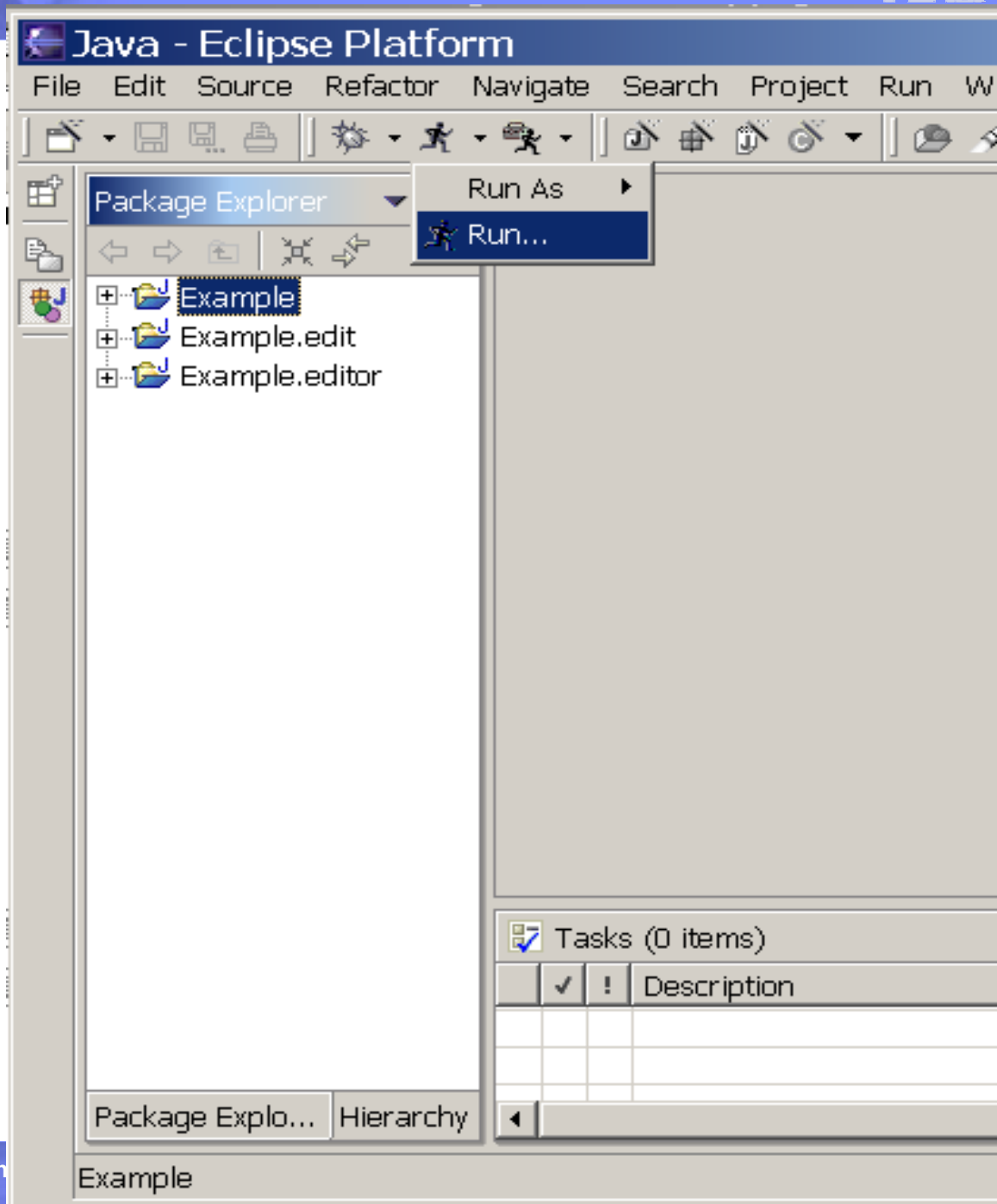
Testing

1. Launch a new Eclipse workbench
2. Create an instance of your model
3. Use the generated editor to view and edit your model instance

Creating a Launch Configuration

1. Switch to the Java perspective (if you are not there already)
2. Select your .editor project
3. Select **Run > Run as > Runtime Workbench**

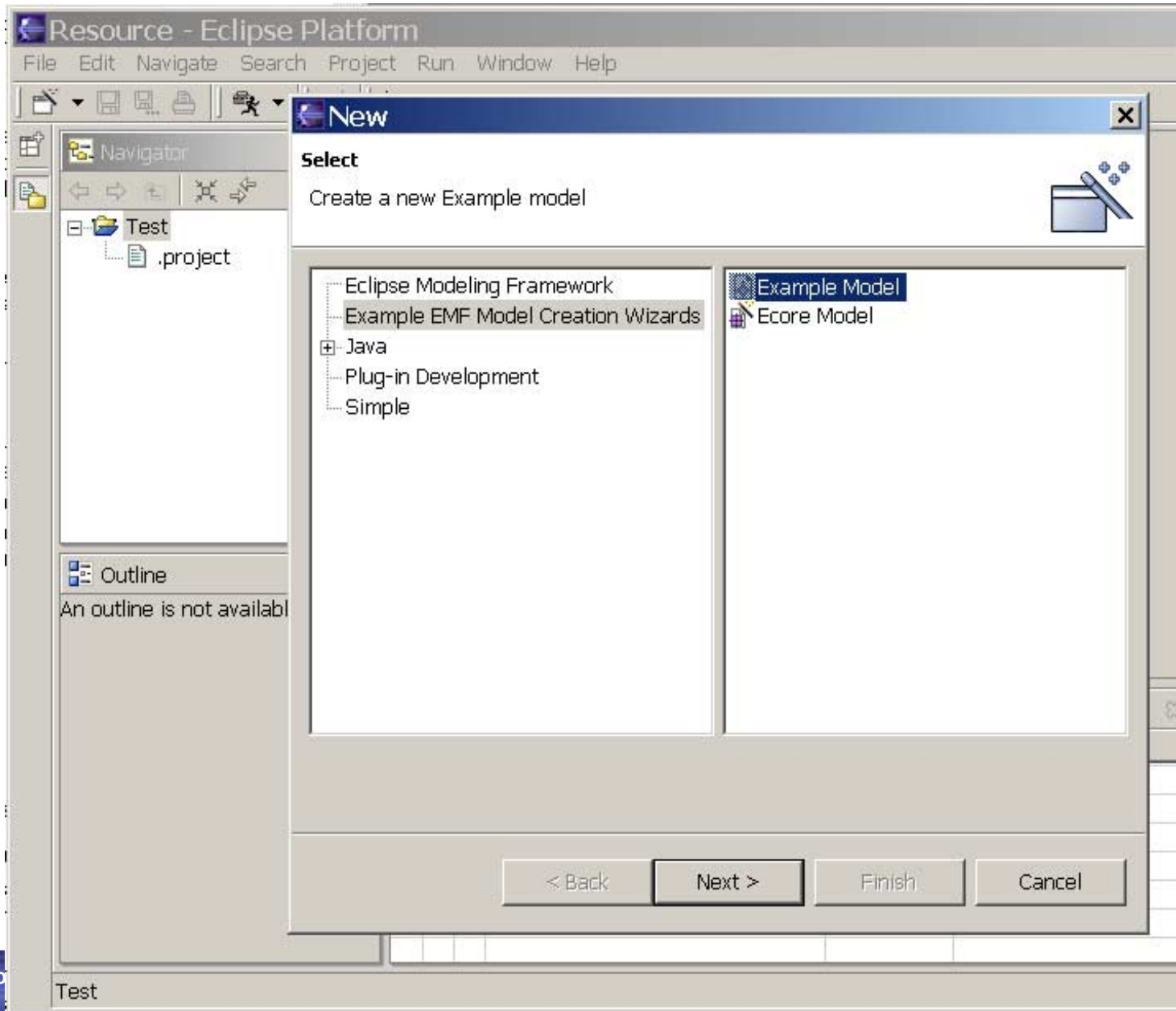
   This will launch a new Eclipse workbench and also creates a new launch configuration which will appear as a shortcut in the Run menu



1. The first time you launch a run-time workbench, its workspace will not contain any projects or files

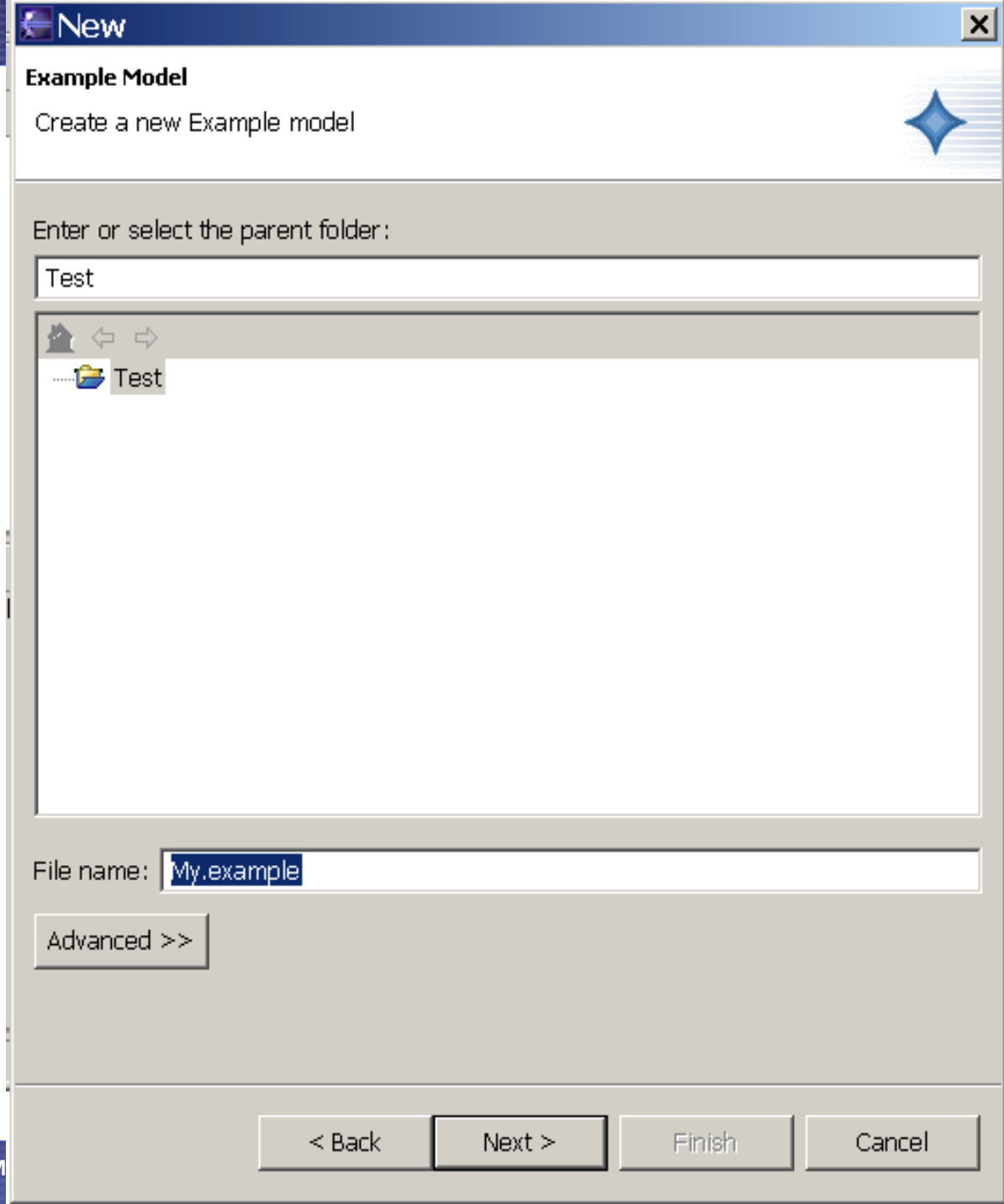
2. Create a new project (of any kind) to work in

3. Select from the menu **File > New > Other..**



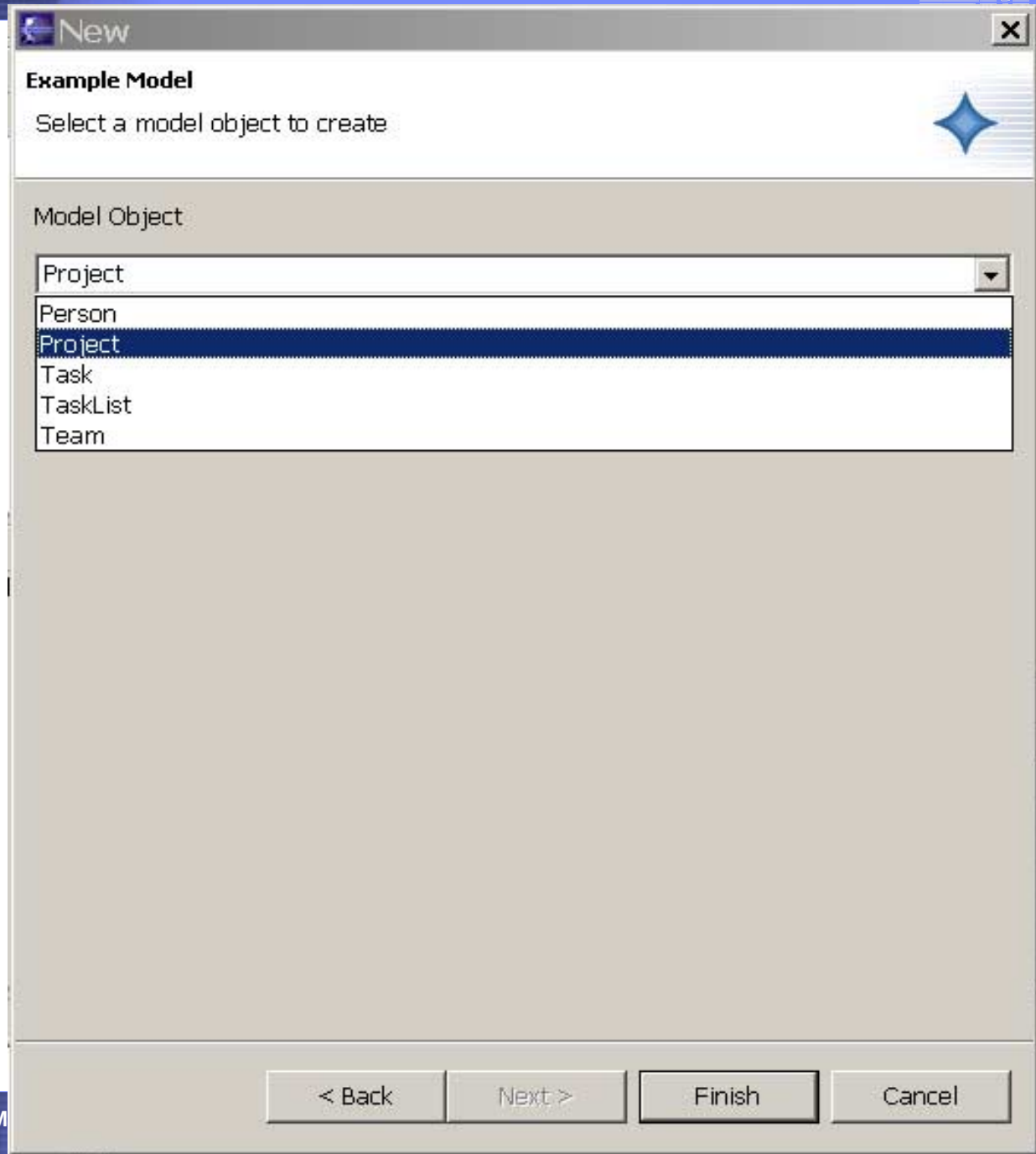
Create a new model file

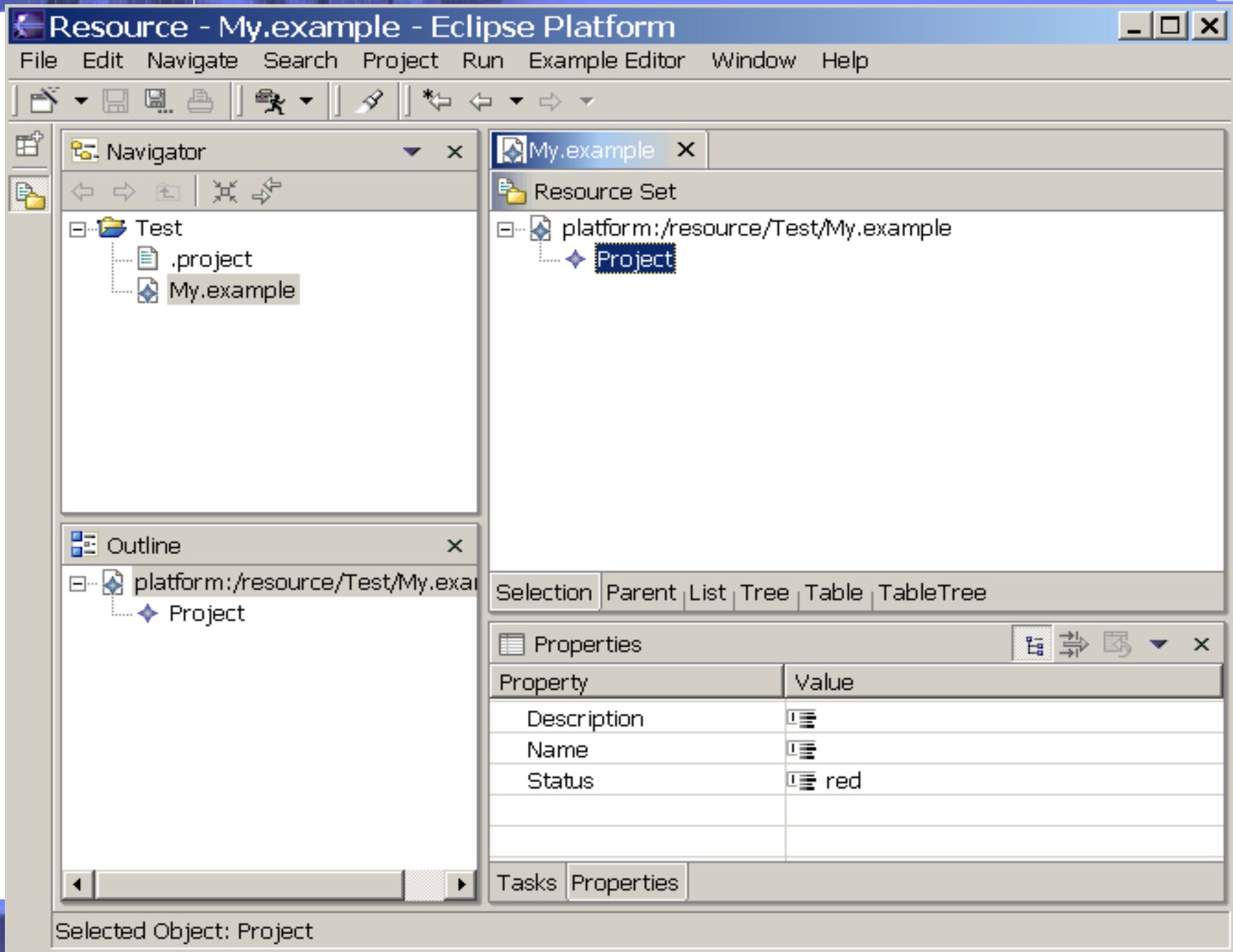
1. Select your new kind of model from the list of available EMF Example Model Creation Wizards
2. Click on **Next >**
3. Pick a folder and a file name for the new file. Do not change the default file type !
4. Click on **Next >**



Select model object to create

1. Select from the drop-down list a class from your model to create in the new file.
2. Select **Finish ...**
3. The new file is created and opened for editing with the generated editor




Resource - My.example - Eclipse Platform
File Edit Navigate Search Project Run Example Editor Window Help
Navigator
Test
.project
My.example
Outline
platform:/resource/Test/My.exa
Project
My.example
Resource Set
platform:/resource/Test/My.example
Project
Selection Parent List Tree Table TableTree
Properties
Property
Value
Description
Name
Status
red
Tasks Properties
Selected Object: Project

Using the Editor

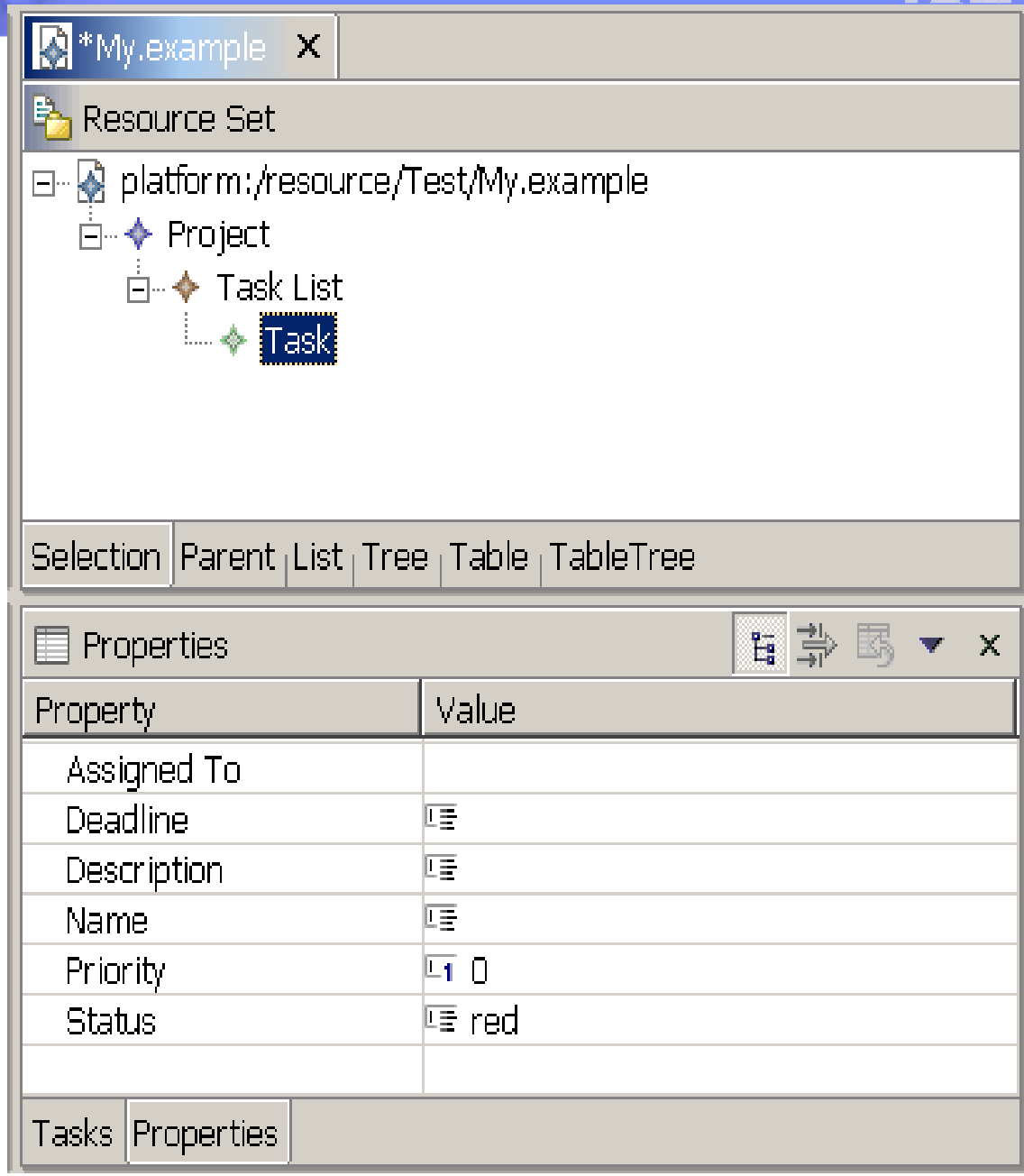
- The generated editor allows you to test your model by building examples
- You can use the generated editor code as a base for developing a ‘real’ editor if required
- For very simple applications, a few small changes to the generated code may be all that is needed
- This is a multi-page editor - each page demonstrates different ways of viewing and editing your model

Outline View

- The outline view is a tree view which shows the currently loaded resources and their contents.
- The first page of the editor shows the same information
- You can add and remove new model objects, but only one ‘top’ object in a file is allowed
- Cut, Copy, Paste and Drag and Drop are supported

Properties View

- The Properties view allows you to edit attributes and reference relationships for the selected model object
- If the Properties view is not visible, use **Window > Show View** to show it

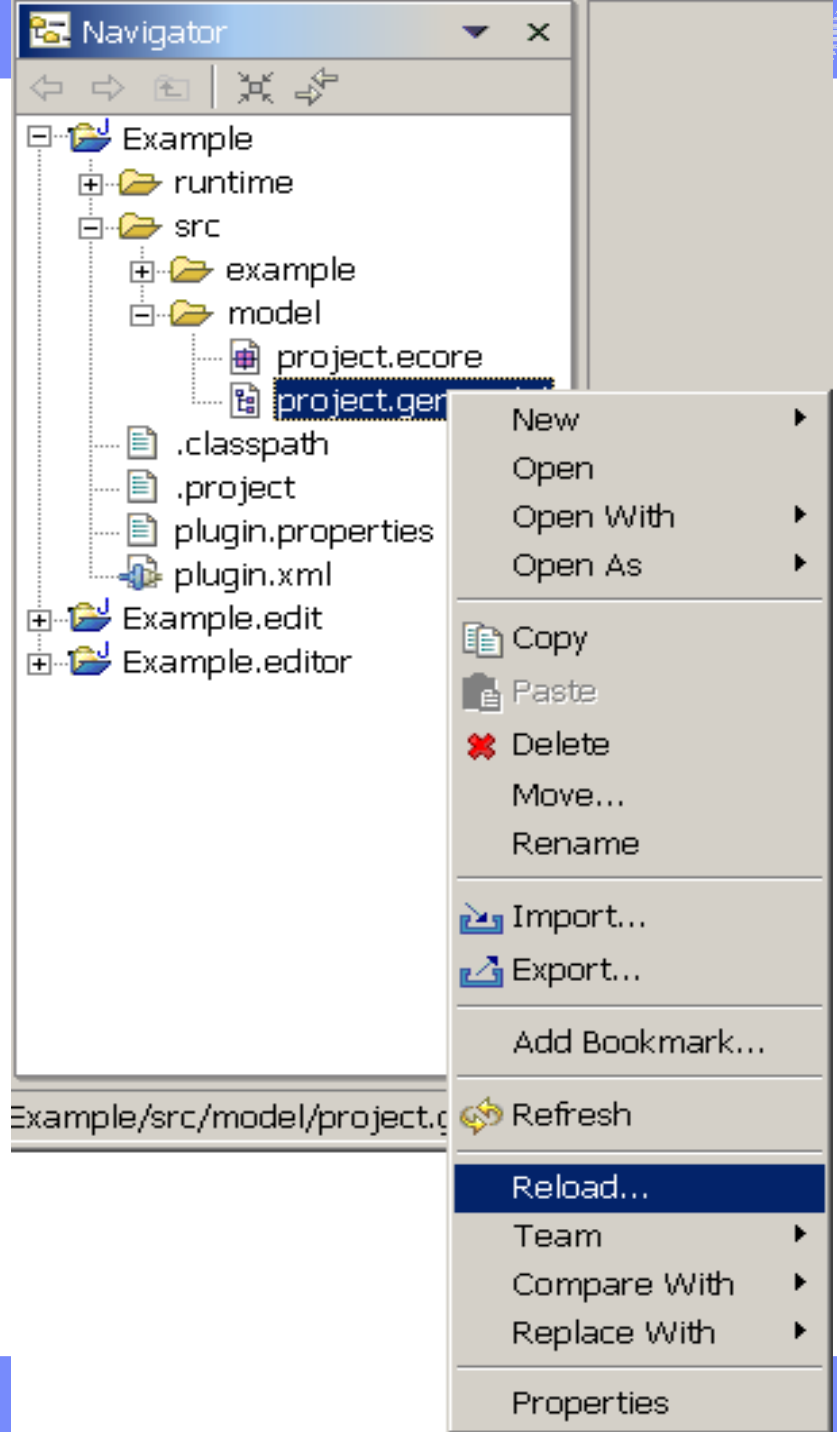


Customizing the generated editor

- The editor code is generated from templates in the same way as the model implementation code
- If you re-generate your model implementation, you will need to re-generate the .edit project, but probably not the .editor project
- If you are developing an editor, you would usually expect to heavily customize the generated editor code
- The .edit project contains code that interfaces between the model implementation and the editor
- This code controls what items appear in the editor, properties view, and menus, and how changes are made to the model

Re-generating code

1. If you change your model, you need to re-generate the code
2. Right-click on the .genmodel file to access the pop-up menu
3. Select Reload…
4. Proceed to import the Rose .mdl as before
5. Open the .genmodel file with the editor and generate the code



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