Model-Based Engineering and Code Generation

Application to BPMN

F. Mallet

Frederic.Mallet@unice.fr

Université Nice Sophia Antipolis

Introduction

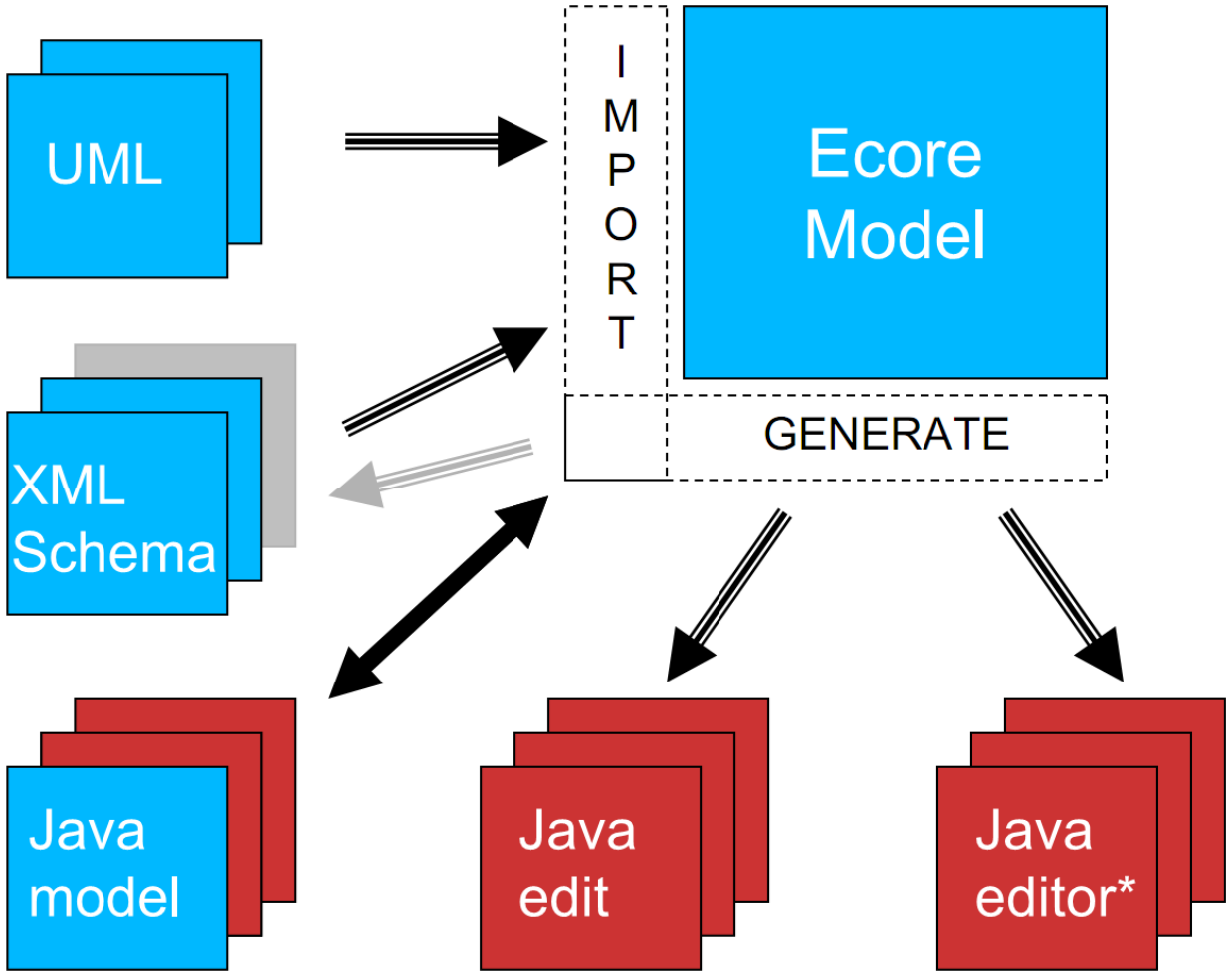
- Outline
  - Meta-Modeling & EMF
- Application
  - BPEL & BPMN
    - Domain Model
    - UML Profile
    - EMF Metamodel

ECLIPSE META-MODELING FRAMEWORK

Eclipse Modeling Framework

- Modeling Framework with code generation
  - To build tools based on data models
  - The model is captured as a **XMI** (XML Metadata Interchange) file
- Import existing code to build the model
  - Java code with annotations
  - XML documents (**XSD** – XML Schema Definition)
  - UML tools (e.g., Rational Rose)
- Code generation from the model
  - Set of Java classes and interfaces
  - An Edit/Editor environment (editing tree)
- Many (and many more coming) extensions
  - Generate a graphical editor (Graphical Modeling Framework, Sirius)
  - Generate a parser, syntax highlighting (XText, TCS, Sintaks)

EMF import/export

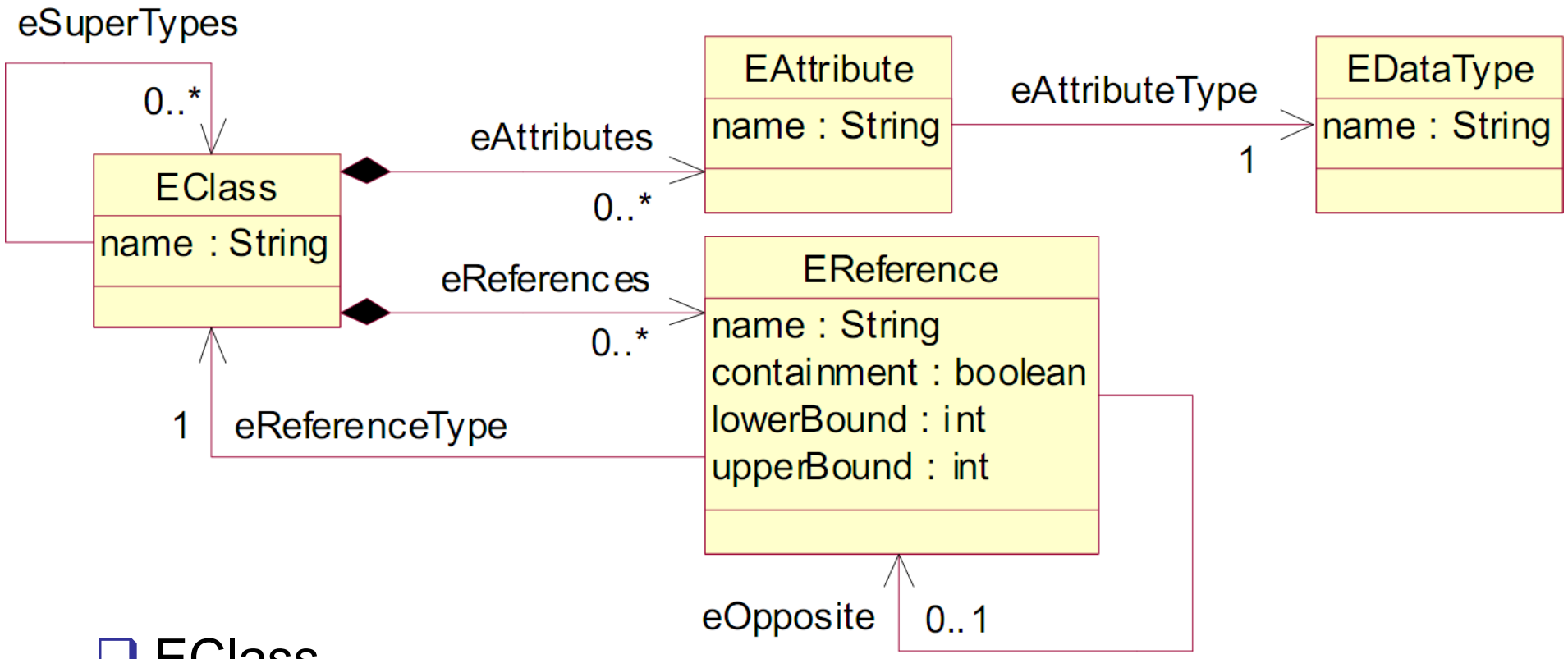


IBM, Ed. Merks & D. Steinberg, EclipseCon 2005

EMF and UML ?

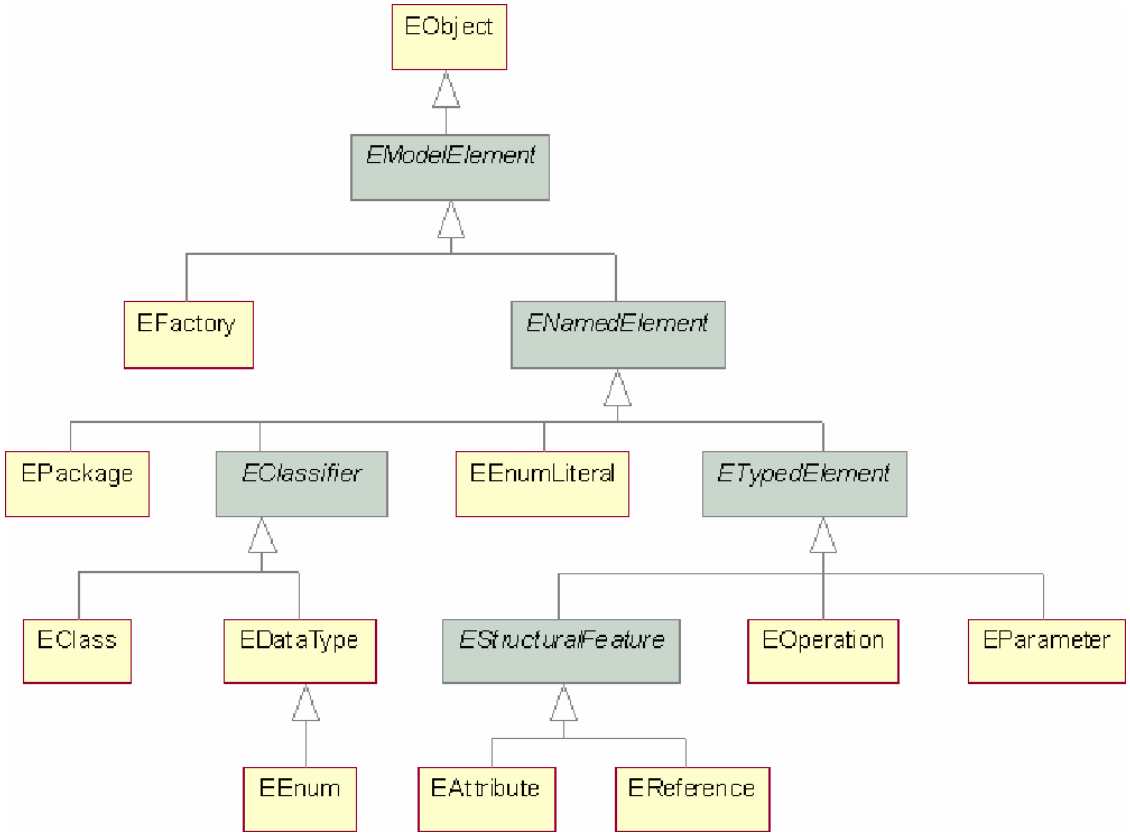
- **MOF**: Meta-metamodel (M3) by OMG
  - **M**eta-**O**bject **F**acilities
  - EMOF (Essential MOF) is a subset
- EMF
  - Was initially just an implementation of the MOF
  - Has evolved to become **ECORE**
- Two very different business models
  - OMG # Eclipse Foundation

Ecore: EMF meta-metamodel (M3)



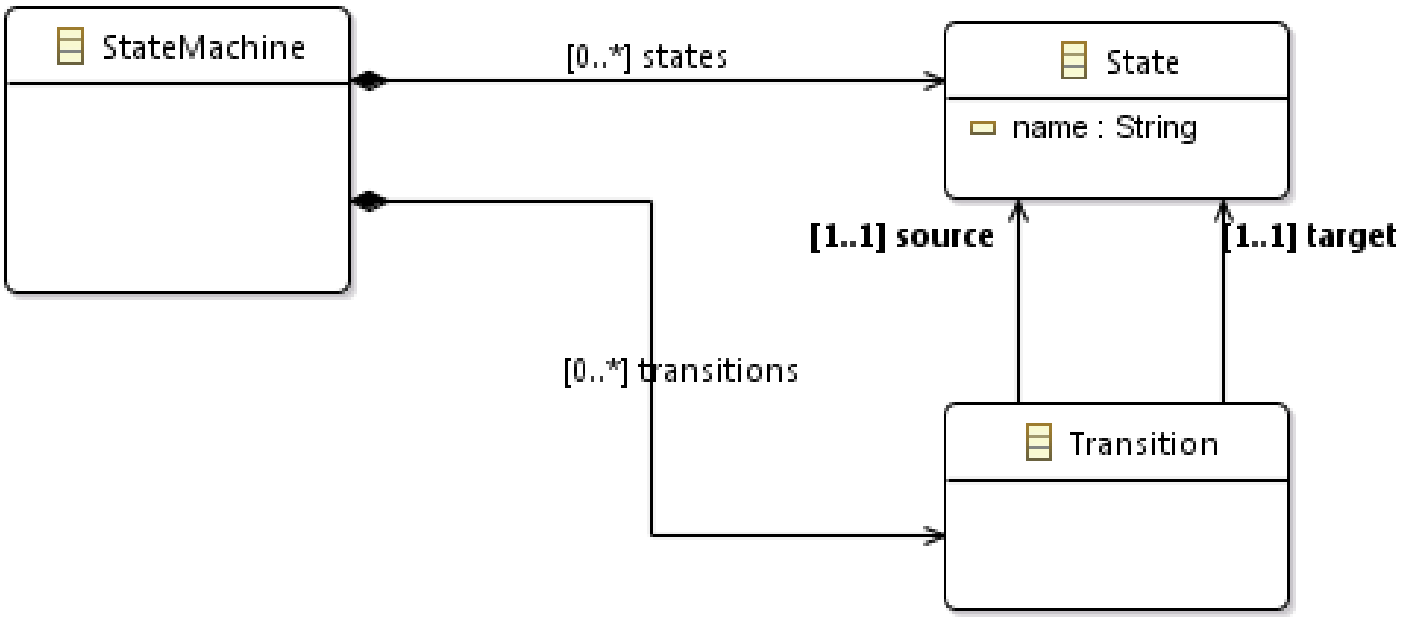
- EClass
  - Own attributes (data types) and typed references (classes)
  - Can have a super type (autres EClass) **[specialization]**

Ecore: EMF meta-metamodel (M3)



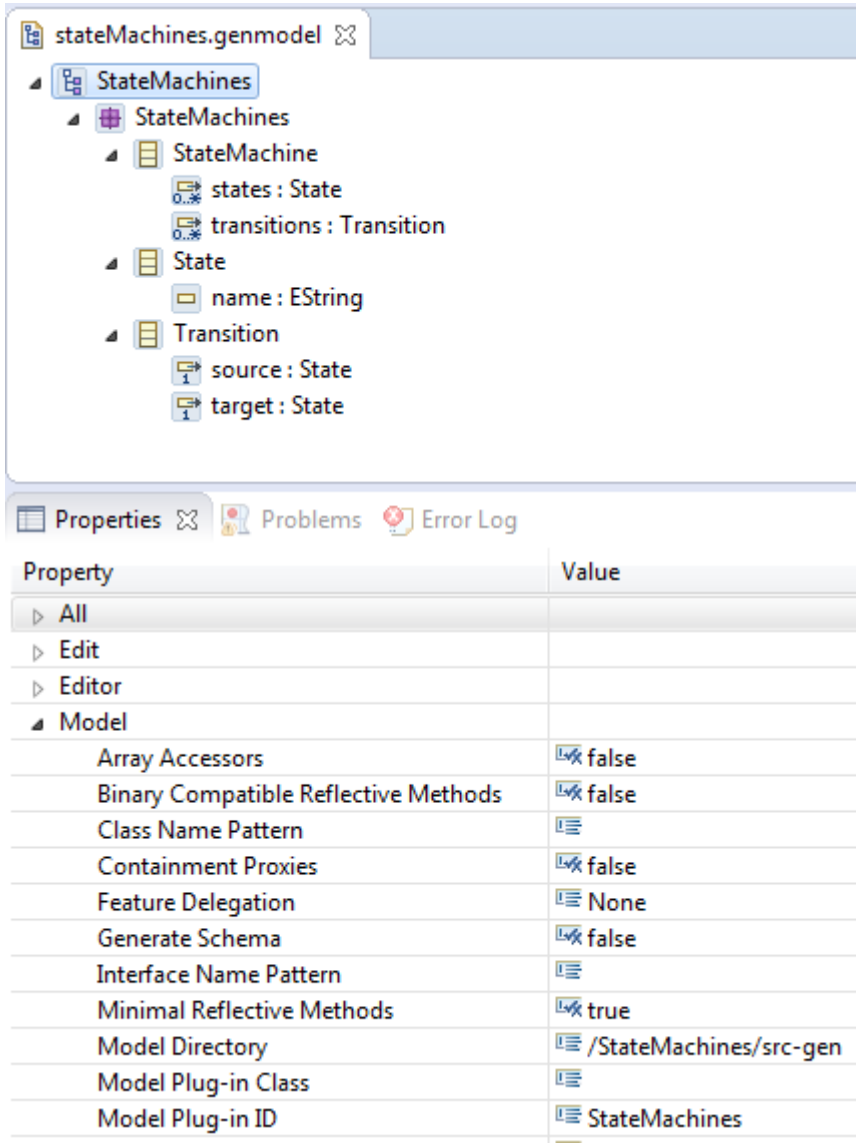
- Small meta-metamodel
  - Enhance the native introspection of Java
  - Only structural information (no access to the code)

Example – State Machines

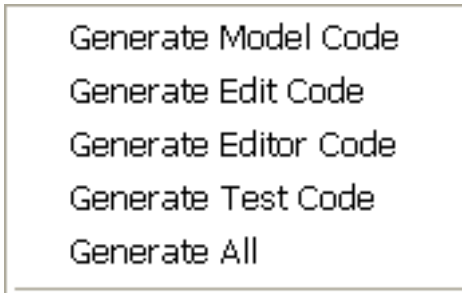


- Ecore Modeling Project (Eclipse Modeling Mars)
  - StateMachines.aird
  - StateMachines.ecore

Generation model: .genmodel



- Import Ecore model
- Create a .genmodel
  - What to generate
  - Where to generate
  - How to generate



Generate code/Edit/Editor

- Abstract model
  - Java interfaces

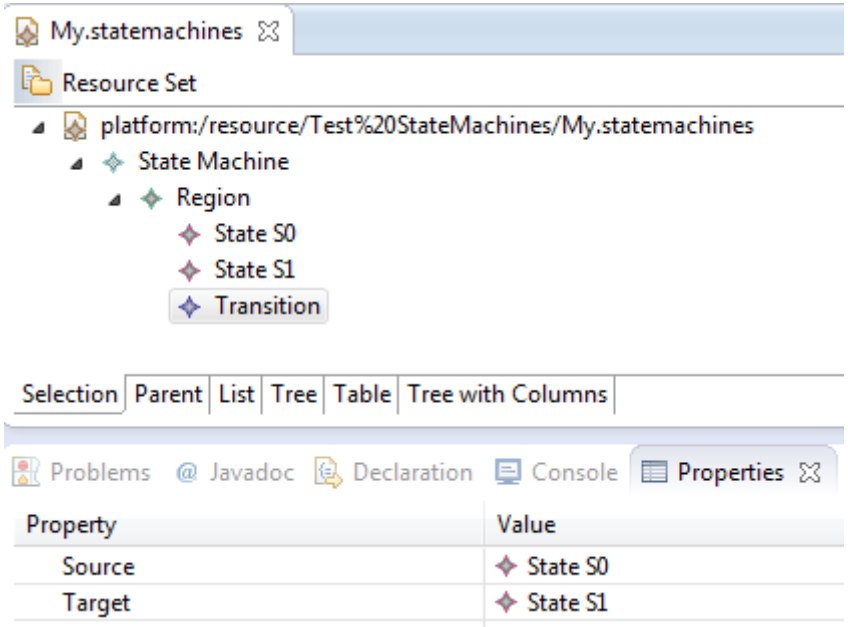
```
public interface State extends EObject {
 /** @generated */  String getName();
 /** @generated */  void setName(String value);
```

- Implementation
  - With listeners

```
public abstract class StateImpl extends EObjectImpl implements State {
  protected static final String NAME_EDEFAULT = null;
  protected String name = NAME_EDEFAULT;
  public void setName(String newName) {
   String oldName = name;
   name = newName;
   if (eNotificationRequired())
    eNotify(new ENotificationImpl(this, Notification.SET, StsPackage.STATE__NAME, oldName, name));
  }
```

Automatic code generation

- Automatic generation
  - Tree editor
  - XML Marshalling/Unmashalling
  - XML Validator
  - Wizard for creating new models



CODE GENERATION

Kinds of model transformations

❑Model to text

- Generate text (or code) from a model
- Dedicated languages: XSLT
- Manual: in Java through the Ecore API

❑Model to model

- Transform a model into another model
  - Ex: UML State Machines into NuSMV files
- Dedicated transformation languages
  - ATL, Kermeta, QVTo

Accessing the model

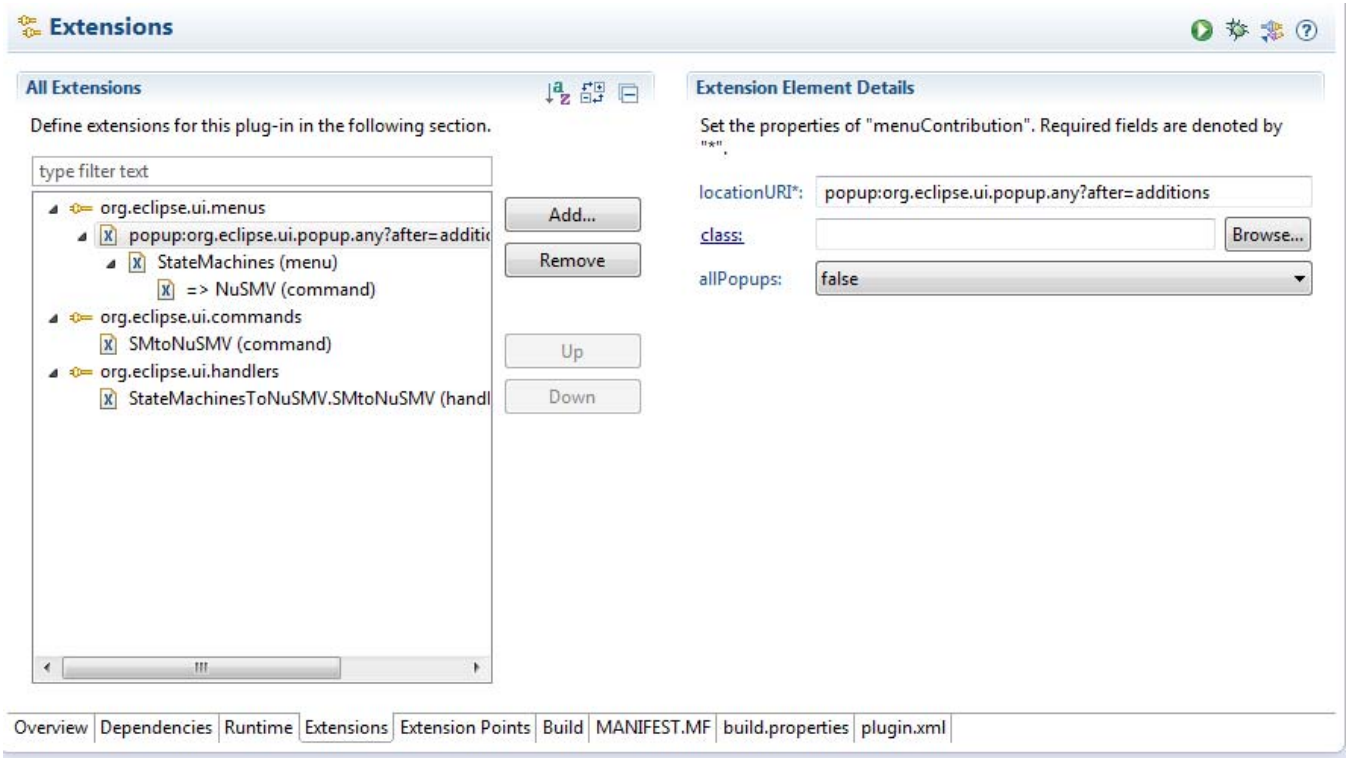
- Standalone applications
  - EMF generates a set of helpers to access/parse/generate models
- Through an eclipse plugin
  - Small Java program that augments Eclipse
    - Add menu, button, editors, …
  - Better/easier integration with other tools
  - Needs *Eclipse Modeling (Kepler)*
  - File/New/Plug-in project…

An example of plug-in

- Add a menu to Eclipse (3 extensions needed)
  - org.eclipse.ui.menus
    - Add a menu and menu item into Eclipse
  - org.eclipse.ui.commands
    - Add a command: can be (un)done through menus or toolbars
  - org.eclipse.ui.handlers
    - Attach a handler to a command (code to be executed)

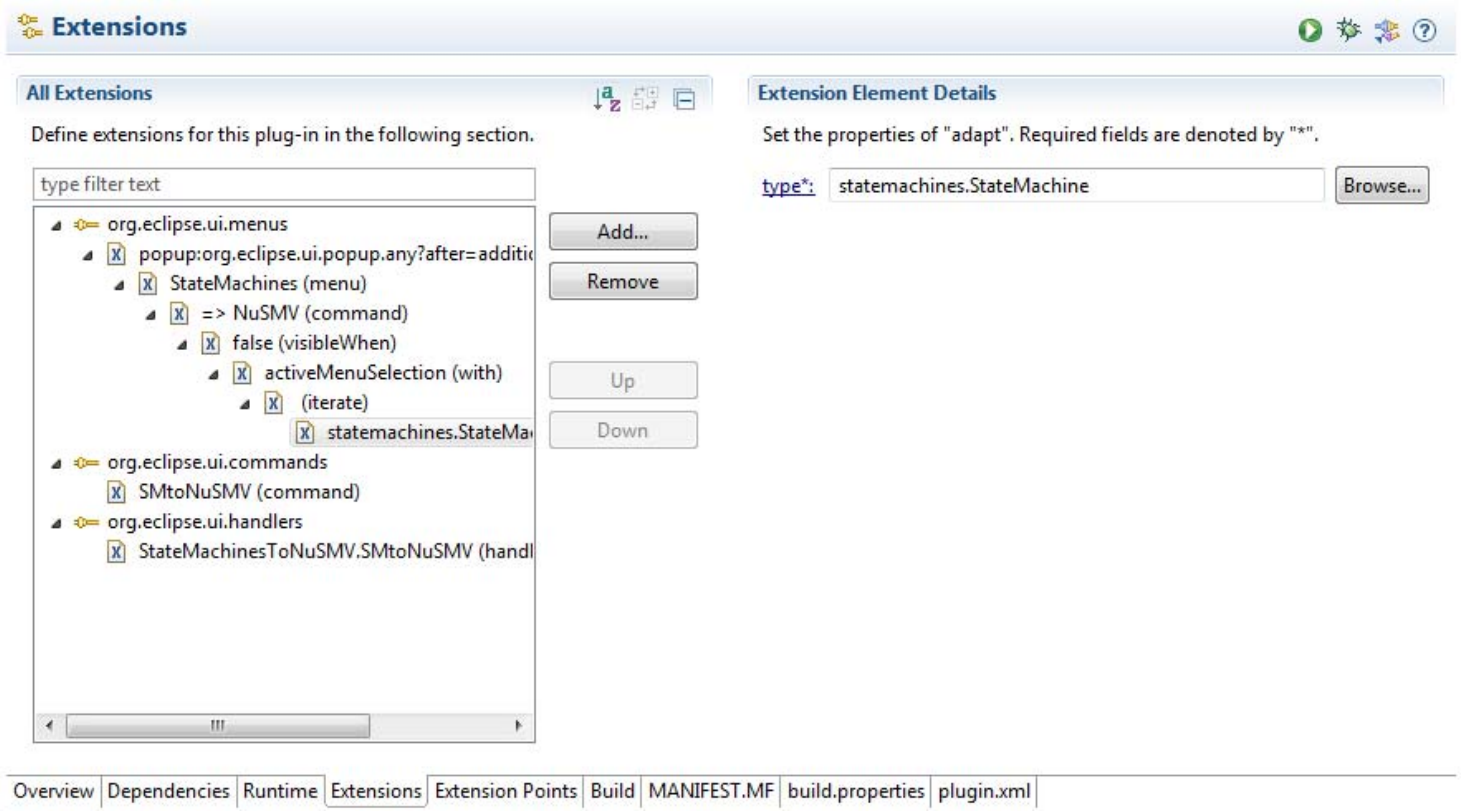
org.eclipse.ui.menus

- 3 stages
  - menuContribution: popup:org.eclipse.ui.popup.any?after=additions
  - menu: with a label
  - command: MenuItem that references a command



org.eclipse.ui.menus

- Select when the menu is visible
  - Ex1: only when a statemachines.StateMachine is selected
    - Requires a **dependency** to the code generated by EMF
  - Ex2: org.eclipse.uml2.uml.StateMachine
    - Requires a **dependency** to org.eclipse.uml2.uml



Visibility of the menu

- Either programmatically in the code
- Through the extension interface
  - menuContribution locationURI: popup:org.eclipse.ui.popup.any?after=additions
  - menu label: « Name of the menu »
  - Command
    - Label: « Name of the command »
    - Id: same as the id of the command
  - isVisibleWhen: checkifEnabled=true
  - With variable: activeMenuSelection
  - Iterate operator: and isEmpty:false
  - Adapter (depends on where to integrate)
    - Type: org.eclipse.core.resources.IFile (File in the Navigator)
    - Type: org.eclipse.jdt.core.ICompilationUnit (Java file in Package explorer)

org.eclipse.ui.commands

- Allows for the creation of commands
  - A command can be done/undone by clicking a menu or a toolbar icon or by code
  - Give a unique id
    - Ex: fr.unice.m1.SMtoNuSMV.command
  - Must be referenced by menus, toolbars, handlers

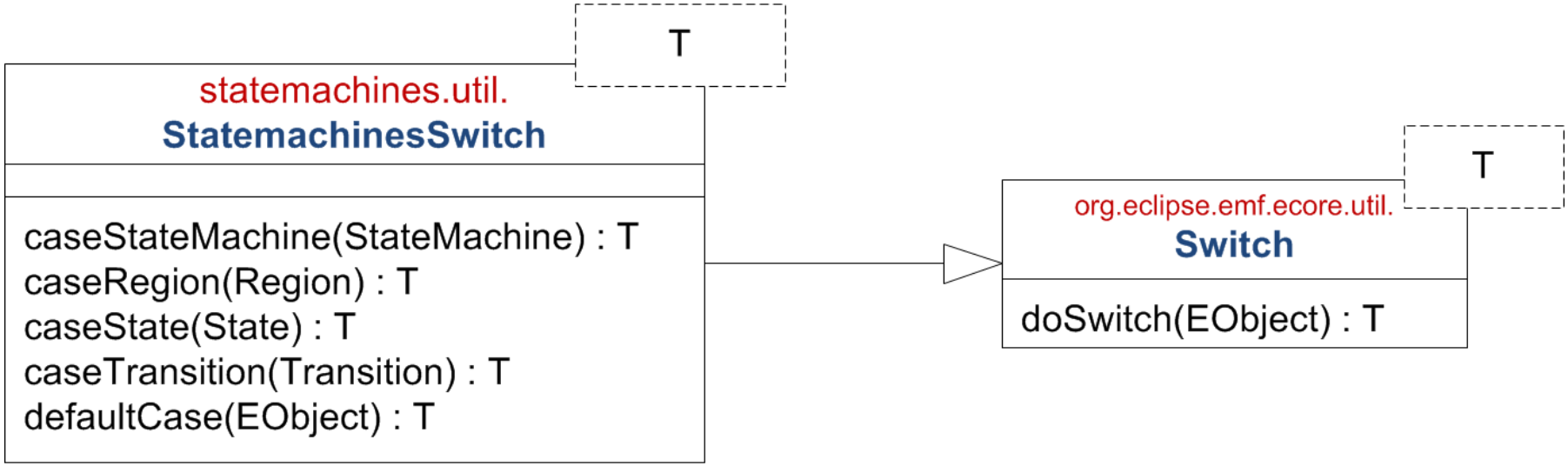
org.eclipse.ui.handlers

- Specify what code should be executed/attached to a command
  - Reference a command through its id
  - Define a class that must implement **`org.eclipse.core.commands.IHandler`**

```
public class SMToNuSMV implements IHandler {
  public void addHandlerListener(IHandlerListener handlerListener) {}
  public void dispose() {}
  public Object execute(ExecutionEvent event) throws ExecutionException {
    // TODO Auto-generated method stub
    return null;
  }
  public boolean isEnabled() { return true; }
  public boolean isHandled() { return true; }
  public void removeHandlerListener(IHandlerListener handlerListener) {}
}
```

EMF Switches

- Realize the **visitor** design patterns
  - Automatically generated by EMF
  - Allows for *visiting* a complex hierarchical structure



Switch: do it yourself

- Example that counts the number of elements

```
public class SMCountElements extends StatemachinesSwitch<Boolean> {
  private int nbStatemachines = 0;
  private int nbStates = 0;
  private int nbTransitions = 0;

  public Boolean caseStateMachine(StateMachine object) {
    nbStatemachines ++;
    for(Region region : sm.getRegions()) doSwitch(region);
    return true;
  }
  public Boolean caseRegion(Region region) {
    for(State state : region.getStates()) doSwitch(state);
    for(Transition transition : region.getTransitions()) doSwitch(transition);
    return true;
  }
  public Boolean caseState(State object) {
    nbStates++;
    return true;
  }
  public Boolean caseTransition(Transition object) {
    nbTransitions++;
    return true;
  }
```

Use the Switch

- Define the right handler

```
public class SMToNuSMVHandler extends AbstractHandler {
  @Override
  public Object execute(ExecutionEvent event) throws ExecutionException {
    ISelection selection = PlatformUI.getWorkbench().getActiveWorkbenchWindow()
                                     .getActivePage().getSelection();
    if (!(selection instanceof StructuredSelection)) return null;
    Object selected = ((StructuredSelection)selection).getFirstElement();

    // The type should be guaranteed by the "isVisibleWhen"
    assert(selected instanceof StateMachine);
    SMCountElements counter = new SMCountElements();
    counter.doSwitch((StateMachine)selected);
    JOptionPane.showMessageDialog(null, counter.getNbStatemachines()+" state machines\n"+
                                        counter.getNbStates()+" states\n"+
                                        counter.getNbTransitions()+" transitions",
                                  "State Machines", JOptionPane.INFORMATION_MESSAGE);
    return null;
  }
}
```