INRIA	**ATL** **TRANSFORMATION EXAMPLE**	Contributor Pierrick Guyard pielepsy@gmail.com
	Bridging Grafcet, Petri net, PNML and XML.	Date 08/08/2005

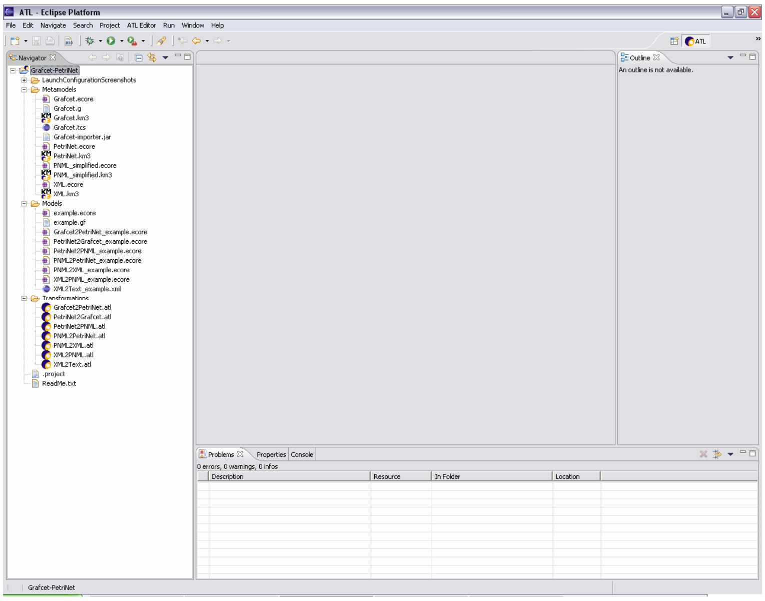
1. Overview

This document provides a complete overall picture of bridging between Grafcet, Petri Net and PNML. It also provides an overview of the whole transformation sequence that enables to produce an XML Petri net representation (in the PNML format [1]) from a textual definition of a Grafcet and in the opposite way.

So this document describes how bridges between Grafcet, Petri Net and PNML have been built, using a model transformation language ATL. This construction is composed of five steps:

- Grafcet Models conforming to its metamodel are injected from a textual definition of the grafcet by means of a TCS (Textual Concrete Syntax) program (this part is out of the scope of the document).
- A transformation from Grafcet in their Petri Net equivalent and inverse: the Grafcet – Petri Net Bridge.
- A transformation from Petri Net generated with Grafcet in their PNML equivalent and inverse: the Petri Net - PNML Bridge.
- A transformation from PNML generated with Petri Net in their XML equivalent and inverse: the PNML - XML Bridge.
- As a final step, the XML model is extracted to the textual XML representation using an ATL query.

The next sections will explain the different steps to realize these bridges between Grafcet, Petri Net, PNML and XML. Section 2 presents all metamodels; Section 3 explains all bridges and their transformations.



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0 errors, 0 warnings, 0 infos

Figure 1 - ATL project overview

2. Metamodels

2.1. Grafcet

2.1.1. Generalities about Grafcet

Grafcet is a mainly French-based representation support for discrete system. It is a mode of representation and analysis of an automatism, particularly adapted to sequential systems with evolution, i.e. decomposable in steps. The Grafcet's name came from «graph» because this model had a graphic basis, and AFCET (Association française de cybernétique économique et technique) from the scientific association which supported it. The Grafcet represents graphically the operation of an automatism by: steps with associated action, transitions between steps, and directed connections between the steps and the transitions.

2.1.2. A simplified metamodel of Grafcet

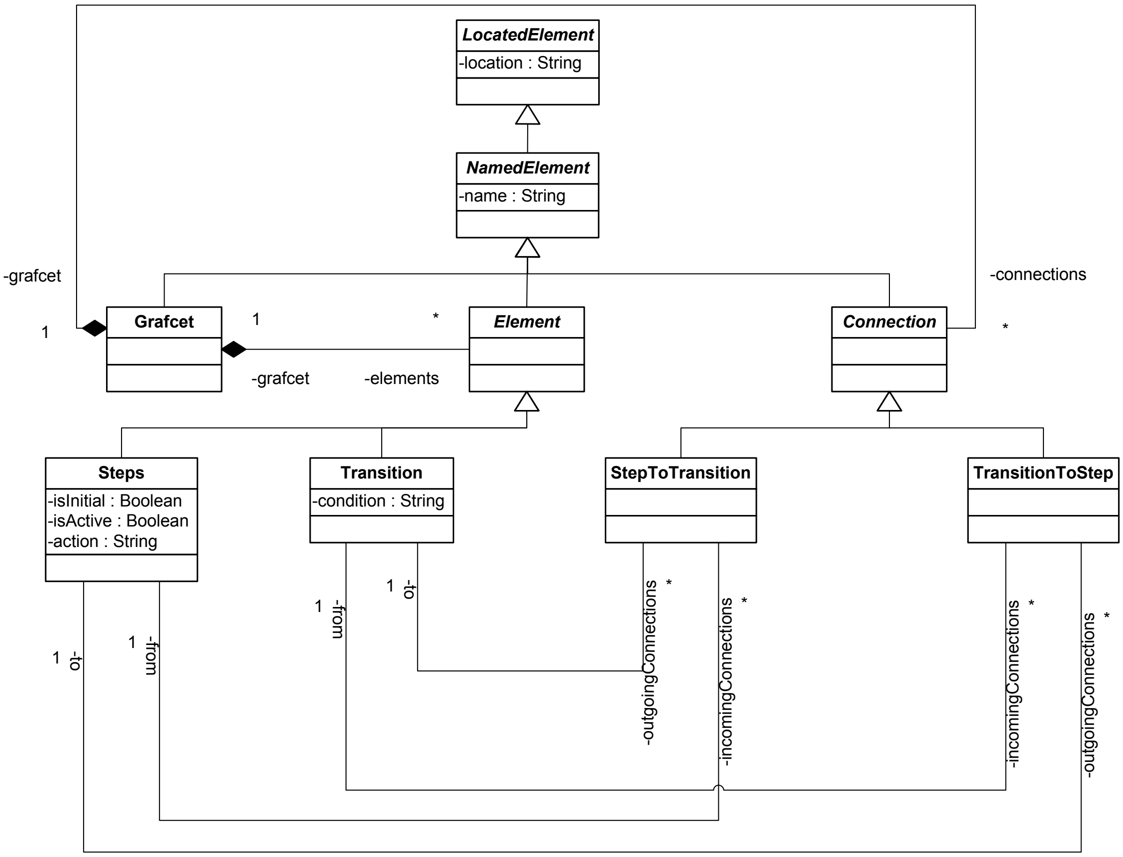


Figure 2 - Grafcet metamodel

Description of this metamodel:

- “Grafcet”: the main or root element which represent a grafcet,
- It is composed of elements and connections which are abstract class,
- Elements are “Step” or “Transition”,
- Connections are “StepToTransition” or “TransitionToStep”,
- Steps and transitions can have many incoming or outgoing connections.

2.2. Petri Net

2.2.1. Generalities about Petri Net

Petri nets are also known as a place/transition net or P/T net. Defined in 1962 by Carl Adam Petri, they extend state machines with a notion of concurrency. It is a graphical and mathematical representation of discrete distributed systems. Petri nets consist of places, transitions and directed arcs that connect them, so arcs run between places and transitions, not between places and places or transitions and transitions. There are two sorts of arcs connecting place to transition or transition to place.

2.2.2. A simplified metamodel of Petri Net

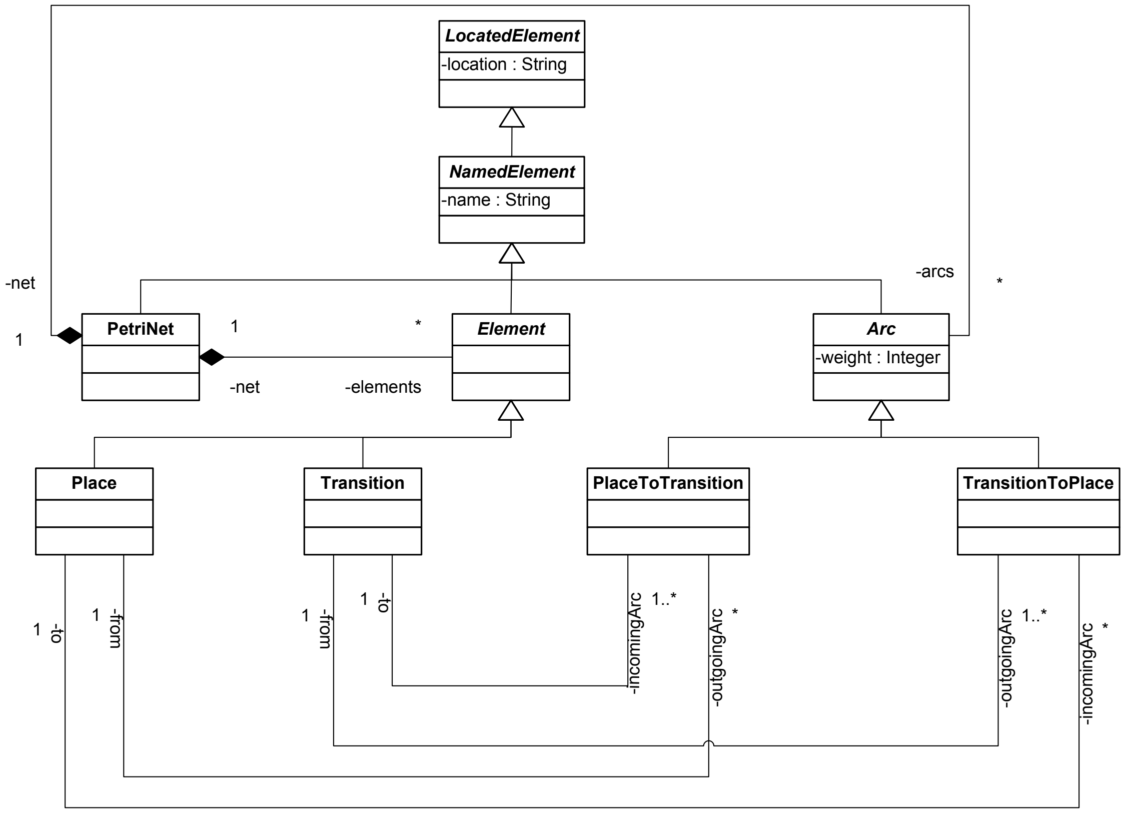


Figure 3 - Petri Net metamodel

Description of the basic metamodel:

- “PetriNet”: the main or root element which represent a Petri net,
- It is composed of elements and arcs which are abstract class,
- Elements are “Place” or “Transition”,
- Arcs are “PlaceToTransition” or “TransitionToPlace”,
- Places and transitions can have many incoming or outgoing arcs.

2.3. PNML

2.3.1. Generalities about PNML

The Petri Net Markup Language (PNML) is a proposal of an XML-based interchange format for Petri nets (see [1]). Originally, it was intended to serve as a file format for the Java version of the Petri Net Kernel. PNML is a concept for defining the overall structure of a Petri net file.

2.3.2. A simplified metamodel of PNML

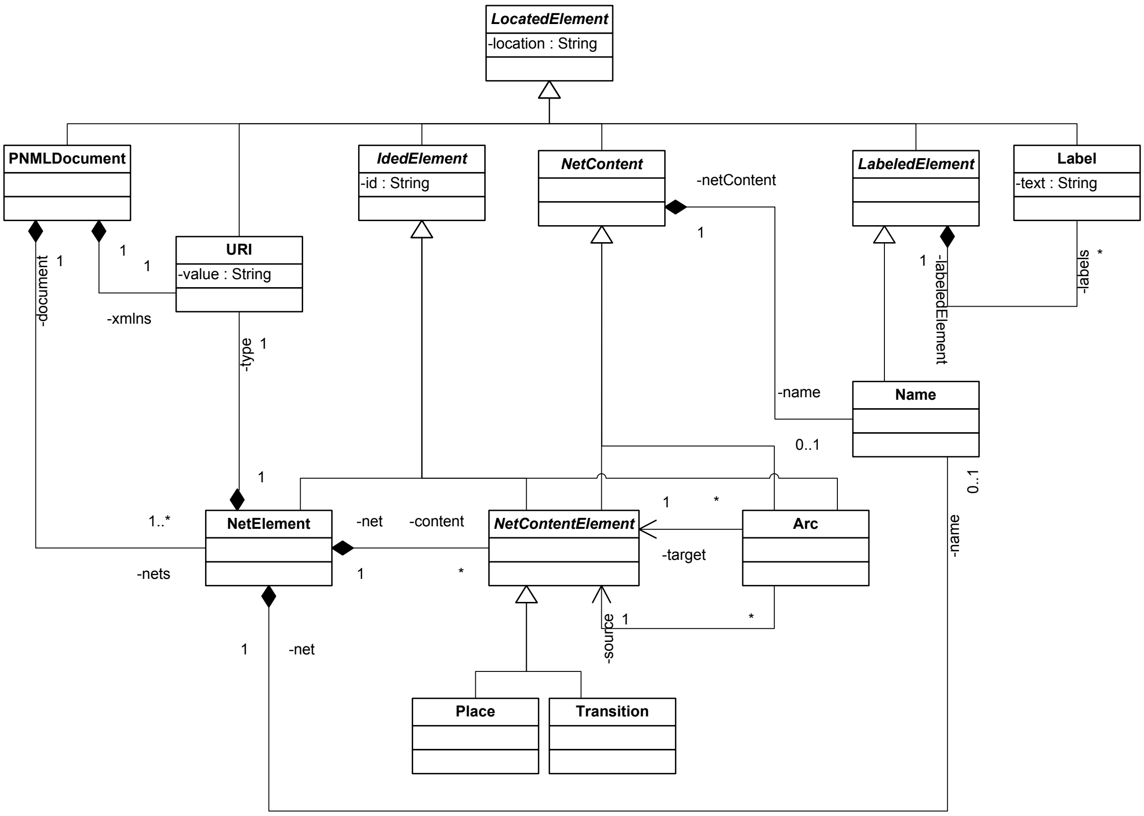


Figure 4 - PNML metamodel

Description of the simplified metamodel:

- “PNMLDocument”: the main or root element which contains Petri nets,
- “NetElement” represents the Petri net; it is composed of “NetContent” which are “Arc”, “Place” and “Transition”.
- Arcs reference a source and a target (“Place” or “Transition”) but the two kinds of arcs are not differentiated in this model (PlaceToTransition and TransitionToPlace).
- Net elements and net contents can have a name which is a labelled element composed of labels.

2.4. XML

The XML metamodel describes the different model elements that compose a XML model, as well as the way they can be linked to each other. The considered metamodel is presented in Figure 7. It is moreover provided in KM3 format [2] in Appendix V.

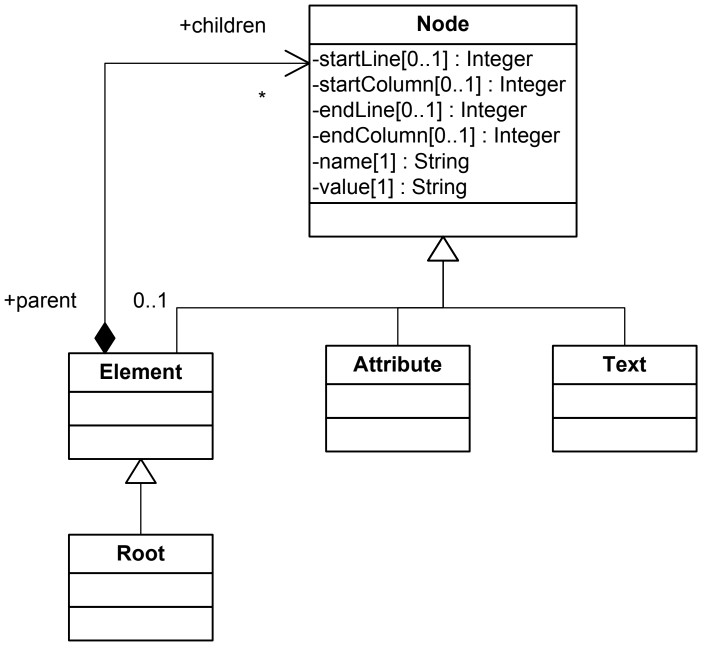


Figure 5 - XML metamodel

Description of the basic metamodel:

A XML model has a single Root element. It also contains Elements, Texts, Attributes entities. The Attribute, Text and Element elements all directly inherit from the abstract Node element, whereas Root inherits from the Element entity. The following attributes are defined for the abstract Node entity: “startLine”, “startColumn”, “endLine”, “endColumn”, “name” and “value”. In the scope of this example, we only make use of the two last attributes, “name” and “value”. In case of an Attribute entity, “name” encodes the name of the attribute, whereas “value” contains the value associated with the Attribute. In case of a Text entity, “value” contains the textual content of the Text. Finally, considering an Element entity, “name” encodes the name of the modelled XML tag.

An Element can contain several Nodes, which can be either of type Attribute, Text or Element. Inversely, a Node can be contained by zero or one Element. In fact, each Node is contained by an Element except the Root element which has no parent.

3. Bridges

3.1. The Grafcet – Petri Net Bridge

3.1.1. Grafcet to Petri Net Transformation

In order to realize the bridge, and as there is no markup language for Grafcet, we need a textual input file. So, the Grafcet model is imported to a textual representation by means of a TCS (Textual Concrete Syntax) program. This part is not documented in this document.

3.1.1.1. Description of the Transformation

This transformation takes a Grafcet model conforming to our Grafcet metamodel and maps all Grafcet's features to Petri Net. In fact the two metamodels of Grafcet and Petri Net are very close. So this transformation is quite easy. The ATL code for this transformation consists of 5 rules and no helpers.

Rules:

- The **PetriNet** rule generates a PetriNet element from the input Grafcet element. The name of the generated PetriNet element is copied from the one of the input Grafcet. Its set of Elements corresponds to Elements generated by Place and Transition rules. And its set of Arcs corresponds to Connections generated by PlaceToTransition and TransitionToPlace rules.

- The **Place** rule generates a Place element from the input Step element. The name of the generated Place element is copied from the one of the input Step. Its set of incomingArcs corresponds to incomingConnections generated by TransitionToPlace rule. And its set of outgoingArc corresponds to outgoingConnections generated by PlaceToTransition rule.

- The **Transition** rule generates a Transition element from the input Transition element. The name of the generated Transition element is copied from the one of the input Transition. Its set of incomingArcs corresponds to incomingConnections generated by PlaceToTransition rule. And its set of outgoingArc corresponds to outgoingConnections generated by TransitionToPlace rule.

- The **PlaceToTransition** rule generates a PlaceToTransition element from the input StepToTransition element. The name of the generated PlaceToTransition element is copied from the one of the input StepToTransition. Its *from* and *to* references are also copied from the ones of the input StepToTransition.

- The **TransitionToPlace** rule generates a TransitionToPlace element from the input TransitionToStep element. The name of the generated TransitionToPlace element is copied from the one of the input TransitionToStep. Its *from* and *to* references are also copied from the ones of the input TransitionToStep.

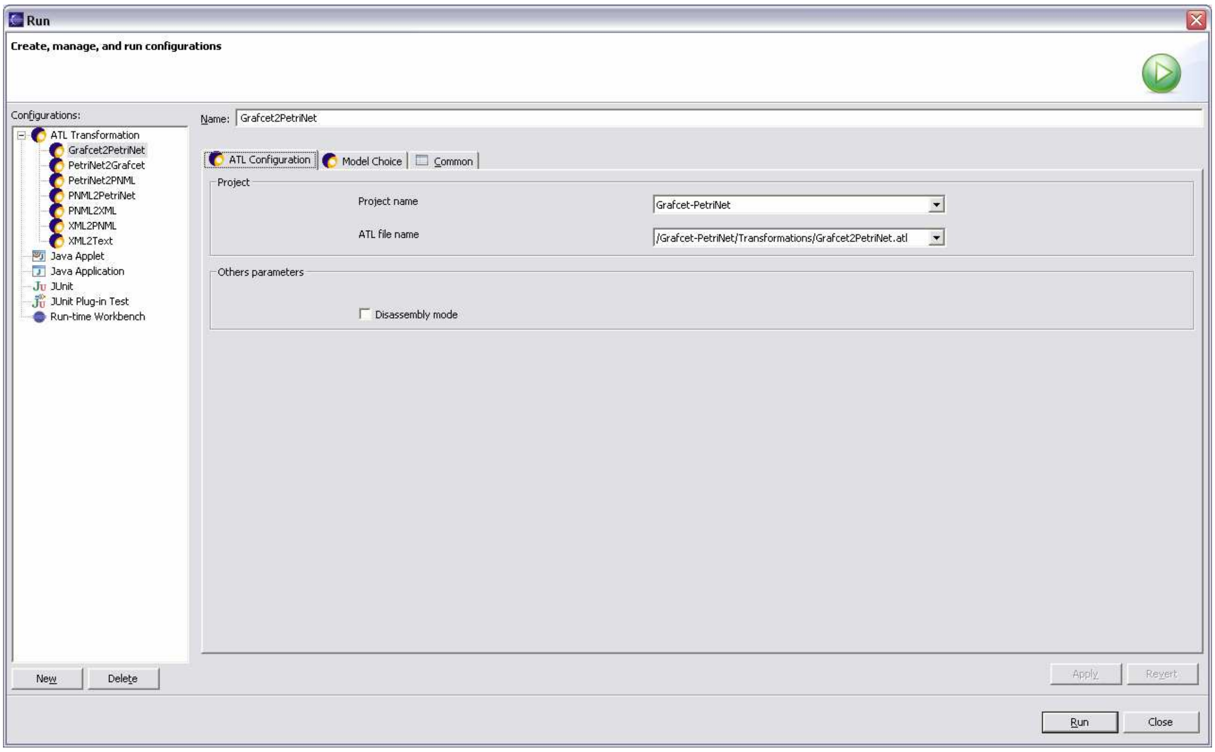
3.1.1.2. ATL Code

```
module Grafcet2PetriNet;
create OUT : PetriNet from IN : Grafcet;

-- The PetriNet rule generates a PetriNet element from the input Grafcet
element.
-- Name of the generated PetriNet element is copied from the one of the
input Grafcet.
-- Its set of Elements corresponds to Elements generated by Place and
Transition rules.
-- And its set of Arcs corresponds to Connections generated by
PlaceToTransition and TransitionToPlace rules.
rule PetriNet {
  from
    g : Grafcet!Grafcet
  to
    p : PetriNet!PetriNet
    (
      location <- g.location,
      name <- g.name,
      elements <- g.elements,
      arcs <- g.connections
    )
}

-- The Place rule generates a Place element from the input Step element.
-- Name of the generated Place element is copied from the one of the input
Step.
-- Its set of incomingArcs corresponds to incomingConnections generated by
TransitionToPlace rule.
-- And its set of outgoingArc corresponds to outgoingConnections generated
by PlaceToTransition rule.
rule Place {
  from
    g : Grafcet!Step
  to
    p : PetriNet!Place
    (
      location <- g.location,
      name <- g.name,
      net <- g.grafcet,
      incomingArc <- g.incomingConnections,
      outgoingArc <- g.outgoingConnections
    )
}

-- The Transition rule generates a Transition element from the input
Transition element.
-- Name of the generated Transition element is copied from the one of the
input Transition.
-- Its set of incomingArcs corresponds to incomingConnections generated by
PlaceToTransition rule.
```

```
-- And its set of outgoingArc corresponds to outgoingConnections generated
by TransitionToPlace rule.
rule Transition {
  from
     g : Grafcet!Transition
  to
     p : PetriNet!Transition
     (
       location <- g.location,
       name <- g.name,
       net <- g.grafcet,
       incomingArc <- g.incomingConnections,
       outgoingArc <- g.outgoingConnections
     )
}

-- The PlaceToTransition rule generates a PlaceToTransition element from
the input StepToTransition element.
-- Name of the generated PlaceToTransition element is copied from the one
of the input StepToTransition.
-- Its from and to references are also copied from the ones of the input
StepToTransition.
rule PlaceToTransition {
  from
     g : Grafcet!StepToTransition
  to
     p : PetriNet!PlaceToTransition
     (
       location <- g.location,
       name <- g.name,
       net <- g.grafcet,
       "from" <- g."from",
       "to" <- g."to"
     )
}
-- The TransitionToPlace rule generates a TransitionToPlace element from
the input TransitionToStep element.
-- Name of the generated TransitionToPlace element is copied from the one
of the input TransitionToStep.
-- Its from and to references are also copied from the ones of the input
TransitionToStep.
rule TransitionToPlace {
  from
     g : Grafcet!TransitionToStep
  to
     p : PetriNet!TransitionToPlace
     (
       location <- g.location,
       name <- g.name,
       net <- g.grafcet,
       "from" <- g."from",
       "to" <- g."to"
     )
}
```

3.1.1.3. *Configuration of the Transformation*

As illustrated by the transformation configuration's Figure 6 and Figure 7, there is one input metamodel (Grafcet) and one output (Petri Net). In Path Editor, place in "Grafcet" the path of the Grafcet metamodel; do the same for "PetriNet". In "IN" place the path of an Ecore file (a model conforming to our Grafcet metamodel in Ecore format), and in "OUT" the path for the results (the generated file is an Ecore file conforming to the Petri Net metamodel).



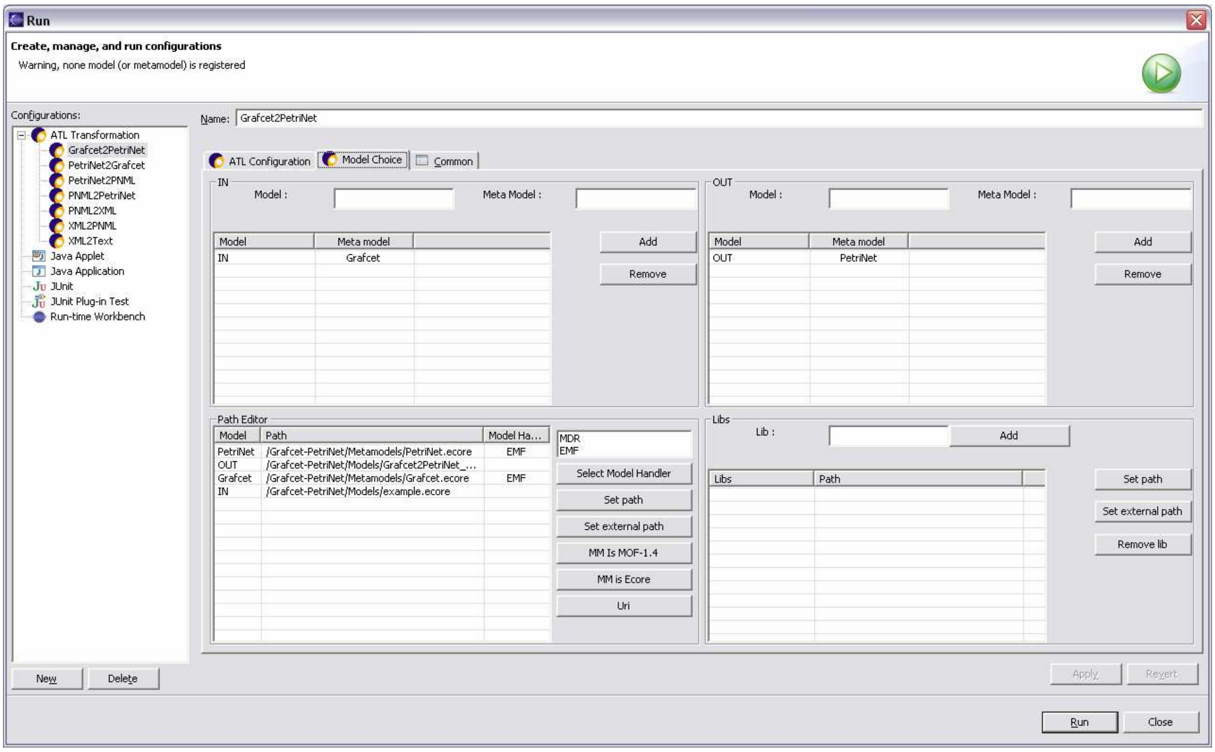
Name: Grafcet2PetriNet

Project name: Grafcet-PetriNet

ATL file name: /Grafcet-PetriNet/Transformations/Grafcet2PetriNet.atl

☐ Disassembly mode

Figure 6 - Grafcet to Petri Net configuration - part one



Run

Create, manage, and run configurations

Warning, none model (or metamodel) is registered

Name: Grafcet2PetriNet

Model	Meta model
IN	Grafcet

Model	Meta model
OUT	PetriNet

Model	Path	Model Ha...
PetriNet	/Grafcet-PetriNet/Metamodels/PetriNet.ecore	EMF
OUT	/Grafcet-PetriNet/Models/Grafcet2PetriNet_...	
Grafcet	/Grafcet-PetriNet/Metamodels/Grafcet.ecore	EMF
IN	/Grafcet-PetriNet/Models/example.ecore	

Libs	Path

Figure 7 - Grafcet to Petri Net configuration - part two

3.1.2. Petri Net to Grafcet Transformation

3.1.2.1. Description of the Transformation

As two metamodels of Grafcet and Petri Net are very close, this transformation is very similar to the previous one. The ATL code for the Petri Net to Grafcet transformation also consists of 5 rules and no helpers. All the rules are identical, only the input elements became output elements and in the reverse way.

Rules:

- The **Grafcet** rule generates a Grafcet element from the input Petri Net element. The name of the generated Grafcet element is copied from the one of the input Petri Net. Its set of Elements corresponds to Elements generated by Step and Transition rules. And its set of Connections corresponds to Arcs generated by StepToTransition and TransitionToStep rules.

- The **Step** rule generates a Step element from the input Place element. The name of the generated Step element is copied from the one of the input Place. Its set of incomingConnections corresponds to incomingArcs generated by TransitionToStep rule. And its set of outgoingConnections corresponds to outgoingArc generated by StepToTransition rule.

- The **Transition** rule generates a Transition element from the input Transition element. The name of the generated Transition element is copied from the one of the input Transition. Its set of incomingConnections corresponds to incomingArcs generated by StepToTransition rule. And its set of outgoingConnections corresponds to outgoingArc generated by TransitionToStep rule.

- The **StepToTransition** rule generates a StepToTransition element from the input PlaceToTransition element. The name of the generated StepToTransition element is copied from the one of the input PlaceToTransition. Its *from* and *to* references are also copied from the ones of the input PlaceToTransition.

- The **TransitionToStep** rule generates a TransitionToStep element from the input TransitionToPlace element. The name of the generated TransitionToStep element is copied from the one of the input TransitionToPlace. Its *from* and *to* references are also copied from the ones of the input TransitionToPlace.

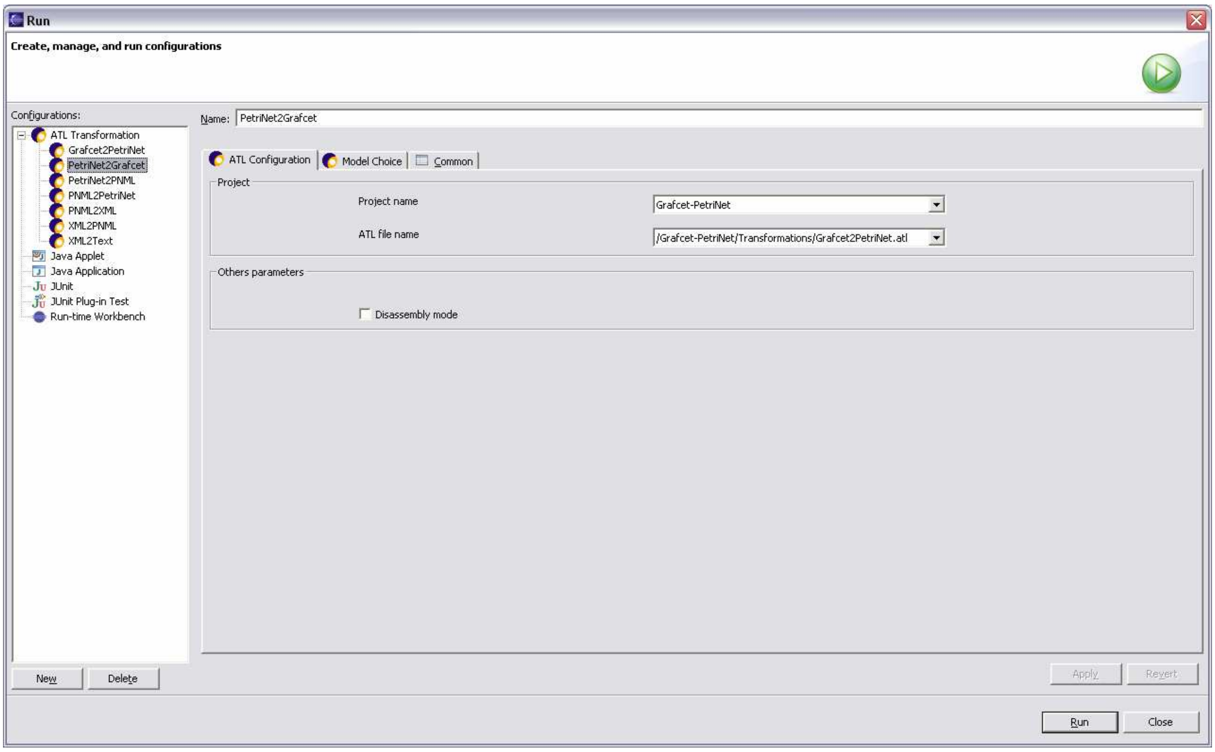
3.1.2.2. ATL Code

```
module PetriNet2Grafcet;
create OUT : Grafcet from IN : PetriNet;

-- The Grafcet rule generates a Grafcet element from the input Petri Net
element.
-- Name of the generated Grafcet element is copied from the one of the
input Petri Net.
-- Its set of Elements corresponds to Elements generated by Step and
Transition rules.
-- And its set of Connections corresponds to Arcs generated by
StepToTransition and TransitionToStep rules.
rule Grafcet {
  from
    p : PetriNet!PetriNet

  to g : Grafcet!Grafcet
    (
      location <- p.location,
      name <- p.name,
      elements <- p.elements,
      connections <- p.arcs
    )
}
```

```

-- The Step rule generates a Step element from the input Place element.
-- Name of the generated Step element is copied from the one of the input
Place.
-- Its set of incomingConnections corresponds to incomingArcs generated by
TransitionToStep rule.
-- And its set of outgoingConnections corresponds to outgoingArc generated
by StepToTransition rule.
rule Step {
  from
    p : PetriNet!Place
  to
    g : Grafcet!Step
    (
      location <- p.location,
      name <- p.name,
      grafcet <- p.net,
      isInitial <- false,
      isActive <- false,
      incomingConnections <- p.incomingArc,
      outgoingConnections <- p.outgoingArc
    )
}

-- The Transition rule generates a Transition element from the input
Transition element.
-- Name of the generated Transition element is copied from the one of the
input Transition.
-- Its set of incomingConnections corresponds to incomingArcs generated by
StepToTransition rule.
-- And its set of outgoingConnections corresponds to outgoingArc generated
by TransitionToStep rule.
rule Transition {
  from
    p : PetriNet!Transition

  to
    g : Grafcet!Transition
    (
      location <- p.location,
      name <- p.name,
      grafcet <- p.net,
      incomingConnections <- p.incomingArc,
      outgoingConnections <- p.outgoingArc
    )
}

-- The StepToTransition rule generates a StepToTransition element from the
input PlaceToTransition element.
-- Name of the generated StepToTransition element is copied from the one of
the input PlaceToTransition.
-- Its from and to references are also copied from the ones of the input
PlaceToTransition.
rule StepToTransition {
  from
    p : PetriNet!PlaceToTransition
  to
    g : Grafcet!StepToTransition
    (
      location <- p.location,
      name <- p.name,
      grafcet <- p.net,
      "from" <- p."from",
      "to" <- p."to"
    )
}

-- The TransitionToStep rule generates a TransitionToStep element from the
input TransitionToPlace element.
-- Name of the generated TransitionToStep element is copied from the one of
the input TransitionToPlace.
-- Its from and to references are also copied from the ones of the input
TransitionToPlace.
rule TransitionToStep {
  from
    p : PetriNet!TransitionToPlace
  to
    g : Grafcet!TransitionToStep
    (
      location <- p.location,
      name <- p.name,
      grafcet <- p.net,
      "from" <- p."from",
      "to" <- p."to"
    )
}
```

3.1.2.3. Configuration of the Transformation

As illustrated by the transformation configuration’s Figure 8 and Figure 9, there is one input metamodel (Petri Net) and one output (Grafcet). In Path Editor, place in “PetriNet” the path of the Petri net metamodel; do the same for “Grafcet”. In “IN“ place the path of an Ecore file (a model conforming to our Petri net metamodel in Ecore format), and in “OUT” the path for the results (the generated file is an Ecore file conforming to the Grafcet metamodel).



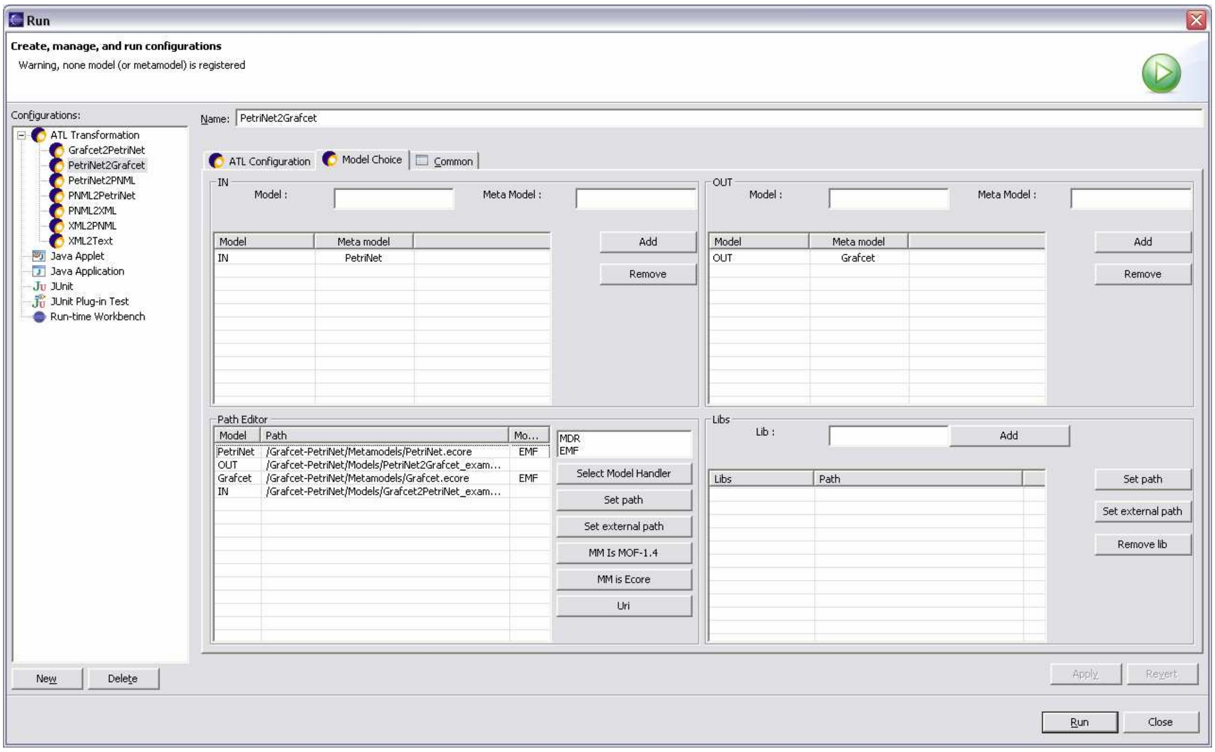
Name: PetriNet2Grafcet

Project name: Grafcet-PetriNet

ATL file name: /Grafcet-PetriNet/Transformations/Grafcet2PetriNet.atl

□ Disassembly mode

Figure 8 - Petri Net to Grafcet configuration - part one



Create, manage, and run configurations

Warning, none model (or metamodel) is registered

Name: PetriNet2Grafcet

Model	Meta model	
IN	PetriNet	

Model	Meta model	
OUT	Grafcet	

Model	Path	Mo...
PetriNet	/Grafcet-PetriNet/Metamodels/PetriNet.ecore	EMF
OUT	/Grafcet-PetriNet/Models/PetriNet2Grafcet_exam...	
Grafcet	/Grafcet-PetriNet/Metamodels/Grafcet.ecore	EMF
IN	/Grafcet-PetriNet/Models/Grafcet2PetriNet_exam...	

Libs	Path	

Figure 9 - Petri Net to Grafcet configuration - part two

3.2. The Petri Net - PNML Bridge

3.2.1. Petri Net to PNML Transformation

3.2.1.1. Description of the Transformation

The ATL code for the Grafcet to Petri Net transformation consists of 4 rules and no helpers. In fact the two metamodels of Grafcet and Petri Net are quite close. So this transformation is quite easy.

Rules:

- The **PNMLDocument** rule generates a PNMLDocument and the NetElement which corresponds to the input PetriNet element. The name of the generated NetElement is copied from the one of the input PetriNet, by creating a PNML Name composed of a PNML Label which value is initialized by the PetriNet name. Its set of Contents corresponds to the union of the PetriNet Elements and Arcs.

- The **Place** rule generates a Place corresponds to the input PetriNet Place element. The name of the generated Place is copied from the one of the input Place, by creating a PNML Name composed of a PNML Label which value is initialized by the PetriNet Place name.

- The **Transition** rule generates a Transition corresponds to the input PetriNet Transition element. The name of the generated Transition is copied from the one of the input Transition, by creating a PNML Name composed of a PNML Label which value is initialized by the PetriNet Transition name.

- The **Arc** rule generates a Arc corresponds to the input PetriNet Arc element (TransitionToPlace and PlaceToTransition). The name of the generated Arc is copied from the one of the input Arc, by creating a PNML Name composed of a PNML Label which value is initialized by the PetriNet Arc name. Its *source* and *target* references are also copied from the input Arc and correspond respectively to *from* and *to* references.

3.2.1.2. ATL Code

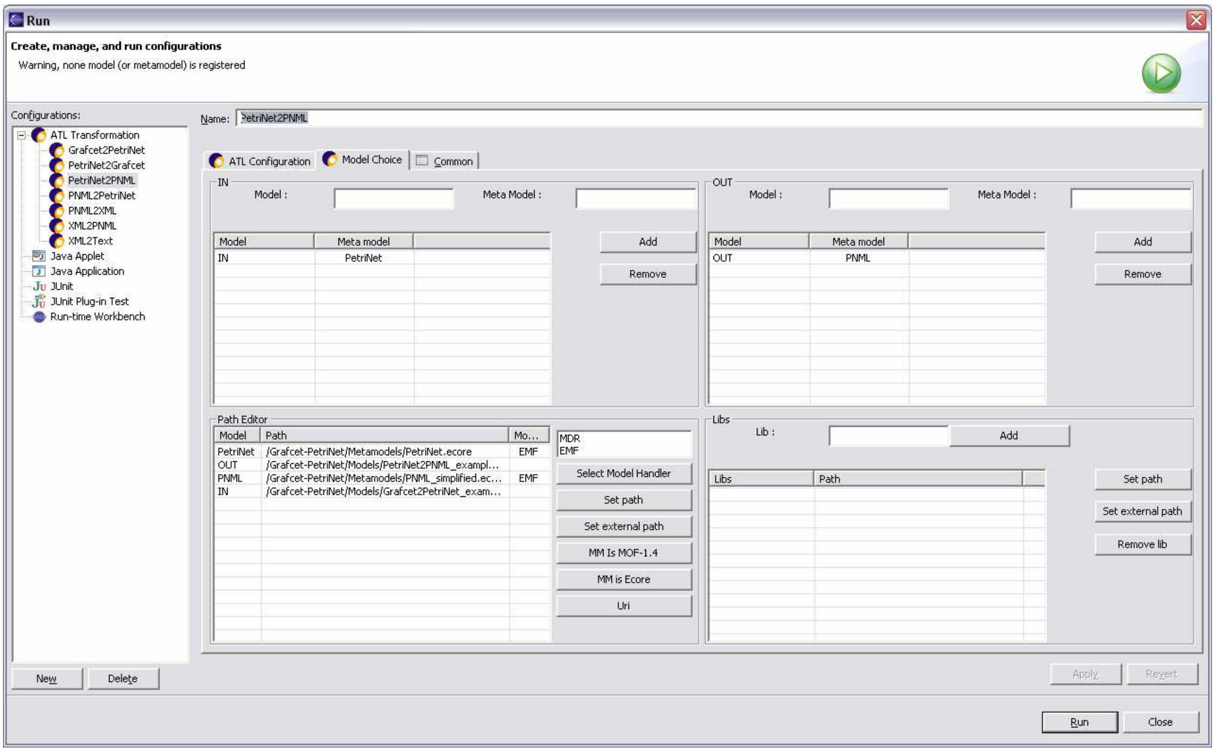
```
module PetriNet2PNML;
create OUT : PNML from IN : PetriNet;

-- The PNMLDocument rule generates a PNMLDocument  and the NetElement which
corresponds to the input PetriNet element.
-- Name of the generated NetElement is copied from the one of the input
PetriNet, by creating a PNML Name composed of a PNML Label which value is
initialized by the PetriNet name.
-- Its set of Contents corresponds to the union of the PetriNet Elements
and Arcs.
rule PNMLDocument {
   from
      e : PetriNet!PetriNet
   to
      n : PNML!PNMLDocument
      (
         location <- e.location,
         xmlns <- uri,
         nets <- net
      ),
      uri : PNML!URI
      (
         value <- 'http://www.informatik.hu-berlin.de/top/pnml/ptNetb'
      ),
      net : PNML!NetElement
      (
         name <- name,
         location <- e.location,
         id <- e.location,
         type <- type_uri,
         contents <- e.elements.union(e.arcs)
      ),
      name : PNML!Name
      (
         labels <- label
      ),
      label : PNML!Label
      (
         text <- e.name
      ),
      type_uri : PNML!URI
      (
         value <- 'http://www.informatik.hu-berlin.de/top/pntd/ptNetb'
      )
}

```

```
-- The Place rule generates a Place corresponds to the input PetriNet Place
element.
-- Name of the generated Place is copied from the one of the input Place,
by creating a PNML Name composed of a PNML Label which value is initialized
by the PetriNet Place name.
rule Place {
  from
    e : PetriNet!Place
  to
    n : PNML!Place
    (
      name <- name,
      id <- e.name,
      location <- e.location
    ),
    name : PNML!Name
    (
      labels <- label
    ),
    label : PNML!Label
    (
      text <- e.name
    )
}

-- The Transition rule generates a Transition corresponds to the input
PetriNet Transition element.
-- Name of the generated Transition is copied from the one of the input
Transition, by creating a PNML Name composed of a PNML Label which value is
initialized by the PetriNet Transition name.
rule Transition {
  from
    e : PetriNet!Transition
  to
    n : PNML!Transition
    (
      name <- name,
      id <- e.name,
      location <- e.location
    ),
    name : PNML!Name
    (
      labels <- label
    ),
    label : PNML!Label
    (
      text <- e.name
    )
}

-- The Arc rule generates a Arc corresponds to the input PetriNet Arc
element (TransitionToPlace and PlaceToTransition).
```

```
-- Name of the generated Arc is copied from the one of the input Arc, by
creating a PNML Name composed of a PNML Label which value is initialized by
the PetriNet Arc name.
-- Its source and target references are also copied from the input Arc and
correspond respectively to the from and to references.
rule Arc {
  from
    e : PetriNet!Arc
  to
    n : PNML!Arc
    (
      name <- name,
      location <- e.location,
      id <- e.name,
      source <- e."from",
      target <- e."to"
    ),
    name : PNML!Name
    (
      labels <- label
    ),
    label : PNML!Label
    (
      text <- e.name
    )
}
```

3.2.1.3. Configuration of the Transformation

As illustrated by the transformation configuration's Figure 10 and Figure 11, there is one input metamodel (Petri Net) and one output (PNML). In Path Editor, place in "PetriNet" the path of the Petri net metamodel; do the same for "PNML". In "IN" place the path of an Ecore file (a model conforming to our Petri net metamodel in Ecore format), and in "OUT" the path for the results (the generated file is an Ecore file conforming to the PNML metamodel).


Run

Create, manage, and run configurations

Warning, none model (or metamodel) is registered

Configurations:
- ATL Transformation
  - Grafcet2PetriNet
  - PetriNet2Grafcet
  - PetriNet2PNML
  - PNML2PetriNet
  - PNML2XML
  - XML2PNML
  - XML2Text
- Java Applet
- Java Application
- JUnit
- JUnit Plug-in Test
- Run-time Workbench

Name: PetriNet2PNML

IN

Model	Meta model
IN	PetriNet

OUT

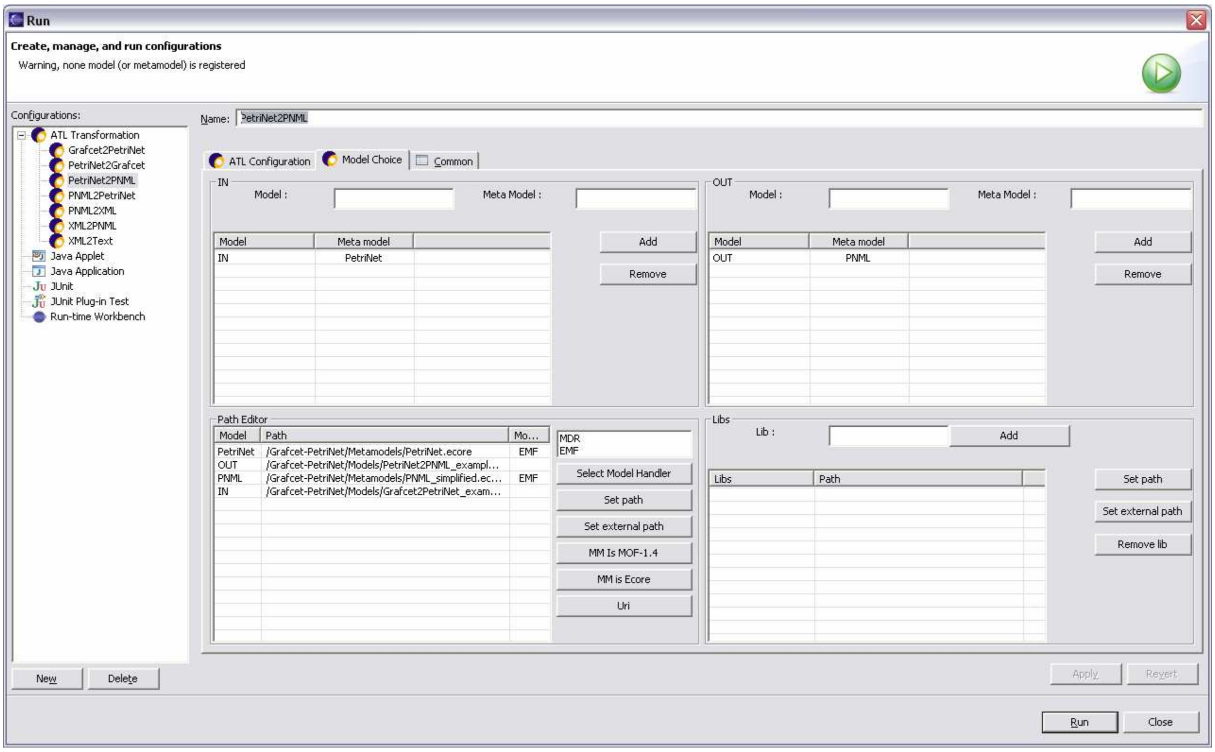
Model	Meta model
OUT	PNML

Path Editor

Model	Path	Mo...
PetriNet	/Grafcet-PetriNet/Metamodels/PetriNet.ecore	EMF
OUT	/Grafcet-PetriNet/Models/PetriNet2PNML_exampl...	
PNML	/Grafcet-PetriNet/Metamodels/PNML_simplified.ec...	EMF
IN	/Grafcet-PetriNet/Models/Grafcet2PetriNet_exam...	

MDR
EMF

Figure 10 - Petri Net to PNML configuration - part one



Run

Create, manage, and run configurations

Warning, none model (or metamodel) is registered

Name: PetriNet2PNML

IN
Model :
Meta Model :

Model	Meta model
IN	PetriNet

OUT
Model :
Meta Model :

Model	Meta model
OUT	PNML

Path Editor

Model	Path	Mo...
PetriNet	/Grafcet-PetriNet/Metamodels/PetriNet.ecore	EMF
OUT	/Grafcet-PetriNet/Models/PetriNet2PNML_exampl...	
PNML	/Grafcet-PetriNet/Metamodels/PNML_simplified.ec...	EMF
IN	/Grafcet-PetriNet/Models/Grafcet2PetriNet_exam...	

MDR
EMF

Libs
Lib :

Libs	Path

Figure 11 - Petri Net to PNML configuration - part two

3.2.2. PNML to Petri Net Transformation

3.2.2.1. Description of the Transformation

The ATL code for the Grafcet to Petri Net transformation consists of 5 rules and no helpers. In fact the two metamodels of Grafcet and Petri Net are quite close. So this transformation is quite easy.

Rules:

- The **PetriNet** rule generates a PetriNet which corresponds to the input NetElement included in the PNMLDocument. The name of the generated PetriNet is copied from the one of the input NetElement, by recovering the value of the PNML Label included in the PNML Name of the NetElement. Its set of Elements is the corresponding set named “elementsSet” calculated in the using clause. And its set of Arcs is the corresponding set named “arcsSet” calculated in the using clause.

- The **Place** rule generates a Place which corresponds to the input Place. The name of the generated Place is copied from the one of the input Place, by recovering the value of the PNML Label included in the PNML Name of the PNML Place.

- The **Transition** rule generates a Transition which corresponds to the input Transition. The name of the generated Transition is copied from the one of the input Transition, by recovering the value of the PNML Label included in the PNML Name of the PNML Transition.

- The **PlaceToTransition** rule generates a PlaceToTransition which corresponds to the input Arc which has a Place for source and a Transition for Target. The name of the generated PlaceToTransition is copied from the one of the input Arc, by recovering the value of the

PNML Label included in the PNML Name of the PNML Arc. Its *from* and *to* references are also copied from the input Arc and correspond respectively to the *source* and *target* references.

- The **TransitionToPlace** rule generates a TransitionToPlace which corresponds to the input Arc which has a Transition for source and a Place for Target. The name of the generated TransitionToPlace is copied from the one of the input Arc, by recovering the value of the PNML Label included in the PNML Name of the PNML Arc. Its *from* and *to* references are also copied from the input Arc and correspond respectively to the *source* and *target* references.

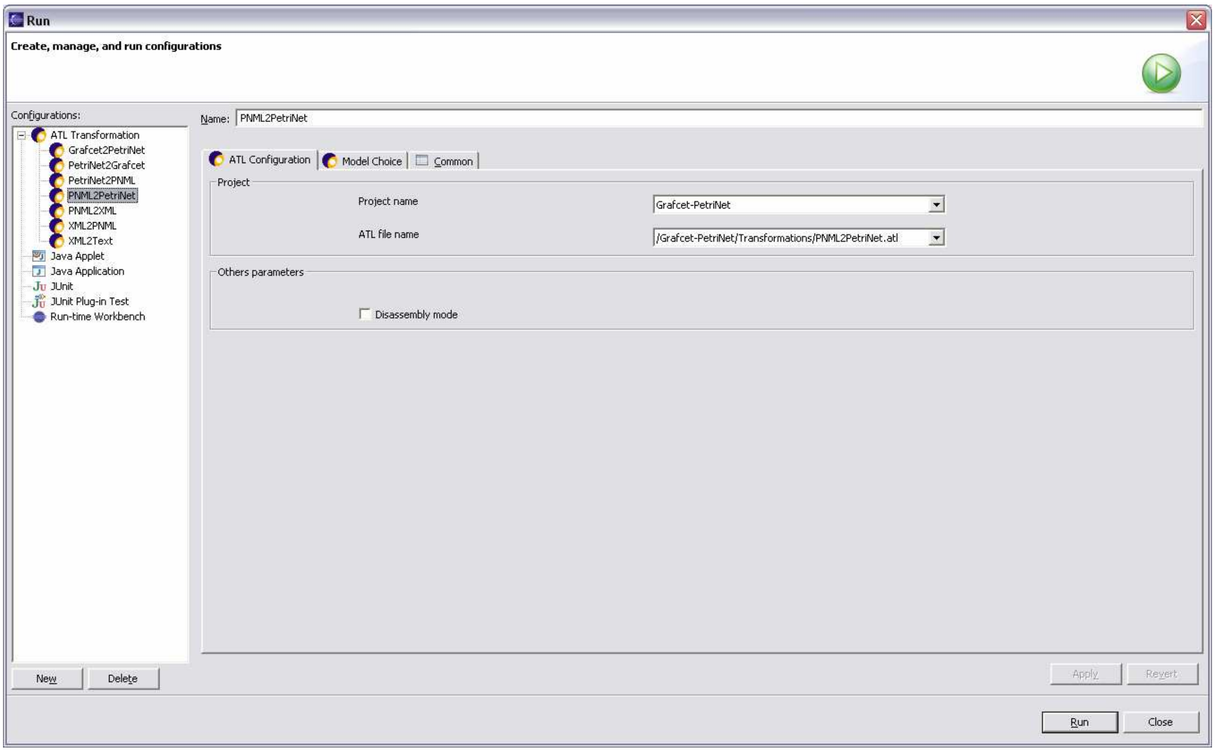
3.2.2.2. *ATL Code*

```
module PNML2PetriNet;
create OUT : PetriNet from IN : PNML;

-- The PetriNet rule generates a PetriNet which corresponds to the input
NetElement included in the PNMLDocument.
-- Name of the generated PetriNet is copied from the one of the input
NetElement, by recovering the value of the PNML Label included in the PNML
Name of the NetElement.
-- Its set of Elements is the corresponding set named “elementsSet”
calculated in the using clause.
-- And its set of Arcs is the corresponding set named “arcsSet” calculated
in the using clause.
rule PetriNet {
  from
    n : PNML!PNMLDocument
  using{
      elementsSet : Set(PetriNet!Element) =
        PNML!NetContentElement.allInstances();

      arcsSet : Set(PetriNet!Arc) =
        PNML!Arc.allInstances();
    }
  to
    p : PetriNet!PetriNet
    (
      location <- n.location,
      name <- n.nets.first().name.labels.first().text,
      elements <- elementsSet,
      arcs <- arcsSet
    )
}

-- The Place rule generates a Place which corresponds to the input Place.
-- Name of the generated Place is copied from the one of the input Place ,
by recovering the value of the PNML Label included in the PNML Name of the
PNML Place.
rule Place {
  from
    n : PNML!Place
  to
    p : PetriNet!Place
    (
      location <- n.location,
      name <- n.name.labels.first().text,
      net <- n.net.document
    )
}

-- The Transition rule generates a Transition which corresponds to the
input Transition .
-- Name of the generated Transition is copied from the one of the input
Transition , by recovering the value of the PNML Label included in the PNML
Name of the PNML Transition .
rule Transition {
  from
    n : PNML!Transition
  to
    p : PetriNet!Transition
    (
      location <- n.location,
      name <- n.name.labels.first().text,
      net <- n.net.document
    )
}

-- The PlaceToTransition rule generates a PlaceToTransition which
corresponds to the input Arc which has a Place for source and a Transition
for Target.
-- Name of the generated PlaceToTransition is copied from the one of the
input Arc, by recovering the value of the PNML Label included in the PNML
Name of the PNML Arc.
-- Its from and to references are also copied from the input Arc and
correspond respectively to the source and target references.
rule PlaceToTransition {
  from
    n : PNML!Arc
    (  -- arc source must be a place and arc target a transition
      n.source.oclIsKindOf(PNML!Place) and
n.target.oclIsKindOf(PNML!Transition)
    )
  to
    p : PetriNet!PlaceToTransition
    (
      location <- n.location,
      name <- n.name.labels.first().text,
      net <- n.net.document,
      "from" <- n.source,
      "to" <- n.target
    )
}

-- The TransitionToPlace rule generates a TransitionToPlace which
corresponds to the input Arc which has a Transition for source and a Place
for Target.
-- Name of the generated TransitionToPlace is copied from the one of the
input Arc, by recovering the value of the PNML Label included in the PNML
Name of the PNML Arc.
```

```
-- Its from and to references are also copied from the input Arc and
correspond respectively to the source and target references.
rule TransitionToPlace {
  from
    n : PNML!Arc
    ( -- arc source must be a transition and arc target a place
      n.source.oclIsKindOf(PNML!Transition) and
n.target.oclIsKindOf(PNML!Place)
    )
  to
    p : PetriNet!TransitionToPlace
    (
      location <- n.location,
      name <- n.name.labels.first().text,
      net <- n.net.document,
      "from" <- n.source,
      "to" <- n.target
    )
}
```

3.2.2.3. Configuration of the Transformation

As illustrated by the transformation configuration's Figure 12 and Figure 13, there is one input metamodel (PNML) and one output (PetriNet). In Path Editor, place in "PetriNet" the path of the Petri net metamodel; do the same for "PNML". In "IN" place the path of an Ecore file (a model conforming to our PNML metamodel in Ecore format), and in "OUT" the path for the results (the generated file is an Ecore file conforming to the Petri net metamodel).



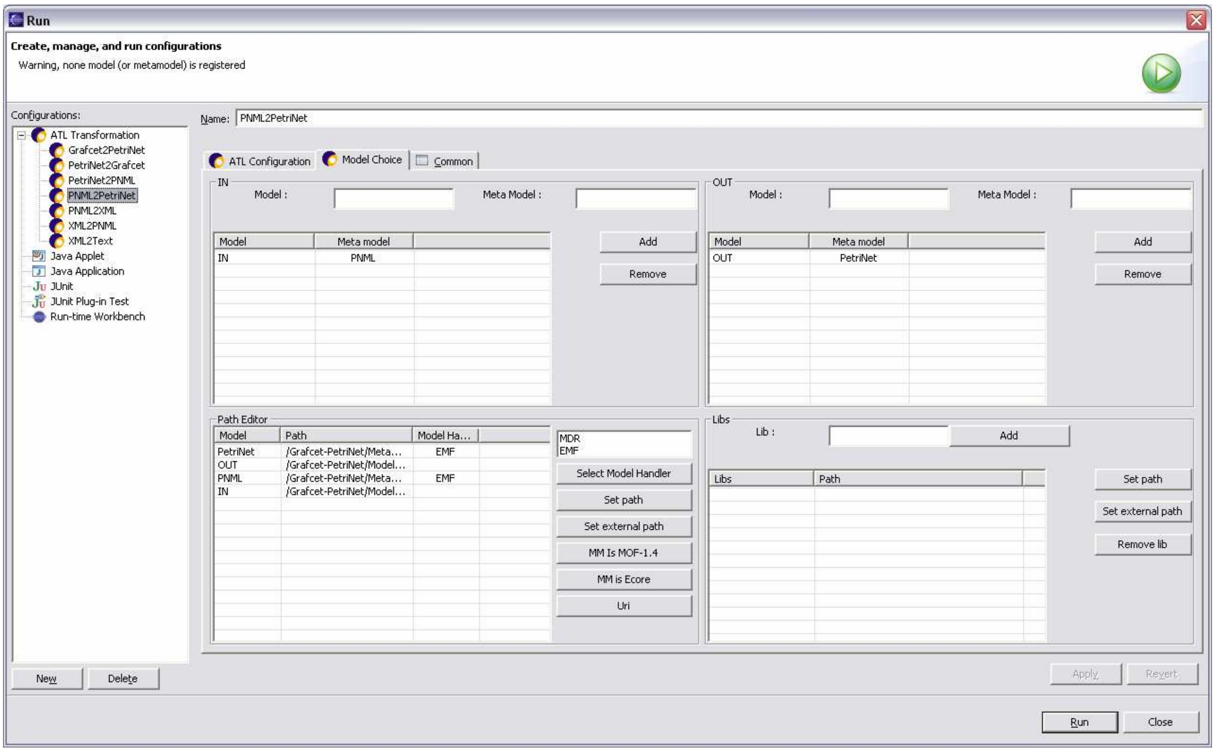
Name: PNML2PetriNet

Project name: Grafcet-PetriNet

ATL file name: /Grafcet-PetriNet/Transformations/PNML2PetriNet.atl

☐ Disassembly mode

Figure 12 - PNML to Petri Net configuration - part one



Create, manage, and run configurations

Warning, none model (or metamodel) is registered

Name: PNML2PetriNet

IN — Model : Meta Model :

Model	Meta model
IN	PNML

OUT — Model : Meta Model :

Model	Meta model
OUT	PetriNet

Path Editor

Model	Path	Model Ha...
PetriNet	/Grafcet-PetriNet/Meta...	EMF
OUT	/Grafcet-PetriNet/Model...	
PNML	/Grafcet-PetriNet/Meta...	EMF
IN	/Grafcet-PetriNet/Model...	

MDR
EMF

Libs — Lib :

Libs	Path

Figure 13 - PNML to Petri Net configuration - part two

3.3. The PNML - XML Bridge

3.3.1. PNML to XML Transformation: Extractor

3.3.1.1. Description of the Transformation

The ATL code for the Grafcet to Petri Net transformation consists of 4 rules and 1 helper.

Helper:

- The **getRoot** helper is a constant helper. It seeks the root element of PNML model: the PNML document. This helper allows to link elements and their parents, thanks to a “resolveTemp” instruction.

Rules:

- The **Root** rule generates the XML Root element as well as a collection of attributes and elements and Text node from the input PNMLDocument element. The generated Root element is a “pnml” tag that has an “xmlns” Attribute and a “net” Element as children. The value of the “xmlns” attribute is copied from the PNMLDocument. The “net” Element has an “id” and a “type” Attribute, a “name” sub-Element. The “id” attribute and the “type” attribute are also copied from the input element. Finally, the “name” Element contains a “text” Element, which itself contains a Text node whose value corresponds to the name of the input PNMLDocument element.
- The **Place** rule generates three XML Elements, one XML Attribute and one XML Text for each PNML Place input element. The first generated Element, “place”, is a “place” tag which

accepts an “id” Attribute as well as a child “name” Element. The value of the “id” attribute corresponds to the one of the PNML Place. The generated “name” Element accepts a “text” Element as child. This last one has a child which is a Text node. Its value corresponds to the name of the input Place.

- The **Transition** rule generates three XML Elements, one XML Attribute and one XML Text for each PNML Transition input element. The first generated Element, “transition”, is a “transition” tag which accepts an “id” Attribute as well as a child “name” Element. The value of the “id” attribute corresponds to the one of the PNML Transition. The generated “name” Element accepts a “text” Element as child. This last one has a child which is a Text node. Its value corresponds to the name of the input Transition.

- The **Arc** rule generates three XML Elements, three XML Attributes and one XML Text for each PNML Arc input element. The generated Element is an “arc” tag that has three Attribute children: “id”, “source” and “target”, as well as a child “name” Element. The value of the “id” attribute corresponds to the one of the PNML Arc. Values of the “source” and “target” attributes respectively correspond to the id of the source and the id of the target of the input Arc. The generated “name” Element accepts a “text” Element as child. This last one has a child which is a Text node. Its value corresponds to the name of the input Transition.

3.3.1.2. ATL Code

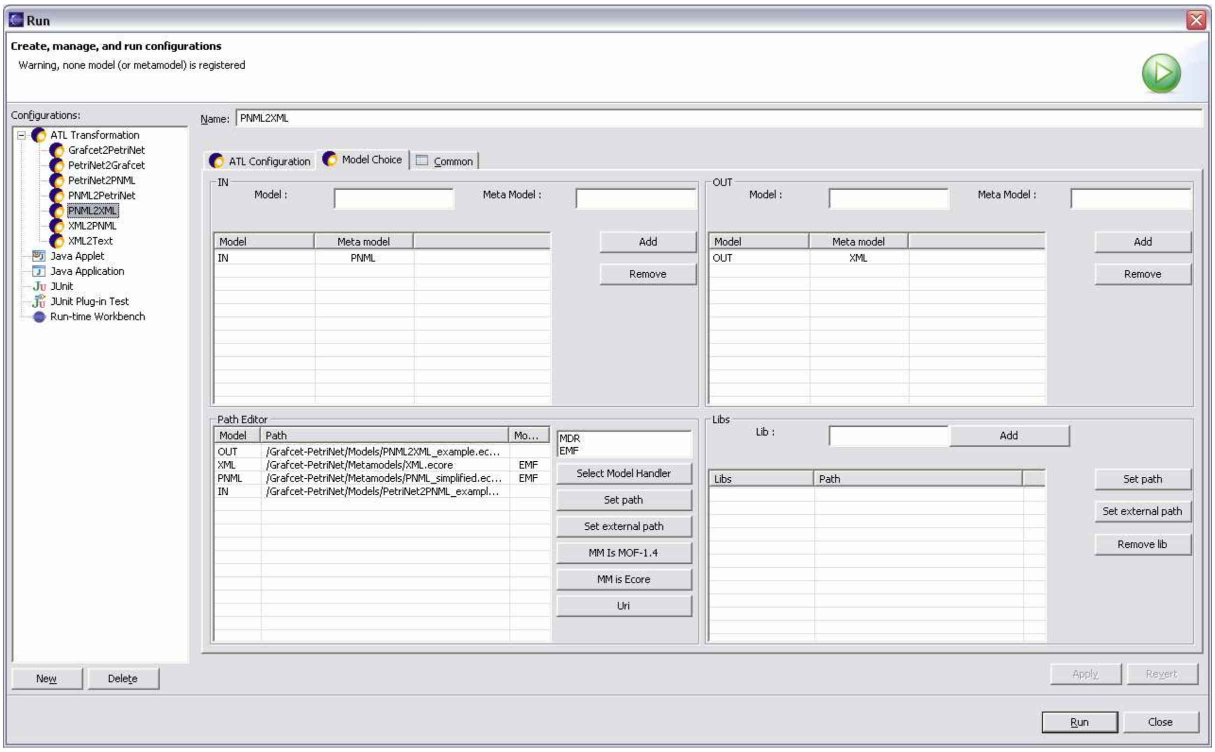
```
module PNML2XML;
create OUT : XML from IN : PNML;

-- The getRoot helper, is a constant helper. It seeks the root element of
PNML model : the PNML document.
-- This helper allows to link elements and their parents, thanks to a
“resolveTemp” instruction and to the helper.
-- CONTEXT: n/a
-- RETURN: PNML!PNMLDocument
helper def: getRoot() : PNML!PNMLDocument =
   PNML!PNMLDocument.allInstances()->asSequence()->first();


-- The Root rule generates the XML Root element as well as a collection of
attributes and elements and Text node from the input PNMLDocument element.
The generated Root element is a “pnml” tag that has an “xmlns” Attribute
and a “net” Element as children.
-- Value of the “xmlns” attribute is copied from the PNMLDocument. The
“net” Element has an “id” and a “type” Attribute, a “name” sub-Element.The
“id” attribute and the “type” attribute are also copied from the input
element.
-- Finally, the “name” Element contains a “text” Element, which itself
contains a Text node whose value corresponds to the name of the input
PNMLDocument element.
rule Root {
   from
      n : PNML!PNMLDocument
   to
      e : XML!Root
      (
      name <- 'pnml',
      -- value = name of the net contained by this document
      value <- n.nets.first().name.labels.first().text,
      children <- Sequence {document_name, document_xmlns, document_net}
    ),
    document_name : XML!Element
    (
      name <- 'name',
      parent <- n,
      children <- document_text
    ),
    document_text : XML!Element
    (
      name <- 'text',
      parent <- document_name,
      children <- document_xml_text
    ),
    document_xml_text : XML!Text
    (
      value <- n.nets.first().name.labels.first().text,
      parent <- document_text
    ),
    document_xmlns : XML!Attribute
    (
      name <- 'xmlns',
      value <- n.xmlns.value,
      parent <- n
    ),
    document_net : XML!Element
    (
      name <-'net',
      value <- n.nets.first().name.labels.first().text,
      parent <- n,
      children <- Sequence {net_name, net_id, net_type}
    ),
    net_name : XML!Element
    (
      name <- 'name',
      parent <- document_net,
      children <- net_text
    ),
    net_text : XML!Element
    (
      name <- 'text',
      parent <- net_name,
      children <- net_xml_text
    ),
    net_xml_text : XML!Text
    (
      value <- n.nets.first().name.labels.first().text,
      parent <- net_text
    ),
    net_id : XML!Attribute
    (
      name <- 'id',
      value <- n.nets.first().id,
      parent <- document_net
    ),
    net_type : XML!Attribute
    (
      name <-'type',
      value <- n.nets.first().type.value,
      parent <- document_net
    )
}

-- The Place rule generates three XML Elements, one XML Attribute and one
XML Text for each PNML Place input element.
-- The first generated Element, “place”, is a “place” tag which accepts an
“id” Attribute as well as a child “name” Element. The value of the “id”
attribute corresponds to the one of the PNML Place.
-- The generated “name” Element accepts a “text” Element as child. This
last one has a child which is a Text node. Its value corresponds to the
name of the input Place.
rule Place {
  from
    n : PNML!NetContentElement
    (
      n.oclIsKindOf(PNML!Place)
    )
  to
    place : XML!Element
    (
      name <- 'place',
      value <- n.name.labels.first().text,
      parent <- thisModule.resolveTemp(thisModule.getRoot(),
'document_net'),
      children <- Sequence{place_id, place_name}
    ),
    place_id : XML!Attribute
    (
      name <- 'id',
      value <- n.id,
      parent <- n
    ),
    place_name : XML!Element
    (
      name <- 'name',
      parent <- n,
      children <- place_text
    ),
    place_text : XML!Element
    (
      name <- 'text',
      parent <- place_name,
      children <- place_xml_text
    ),
    place_xml_text : XML!Text
    (
      value <- n.name.labels.first().text,
      parent <- place_text
    )

}

-- The Transition rule generates three XML Elements, one XML Attribute and
one XML Text for each PNML Transition input element.
-- The first generated Element, “transition”, is a “transition” tag which
accepts an “id” Attribute as well as a child “name” Element. The value of
the “id” attribute corresponds to the one of the PNML Transition.
-- The generated “name” Element accepts a “text” Element as child. This
last one has a child which is a Text node. Its value corresponds to the
name of the input Transition.
rule Transition {
  from
    n : PNML!NetContentElement
    (
      n.oclIsKindOf(PNML!Transition)
    )
  to
    transition : XML!Element
    (
      name <- 'transition',
      value <- n.name.labels.first().text,
      parent <- thisModule.resolveTemp(thisModule.getRoot(),
'document_net'),
      children <- Sequence{transition_id, transition_name}
    ),
    transition_id : XML!Attribute
    (
      name <- 'id',
      value <- n.id,
      parent <- n
    ),
    transition_name : XML!Element
    (
      name <- 'name',
      parent <- n,
      children <- transition_text
    ),
    transition_text : XML!Element
    (
      name <- 'text',
      parent <- transition_name,
      children <- transition_xml_text
    ),
    transition_xml_text : XML!Text
    (
      value <- n.name.labels.first().text,
      parent <- transition_text
    )

```

```
}

-- The Arc rule generates three XML Elements, three XML Attributes and one
XML Text for each PNML Arc input element.
-- The generated Element is an “arc” tag that has three Attribute children:
“id”, “source” and “target”, as well as a child “name” Element. The value
of the “id” attribute corresponds to the one of the PNML Arc. Values of the
“source” and “target” attributes respectively correspond to the id of the
source and the id of the target of the input Arc.
-- The generated “name” Element accepts a “text” Element as child. This
last one has a child which is a Text node. Its value corresponds to the
name of the input Transition.
rule Arc {
   from
      n : PNML!Arc
   to
      arc : XML!Element
      (
         name <- 'arc',
         value <- n.name.labels.first().text,
         parent <- thisModule.resolveTemp(thisModule.getRoot(),
'document_net'),
         children <- Sequence {arc_name, arc_id, source, target}
      ),
      arc_id : XML!Attribute
      (
         name <- 'id',
         value <- n.id,
         parent <- n
      ),
      arc_name : XML!Element
      (
         name <- 'name',
         parent <- n,
         children <- arc_text
      ),
      arc_text : XML!Element
      (
         name <- 'text',
         parent <- arc_name,
         children <- arc_xml_text
      ),
      arc_xml_text : XML!Text
      (
         value <- n.name.labels.first().text,
         parent <- arc_text
      ),
      -- source and target attribute are initialised by the id of the
element pointed
      source : XML!Attribute
      (
         name <- 'source',
         value <- n.source.id,
         parent <- n
```

```
     ),
     target : XML!Attribute
     (
       name <- 'target',
       value <- n.target.id,
       parent <- n
     )
}
```

3.3.1.3. Configuration of the Transformation

As illustrated by the transformation configuration’s Figure 14 and Figure 15, there is one input metamodel (PNML) and one output (XML). In Path Editor, place in “PNML” the path of the PNML metamodel; do the same for “XML”. In “IN“ place the path of an Ecore file (a model conforming to our PNML metamodel in Ecore format), and in “OUT” the path for the results (the generated file is an Ecore file conforming to the XML metamodel).



Run

Create, manage, and run configurations

Warning, none model (or metamodel) is registered

Configurations:

- ATL Transformation
  - Grafcet2PetriNet
  - PetriNet2Grafcet
  - PetriNet2PNML
  - PNML2PetriNet
  - PNML2XML
  - XML2PNML
  - XML2Text
- Java Applet
- Java Application
- JUnit
- JUnit Plug-in Test
- Run-time Workbench

Name: PNML2XML

IN

Model	Meta model
IN	PNML

OUT

Model	Meta model
OUT	XML

Path Editor

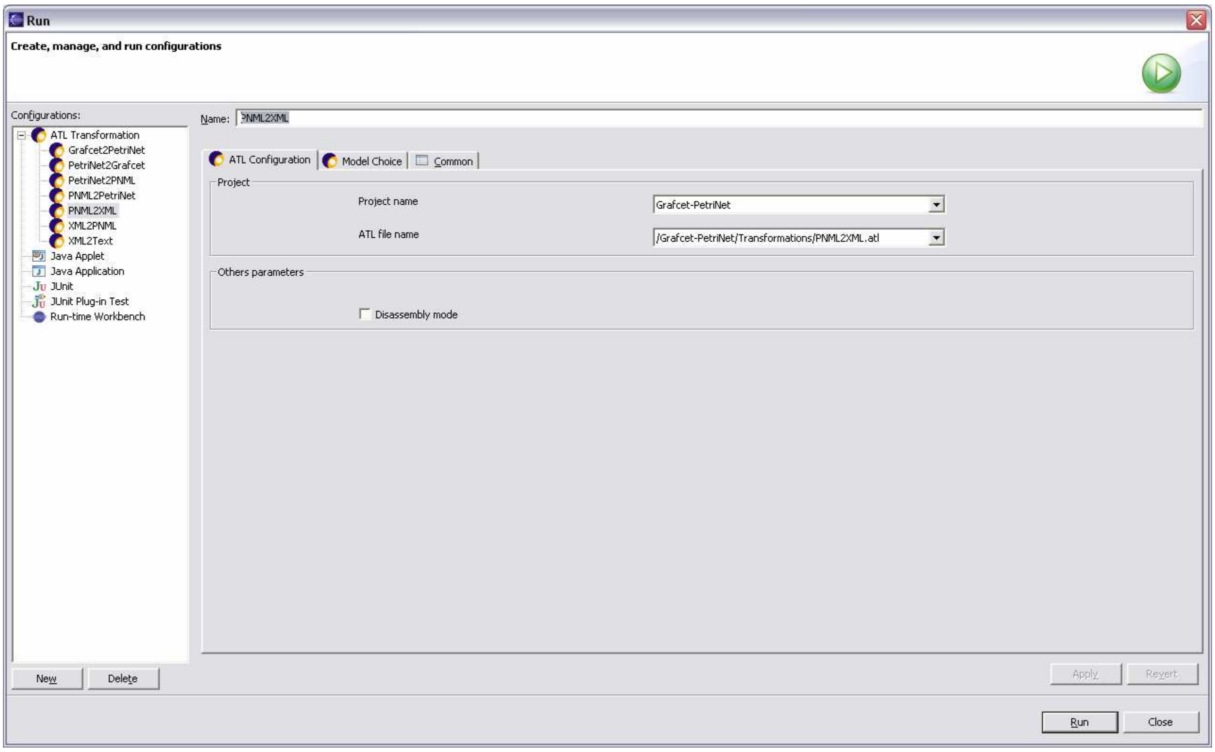
Model	Path	Mo...
OUT	/Grafcet-PetriNet/Models/PNML2XML_example.ec...	
XML	/Grafcet-PetriNet/Metamodels/XML.ecore	EMF
PNML	/Grafcet-PetriNet/Metamodels/PNML_simplified.ec...	EMF
IN	/Grafcet-PetriNet/Models/PetriNet2PNML_exampl...	

MDR
EMF

Libs

Libs	Path

Figure 14 - PNML to XML configuration - part one



Name: PNML2XML

Project name: Grafcet-PetriNet

ATL file name: /Grafcet-PetriNet/Transformations/PNML2XML.atl

□ Disassembly mode

Figure 15 - PNML to XML configuration - part two

3.3.2. XML to PNML Transformation: Injector

3.3.2.1. Description of the Transformation

The ATL code for the Grafcet to Petri Net transformation consists of 5 rules and 3 helpers.

Helpers:

- The first helper **getAttrVal**, returns the value of an attribute (identified by its name, passed as a parameter) of the contextual XML Element. For this purpose, its collects, among the children of this contextual Element, the Attribute whose name matches the name passed in parameter. The helper returns the value of the first matched attribute.
- The **getName** helper returns the name of a “net” or a “place” XML Element. To this end, it first gets, among its Element children, the one named “name”. It then gets the “text” XML Element child of this new node, and finally returns the value associated with it.
- The **getLink** helper collects all instances of xml element and search the one whose id matches the id passed in parameter. The helper returns the first xml element of the collection.

Rules:

- The **PNMLDocument** rule generates a PNMLDocument from the input XML Root Element.
- The **Net** rule generates a NetElement from each "net" XML Element input element. The name of the generated NetElement is computed by calling the **getName** helper. Its set of Places, Transitions and Arcs are initialized by the other rules. The link to its parent, the PNMLDocument, is also created.
- The **Place** rule generates a PNML Place for each "place" XML Element. The name of the generated Place is computed by a call to the **getName** helper. Its id is copied from the one of the input XML Element. The link to its parent, the NetElement, is also created.
- The **Transition** rule generates a PNML Transition for each "transition" XML Element. The name of the generated Transition is computed by a call to the **getName** helper. Its id is copied from the one of the input XML Element. The link to its parent, the NetElement, is also created.
- The **Arc** rule generates a PNML Arc for each "arc" XML Element. The name of the generated Arc is computed by a call to the **getName** helper. Its id is copied from the one of the input XML Element. Its source (obtained by means of the **getLink** helper) corresponds to the XML Element which id is contained in the child attribute named "source". Idem for the target. The link to its parent, the NetElement, is also created.

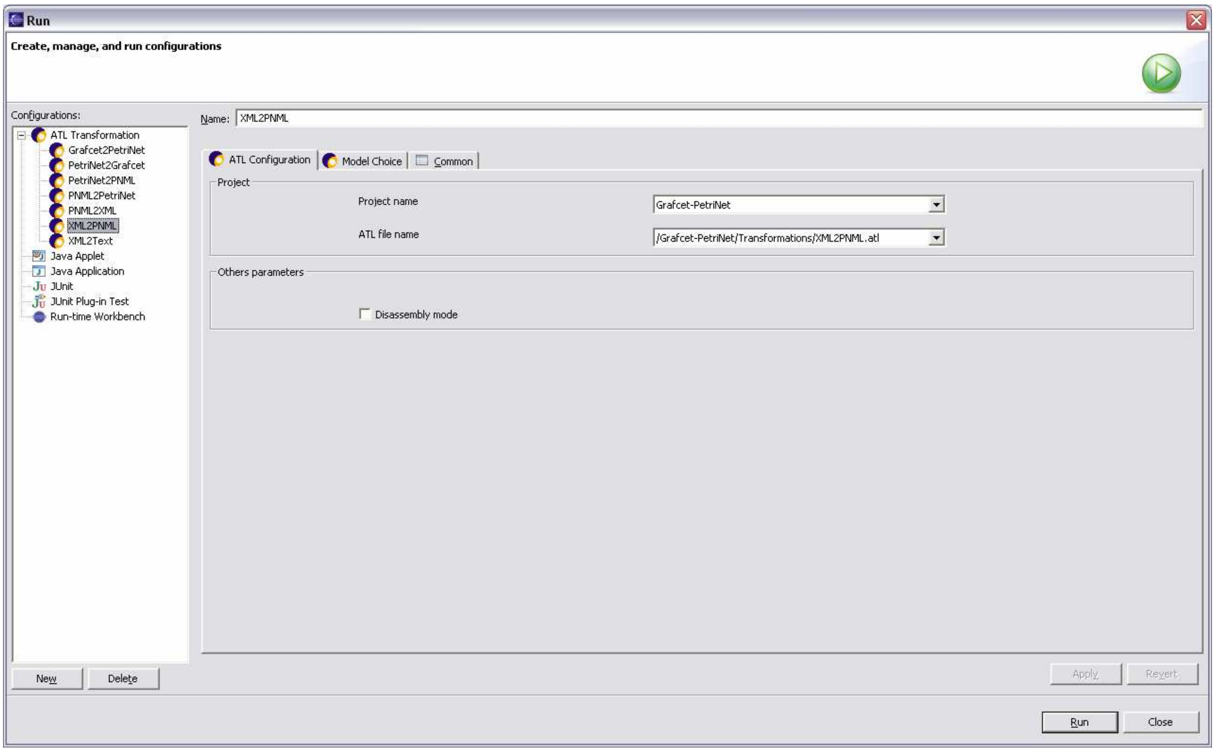
3.3.2.2. ATL Code

```
module XML2PNML;
create OUT : PNML from IN : XML;

-- The getAttrVal helper, returns the value of an attribute (identified by
its name, passed as a parameter) of the contextual XML Element.
-- For this purpose, its collects, among the children of this contextual
Element, the Attribute whose name matches the name passed in parameter.
-- The helper returns the value of the first matched attribute.
-- CONTEXT: XML!Element
-- RETURN: String
helper context XML!Element def: getAttrVal(name : String) : String =
  let a : Sequence(XML!Attribute) = self.children->select(c |
c.oclIsTypeOf(XML!Attribute) and c.name = name) in
  if a.isEmpty() then
     ''
  else
     a.first().value
  endif;

-- The getName() helper returns the name of a "net" or a "place" XML
Element.
-- To this end, it first gets, among its Element children, the one named
"name".
-- It then gets the "text" XML Element child of this new node, and finally
returns the value associated with it.
-- CONTEXT: XML!Element
-- RETURN: String
helper context XML!Element def : getName() : String =
  self.children->select(c | c.oclIsTypeOf(XML!Element) and c.name =
'name')->first().children
    ->select(d | d.oclIsTypeOf(XML!Element) and d.name = 'text')-
>first().children
    ->select(e | e.oclIsKindOf(XML!Text))->first().value;

-- The getLink helper, collects all instances of xml element and search the
one whose id matches the id passed in parameter.
-- The helper returns the first xml element of the collection.
-- CONTEXT: n/a
-- RETURN: XML!Element
helper def: getLink(id : String) : XML!Element =
  XML!Element.allInstances()->select(z | z.getAttrVal('id') = id)->first();


-- The PNMLDocument rule generates a PNMLDocument from the input XML Root
Element.
rule PNMLDocument {
  from
    x : XML!Root
  to
    document : PNML!PNMLDocument
    (
      xmlns <- uri
    ),
    uri : PNML!URI
    (
      value <- x.getAttrVal('xmlns')
    )
}

-- The Net rule generates a NetElement from each “net” XML Element input
element.
-- Name of the generated NetElement is computed by calling the getName
helper.
-- Its set of Places, Transitions and Arcs are initialized by the other
rules.
-- The link to its parent, the PNMLDocument, is also created.
rule Net {
  from
    x : XML!Element
    (
      x.name = 'net'
    )
  to
    net_element : PNML!NetElement
    (
      name <- named_element,
      type <- type_uri,
      -- pointer on the root element
      document <- x.parent
    ),
    type_uri : PNML!URI
    (
      value <- x.getAttrVal('type')
    ),
    named_element : PNML!Name
    (
      labels <- label
    ),
    label : PNML!Label
    (
      text <- x.getName()
    )
}

-- The Place rule generates a PNML Place for each “place” XML Element.
-- Name of the generated Place is computed by a call to the getName helper.
-- Its id is copied from the one of the input XML Element.
-- The link to its parent, the NetElement, is also created.
rule Place {
  from
    x : XML!Element
    (
      x.name = 'place'
    )
  to
    n : PNML!Place
    (
      name <- named_element,
      -- pointer on the net element
      net <- x.parent,
      id <- x.getAttrVal('id'),
      location <- ''
    ),
    named_element : PNML!Name
    (
      labels <- label
    ),
    label : PNML!Label
    (
      text <- x.getName()
    )
}

-- The Transition rule generates a PNML Transition for each “transition”
XML Element.
-- Name of the generated Transition is computed by a call to the getName
helper.
-- Its id is copied from the one of the input XML Element.
-- The link to its parent, the NetElement, is also created.
rule Transition {
  from
    x : XML!Element
    (
      x.name = 'transition'
    )
  to
```

```
    n : PNML!Transition
    (
      name <- named_element,
      -- pointer on the net element
      net <- x.parent,
      id <- x.getAttrVal('id')
    ),
    named_element : PNML!Name
    (
      labels <- label
    ),
    label : PNML!Label
    (
      text <- x.getName()
    )
}

-- The Arc rule generates a PNML Arc for each “arc” XML Element.
-- Name of the generated Arc is computed by a call to the getName helper.
-- Its id is copied from the one of the input XML Element.
-- Its source (obtained by means of the getLink helper) corresponds to the
XML Element which id is contained in the child attribute named “source”.
Idem for the target.
-- The link to its parent, the NetElement, is also created.
rule Arc {
  from
    x : XML!Element
    (
      x.name = 'arc'
    )
  to
    n : PNML!Arc
    (
      name <- named_element,
      id <- x.getAttrVal('id'),
      net <- x.parent,
      -- seek of the element pointed by the source id contained in the xml
file
      source <- thisModule.getLink(
        (x.children->select(c | c.oclIsKindOf(XML!Attribute) and c.name =
'source')->first().value)
      ),
      -- seek of the element pointed by the target id contained in the xml
file
      target <- thisModule.getLink(
        (x.children->select(c | c.oclIsKindOf(XML!Attribute) and c.name =
'target')->first().value)
      )

    ),
    named_element : PNML!Name
    (
      labels <- label
    ),
    label : PNML!Label
    (
      text <- x.getName()
    )
}

```

3.3.2.3. *Configuration of the Transformation*

As illustrated by the transformation configuration’s Figure 16 and Figure 17, there is one input metamodel (XML) and one output (PNML). In Path Editor, place in “XML” the path of the XML metamodel; do the same for “PNML”. In “IN“ place the path of an Ecore file (a model conforming to our XML metamodel in Ecore format), and in “OUT” the path for the results (the generated file is an Ecore file conforming to the PNML metamodel).



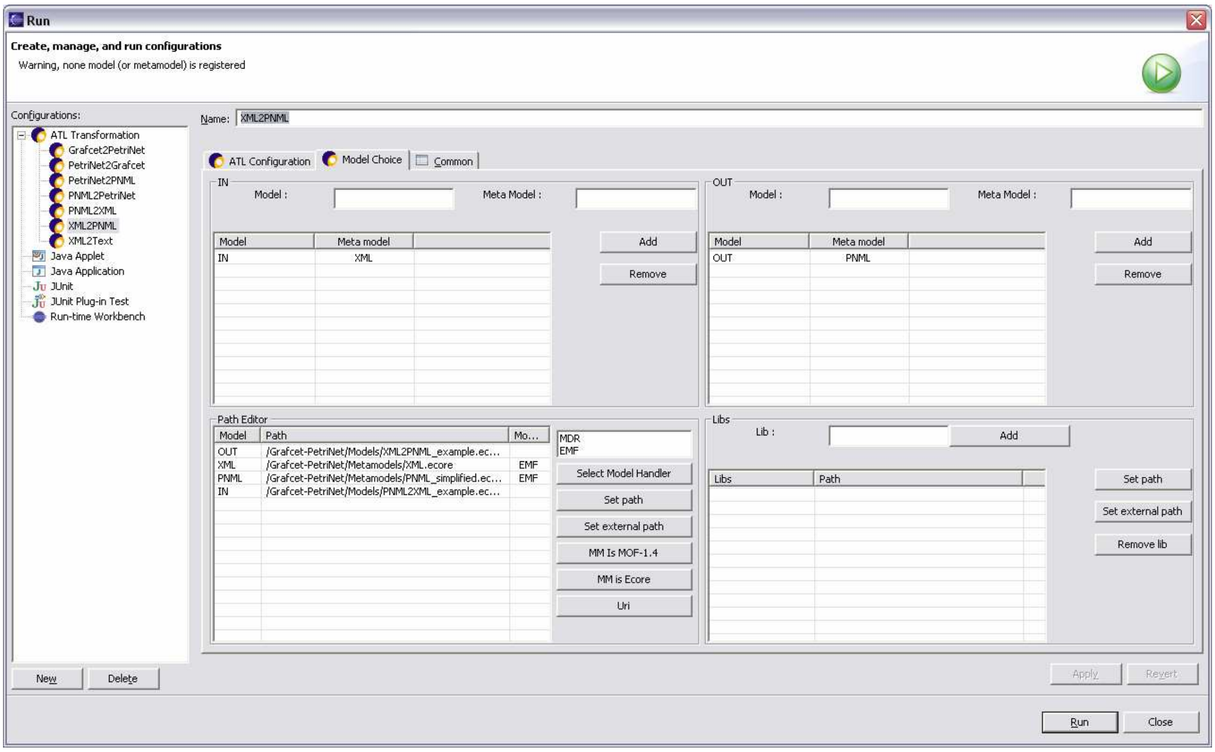
Name: XML2PNML

Project name: Grafcet-PetriNet

ATL file name: /Grafcet-PetriNet/Transformations/XML2PNML.atl

□ Disassembly mode

Figure 16 - XML to PNML configuration - part one



Run

Create, manage, and run configurations

Warning, none model (or metamodel) is registered

Configurations:
- ATL Transformation
  - Grafcet2PetriNet
  - PetriNet2Grafcet
  - PetriNet2PNML
  - PNML2PetriNet
  - PNML2XML
  - XML2PNML
  - XML2Text
- Java Applet
- Java Application
- JUnit
- JUnit Plug-in Test
- Run-time Workbench

Name: XML2PNML

IN

Model	Meta model
IN	XML

OUT

Model	Meta model
OUT	PNML

Path Editor

Model	Path	Mo...
OUT	/Grafcet-PetriNet/Models/XML2PNML_example.ec...	
XML	/Grafcet-PetriNet/Metamodels/XML.ecore	EMF
PNML	/Grafcet-PetriNet/Metamodels/PNML_simplified.ec...	EMF
IN	/Grafcet-PetriNet/Models/PNML2XML_example.ec...	

MDR
EMF

Libs

Libs	Path

Figure 17 - XML to PNML configuration - part two

3.3.3. XML to PNML text (Extract XML)

3.3.3.1. *Description of the Transformation*

The ATL code, that allows generating a PNML valid and well-formed XML text file from an XML model, for this transformation consists in 4 helpers and 1 query.

The aim of this query is to extract each of the elements that compose the input XML model into an output XML file. Contrary to rules that are implemented to generate a model from another model, a query allows calculating output text files from an input model (see [3]). This is the reason why we need to use queries for this type of transformation: generating an XML file from an XML model.

The implemented query get the Root element of the XML model and call the “toString2()” helper on it. The content is generated by the “toString2()” helper called on the Root element of the XML model.

There are three “toString2()” helpers with different contexts. The XML!Attribute one simply returns the name and the value of an attribute in the correct string format. The XML!Text one only returns the string value contained in a text node. The XML!Element one returns the valid and well-formed content of the output XML file by parsing recursively all the element of the input XML model. Note that it sometimes calls the XML!Attribute and XML!Text “toString2()” helpers.

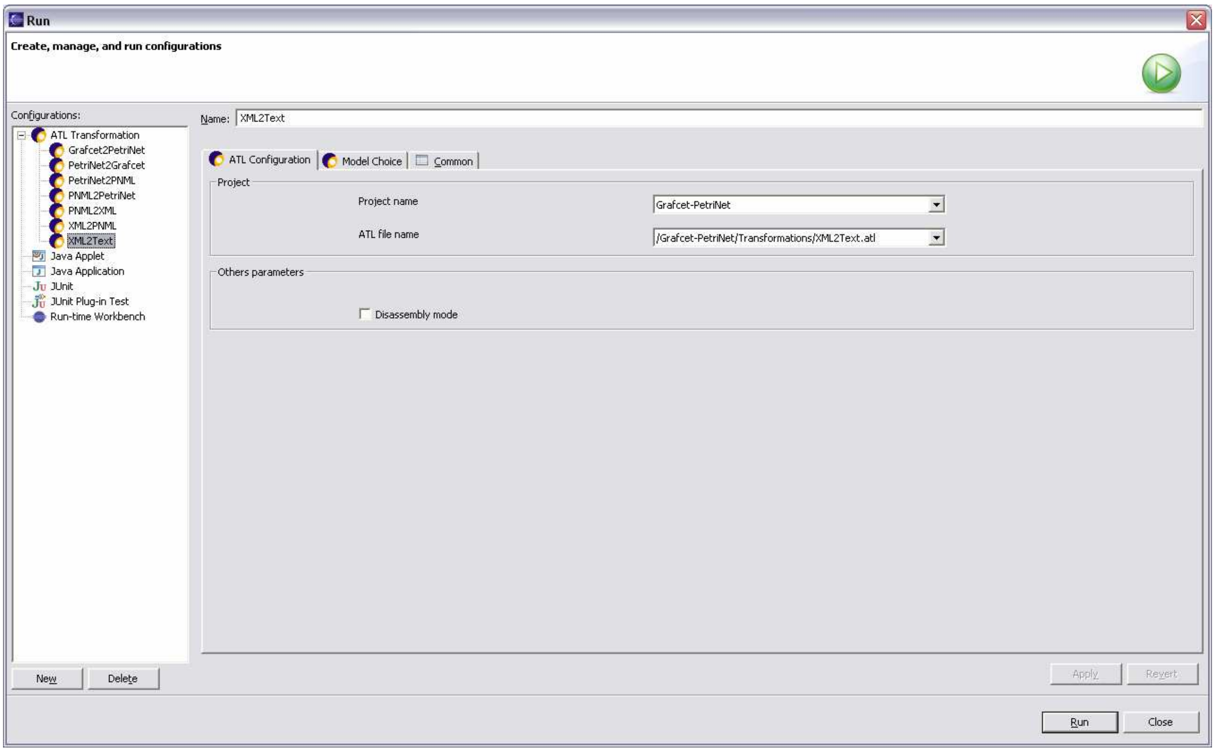
3.3.3.2. *ATL Code*

```
query XML2Text = XML!Root.allInstances()
  ->asSequence()
  ->first().toString2('').writeTo('C:\\... Complete this path ...\\Grafcet-
PetriNet\\Models\\XML2Text_example.xml');

helper context XML!Element def: toString2(indent : String) : String =
  let na : Sequence(XML!Node) =
    self.children->select(e | not e.oclIsKindOf(XML!Attribute)) in
  let a : Sequence(XML!Node) =
    self.children->select(e | e.oclIsKindOf(XML!Attribute)) in
  indent + '<' + self.name +
  a->iterate(e; acc : String = '' |
    acc + ' ' + e.toString2()
  ) +
  if na->size() > 0 then
    '>'
    + na->iterate(e; acc : String = '' |
      acc +
      if e.oclIsKindOf(XML!Text) then
        ''
      else
        '\r\n'
      endif
      + e.toString2(indent + '  ')
    ) +
    if na->first().oclIsKindOf(XML!Text) then
      '</' + self.name + '>'
      else
        '\r\n' + indent + '</' + self.name + '>'
    endif
  else
    '/>'
  endif;

helper context XML!Attribute def: toString2() : String =
  self.name + '=\"' + self.value + '\"';

helper context XML!Text def: toString2() : String =
  self.value;
```

3.3.3.3. Configuration of the Transformation

As illustrated by the transformation configuration's Figure 18 and Figure 19, there is one input metamodel (XML). In Path Editor, place in “XML” the path of the XML metamodel. In “IN“place the path of an Ecore file (a model conforming to our XML metamodel in Ecore format).

The generated file is an Ecore file conforming to the XML metamodel. This file does not appear in the configuration, it is defined in the ATL code of the transformation. So in the XML to Text ATL file, ensure that the output file path is correct at the top of the file (Figure 20).



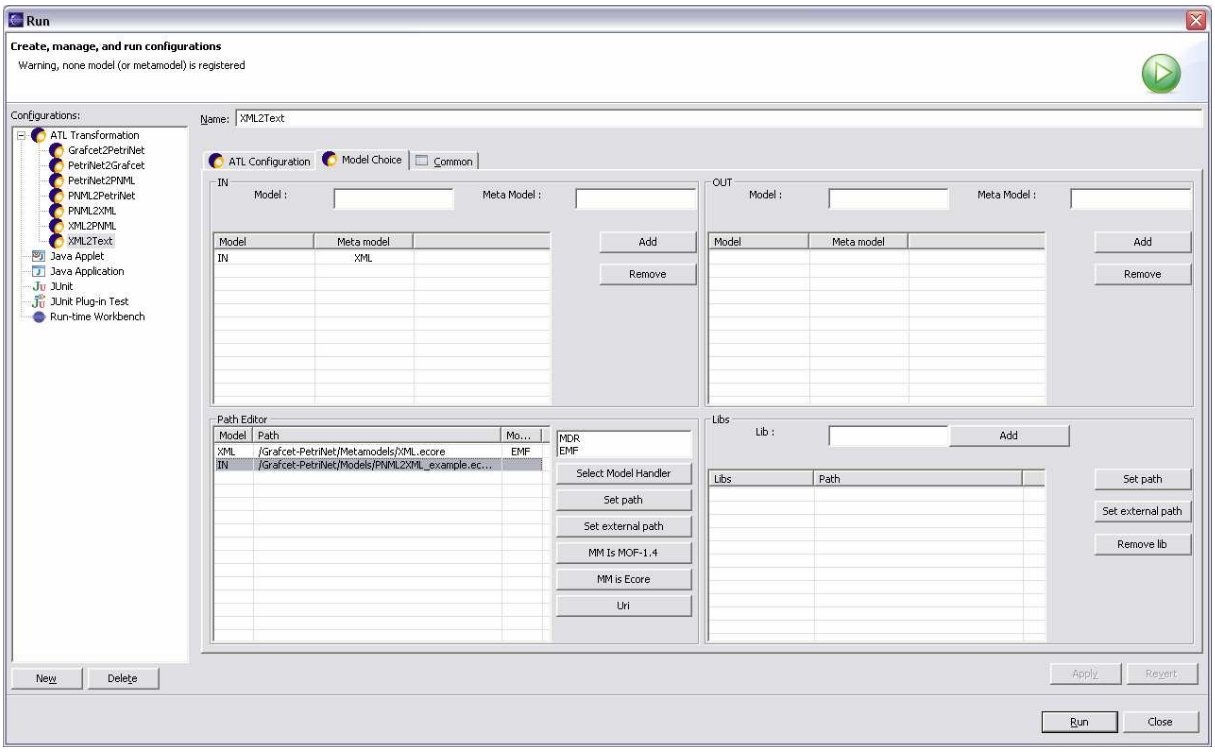
Name: XML2Text

Project name: Grafcet-PetriNet

ATL file name: /Grafcet-PetriNet/Transformations/XML2Text.atl

□ Disassembly mode

Figure 18 - XML to Text configuration - part one



Name: XML2Text

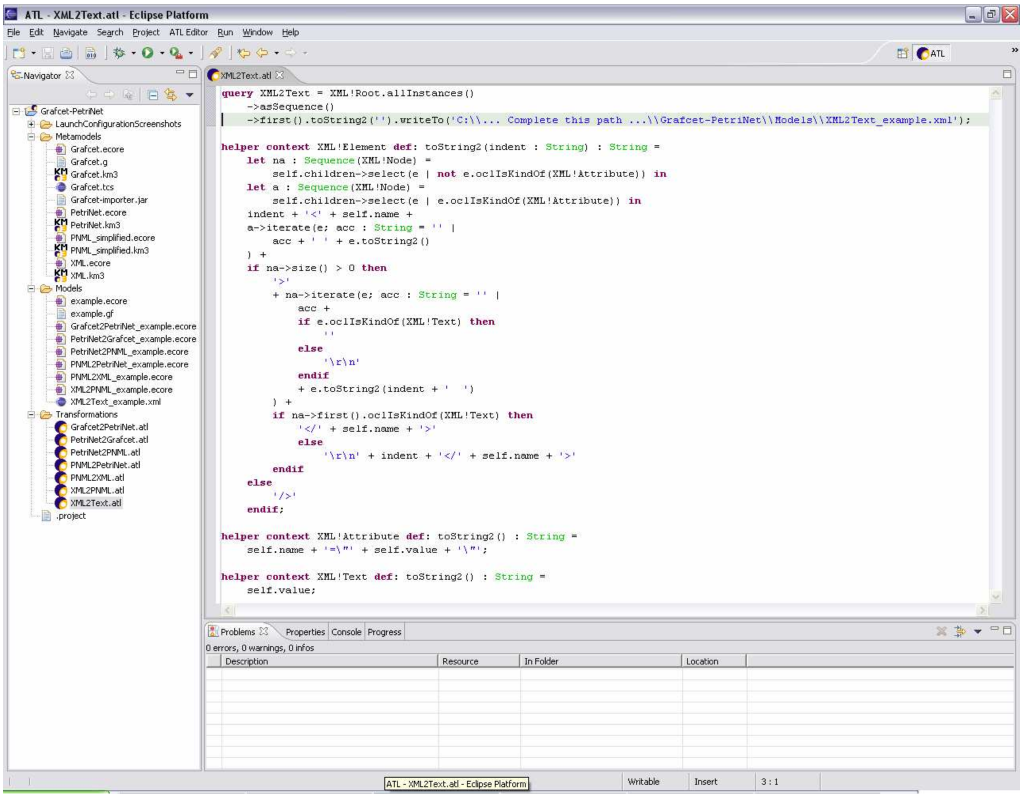
Model	Meta model
IN	XML

Model	Path	Mo...
XML	/Grafcet-PetriNet/Metamodels/XML.ecore	EMF
IN	/Grafcet-PetriNet/Models/PNML2XML_example.ec...	

MDR
EMF

Libs	Path

Figure 19 - XML to Text configuration - part two



```
query XML2Text = XML!Root.allInstances()
    ->asSequence()
    ->first().toString2('').writeTo('C:\\... Complete this path ...\\Grafcet-PetriNet\\Models\\XML2Text_example.xml');

helper context XML!Element def: toString2(indent : String) : String =
    let na : Sequence(XML!Node) =
        self.children->select(e | not e.oclIsKindOf(XML!Attribute)) in
    let a : Sequence(XML!Node) =
        self.children->select(e | e.oclIsKindOf(XML!Attribute)) in
    indent + '<' + self.name +
    a->iterate(e; acc : String = '' |
        acc + ' ' + e.toString2()
    ) +
    if na->size() > 0 then
        '>'
        + na->iterate(e; acc : String = '' |
            acc +
            if e.oclIsKindOf(XML!Text) then
                ''
            else
                '\r\n'
            endif
            + e.toString2(indent + '  ')
        ) +
        if na->first().oclIsKindOf(XML!Text) then
            '</' + self.name + '>'
            else
                '\r\n' + indent + '</' + self.name + '>'
        endif
    else
        '/>'
    endif;

helper context XML!Attribute def: toString2() : String =
    self.name + '=\"' + self.value + '\"';

helper context XML!Text def: toString2() : String =
    self.value;
```

0 errors, 0 warnings, 0 infos

Description	Resource	In Folder	Location

Figure 20 - XML to Text ATL file

I. Grafcet metamodel in KM3 format

```
package Grafcet {
   abstract class LocatedElement {
      attribute location : String;
   }
   abstract class NamedElement extends LocatedElement {
      attribute name : String;
   }
   class Grafcet extends NamedElement {
      reference elements[*] container : Element oppositeOf grafcet;
      reference connections[*] container : Connection oppositeOf grafcet;
   }
   -- @begin elements
   abstract class Element extends NamedElement {
      reference grafcet : Grafcet oppositeOf elements;
   }
   class Step extends Element {
      attribute isInitial : Boolean;
      attribute isActive : Boolean;
      attribute action : String;
      reference incomingConnections[*] : TransitionToStep oppositeOf to;
      reference outgoingConnections[*] : StepToTransition oppositeOf from;
   }
   class Transition extends Element {
      attribute condition : String;
      reference incomingConnections[*] : StepToTransition oppositeOf to;
      reference outgoingConnections[*] : TransitionToStep oppositeOf from;

   }
   -- @end elements
   --@begin connections
   abstract class Connection extends NamedElement {
      reference grafcet : Grafcet oppositeOf connections;
   }
   class StepToTransition extends Connection {
      reference from : Step oppositeOf outgoingConnections;
      reference to : Transition oppositeOf incomingConnections;
   }
   class TransitionToStep extends Connection {
      reference from : Transition oppositeOf outgoingConnections;
      reference to : Step oppositeOf incomingConnections;
   }

   --@end connections
}
package PrimitiveTypes {
   datatype String;
   datatype Boolean;
}
```

II. Petri Net metamodel in KM3 format

```
package PetriNet {
   abstract class LocatedElement {
      attribute location : String;
   }
   abstract class NamedElement extends LocatedElement {
      attribute name : String;
   }
   -- @comment top element
   class PetriNet extends NamedElement {
      reference elements[*] container : Element oppositeOf net;
      reference arcs[*] container : Arc oppositeOf net;
   }
   -- @begin elements
   abstract class Element extends NamedElement {
      reference net : PetriNet oppositeOf elements;
   }
   class Place extends Element {
      reference incomingArc[*] : TransitionToPlace oppositeOf to;
      reference outgoingArc[*] : PlaceToTransition oppositeOf from;
   }
   class Transition extends Element {
      reference incomingArc[1-*] : PlaceToTransition oppositeOf to;
      reference outgoingArc[1-*] :  TransitionToPlace oppositeOf from;
   }
   -- @end elements
   --@begin arcs
   abstract class Arc extends NamedElement {
      attribute weight : Integer;
      reference net : PetriNet oppositeOf arcs;
   }
   class PlaceToTransition extends Arc {
      reference from : Place oppositeOf outgoingArc;
      reference to : Transition oppositeOf incomingArc;
   }
   class TransitionToPlace extends Arc {
      reference from : Transition oppositeOf outgoingArc;
      reference to : Place oppositeOf incomingArc;
   }
   --@end arcs
}
package PrimitiveTypes {
   datatype String;
   datatype Integer;
}
```

III. PNML metamodel in KM3 format

```
package PNML {
   abstract class LocatedElement {
      attribute location : String;
   }
   abstract class IdedElement extends LocatedElement {
      attribute id : String;
   }
   -- @begin declaration of types
   class URI extends LocatedElement {
      attribute value : String;
   }
   -- @end declaration of types
   -- @comment single top element (like in XML document)
   class PNMLDocument extends LocatedElement {
      reference xmlns container : URI;
      reference nets[1-*] container : NetElement oppositeOf document;
   }
   -- @comment a petri net element
   class NetElement extends IdedElement {
      -- @comment typer reference the PNTD associed with the net
      reference type container : URI;
      reference document : PNMLDocument oppositeOf nets;
      reference contents[*] container : NetContent oppositeOf net;
      reference name[0-1] container : Name oppositeOf net;
   }
   -- @comment content of a petri net element
   abstract class NetContent extends LocatedElement {
      reference net : NetElement oppositeOf contents;
      reference name[0-1] container : Name oppositeOf netContent;
   }
   -- @comment element used for abstraction (Name, Inscription and InitialMarking)
   abstract class LabeledElement extends LocatedElement {
      reference labels[*] container : Label oppositeOf labeledElement;
   }
   class Label extends LocatedElement {
      attribute text : String;
      reference labeledElement : LabeledElement oppositeOf labels;
   }
   class Name extends LabeledElement {
      reference net[0-1] : NetElement oppositeOf name;
      reference netContent[0-1] : NetContent oppositeOf name;
   }
   -- @comment element used for abstraction (Place and Transition)
   abstract class NetContentElement extends NetContent,IdedElement {
   }
   class Arc extends NetContent,IdedElement {
      reference source : NetContentElement;
      reference target : NetContentElement;
   }
   class Place extends NetContentElement {
   }
   -- @comment a transition element
   class Transition extends NetContentElement {
   }
}
package PrimitiveTypes { datatype String; }
```

IV. XML metamodel in KM3 format

```
package XML {
   abstract class Node {
      attribute startLine[0-1] : Integer;
      attribute startColumn[0-1] : Integer;
      attribute endLine[0-1] : Integer;
      attribute endColumn[0-1] : Integer;
      attribute name : String;
      attribute value : String;
      reference parent[0-1] : Element oppositeOf children;
   }
   class Attribute extends Node {}
   class Text extends Node {}
   class Element extends Node {
      reference children[*] ordered container : Node oppositeOf parent;
   }
   class Root extends Element {}
}
package PrimitiveTypes {
   datatype Boolean;
   datatype Integer;
   datatype String;
}
```

V. References

[1] The Petri Net Markup Language (PNML). Documentation and tools available at http://www.informatik.huberlin.de/top/pnml/about.html.

[2] KM3: Kernel MetaMetaModel. Available at http://dev.eclipse.org/viewcvs/indextech.cgi/~checkout~/gmthome/doc/atl/index.html.

[3] ATL User manual, “4.1 Queries and the Generation of Text” subsection, http://www.eclipse.org/gmt/, ATL subproject, ATL Documentation Section