

Coupling Overture to MDA and UML

Overture Workshop
Newcastle 2009
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Agenda

- Motivation
- Goal
- Main results
- Development

Motivation

- Improve tools support for formal methods (VDM++)
 - 1. Commercial tool (VDM Tools)
 - Rose VDM Link UML1 (last updated 1997)
- Best of both worlds VDM / UML

Goal

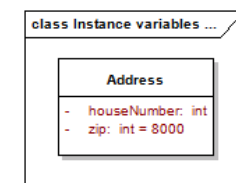
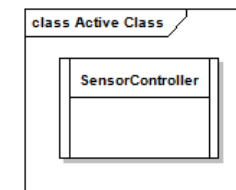
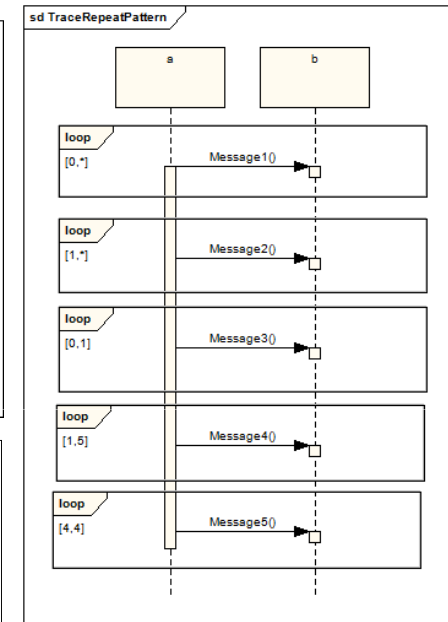
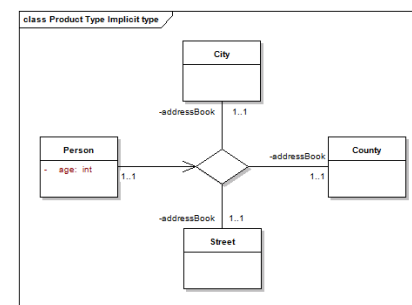
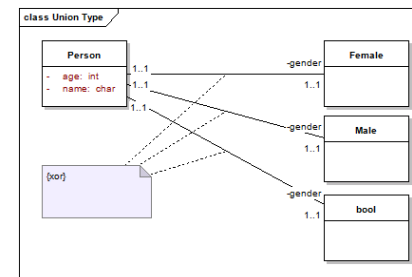
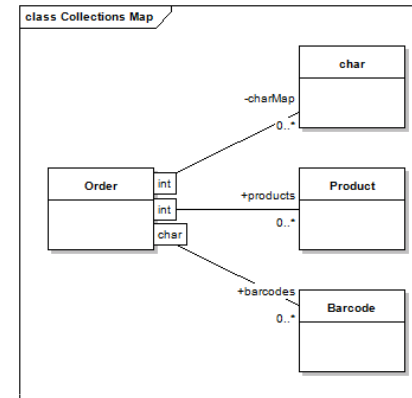
- Find mapping potential between:
 - VDM++ model and UML 2 Class Diagrams
 - VDM++ traces and UML 2 Sequence Diagrams
- Specify bidirectional mapping VDM / UML
 - Natural language
 - VDM++ specification
- Extend tool support for VDM++
 - Eclipse plug-in. Easy access / use.
 - Verify rules/specification

Main results

- Mapping potential:
 - Class Diagrams
 - Sequence Diagrams (VDM traces)
- Mapping specified
 - Rules
 - VDM specification around 6892 lines (~3200 hand written)
- Prototype for Eclipse (update site)
- Utility tools
 - Maven plug-in for VDM Tools
 - Eclipse plug-in /update site
 - XML parser/de-parser
 - etc.

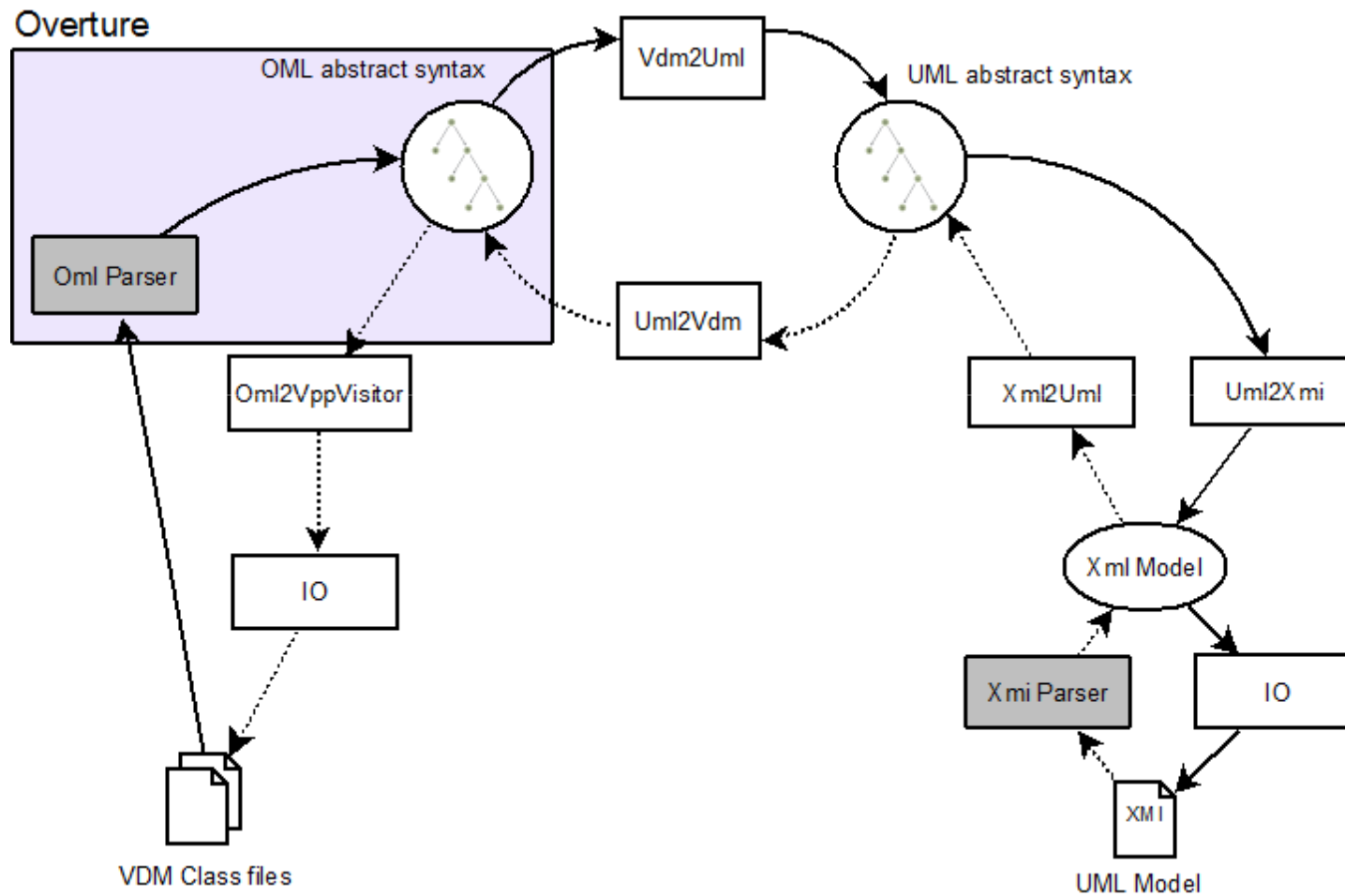
Main result - Supported features

Name (VDM)	Rule #	AST	VDM►UML	UML►VDM
Core				
Classes	1	X	X	X
Inheritance	14	X	X	X
Functions	17	X	X	X
Operations	17	X	X	X
Generic classes	16	X	X	-
Values	6, 5	X	X	X
Instance variables	6, 5	X	X	X
Initial value	7	X	X	X
Visibility	2	X	X	X
Thread	13	X	X	-
Abstract Class	15	X	X	-
Static Access	3	X	X	X
Types				
Product Types	10	X	X	X
Union Types	9	X	X	X
Record Types	-	-	-	-
Optional Types	5	X	X	-
Object Reference Types	5	X	X	X
Collections and Relationships				
map	12	X	X	-
set	11	X	X	(X)
seq	11	X	X	(X)
seq1	11	X	X	(X)
Traces				
Core Definition	18,19,20,24	X	-	X
Definition List	21	X	-	X
Choice Definition	22	X	-	X
Repeat Pattern	23	X	-	X
Bindings	-	-	-	-



Development

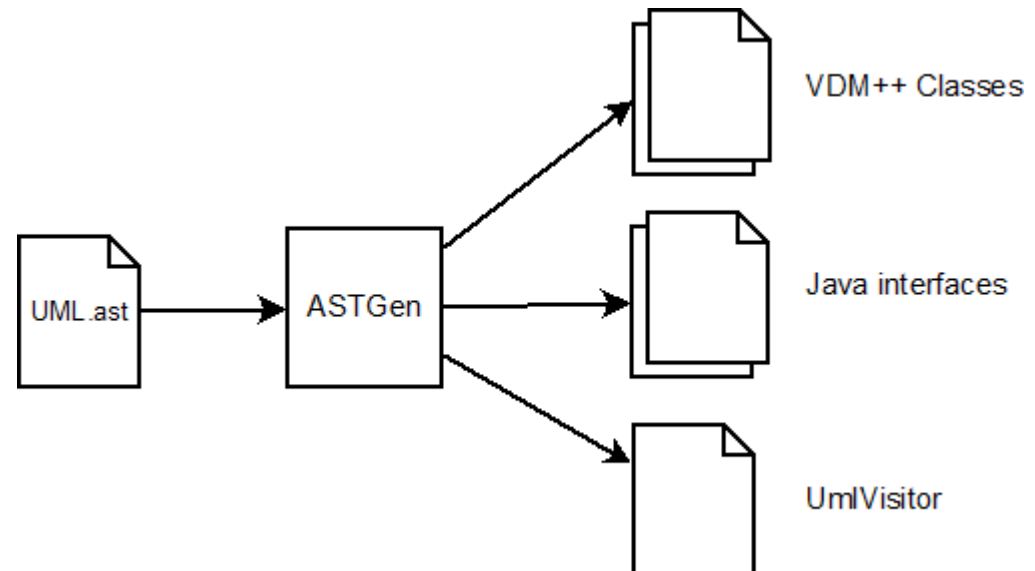
Main result - Specification Overview



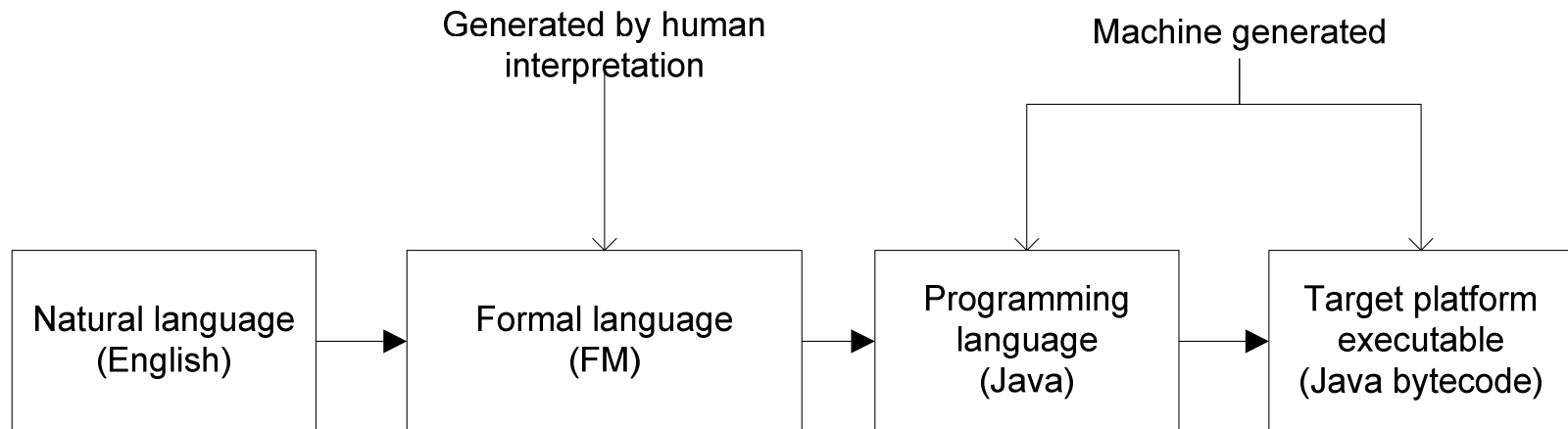
Abstract Syntax Tree

- Creation of the UML AST
- Use the overture tool ASTGen to:
 - Generate VDM++ Classes
 - Generate Java Interfaces
 - Generate a visitor for the UML AST
- Enables easy plug-in of new structures. No extensive changes.

```
%top Model;  
  
Model ::  
  name : String  
  definitions : set of ModelElement;  
  
ModelElement = Class | Association |  
              Constraint | Collaboration;  
  
Class ::  
  name : String  
  classBody : set of DefinitionBlock  
  isAbstract : bool  
  superClass : seq of ClassNameType  
  visibility : VisibilityKind  
  isStatic : bool  
  isActive : bool  
  templatesignature : [TemplateSignature];  
  
VisibilityKind = <PUBLIC> | <PRIVATE> | <PROTECTED> ;
```



Text – VDM – Java



- Loose
- Room for interpretation

- Formal description
- Abstract
- Precise
- Proof

- Precise semantic
- Complex
- Detailed

- Not for humans

Code generation

Name	AST level		VDM model		Java source	
	Size (kB)	Lines	Size (kB)	Lines	Size (kB)	Lines
UML.ast	5.262	212	89.767	3556	287.769	9.921
Vdm2Uml.tex			21.684	533	55.728	1.550
Vdm2UmlType.tex			5.172	166	13.341	362
Uml2XmiEAXml.tex			19.391	622	53.992	1.498
Uml2Vdm.tex			26.416	609	76.173	2.128
Xml2UmlModel.tex			24.005	558	82.828	2.306
StdLib.vpp			4.260	143	13.106	359
Oml2Vpp.tex			412	24	1.631	61
Oml2VppVisitor.tex			19.636	681	59.055	1.678
external_IO.java					3.653	131
MainClass.java					2.787	118
Translator.java					2.863	96
XmlParser.java					2.947	99
ClassExtractor- FromTexFiles.java					1.621	65
Total			210.743	6.892	657.494	20.372

Table 8.1: Measure of model size on AST, VDM and Java level.

Demo

Demo

- VDM++ class file
- Eclipse
- Enterprise Architect
- UML XMI file

VDM class file: N-ary association

```
class A
```

```
instance variables
```

```
att1 : seq of B * C * D;
```

```
att2NoAssociation : nat := 0;
```

```
end A
```

```
class B
```

```
end B
```

```
class C
```

```
end C
```

```
class D
```

```
end D
```

Eclipse

The screenshot displays the Eclipse IDE interface with the following components:

- Main Editor:** Shows the VDM file `ClassAssociationN.vpp` with the following code:

```
1  
2 class A  
3  
4 instance variables  
5  
6 att1 : seq of B * C * D;  
7 att2NoAssociation : nat := 0;  
8 end A  
9  
10 class B  
11 end B  
12  
13 class C  
14 end C  
15  
16 class D  
17 end D  
18  
19  
20 end D  
21
```
- Open Dialog:** A file selection dialog is open, showing the `src` directory. The file `ClassAssociationN.vpp` is selected. The file list is as follows:

Name	Date modified	Type
<input checked="" type="checkbox"/> ClassAssociationN	11-12-2008 01:09	VPP File
<input type="checkbox"/> ClassInheritance.tex	11-12-2008 01:09	VPP File
<input type="checkbox"/> ClassInheritance.tex.xml	13-01-2009 00:35	VPP File
<input checked="" type="checkbox"/> ClassWithMalIlllp.vpp.xml	11-12-2008 01:09	VPP File
<input checked="" type="checkbox"/> ClassWithMap	11-12-2008 01:09	VPP File
- Toolbar:** A callout box highlights the `Generate UML model from VDM files` button in the toolbar.
- Message Dialog:** A dialog box titled `Vdm 2 Uml` displays the message: `Processing completed: C:\COMU\Source\umltrans\src\TestClasses\ClassAssociationN.vpp.xml` with an `OK` button.

Enterprise Architect

The screenshot displays the Enterprise Architect interface. The main workspace shows a UML class diagram with four classes: A, B, C, and D. Class A is associated with a central diamond-shaped element (likely a package or interface) with a multiplicity of 1..1 and an association name of -att2NoAssociation: int = 0. Class B is associated with the diamond with a multiplicity of 0..* and an association name of -att1. Class C is associated with the diamond with a multiplicity of 1..1 and an association name of -att1. Class D is associated with the diamond with a multiplicity of 1..1 and an association name of -att1. The Project Browser on the right shows a tree structure under 'Model' containing 'VDM Generated model', 'A', 'B', 'C', 'D', 'NotSupportedType', 'String', 'bool', 'char', 'int', and 'unlimitedNatural'. An 'Import Package from XMI' dialog box is open in the foreground, showing the following details:

- Root Package: Model
- Filename: C:\COMU\Source\umltrans\src\TestClasses\ClassAssociationN.vpp.xml
- Options:
 - Import Diagrams
 - Strip GUID's
 - Write Log file
 - Treat Imported Datatypes as: [Dropdown menu]
- Buttons: Import EMX / UML2 Files, View XML, Import, Close, Help
- XMI Import Progress: [Progress bar]

XMI file: N-ary association

```
<ownedMember isAbstract="false" isActive="false" isLeaf="false" name="A" visibility="public" xmi:id="VDM.9" xmi:type="uml:Class">
  <ownedAttribute name="att2NoAssociation" ownerScope="instance" isReadOnly="false" isStatic="false" visibility="private" xmi:id="VDM.13" xmi:type="uml:Property" isOrdered="false">
    <lowerValue value="1" xmi:id="VDM.14" xmi:type="uml:LiteralInteger"/>      <upperValue value="1" xmi:id="VDM.15" xmi:type="uml:LiteralInteger"/>
    <defaultValue xmi:type="uml:LiteralString" xmi:id="VDM.16" value="0"/>      <type xmi:idref="VDM.4"/>
  </ownedAttribute>
</ownedMember>

<ownedMember isAbstract="false" isActive="false" isLeaf="false" name="D" visibility="public" xmi:id="VDM.10" xmi:type="uml:Class"/>
<ownedMember isAbstract="false" isActive="false" isLeaf="false" name="B" visibility="public" xmi:id="VDM.11" xmi:type="uml:Class"/>
<ownedMember isAbstract="false" isActive="false" isLeaf="false" name="C" visibility="public" xmi:id="VDM.12" xmi:type="uml:Class"/>
<ownedMember isAbstract="false" isDerived="false" isLeaf="false" name="" xmi:id="VDM.17" xmi:type="uml:Association">
  <ownedEnd aggregation="none" association="VDM.17" isNavigable="true" name="" visibility="private" xmi:id="VDM.18" xmi:type="uml:Property" isOrdered="false" isStatic="false">
    <lowerValue value="1" xmi:id="VDM.19" xmi:type="uml:LiteralInteger"/>      <upperValue value="1" xmi:id="VDM.20" xmi:type="uml:LiteralInteger"/>      <type xmi:idref="VDM.9"/>
  </ownedEnd>
<memberEnd xmi:idref="VDM.18"/>
  <ownedEnd aggregation="none" association="VDM.17" isNavigable="false" name="att1" visibility="private" xmi:id="VDM.21" xmi:type="uml:Property" isOrdered="false">
    <lowerValue value="1" xmi:id="VDM.22" xmi:type="uml:LiteralInteger"/>      <upperValue value="1" xmi:id="VDM.23" xmi:type="uml:LiteralInteger"/>      <type xmi:idref="VDM.12"/>
  </ownedEnd>
<memberEnd xmi:idref="VDM.21"/>
  <ownedEnd aggregation="none" association="VDM.17" isNavigable="false" name="att1" visibility="private" xmi:id="VDM.24" xmi:type="uml:Property" isOrdered="true">
    <lowerValue value="0" xmi:id="VDM.25" xmi:type="uml:LiteralInteger"/>      <upperValue value="" xmi:id="VDM.26" xmi:type="uml:LiteralString"/>      <type xmi:idref="VDM.11"/>
  </ownedEnd>
<memberEnd xmi:idref="VDM.24"/>
  <ownedEnd aggregation="none" association="VDM.17" isNavigable="false" name="att1" visibility="private" xmi:id="VDM.27" xmi:type="uml:Property" isOrdered="false">
    <lowerValue value="1" xmi:id="VDM.28" xmi:type="uml:LiteralInteger"/>      <upperValue value="1" xmi:id="VDM.29" xmi:type="uml:LiteralInteger"/>      <type xmi:idref="VDM.10"/>
  </ownedEnd>
<memberEnd xmi:idref="VDM.27"/>
</ownedMember>
```