Recent achievements in automated database design based on business process models

D. Banjac, D. Brdjanin and G. Banjac

University of Banja Luka, Bosnia & Herzegovina

About this presentation

- **Introduction**
- **Domain specific languages**
  - Examples of DSLs
- **Business modeling language**
  - Implementation
  - Approach
  - Metamodel
- **Example of automated generation of CDM**
- **Conclusion**

Introduction

- There are papers that present automated generation of the initial **conceptual database model** (CDM) based on different business process modeling notations
- **Source**: **Business process model** (BPM) represented by different business process modeling notations (UML activity diagram, BPMN, etc.)
- **Target**: CDM represented by UML class diagram
- In order to achieve **metamodel independency** we implemented **Domain specific language** (DSL) as **intermediate layer**, between source and target model

Domain specific languages

- "*Domain Specific Language (DSL) is a computer programming language of limited expressiveness focused on a particular domain.*" (Martin Fowler)
- **Domain** - an area or sphere of knowledge, influence, or activity
- Two main forms:
  - **External DSL** (*free standing*) – language parsed independently of the host general purpose language (GPL), e.g. regular expressions, CSS
  - **Internal DSL** (*embedded*) – designed and implemented using GPL, particular form of API in a host GPL, e.g. JMock
- Each DSL consists of:
  - **Abstract syntax** – defines domain concepts, their attributes and relations
  - **Concrete syntax** – language syntax in its representation that we see
  - **Semantics** – usually added with interpretation or code generation

Example of DSLs

- **Regular expressions, SQL, CSS, make, rake, ant, BPMN etc.**

```
/^([a-z0-9_\.-]+)@([\da-z\.-]+)\.([a-z\.]{2,6})$/
```

```
SELECT * FROM Course c WHERE c.ECTS > 6;
```

```
body {
   background-color: lightblue;
}
h1 {
   color: white;
   text-align: center;
}
p {
   font-family: verdana;
   font-size: 20px;
}
```

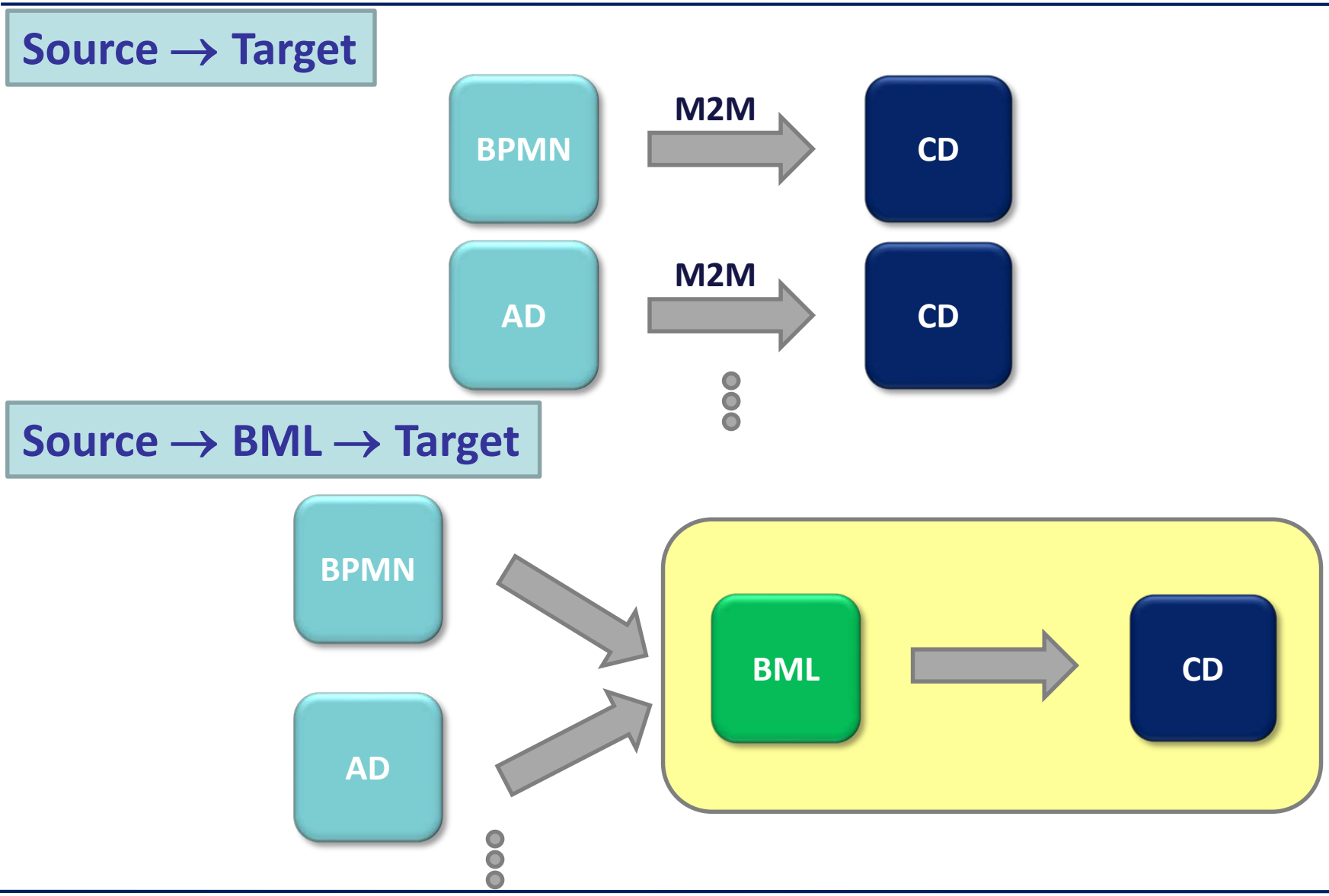
```
hellomake: hellomake.c hellofunc.c
    gcc -o hellomake hellomake.c hellofunc.c -I.
```

```
<project name="AnExampleProject" default="jarit"
    basedir=".">
<property name="src" location="src"/>
<property name="build" location="build"/>
<property name="distrib" location="distrib"/>
<target name="compile" description="compile
    your Java code from src into build" >
<javac srcdir="${src}" destdir="${build}"/>
</target>
<target name="jarit" depends="compile"
    description="jar it up" >
<jar jarfile="${distrib}/AnExampleProject.jar"
    basedir="${build}"/>
</target>
</project>
```

Implementation of BML

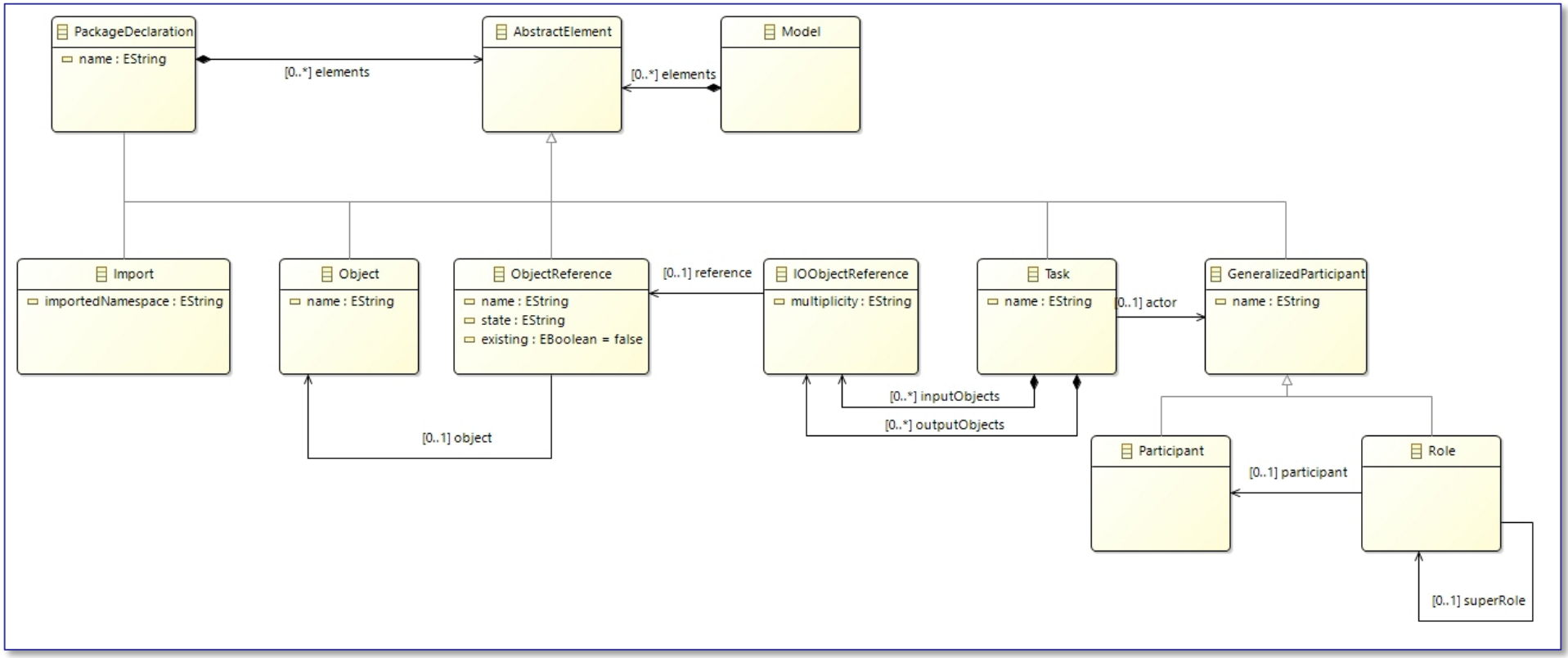
- DSL called **business modeling language** (BML) is developed
- BML describes (so far identified) **semantic capacity** of the business process models
- BML provides **independency** from different business process modeling notations used for modeling the source model
- Identified **transformation rules** were used to implement generator which transforms BML to initial CDM
- We used **Xtext** framework for implementation of DSL
- We used **Xtend** for code generation
- We, also, implemented generators to transform BPM represented by BPMN and UML activity diagram to BML (**Acceleo** implementation)

Approach


Source → Target
BPMN
M2M
CD
AD
M2M
CD
Source → BML → Target
BPMN
AD
BML
CD

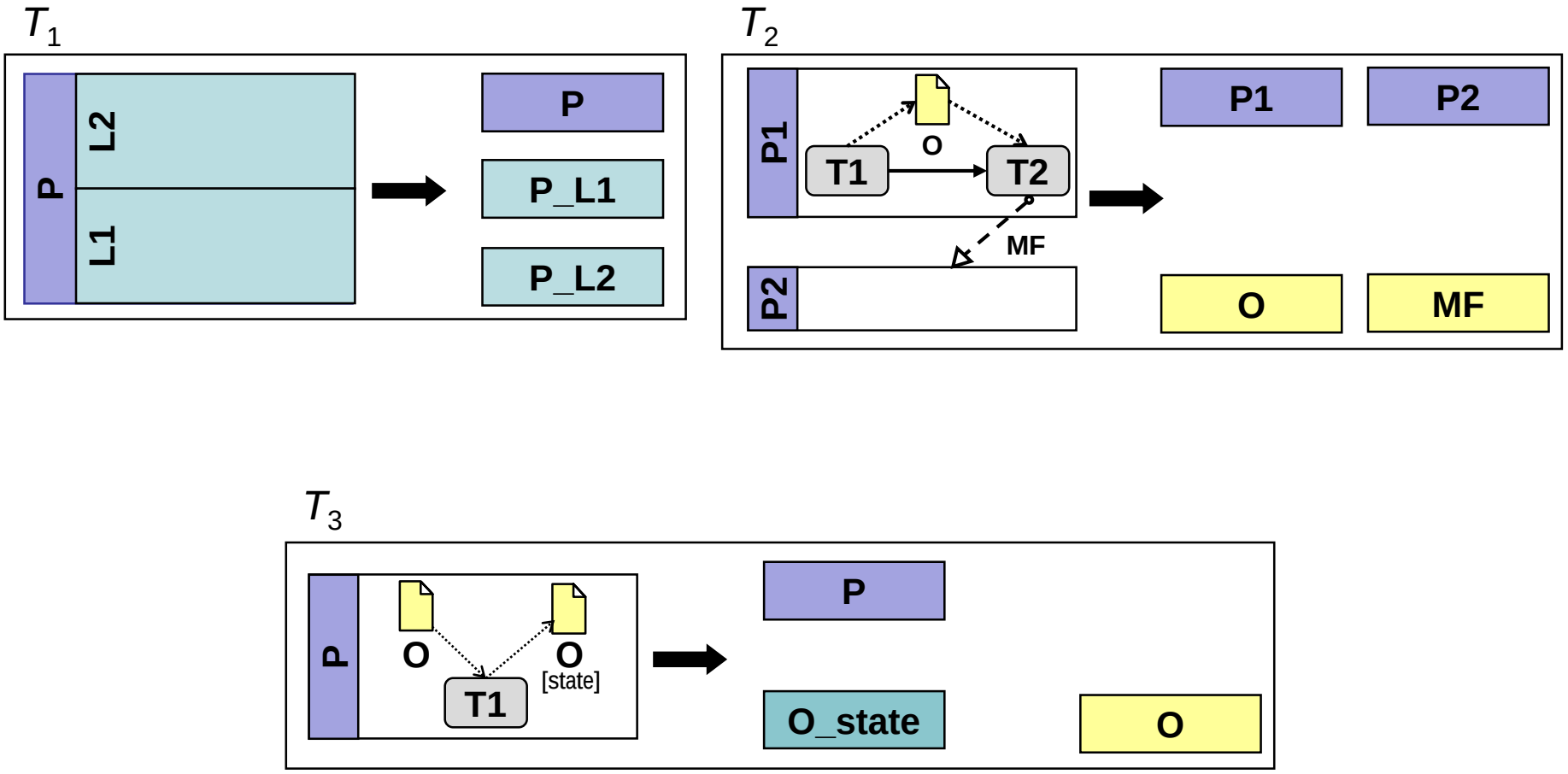
Metamodel of BML

- **Abstract syntax tree (AST) is represented by Ecore model**



Rules for mapping BPM → CDM

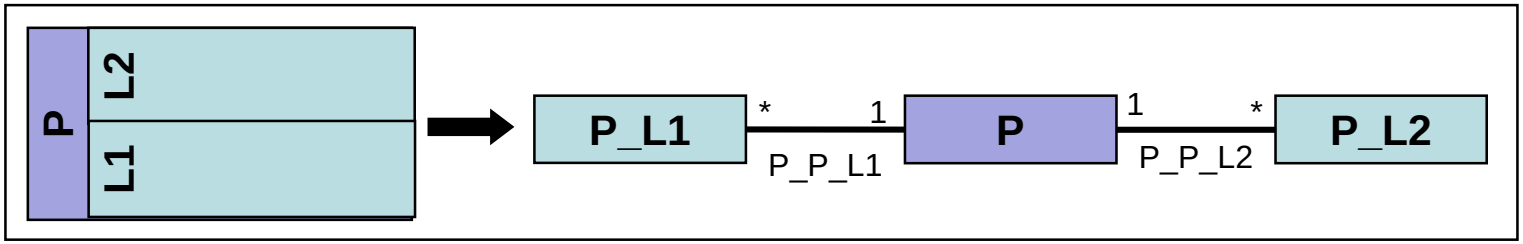
Classes



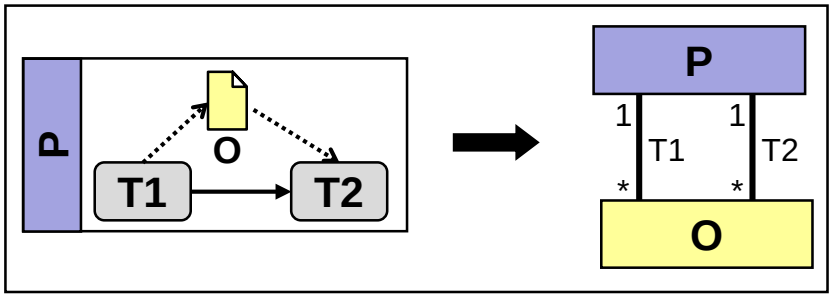
Rules for mapping BPM → CDM

Associations

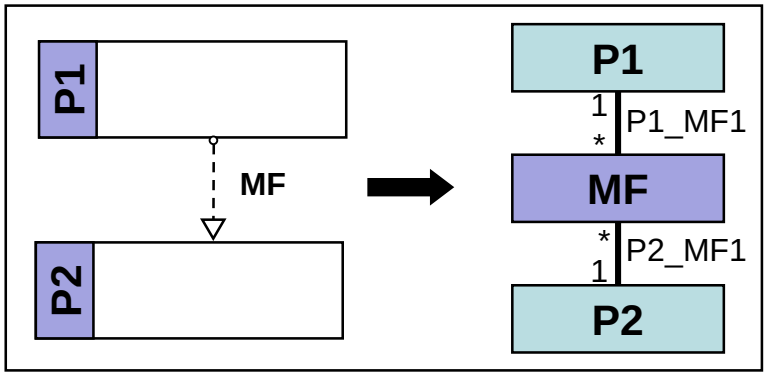
T_4



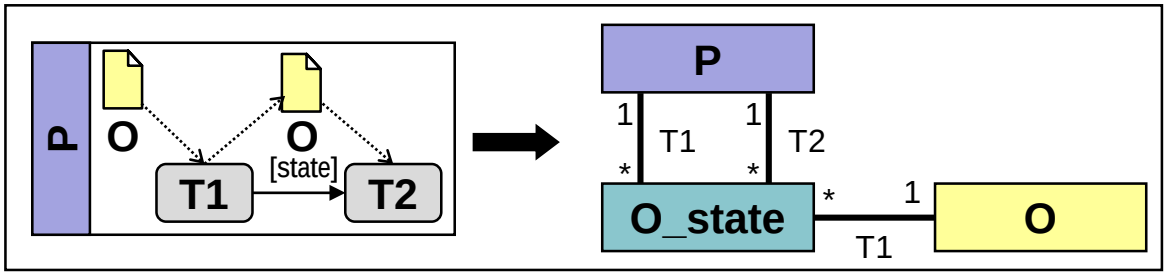
T_5



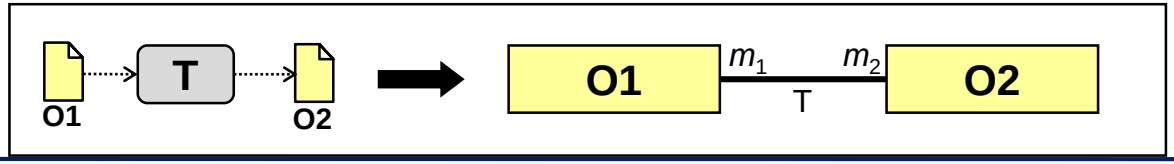
T_6



T_7
T_8

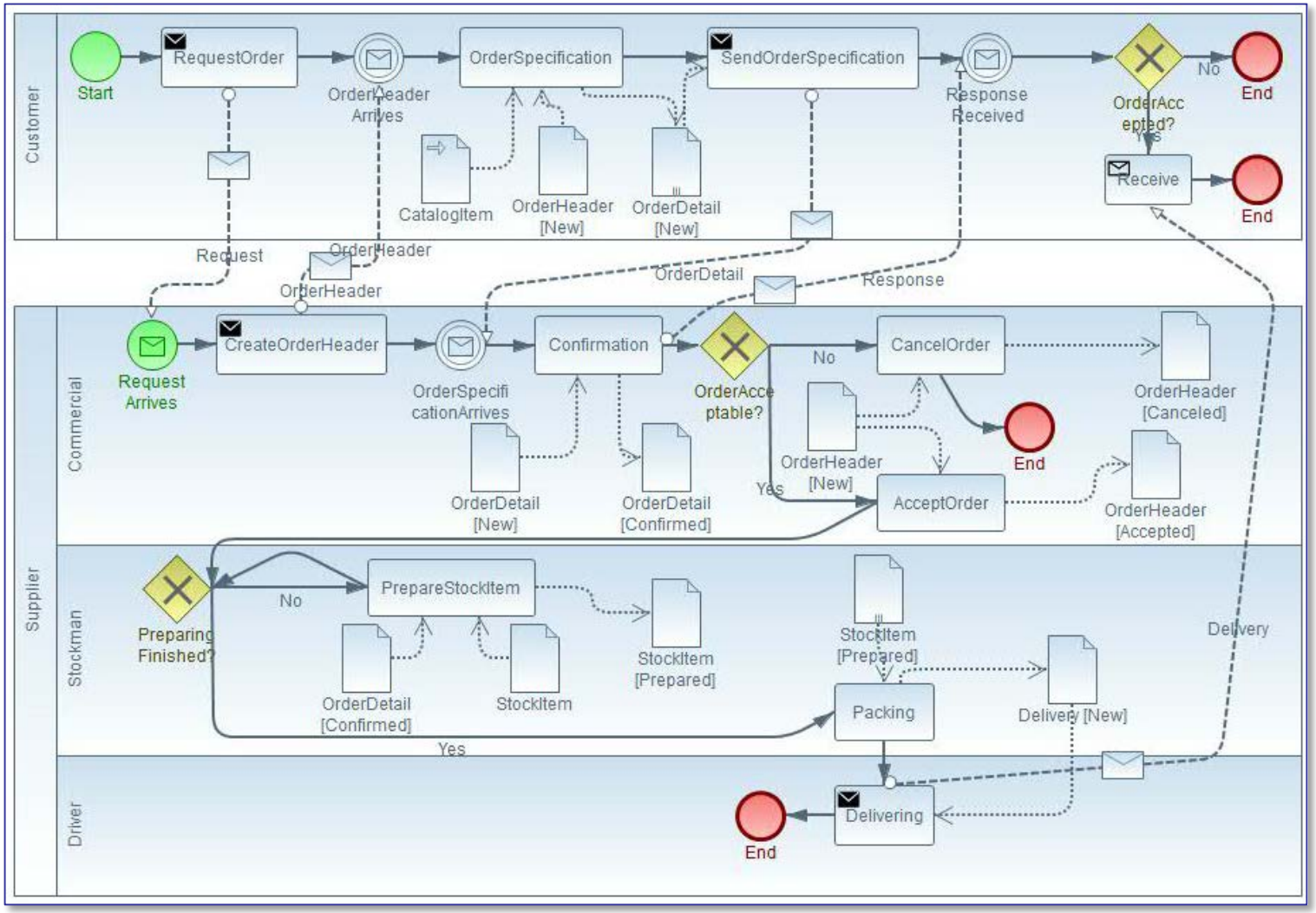


T_9



Source model

- **Order processing - BPMN**



BML

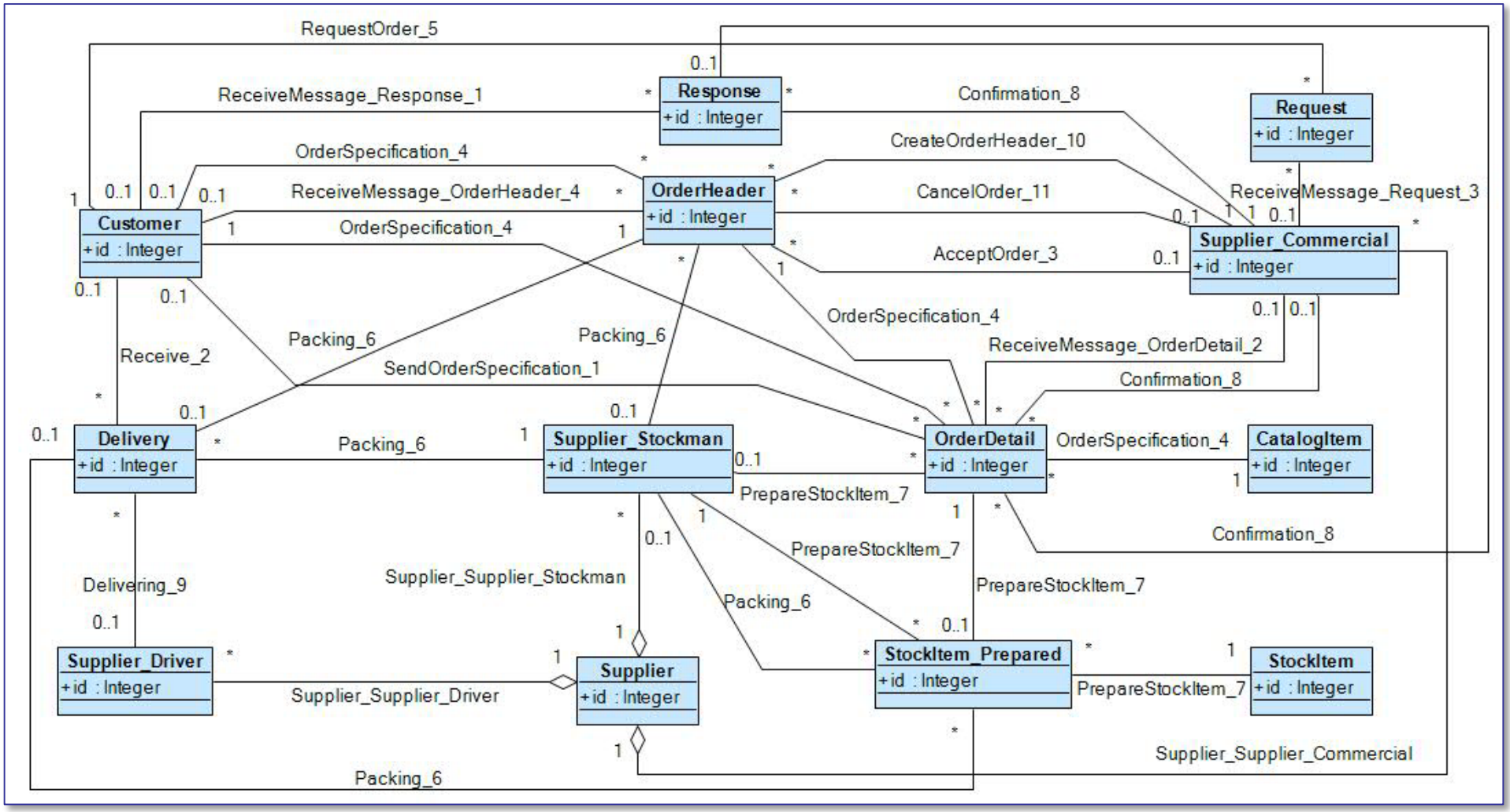
- **Order processing - BPMN**

```
/* Participants and roles */
participant Supplier
role Stockman of Supplier
role Driver of Supplier
role Commercial of Supplier
participant Customer

/* Objects */
object OrderHeader
object Response
object CatalogItem
object Delivery
object Request
object StockItem
object OrderDetail

/* ObjectReference */
objectReference ExistingStockItem_ references StockItem existing
objectReference ExistingCatalogItem_ references CatalogItem existing

objectReference OrderHeader_ references OrderHeader
objectReference Delivery_New references Delivery[New]
objectReference OrderDetail_New references OrderDetail[New]
objectReference StockItem_Prepared references StockItem[Prepared]
objectReference OrderHeader_Accepted references OrderHeader[Accepted]
objectReference OrderHeader_New references OrderHeader[New]
objectReference OrderHeader_Canceled references OrderHeader[Canceled]
objectReference OrderDetail_Confirmed references OrderDetail[Confirmed]
....
```

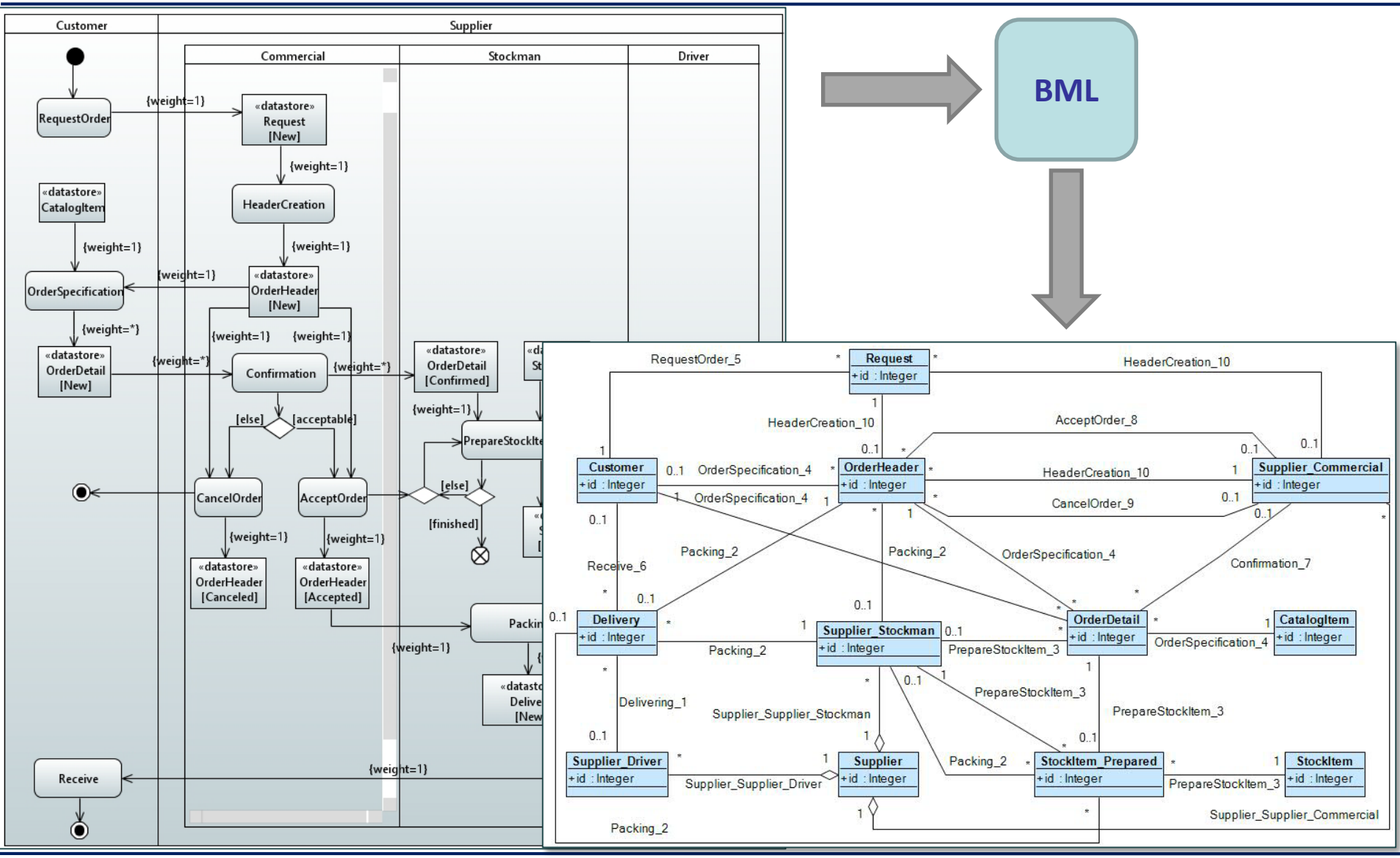
```
/* Tasks  */
task SendOrderSpecification_1 {
   actor: Customer
   input {
      OrderDetail_New multiplicity -1
   }
   output {
      OrderDetail_ multiplicity -1
   }
}

task Receive_2 {
   actor: Customer
   input {
       Delivery_ multiplicity 1
   }
   output {
   }
}

task AcceptOrder_3 {
   actor: Commercial
   input {
      OrderHeader_New multiplicity 1
   }
   output {
      OrderHeader_Accepted multiplicity 1
   }
}
...
```

Target model

- **Order processing - BPMN**

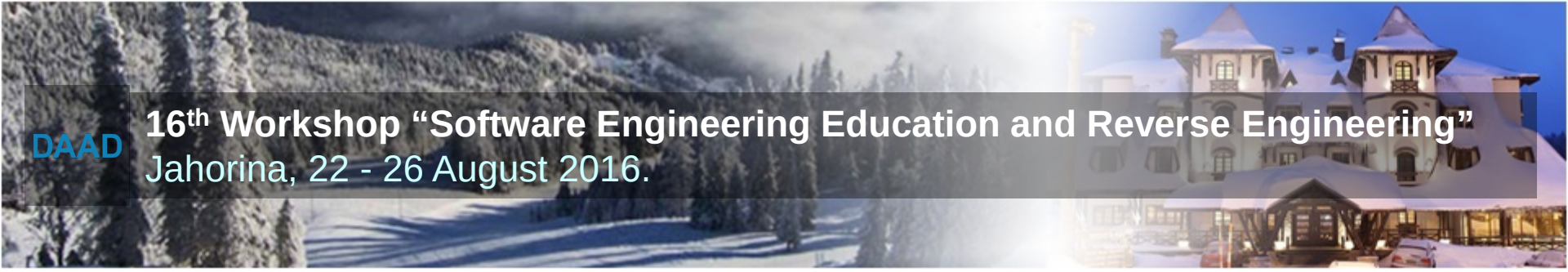


Order processing – Activity diagram



Conclusion

- BML provides source model **independency**
- Potential changes in transformation rules will affect BML → CD generator, while generators which transform concrete business process modeling notations will remain unchanged
- Generation of the target conceptual model with a high percentage of **completeness** and **precision**
- In the future we plan to:
  - further identify the semantic capacity of BPMs for automated CDM design
  - improve the BML accordingly to identification of the semantic capacity of BPMs
  - implement generators for some other business process modeling notations



D. Banjac, D. Brdjanin and G. Banjac

University of Banja Luka, Bosnia & Herzegovina

Recent achievements in automated database design based on business process models

Thank You!