Towards Synchronizing Relations Between Artifacts in the Java Technological Space

Author: William Bombardelli da Silva
Advisor: Dr.-Ing. Frank Trollmann

Technische Universität Berlin
Fakultät IV Elektrotechnik und Informatik
Bachelorstudiengang Informatik

wbombardellis@win.tu-berlin.de

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Organization

Background

Models are used in Software Engineering

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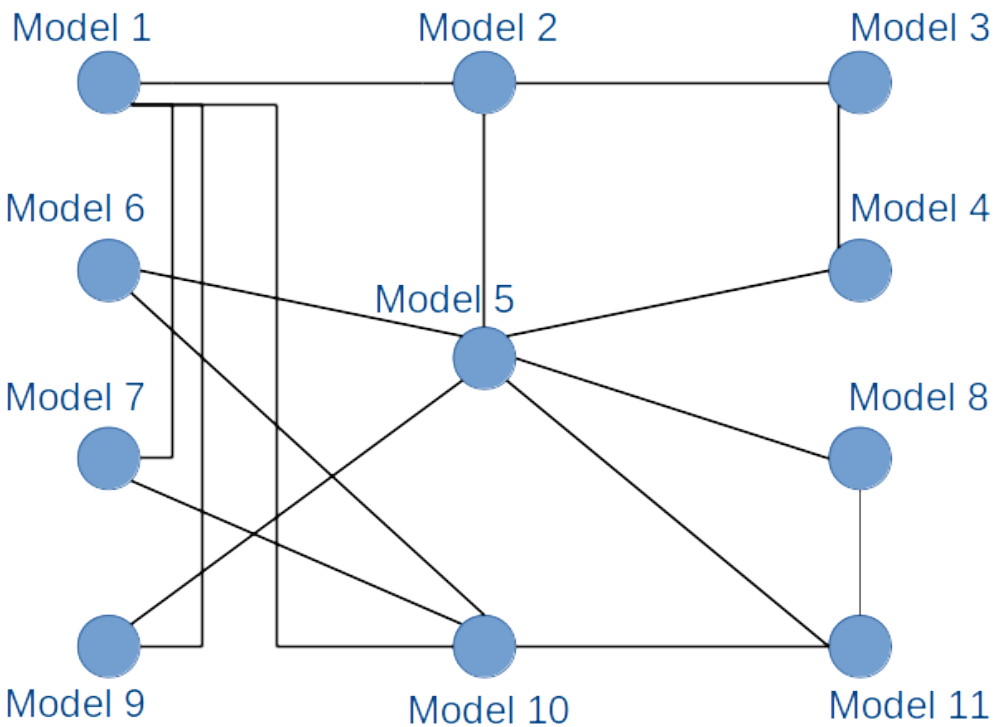
- New needs in industry thrill new methods and paradigms.
- **Model-driven Engineering (MDE):** Software processes are oriented to models.
- One software may have several different models.

Models have to be kept consistent



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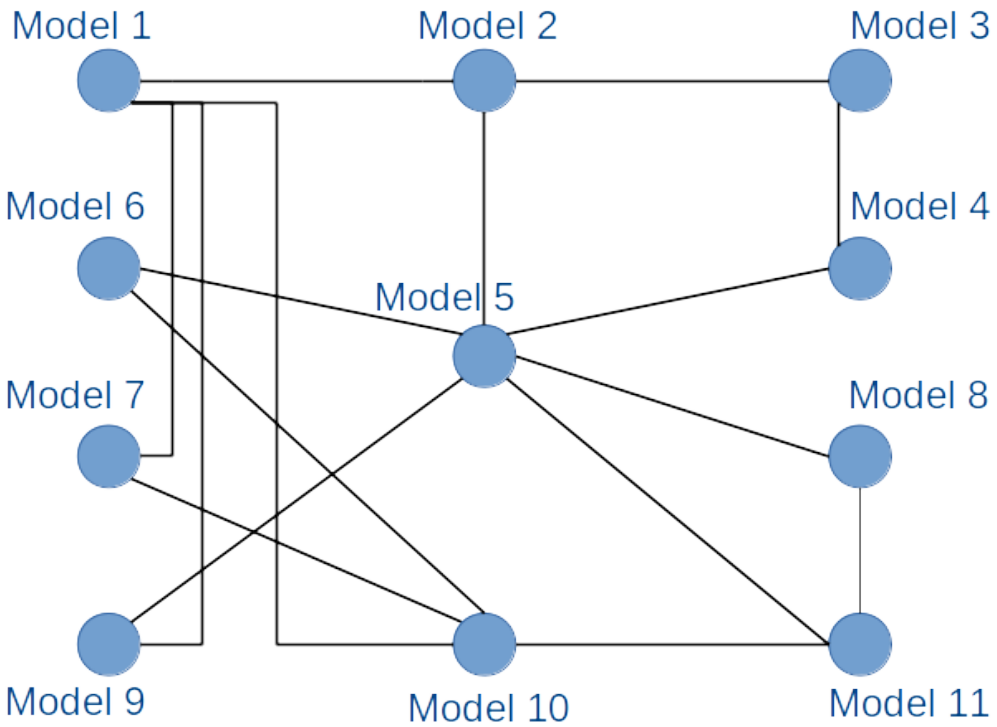

- Models are to be maintained consistent as they evolve.
- This means **models synchronization**.

Model Synchronization in the Network of Models

- For each edge of the network there is a synchronization task.

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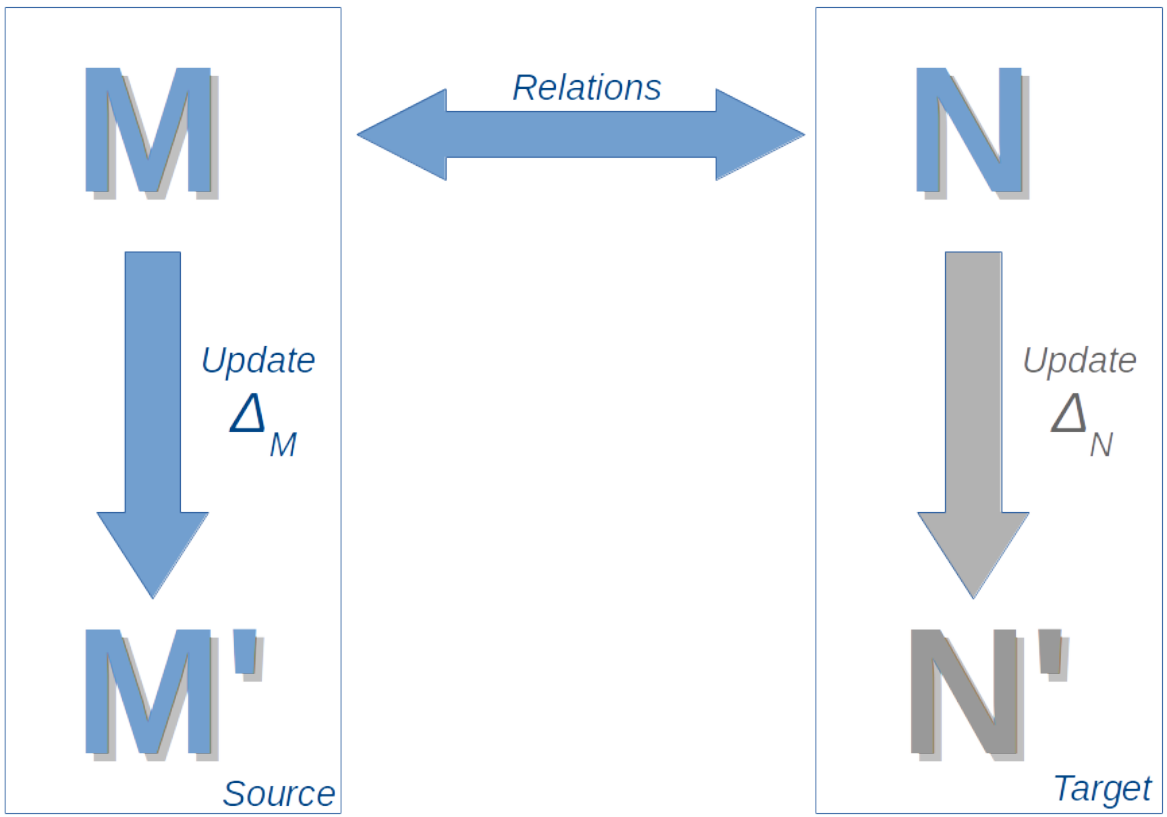
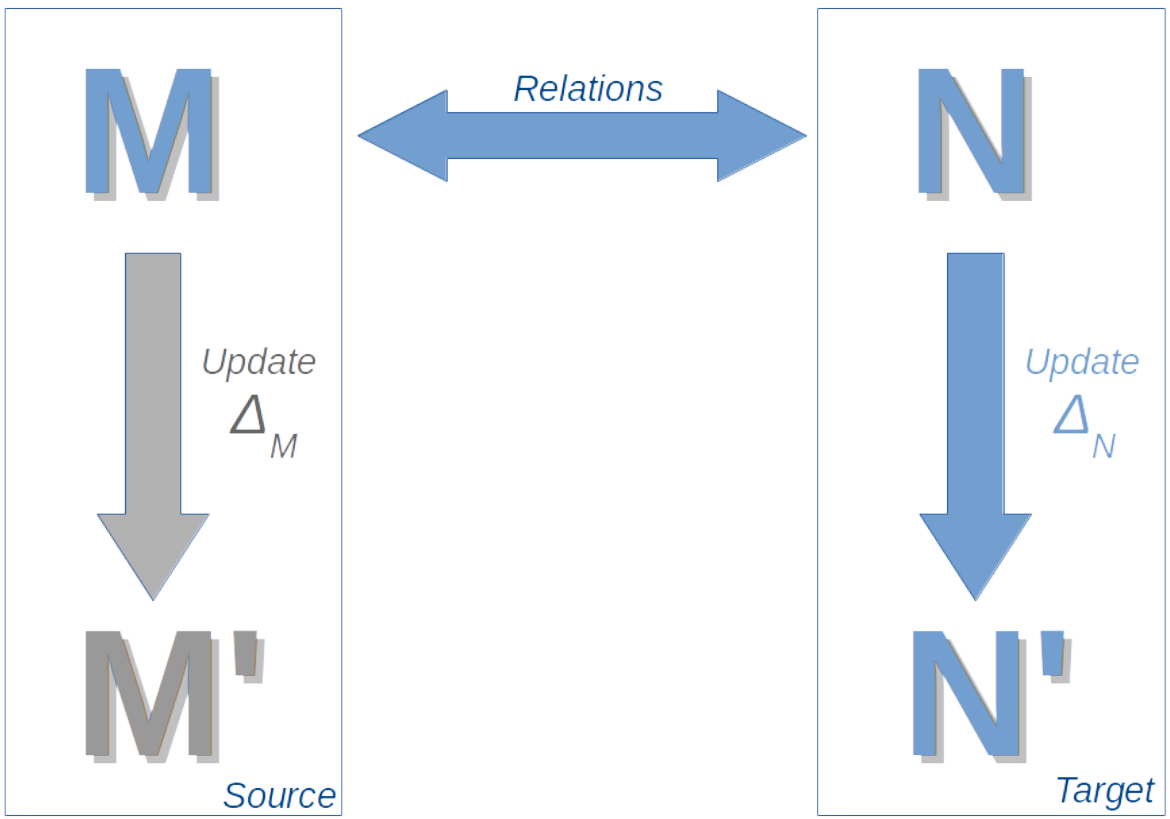
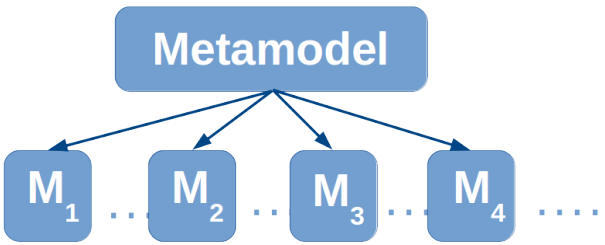


Model Synchronization in the Network of Models

- For each edge of the network there is a synchronization task.



Relations are written between metamodels



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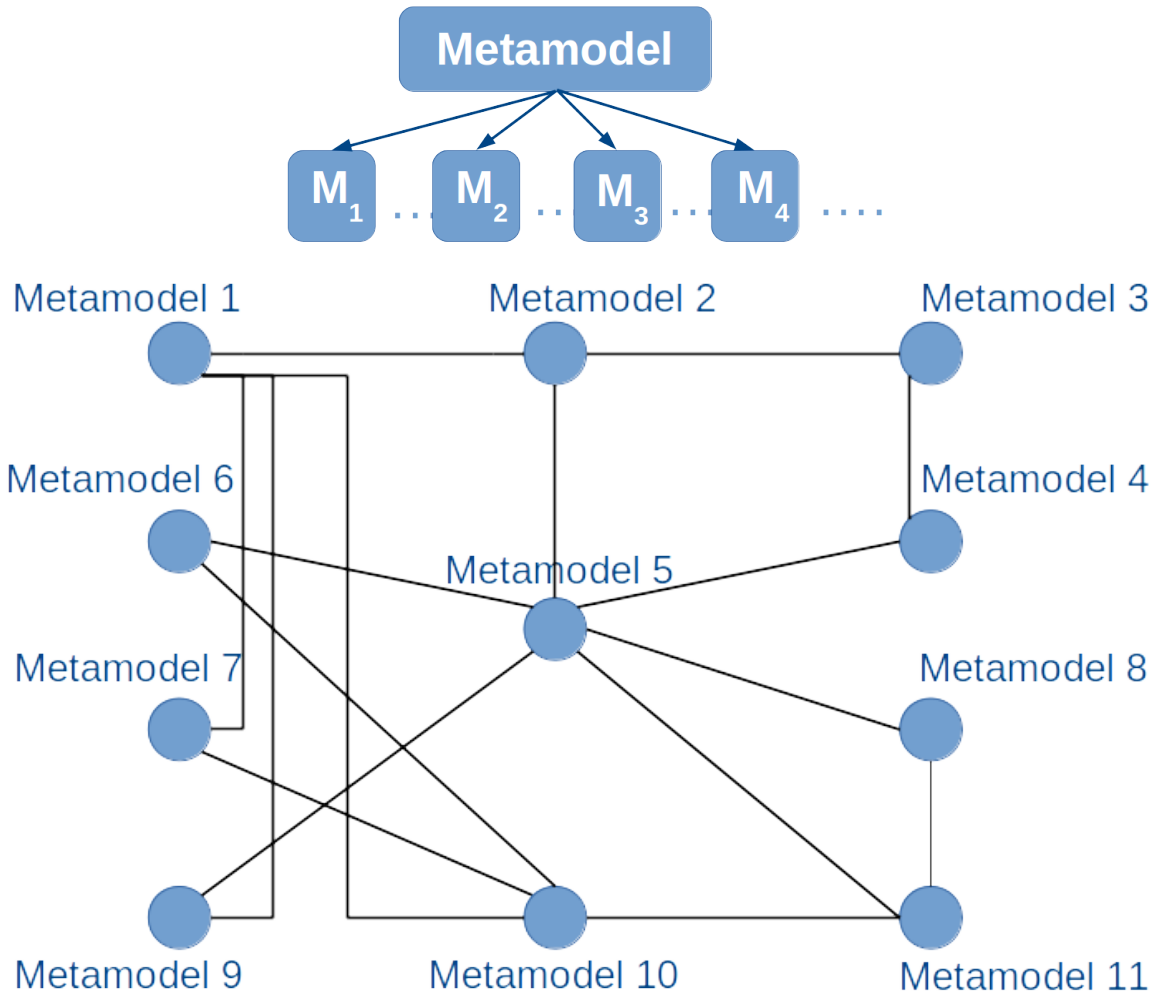

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- Definitions of the **metamodels** in literature
- Definitions of the **relations** in literature
- Approach able to treat synchronization of **complex technological spaces** with a large number of **tangled** metamodels.

Objective

Three Steps

- Focus on the Java technological space.

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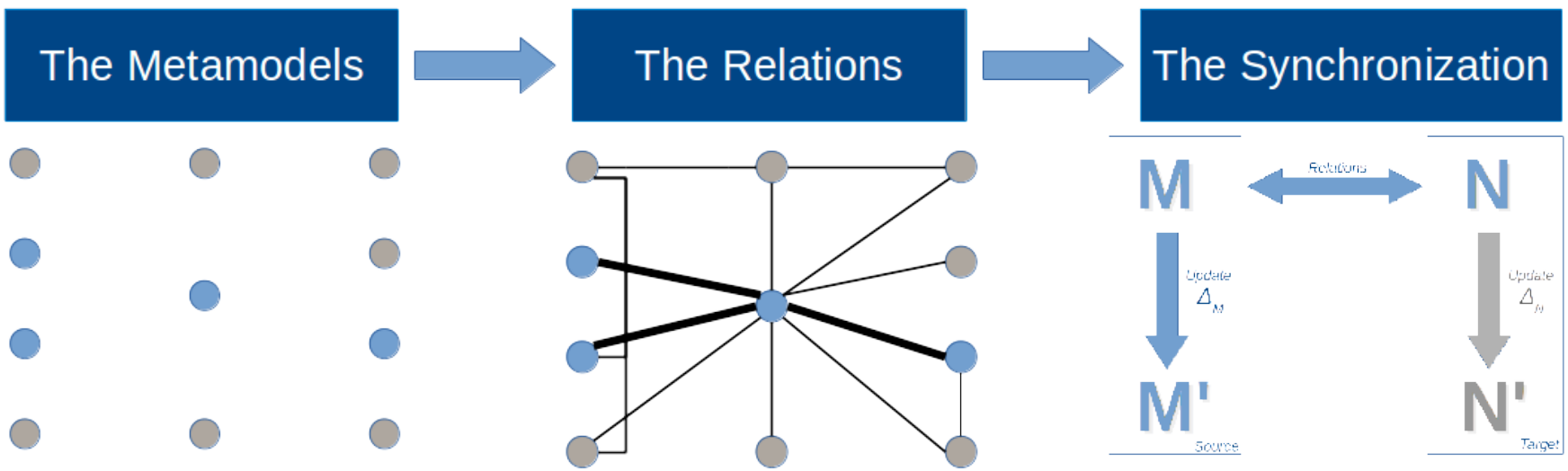
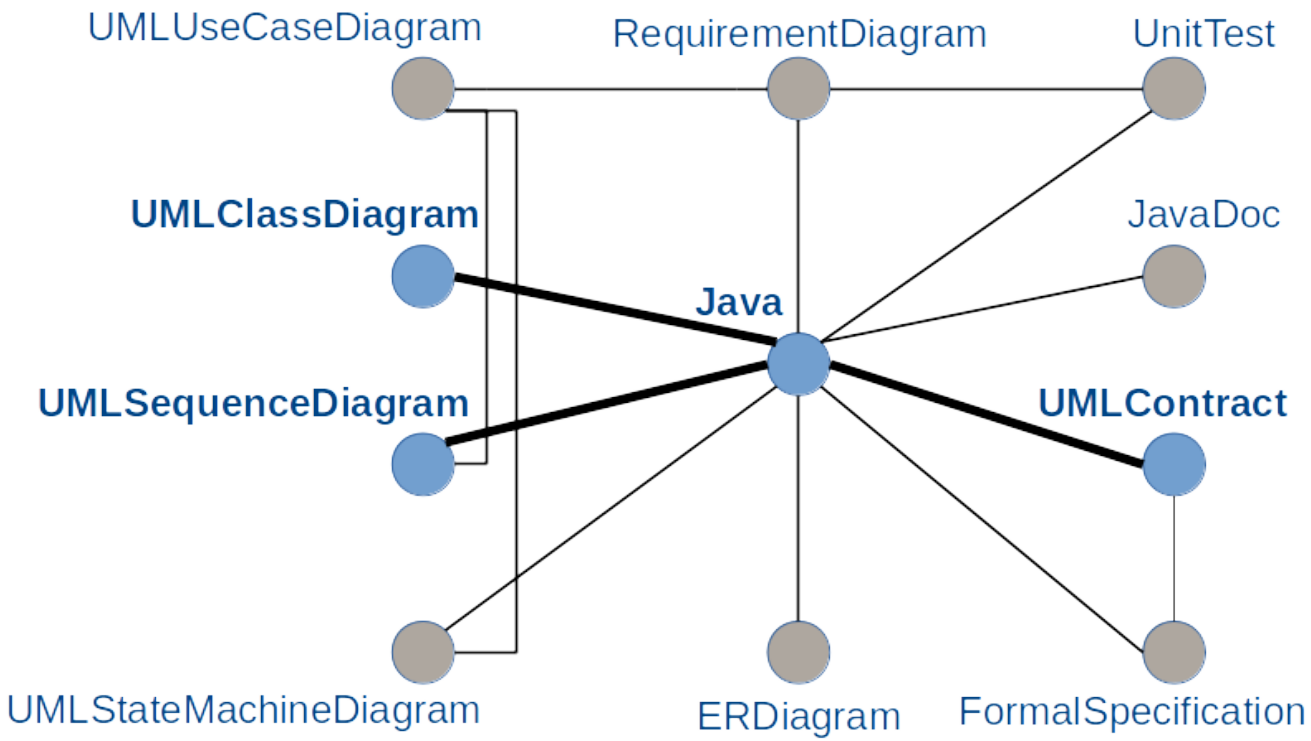
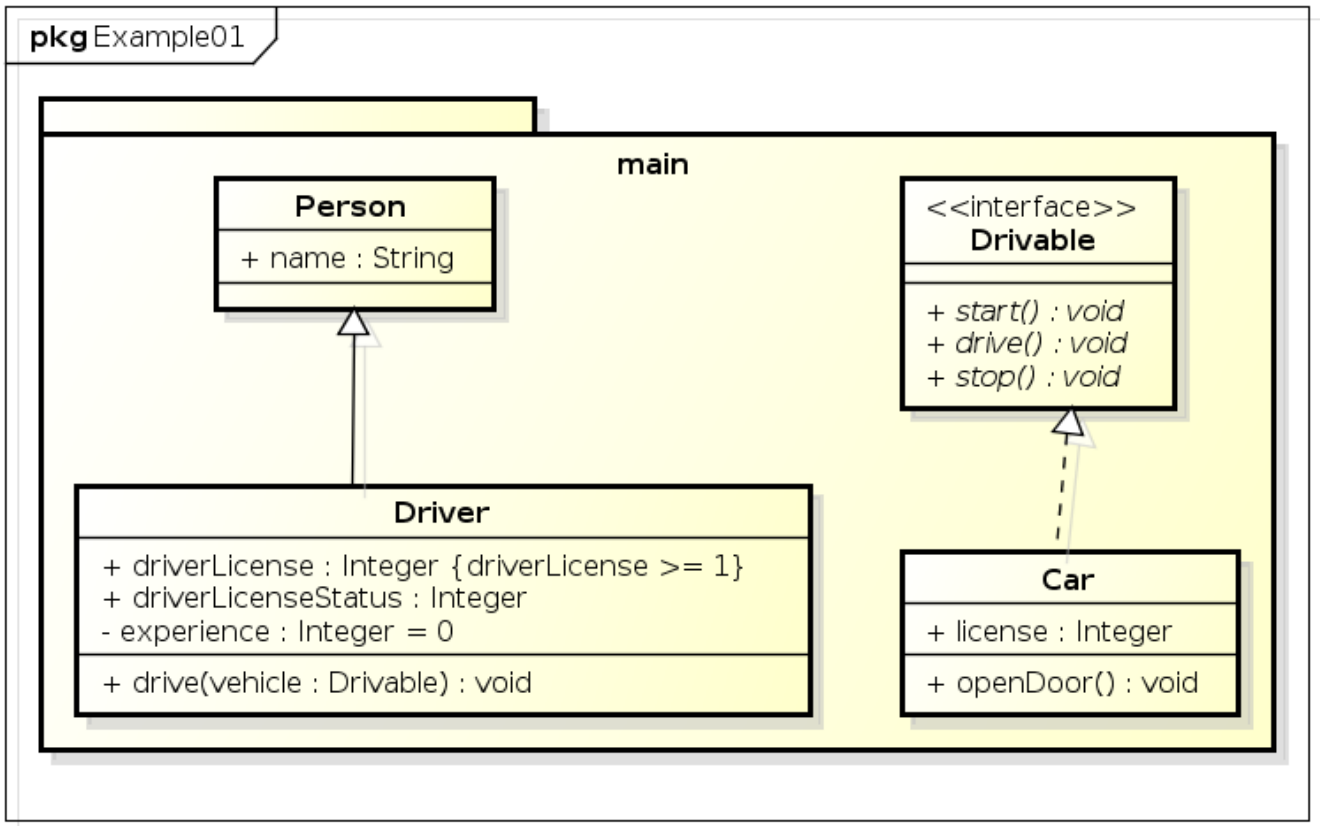


The Metamodels

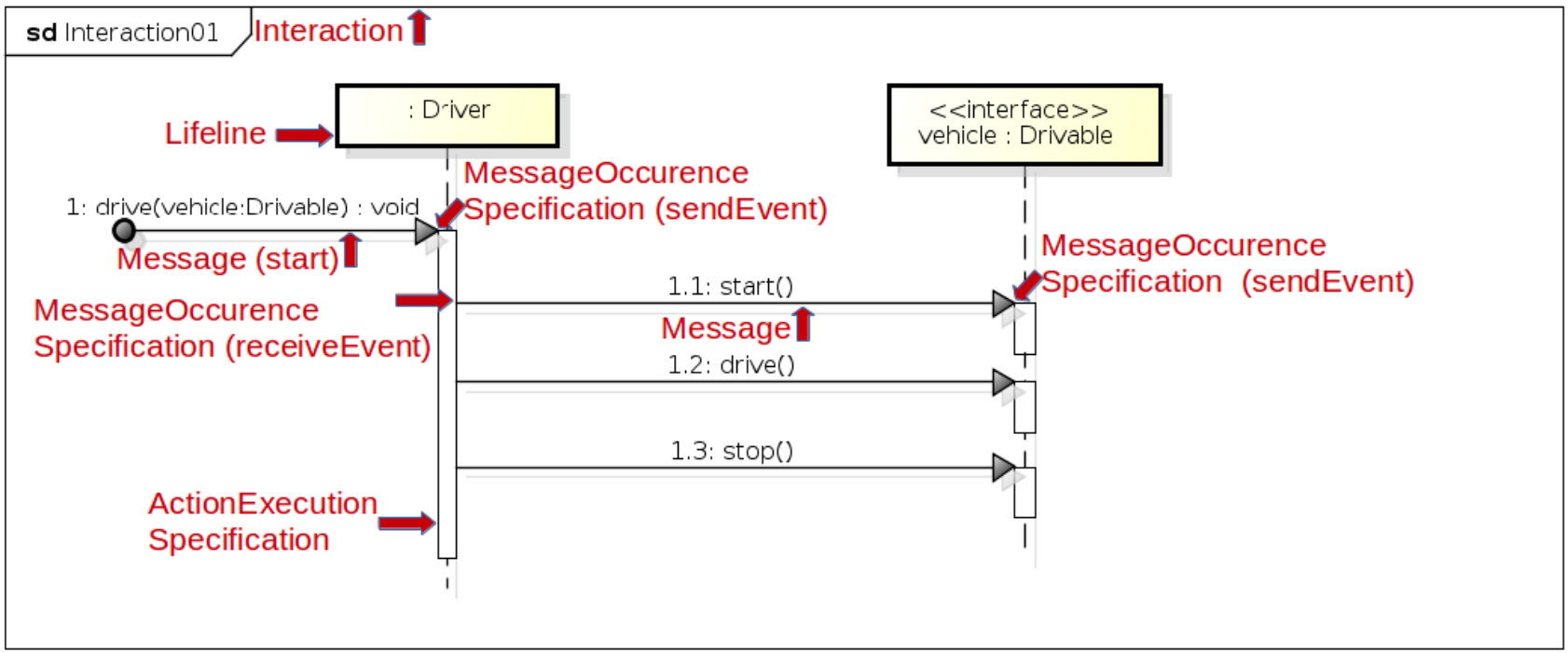
Some Metamodels of the Java Technological Space



UMLClassDiagram Concrete Syntax Example



UMLSequenceDiagram Concrete Syntax Example



UMLContract

- No concrete syntax defined
- Constraints (pre or postcondition or invariant) related to Properties or Operations
  - Opaque Expression (textual definition)
  - Interval

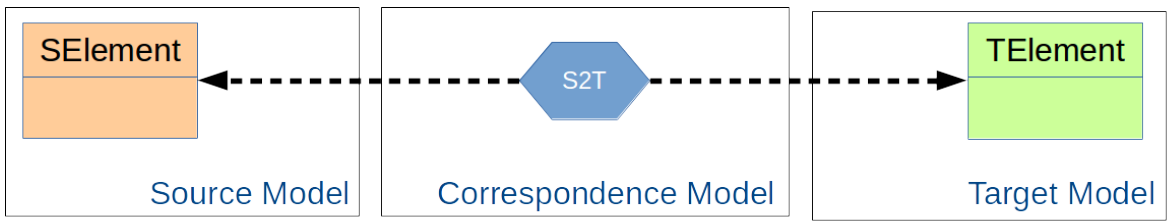
Java Concrete Syntax Example

```java
package main;

import de.silvawb.utils.*;

public class Driver extends Person {
    /*
     * Fields
     */
    @Inv(constraint = "driverLicense >= 1")
    public Integer driverLicense;
    public Integer driverLicenseStatus;
    private Integer experience = 0;

    /*
     * Methods
     */
    public void checkRep(){
        assert driverLicense >= 1;
    }
    public void driveCheckInvConstraint(Drivable vehicle){
        assert vehicle != null;
    }
    public void driveCheckPreConstraint(Drivable vehicle){
        assert driverLicenseStatus >= 1;
    }
    public void driveCheckPosConstraint(Drivable vehicle){
    }

    @Inv(constraint = "vehicle <> null")
    @Pre(constraint = "driverLicenseStatus >= 1")
    @Pos(constraint = "experience > experience@pre")
    @Interaction(interactionSequence = {
            "start","drive","stop",
    })
    public void drive(Drivable vehicle){
        checkRep();
        driveCheckInvConstraint(vehicle);
        driveCheckPreConstraint(vehicle);

        vehicle.start();
        vehicle.drive();
        vehicle.stop();

        checkRep();
        driveCheckInvConstraint(vehicle);
        driveCheckPosConstraint(vehicle);
    }
}
```

The Relations

Triple Graph Grammar

- Relations coded by triple graphs



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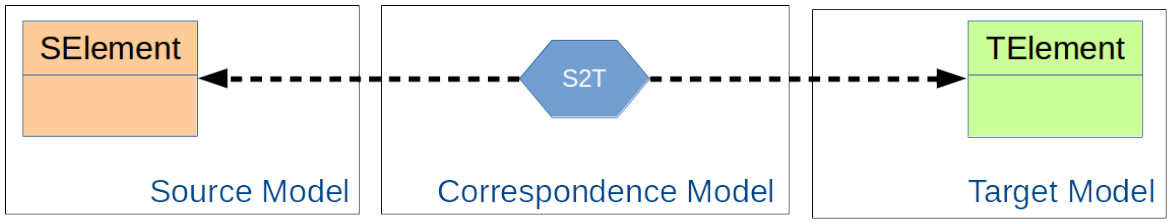
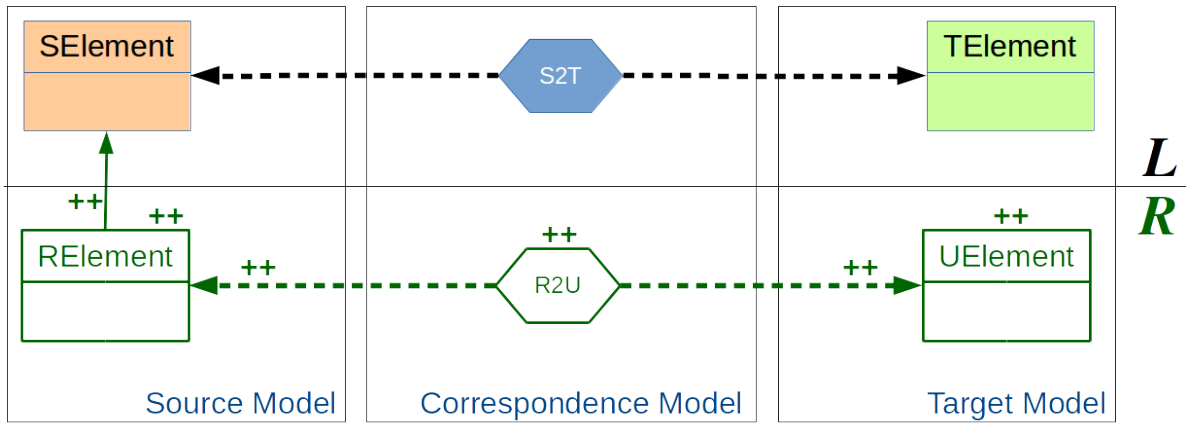


- Triple graphs are organized in triple rules $L \rightarrow R$.



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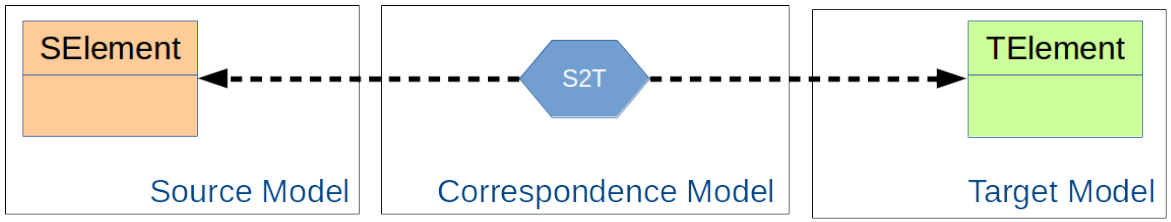

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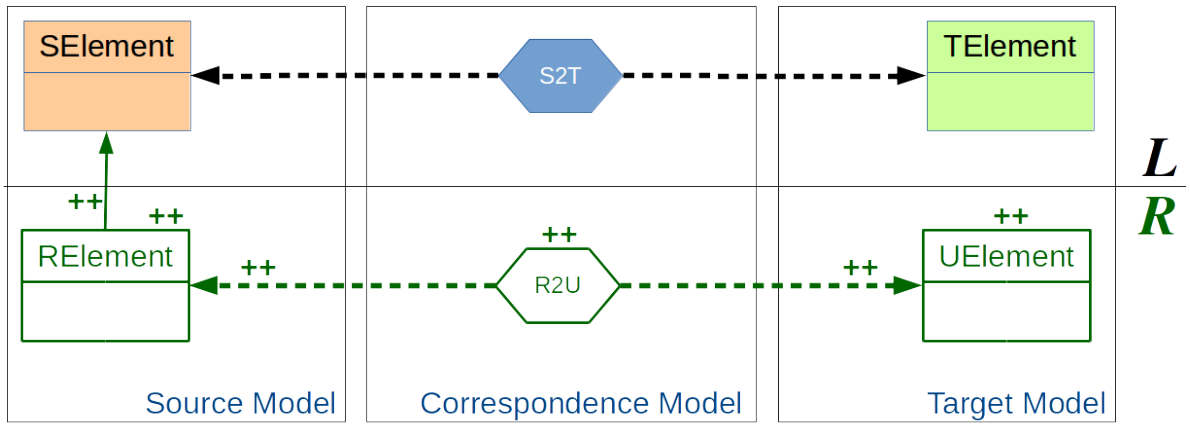
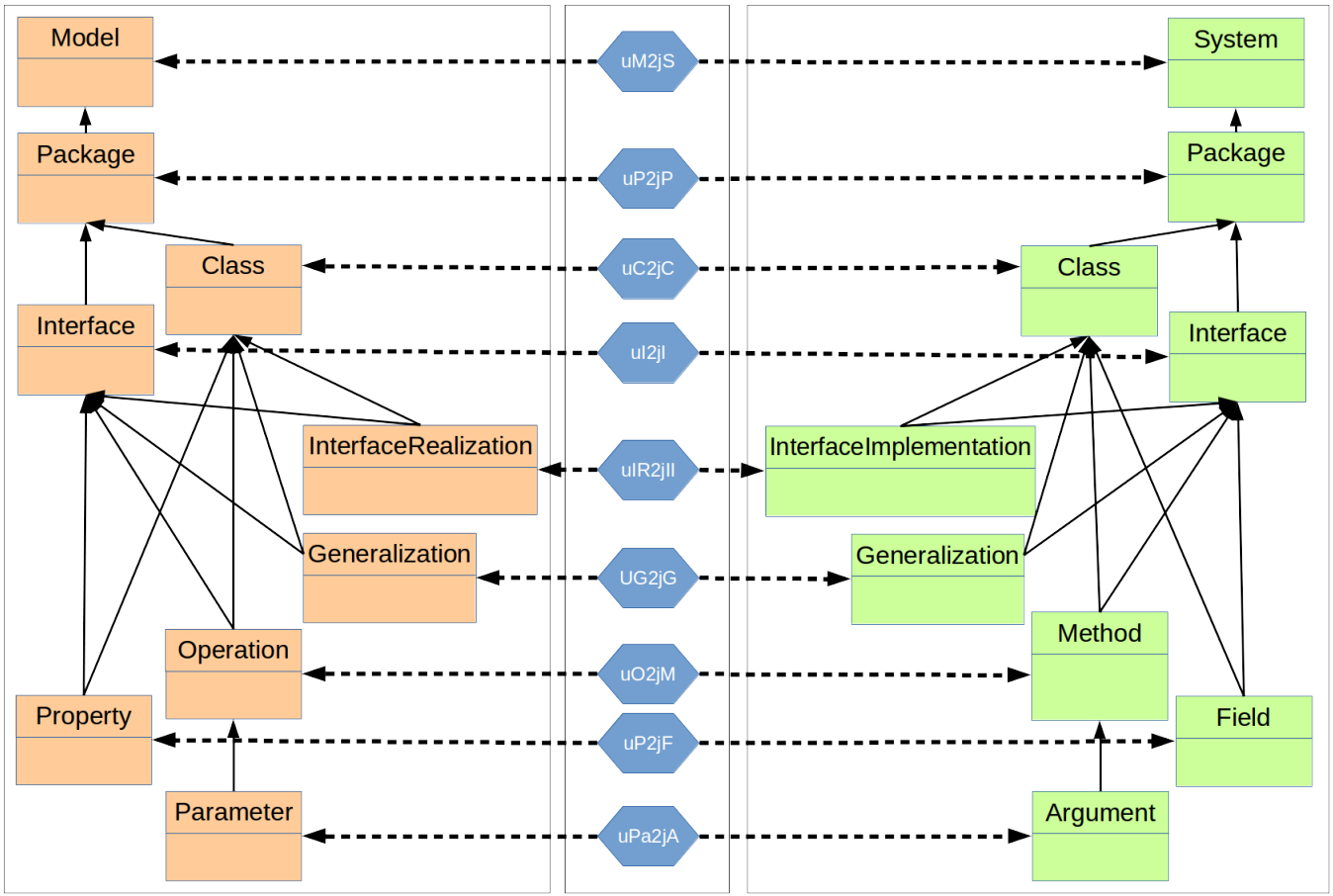


- These triple rules form a triple graph grammar (TGG) for each edge.

UMLClassDiagram2java



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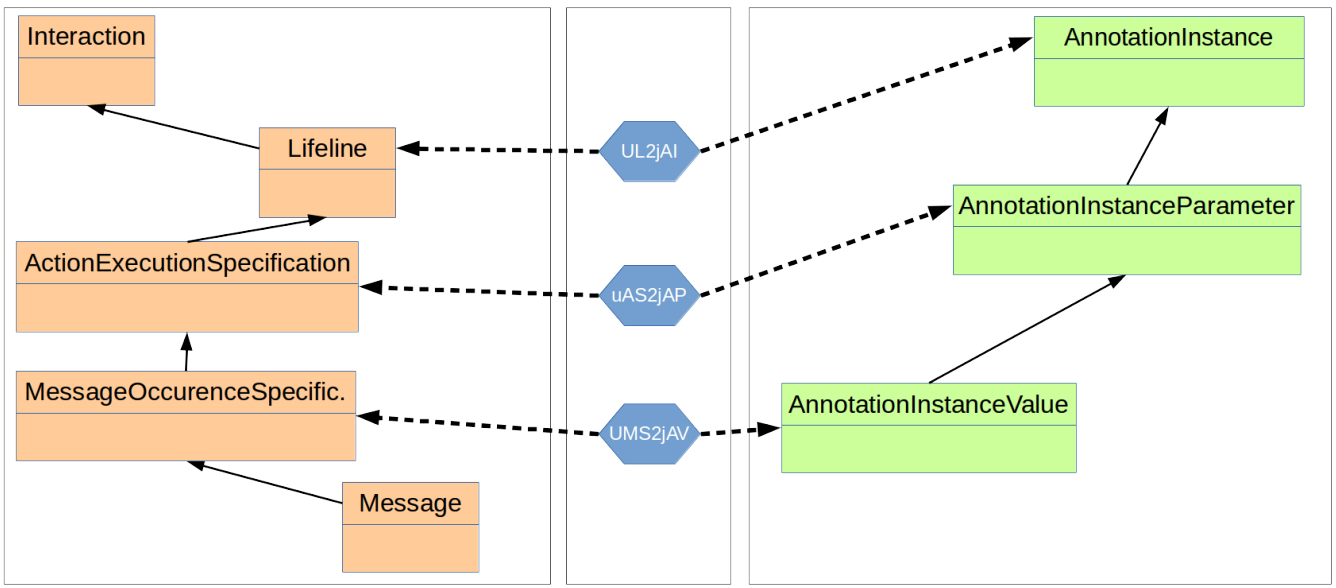
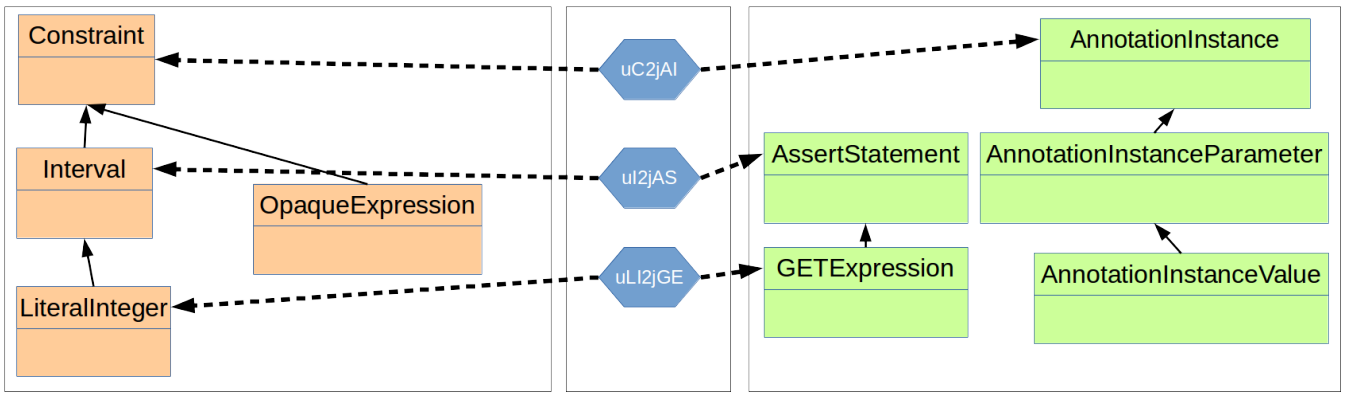


UMLContract2java



The Synchronization

Synchronization Scheme for Each TGG

- Following scheme for every edge of the network of metamodels

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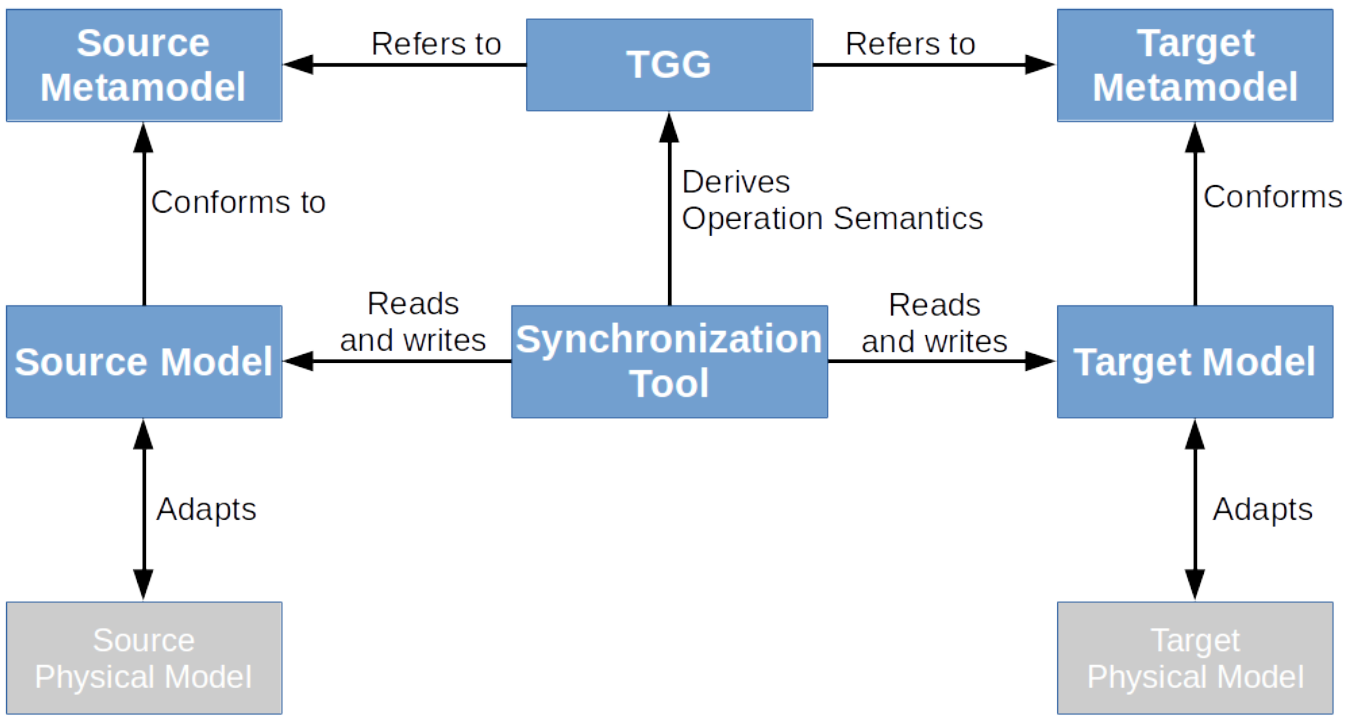

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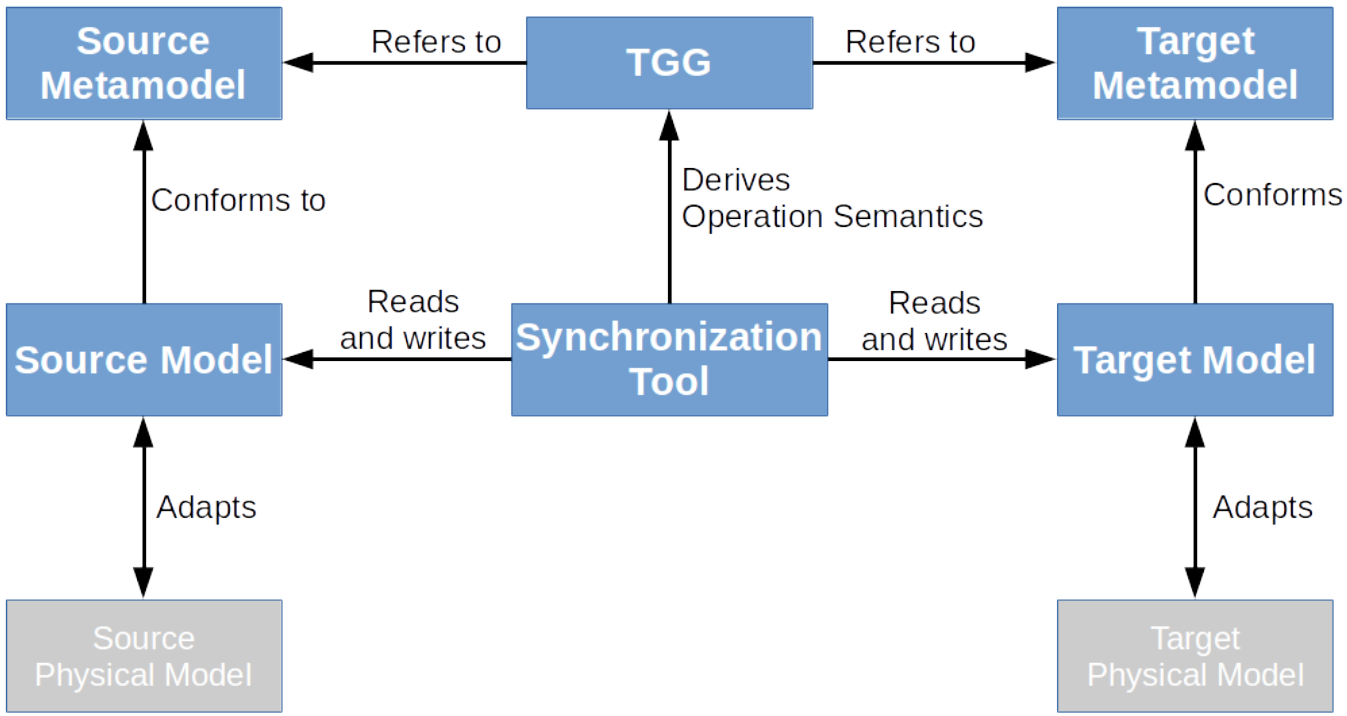

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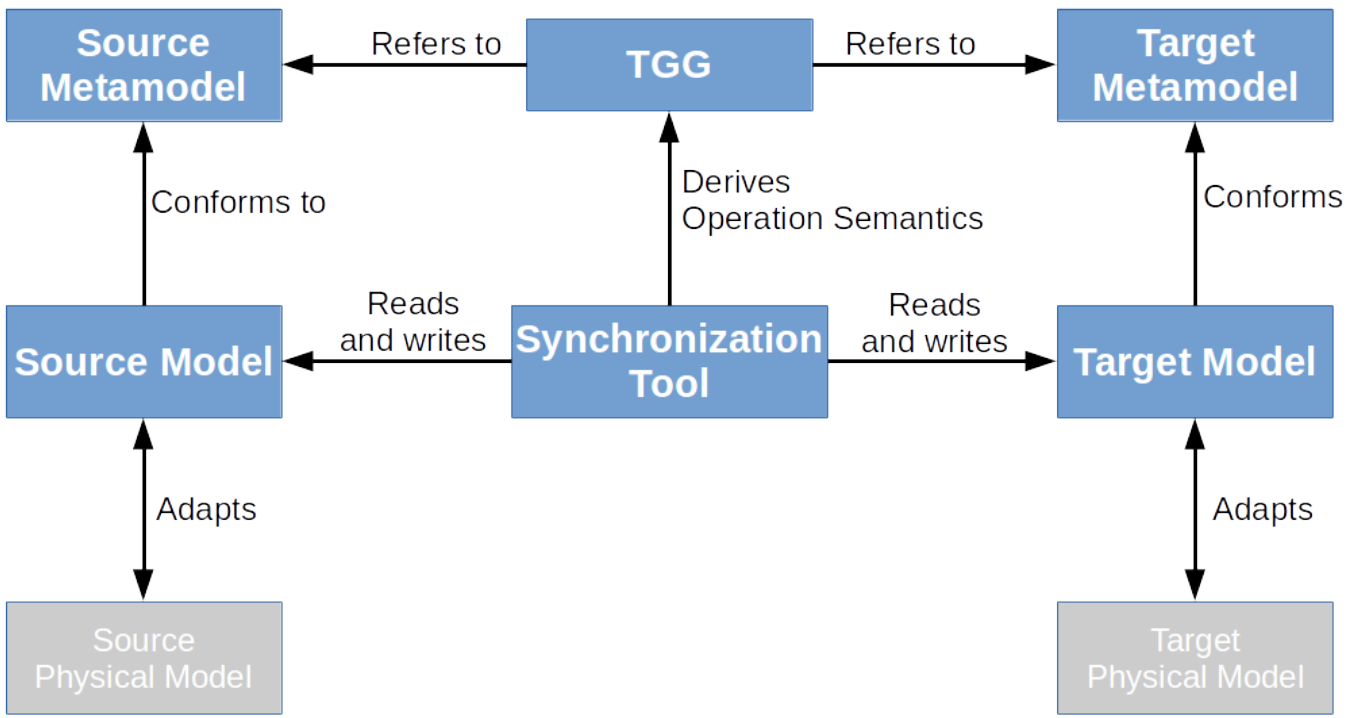

- Treated separately by state-of-the-art approaches
- How to treat the whole network of metamodels?

Synchronization Algorithm for the Network

function NETWORK SYNCHRONIZATION(G, v, v_{new}, δ_v)
    Update v to v_{new} in G
    for all $n_i = N(v)$ **do**
        Synchronize n_i according to v, v_{new} and δ_v
        if n_i was modified **then**
            Network Synchronization (G, n_i, $n_{i_{new}}$, δ_n)
        end if
    end for
    return G
end function

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end function

- Supposing only one modification at a time and unidirectional modifications.
- The algorithm always terminates (for G finite without cycles).
- The algorithm is deterministic (for deterministic synchronization).

Conclusion

Achieved goals

1. Metamodel definitions of artifacts from the Java Technological Space
   - Metamodels can be used in future works.
   - Metamodels are not complete.

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   - Exploration of TGGs for defining the relations
   - Evaluation of the definitions through forward transformation
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1. Metamodel definitions of artifacts from the Java Technological Space
   - Metamodels can be used in future works.
   - Metamodels are not complete.
2. Creation of a network of metamodels including the relations' formalizations
   - Exploration of TGGs for defining the relations
   - Evaluation of the definitions through forward transformation
   - Relations are not complete.
3. The proposal of an algorithm for network synchronization
   - Novel view of the model synchronization problem
   - Algorithm has very limiting assumptions.

Thank you

Thank you for your attention

References

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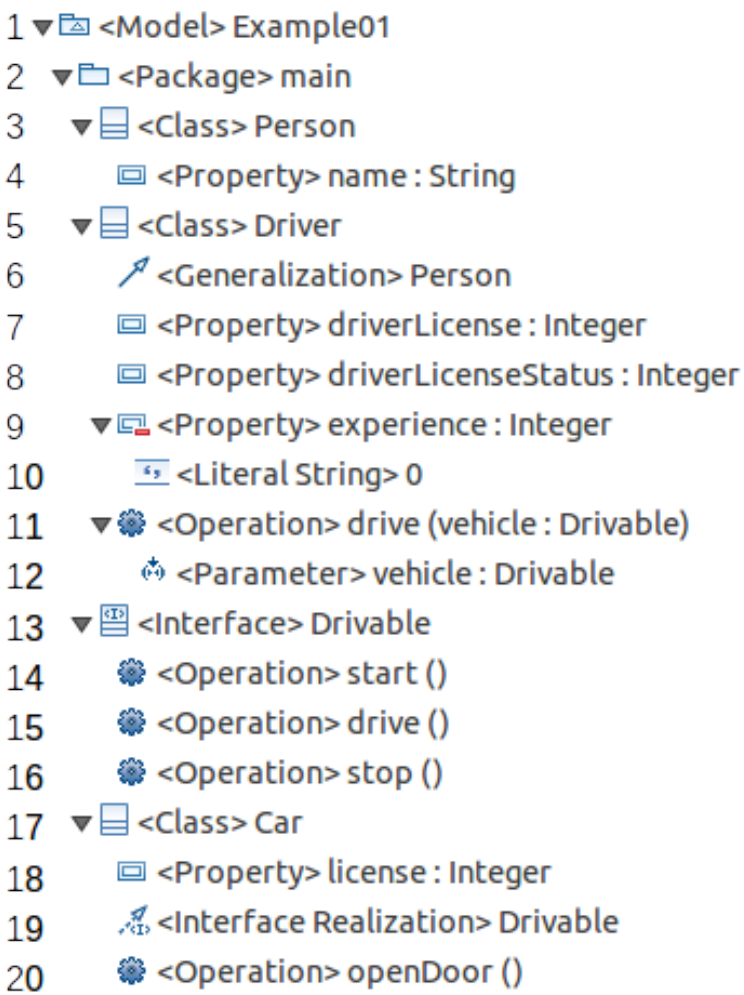
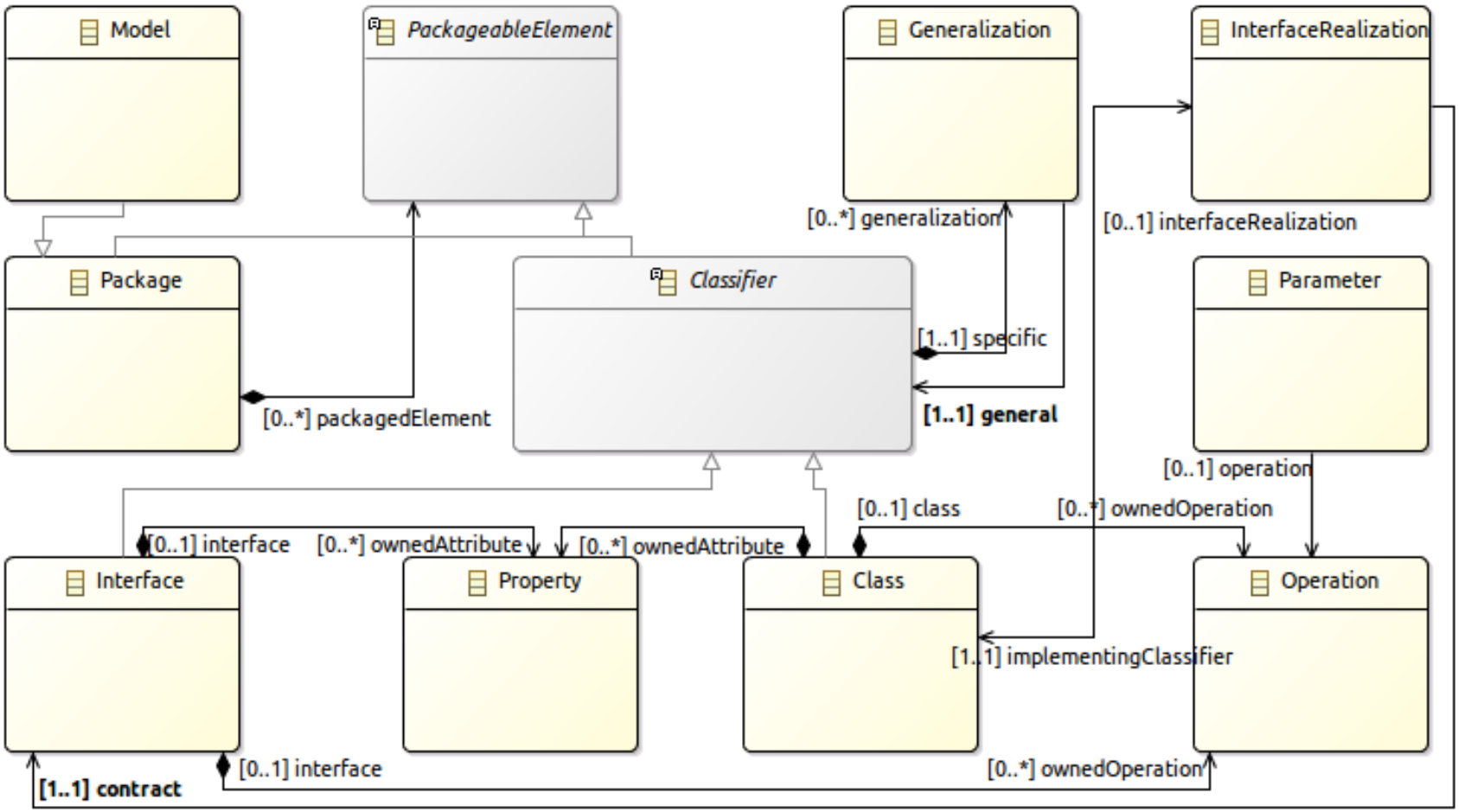
Appendix

UMLClassDiagram Abstract Syntax Example



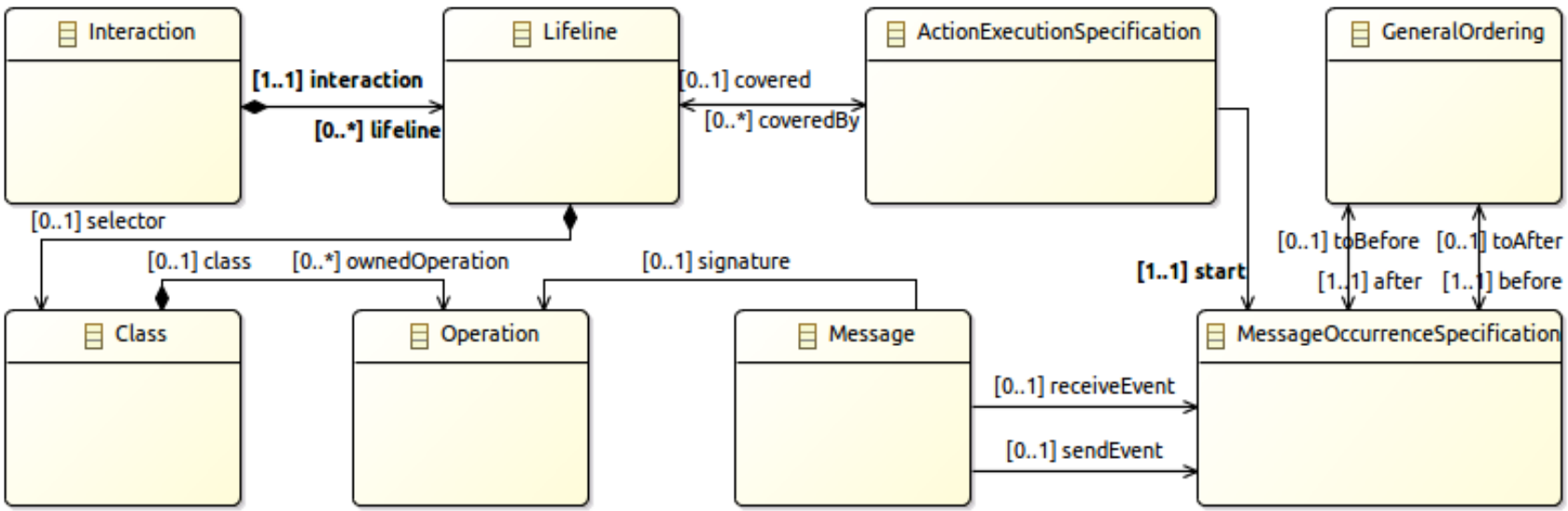
UMLClassDiagram Metamodel



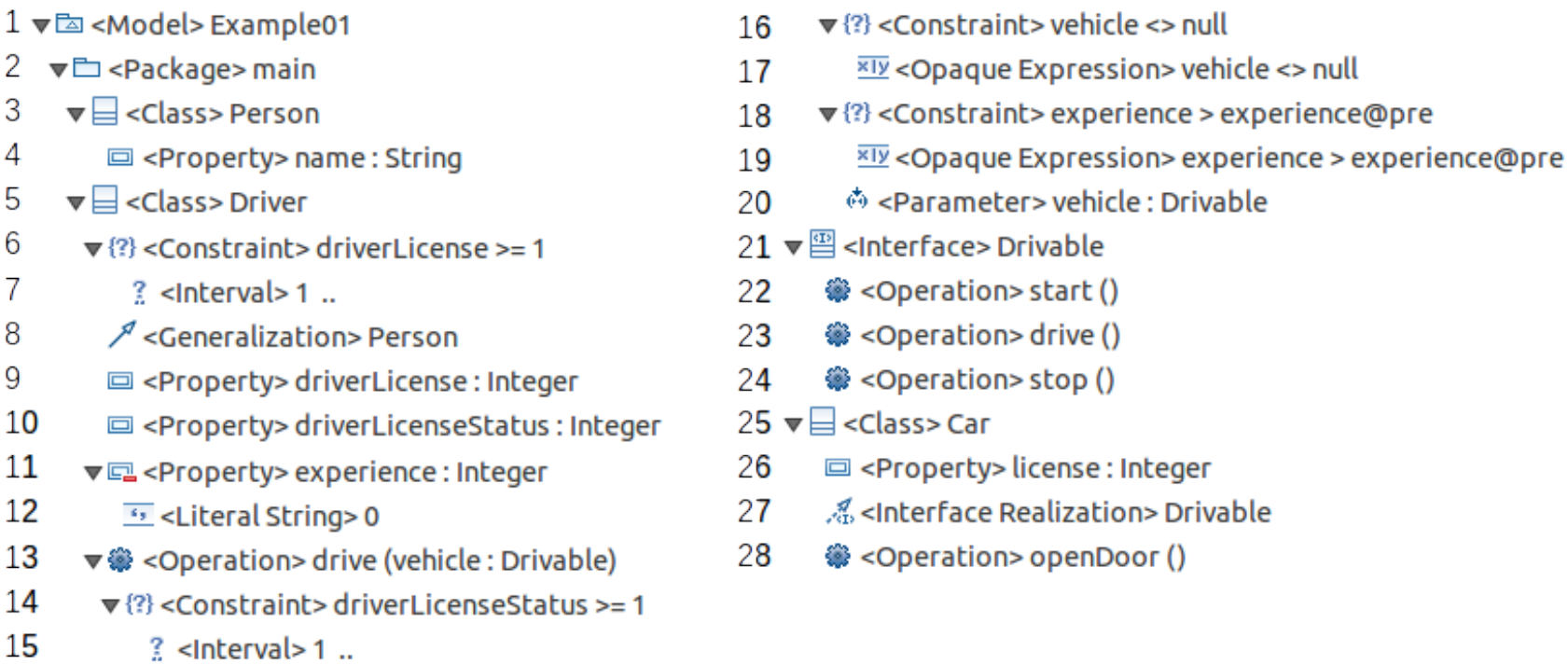
UMLSequenceDiagram Abstract Syntax Example

1 <Model> Example01
2 <Interaction>
3 <General Ordering> 1 < 1.1
4 <General Ordering> 1.1 < 1.2
5 <General Ordering> 1.2 < 1.3
6 <Lifeline> :Driver
7 <Lifeline> :Drivable
8 <Action Execution Specification> :Driver
9 <Message Occurrence Specification> 1 (sendEvent)
10 <Action Execution Specification> :Drivable (1)
11 <Message Occurrence Specification> 1.1 (receiveEvent)
12 <Message Occurrence Specification> 1.1 (sendEvent)
13 <Action Execution Specification> :Drivable (2)
14 <Message Occurrence Specification> 1.2 (receiveEvent)
15 <Message Occurrence Specification> 1.2 (sendEvent)
16 <Action Execution Specification> :Drivable (3)
17 <Message Occurrence Specification> 1.3 (receiveEvent)
18 <Message Occurrence Specification> 1.3 (sendEvent)
19 <Message> 1: drive(vehicle:Drivable) : void
20 <Message> 1.1: start() : void
21 <Message> 1.2: drive() : void
22 <Message> 1.3 : stop() : void

UMLSequenceDiagram Metamodel



UMLContract Abstract Syntax Example



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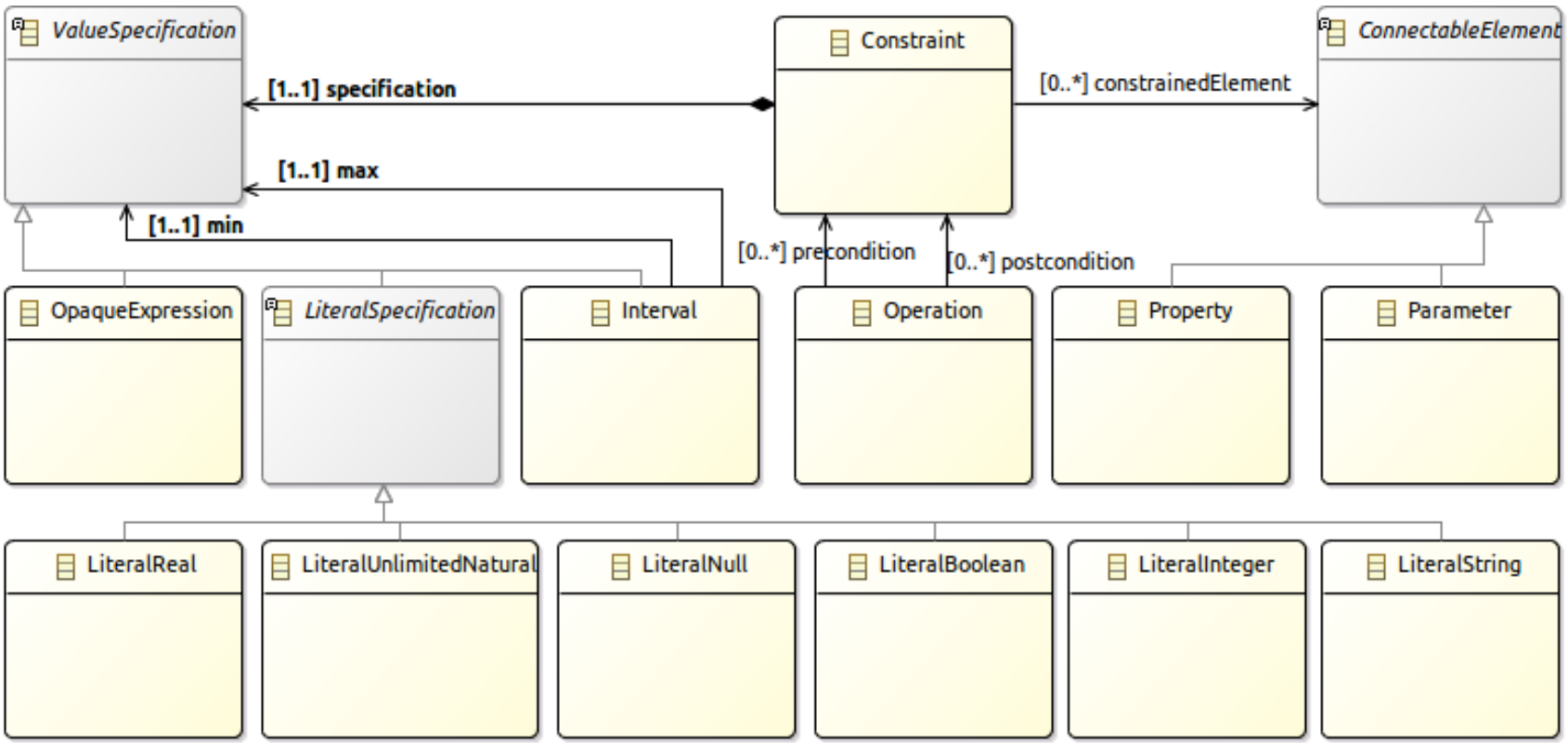
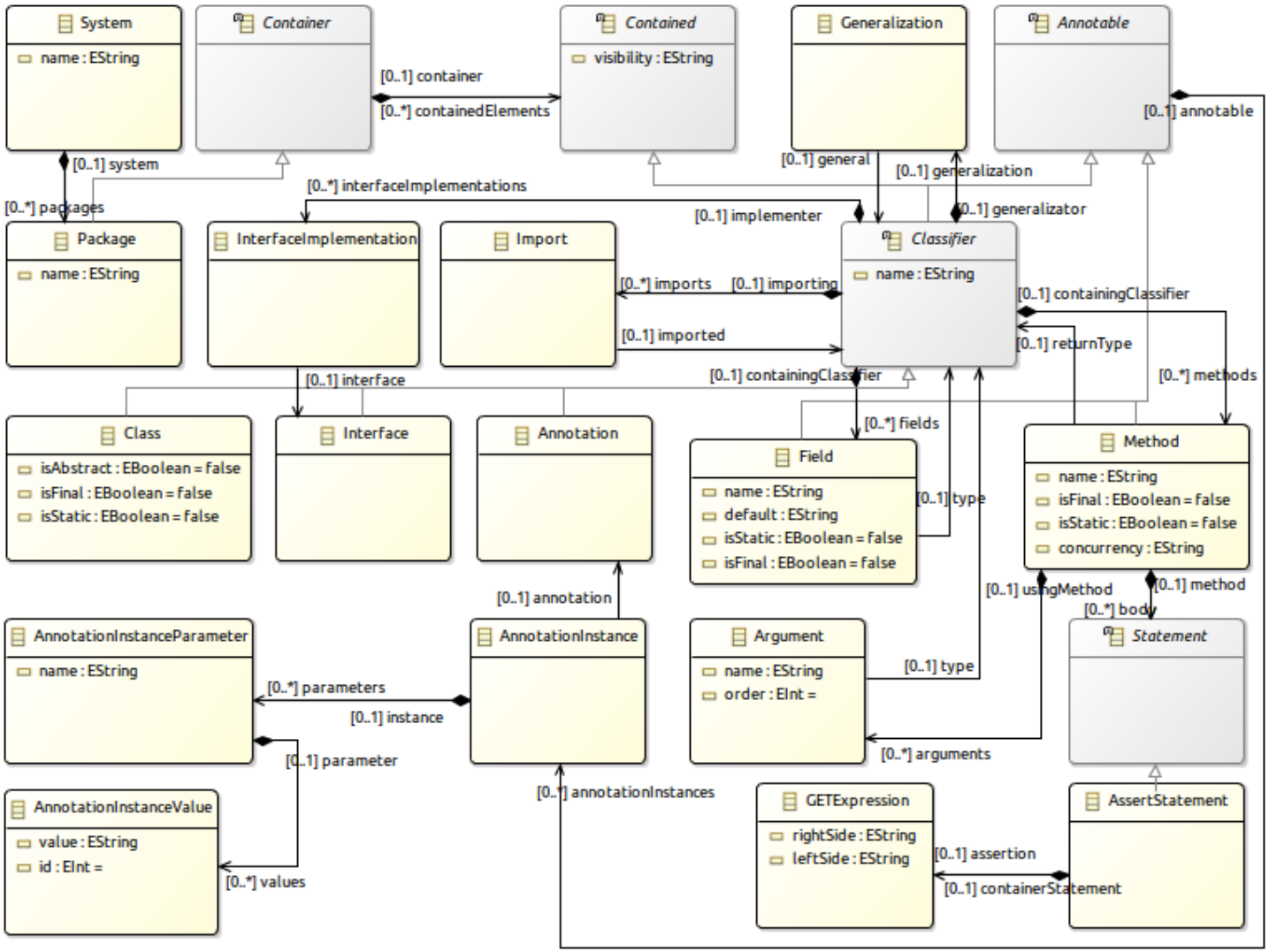
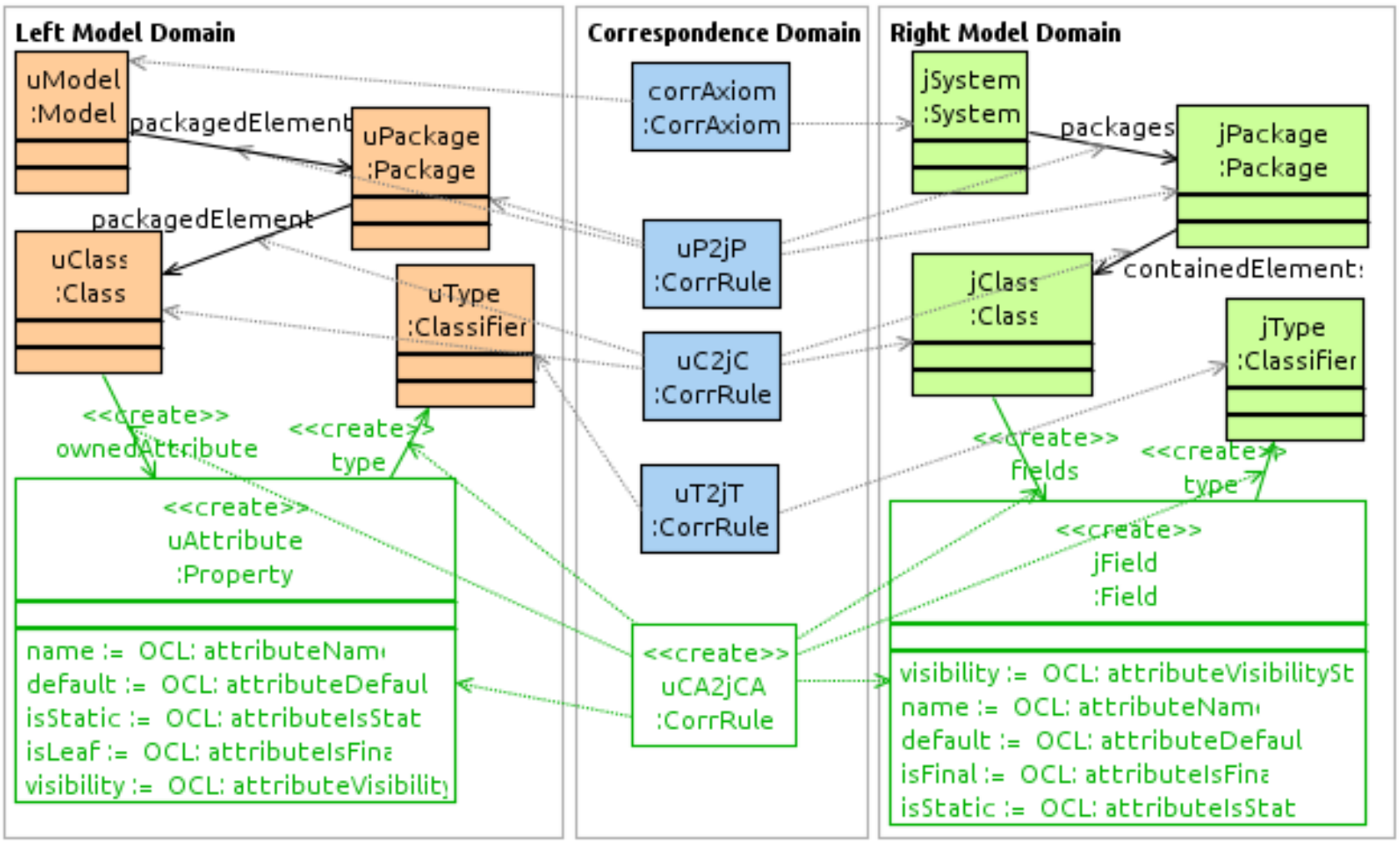


Java Abstract Syntax Example

Java Metamodel



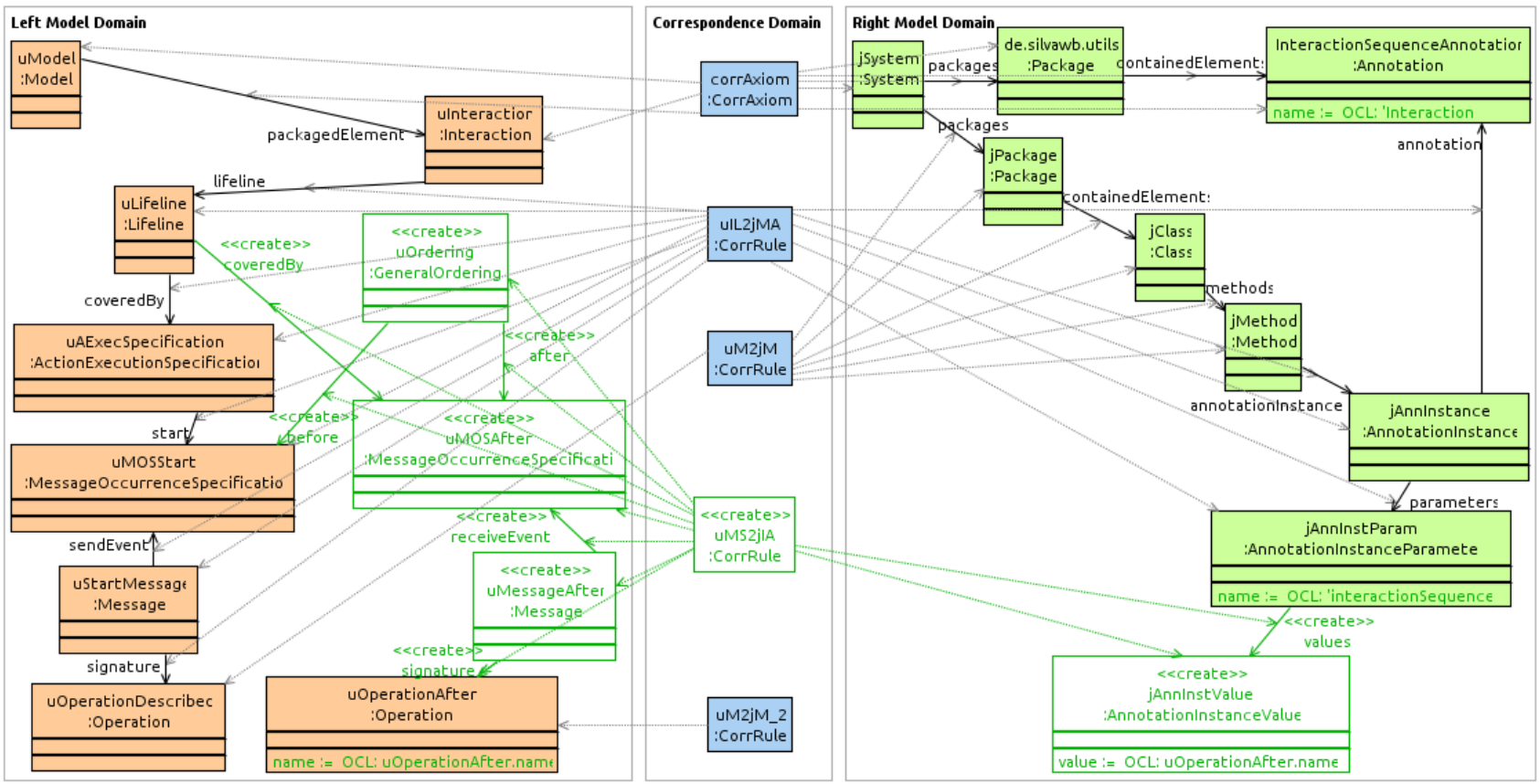
One triple rule for UMLClassDiagram2java



Result of the implementation for UMLClassDiagram2java

- Forward transformation was applied.

One triple rule for UMLSequenceDiagram2java



Implementation for UMLSequenceDiagram2java

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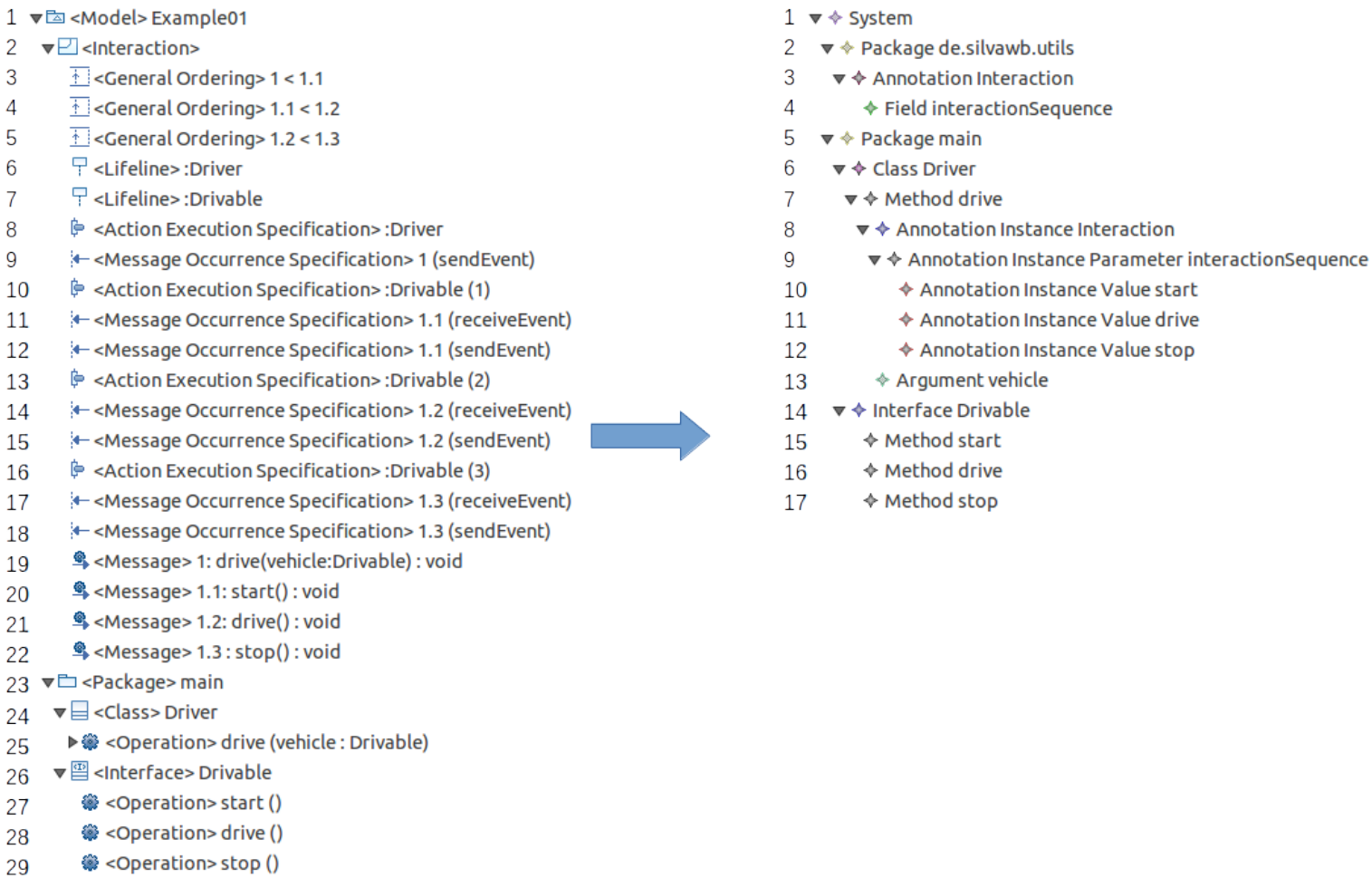
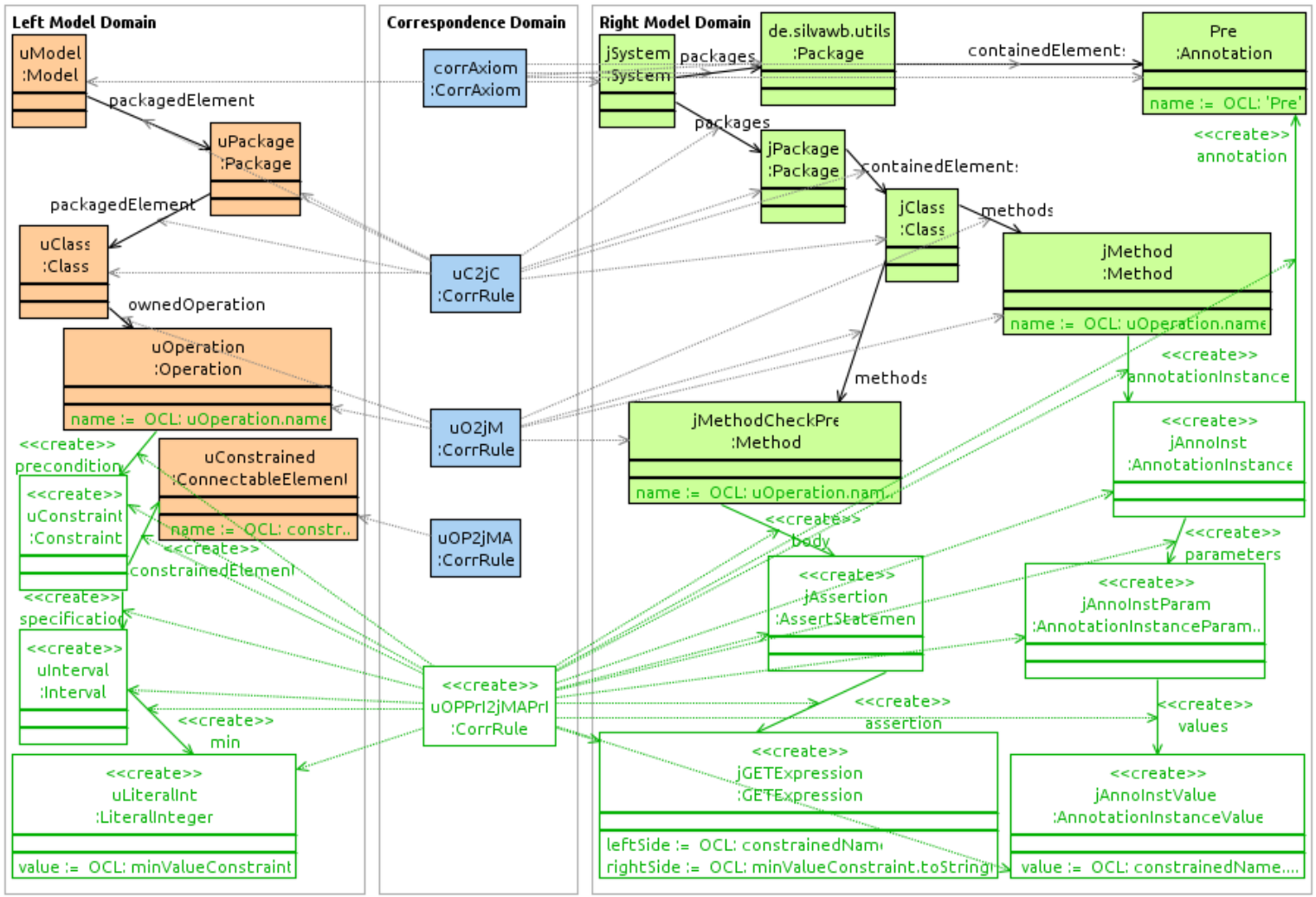


One triple rule for UMLContract2java



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