Towards Synchronizing Relations Between Artifacts in the Java Technological Space

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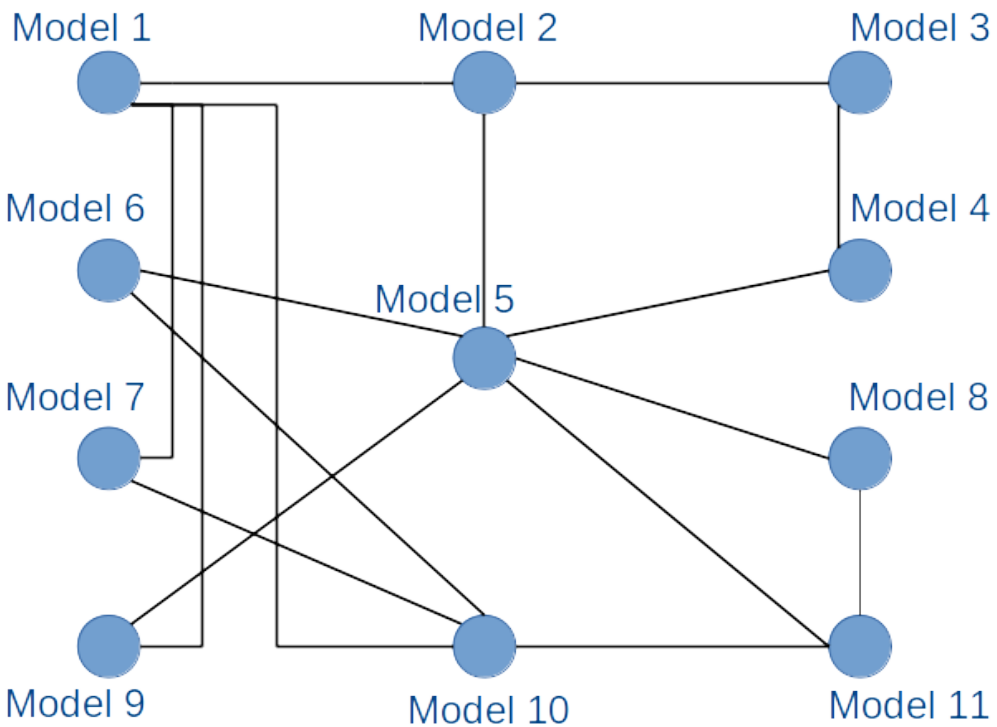
Organization

Background

Models are used in Software Engineering

- New needs in industry and academy 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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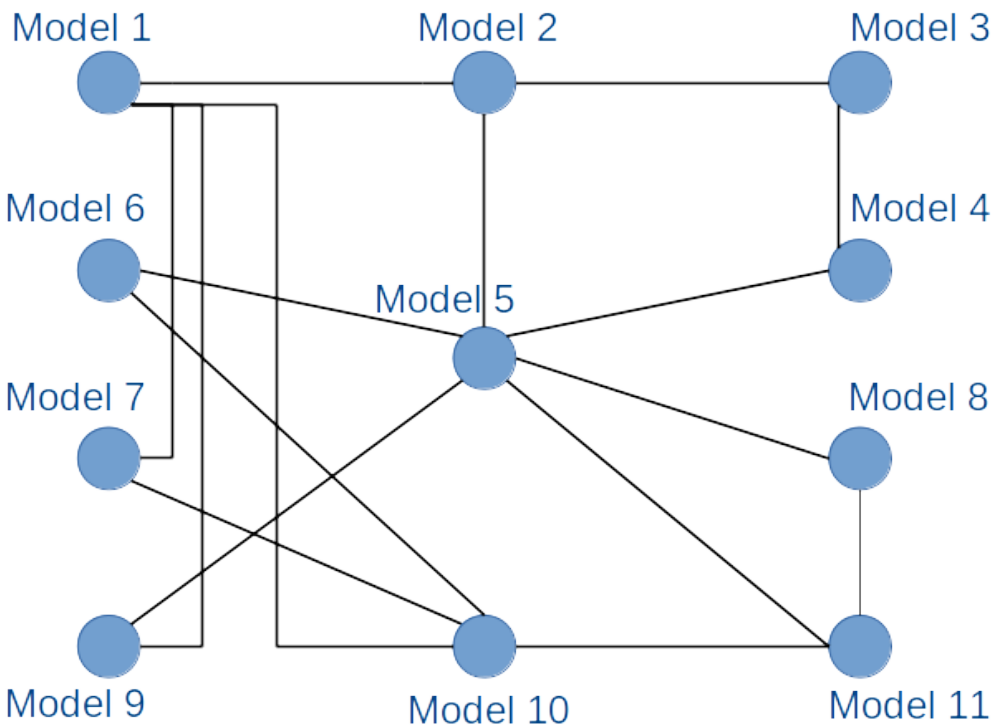

- Models are to be maintained consistent as they evolve.
- This means **models synchronization**.

Model Synchronization in the Network of Models

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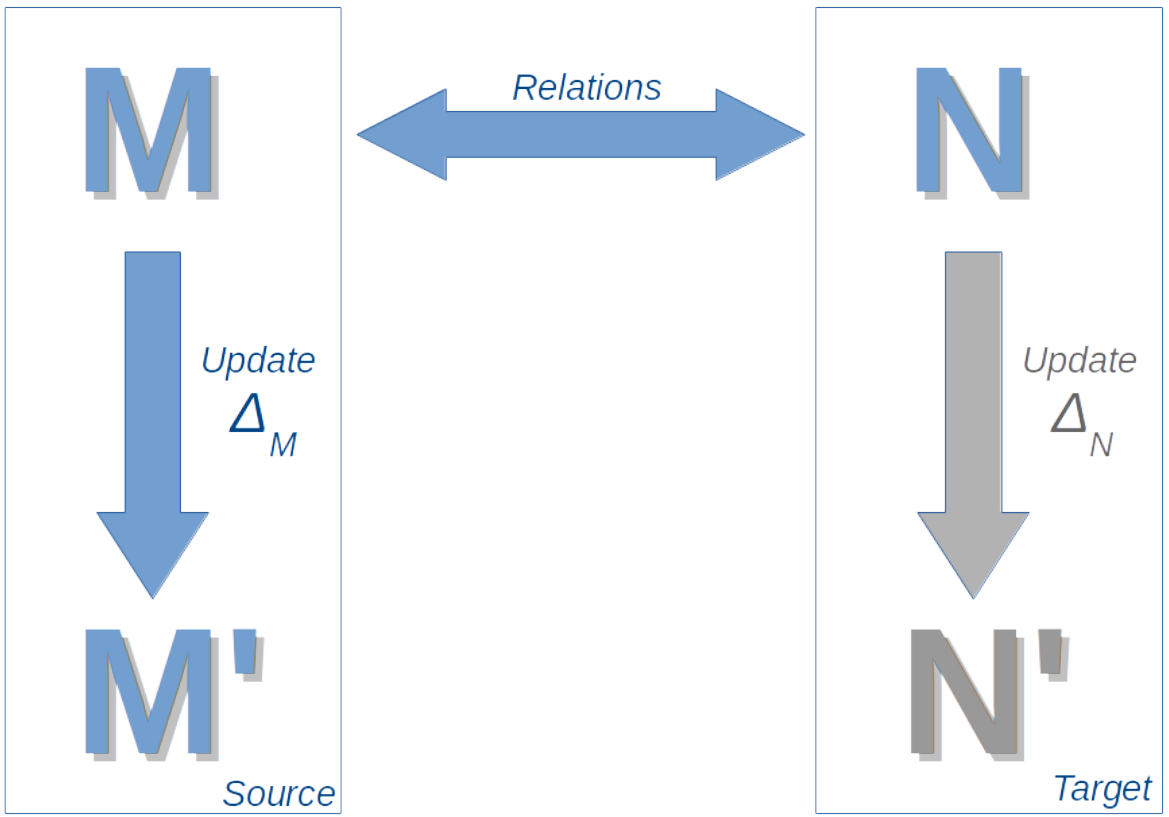

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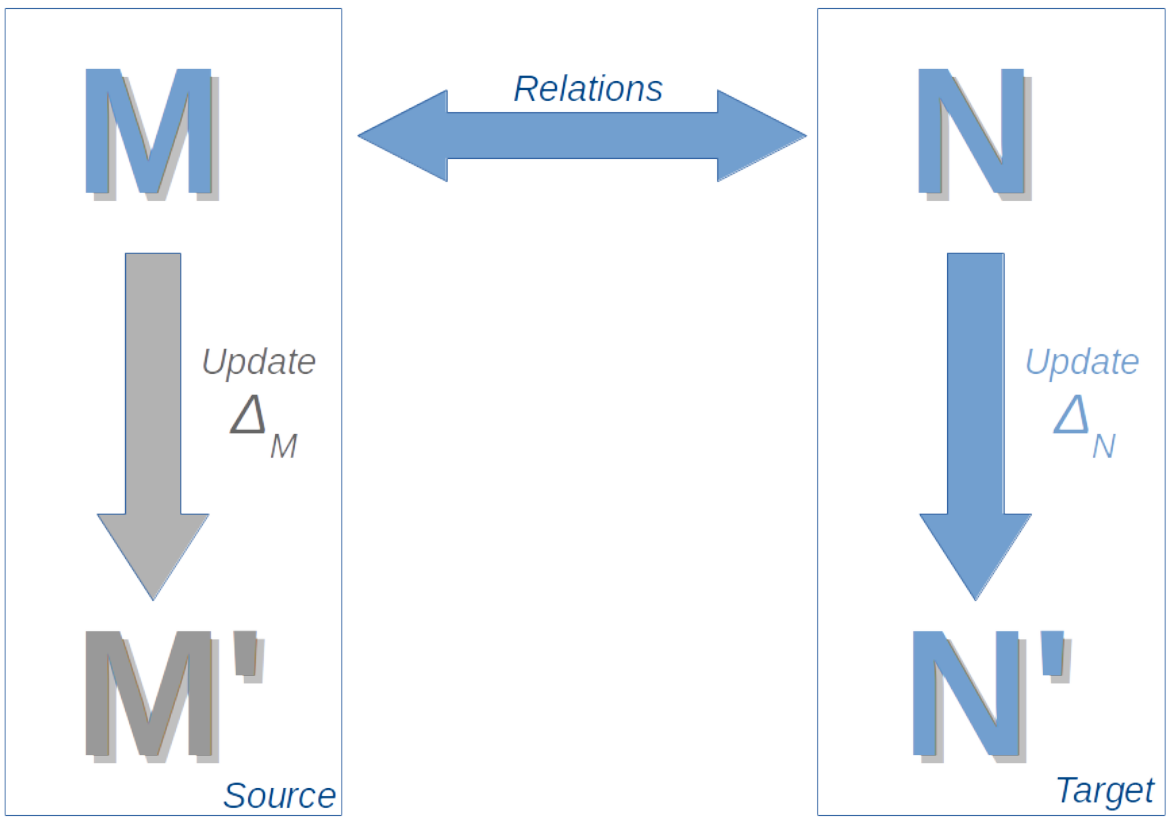
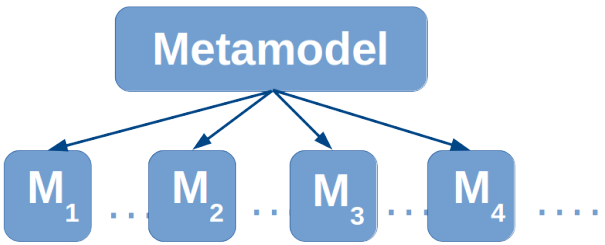


Relations are written between metamodels



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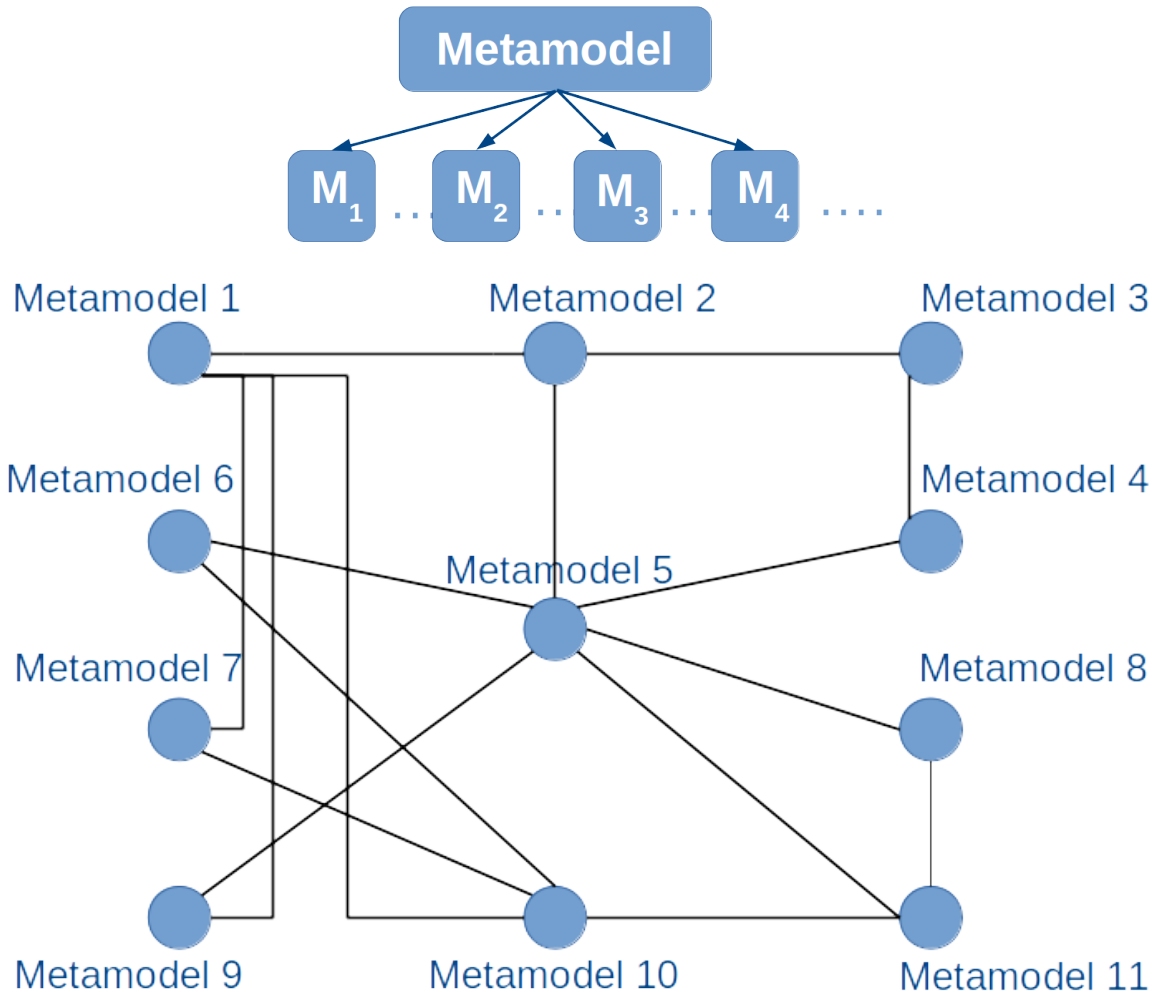

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- Definitions of the **metamodels** in literature
- Definitions of the **relations** in literature
- Approach able to treat synchronization of **complex technological spaces** with a large number of **tangled** metamodels.

Objective

Three Steps

- Focus on the Java technological space.

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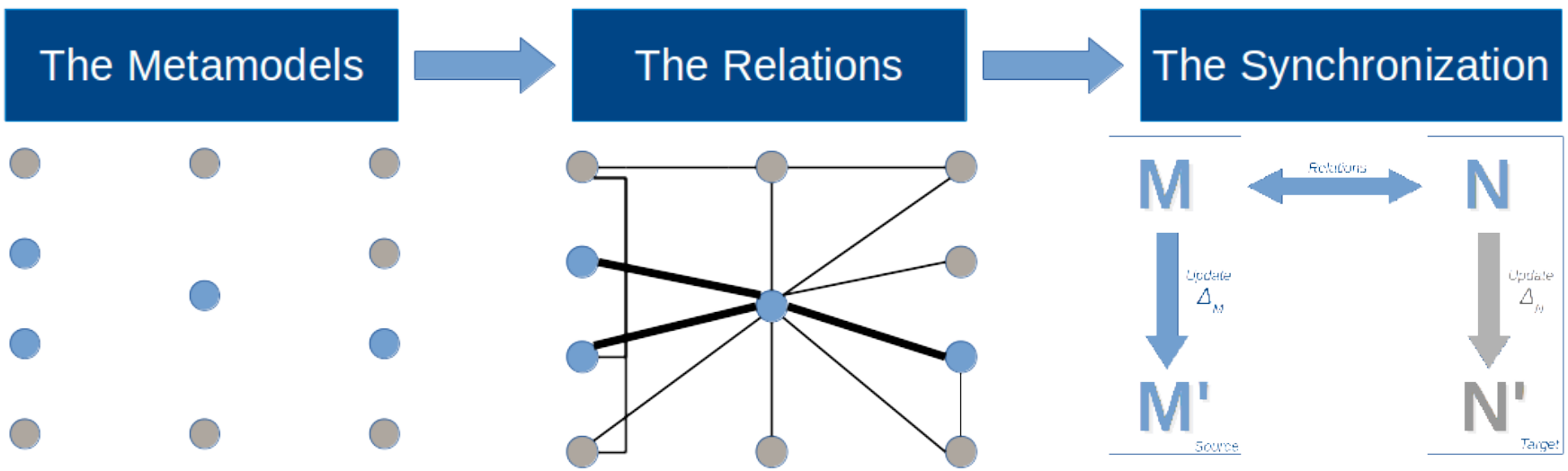
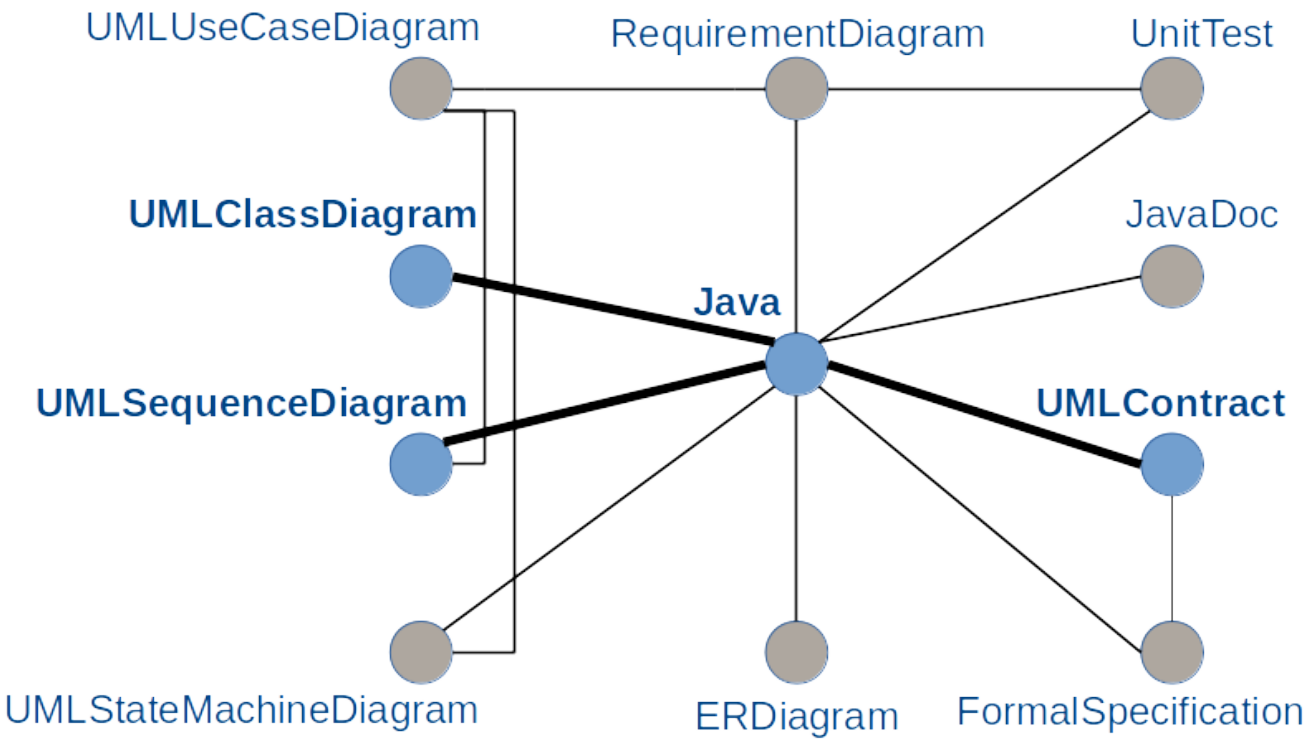
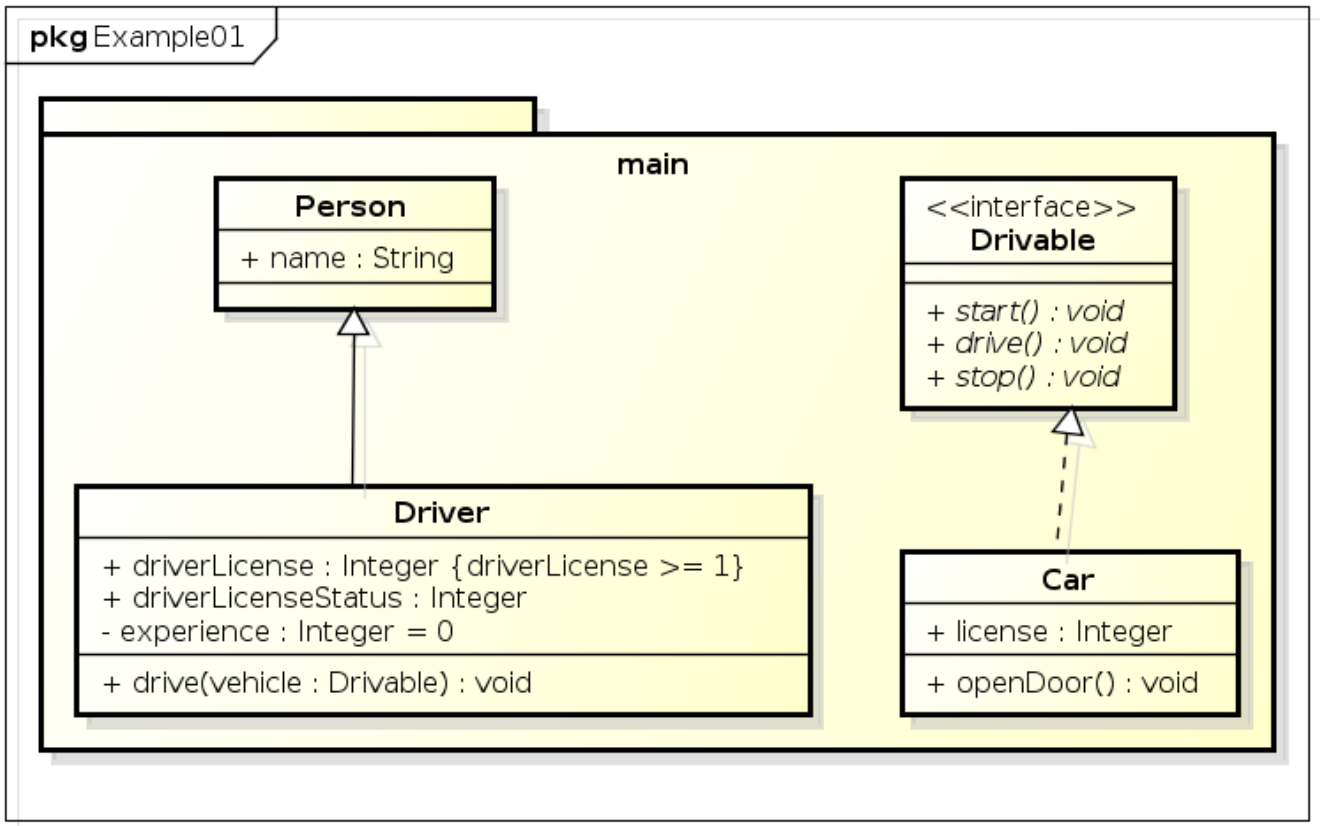


The Metamodels

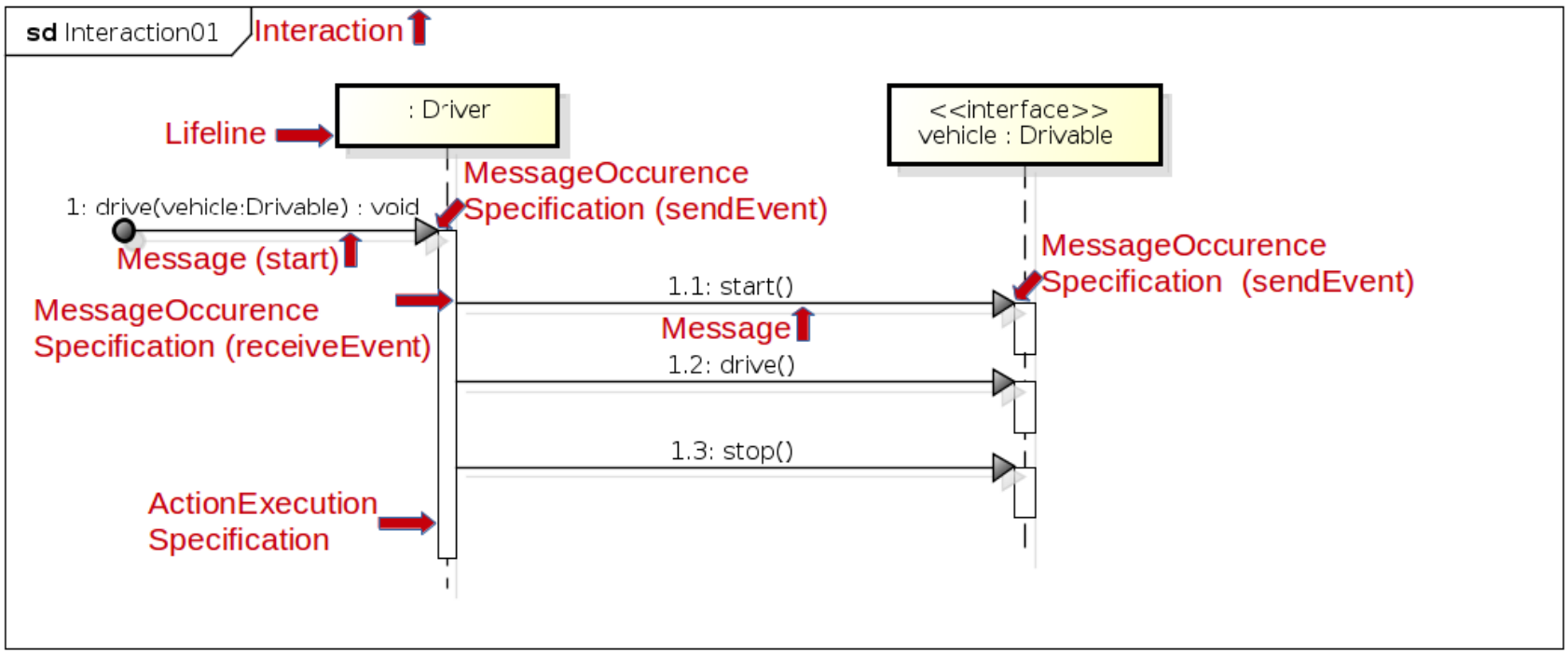
Some Metamodels of the Java Technological Space



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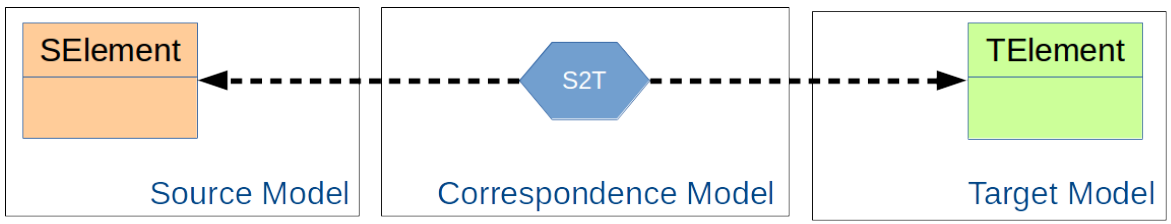

The Relations

Triple Graph Grammar

- Relations coded by triple graphs



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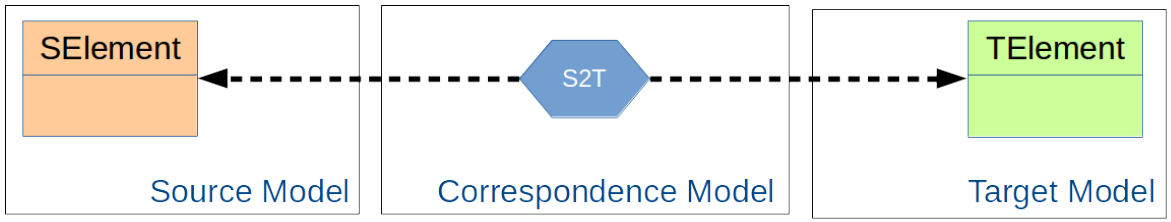
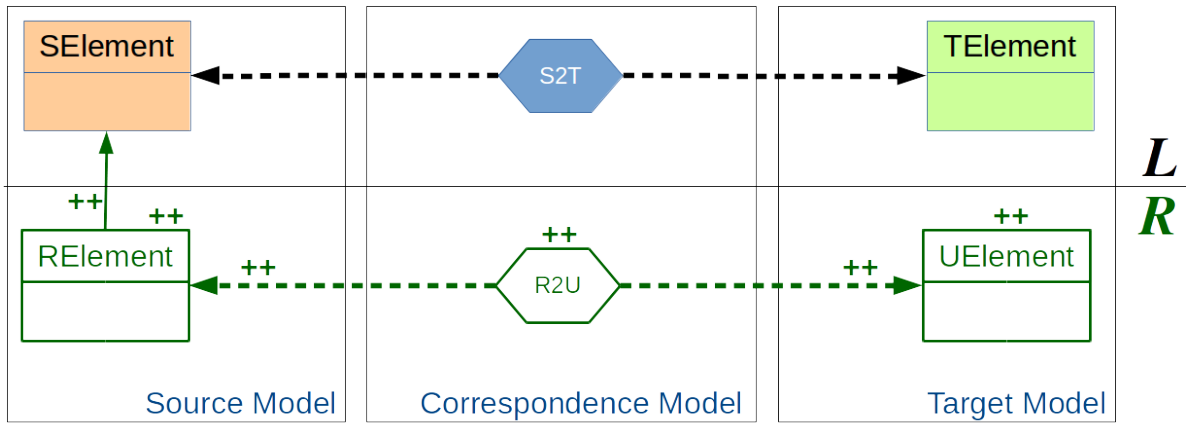


- Triple graphs are organized in triple rules $L \rightarrow R$.



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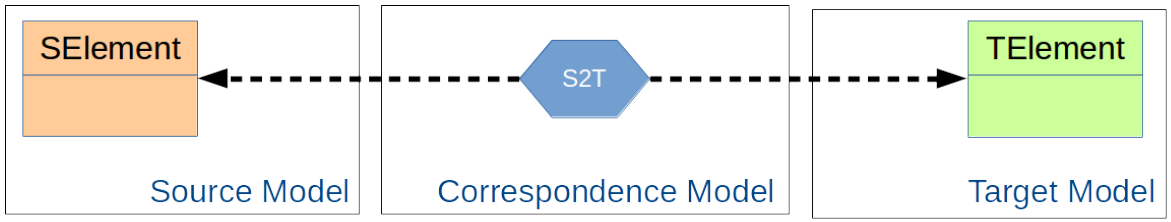

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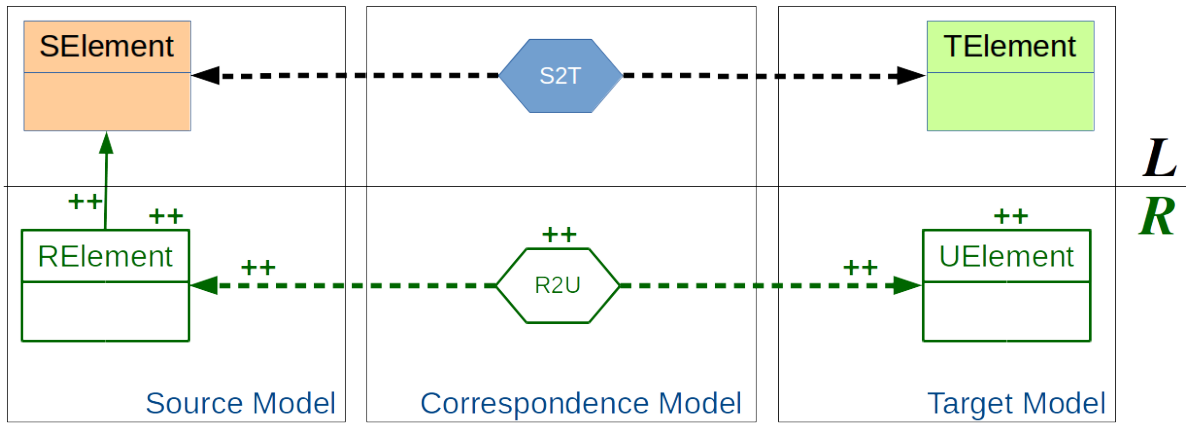
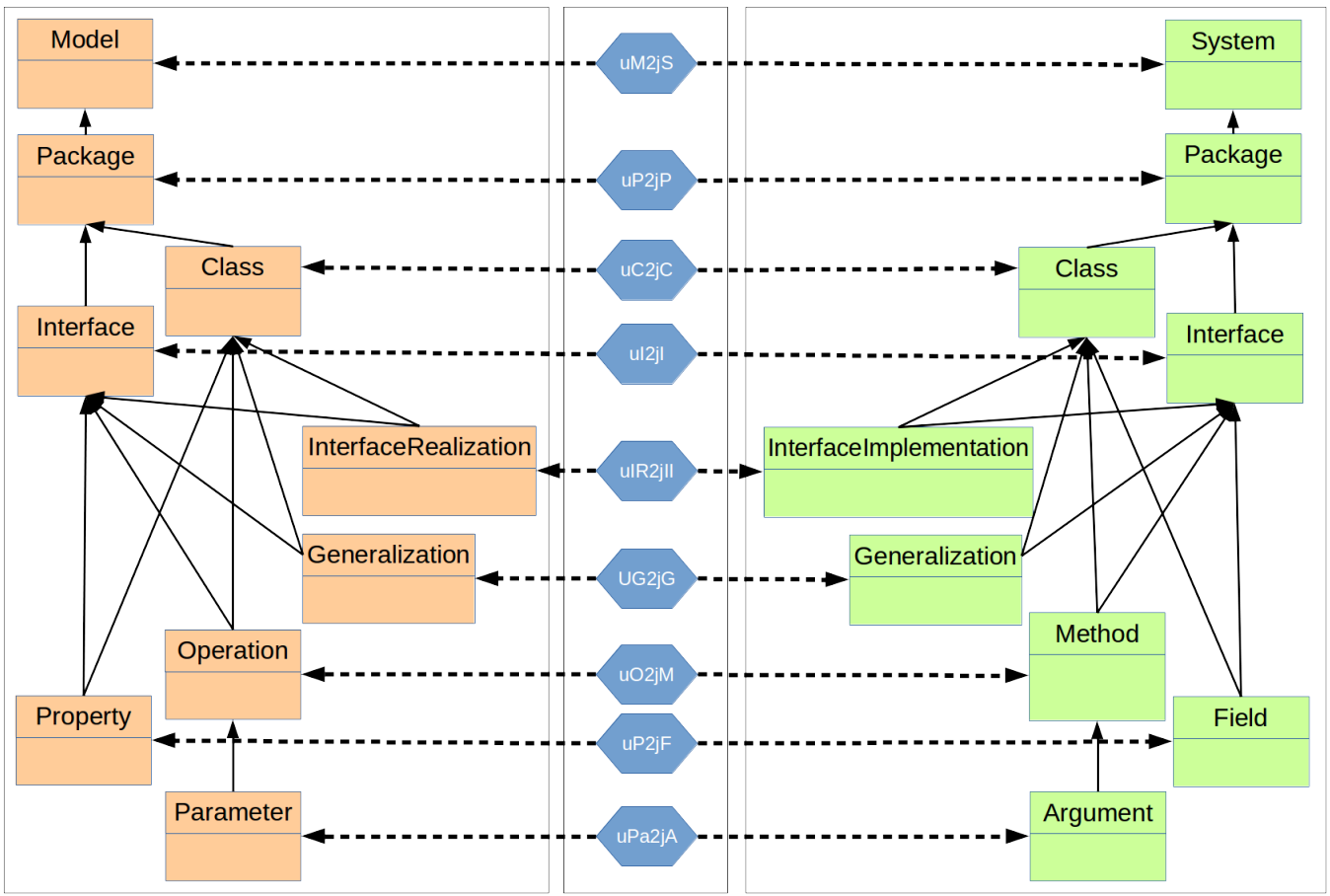


- These triple rules form a triple graph grammar (TGG) for each edge.

UMLClassDiagram2java



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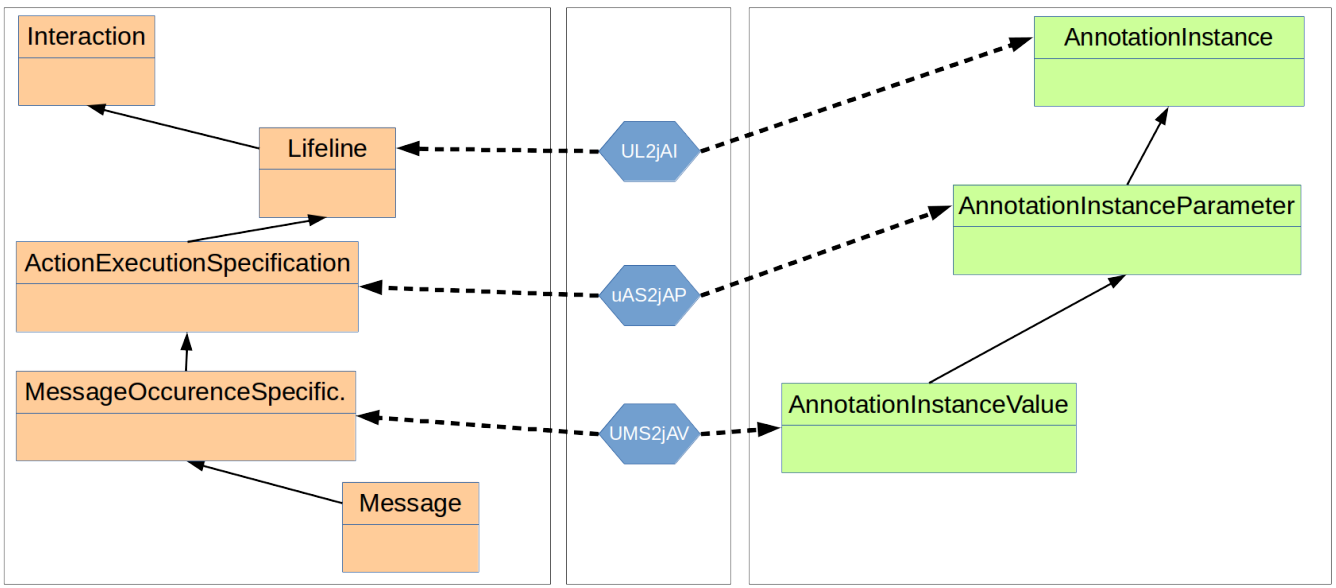

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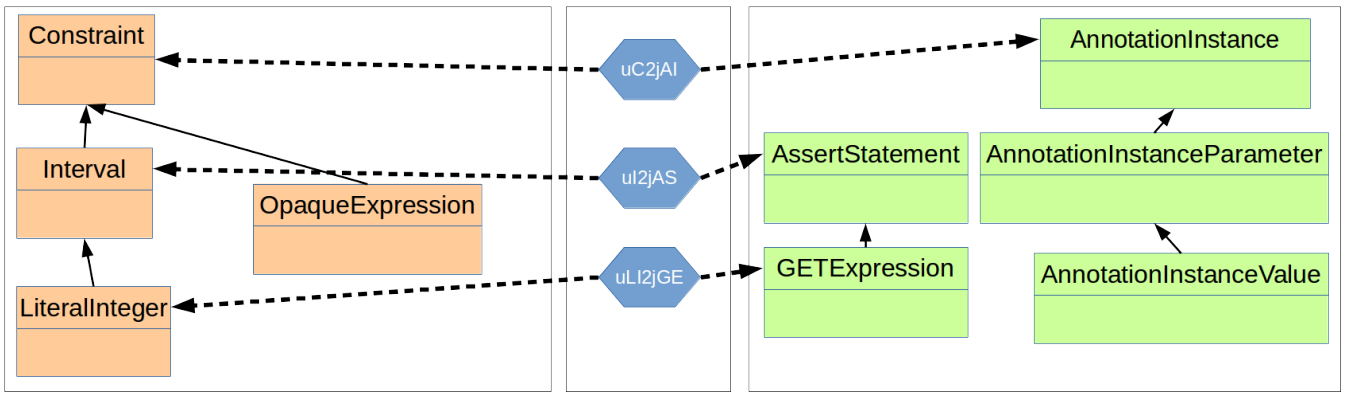
UMLContract2java



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Synchronization Scheme for Each TGG

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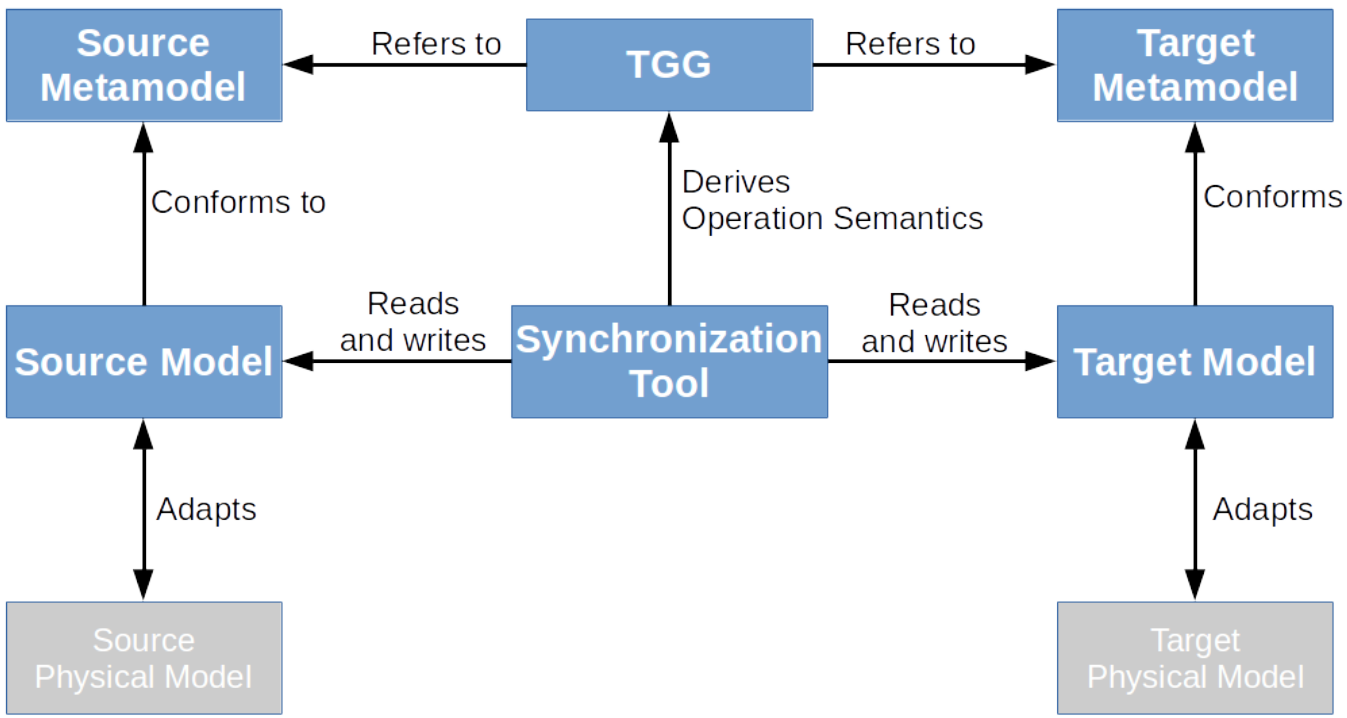

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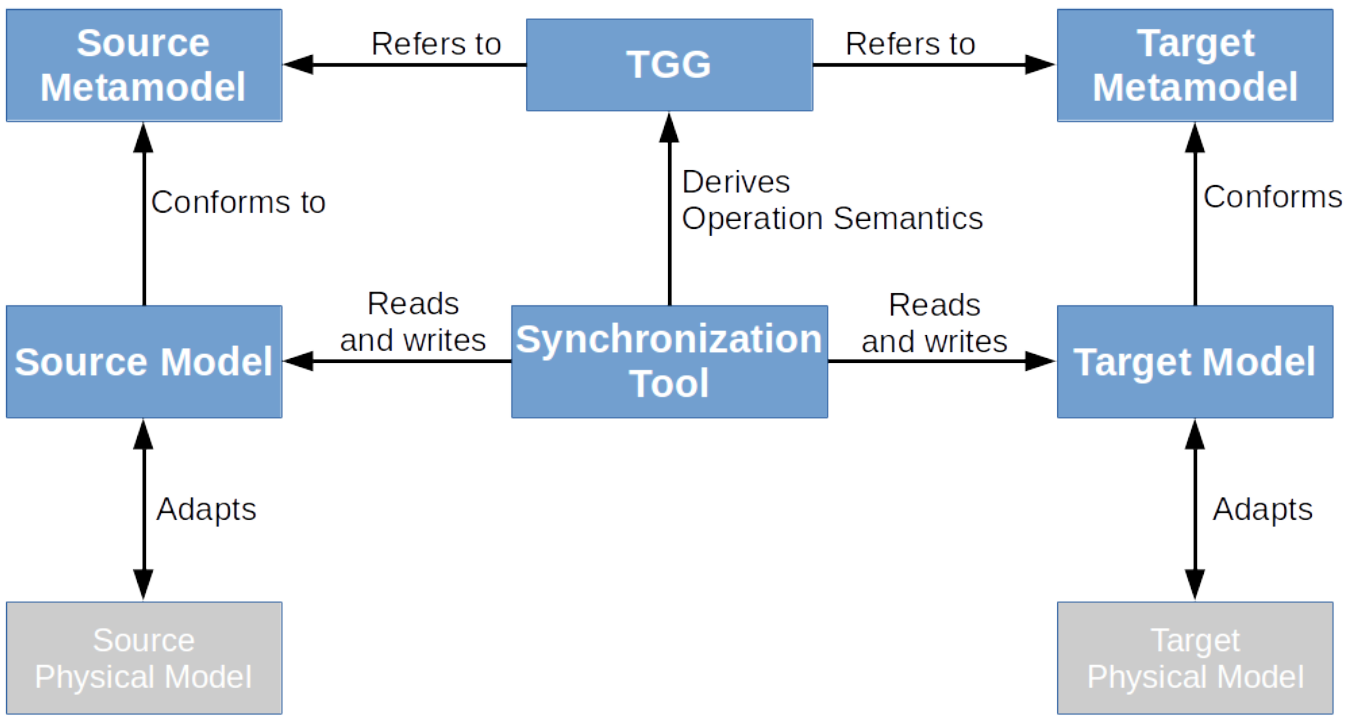

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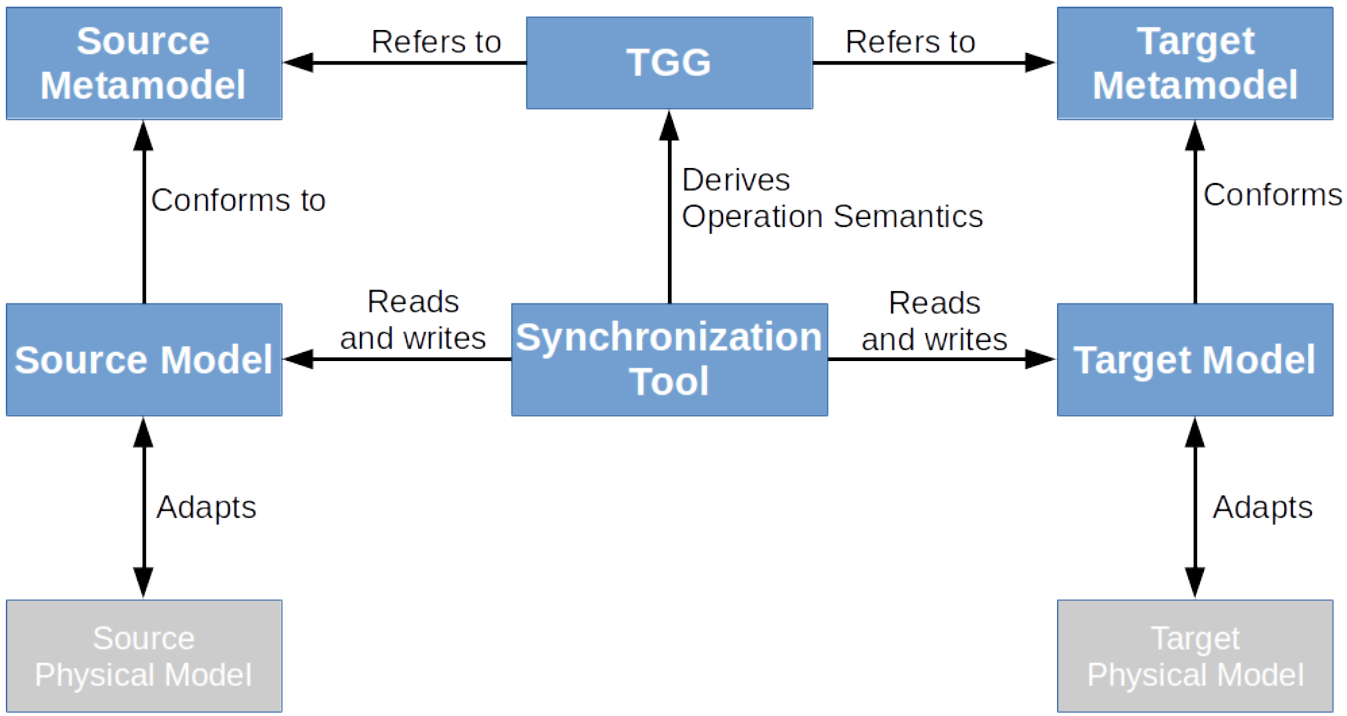

- Treated separately by state-of-the-art approaches
- How to treat the whole network of metamodels?

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
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- 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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   - Evaluation of the definitions through forward transformation
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   - 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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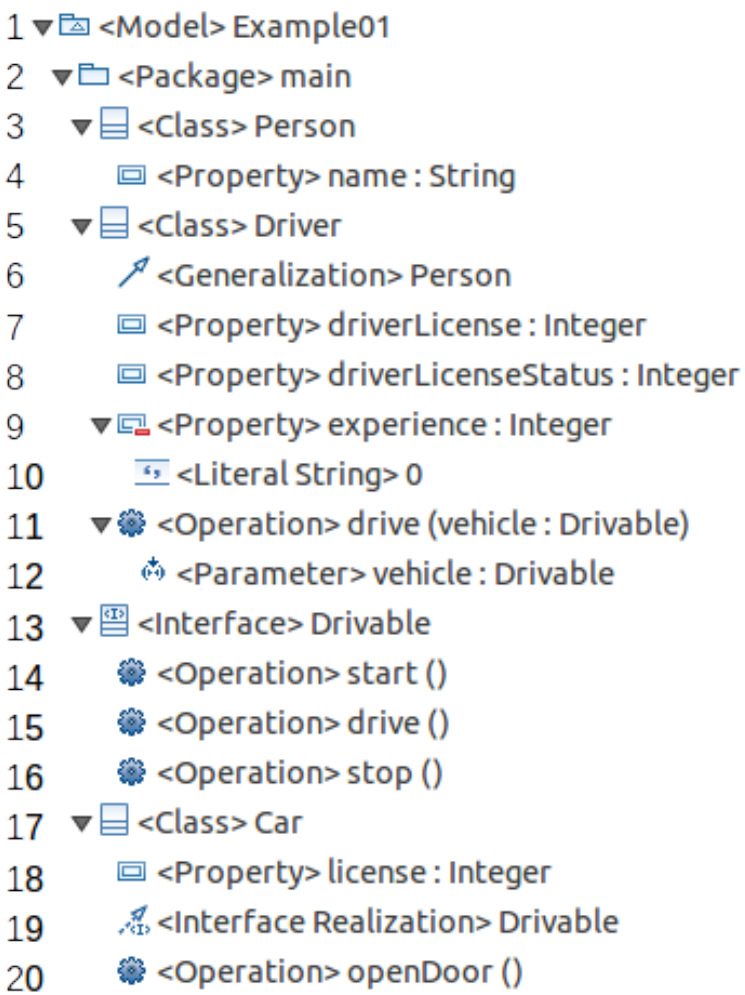
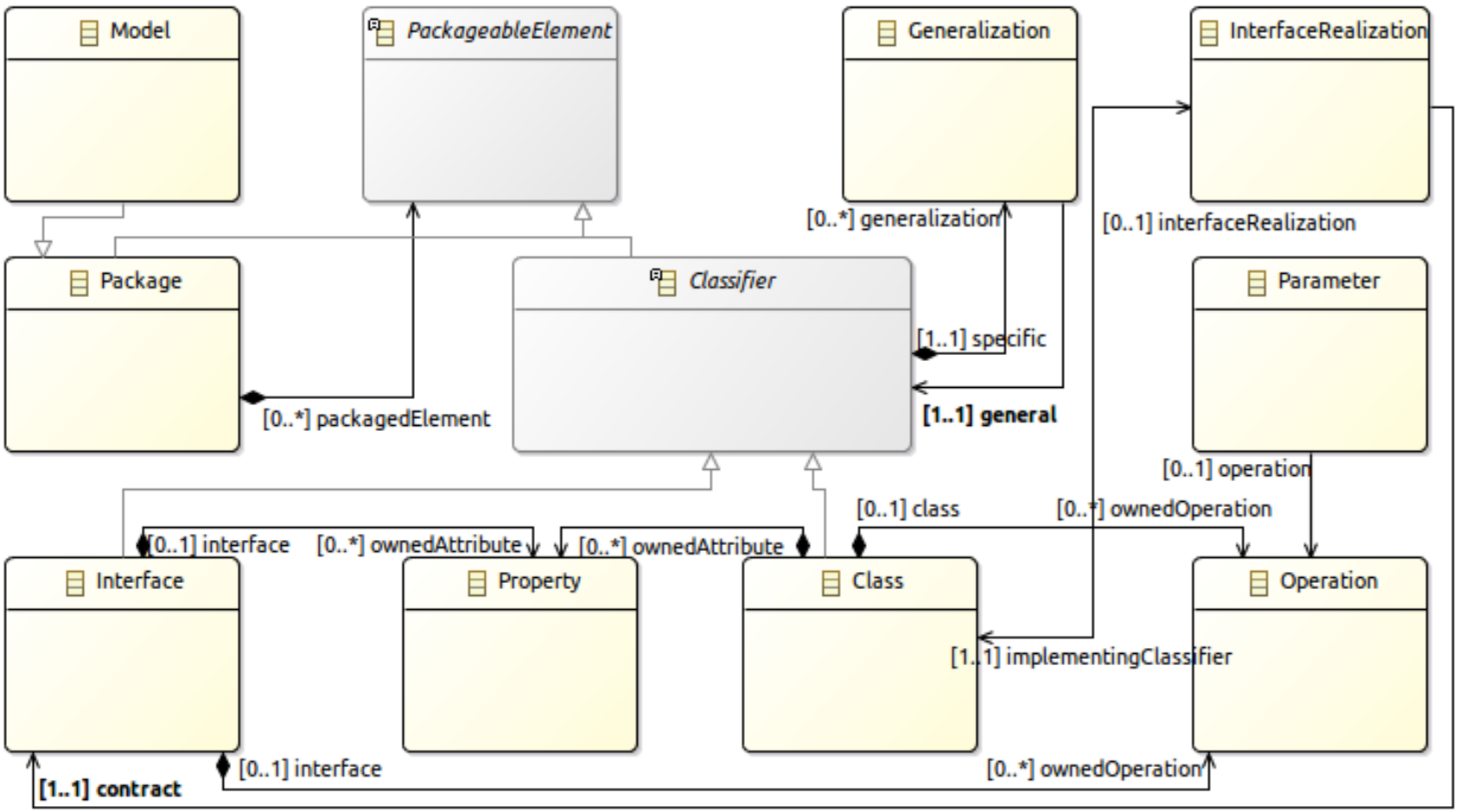
Appendix

UMLClassDiagram Abstract Syntax Example



UMLClassDiagram Metamodel



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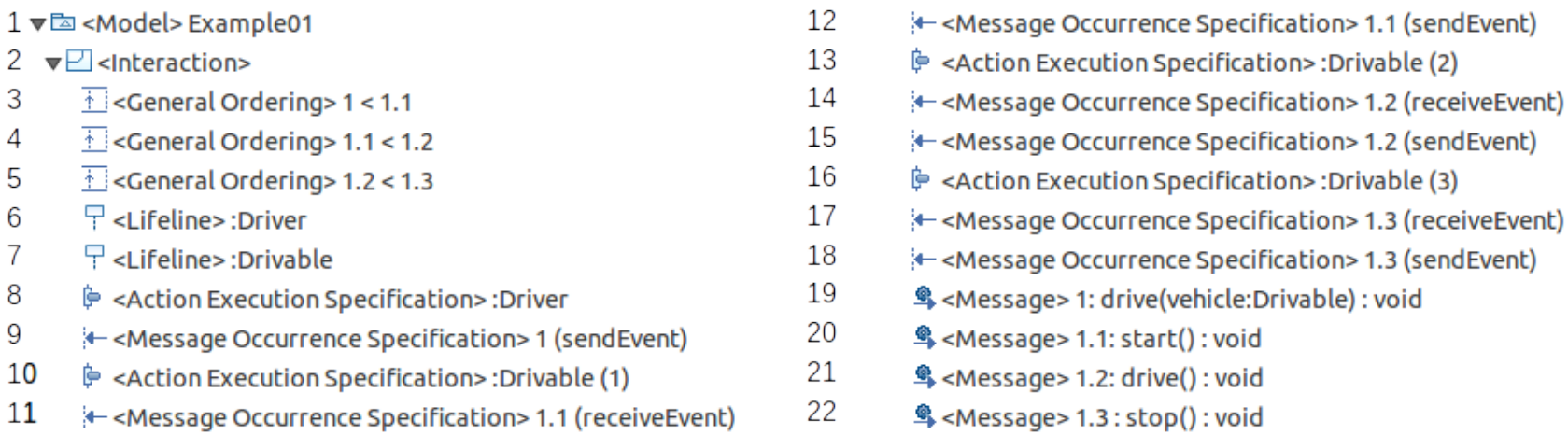

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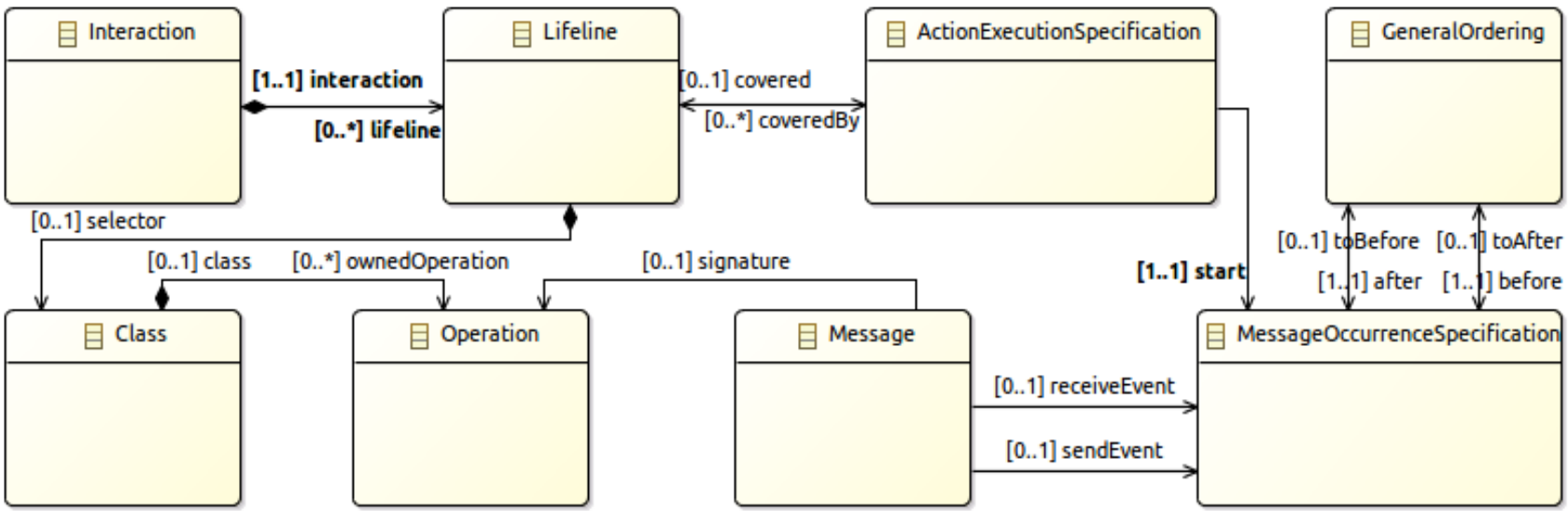
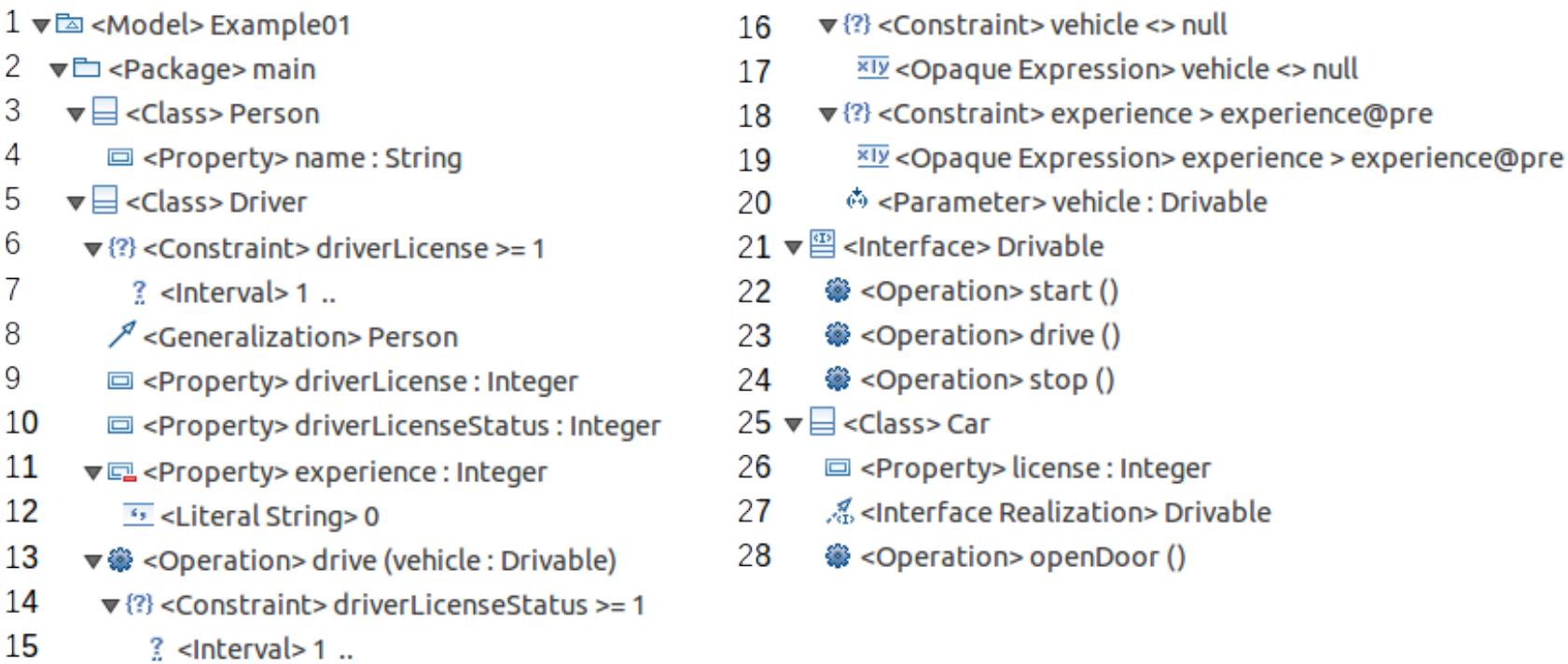


UMLContract Abstract Syntax Example



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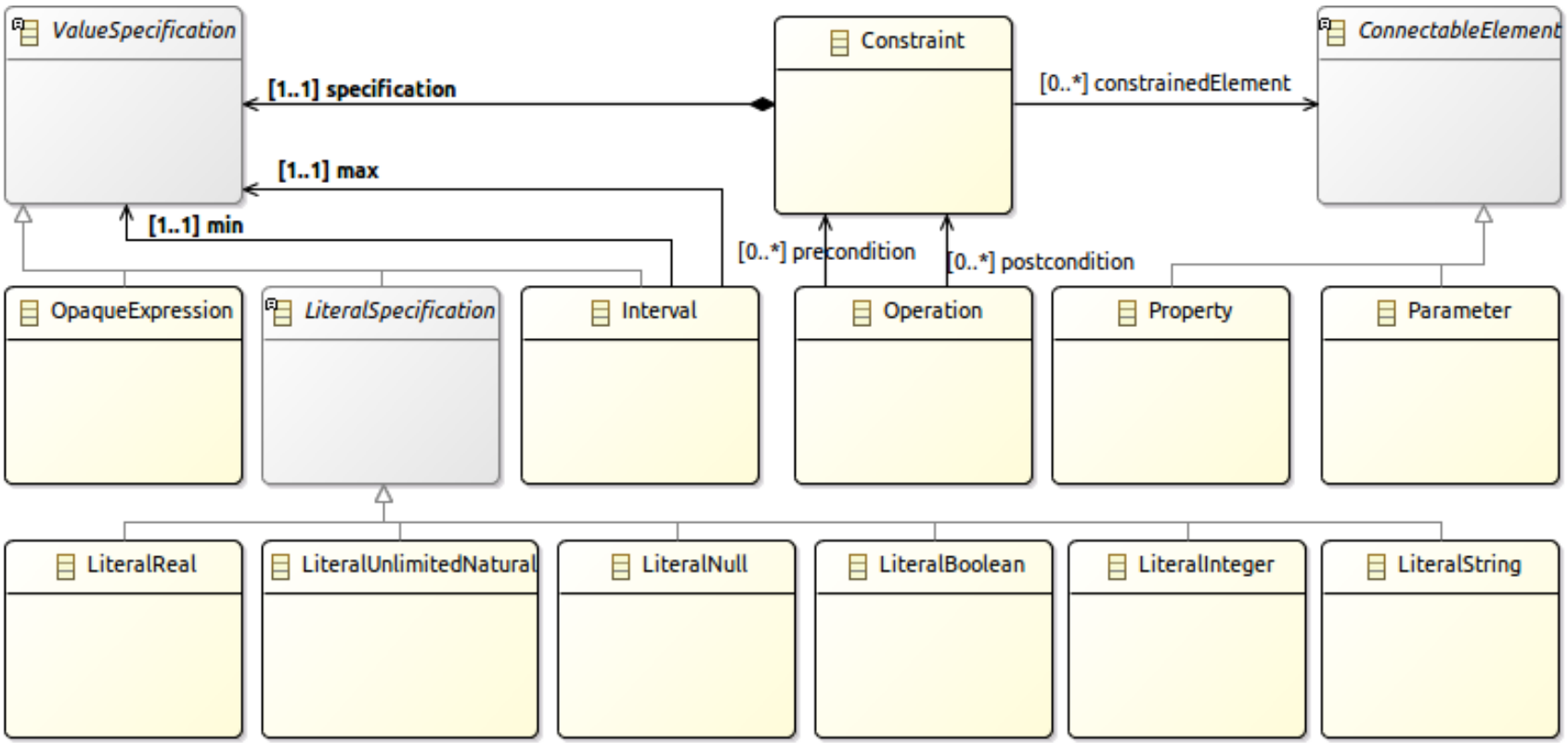
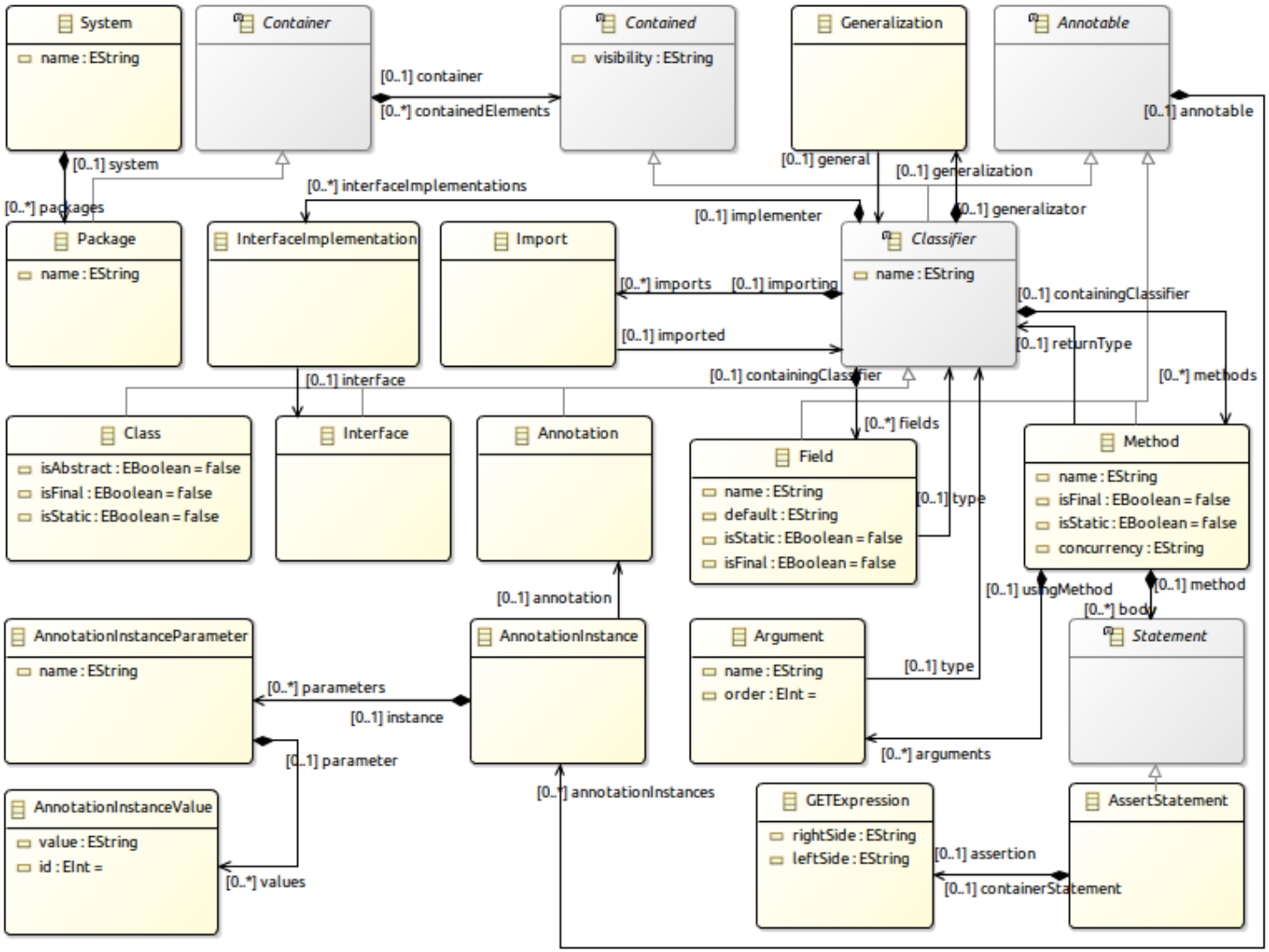
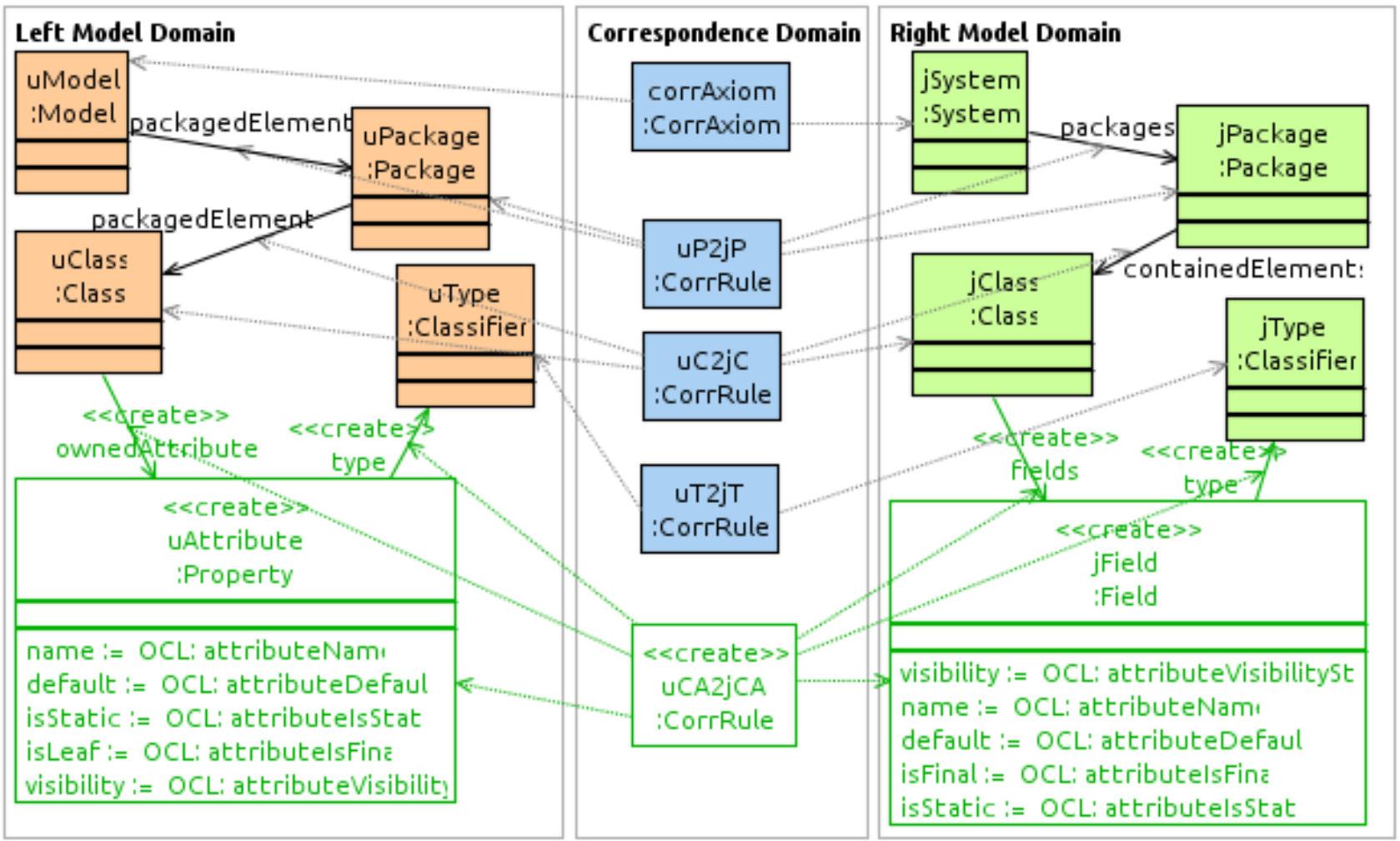


Java Abstract Syntax Example

Java Metamodel



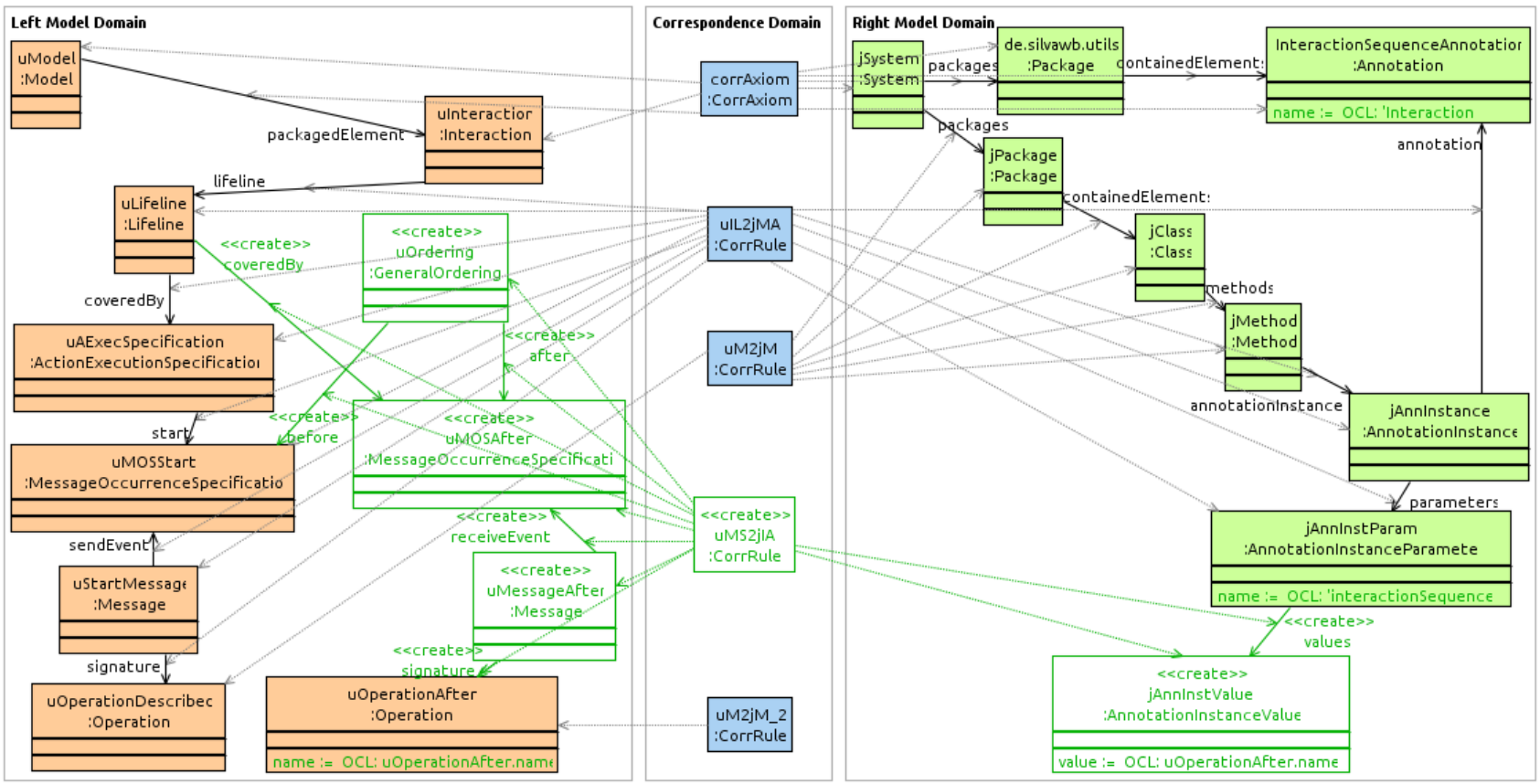
One triple rule for UMLClassDiagram2java



Result of the implementation for UMLClassDiagram2java

- Forward transformation was applied.

One triple rule for UMLSequenceDiagram2java



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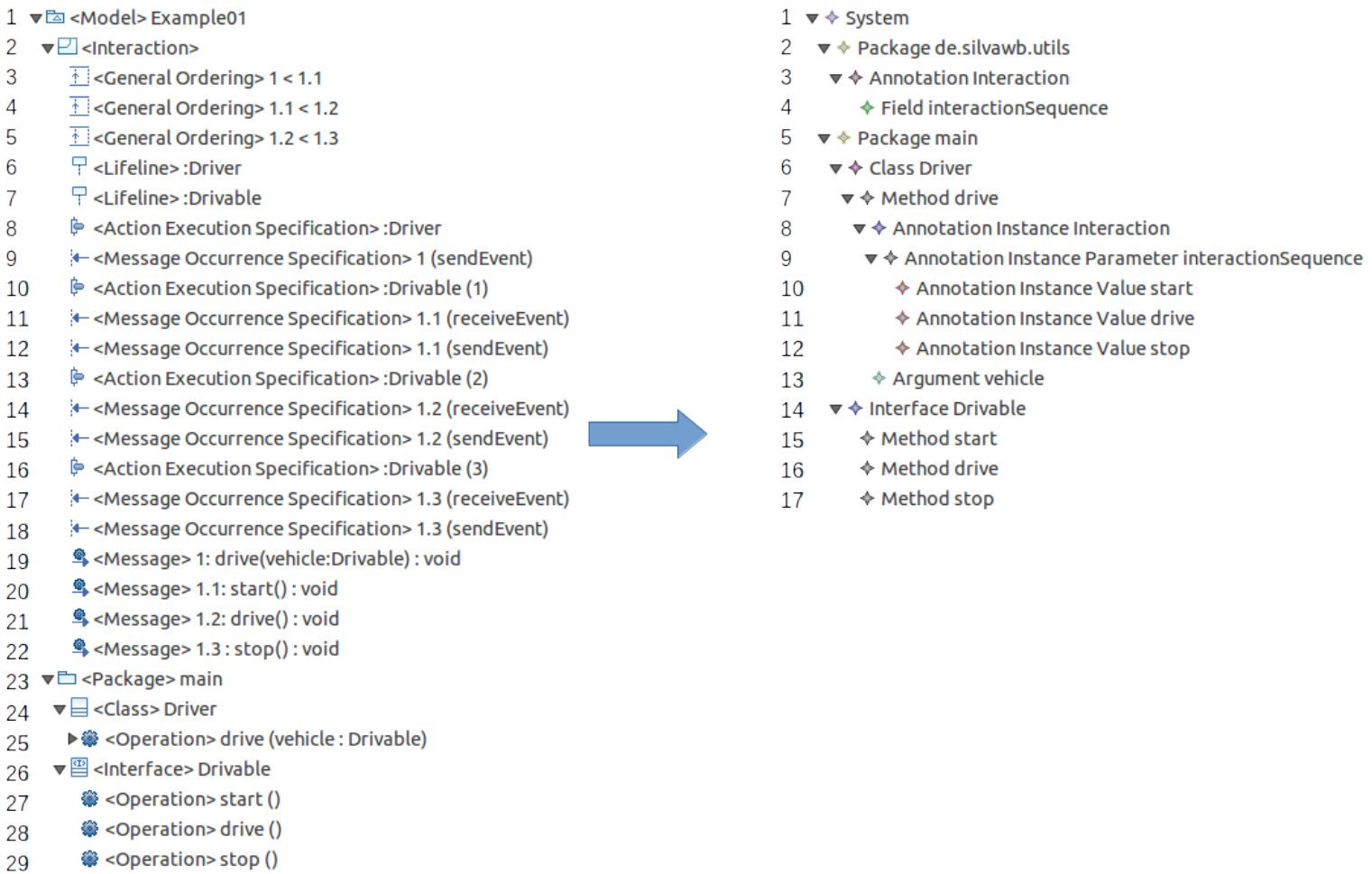
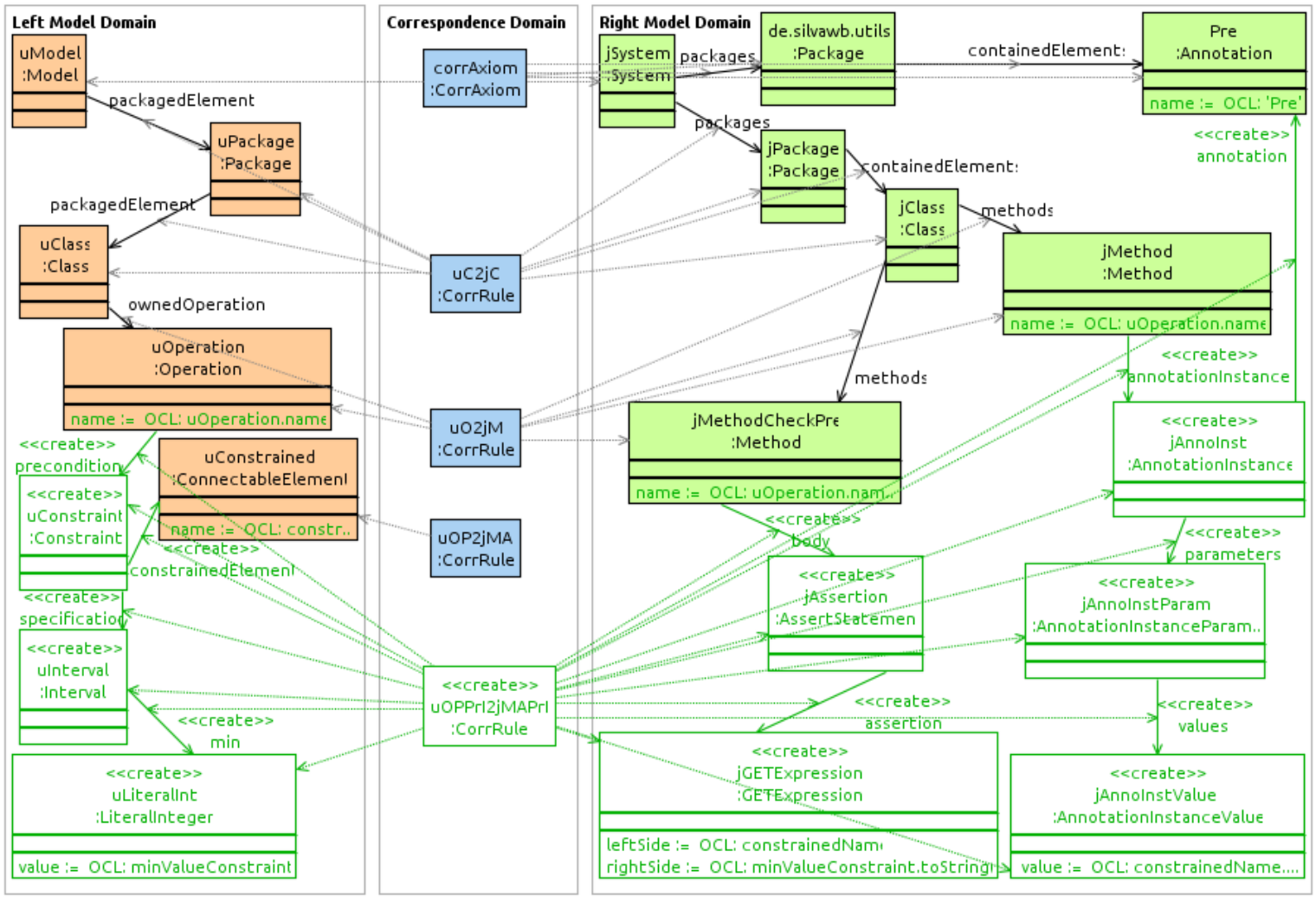


One triple rule for UMLContract2java



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