

# Generating Edit Operations for Profiled UML Models

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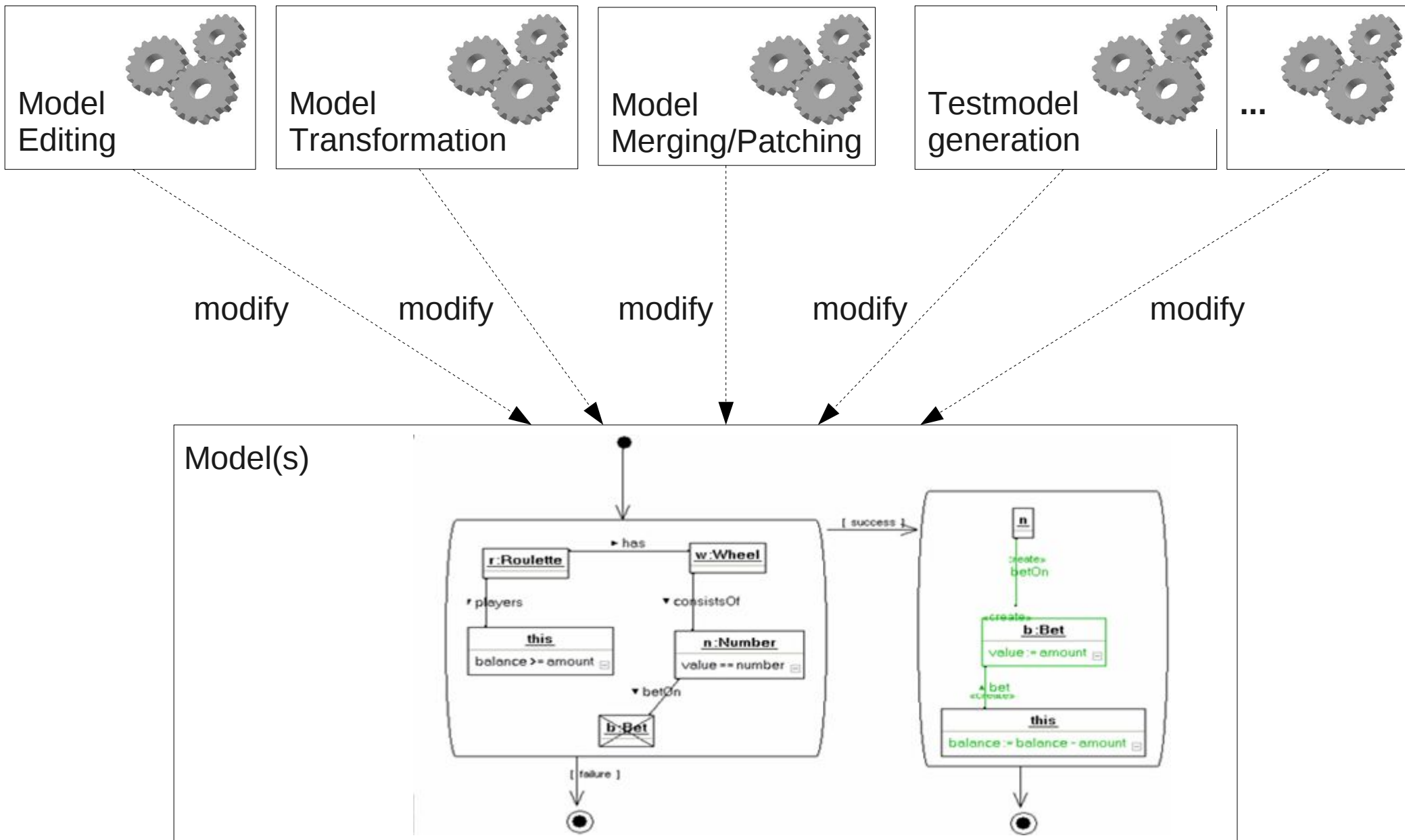
Software Engineering Group  
University of Siegen, Germany

Workshop on Models and Evolution  
@MoDELS 2013

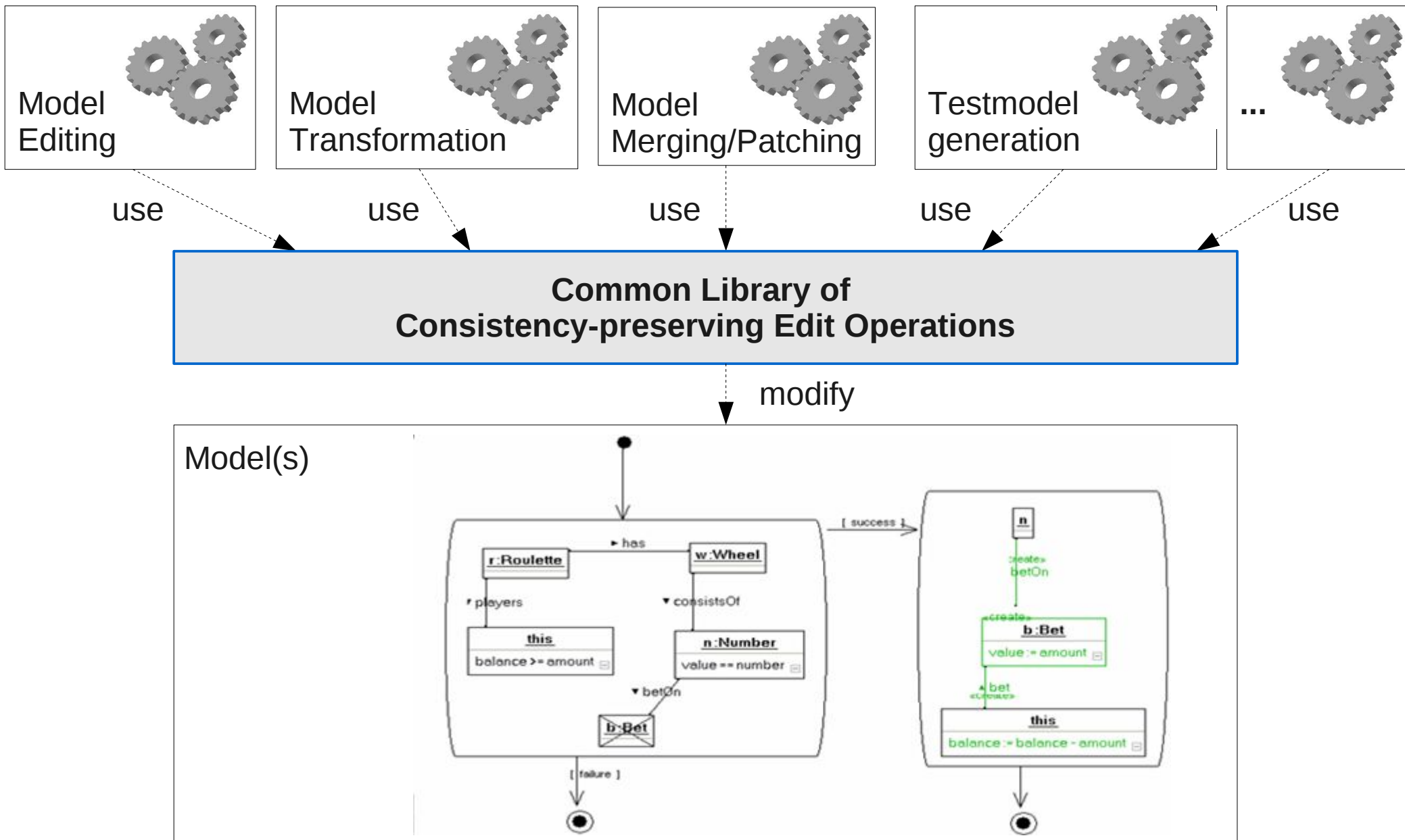
- Motivation
- Consistency-preserving Edit Operations
- The UML Profile Mechanism
- Edit Operations for Profiled UML Models
- Case Study

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# Modification of models



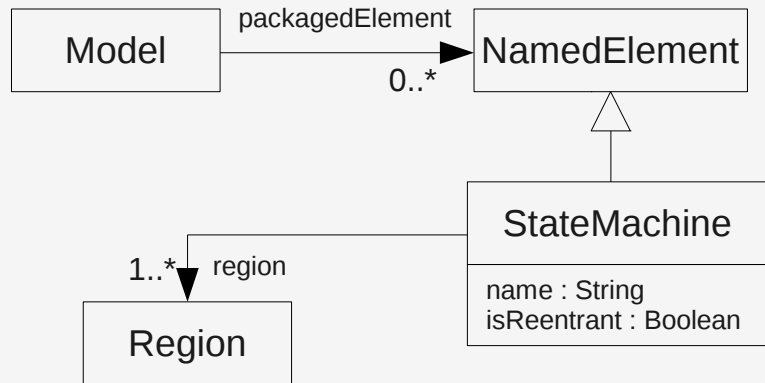
# Modification of models



- Motivation
- Consistency-preserving Edit Operations
- The UML Profile Mechanism
- Edit Operations for Profiled UML Models
- Case Study

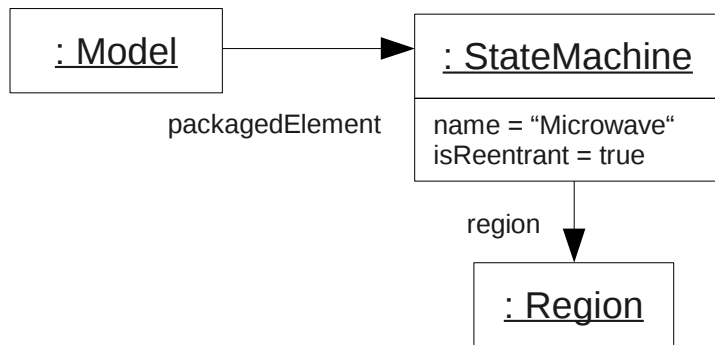
# Meta-models and consistency of models

## Meta-model



conforms to

## Model



## Structural definitions

Types of nodes

Types of edges

Attributes

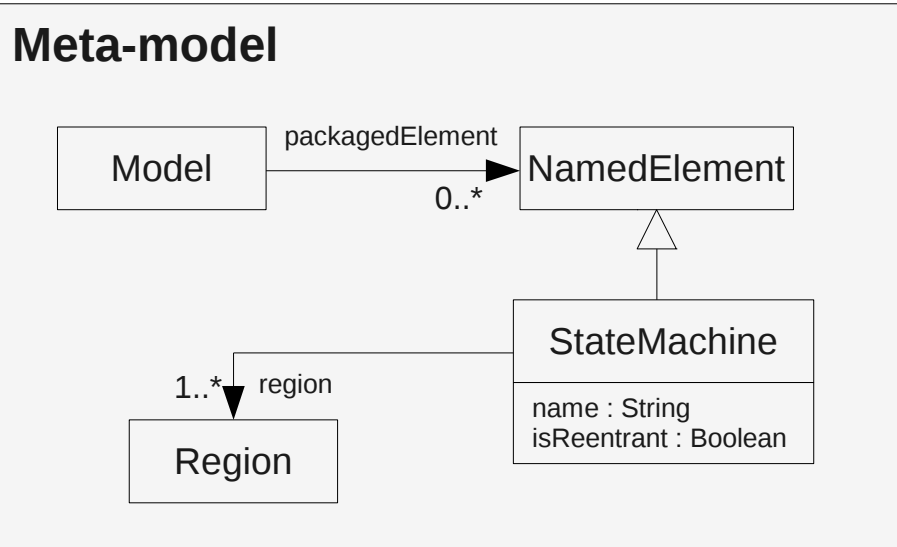
## Well-formedness constraints

Multiplicity constraints

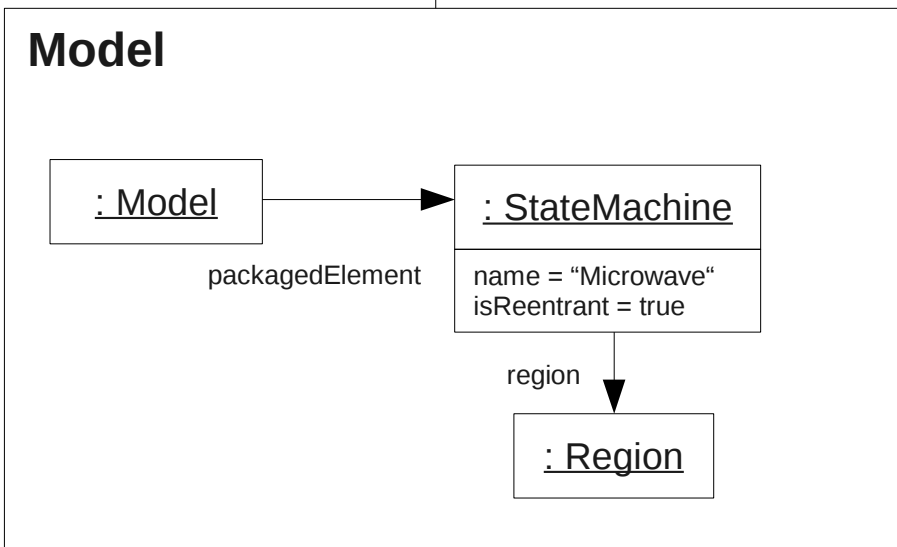
Arbitrary OCL constraints

Represented as  
Abstract Syntax Graph  
(ASG)

# Meta-models and consistency of models

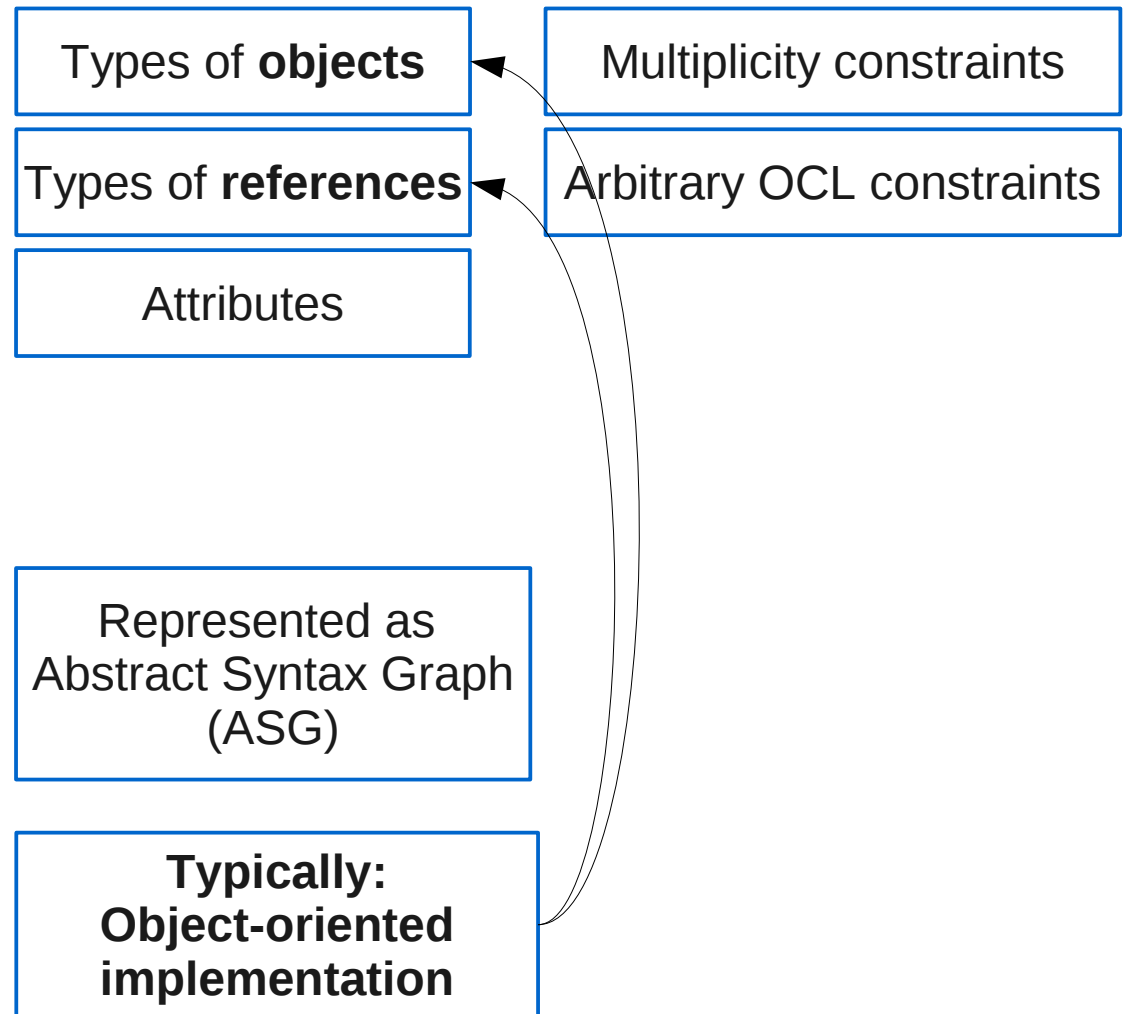


conforms to



**Structural definitions**

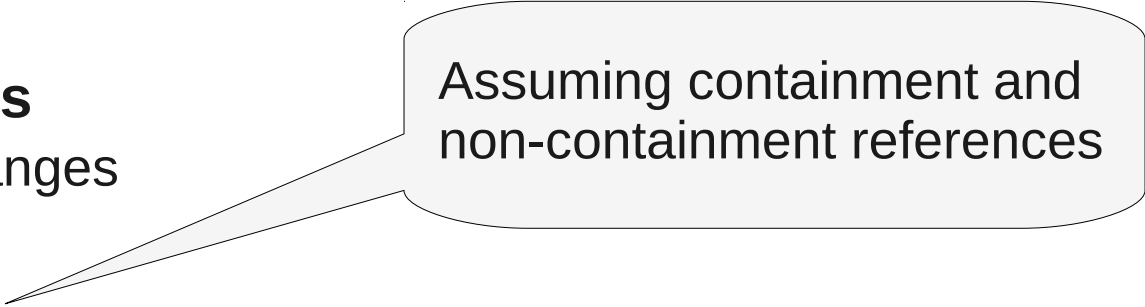
**Well-formedness constraints**





# Basic „graph operations“

- **Creation operations**
  - Add object
  - Add reference
- **Deletion operations**
  - Remove object
  - Remove reference
- **Change operations**
  - Attribute value changes
- **Move operations**
  - Change the container of an object



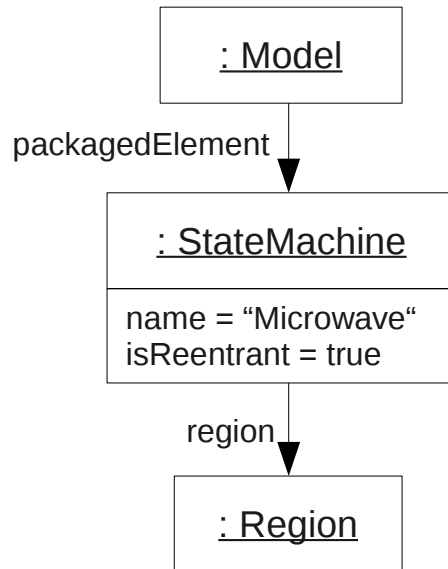
Assuming containment and non-containment references

# Edit operations: Motivating example

Initial model  
(abstract syntax)



Revised model  
(abstract syntax)

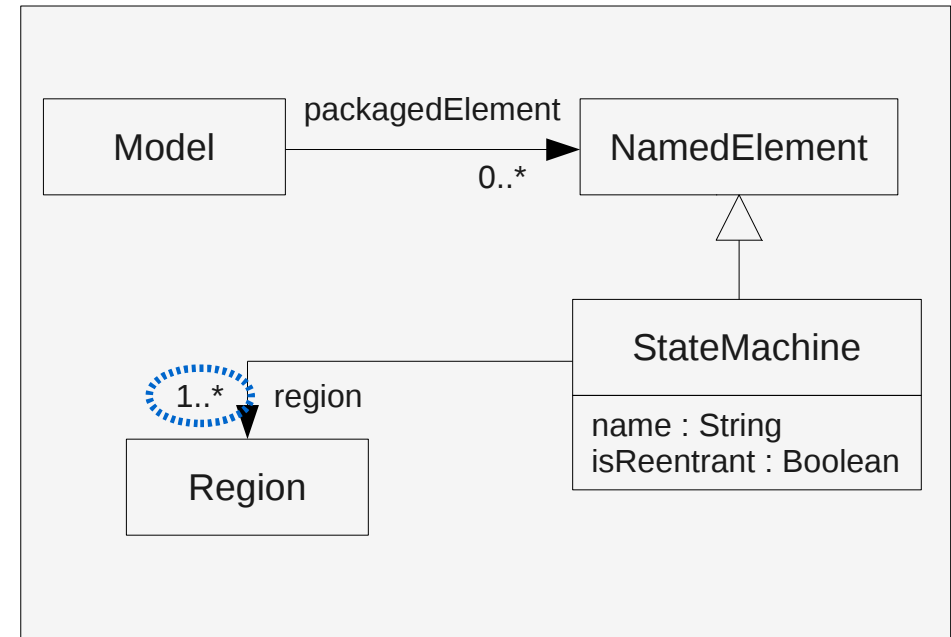


„transactional“

Minimal consistency-preserving  
edit operation (CPEO):

„createStateMachine“

Excerpt of the UML meta-model  
(simplified)



# Specification of edit operations

## CreateStateMachine:

### IN-Parameters:

- Selected : Model
- Name : String
- IsReentrant : Boolean

Object parameter

Value parameter

Value parameter

### OUT-Parameters:

- Child : Region

Object parameter

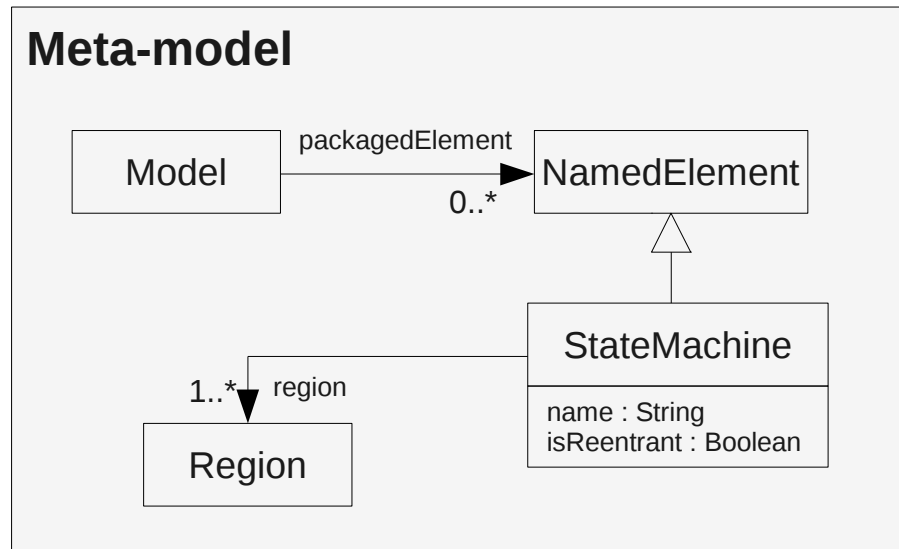
### Preconditions:

- „There must not exist a StateMachine In the given Model with the same Name“

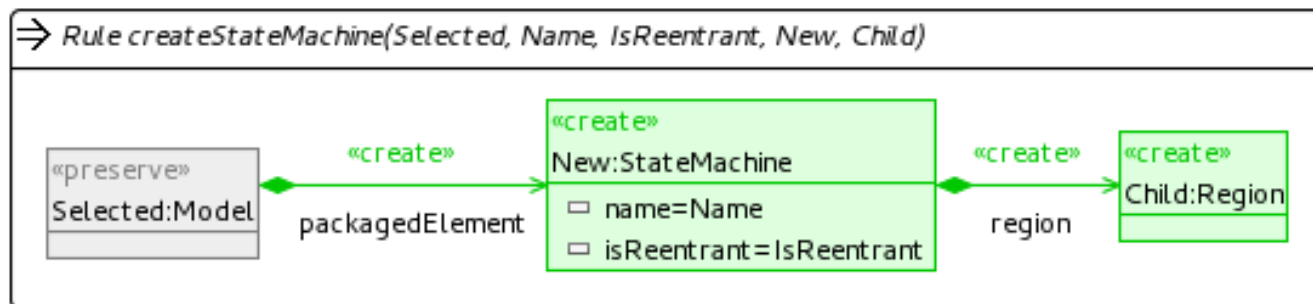
### Postconditions:

- -

# Generating executable edit operations



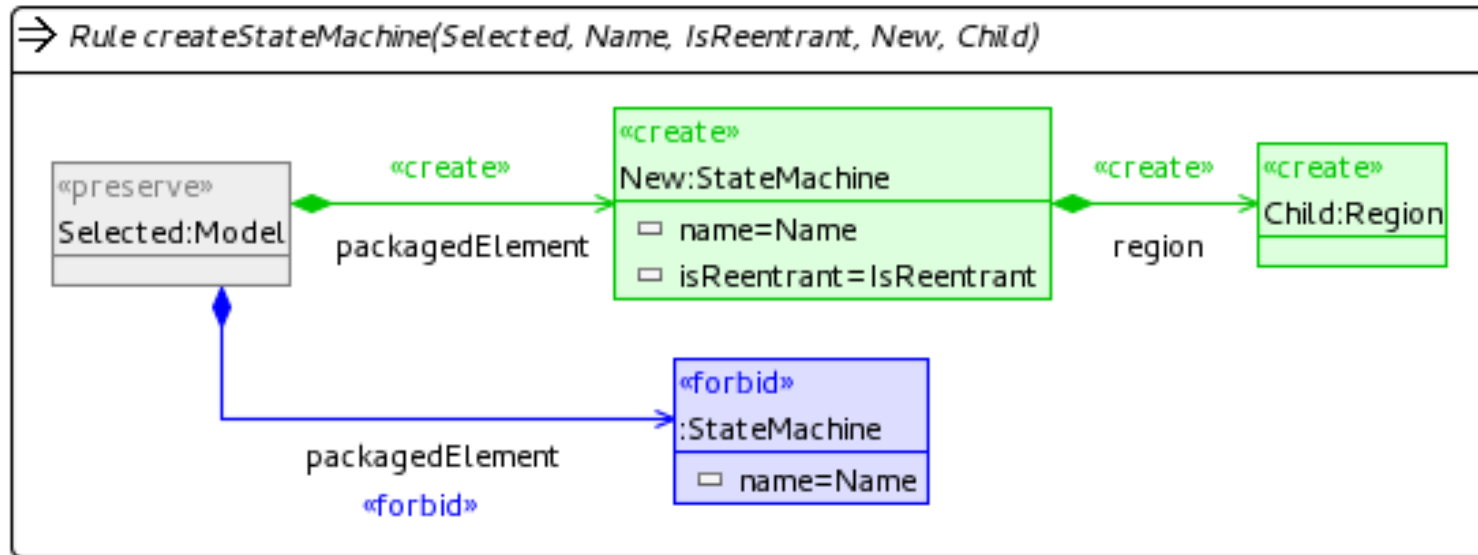
SiDiff Edit Rule Generator  
(SERGe)



Complete set of minimal CPEOs:

- Creation operations
- Deletion operations
- Change operations
- Move operations

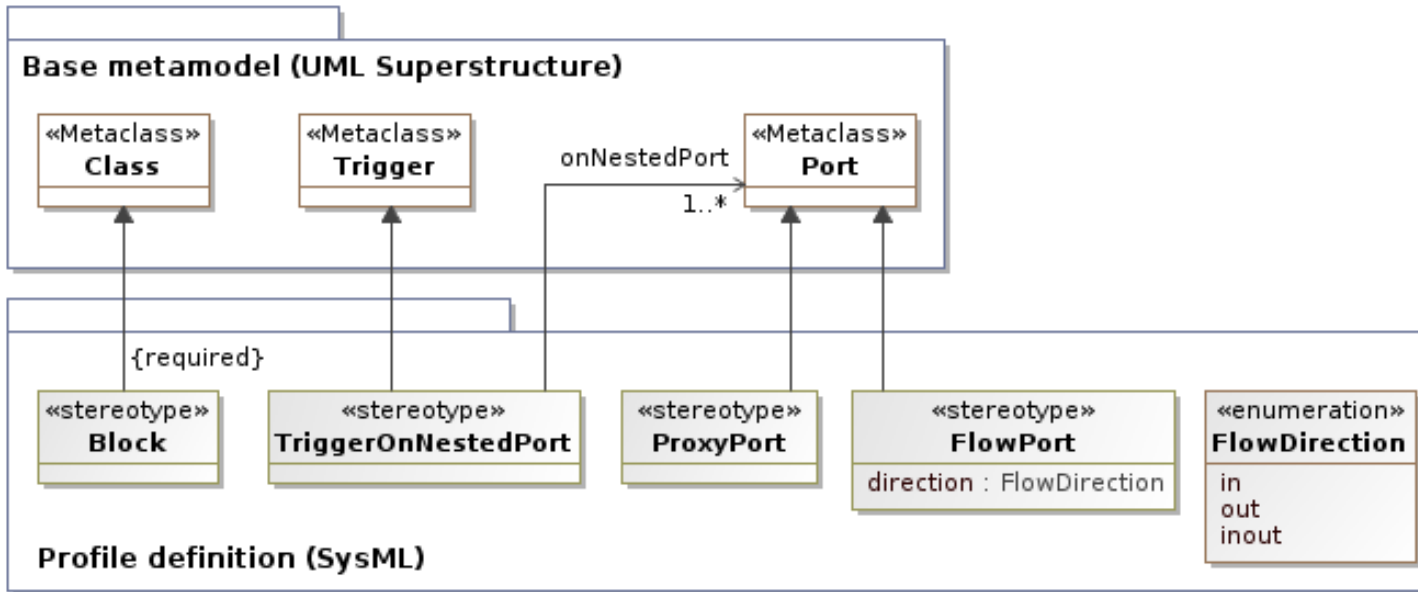
# Manual adaptations of generated operations



- All members of a UML Namespace (which includes the packaged elements of a Model) must be distinguishable by their names.
- **Negative Application Condition (NAC)**

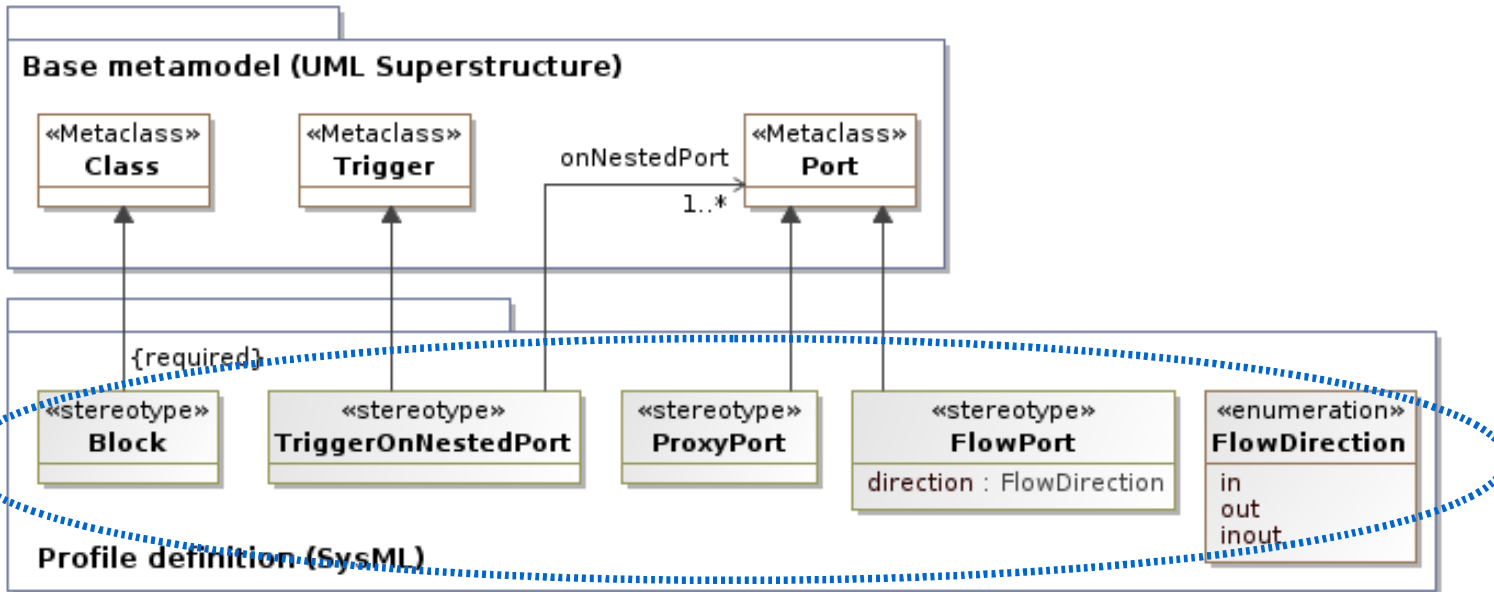
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# Running example: SysML



Profile definition  
(excerpt)

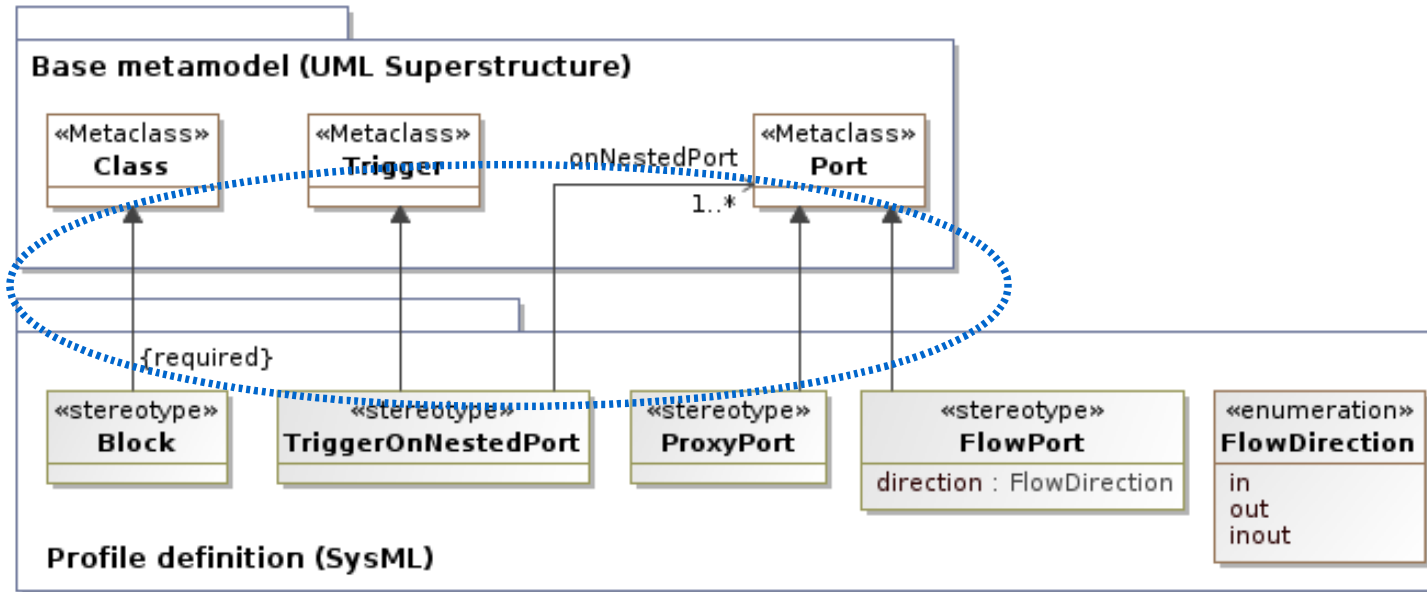
# Running example: SysML



Stereotypes



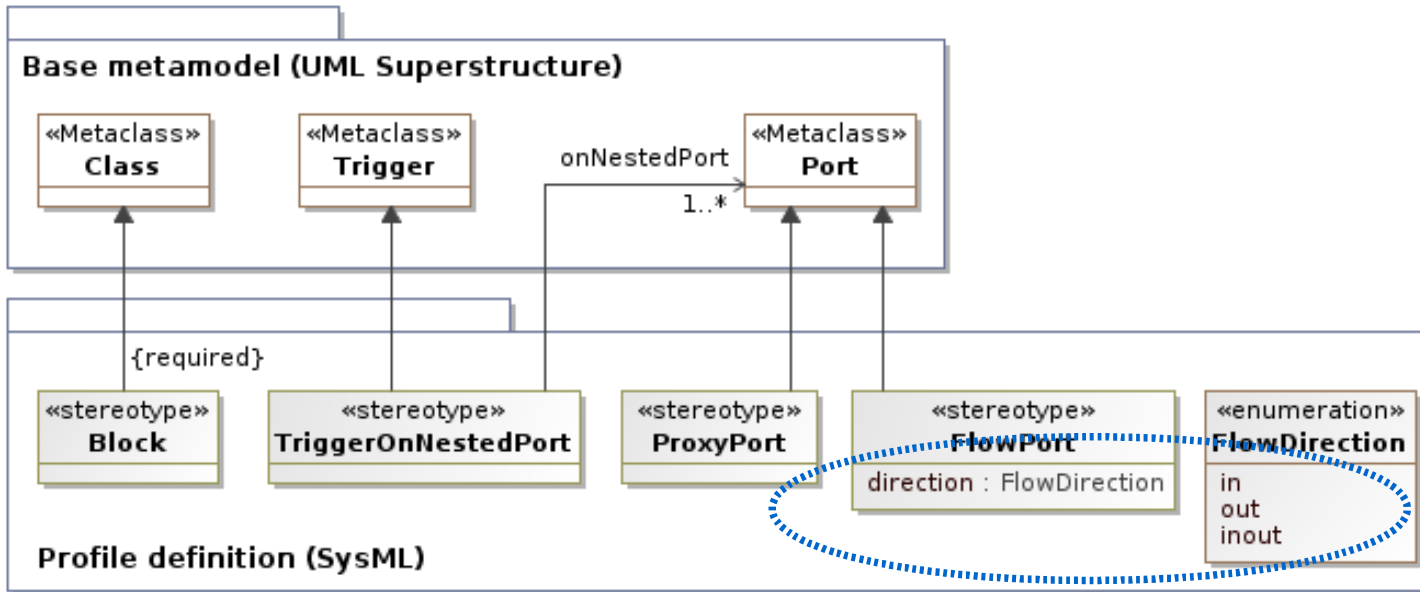
# Running example: SysML



Stereotypes

Extensions

# Running example: SysML

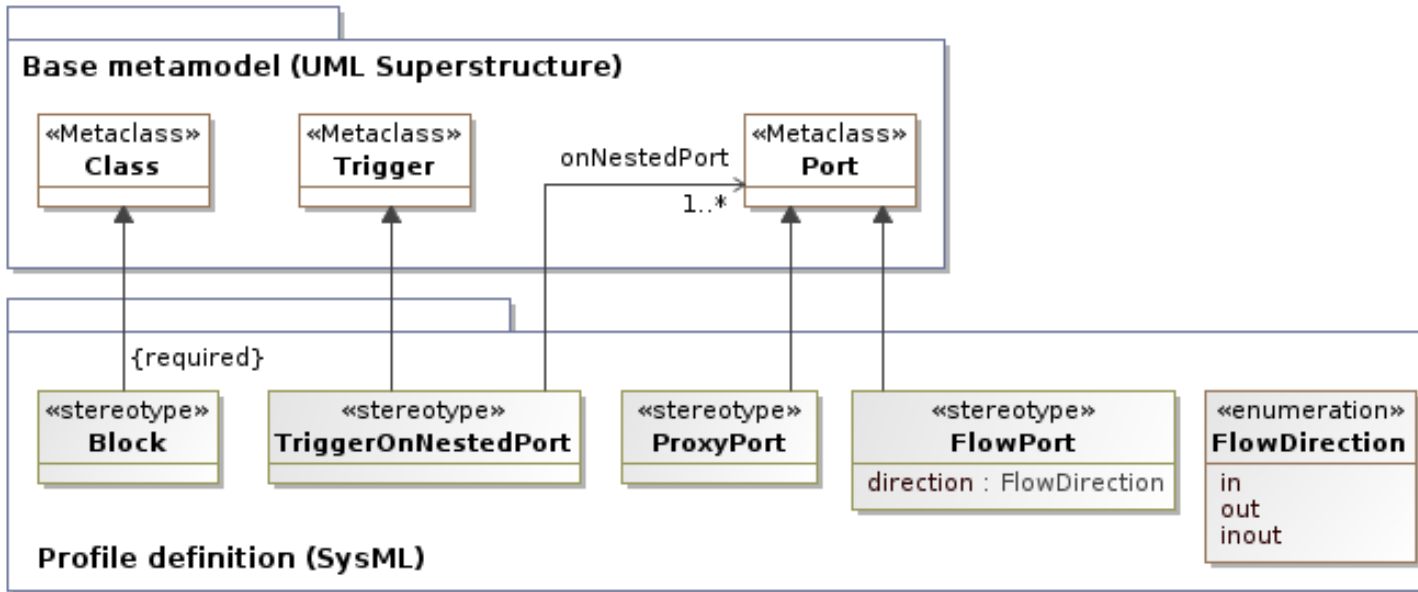


Stereotypes

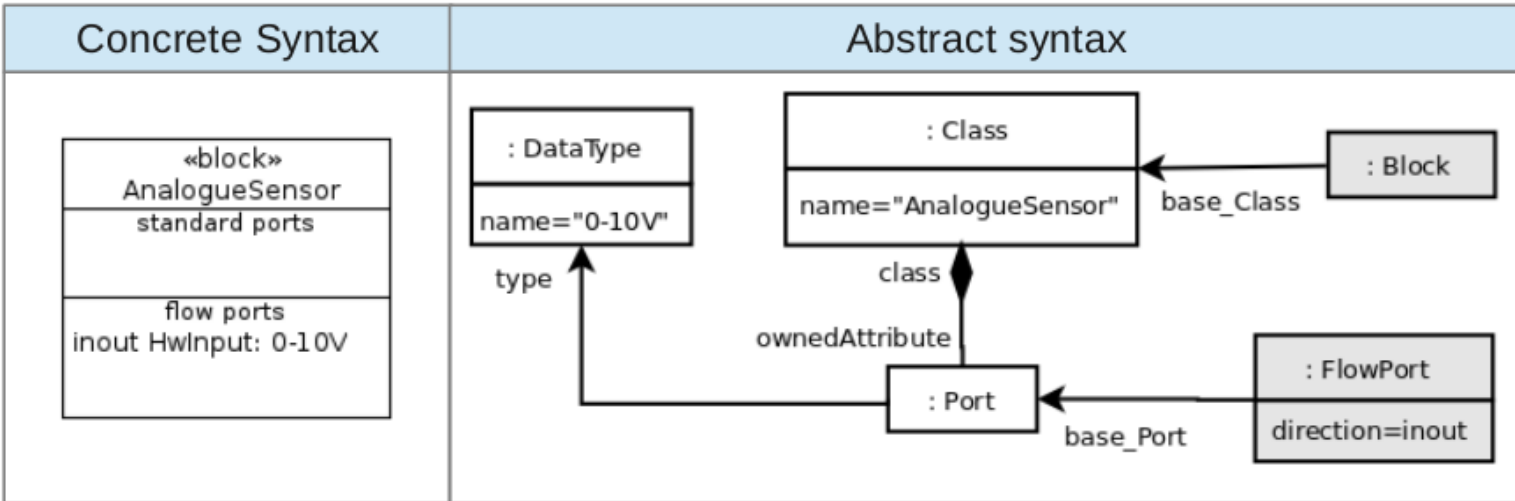
Extensions

Tagged Value Definitions

# Running example: SysML

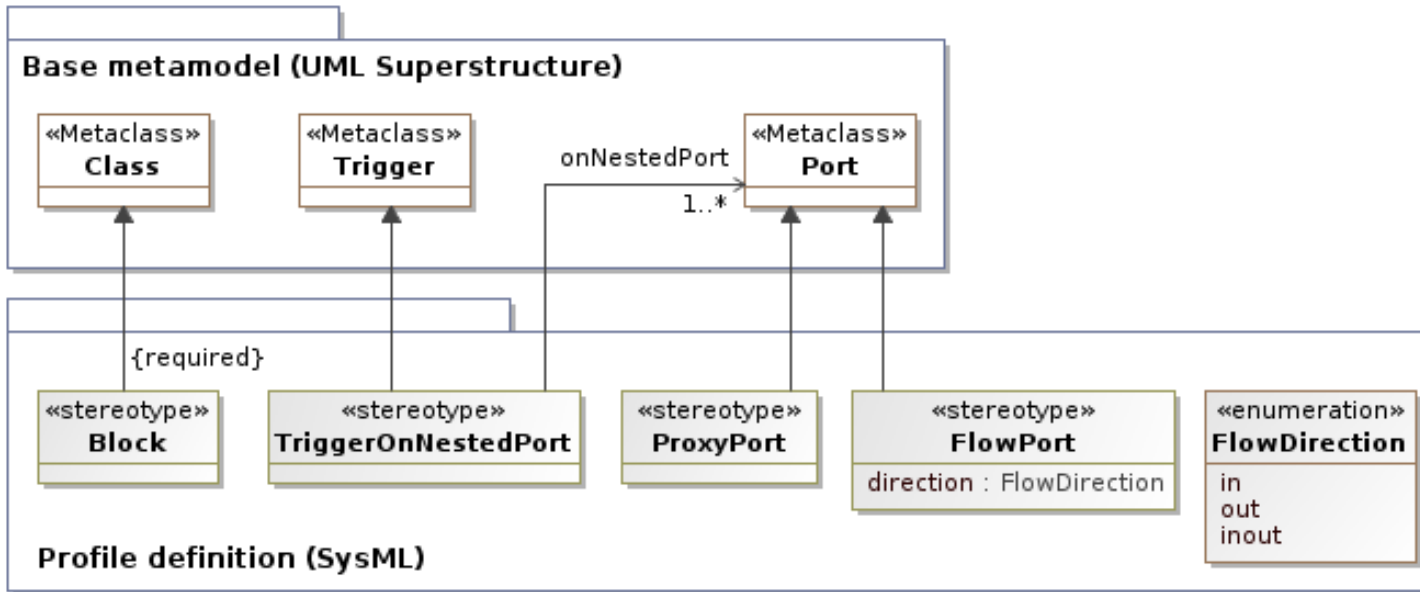


Profile definition (excerpt)



Sample profile application

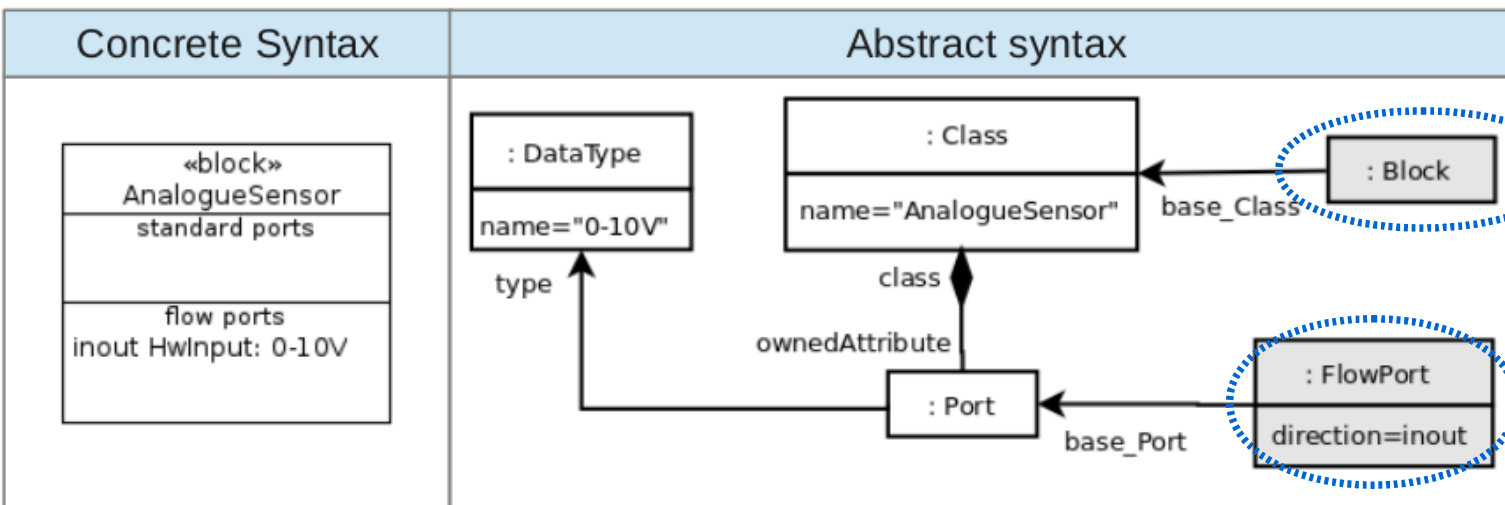
# Running example: SysML



Extensions

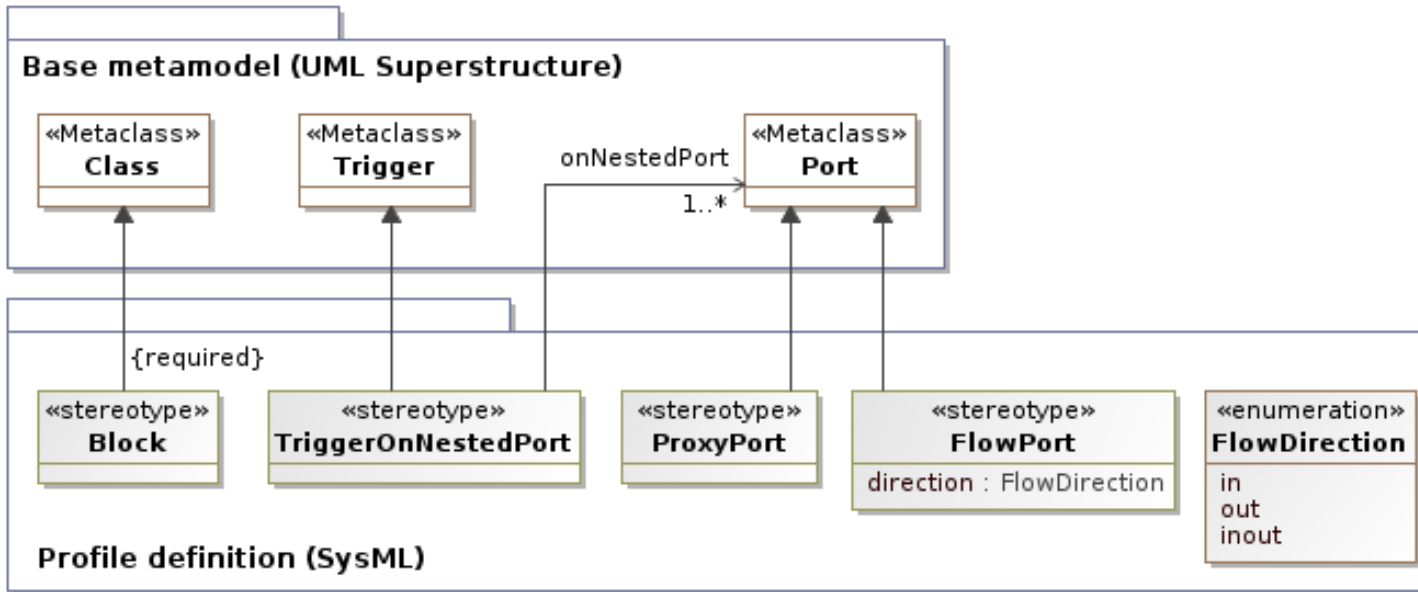
Stereotypes

Tagged Value Definitions

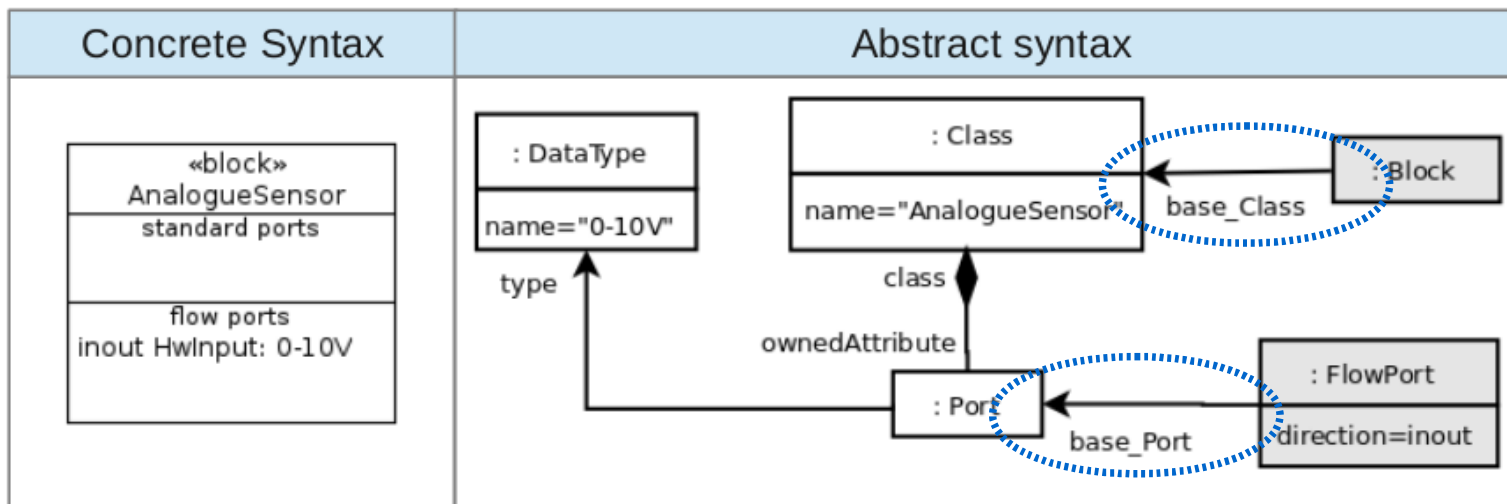


Stereotype Instances

# Running example: SysML

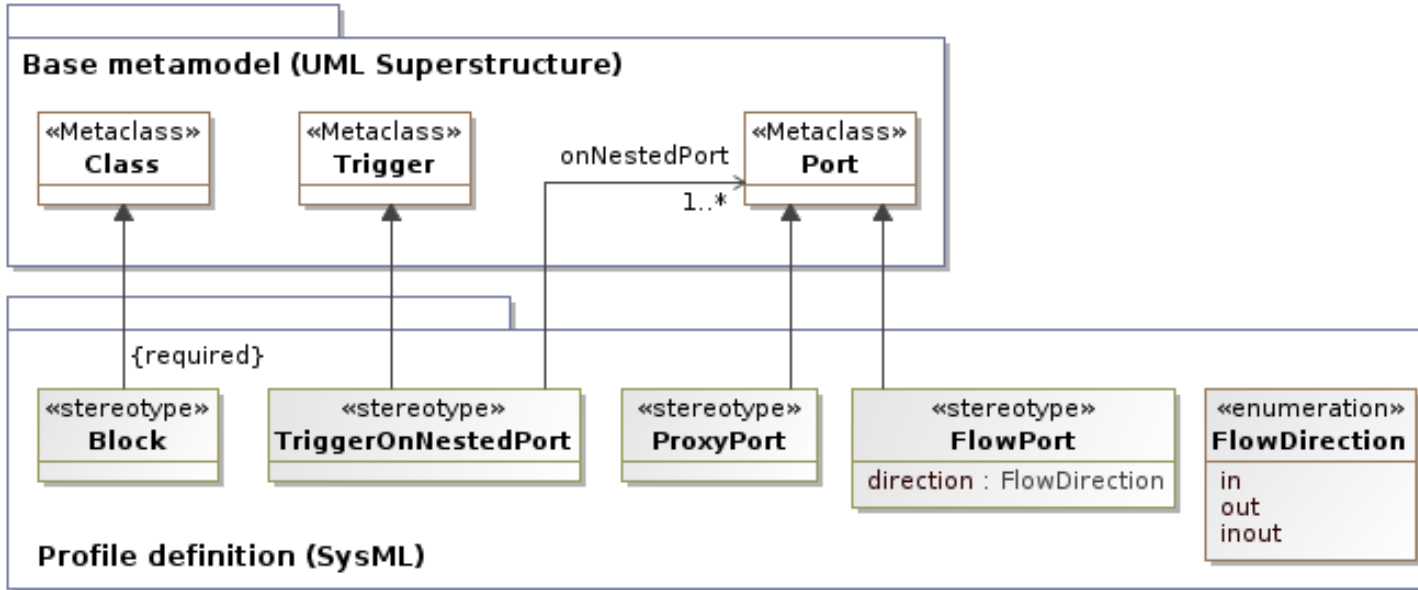


- Extensions
- Stereotypes
- Tagged Value Definitions



- Stereotype Instances
- Extension Links

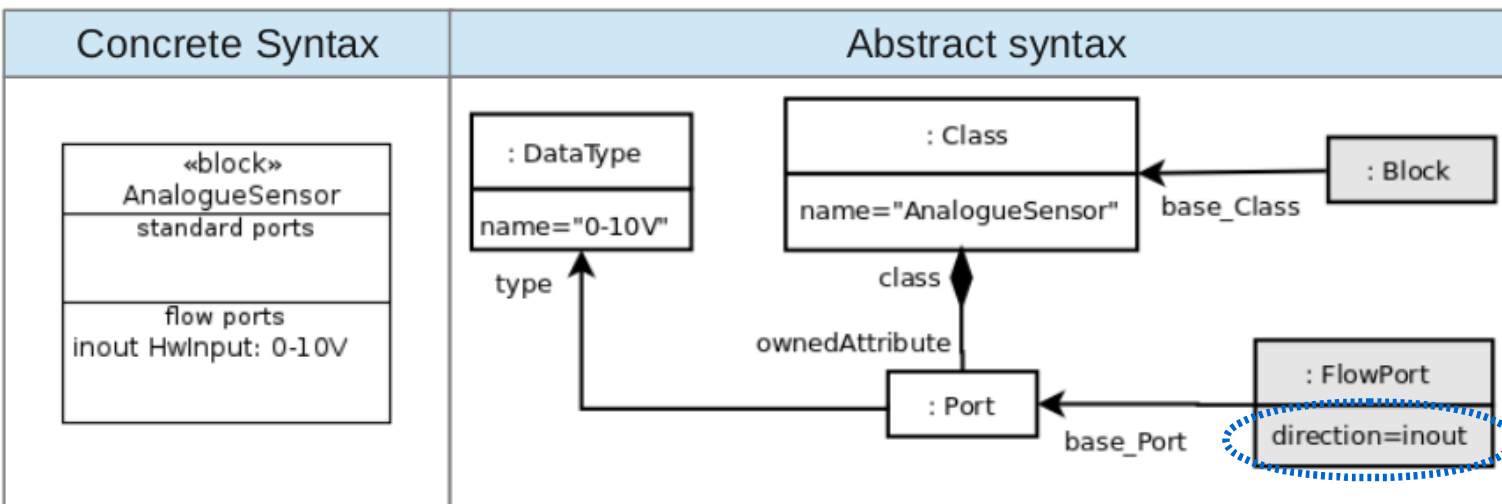
# Running example: SysML



Extensions

Stereotypes

Tagged Value Definitions



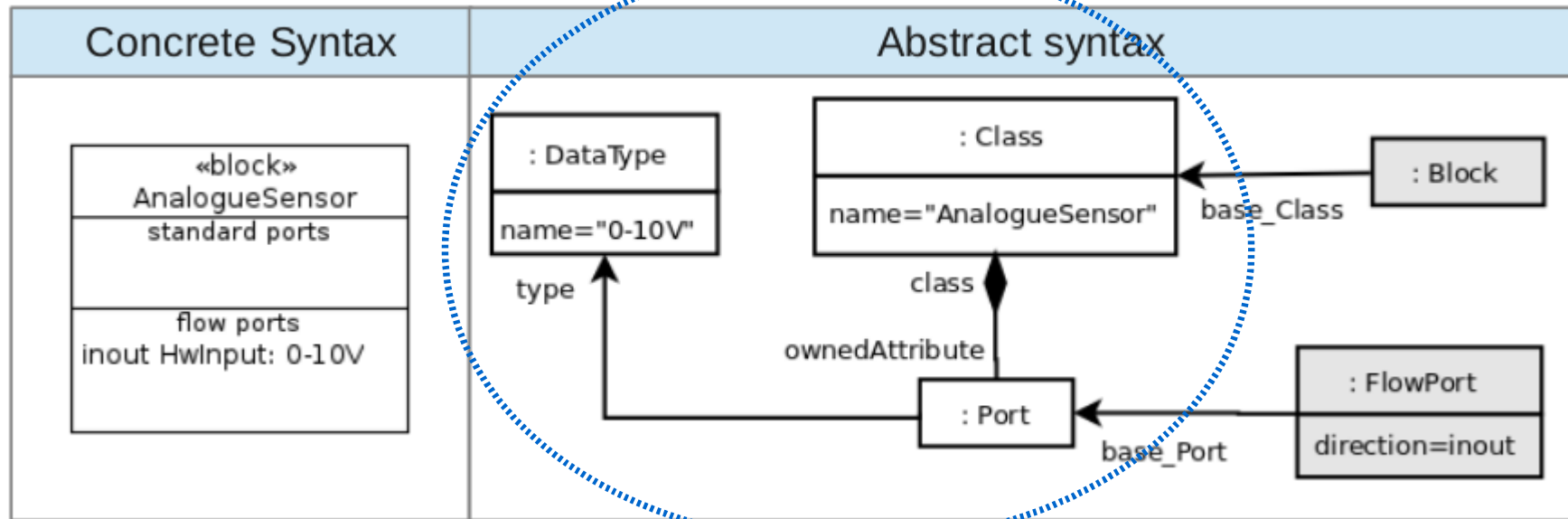
Extension Links

Stereotype Instances

Tagged Values

- Motivation
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# A: UML model element operations



- Operate on instances of meta-classes of the base meta-model
- In principle, no knowledge about applicable profiles is required

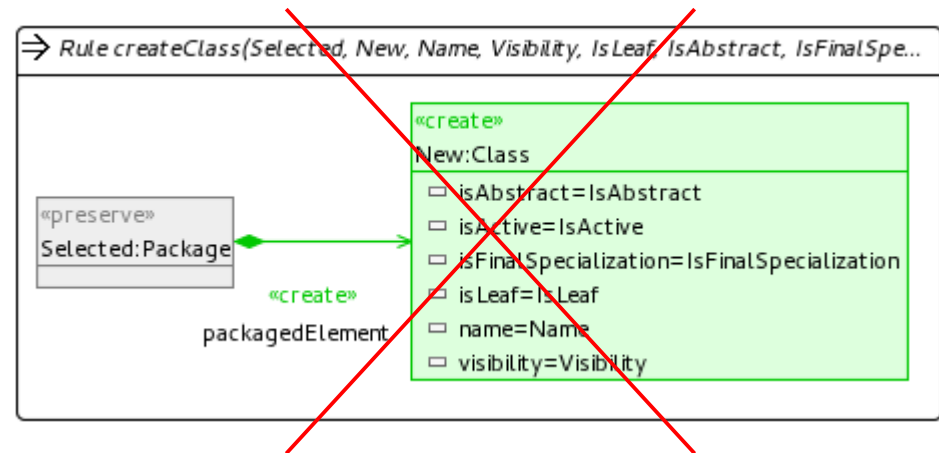


# A: UML model element operations

## Omit or rename...

Creation/deletion operations of UML model elements with required stereotypes

## SysML example



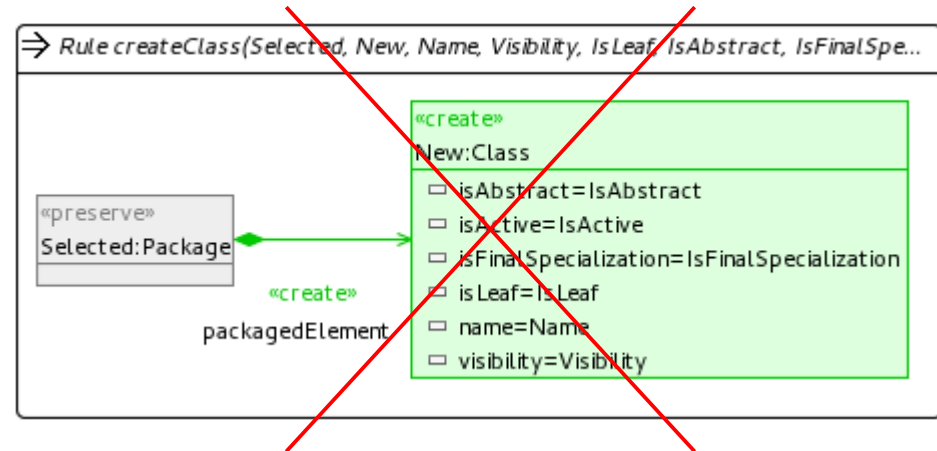
# A: UML model element operations

## Omit or rename...

Creation/deletion operations of UML model elements with required stereotypes

Renaming of change operations for the sake of understandability

## SysML example



setClassIsAbstract(IN:Boolean)

→ setBlockIsAbstract(IN:Boolean)

# A: UML model element operations

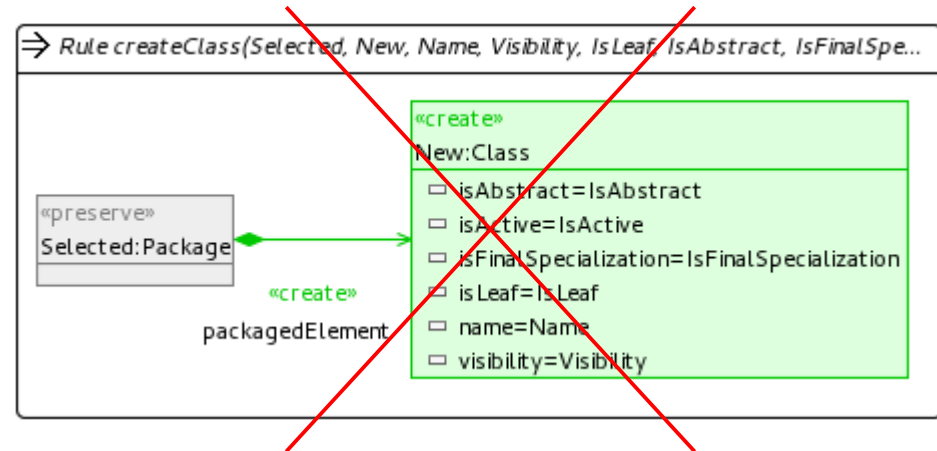
## Omit or rename...

Creation/deletion operations of UML model elements with required stereotypes

Renaming of change operations for the sake of understandability

Operations on model elements which are excluded by the profile definition

## SysML example

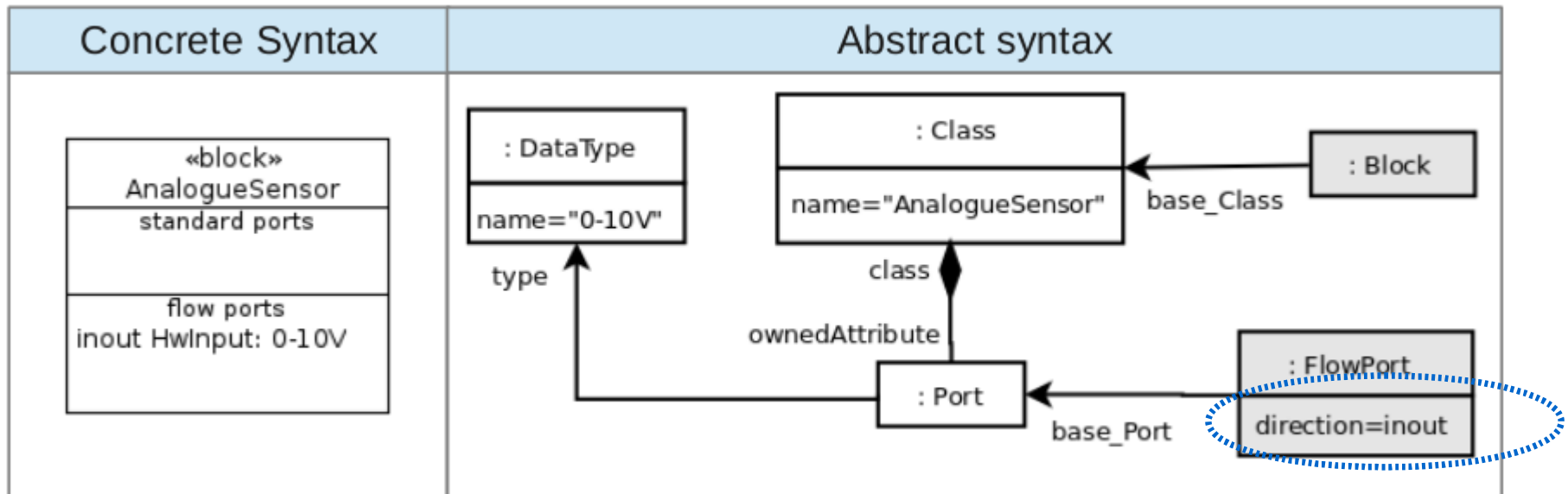


setClassIsAbstract(IN:Boolean)

→ setBlockIsAbstract(IN:Boolean)

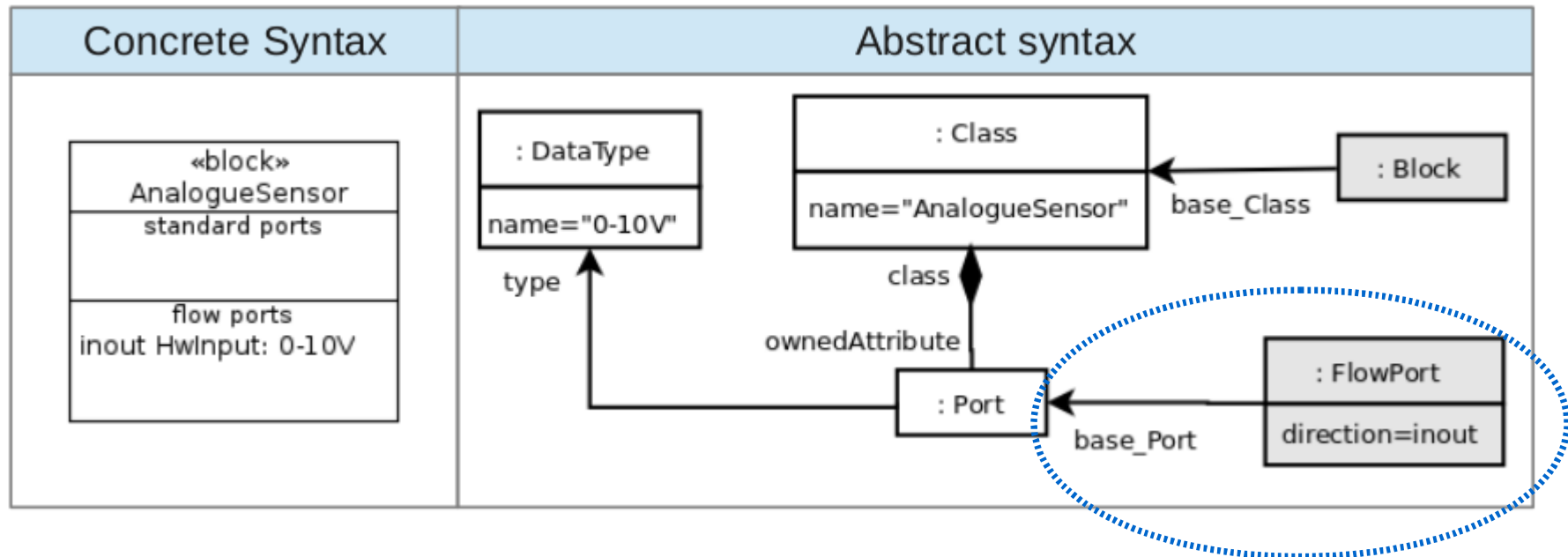
Edit operations modifying elements of type **Interaction**, **InteractionFragment** or **Lifeline**

# B: Tagged value modifications



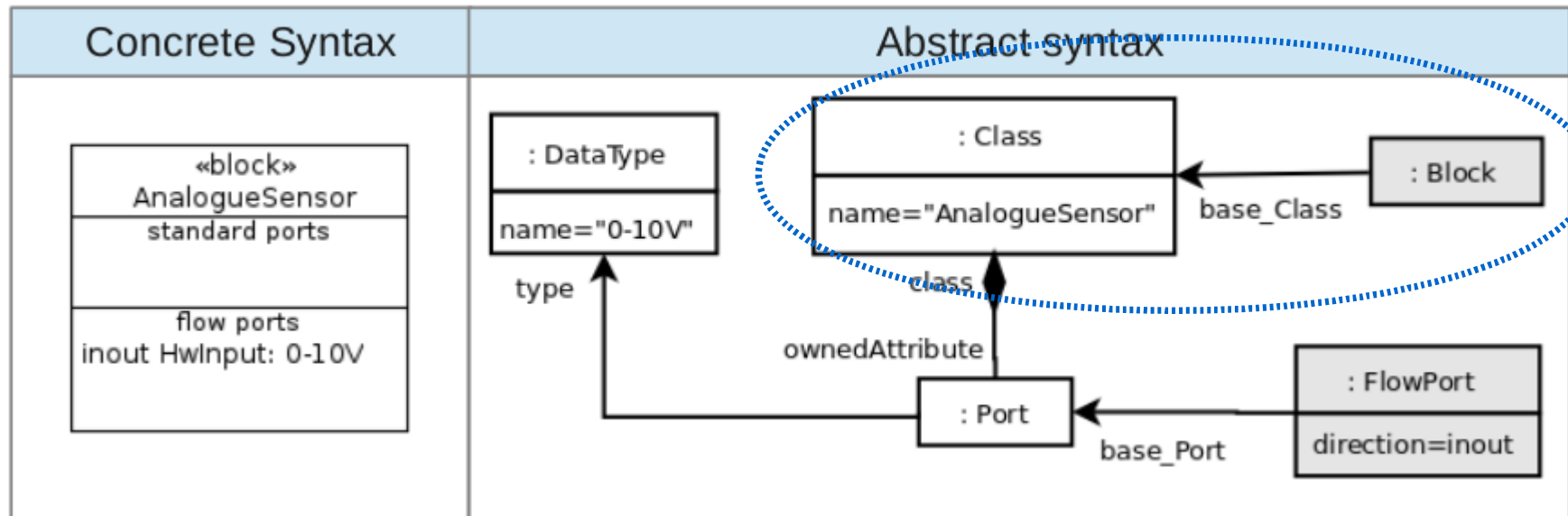
- Change attributes or references of stereotypes

# C: Stereotype applications



- Apply or revoke a stereotype at/from a UML model element
- Not permitted for stereotypes that are declared as required for their base meta-class (--> hybrid edit operations)

# D: Hybrid edit operations

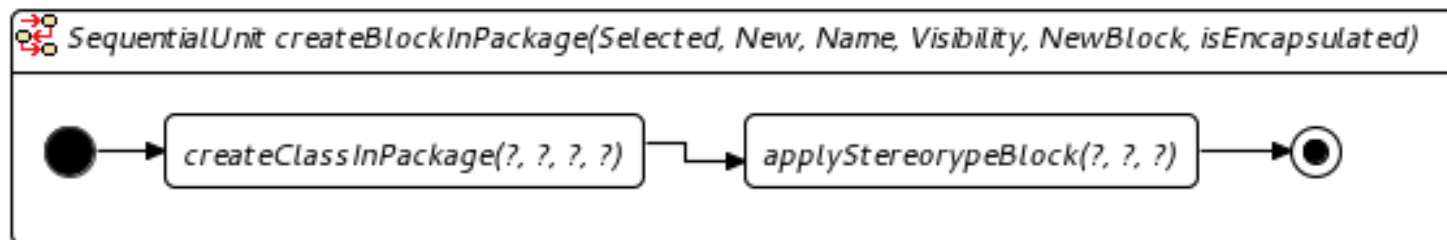


- Concurrently modify instances of base meta-classes and stereotype instances
- Typically, they create or delete model elements that have required stereotypes

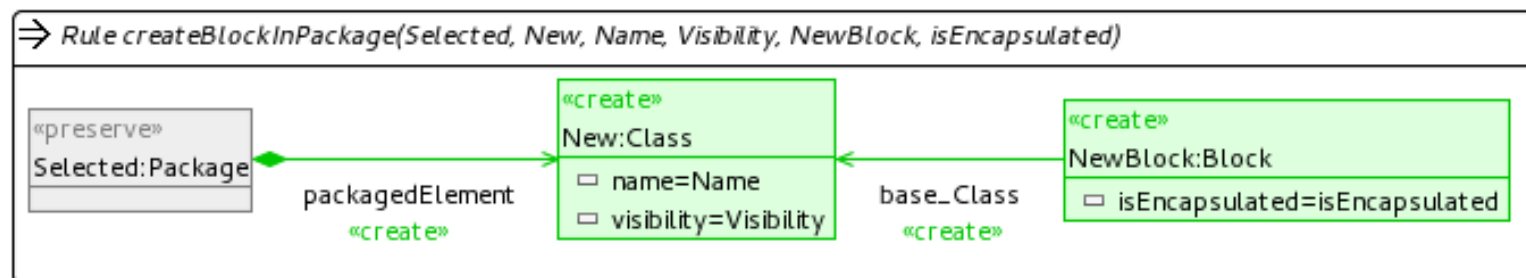
# D: Hybrid edit operations

## Example: Creation of a SysML Block

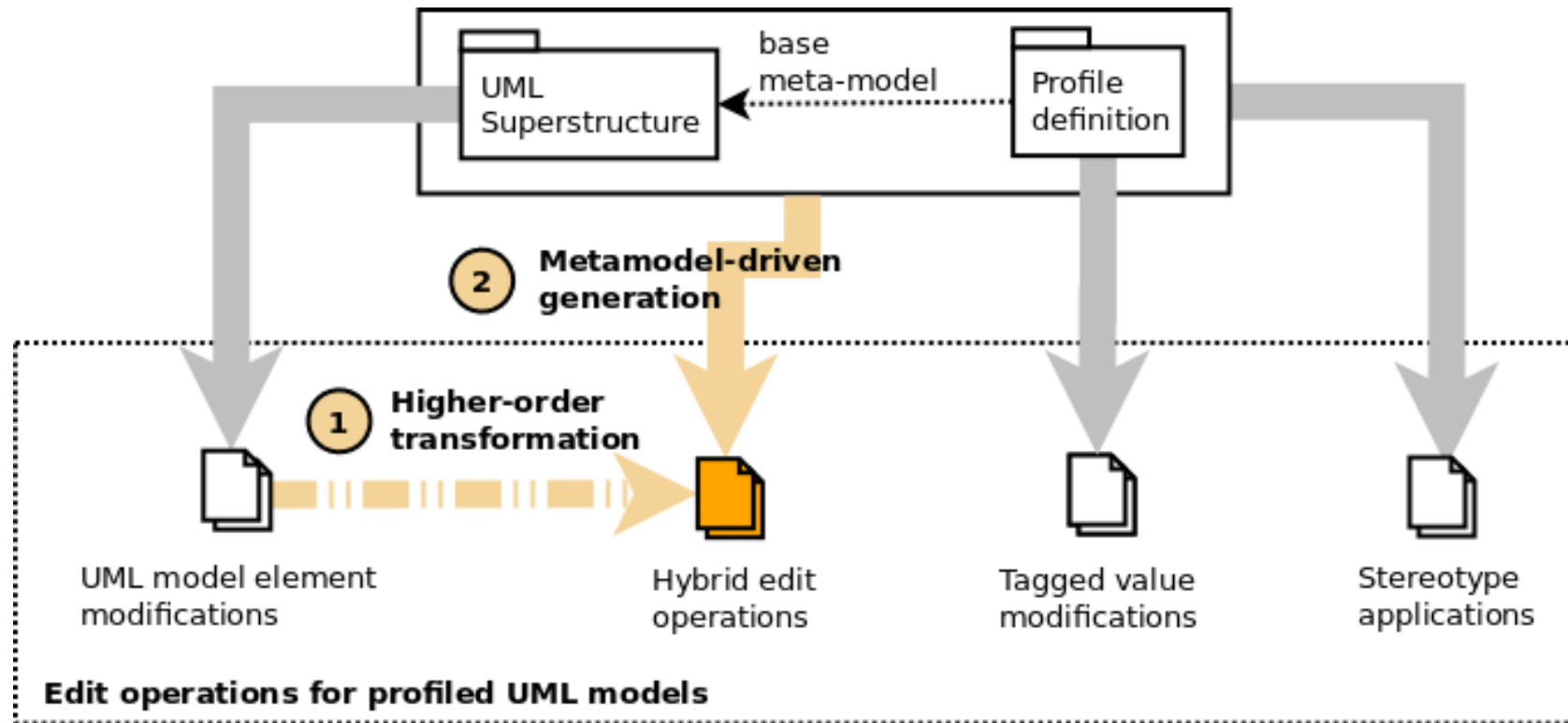
- Implementation variant 1: Sequential transformation unit



- Implementation variant 2: Single transformation rule

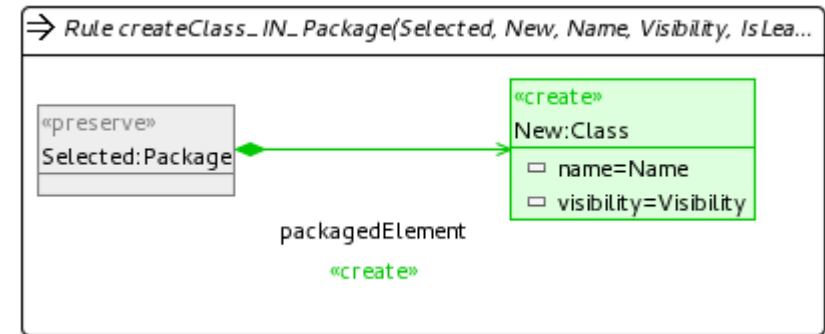
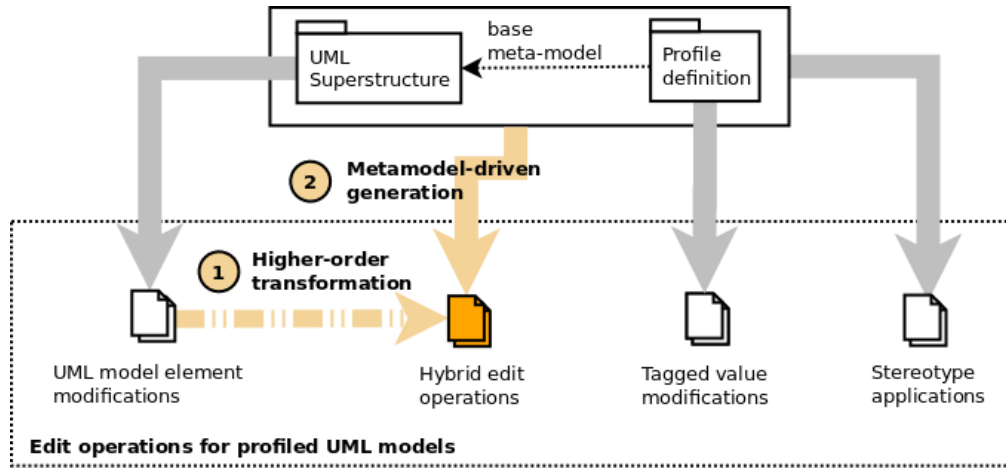


# Generation of edit operations



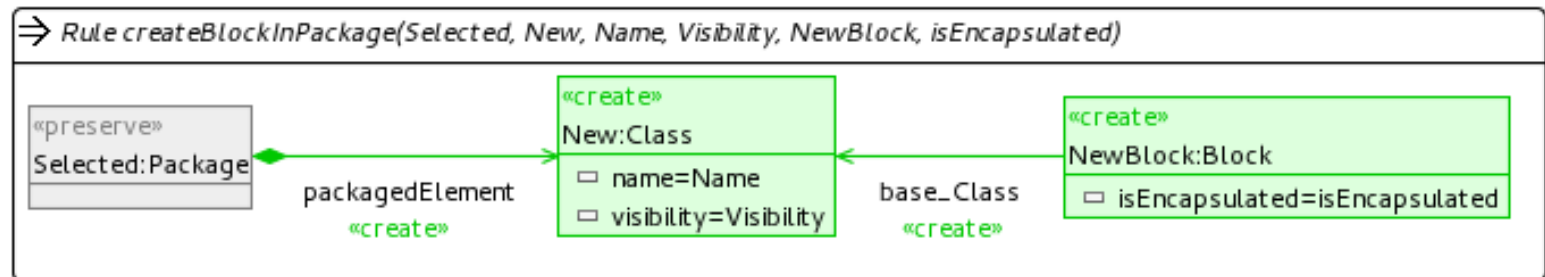


# Higher-order Transformation Approach

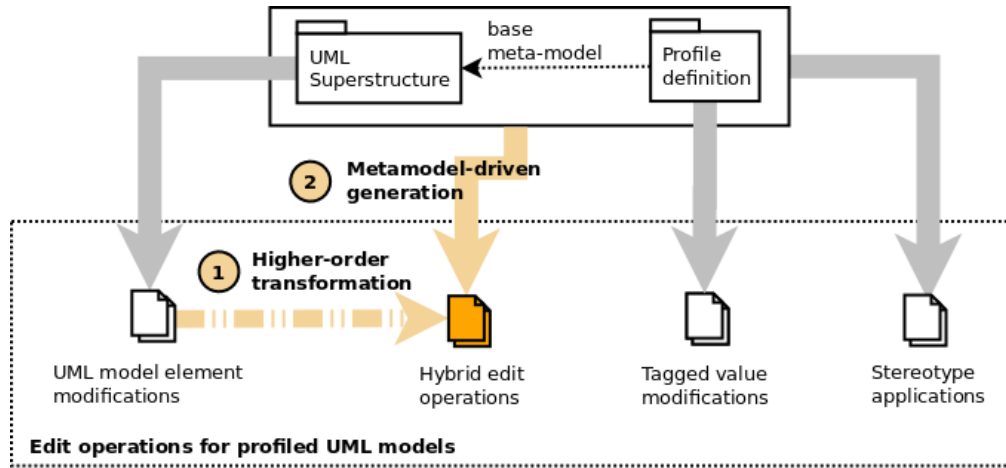


HOT

1

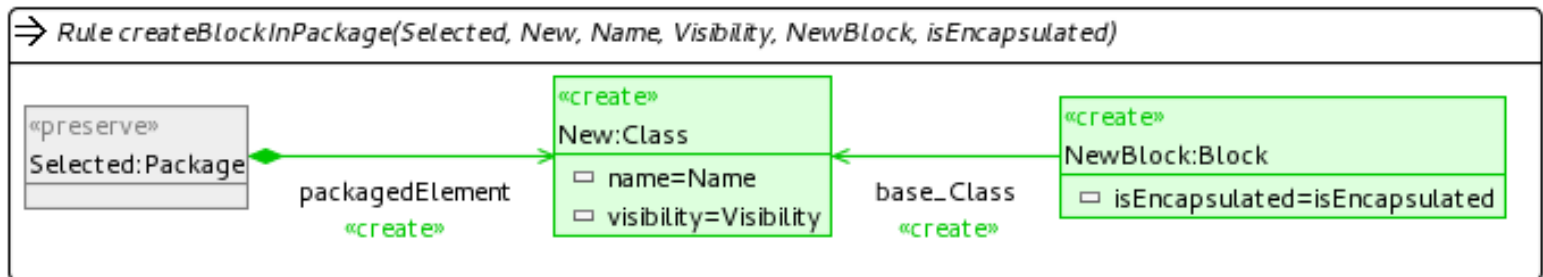


# Metamodel-driven Approach

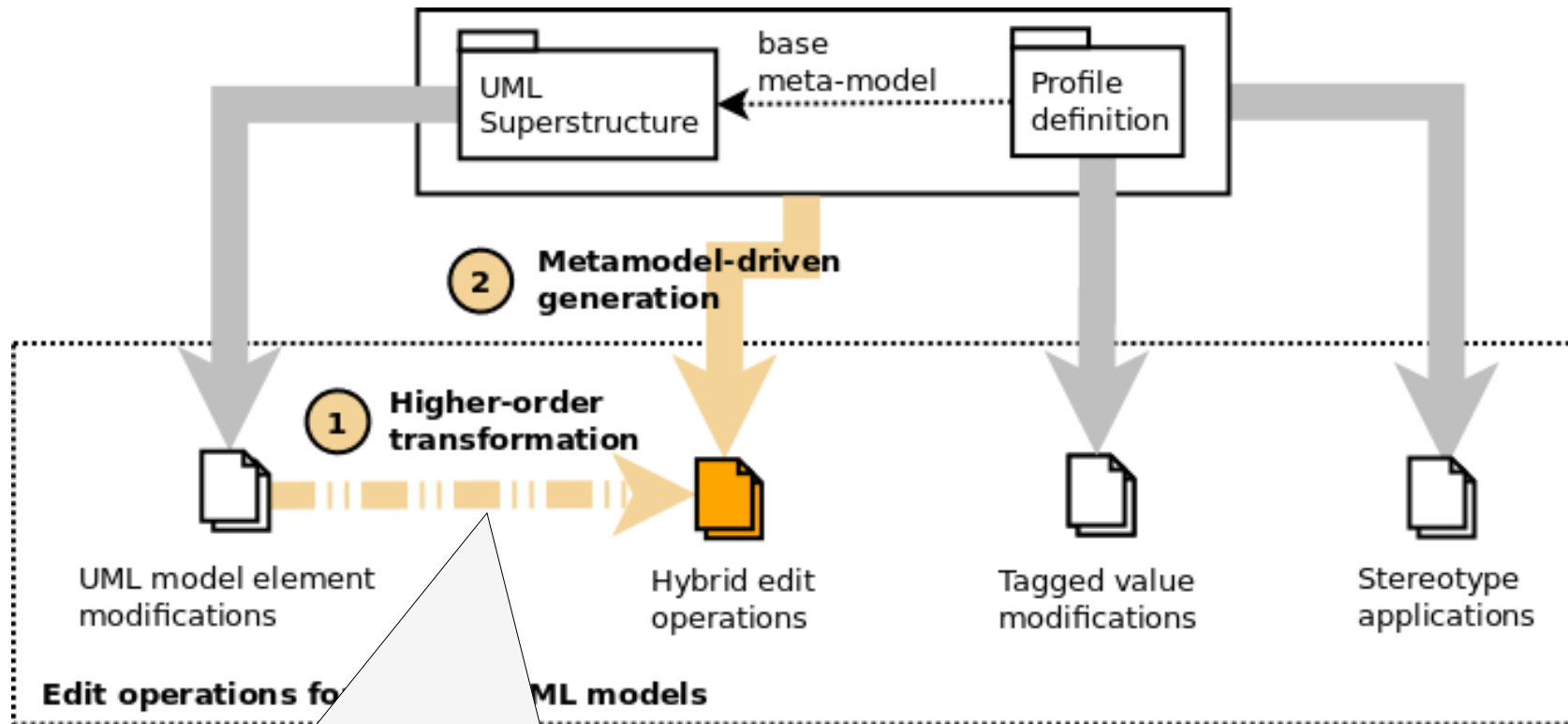


**Base-Metamodel  
+ Profile Definition**

2



# Generation of edit operations

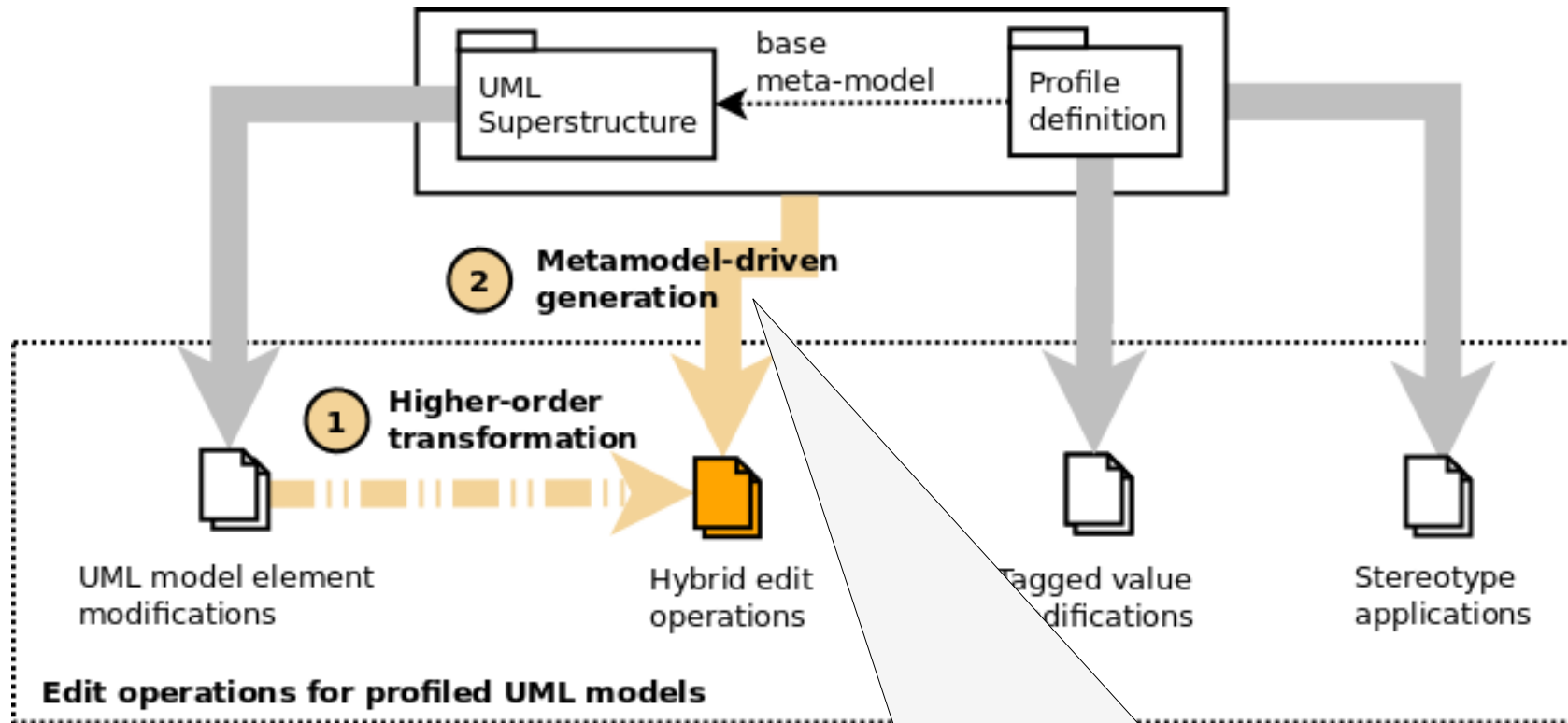




Efforts of manual adjustments on UML edit operations are not lost



Supports only simple profiles: It cannot handle stereotypes which have mandatory references to other stereotypes or UML model elements

# Generation of edit operations



-  Considers multiplicity constraints of (non-)containment references which emanate from stereotypes
-  Manually created/modified edit operations for the base language are not automatically adapted

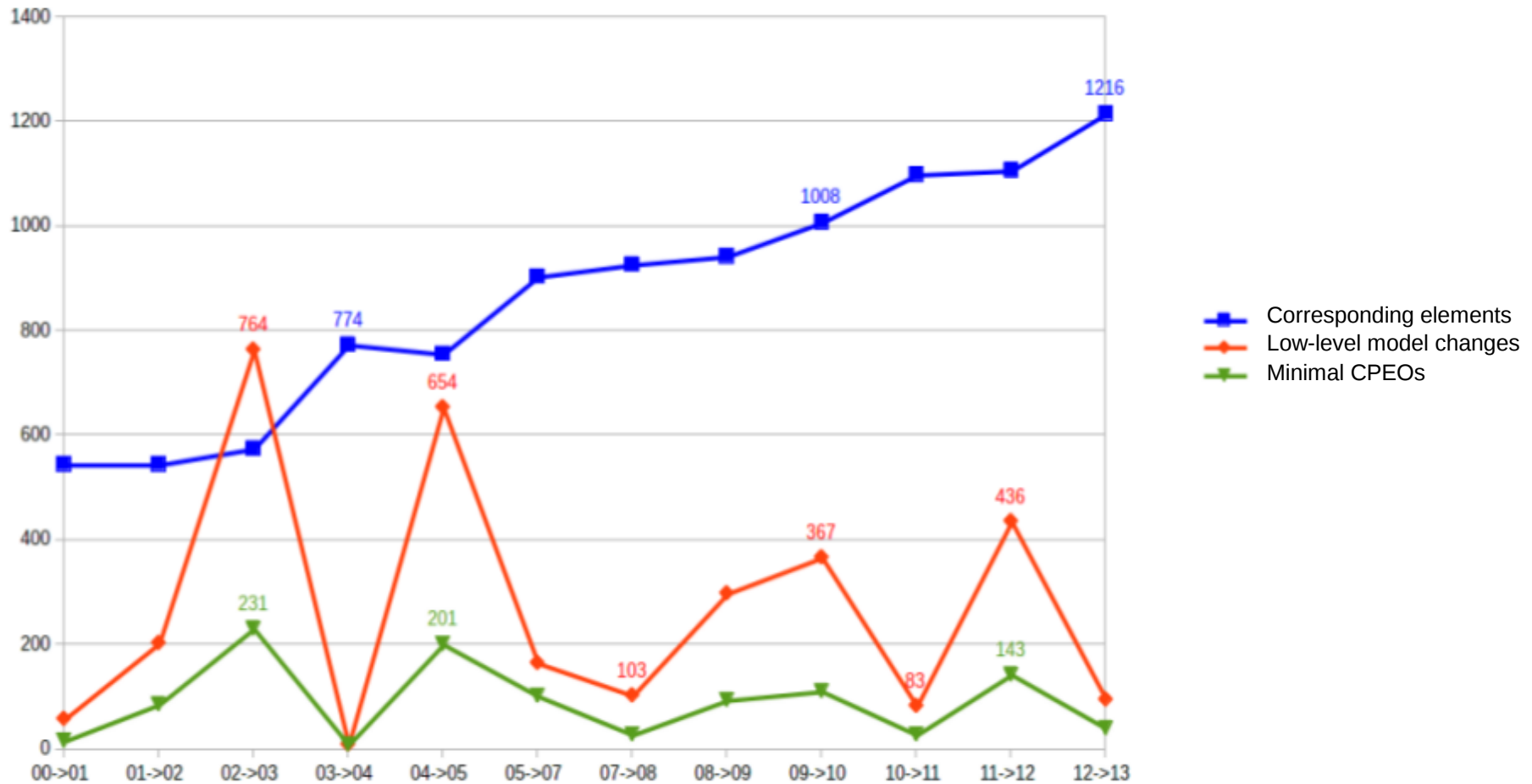
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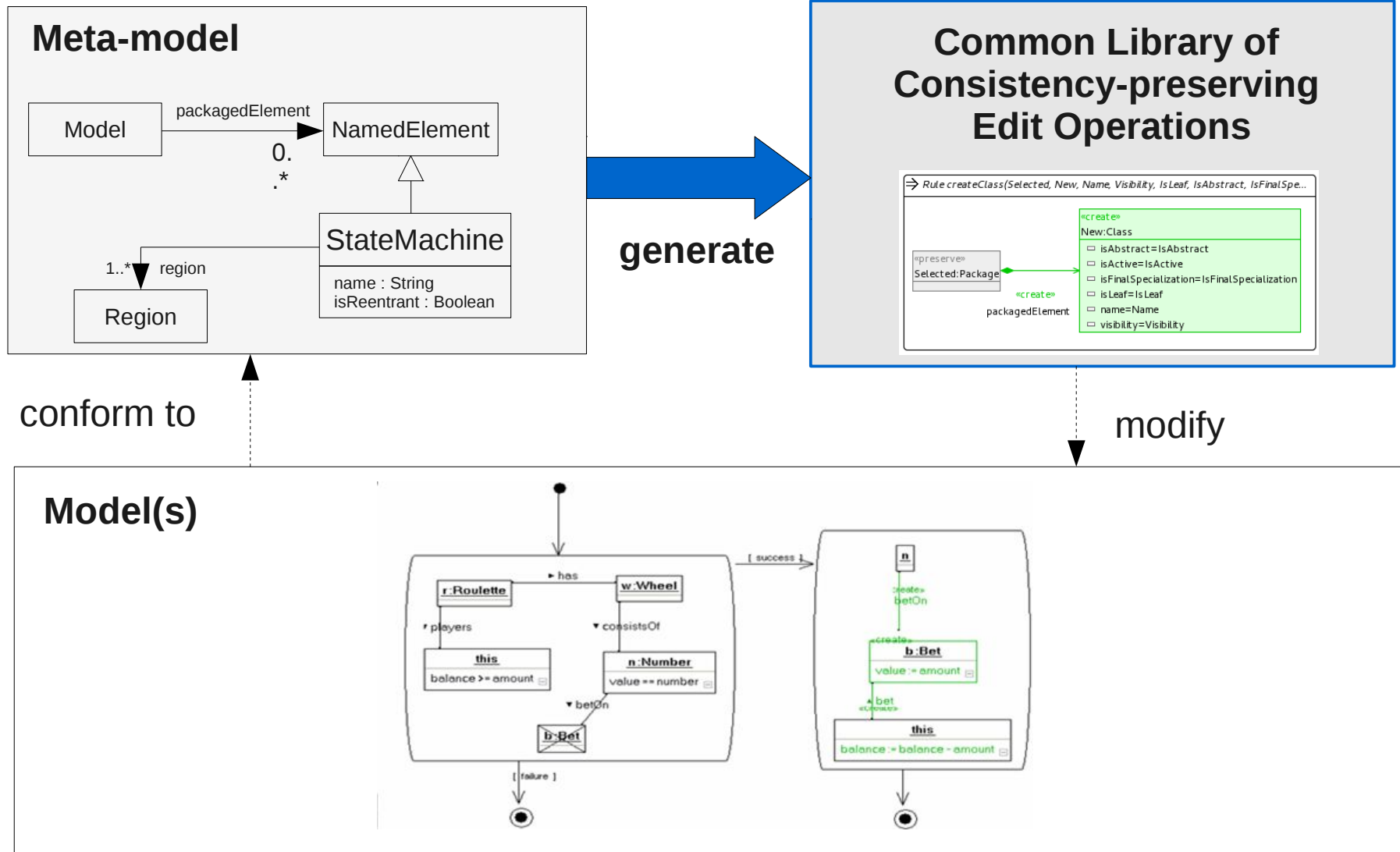
- Case study in DFG Priority Programme „Design for Future“  
<http://www.dfg-spp1593.de/>
- Domain: Production systems in automation engineering
- Evolving SysML model of a Pick and Place Unit (PPU) of the Chair AIS of the Technische Universität München  
<http://www.ais.mw.tum.de>
- Uses Block Definition and State Machine diagrams
- **Basic edit operations:**
  - generated: 1370
  - manually adapted: 177

# Case Study

- Evolution of SysML models with minimal CPEOs



# Summary



<http://pi.informatik.uni-siegen.de/Mitarbeiter/mrindt/SERGe.php>