GECO: Automatic **Ge**nerator-**Co**mposition for (Aspect-oriented) DSLs

Doctoral Symposium - MODELS 2014

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Kiel, Germany

30.09.2014

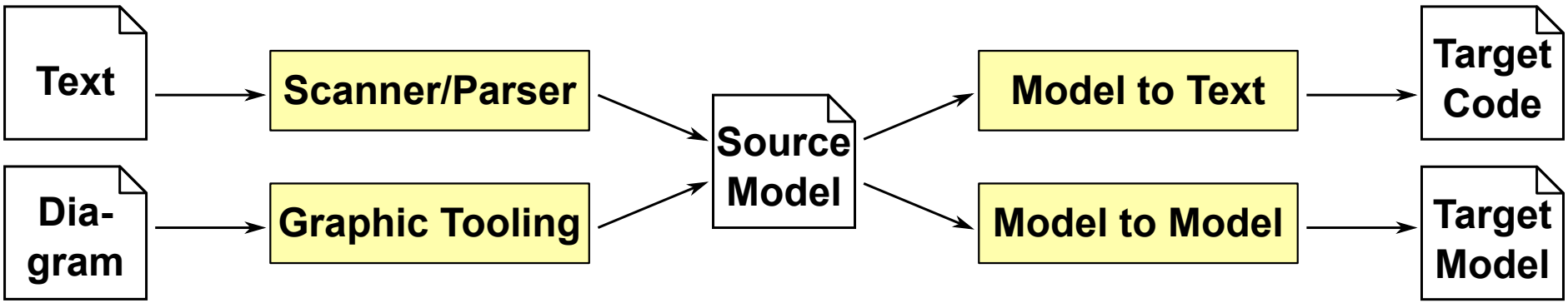
MENGES
KoSSE

Design For
FUTURE

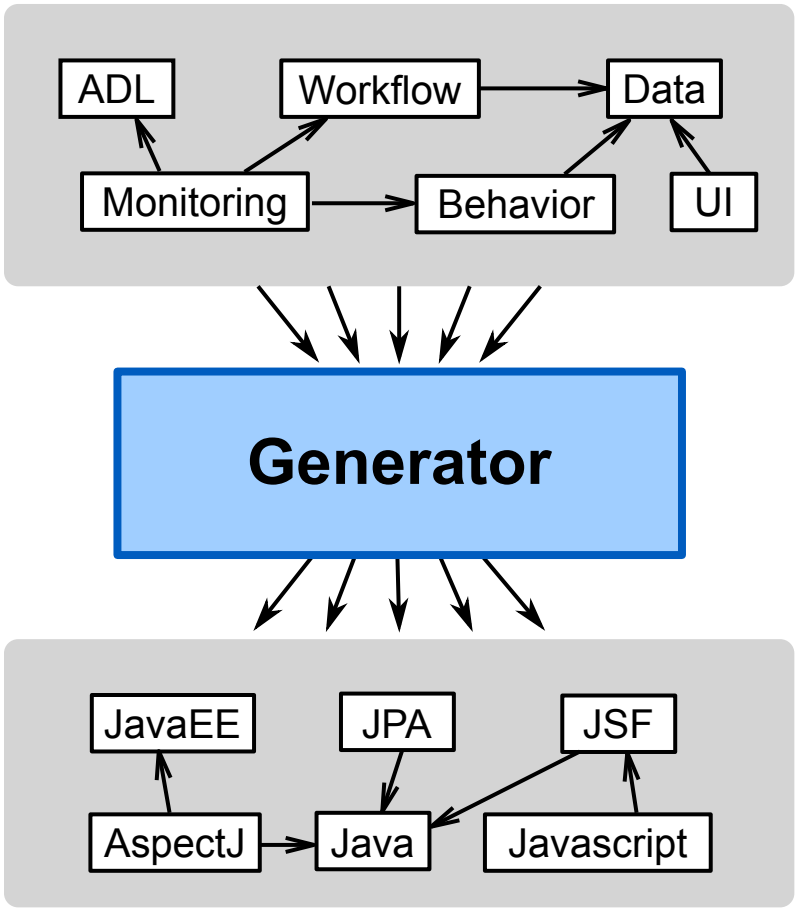
iObserve

Domain-specific Language (DSL)

- Text-based: meta-models and grammars
- Graphical: meta-models and visualization pattern

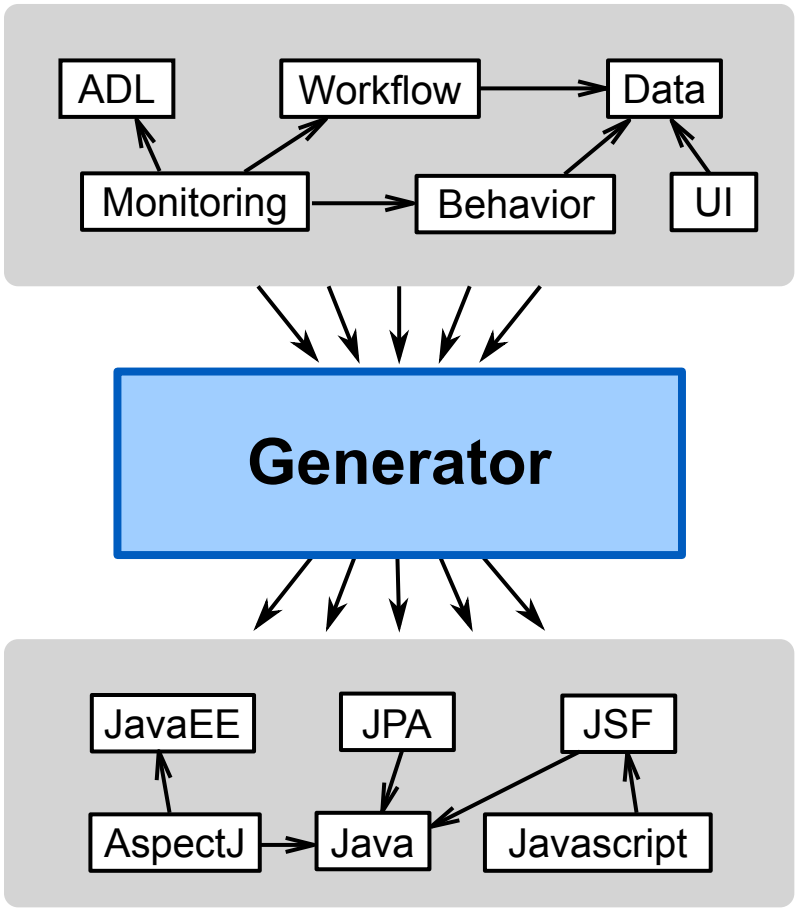


Source Meta-Models



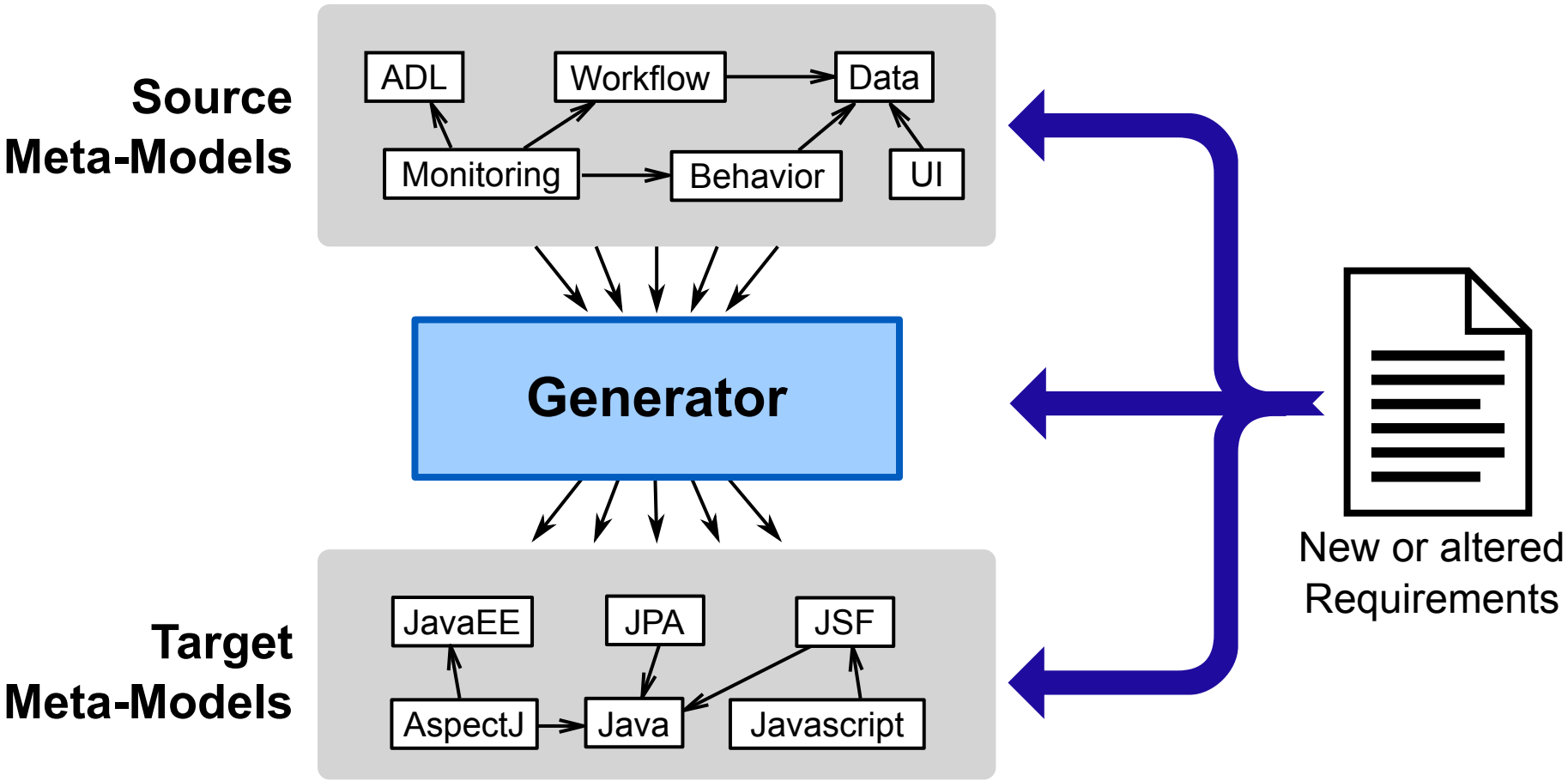
Target Meta-Models

Source Meta-Models



Target Meta-Models

New or altered Requirements



- Every meta-model change cause a generator code change
- Multiple changes convery code degradation

Related Work

Approaches

- Formal Design Analysis Framework [Bennett et al., 2010]
- Theme/UML [Clarke and Baniassad, 2005]
- Reusable Aspect Models [Klein and Kienzle, 2007]

Characteristics

- UML centric
- Use of model weaving [Morin et al., 2008, Didonet et al., 2006]
- Focus on modelling, not on model generation

Aspect Modeling Domain [Mehmood and Jawawi, 2013]
Limited work on generator composition and evolution

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Generator for product lines [Kapova et al., 2010]

- Activation of generator fragments based on features
- Goal: Support of target model variations

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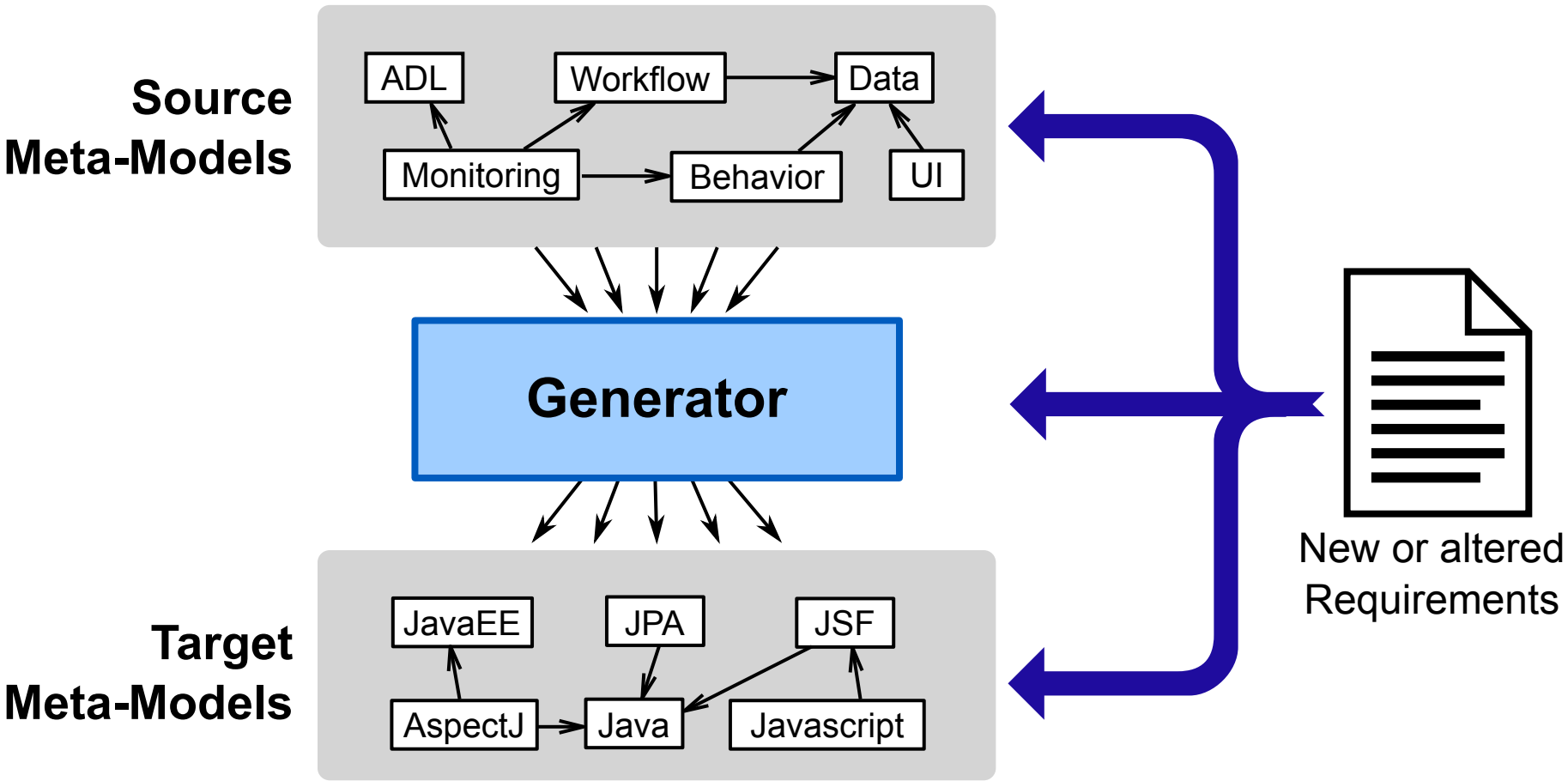
Genesys generator composition [Jörges, 2013]

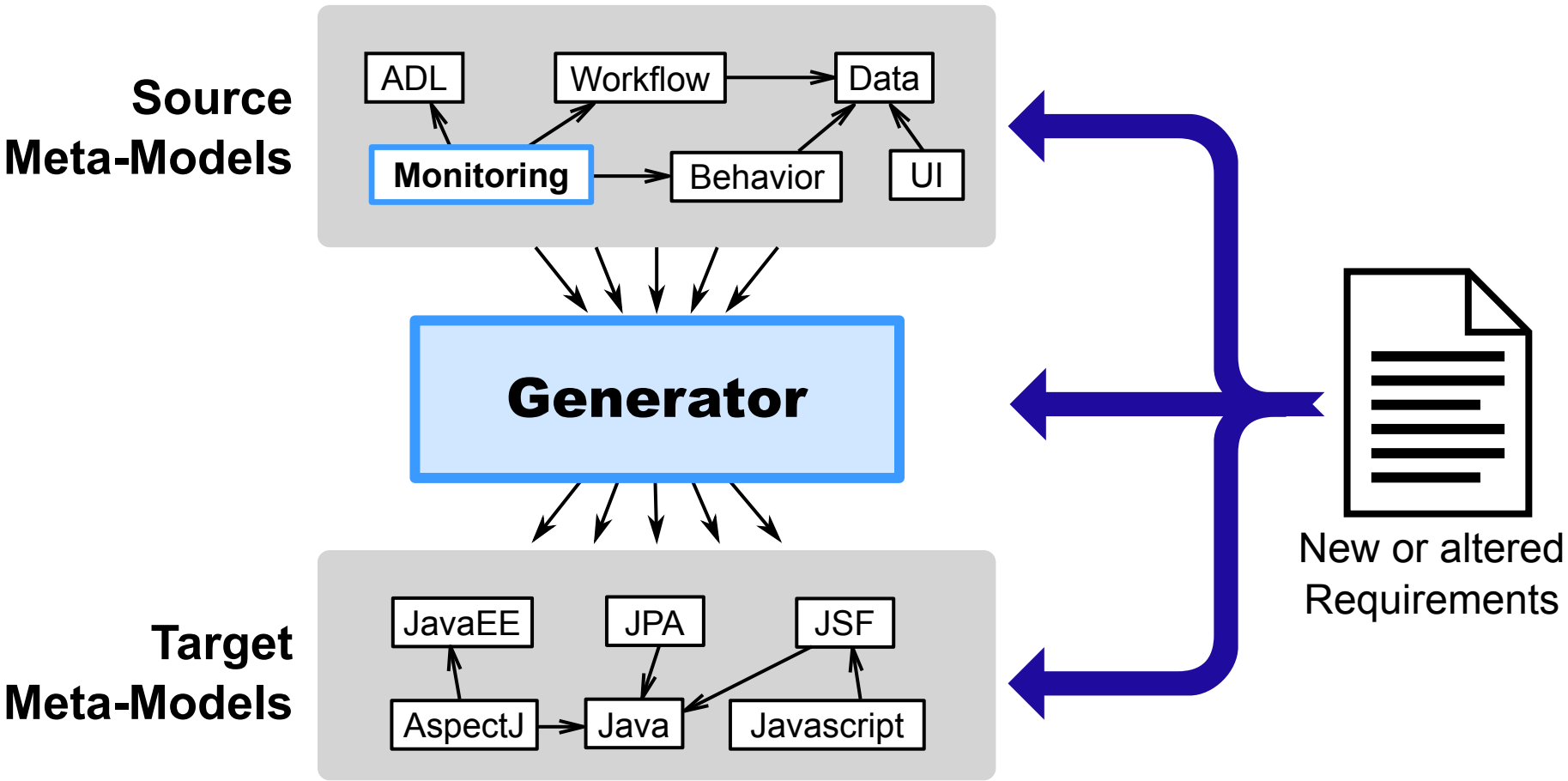
- Combination proofen transformations
- Uses small *correct* transformations
- Goal: correct compilers

Approach

Solution Overview



Key challange How to combine generator outputs?



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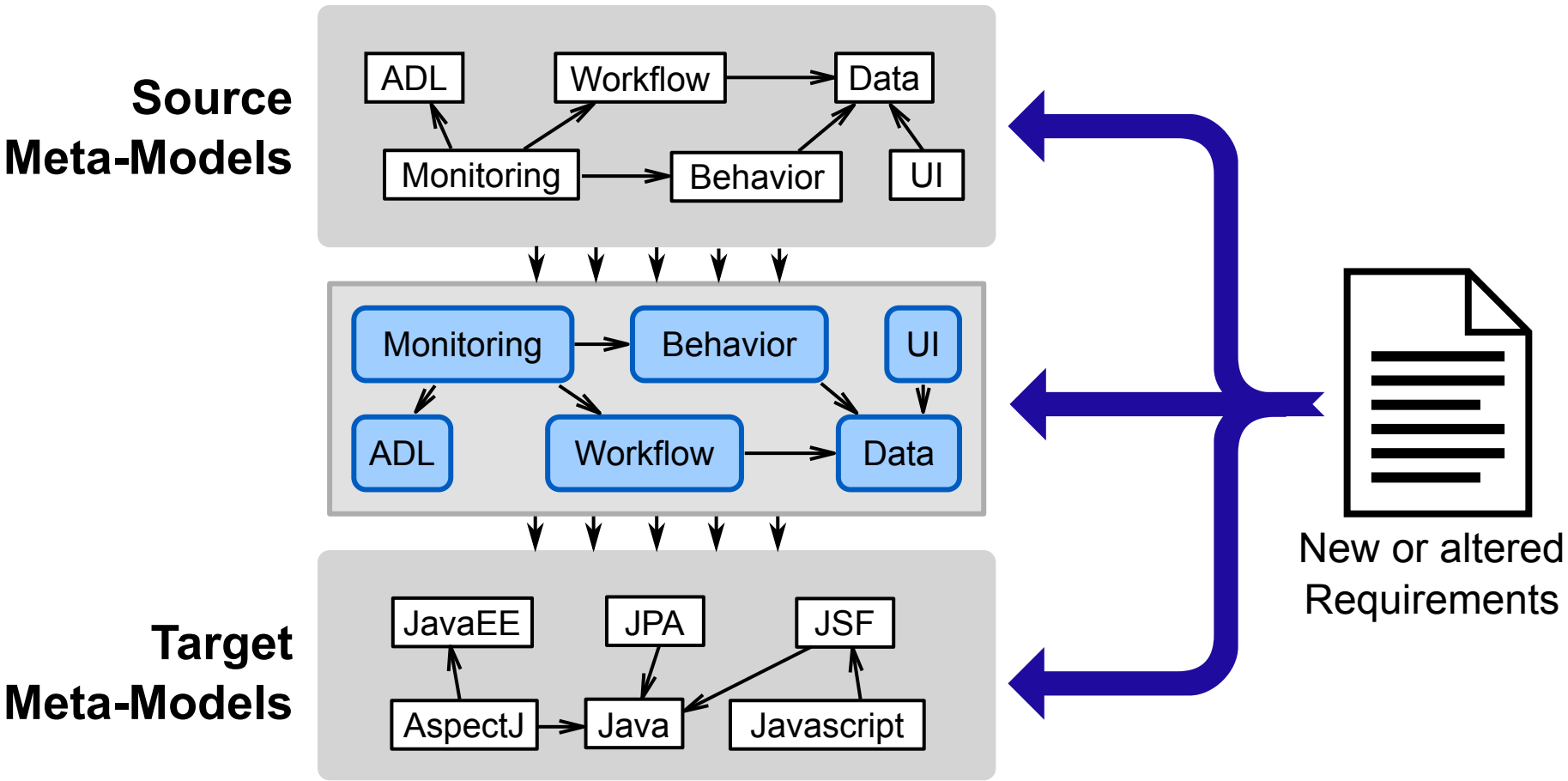

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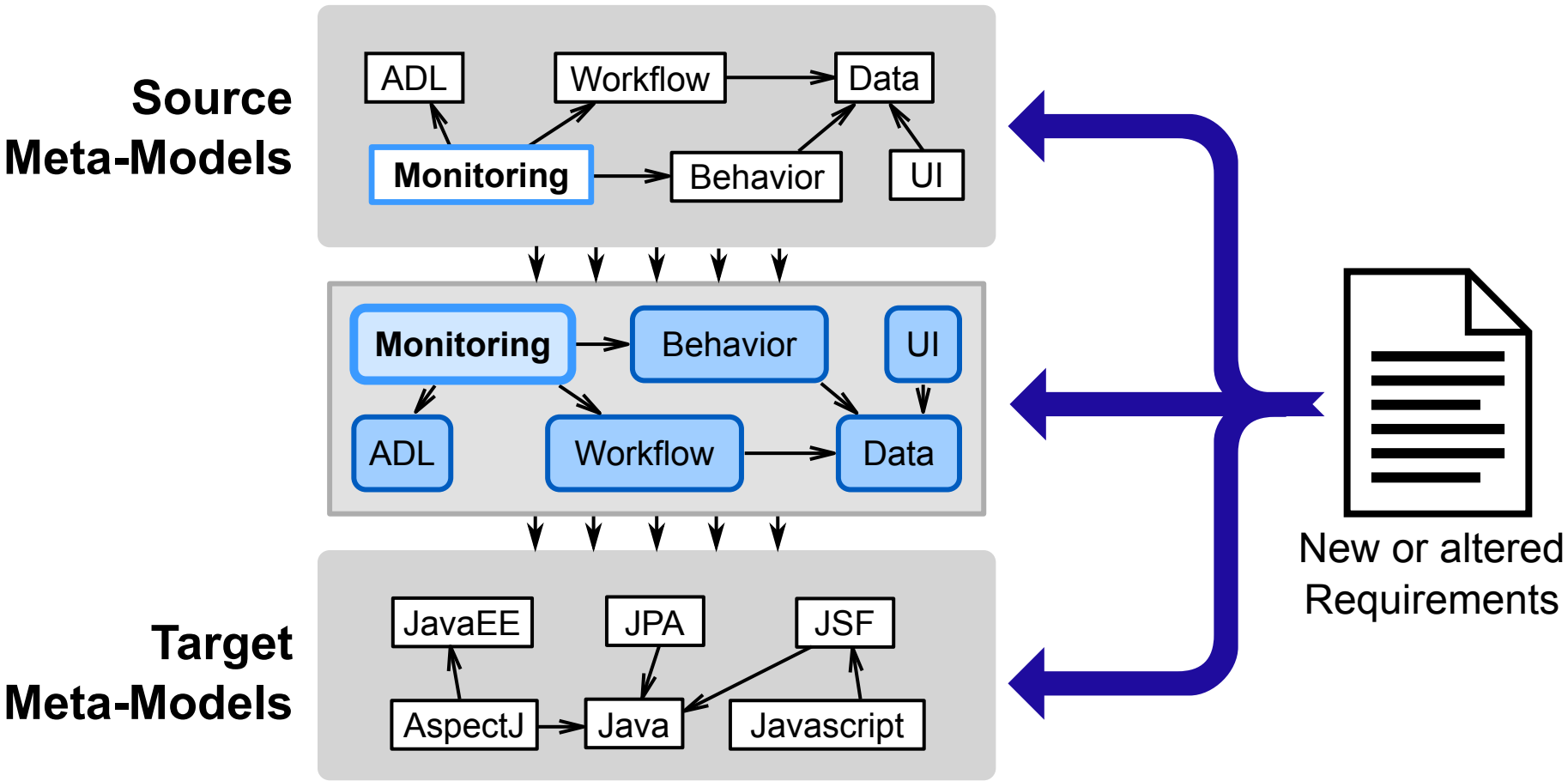

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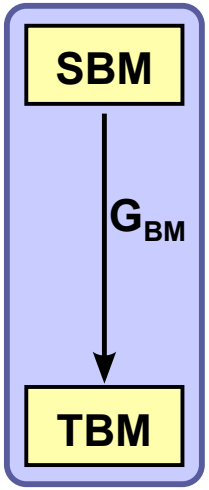
Different Generator Architecture Styles

Different Generator Architecture Styles

Simple

S1



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TBM Target Base Meta-Model
SAM Source Aspect Meta-Model
TAM Target Aspect Meta-Model
G Transformation
References

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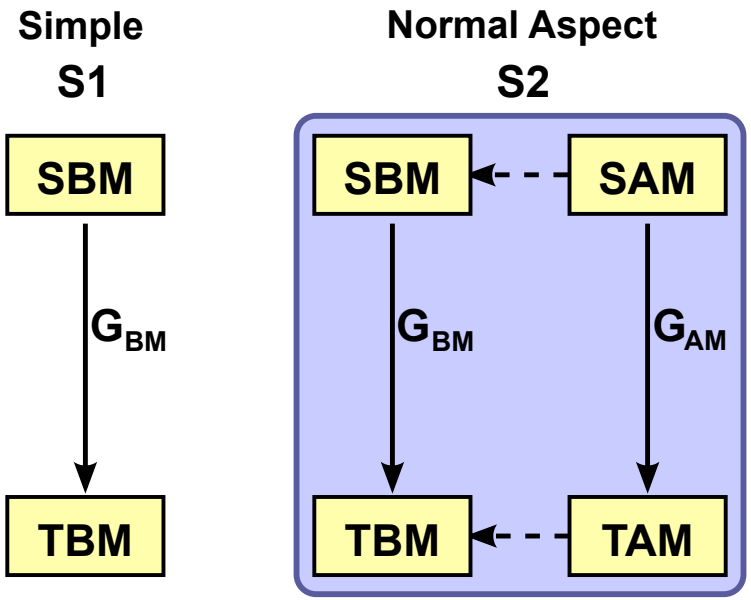

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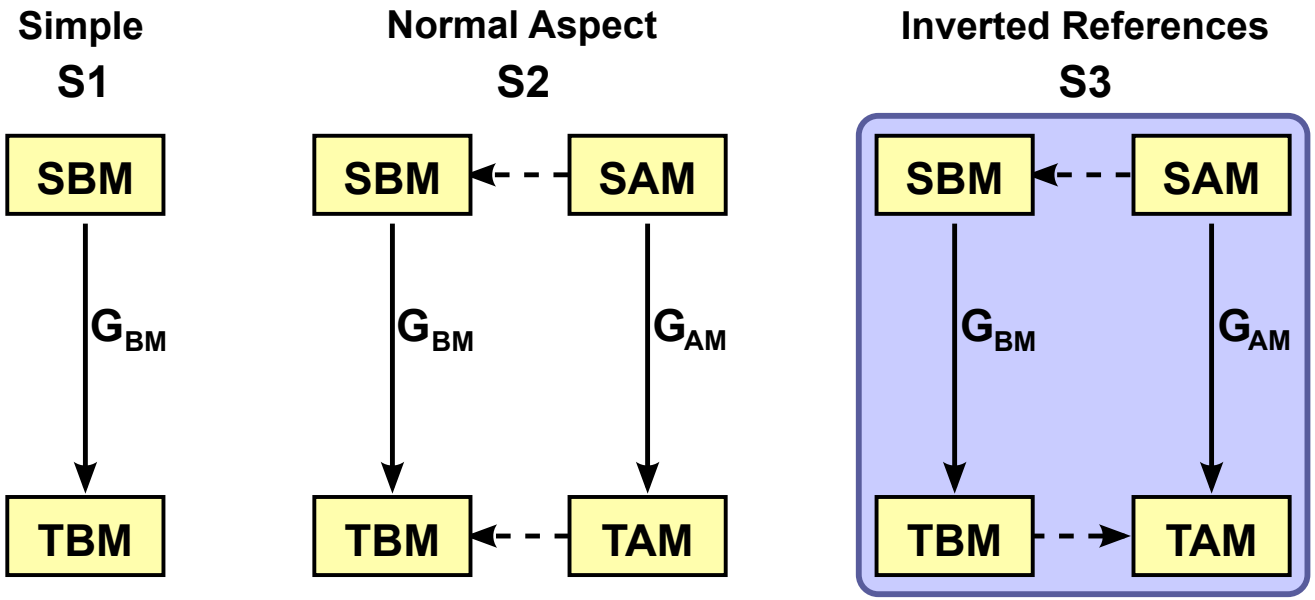

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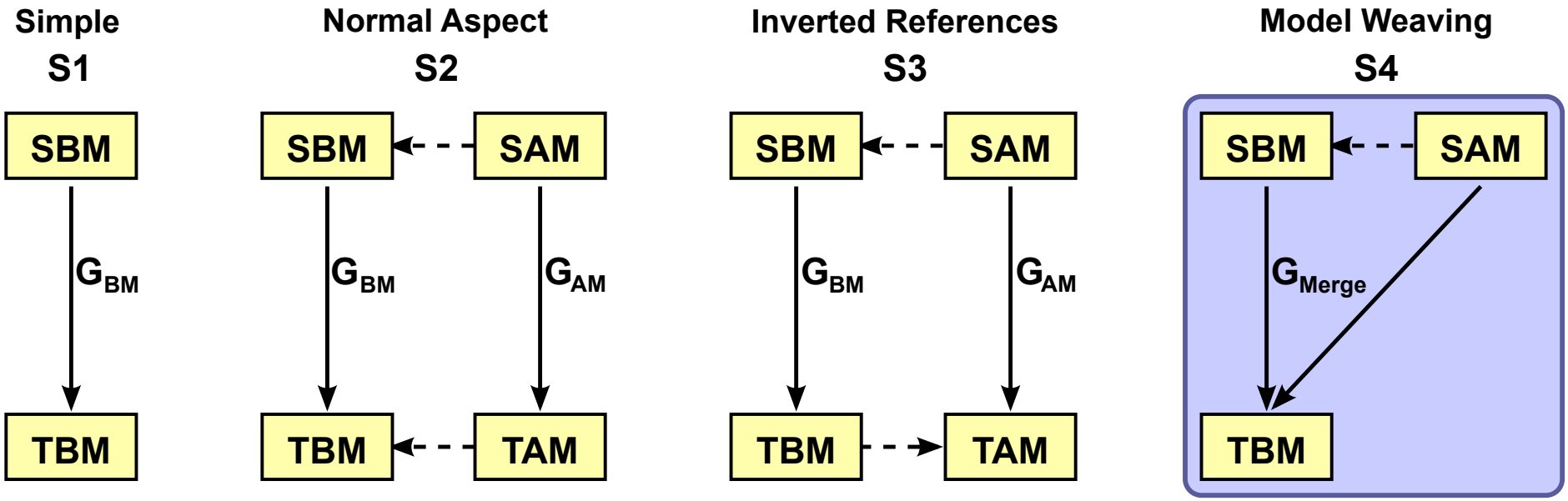

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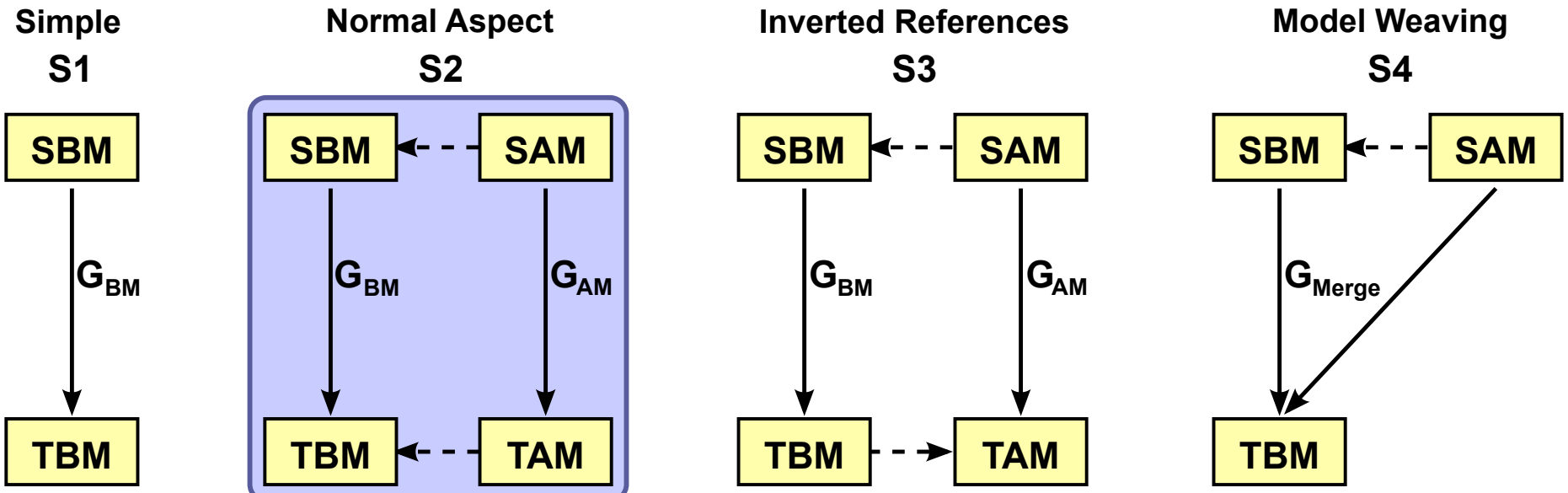

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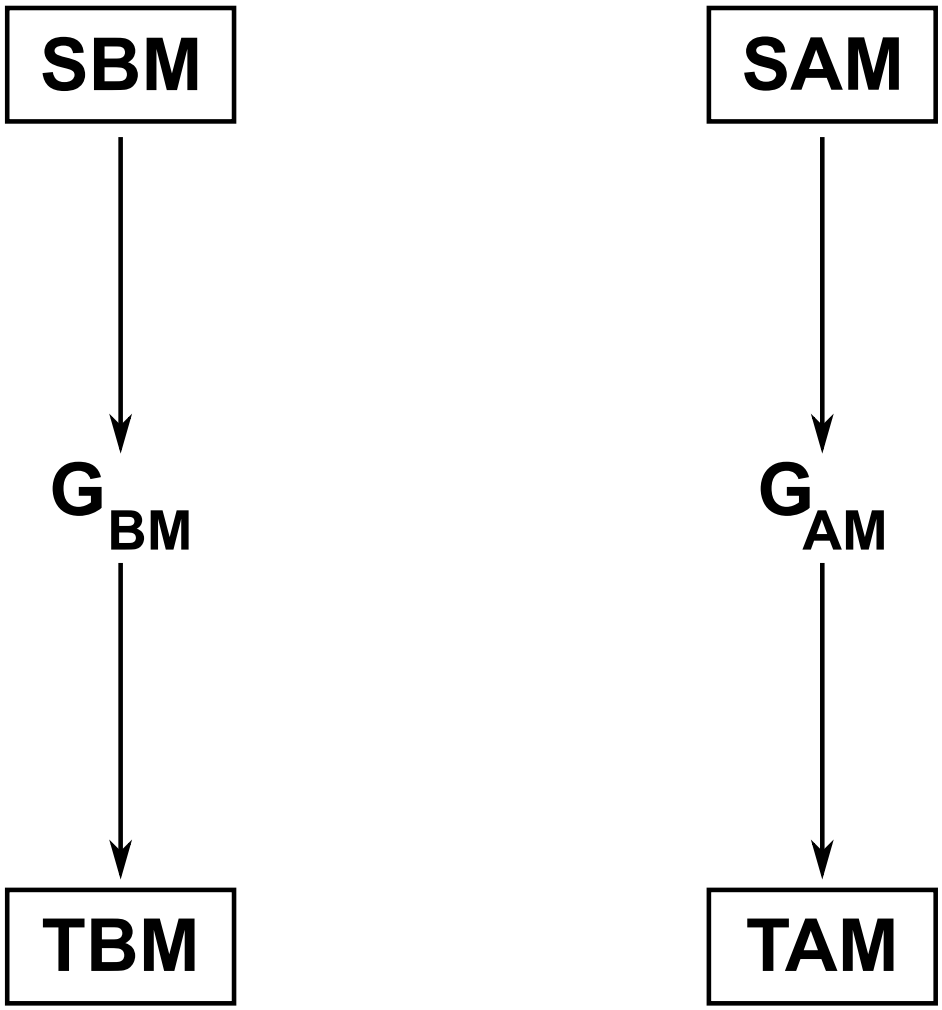

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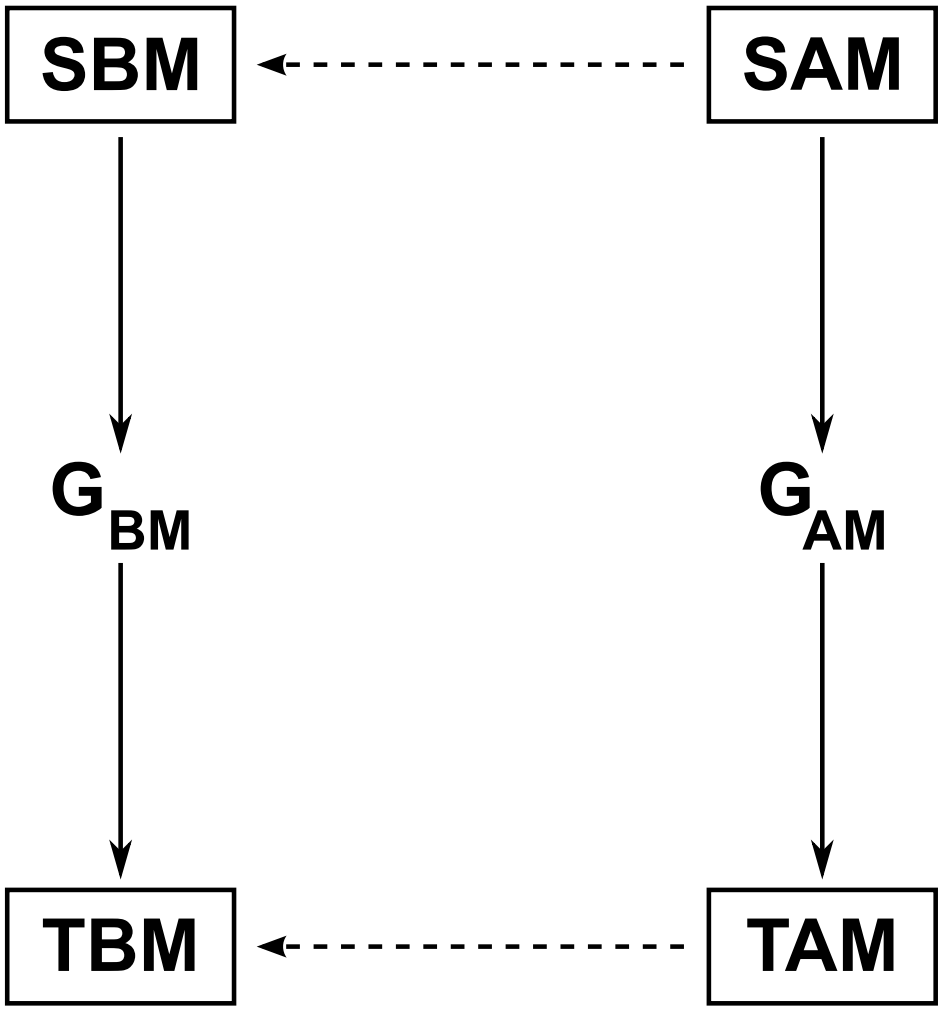
Style 2: Normal Aspect



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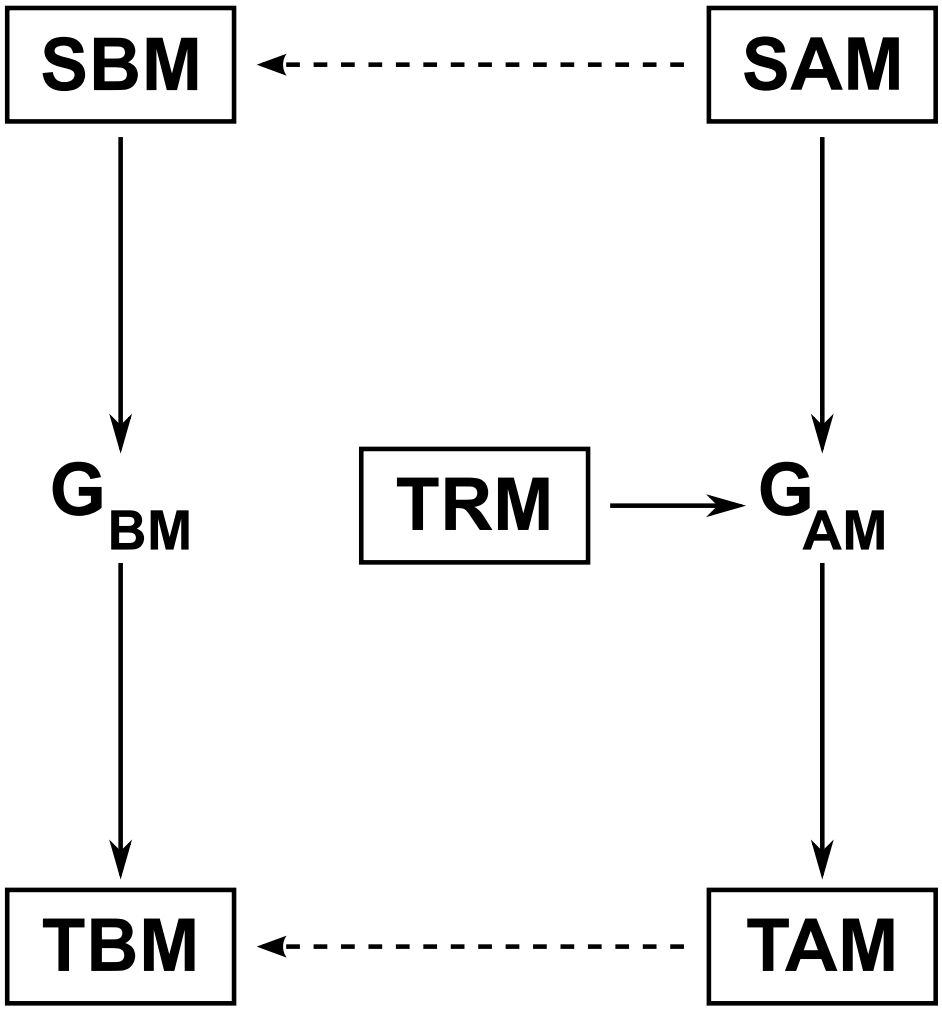

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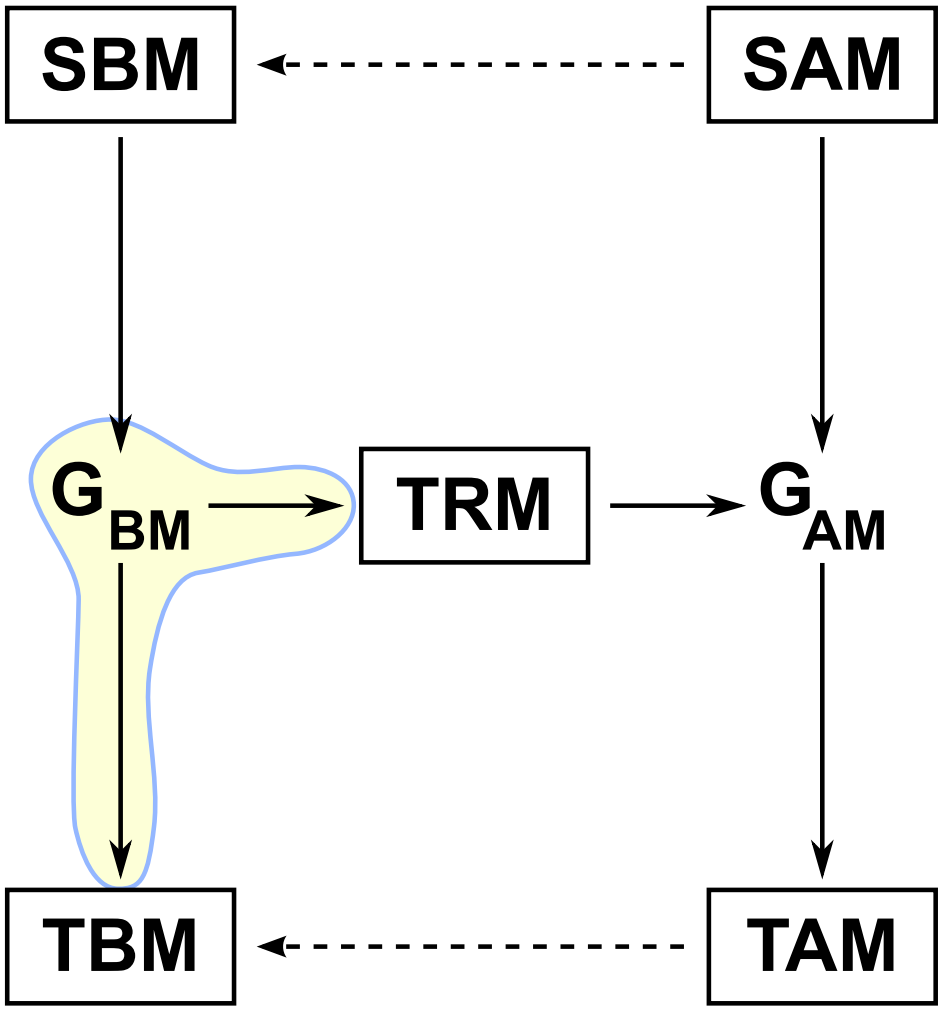

Transformation with two outputs:

- **Base model TBM**
- **Trace model TRM**

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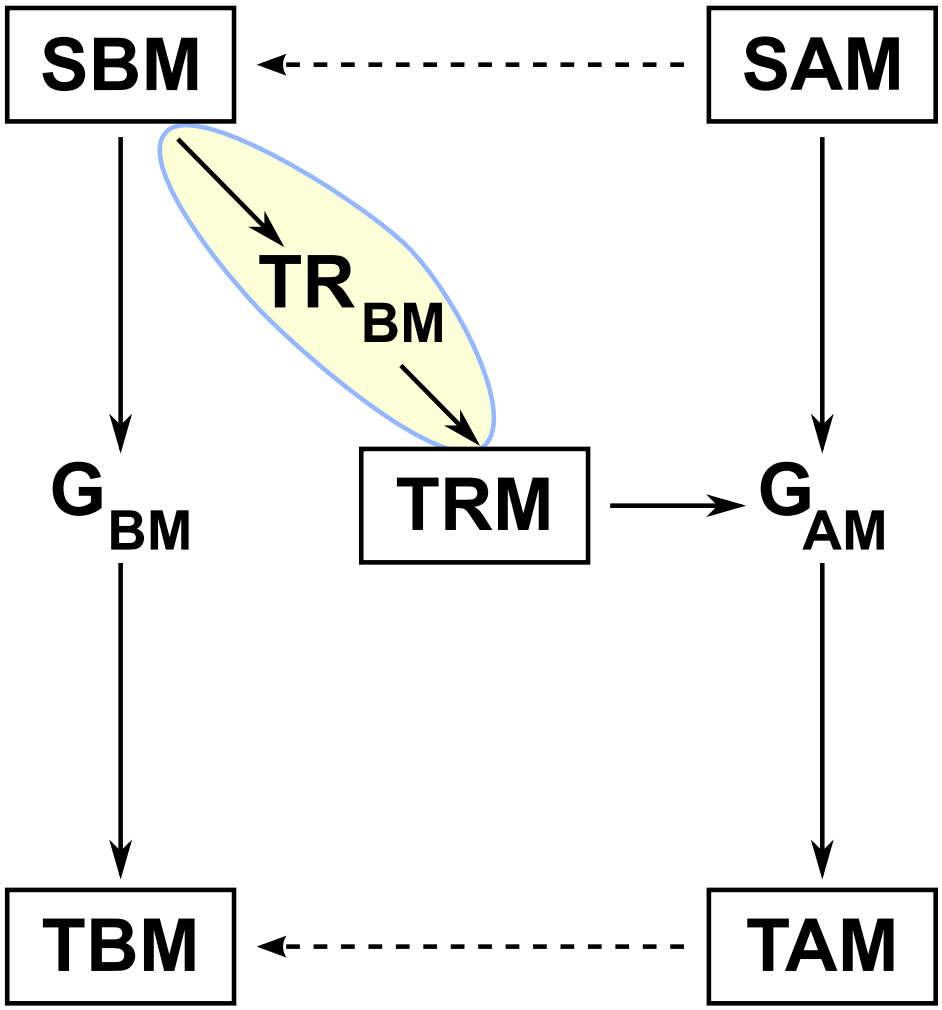

Auxiliary transformation. Used for:
- legacy base model transformations
- API constraints hinder two output models

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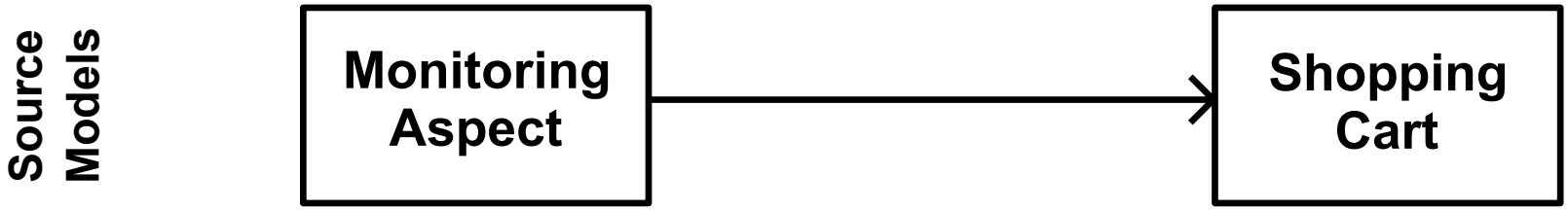
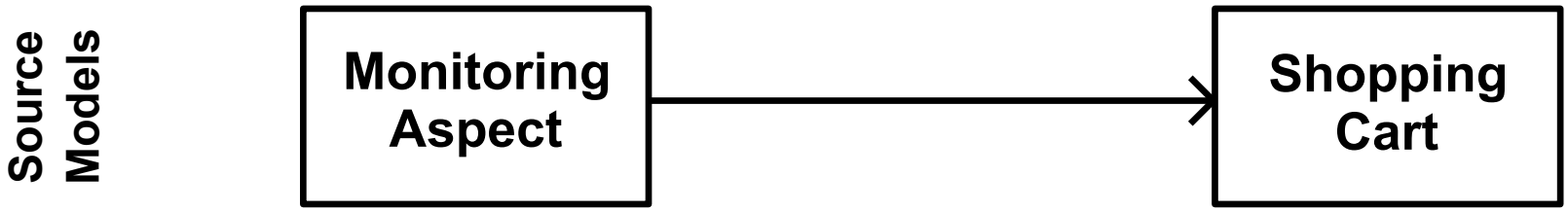

Source Models
Monitoring Aspect
Shopping Cart

Computing Target Model Join Points



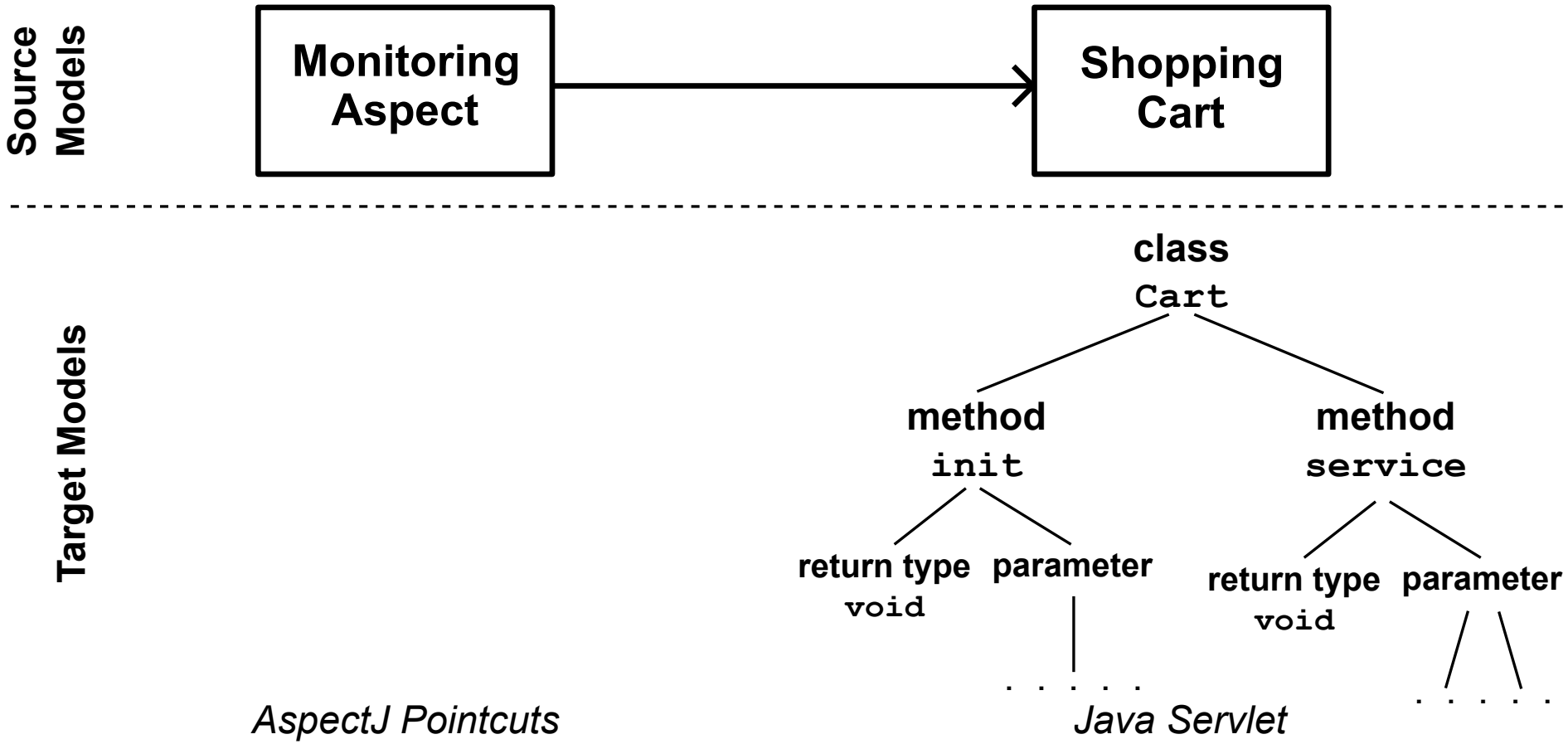
Target Models

```
call(void init (...)) ||
call(void service(...))
```

AspectJ Pointcuts

```
class Cart extends HTTPServlet {
    public void init (...) {
        ...
    }
    public void service (...) {
        ...
    }
    ...
}
```

Java Servlet


Source Models
Monitoring Aspect
Shopping Cart
Target Models
class
Cart
method
init
method
service
return type
void
parameter
return type
void
parameter
. . . . .
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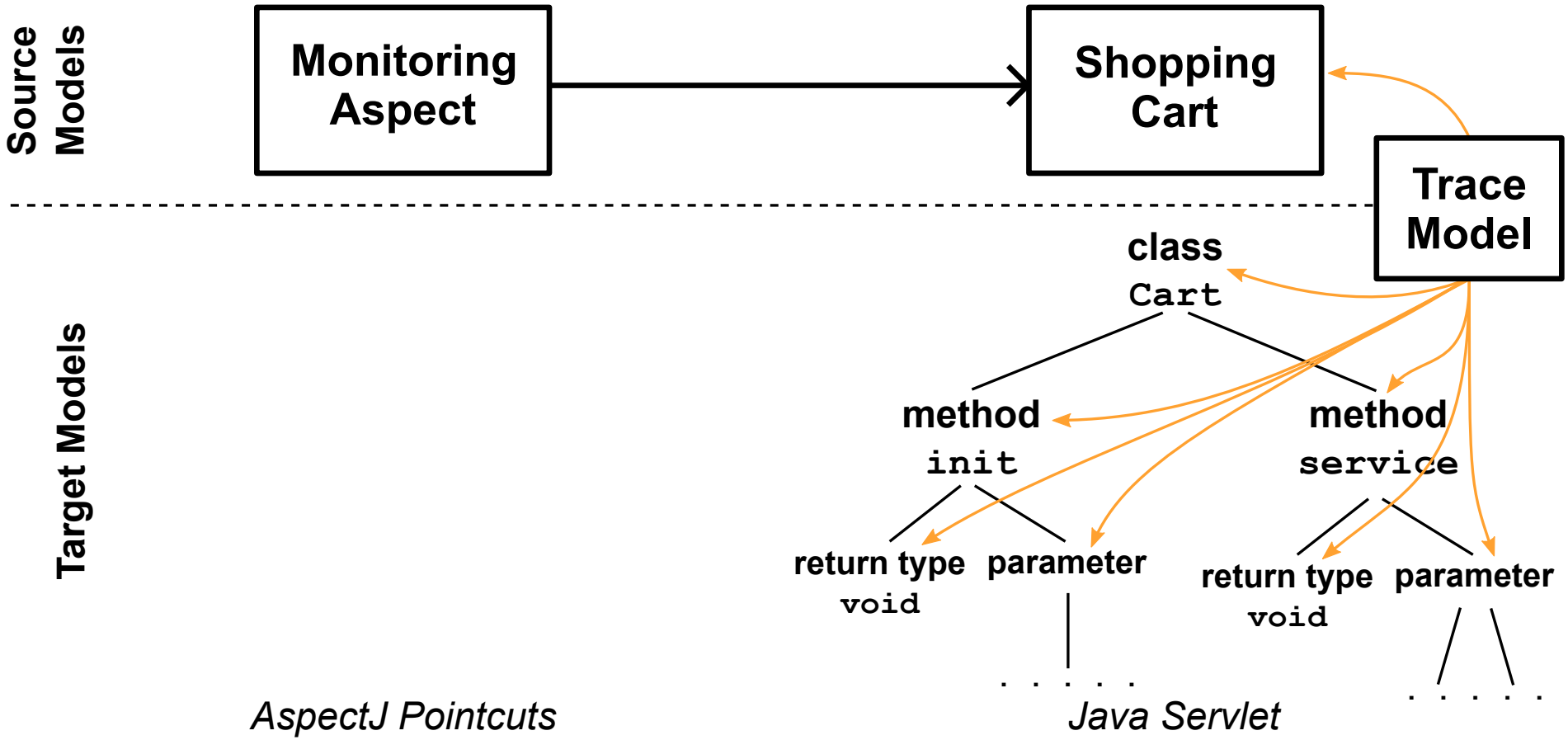
Java Servlet

Computing Target Model Join Points



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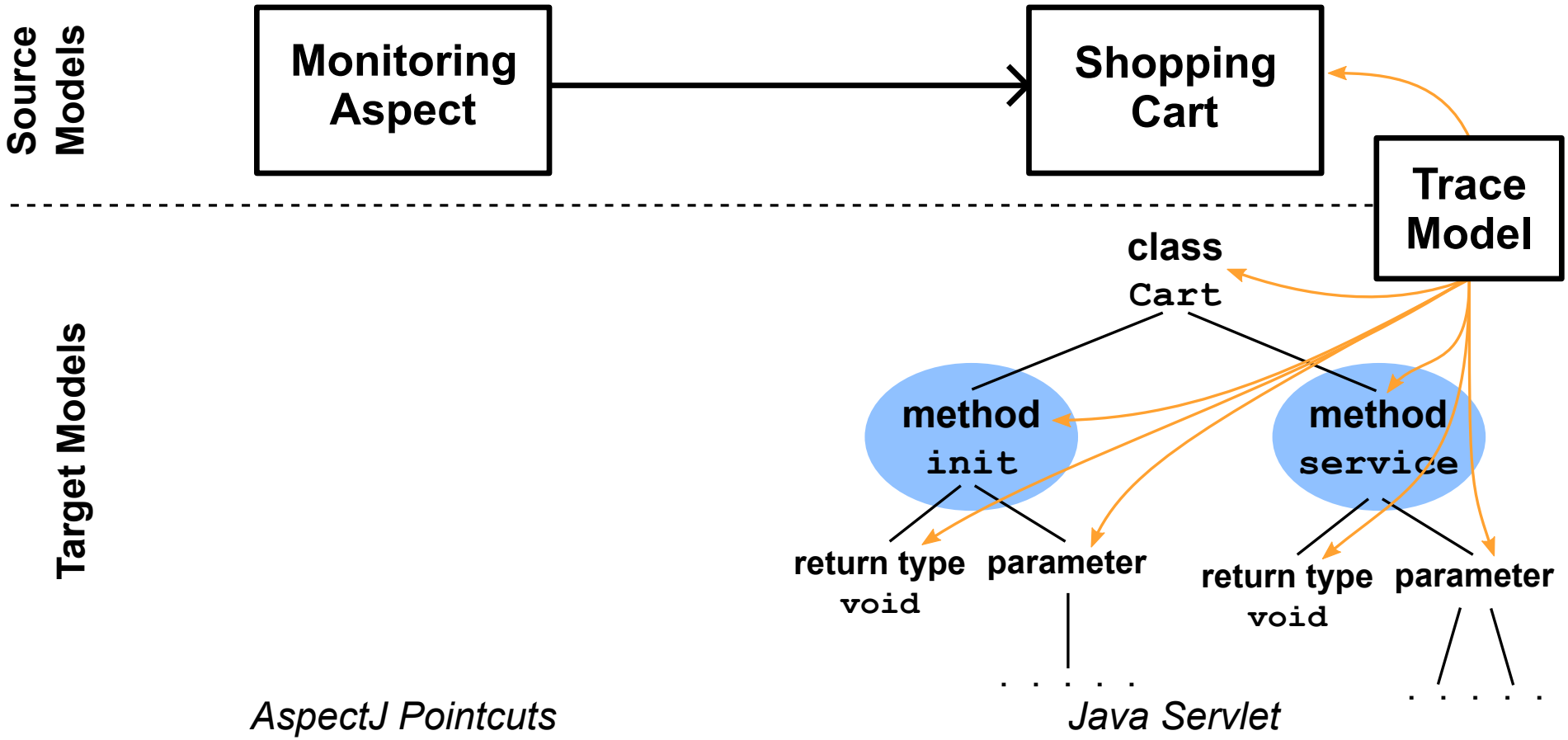

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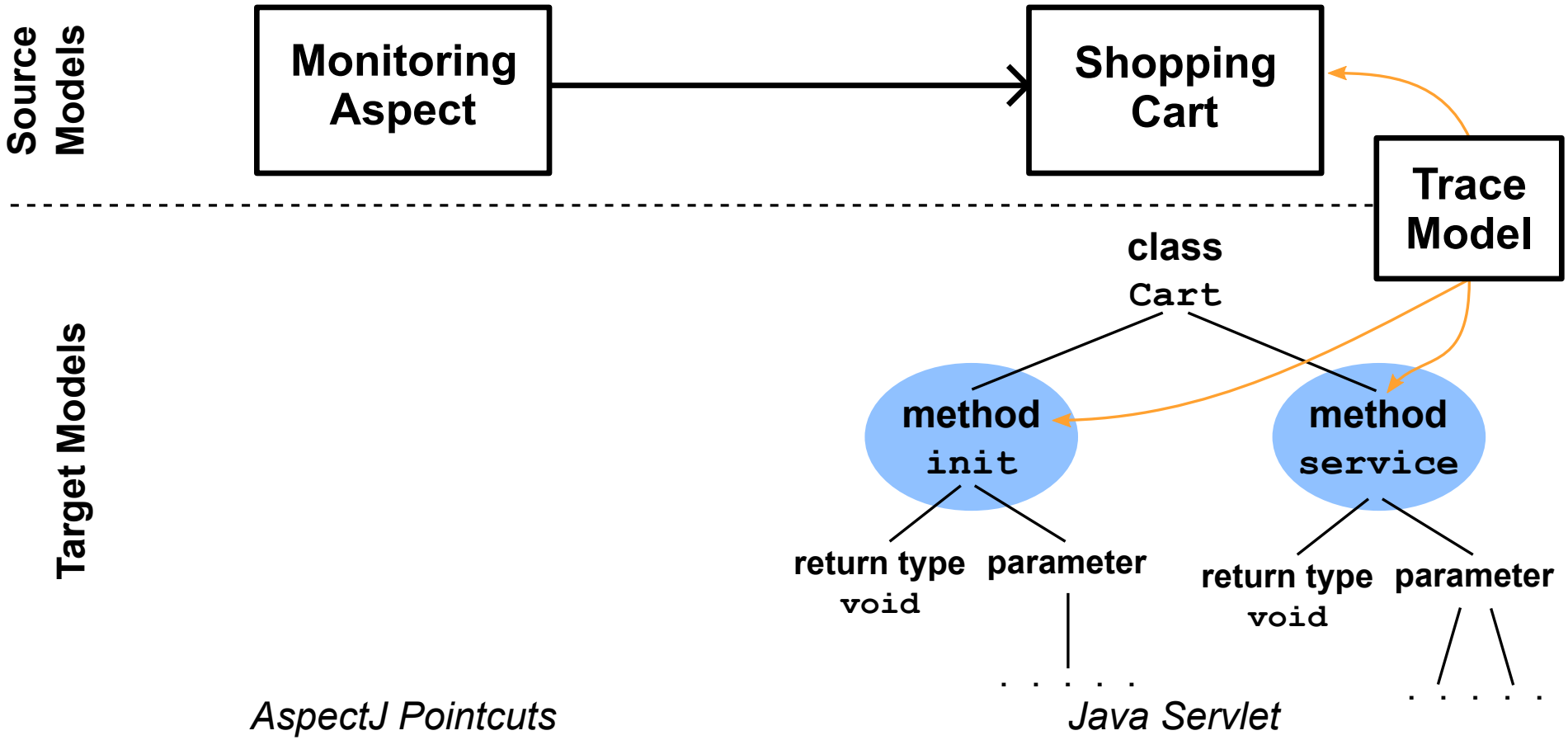

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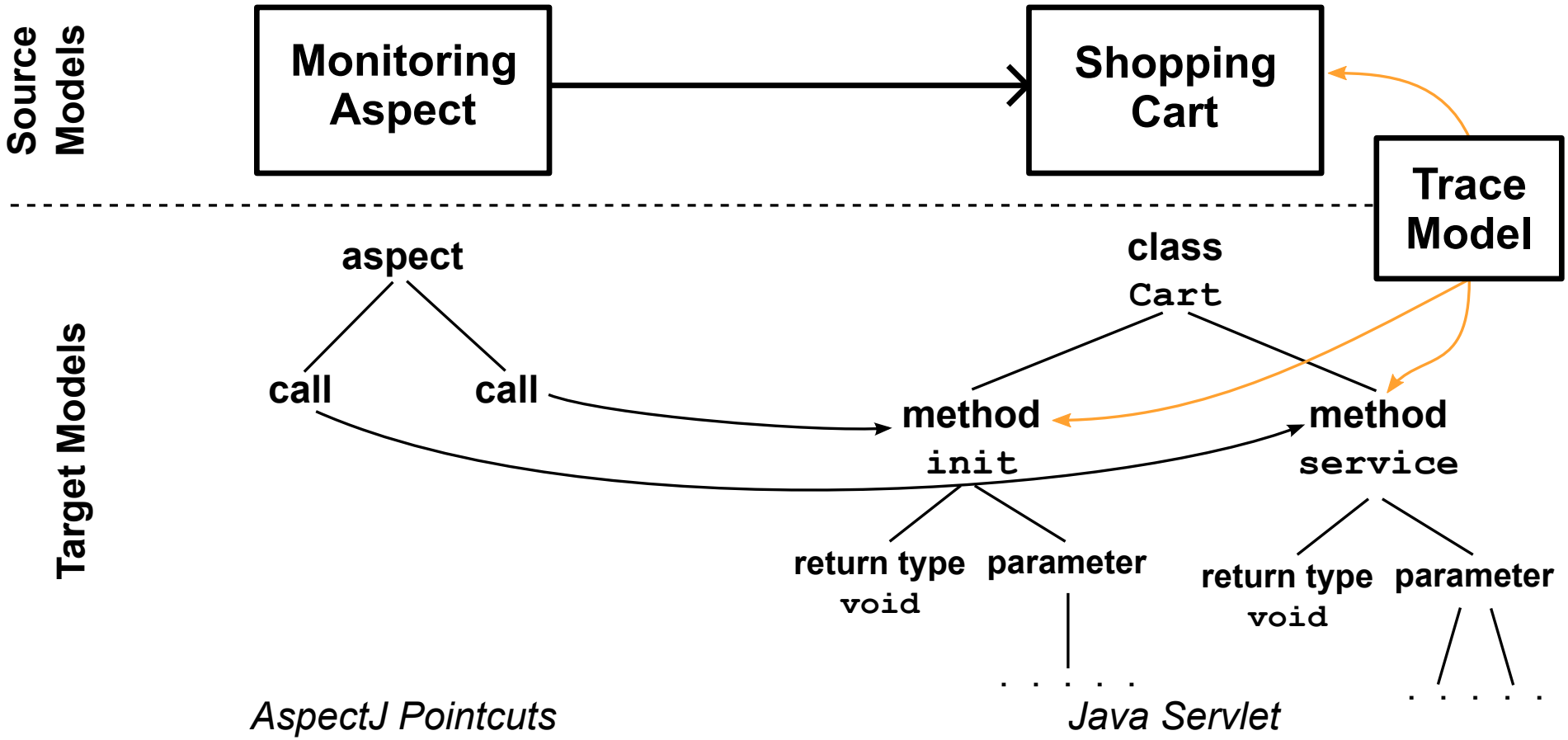

Trace recovery (cf. [Galvao and Goknil, 2007])

- Heuristic [Grammel and Kastenholz, 2010]
  - non-predictable results
- Deterministic
  - Based on node attribute matches
  - May miss relevant traces

Obtaining Model Traces

Trace recovery (cf. [Galvao and Goknil, 2007])

- Heuristic [Grammel and Kastenholz, 2010]
  - non-predictable results
- Deterministic
  - Based on node attribute matches
  - May miss relevant traces

Trace construction

- By the base model generator (fragment)
  - Cause more complex generators
  - Some transformations can be extended automatically [Jouault, 2005]
- By a separate trace model generator
  - Simpler generators
  - Support of legacy generators
  - Have to be adapted separately

Evaluation

Information Systems

- Example: Common Component Modeling Example (CoCoME)[1] [Rausch et al., 2011]
- Source meta-model: Palladio Component Model
- Target platform: Java EE
- Users: Projects of the DFG-SPP *Design for Future*[2]

Embedded Systems

- Example: Railway control center
- Source meta-model: MENGES DSL
- Target platform: PLCopen, C
- Users: Developers and engineers

[1] http://www.cocome.org/
[2] http://www.dfg-spp1593.de

Phases

- A: Technique and method evaluation
- B: Approach evaluation with information system scenario
- C: Approach evaluation with embedded systems scenario

Methods

- Controlled Experiments
- Simulation
- Expert Interviews
  - b+m Informatik, Stefan Zeug, Thomas Stahl
  - Scheidt & Bachmann, Hauke Fuhrmann

Experiment Setup

- Partial CoCoME model
- Source meta-model
  - Palladio Component Model [Becker et al., 2009]
  - Instrumentation aspect language [Jung et al., 2013a]
- Generators
  - ProtoCom for Palladio Component Model [Giacinto and Lehrig, 2013]
  - Generator for instrumentation aspect language

Objectives Proof of concept

- Evaluation of different pointcut concepts
- Evaluation of model/code weaving approach

Method

- Controlled Experiment
- Subjects: engineers and students

Experiment Setup

- Complete CoCoME model based on PCM and additional DSLs
- Adaptation of generators driven by CoCoME modification scenarios

Objectives

- Integration test of method and tooling
- Practicability of approach and tooling (Java EE)

CoCoME Collaboration

- Projects of the Design for Future SPP
- iObserve
  - University of Duisburg-Essen
  - Karlsruhe Institute of Technology
  - Kiel University
- University of Stuttgart

Design For FUTURE

iObserve

EnSure

Experiment Setup

- Legacy meta-model and type-system
- Creation of generators for different target languages

Objectives

- Feasibility for different target model/language domains (text, XML)
- Comparison with existing generator $\Rightarrow$ cost benefit

Method

- Simulation based on DSL versions of the original project

Collaboration

- b+m Informatik AG
- Scheidt & Bachmann GmbH

Goal A method for generator-composition for aspect-oriented DSLs

Publications

- Published
  - Type-Systems for DSLs [Jung et al., 2013b]
  - Data type language (DTL) [Jung, 2013]
  - Instrumentation aspect language [Jung et al., 2013a]
  - Design principles for meta-models [Jung et al., 2014]
- In progress
  - Survey on model join point notations
  - Evaluation of weaver tooling

Next step Realizing the first evaluation scenario

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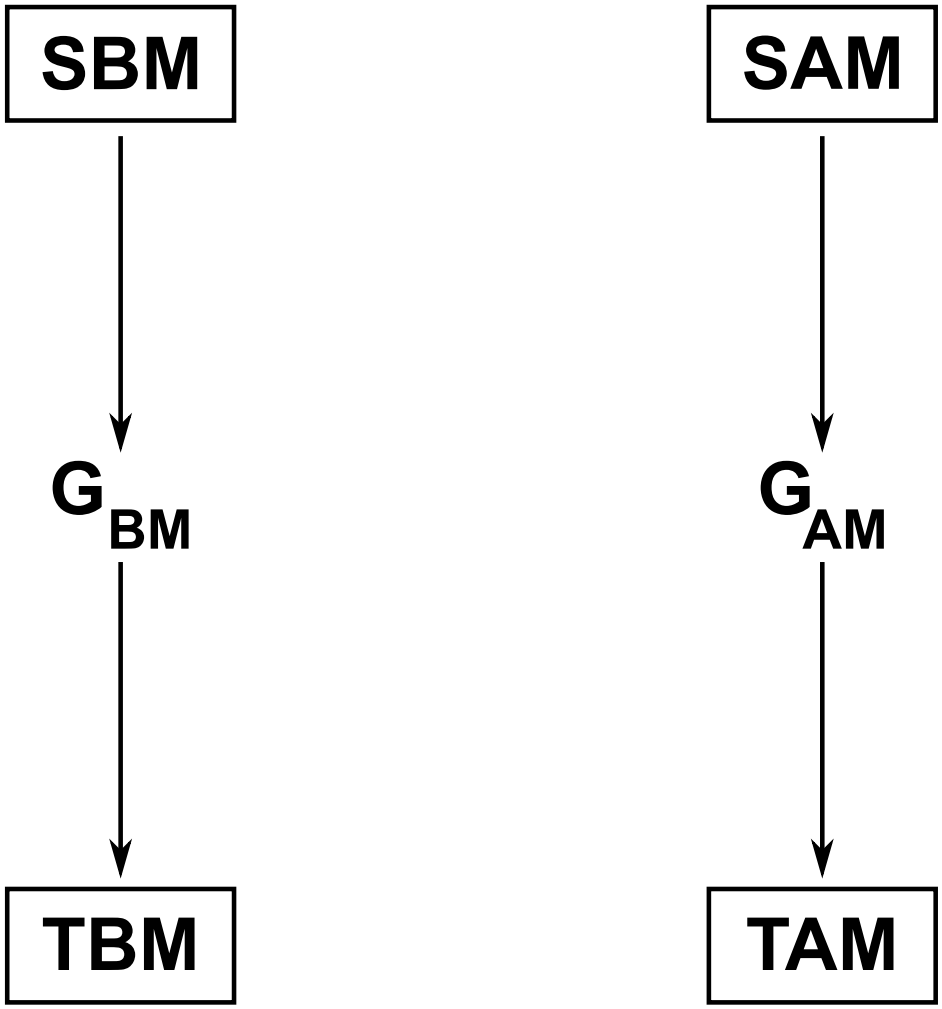

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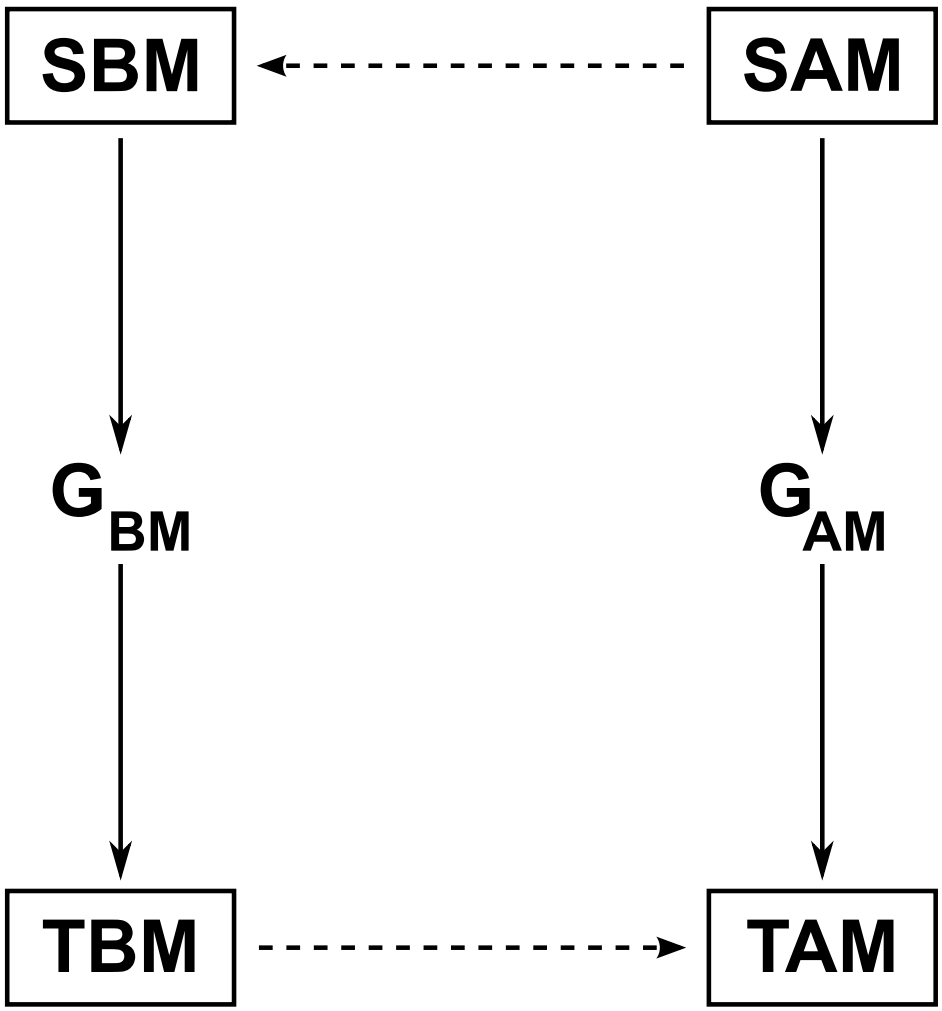

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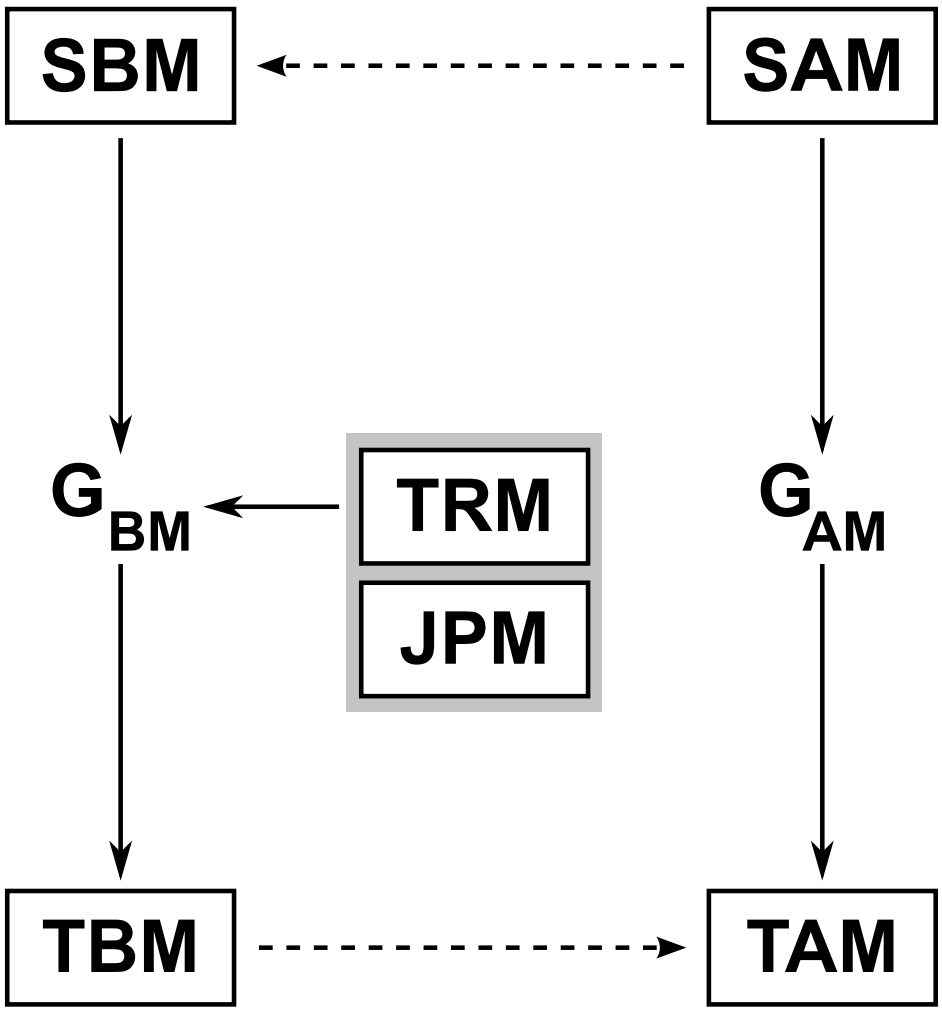

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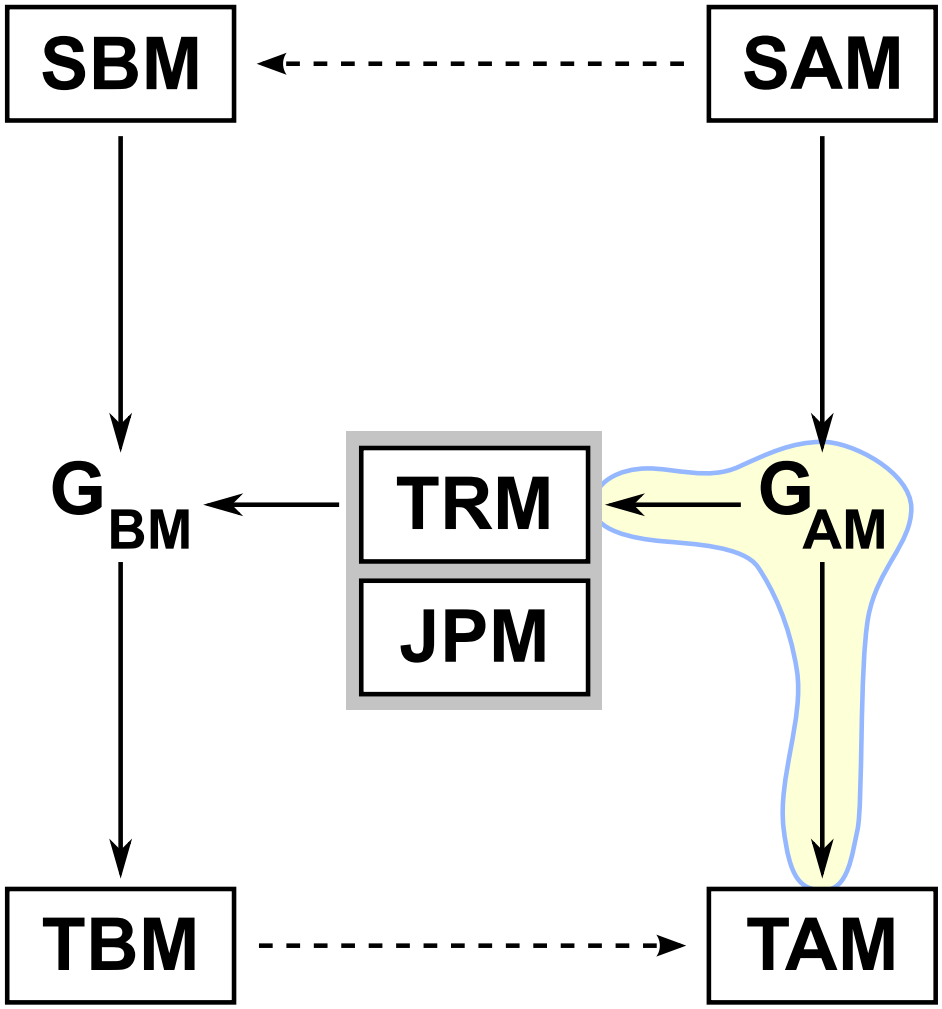

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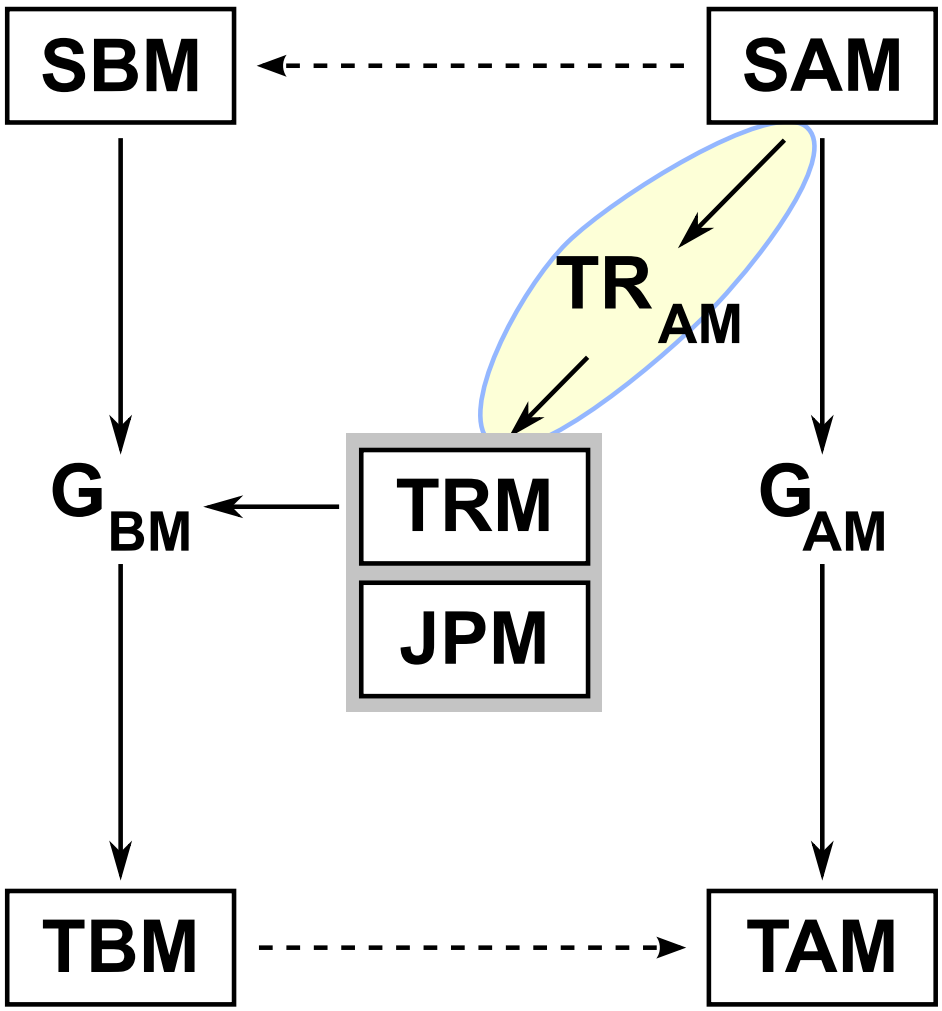

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