A Method for Aspect-Oriented Meta-Model Evolution

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iObserve

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Motivation

Driver of Meta-Model Evolution

1. Long-living software systems
2. Convergence of design-time and run-time models
   e.g. MAPE scenarios [Ghezzi, 2011]

Aspect-Oriented Modeling (Concern-Driven Development)

- Separate concerns
- Reduce meta-model complexity
- Ease meta-model evolution and reuse

Example: Palladio Component Meta-Model

[Becker, Koziolek, & Reussner, 2009]

Palladio

- **Domain** Performance prediction
- **Meta-Model** 188 classes (PCM)
- **Concerns** Components, deployment, workloads, ...

Scenario

- Reuse PCM as run-time meta-model for forecasting

Extensions

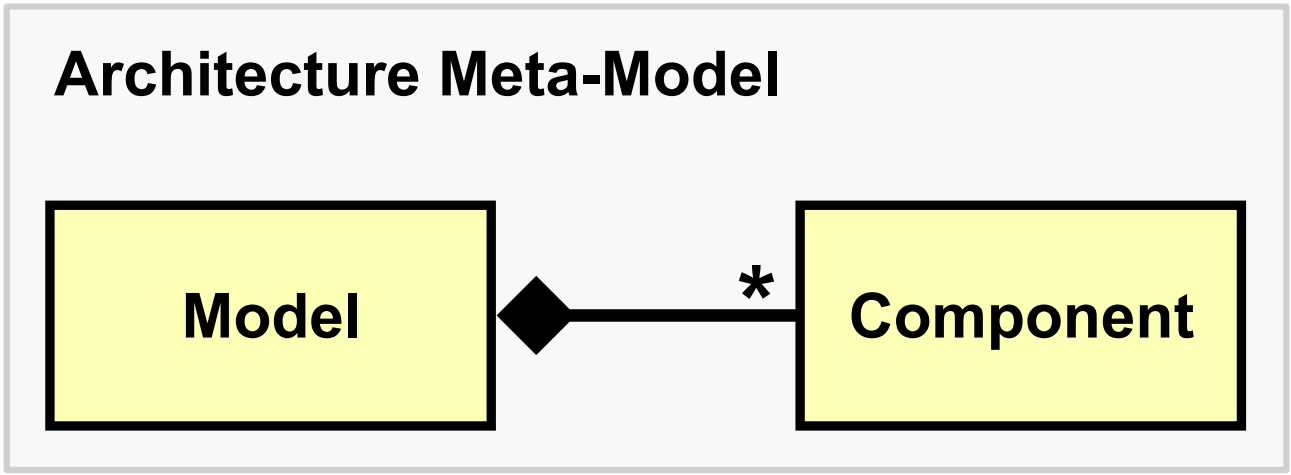
- Cloud
- Monitoring

Related Meta-Modeling Approaches

- Meta-Model Extension by Subclassing [Steinberg et al., 2009]
- Decorator Pattern Approach
- EMF Profiles [Langer et al., 2012]

Meta-Model Extension by Subclassing

[Steinberg et al., 2009]



Meta-Model Extension by Subclassing

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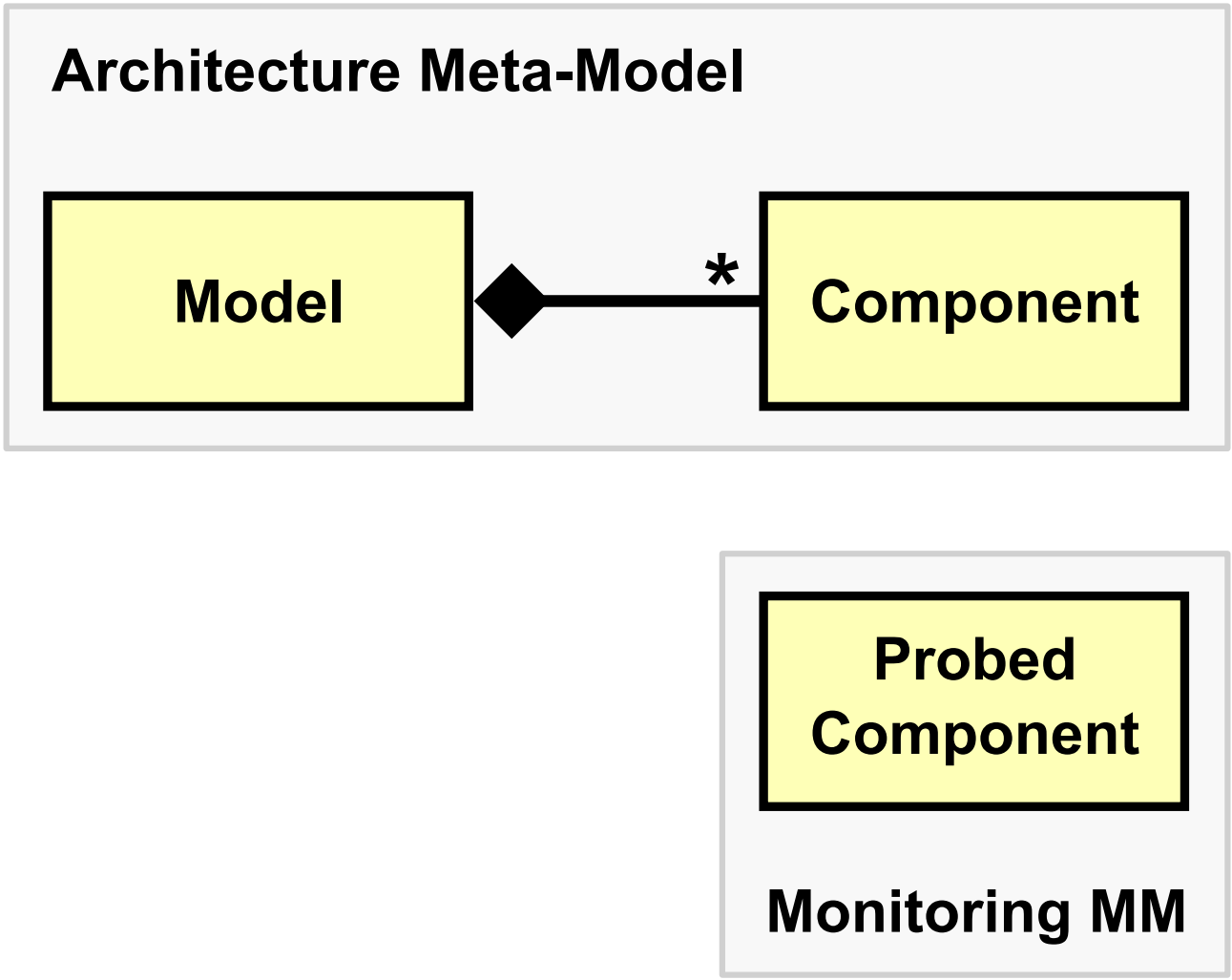

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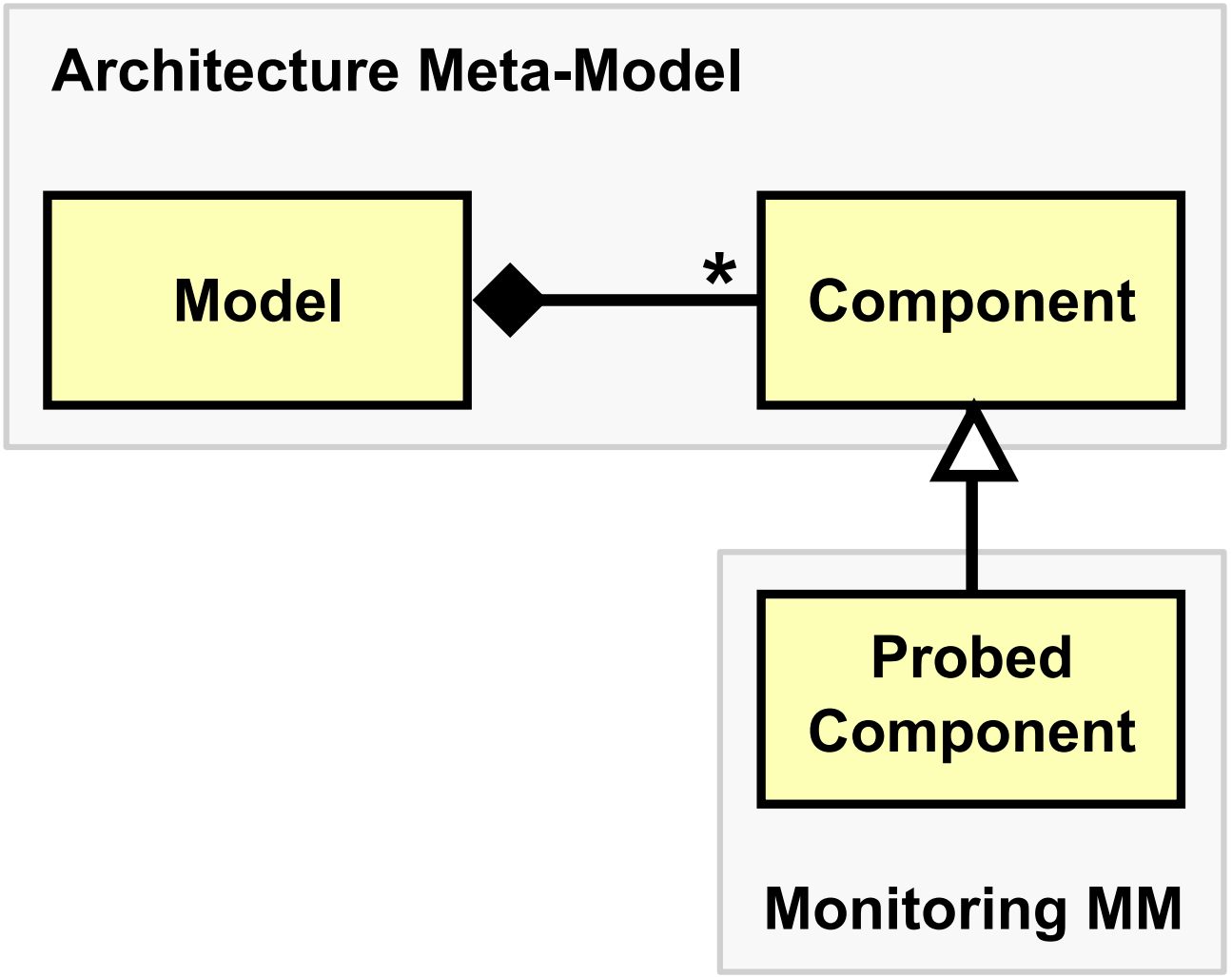

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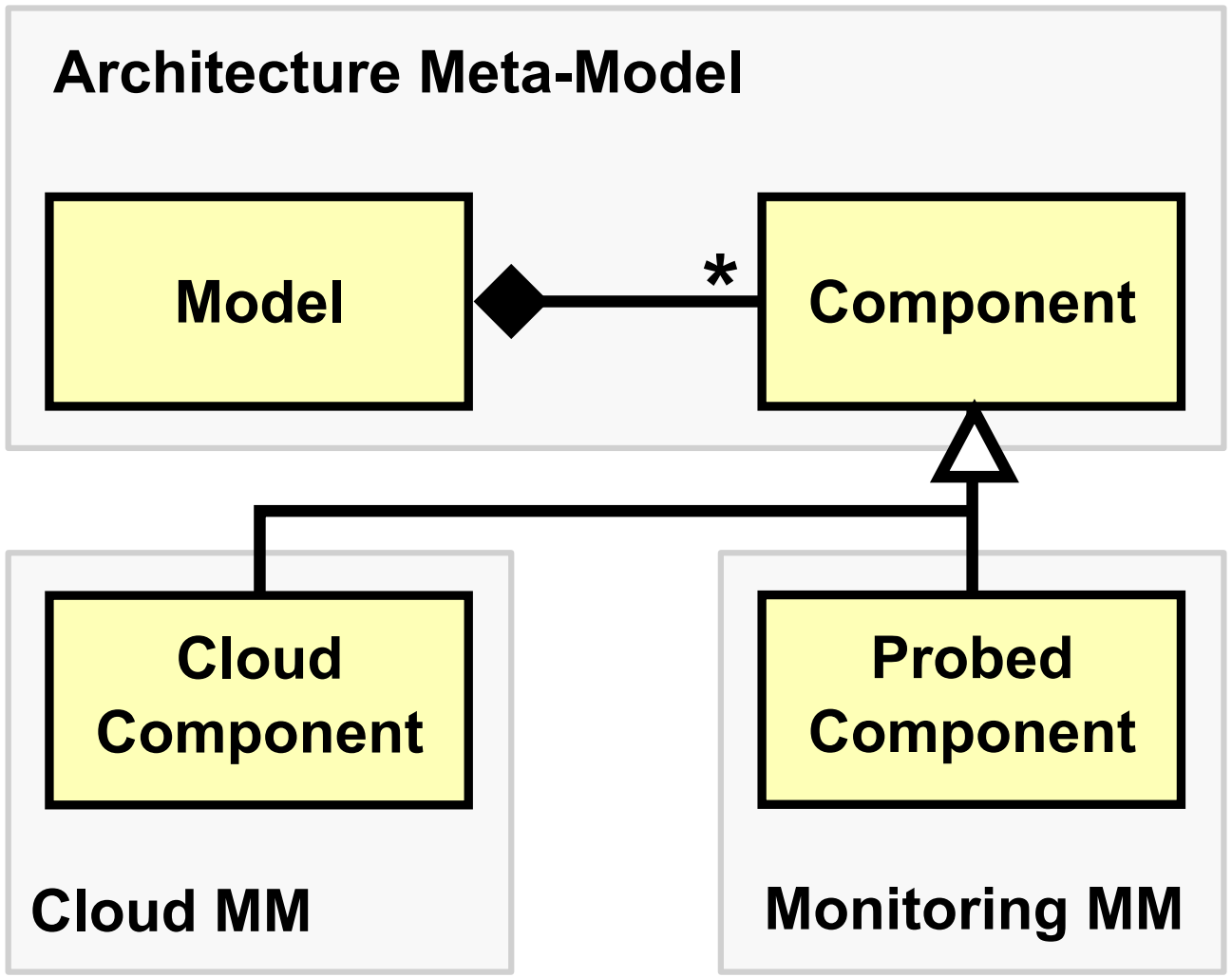

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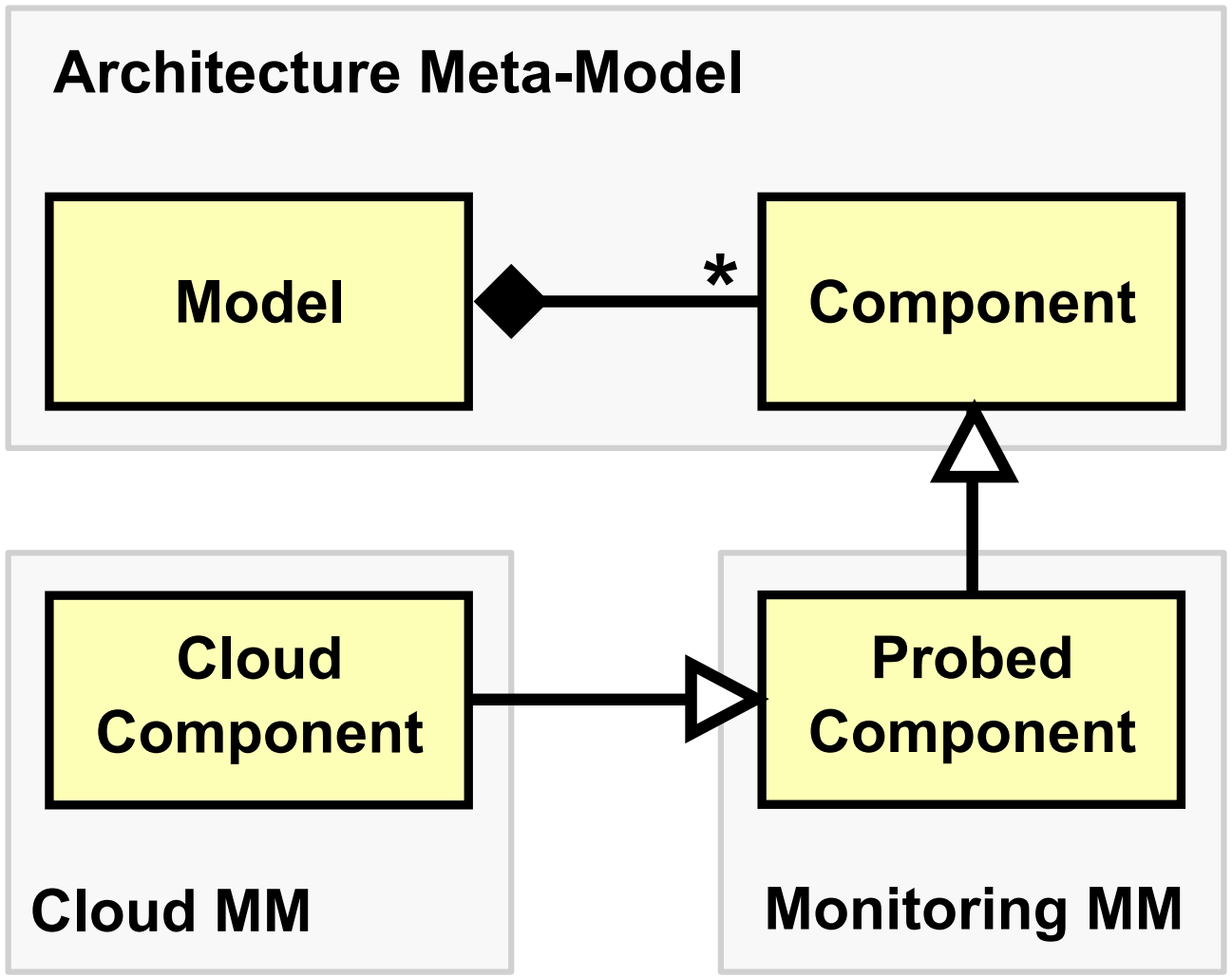


Solution Requirements

cf. [Langer et al., 2012]

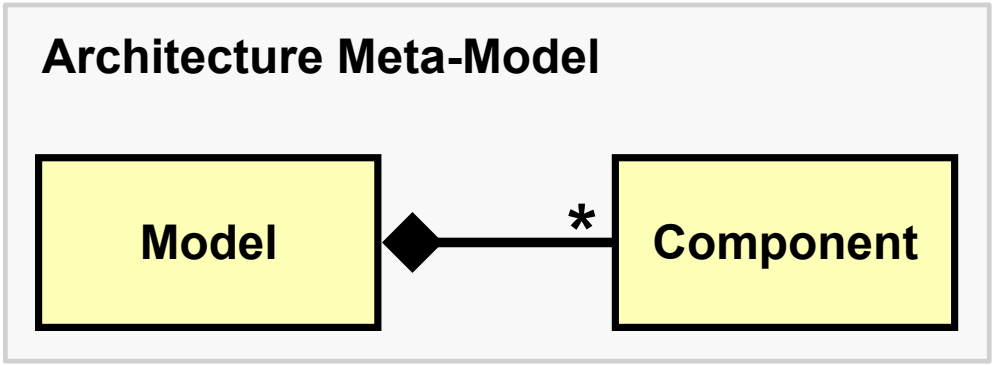
1. **Non-invasive** meta-model annotation mechanism
2. **Separation of concerns** from different modeling domains
3. Honor different **types of relationships and roles** of meta-models
4. Should support a **formal specification** for extensions/annotations
5. Must support **existing technology** to ease integration
6. Easy application and **compatible with existing tooling**

Overview

Central ideas

- Aspect-oriented meta-models
- Semantic of references
- Contextual meta-model patterns

Aspect-oriented Modeling Roles



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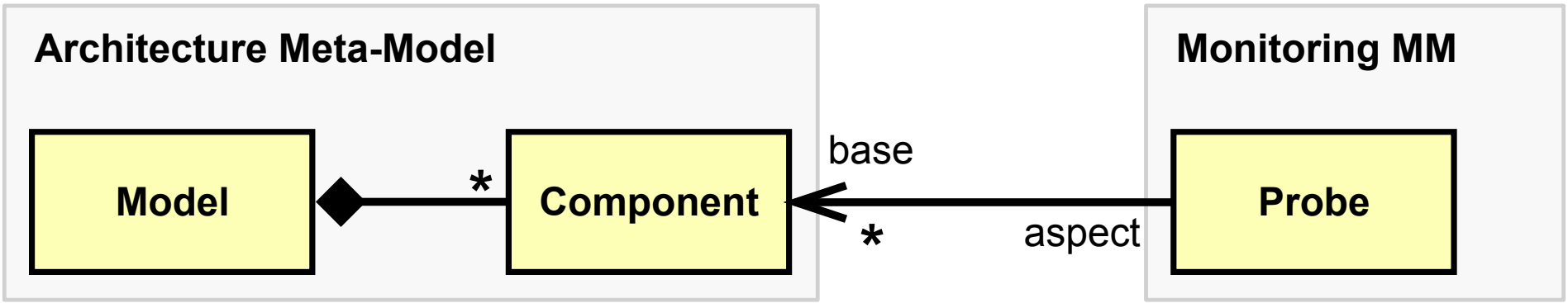

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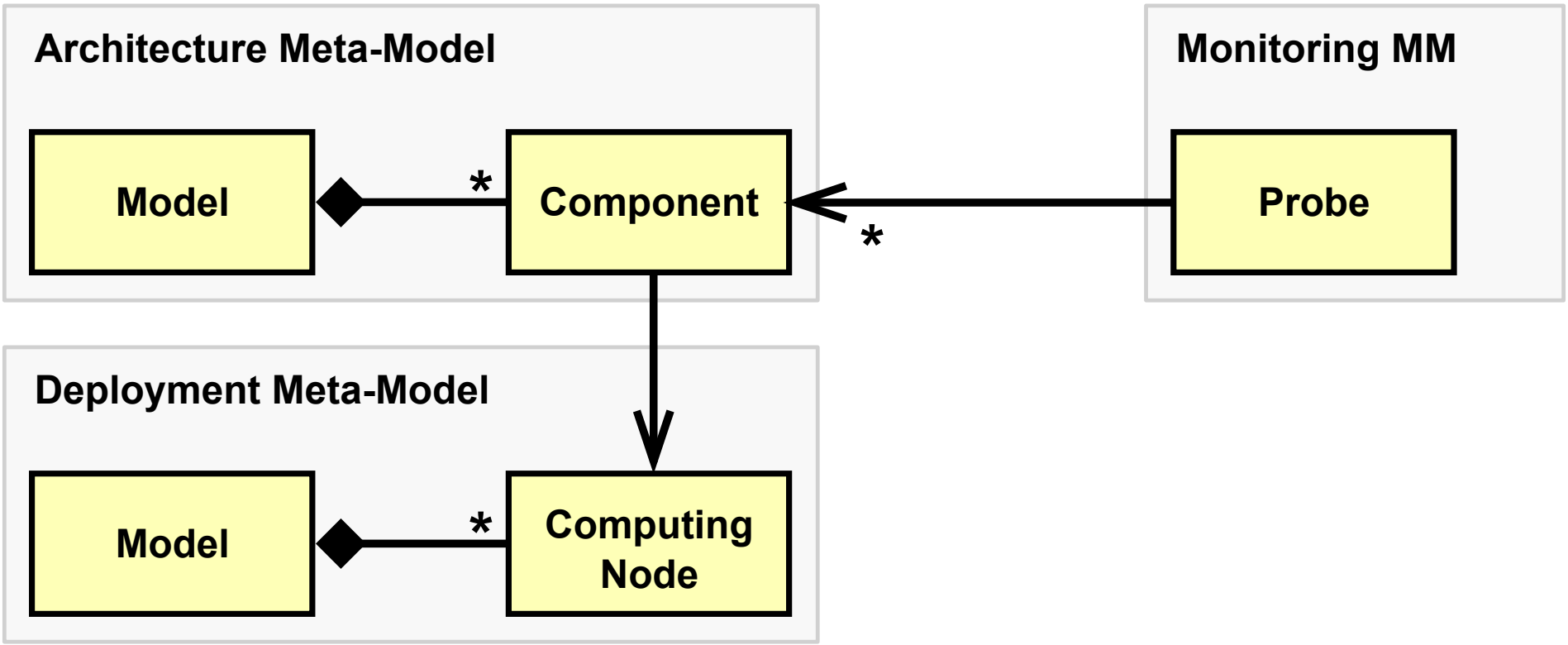

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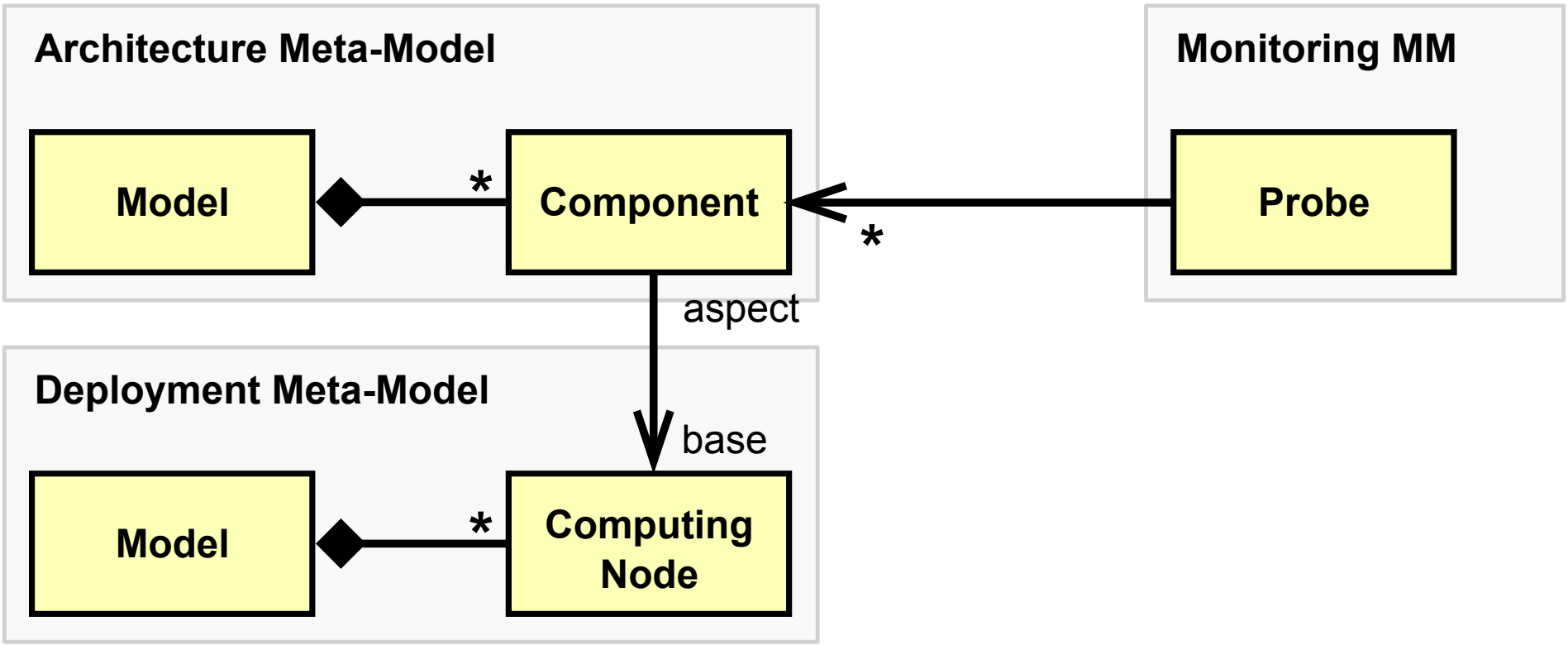

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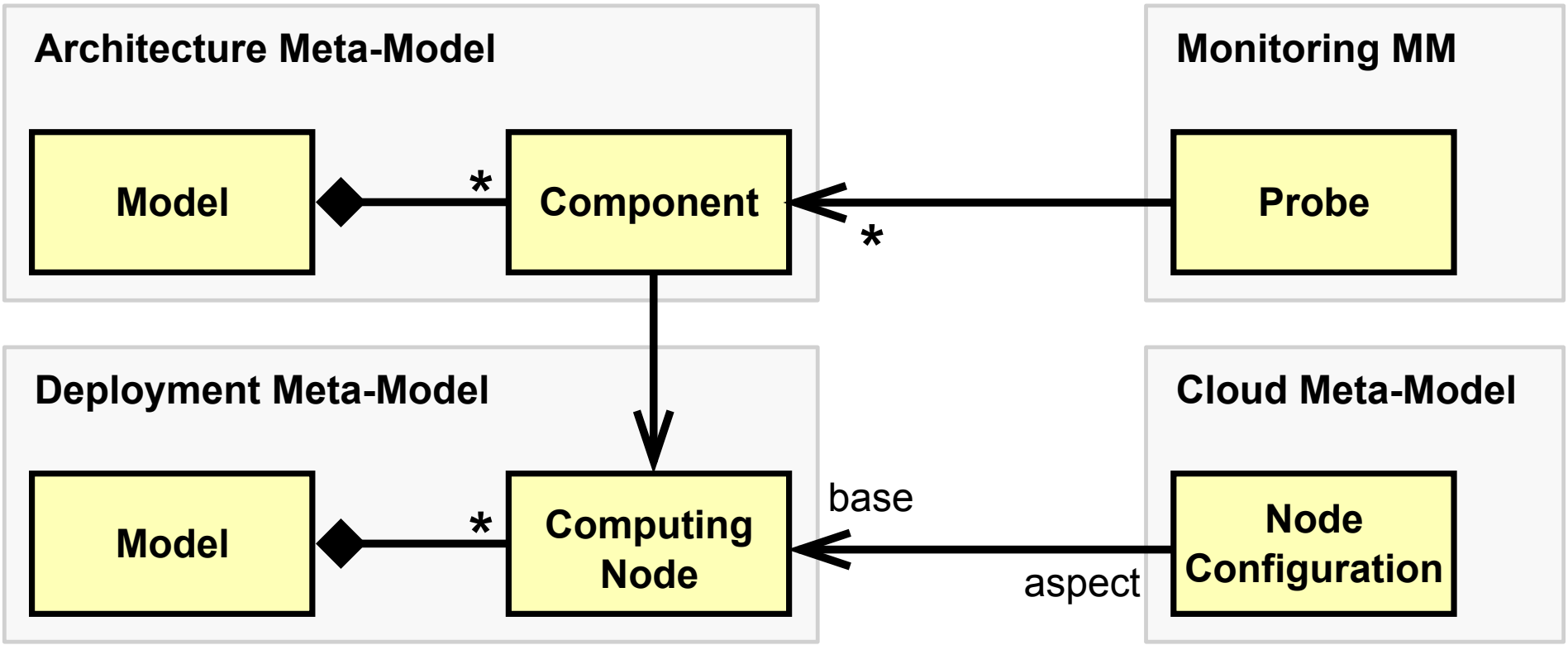
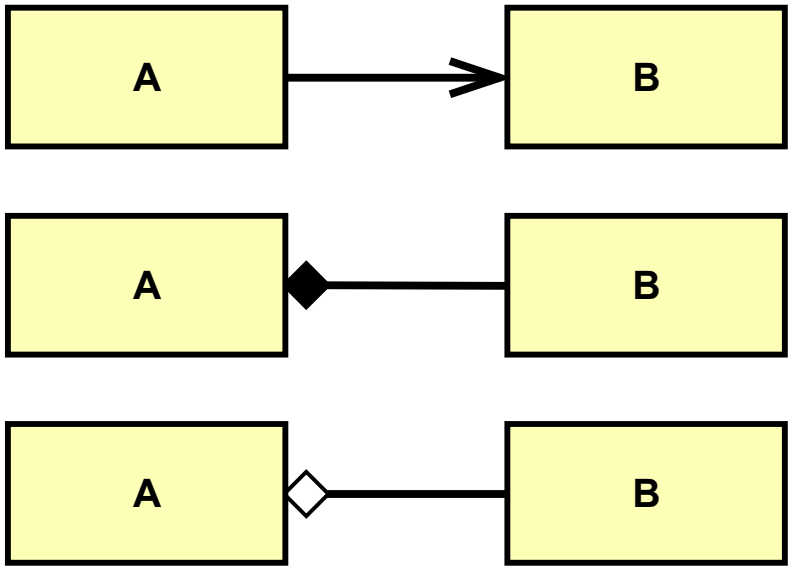


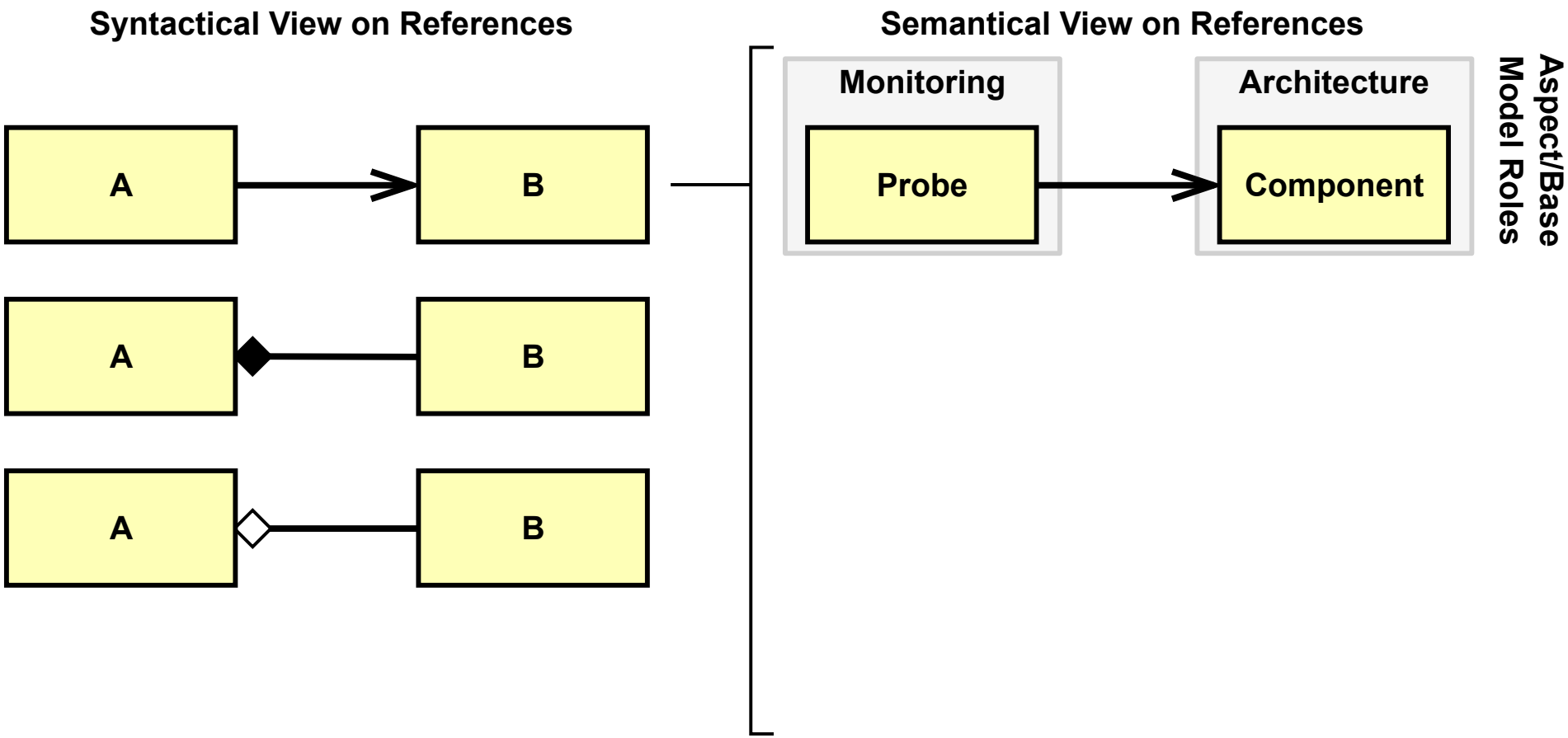
Semantic of References

Syntactical View on References



Semantical View on References

Semantic of References



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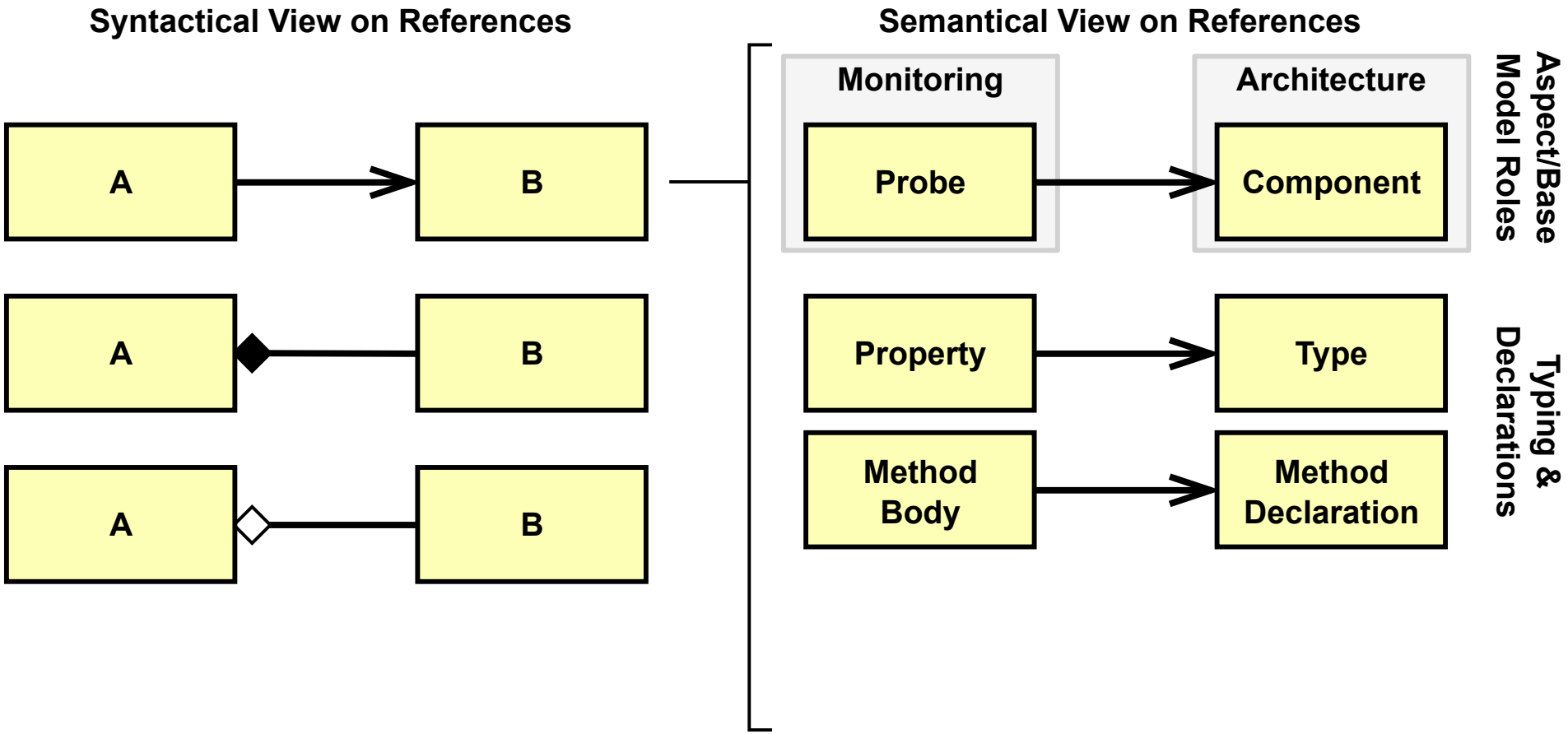
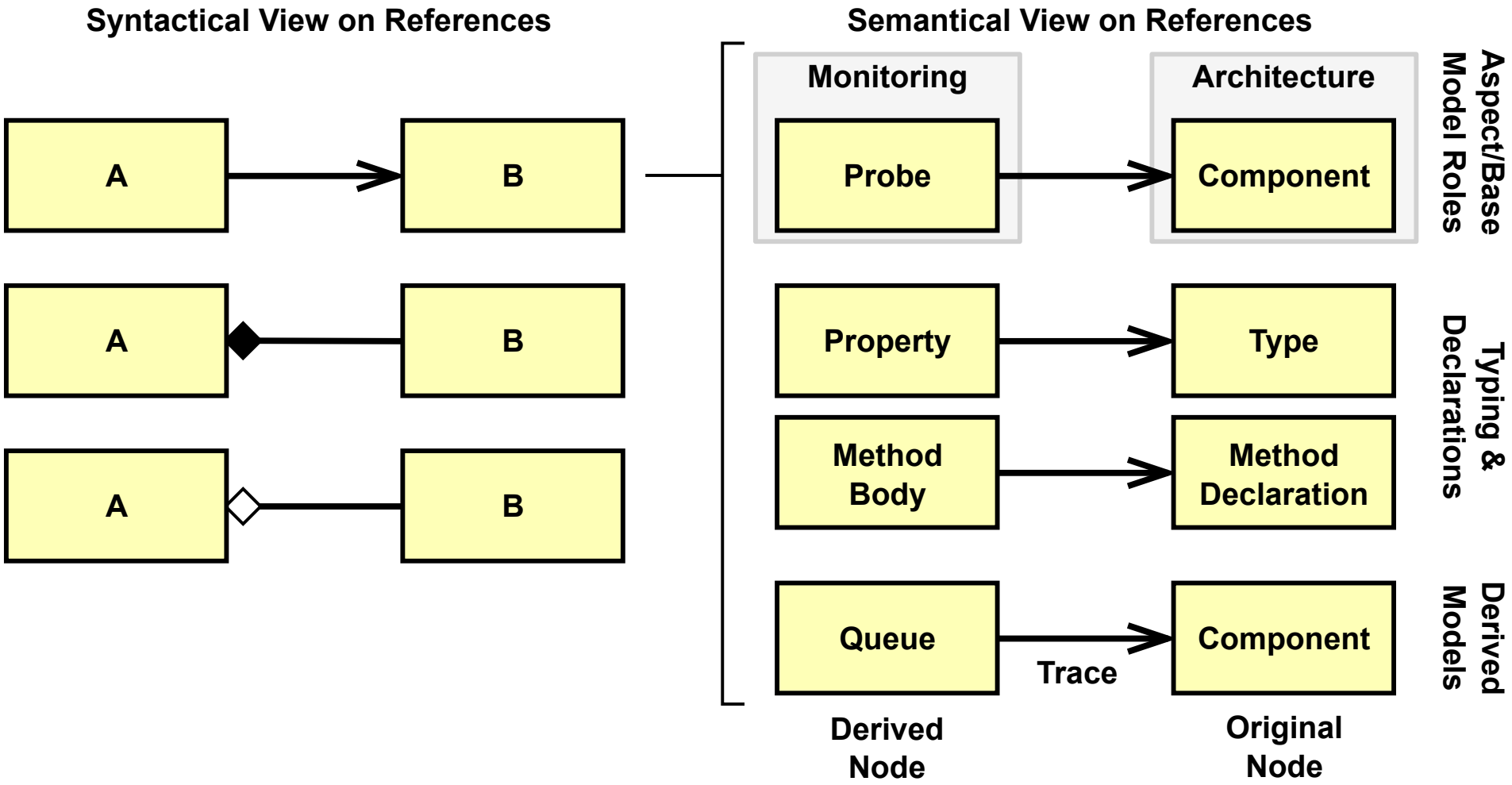


Semantic of References

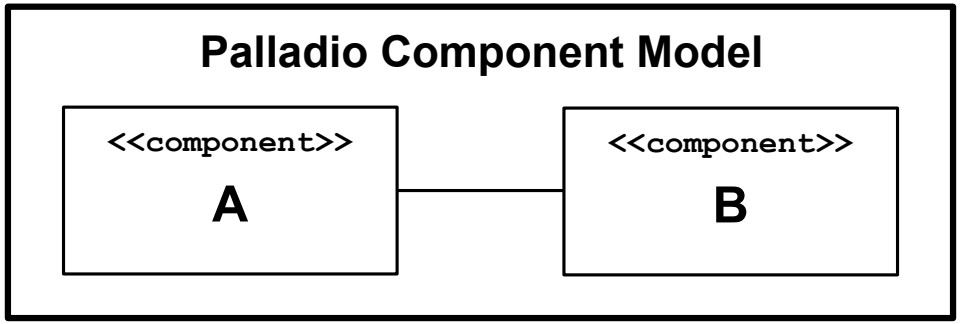
Method



Contextual Meta-Model Pattern

Use Cases	**Pattern**
Models@Runtime	Tracability
Generators	Navigation
Editors	Queries
Simulation and Evaluation	Execution / Behavior
	Data
	State

Use Case: Run-Time Model



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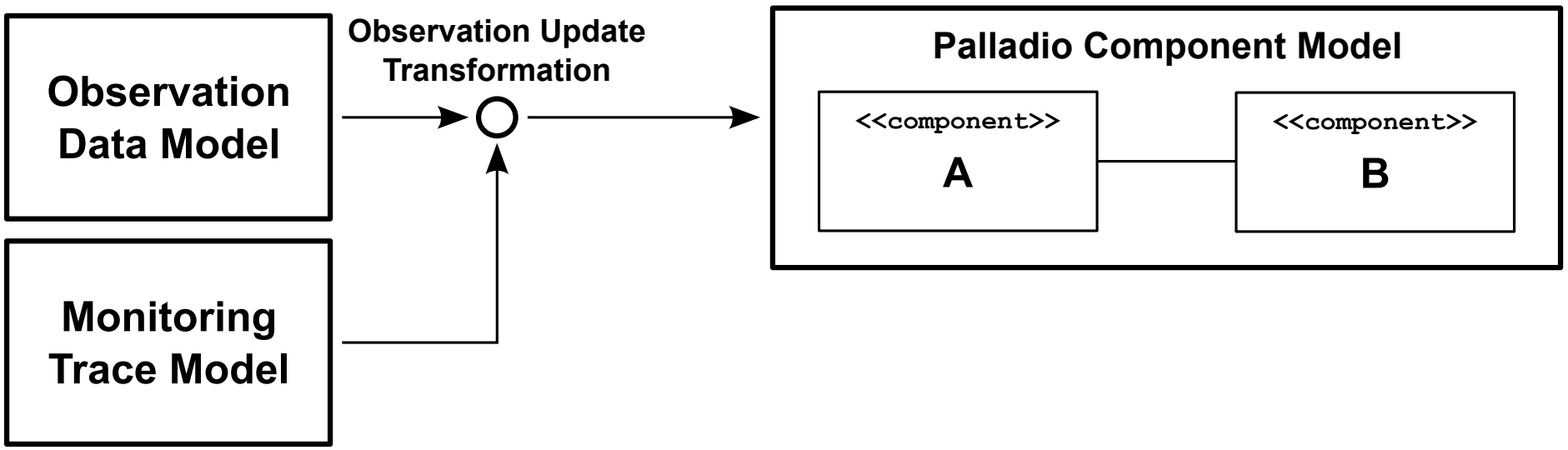

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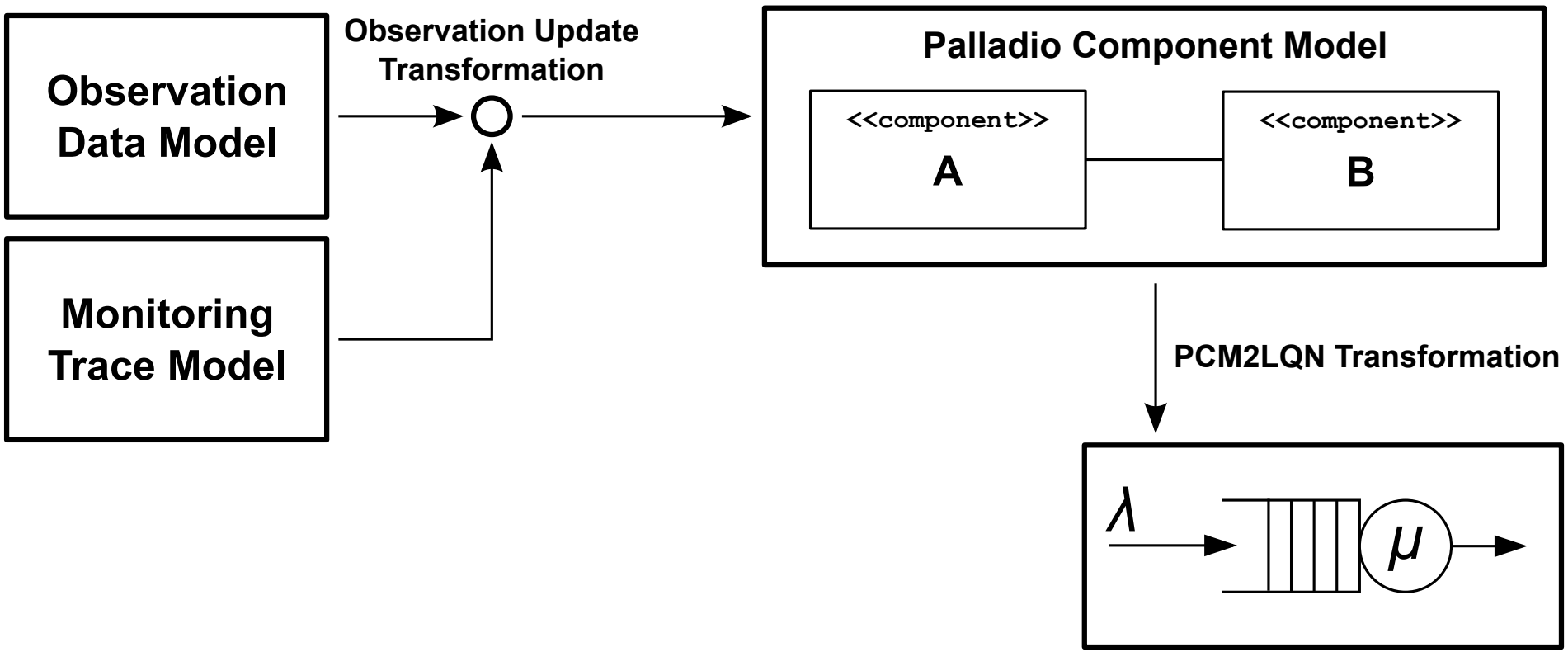

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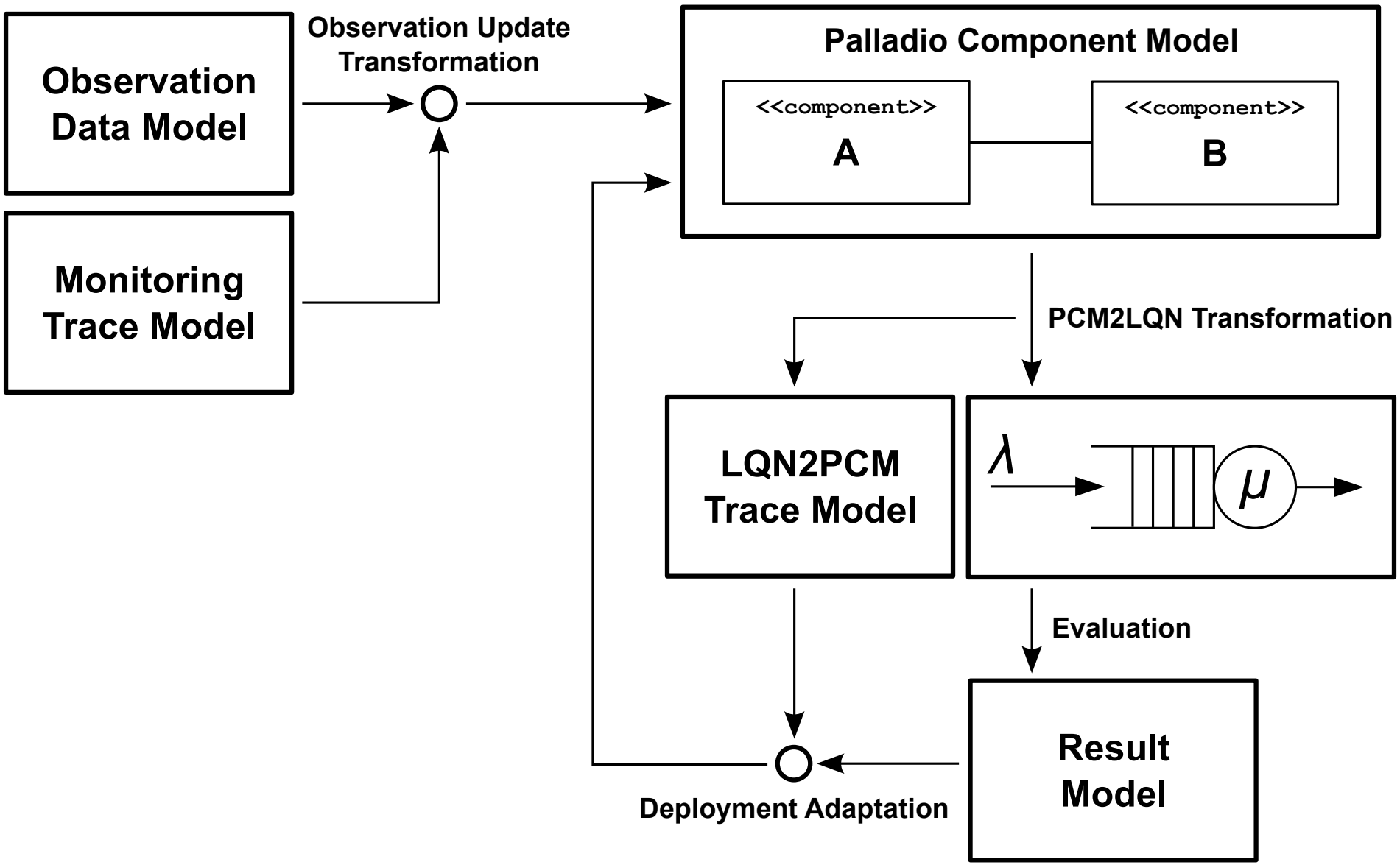


Summary and Outlook

Summary

- **Non-invasive** annotation mechanism through AOM
- **Separate concerns** represented by separate meta-models
- Better understanding of **pattern and semantics** in meta-models
- Use EMF/Ecore as **formal notation** for meta-models
- No new meta-meta-model required
- **Compatible** with existing frameworks

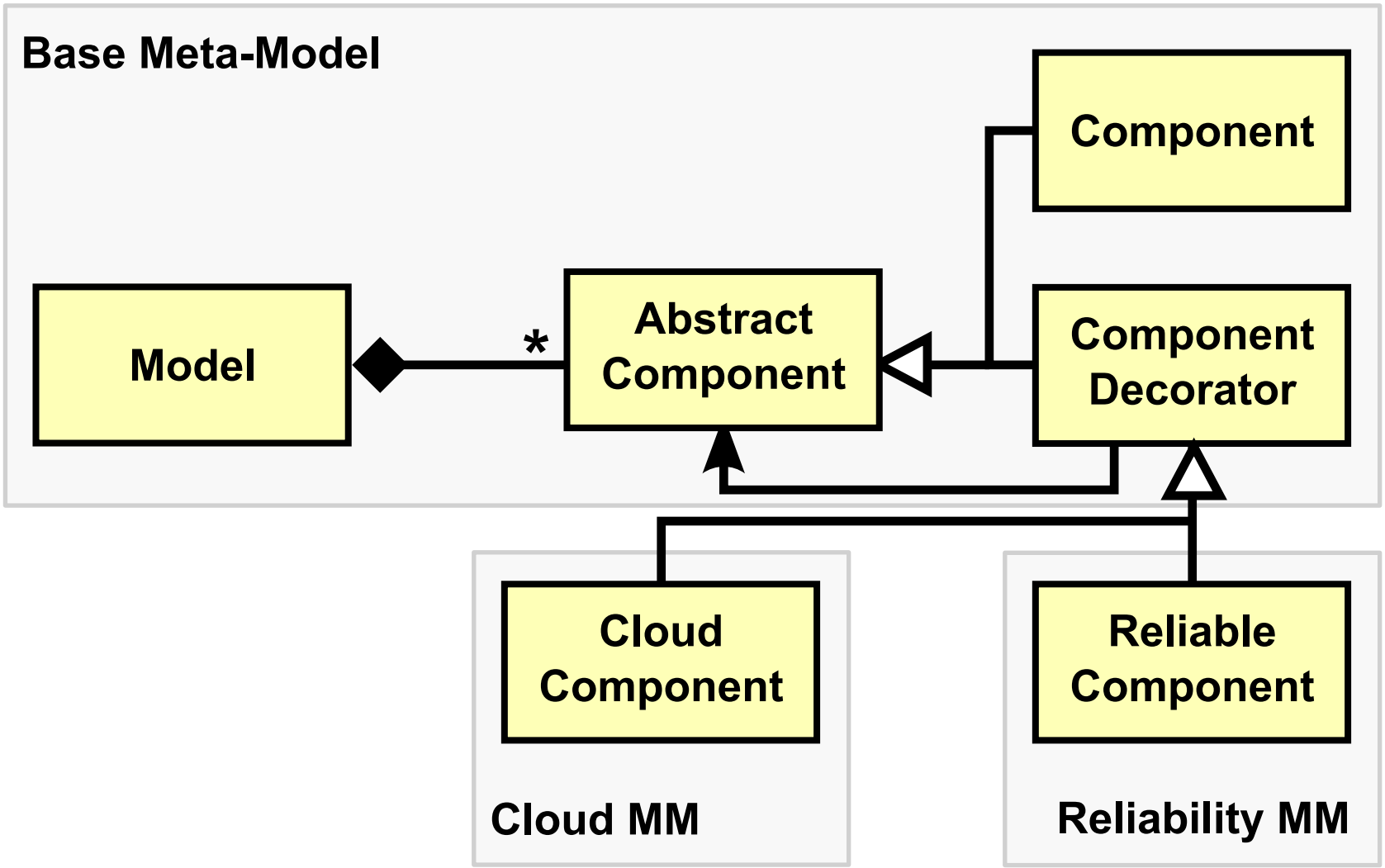
Outlook

- Detailed definition of meta-model pattern
  - Implications on tooling
- **Evaluation** of our method in a PCM modernization effort
  - Solid core PCM
  - Wide palette of extensions

Appendix

Decorator Pattern

[Gamma, Helm, Johnson, & Vlissides, 1994]



Features

- Provide a profile mechanism for EMF
- Multiple profiles can be annotated to one class
- Generic reusable profiles for reuse
- Comes with its own (meta-)meta-model

Downside No tool-integration

- Xtext DSL framework [XText, 2011]
- KLighD diagram and auto-layout framework [Schneider, Spönemann, & von Hanxleden, 2013]
- Genmodel facilities

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