

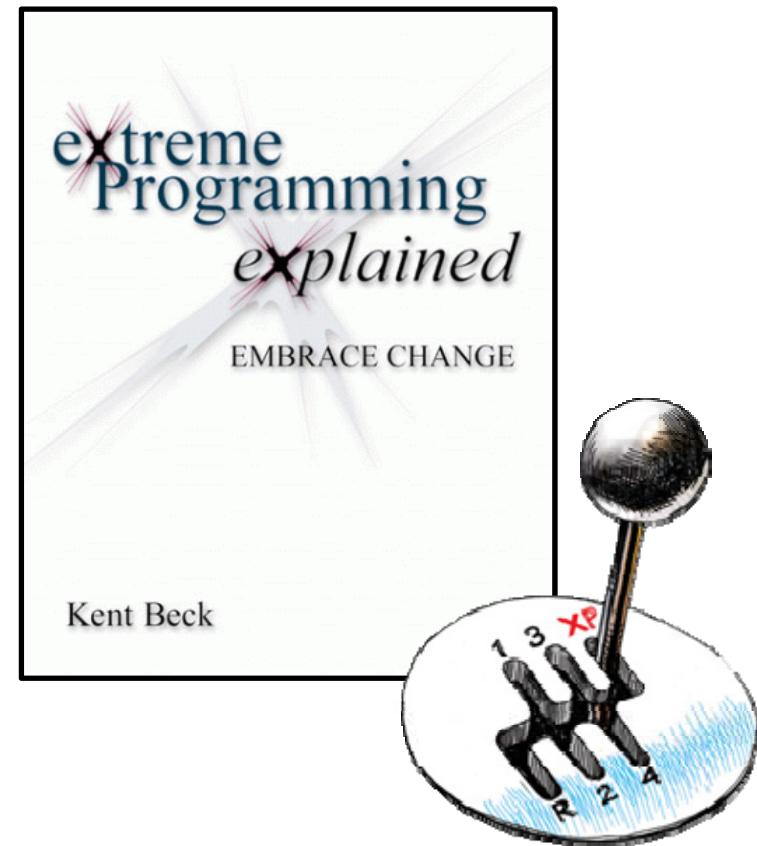
Performance Aware DevOps

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The Road to Agility

- Agile development is a success story
- But development (Dev) hits a bottleneck during operations (Ops)
- Programmable infrastructures provide a solution (e.g., Puppet, Chef, ...)

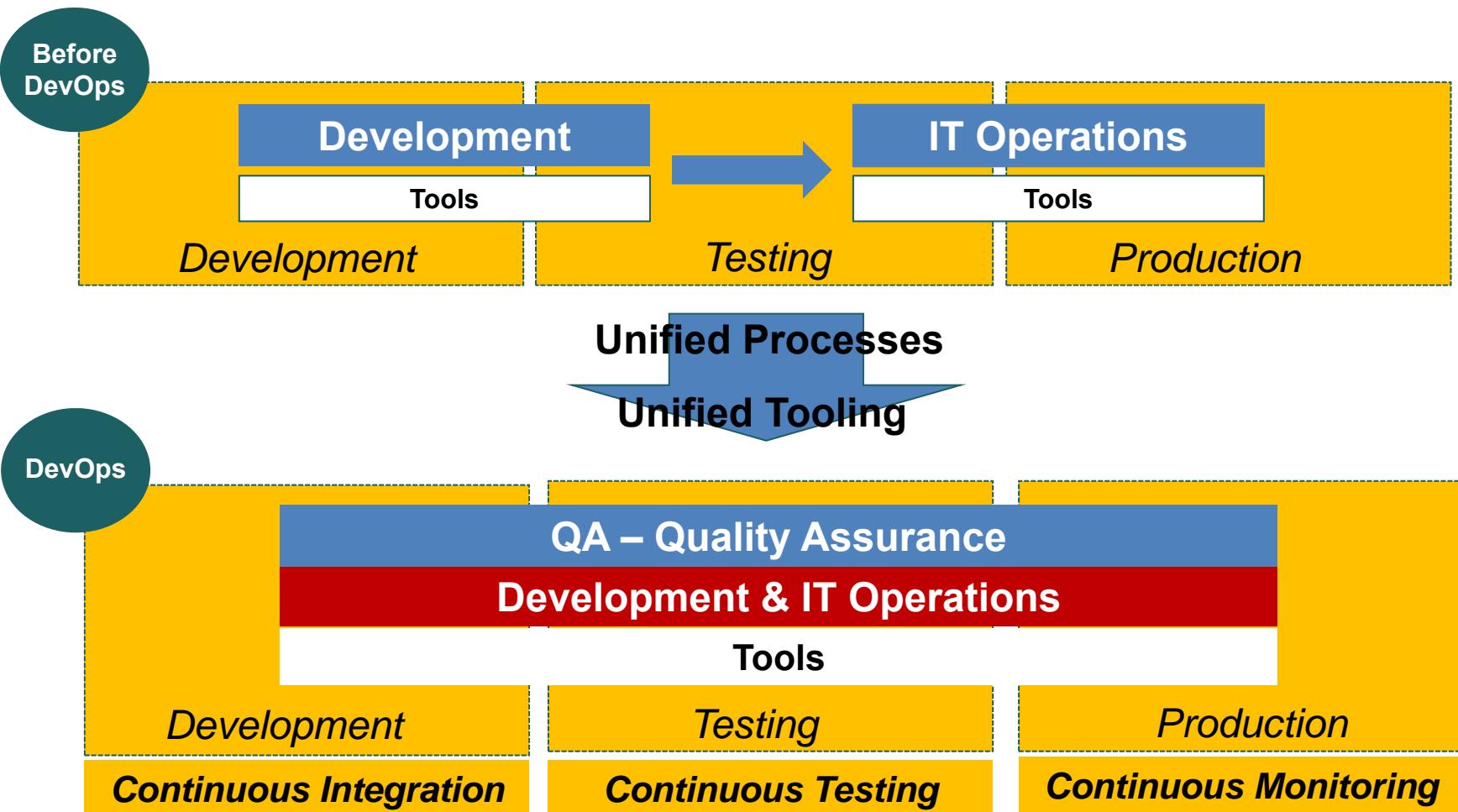


Is DevOps Just IT Automation?

- Automation is the answer
- The question is how to improve:
 - Collaboration of Dev & Ops
 - Sharing of responsibilities
 - System-oriented mindset



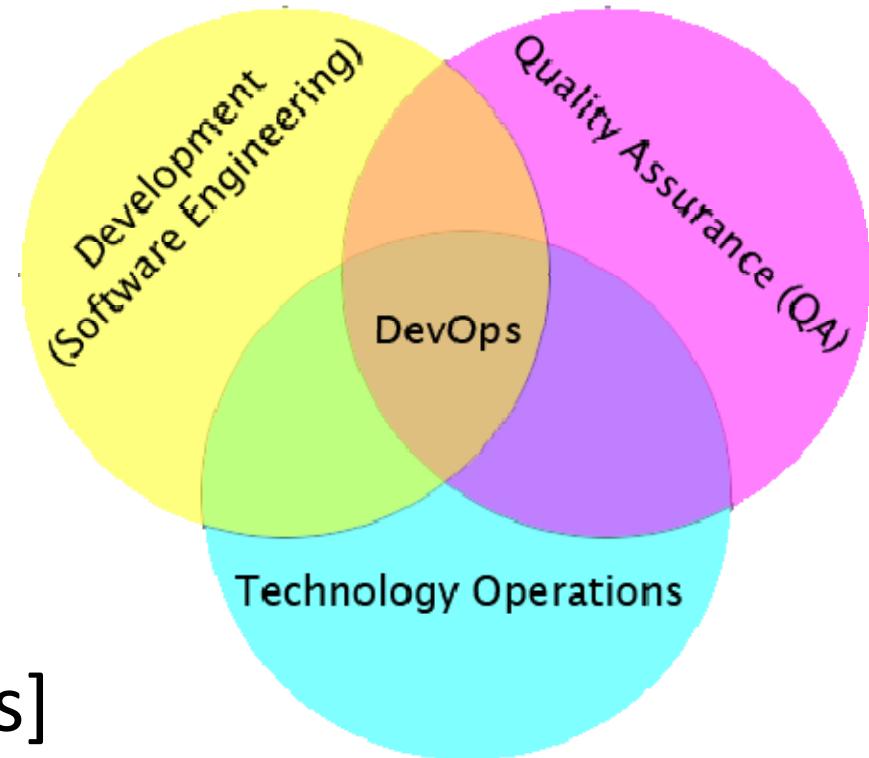
Embracing DevOps



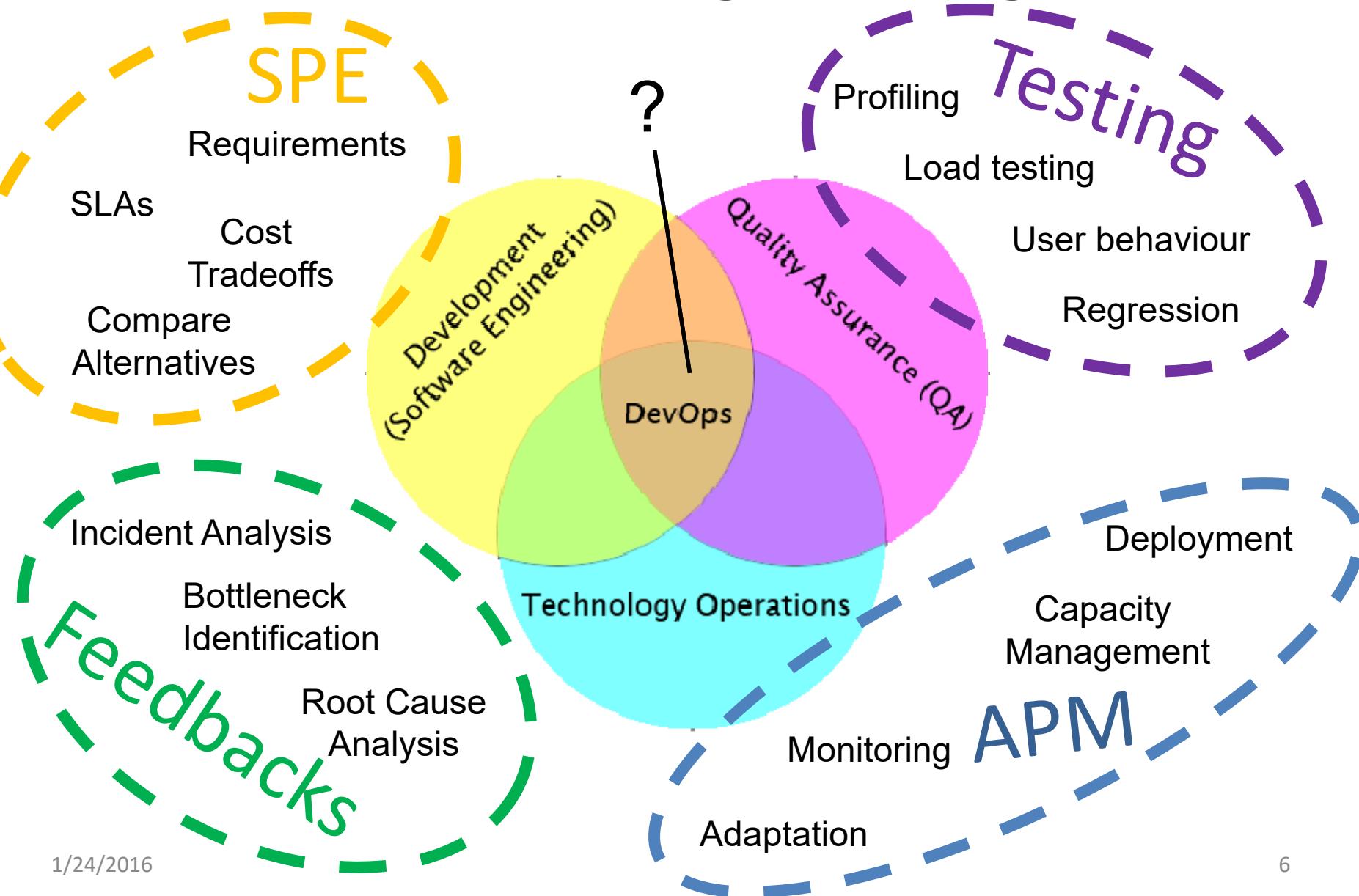
Source: *What is DevOps?* E. Di Nitto et al.

Quality Assurance in Today's DevOps

- Mainly functional testing
- What about performance tests?
- “Just 13% companies run automated performance tests within continuous integration servers” [Neotys]

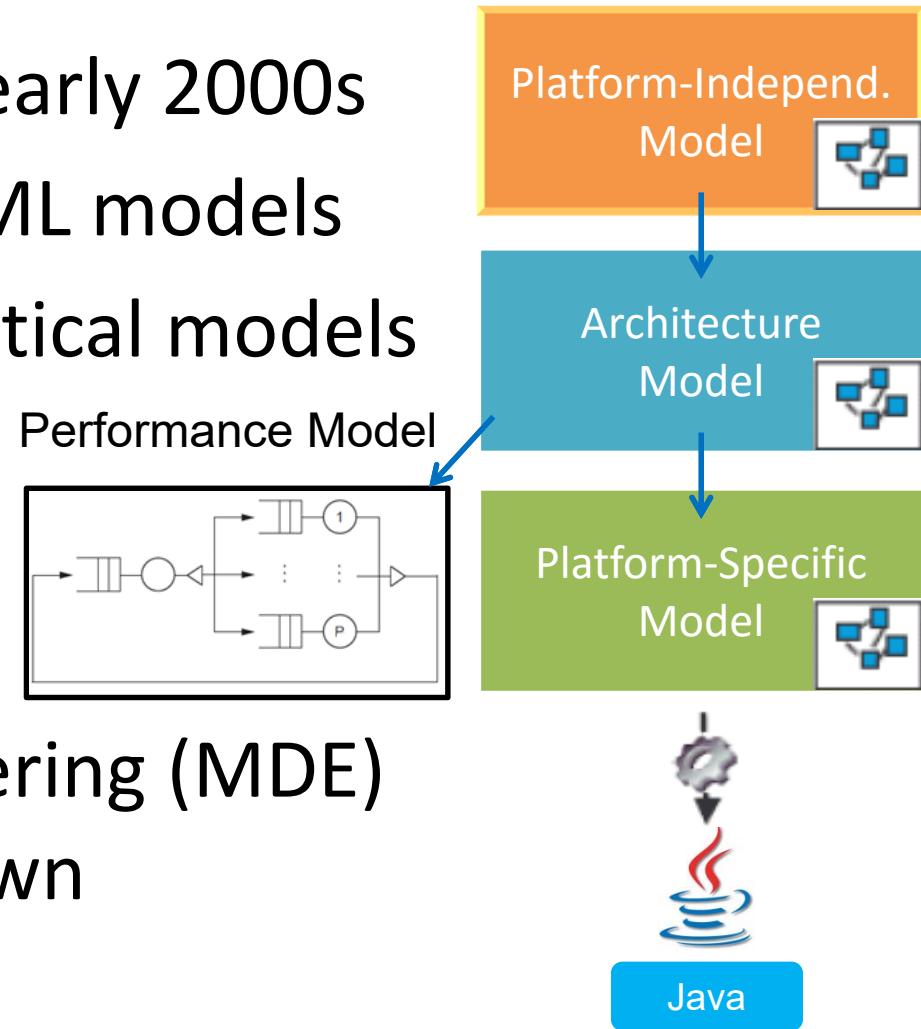


Performance Engineering (PE)



A New Challenge?

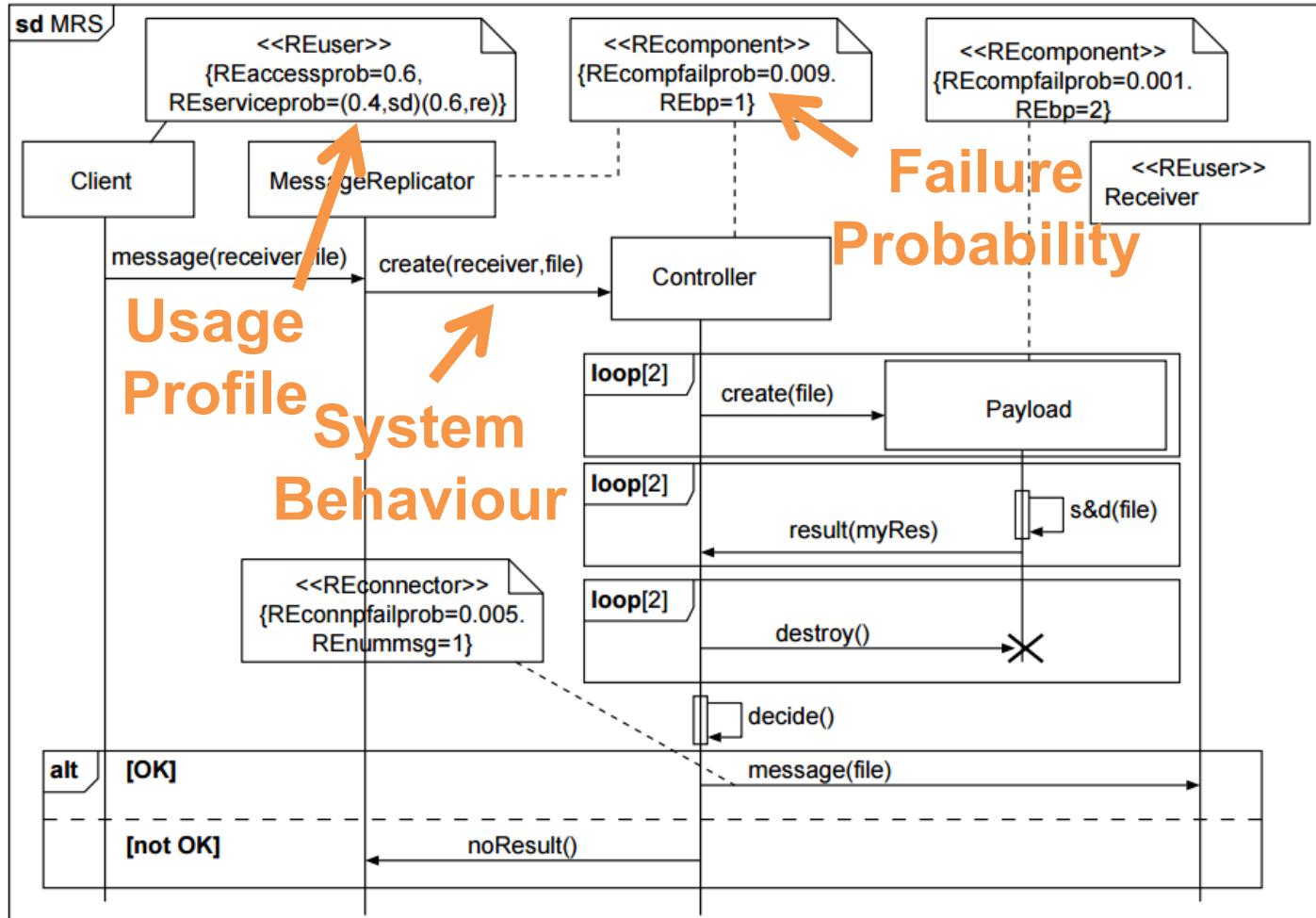
- Somewhat similar to early 2000s
 - Dev teams write UML models
 - PE focuses on analytical models
 - How to facilitate the interaction?
- Model-Driven Engineering (MDE) is the only game in town



Performance Aware MDE

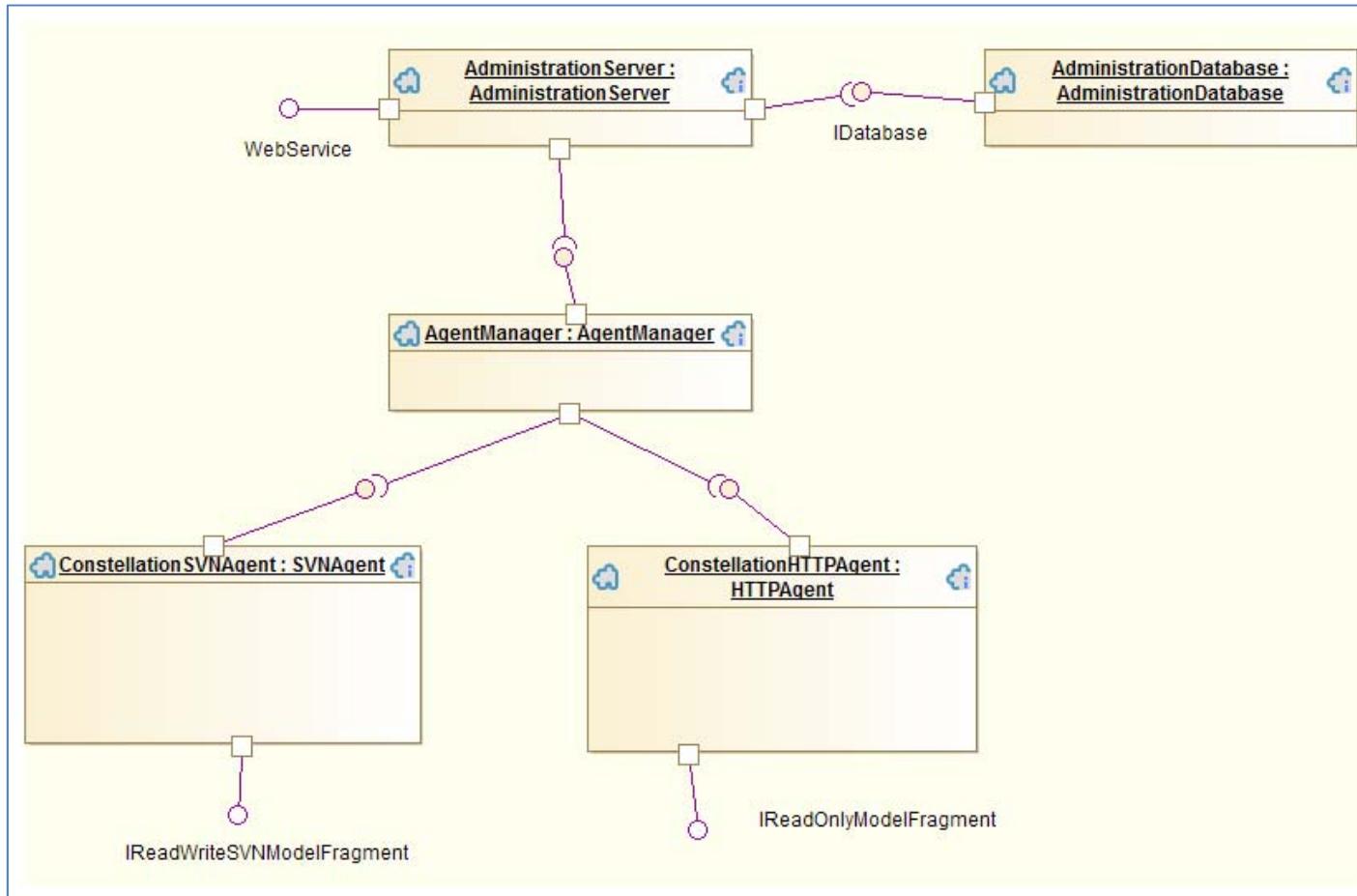
Performance Annotations

- UML MARTE profile, UML DAM profile



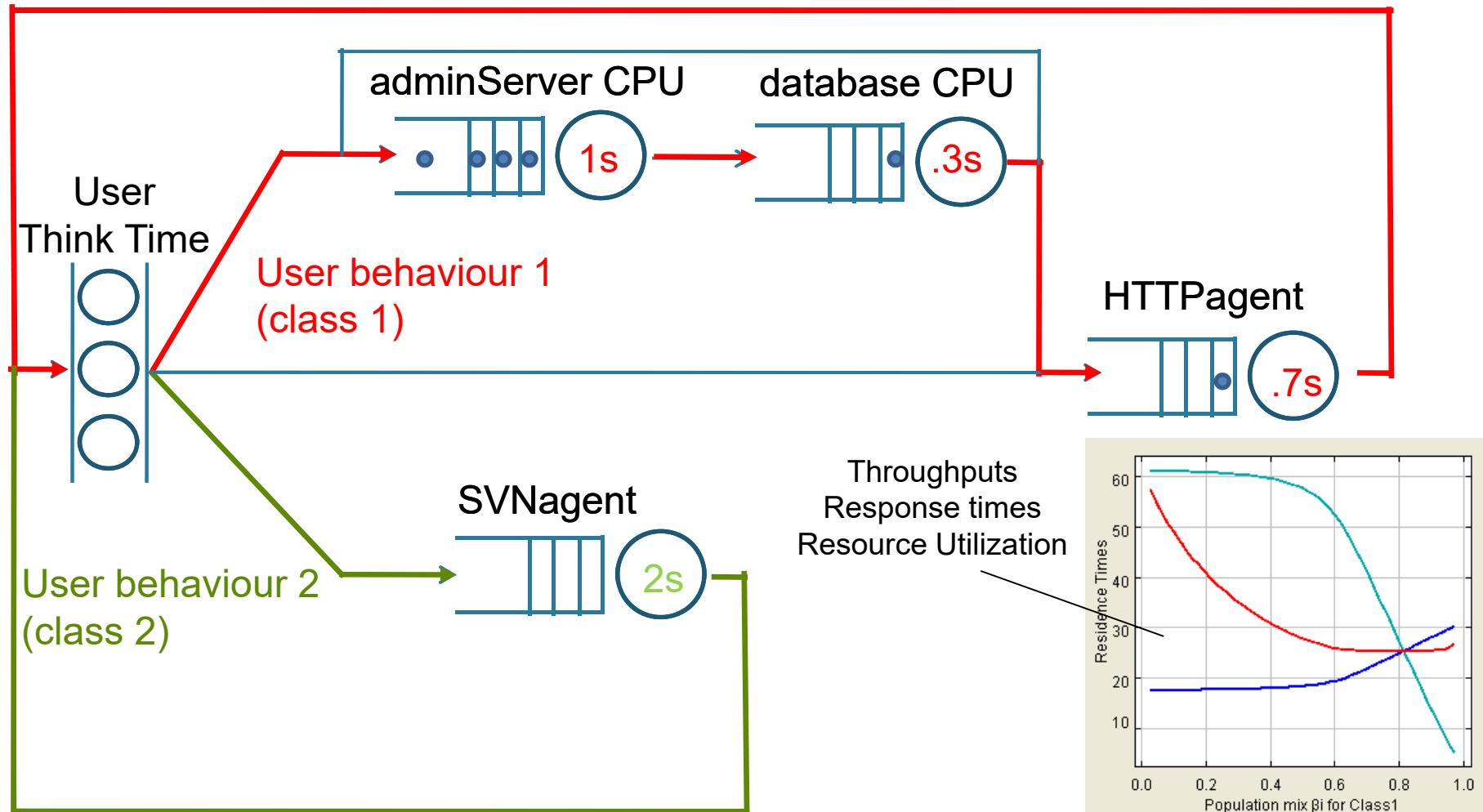
Model-to-Model Transformation

From Architecture to Analytical Models



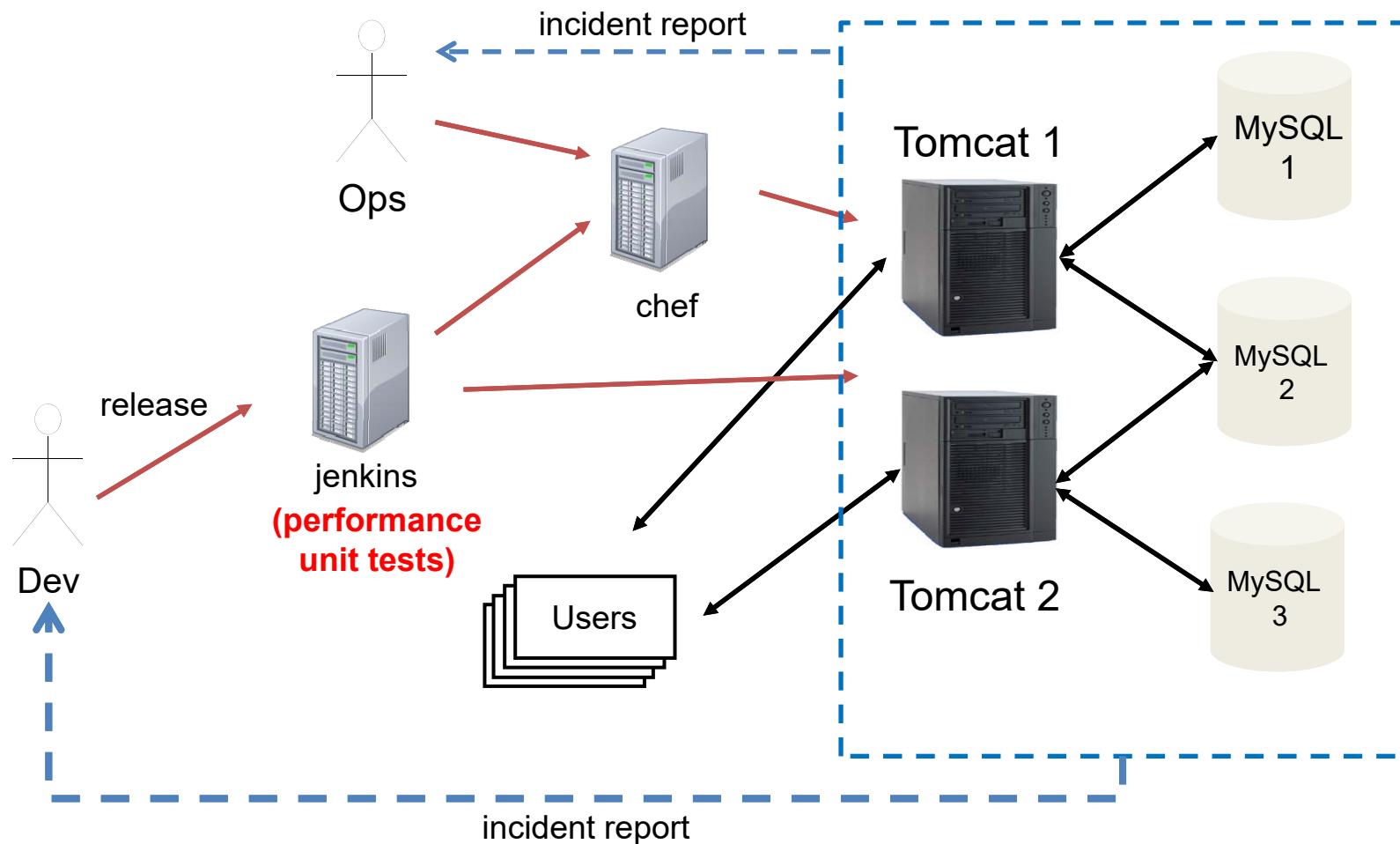
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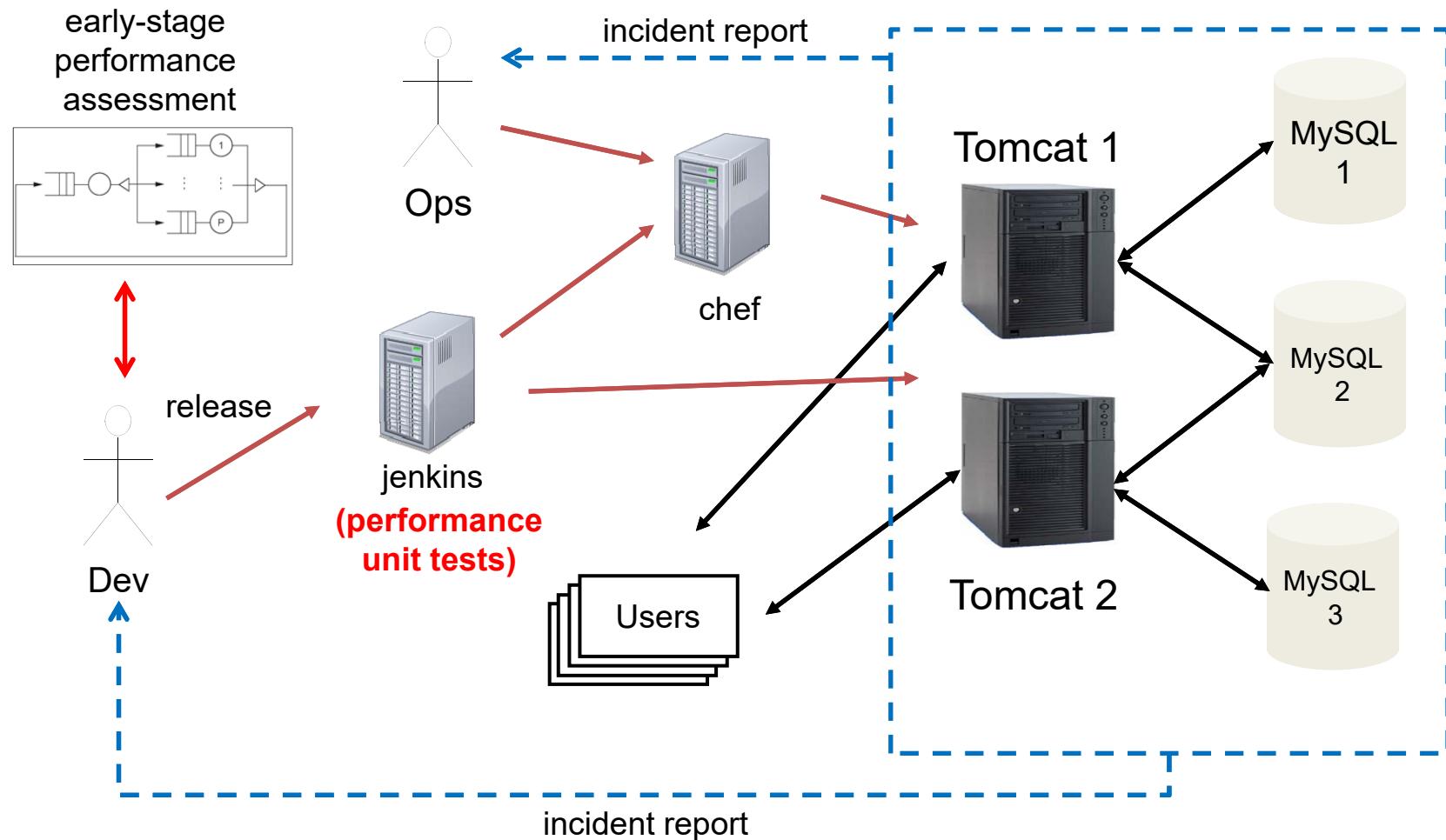
So What About Continuous Delivery?

Measurement-Driven DevOps



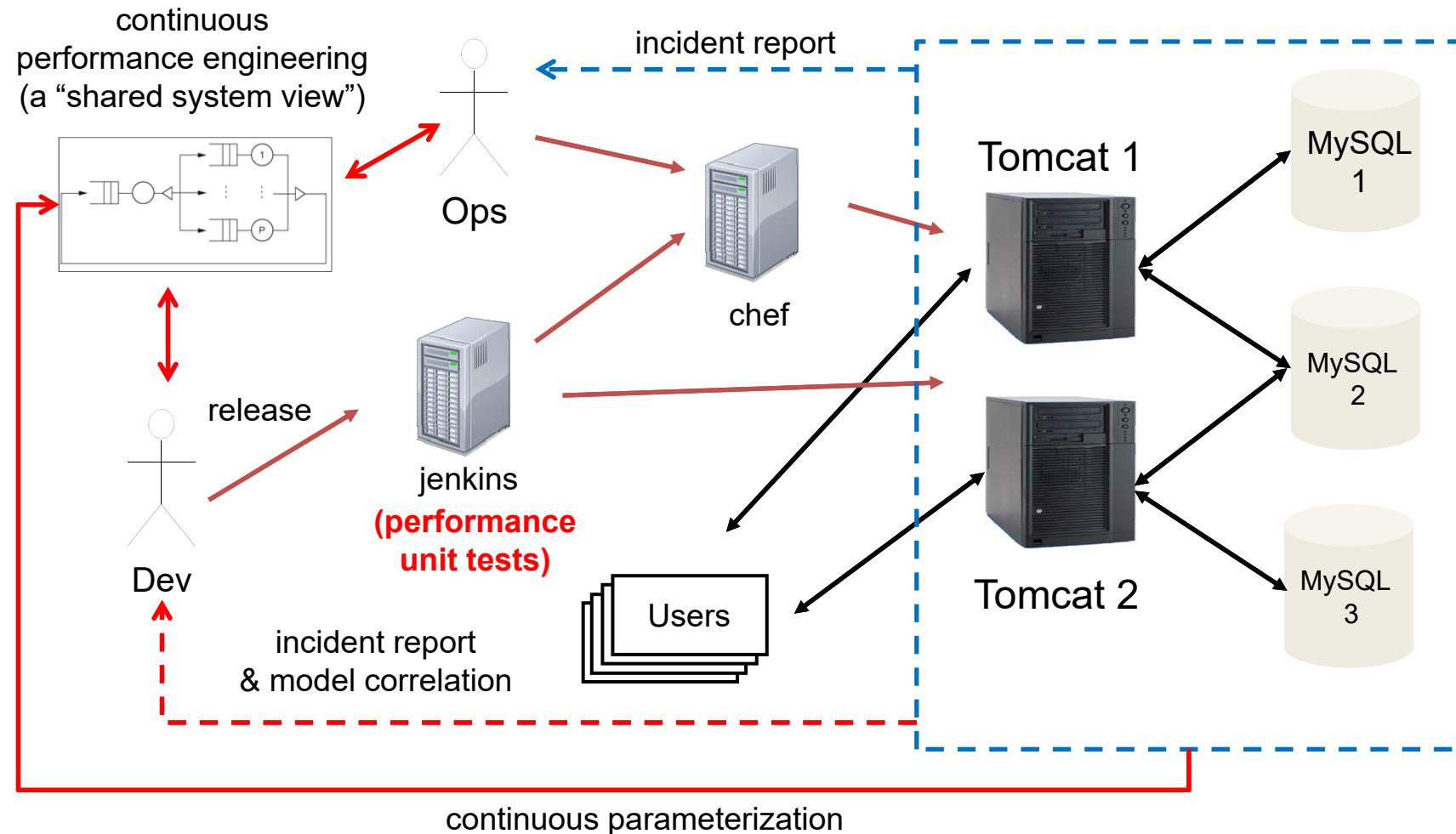
So What About Continuous Delivery?

Today's Performance-Aware MDE methods

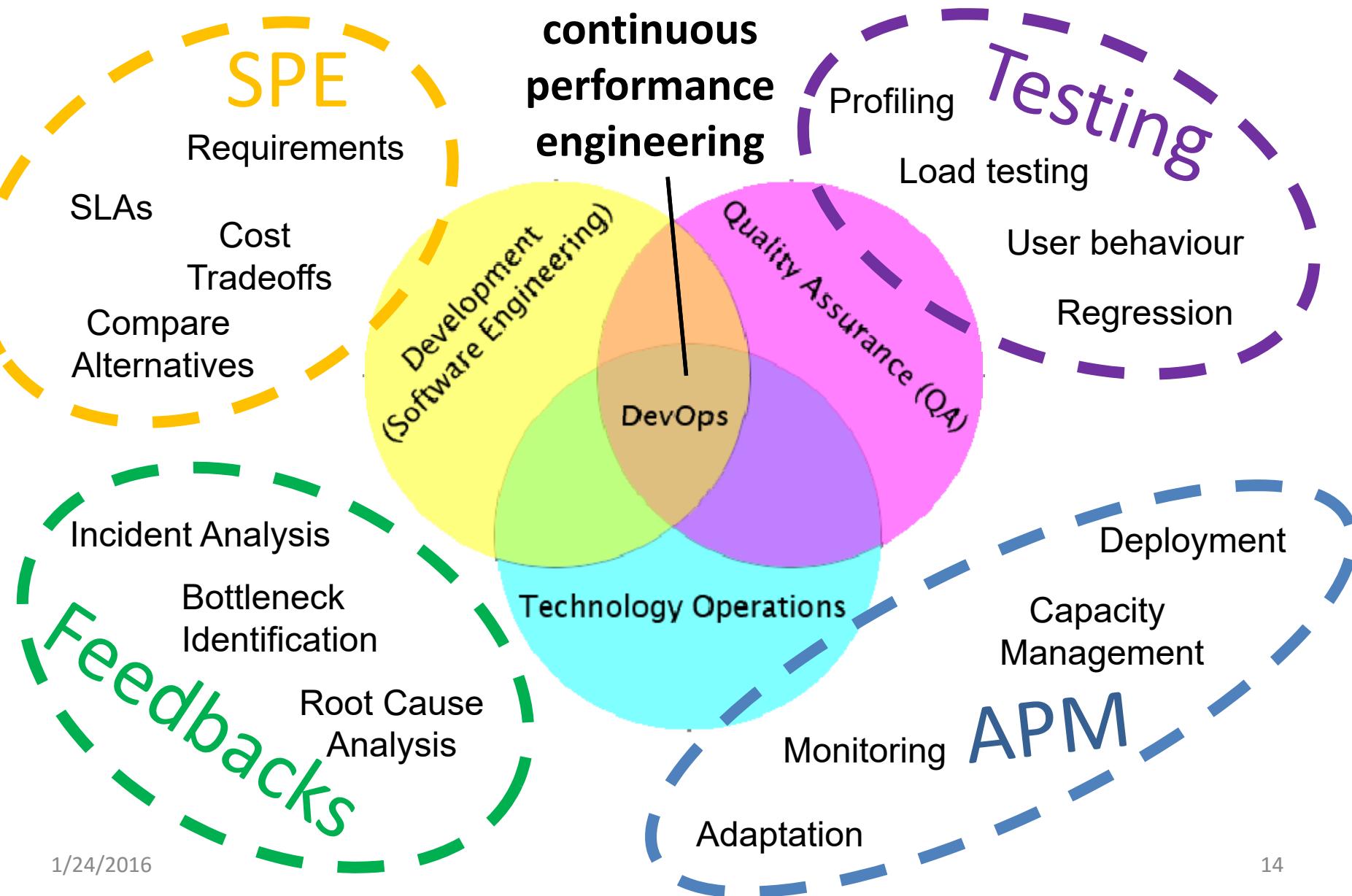


So What About Continuous Delivery?

Performance Aware DevOps



Performance Aware DevOps



Research Roadmap

1. Shared MDE models for both Dev and Ops
2. Extensions of existing tools for performance validation to model Ops environment
3. Continuous parameterization methods
4. Traceability and anomaly detection

Research Roadmap

1. Shared MDE models for both Dev and Ops

- Annotations for recent technologies:
 - Cloud computing
 - Internet-of-Things
 - Cyber-Physical Systems
 - Mobile devices
 - Big data
- Some relevant outputs from large EU projects

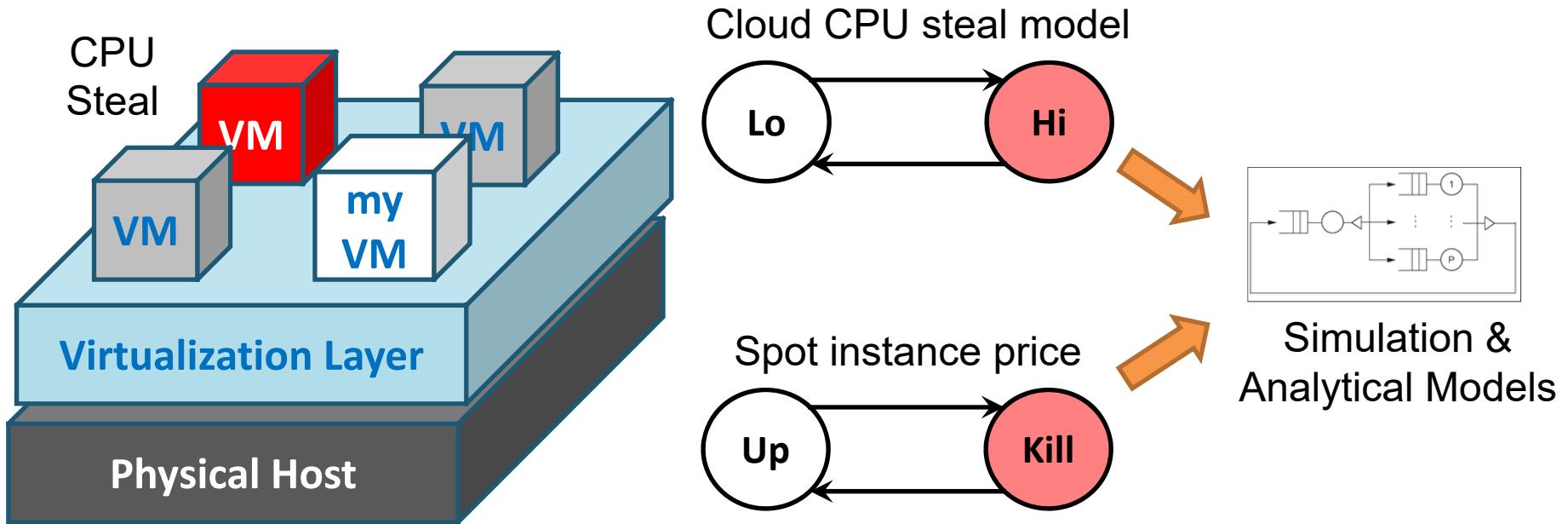
Research Roadmap

1. Shared MDE models for both Dev and Ops
2. **Extensions of existing tools for performance validation to model Ops environment**
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Extension of Existing Tools

Model-Driven Prediction

- Tools: *LQNS, LINE, PerfCenter, JMT, ...*

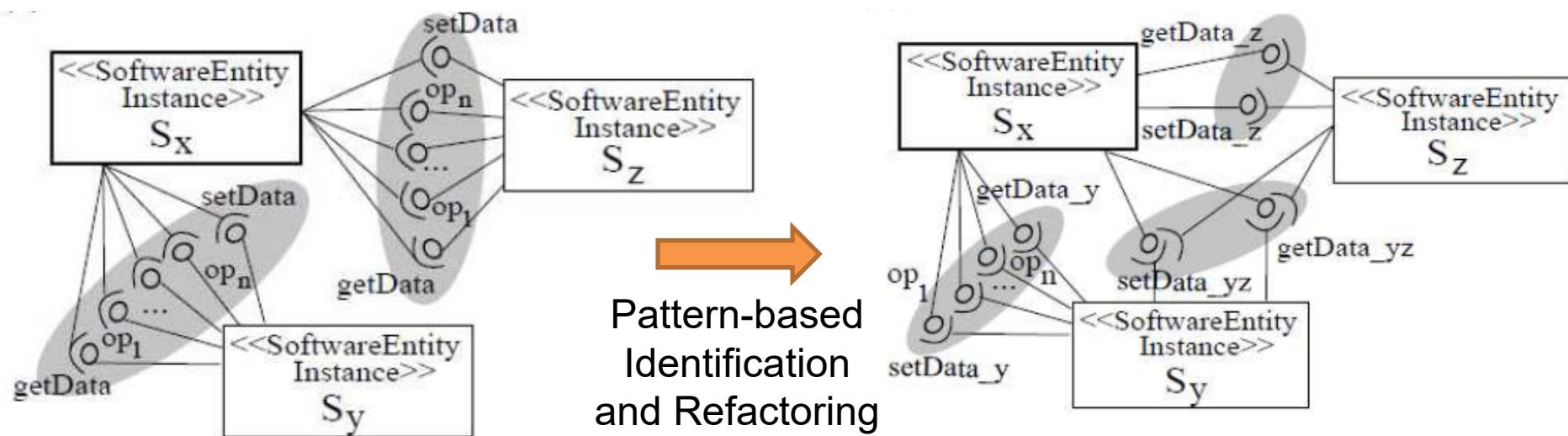


- Challenge:* model new resource types (e.g., spot & micro VM, ...) and platform services

Extension of Existing Tools

Performance Antipatterns

- Tools: *PANDA-Aemilia*



- Challenge: create libraries of anti-patterns for deployment models relevant to Ops

References: Trubiani et al.

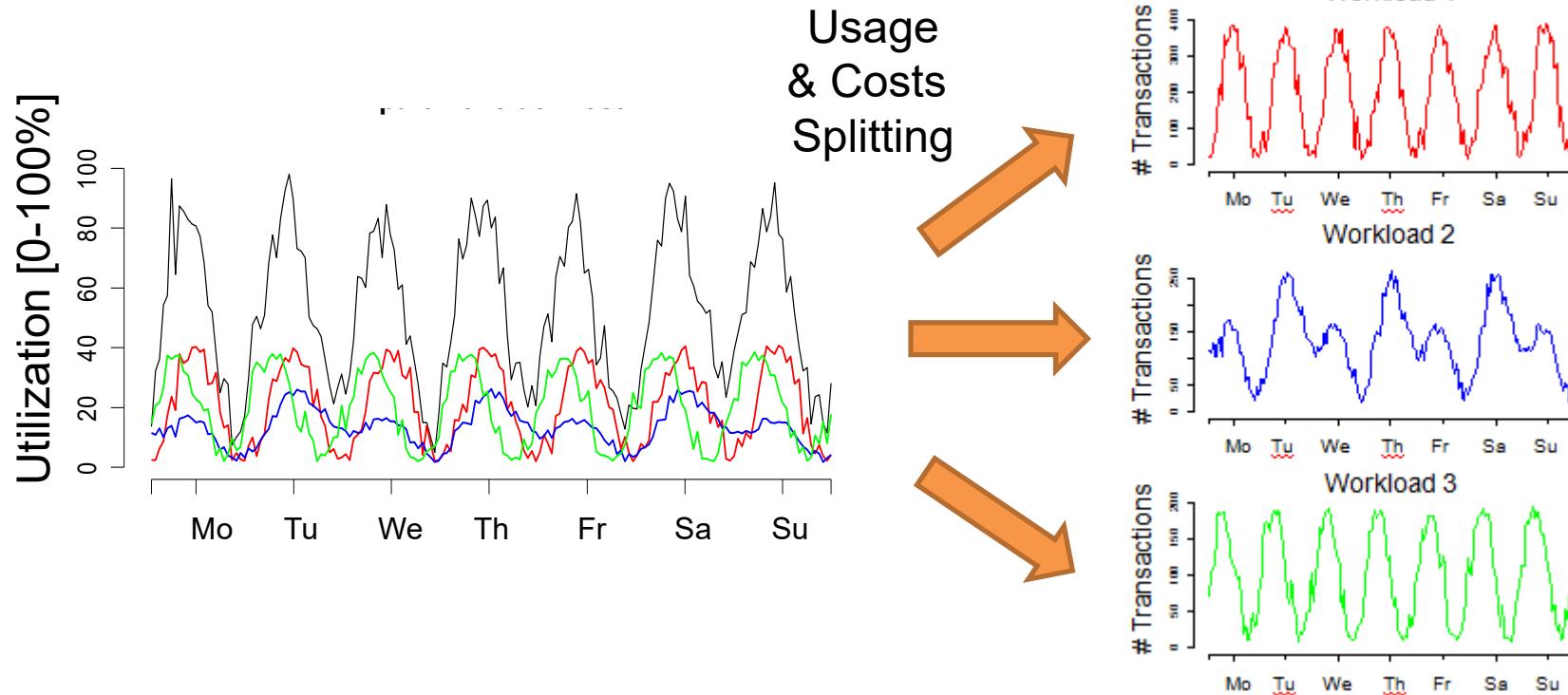
Research Roadmap

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Continuous Parameterization

Resource Consumption Inference

- Tools: *LibReDe*, *Filling-the-Gap (FG)*



- Challenges: inference synchronized to new commits; inference for all model parameters

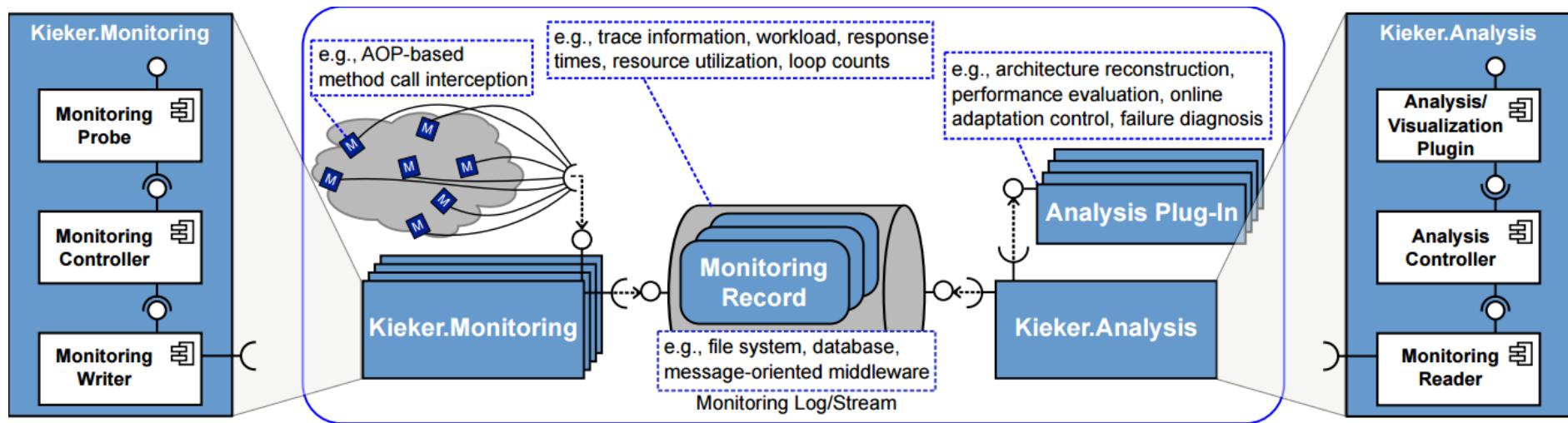
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Performance Traceability

Model-Driven Monitoring

- Tools: *Kieker*
- AOP used to correlate monitoring and models

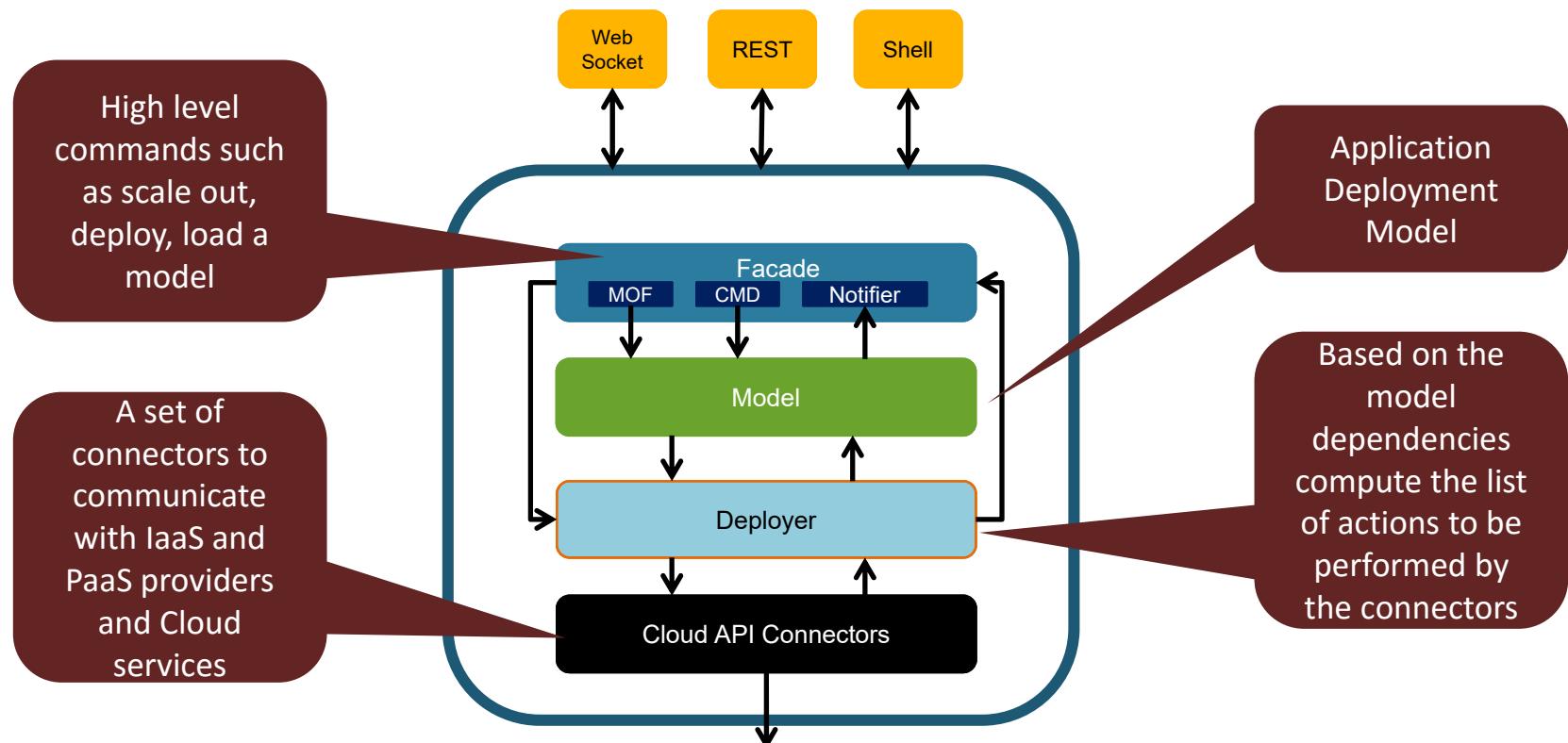


- *Challenges:* low-overhead continuous monitoring, model-based monitoring config.

Model Traceability

Tracking Runtime Adaptations

- Tools: *Models@Runtime*

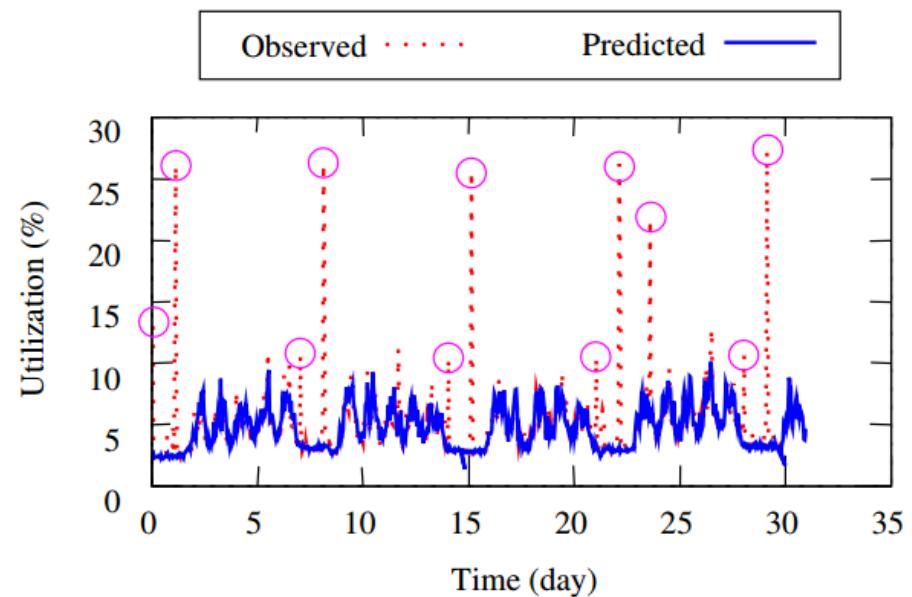
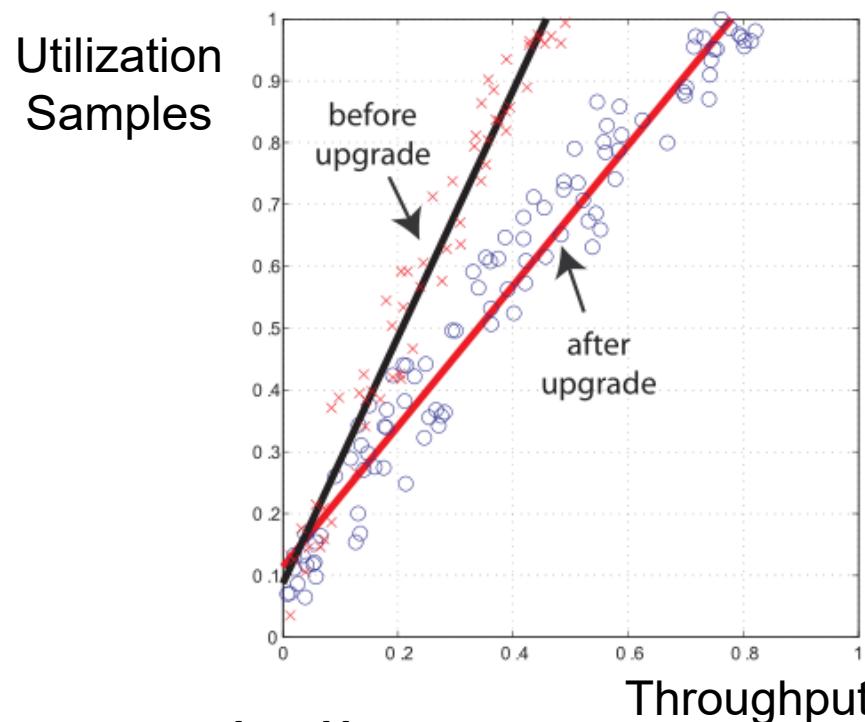


- Challenges: model co-evolution and adaptivity*

Performance Anomaly Detection

Application Performance Signatures

- Methods: *ACE, Demand-Based, ...*



- *Challenge:* continuous model-aided generation of performance signatures

A Case Study



- MODAclouds Project 9M€ (2012-2015)
- DevOps-inspired tools for multi-cloud software
- Tools: <http://www.modaclouds.eu/software>



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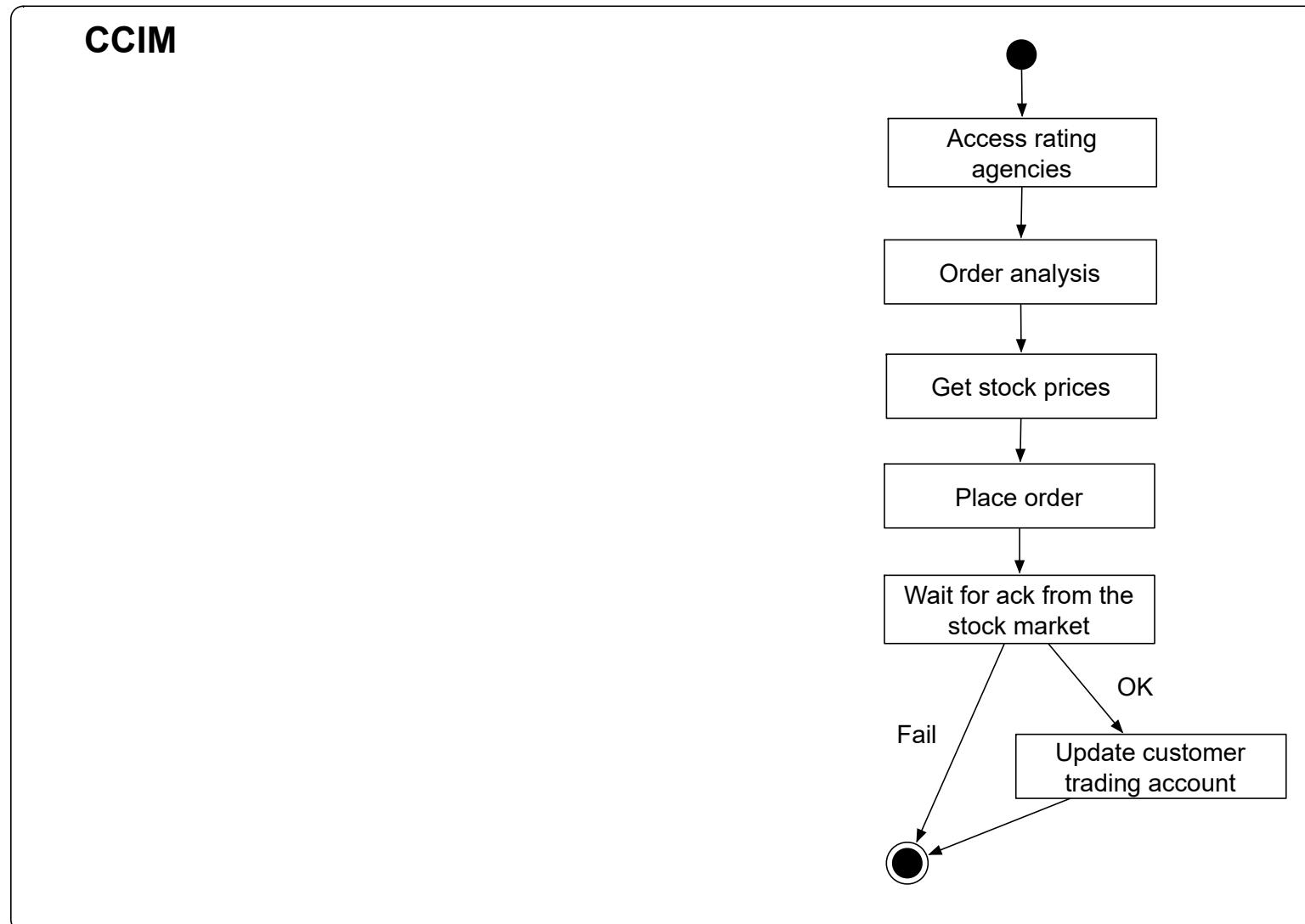


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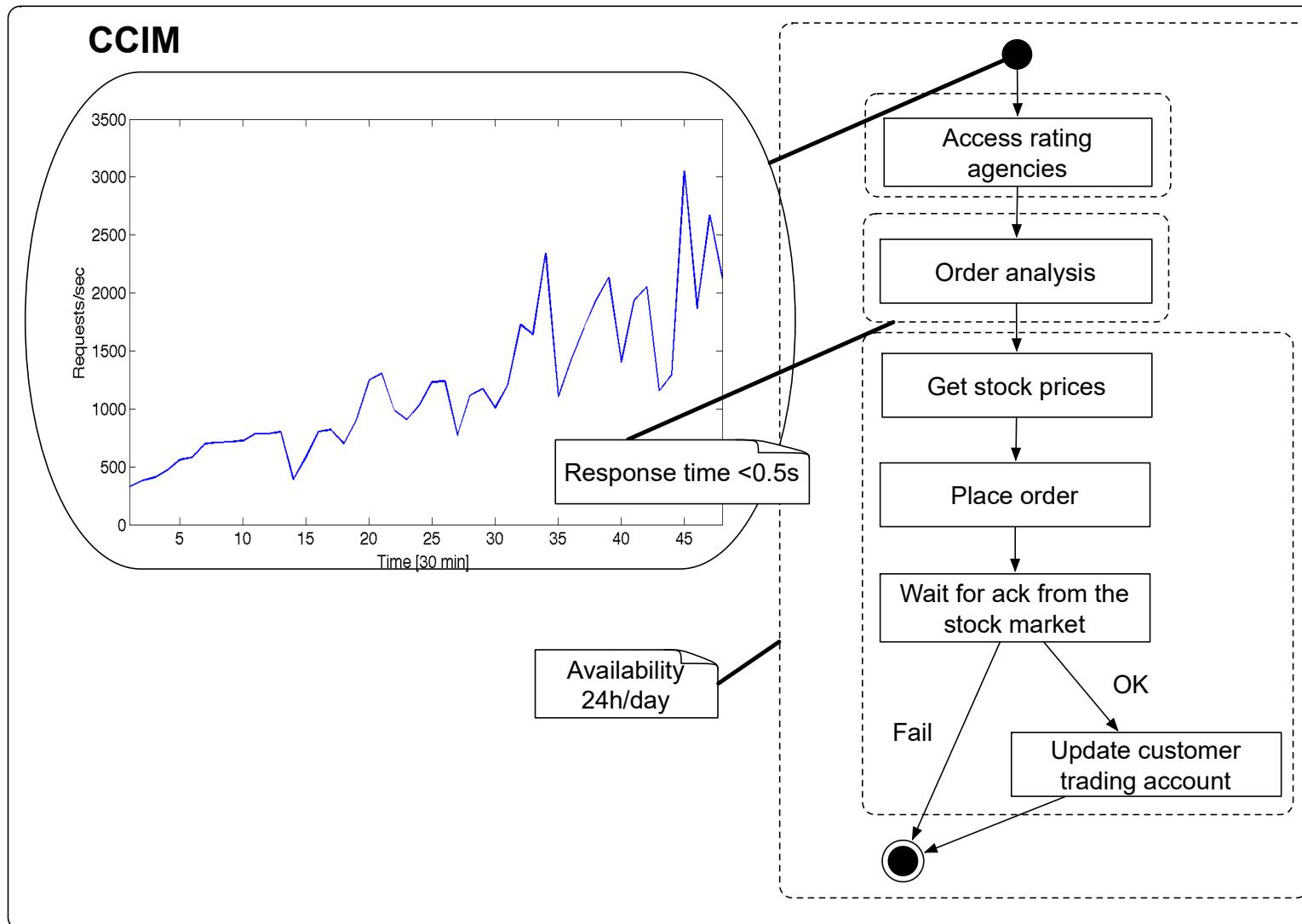
MDE for Multi-Cloud Software

Functional Modelling



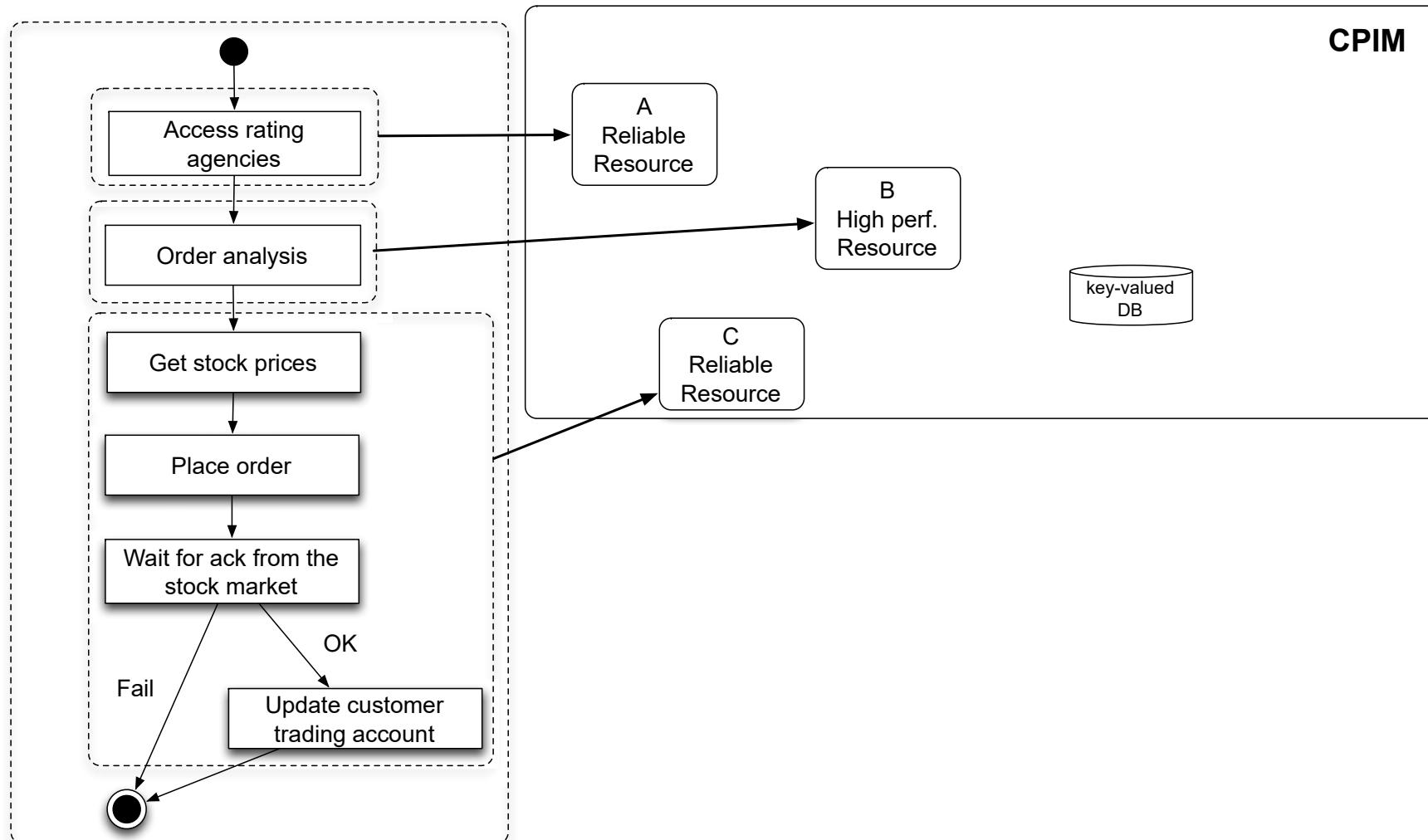
MDE for Multi-Cloud Software

QoS Requirements



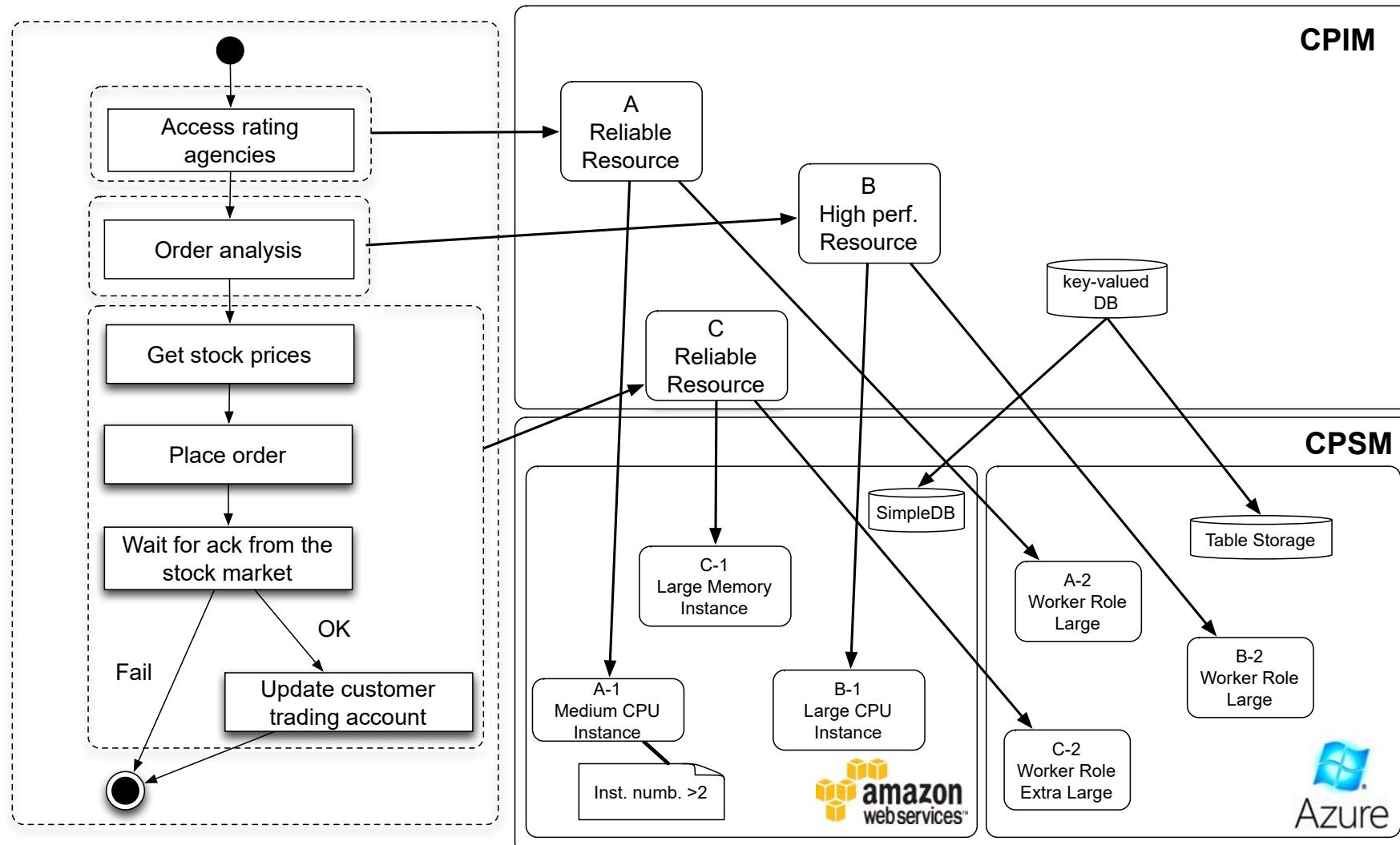
MDE for Multi-Cloud Software

Platform-Independent Models

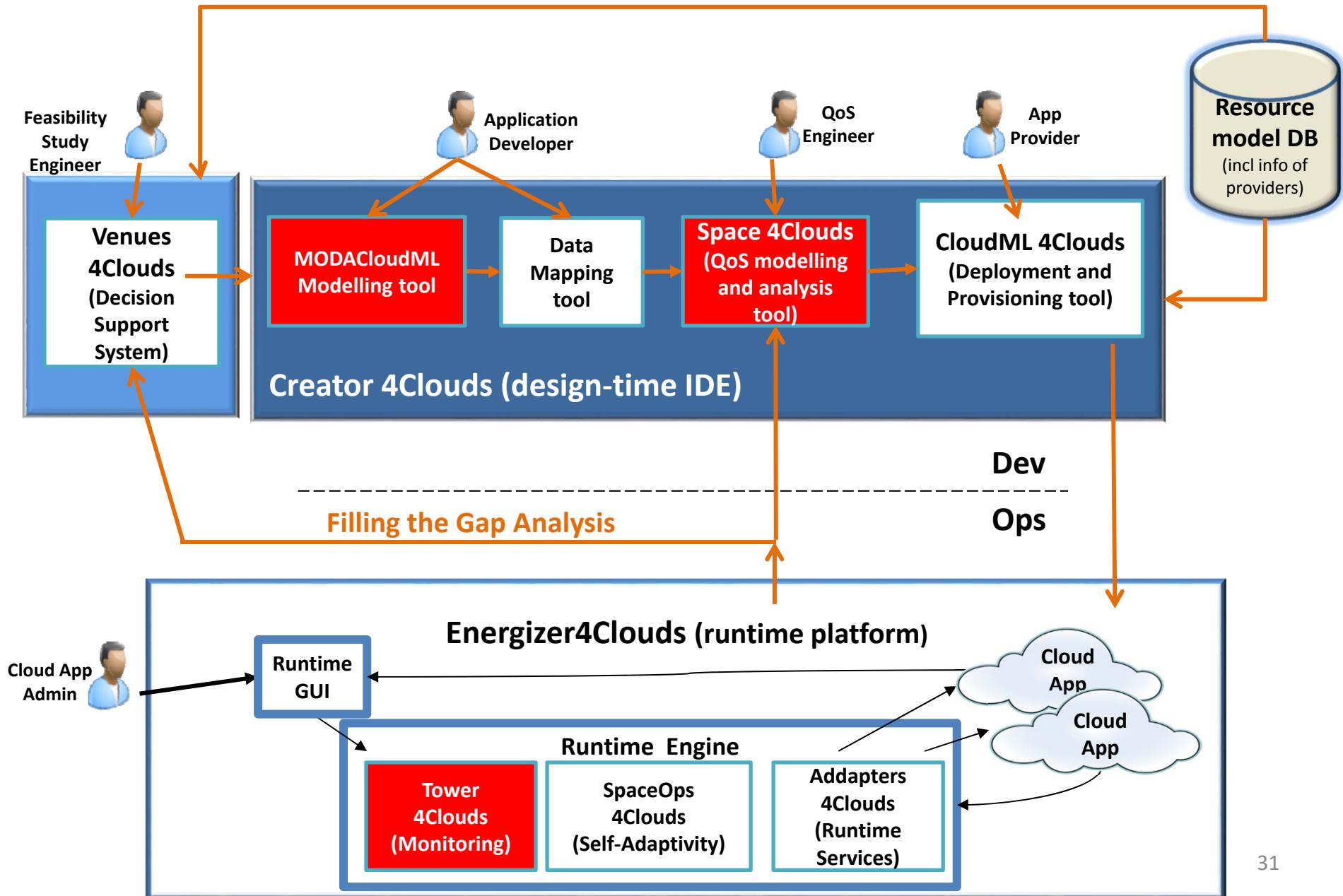


MDE for Multi-Cloud Software

Platform- and Technology-Specific Models



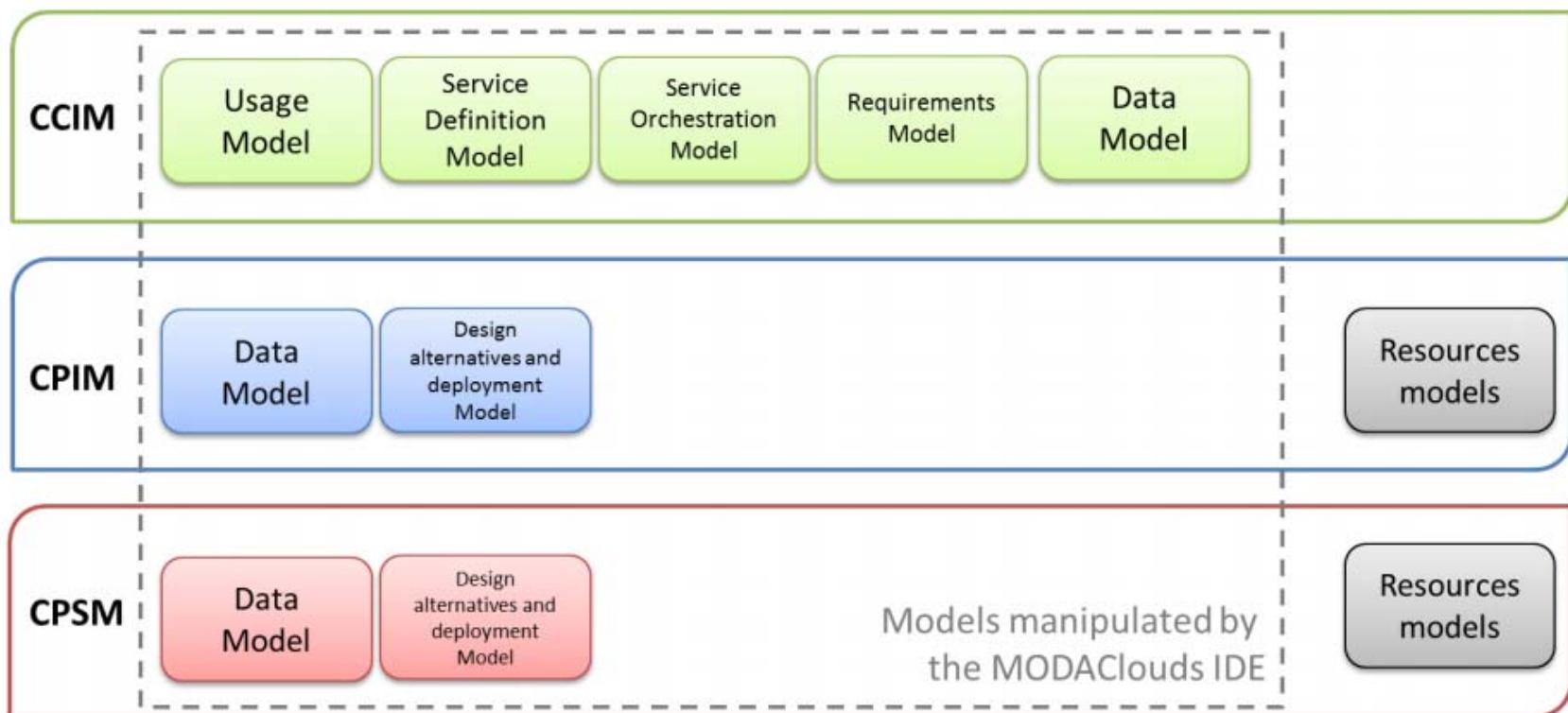
DevOps-Inspired Approach



Ops-Aware MDE

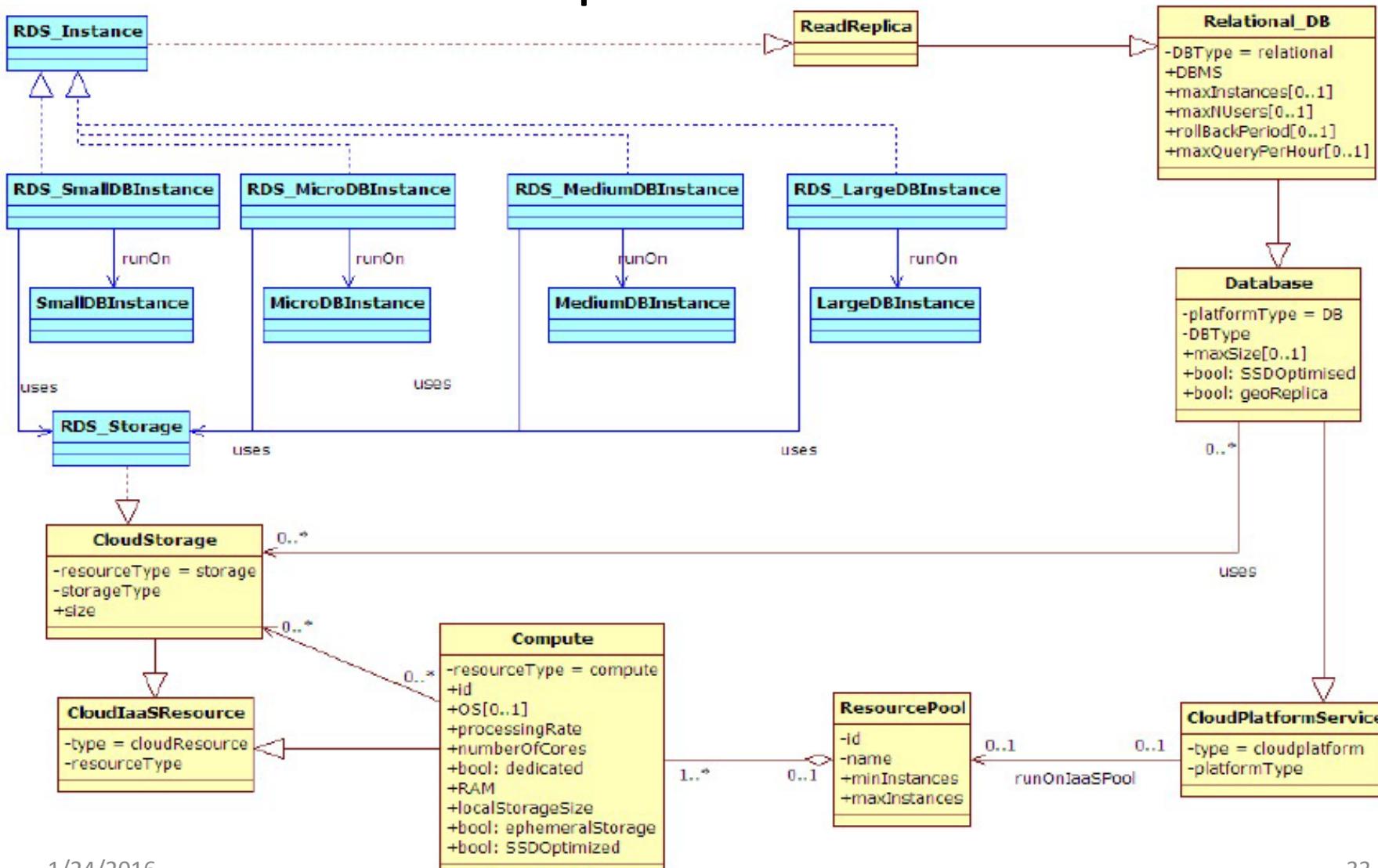
Functional Modelling

- MDE with cloud annotations: (MODA)CloudML
- MDE extensions to describe cloud computing



Ops-Aware MDE

Example: Amazon RDS



Traceability

Configurable Monitoring Rules

The diagram illustrates the traceability between monitoring rules defined in the CPIM Model and their deployment targets in the CPIM Deployment Diagram.

Monitoring Rule: A monitoring rule is shown in the CPIM Model tree under the `frontEndUtilization_frontEnd` node. It includes properties like `useParentActions`, `useParentTargets`, `metricName` (set to `CPUUtilization`), `timeStep` (set to `60`), `timeWindow` (set to `60`), `startEnabled` (set to `true`), `samplingTime` (set to `20`), `samplingProbability` (set to `1`), and a condition `METRIC > 80.0`.

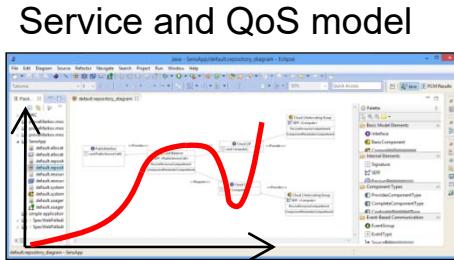
Violation Trigger: A red arrow points from the condition part of the monitoring rule to the `Actions` section of the rule definition.

CPIM Deployment Diagram: The deployment diagram shows a deployment alternative named `frontEnd : FrontEnd`. Inside, a component named `RequestHandler : RequestHandler` is connected to a metric named `frontendMinRam`. Two monitoring annotations, `<<targets>>`, point to two target components: `frontendUtilization` and `frontEnd`.

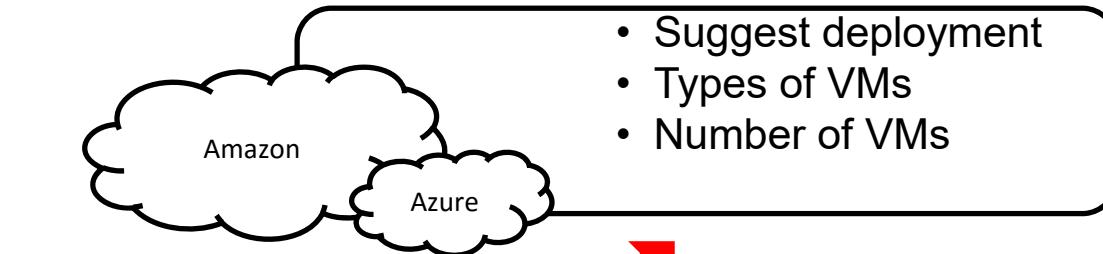
Monitoring Annotation: Red arrows point from the monitoring annotations in the deployment diagram back to the corresponding parts of the monitoring rule in the model tree.

Search-Based Deployment

SPACE4Clouds+LINE



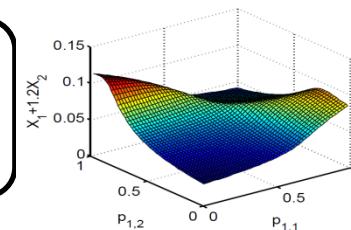
Creator
4Clouds IDE



SPACE4Clouds
Optimization Engine

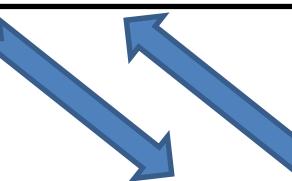


- Quantitative Analysis
- Optimization QoS & SLA



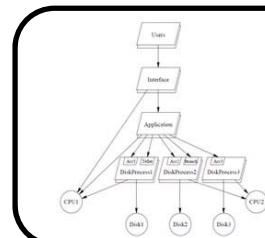
Venues
4Clouds

Candidate Cloud
Providers



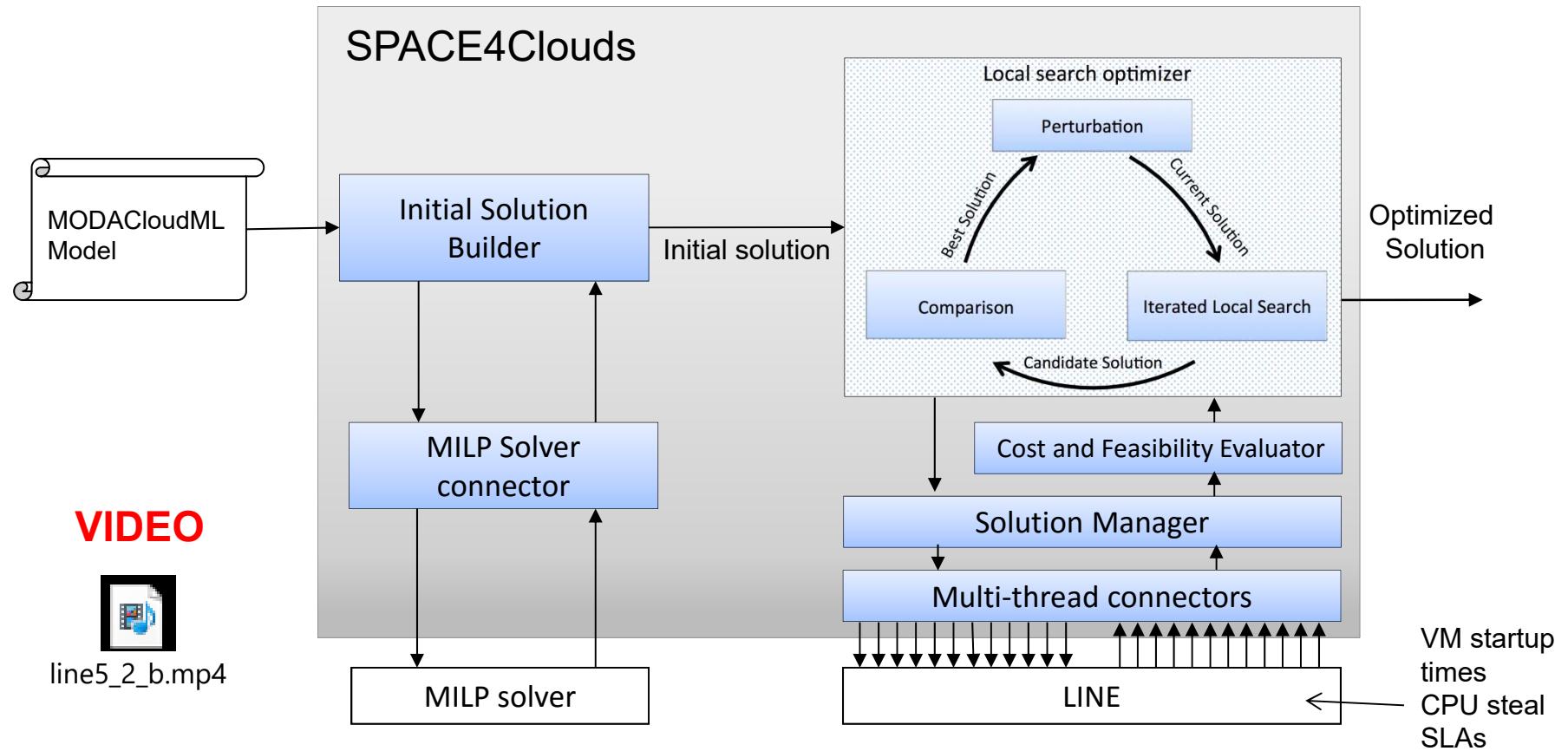
Performance Engine

- Transformation to Queueing Networks
- LINE fluid solver
- SLA percentiles



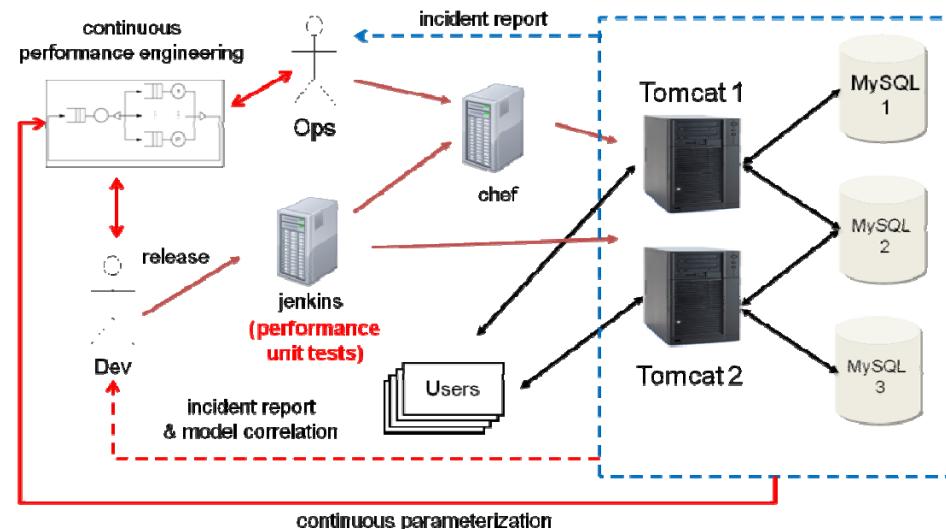
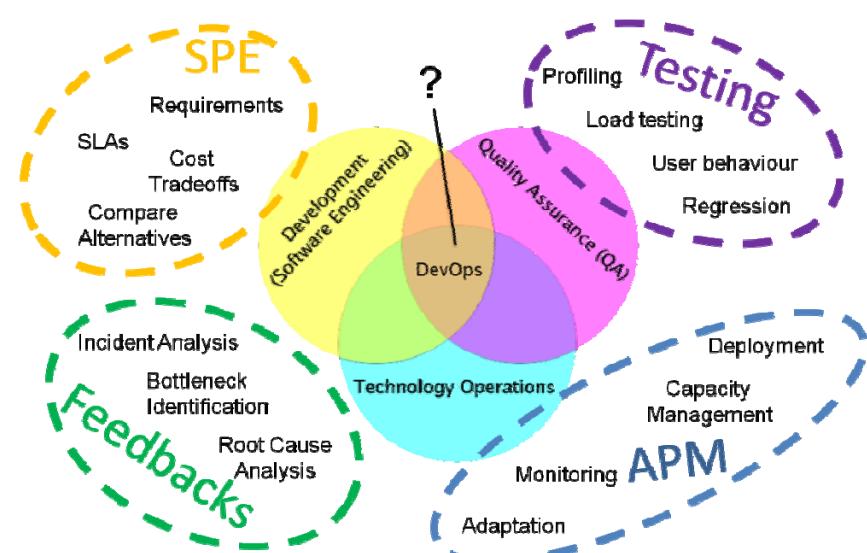
Search-Based Deployment

SPACE4Clouds



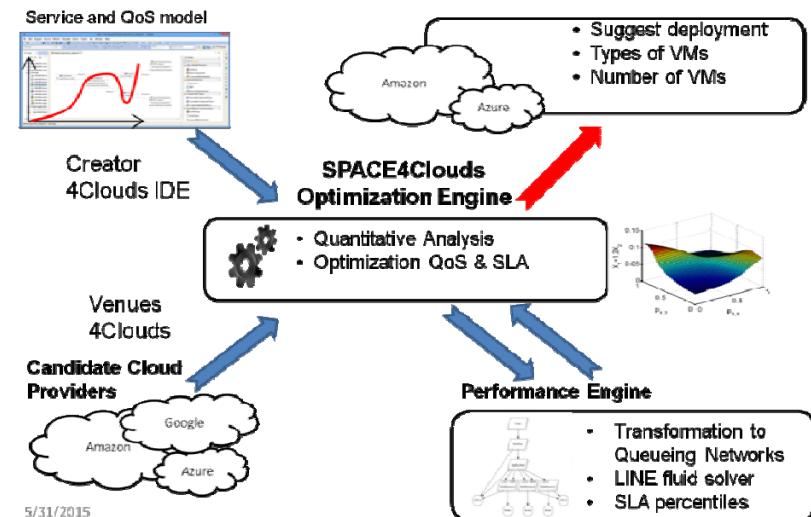
Reference: D. Ardagna et al. A Multi-Model Optimization Framework for the Model Driven Design of Cloud Applications. SSBSE 2014. 61-76.

Conclusion



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Questions?



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