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Towards a Performance Model Management Repository for Component-based Enterprise Applications

Work-in-Progress Paper (WiP)

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Agenda

- Motivation & Vision
- Basic Technologies
- Component (Version) Dependencies
- Handling Resource Demands
- Related Work
- Outlook

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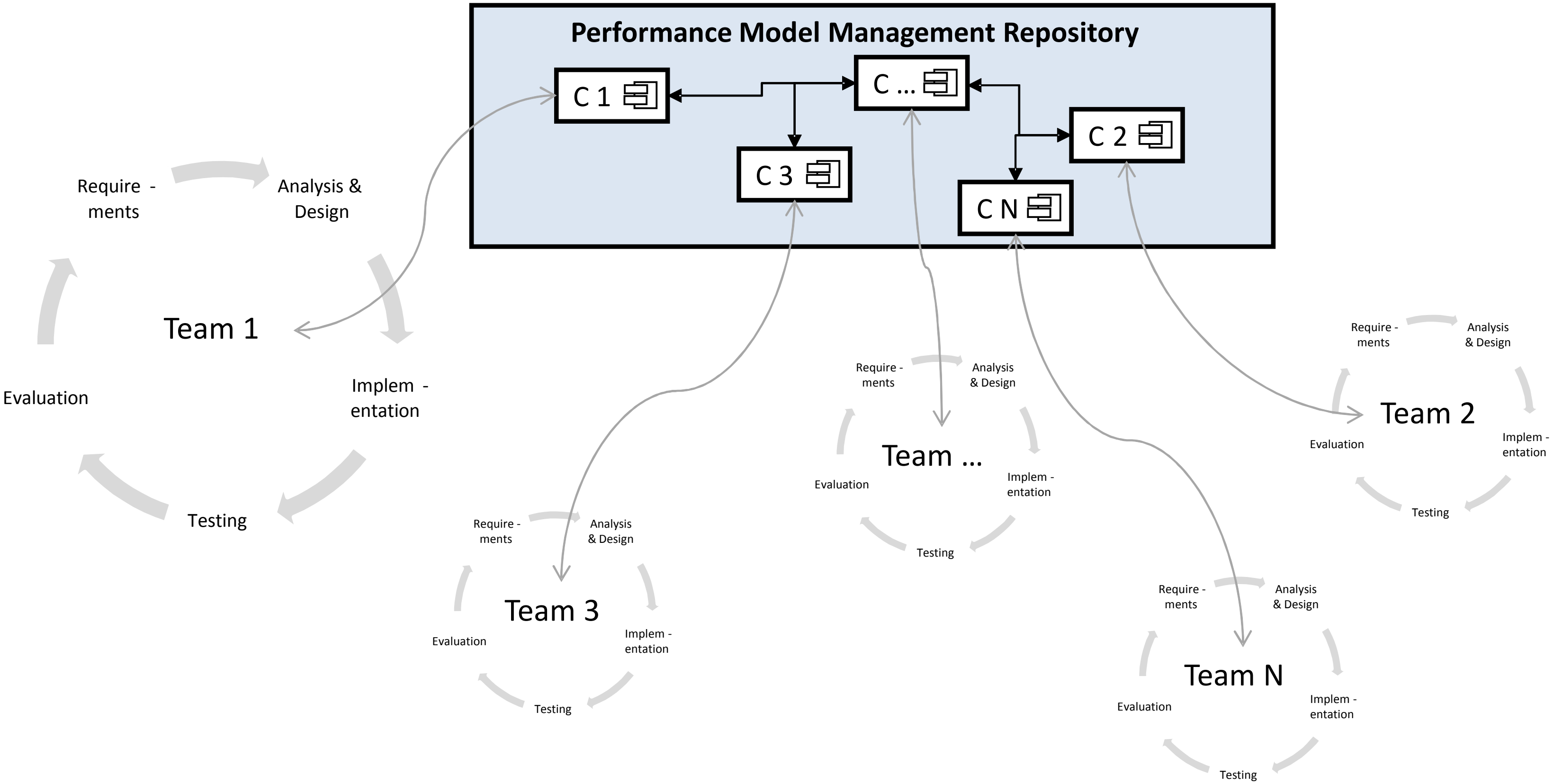
Motivation & Vision

- Performance models are still not in widespread industry use *(Koziolek 2010, Mayer et al. 2011)*:
  - Creation effort often outweighs their benefits *(Brunnert et al. 2013, Kounev 2005)*
  - Several approaches for automatic generation *(Balsamo et al. 2004, Brunnert et al. 2013, Smith 2007)*

- Challenge for applying performance models in industrial practice is the organizational complexity *(Brunnert et al. 2014, Schmietendorf et al. 2002)*:
  - Components of enterprise applications are often under the control of different teams within one or more organizations
  - Teams adhere to different release cycles for their components
  - Challenge to keep a performance model consistent and in sync

Motivation & Vision

- To introduce an integration server for performance models to support the collaboration of distributed teams within an organization.



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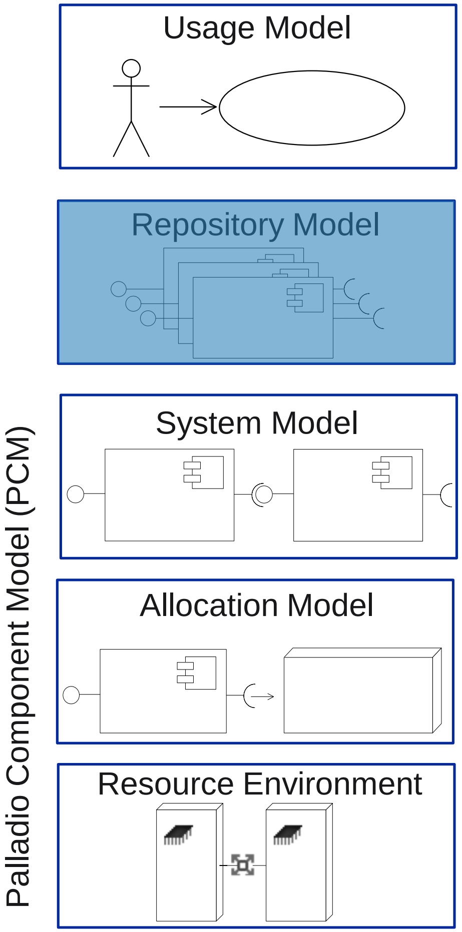
Basic Technologies

PCM as Meta-Model



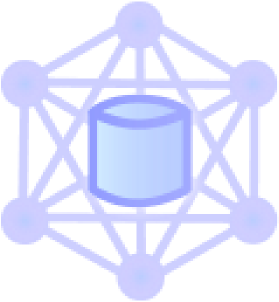
- Workload
- Components, Interfaces, Relationships, Control Flows, Resource Demands
- System composed of components within the repository model
- Mapping of system components to hardware servers
- Specifies available servers, networks, …

Basic Technologies

Required Enhancements

- PCM repository models are represented by single files that are hard to maintain by different teams concurrently

- Multiple PCM repository models with outdated component specifications exist, as multiple component versions need to be maintained at the same time by different teams



- We propose to use EMFStore [1] as PMMR server:
  - The PCM meta-model is based on the Eclipse Modeling Framework (EMF)
  - EMFStore implements the required versioning features for models based on the Ecore meta-model

[1] http://eclipse.org/emfstore/

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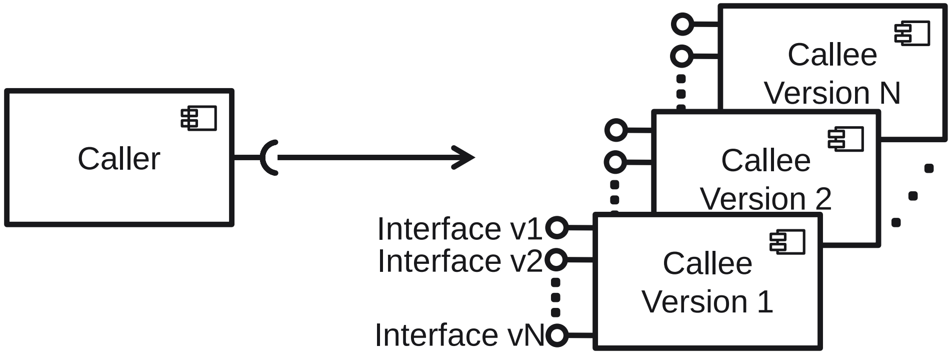
Component (Version) Dependencies

Extension of the PCM Meta-Model



- We propose to extend the PCM meta-model to specify require references across component versions
  - The Palladio-Bench also needs to be extended to support the user while interacting with different component versions

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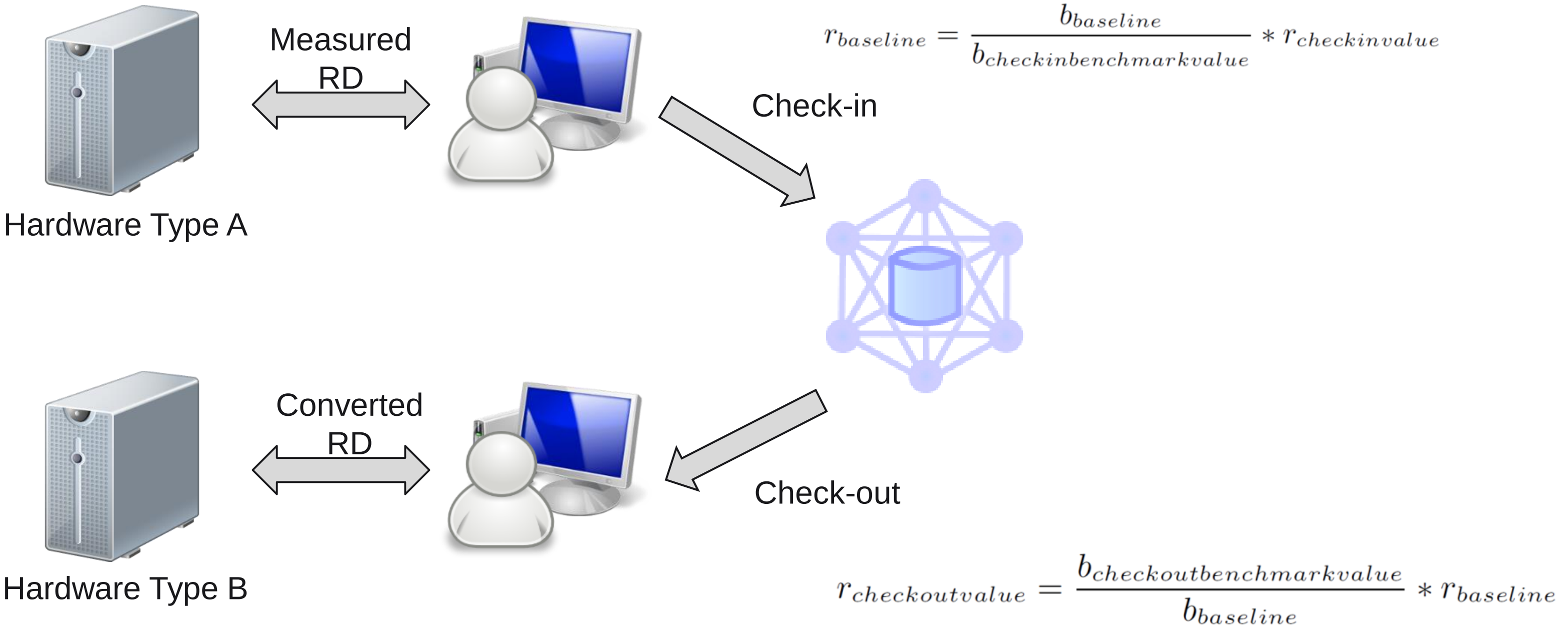
Handling Resource Demands

Hardware-specific Resource Demands

- PCM repository model components can contain hardware-specific resource demands

- Resource demands stored in a PMMR are specified relative to a common baseline



$$r_{baseline} = \frac{b_{baseline}}{b_{checkinbenchmarkvalue}} * r_{checkinvalue}$$

$$r_{checkoutvalue} = \frac{b_{checkoutbenchmarkvalue}}{b_{baseline}} * r_{baseline}$$

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Related Work

- Several approaches for versioning model artifacts exist in literature *(Altmanninger et al. 2009)*
  - These approaches do not address the specific requirements which arise from the versioning of performance models of individual components
- Woodside et al. (2007) proposed the Performance Knowledge Base (PKB) as a central performance repository
  - The PKB is intended to store measurement and model prediction results in a PKB instead of the models itself
  - PKB should allow to build performance models on demand
  - PMMR is designed so that performance models can be stored in it directly
- Koziolek (2010) argues that central performance model repositories (called model libraries) "... could allow rapid performance predictions ...“.

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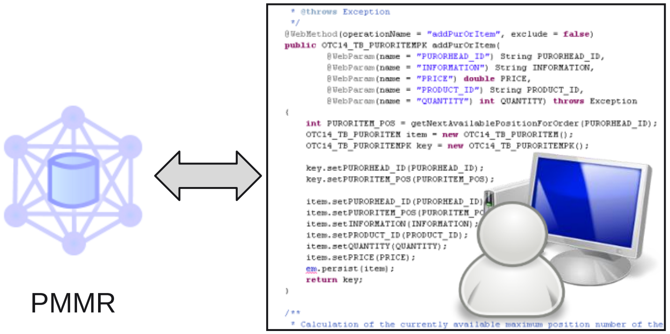
Outlook

- Abstraction Level:
  - Choose abstraction level to reduce the amount of components that need to be represented
  - Level of detail for storing white-box and high-level black-box models
- Evaluation:
  - Experimental setup to validate the feasibility of the approaches
  - Representative software development project to validate the intended improvements
- Integration:
  - Danciu et al. (2014) propose an approach to support developers with insights on the response times of the component they are currently developing



```
 * @throws Exception
 */
@WebMethod(operationName = "addPurOrItem", exclude = false)
public OTC14_TB_PURORITEMPK addPurOrItem(
        @WebParam(name = "PURORHEAD_ID") String PURORHEAD_ID,
        @WebParam(name = "INFORMATION") String INFORMATION,
        @WebParam(name = "PRICE") double PRICE,
        @WebParam(name = "PRODUCT_ID") String PRODUCT_ID,
        @WebParam(name = "QUANTITY") int QUANTITY) throws Exception
{
    int PURORITEM_POS = getNextAvailablePositionForOrder(PURORHEAD_ID);
    OTC14_TB_PURORITEM item = new OTC14_TB_PURORITEM();
    OTC14_TB_PURORITEMPK key = new OTC14_TB_PURORITEMPK();

    key.setPURORHEAD_ID(PURORHEAD_ID);
    key.setPURORITEM_POS(PURORITEM_POS);

    item.setPURORHEAD_ID(PURORHEAD_ID)
    item.setPURORITEM_POS(PURORITEM_PO
    item.setINFORMATION(INFORMATION);
    item.setPRODUCT_ID(PRODUCT_ID);
    item.setQUANTITY(QUANTITY);
    item.setPRICE(PRICE);
    em.persist(item);
    return key;
}

/**
 * Calculation of the currently available maximum position number of the
```

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Basic Technologies

Performance (Meta-)Models

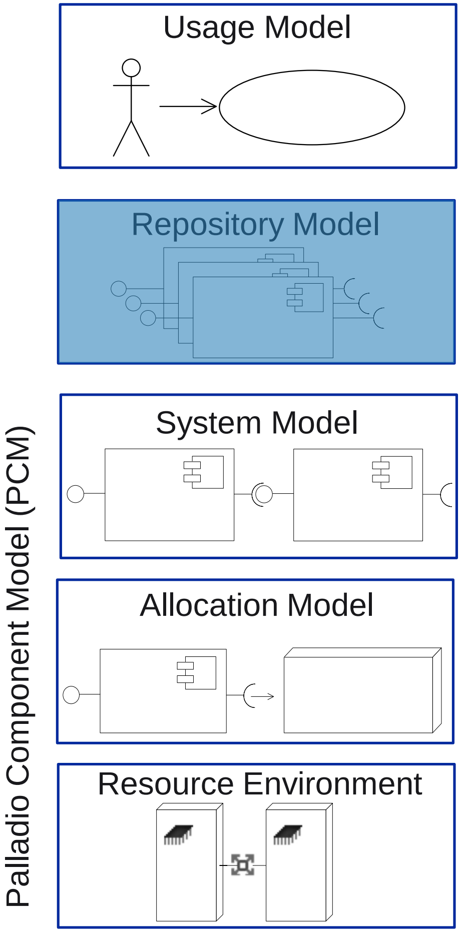
- LQN, QNs, QPNs depict workload, hardware environment and performance-relevant aspects of an application in one monolitic model
  - Hard to change a single aspect without modifying the whole model

- Architecture-level performance models (e.g. the Palladio Component Model (PCM)) allow to specify these aspects independently from each other
  - Used to represent resource profiles
  - Several existing ways to create such models based on static, dynamic or hybrid analysis

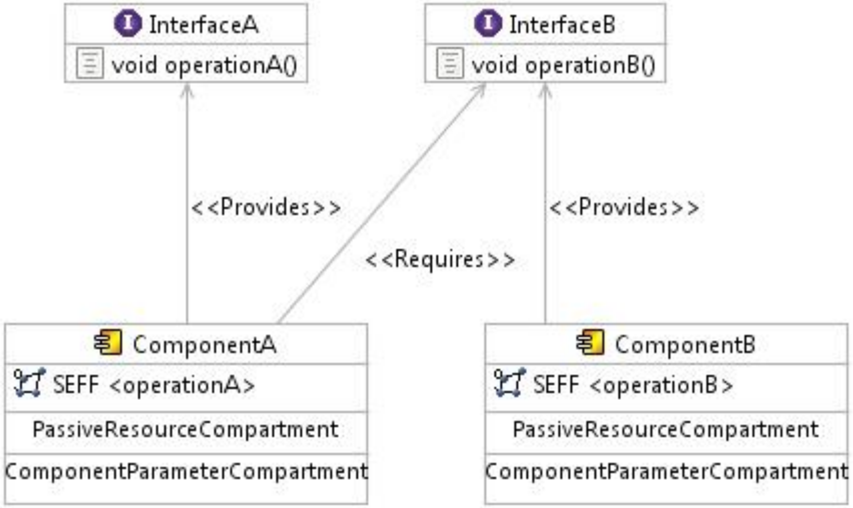
- We propose the use of the Palladio Component Model (PCM) as meta-model for the component performance models managed in a PMMR (*Becker et al. 2009*)

Implementation of the PMMR

PCM as Meta-Model



- Repository models are created by component developers



Implementation of the PMMR

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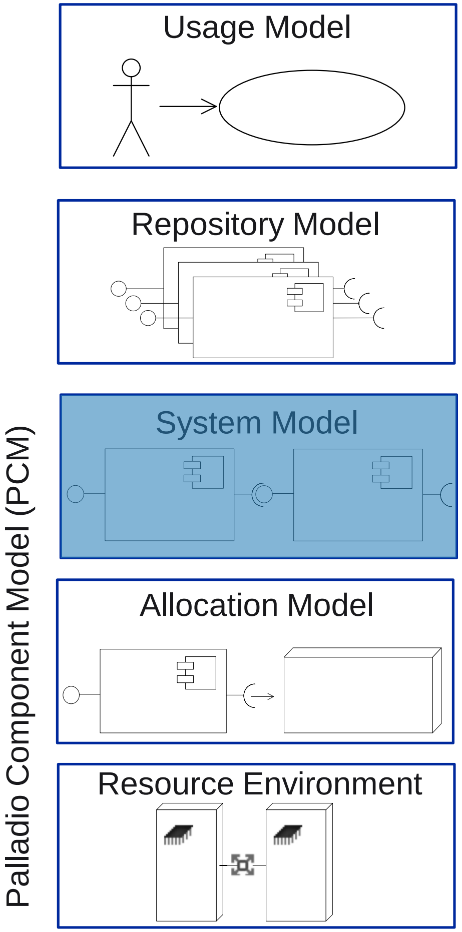
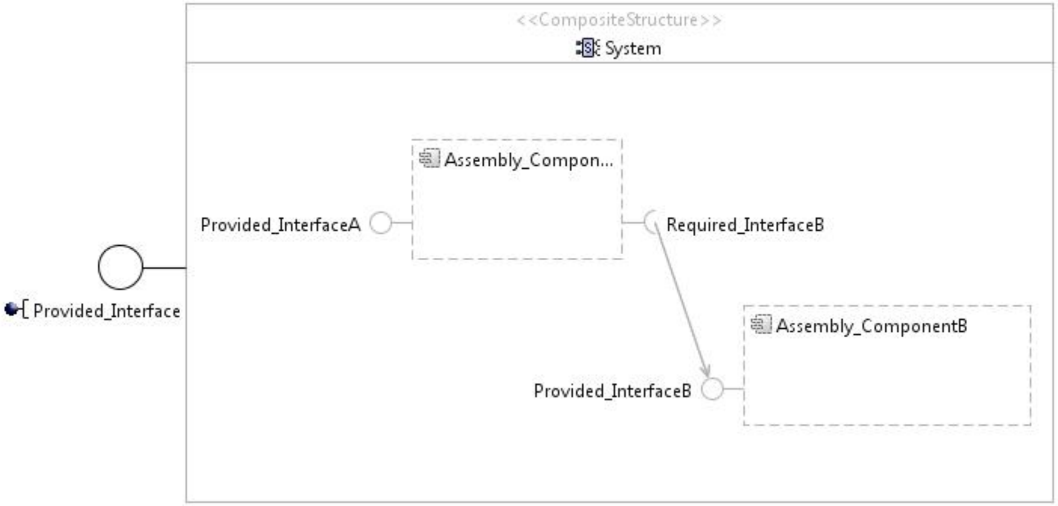


- System models are created by system architects



Handling Resource Demands

Using Benchmark Scores

- Scores are specified for all relevant hardware resources.
  - *$r_{baseline}$ denotes baseline resource demand*
  - *$b_{baseline}$ denotes baseline hardware resource benchmark score*
- *During check-in:*
  - *$r_{checkinvalue}$ denotes resource demand measured by the user*
  - *$b_{checkinbenchmarkvalue}$ denotes benchmark score of the hardware resource*

$$r_{baseline} = \frac{b_{baseline}}{b_{checkinbenchmarkvalue}} * r_{checkinvalue} \qquad (1)$$

- *During check-out:*
  - *$r_{checkoutvalue}$ denotes resource demand calculated relative to benchmark score*
  - *$b_{checkoutbenchmarkvalue}$ denotes benchmark score of the target hardware resource*

$$r_{checkoutvalue} = \frac{b_{checkoutbenchmarkvalue}}{b_{baseline}} * r_{baseline} \qquad (2)$$