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Modeling Complex User Behavior with the Palladio Component Model

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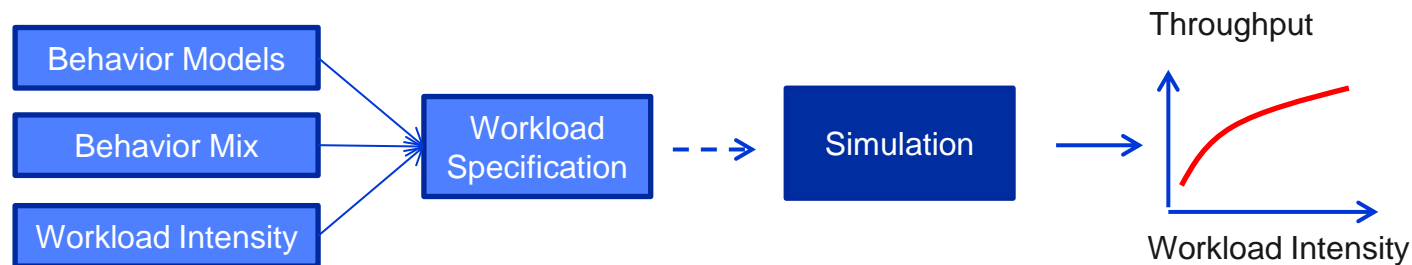
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Motivation

Situation

- **Workload specification and execution/simulation** essential to **evaluate performance properties** of application systems (e.g., Krishnamurthy et al. 2006, Menascé et al. 1999, Arlitt et al. 2001)



Complication

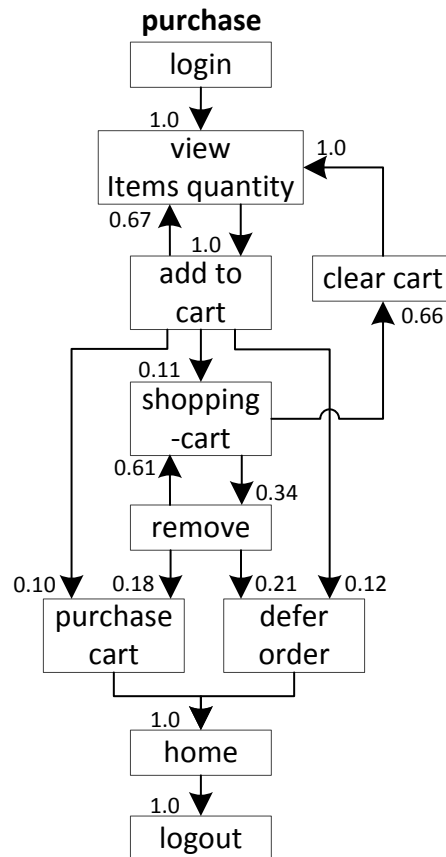
- Modeling of complex and representative user behavior (Behavior Model) can be difficult or even unfeasible solely with the PCM usage model
- Workarounds are available, but:
 - Violates the separation of concerns
 - Increases the complexity of the performance models

Resolution

- Extension of PCM usage model meta-model

Limitations

Modeling Complex User Behavior

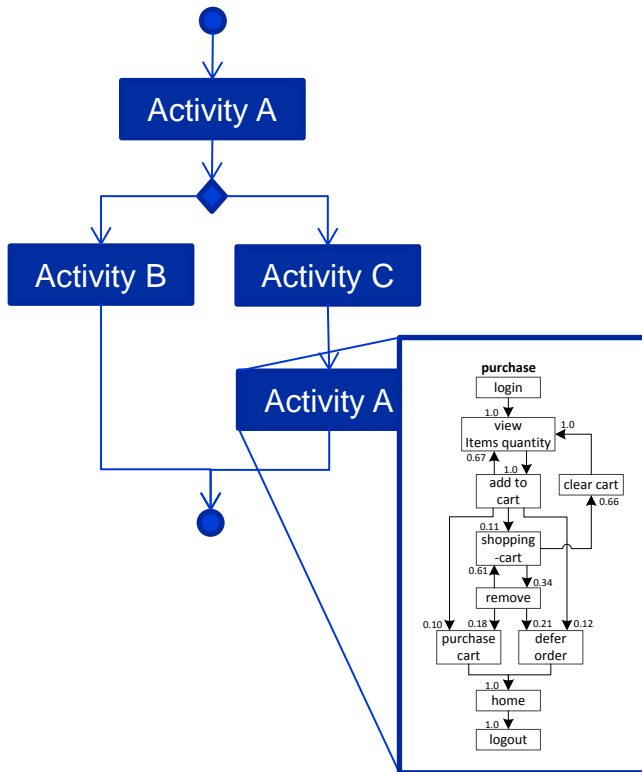


SPECjEnterprise2010
purchase transaction as
probabilistic Behavior Model

- 1) Modeling of backward edges
 - e.g. view_items to add_to_cart
- 2) Modeling of nested loops is difficult
 - e.g. view_items_quantity, add_to_cart, shoppingcart, clear_cart
- 3) Linking elements of one branchTransition to elements of another branchTransitions
 - e.g. remove to purchase_cart or defer_order

Limitations

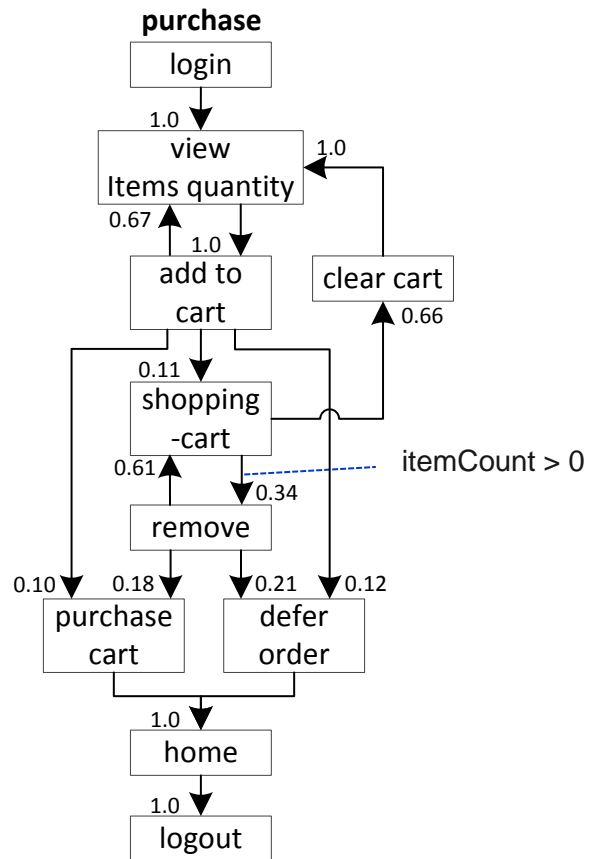
Reusability



- 1) Modeling of business processes (BPs) is difficult
- 2) BPs are a set of one or more linked activities where each activity itself is composed of one or more linked steps
- 3) The PCM Usage Model do not allow to model multiple connected usage scenarios

Limitations

Probabilistic Conditions



- 1) In case a combination of probabilistic and guarded conditions is needed, e.g.
 - remove an item from the shoppingcart with a probability of 34 % when $\text{itemCount} > 0$
- 2) The probability of the edges must be recalculated during simulation
 - When $\text{itemCount} = 0$ then the probability of clear cart is 100% (not 66%)

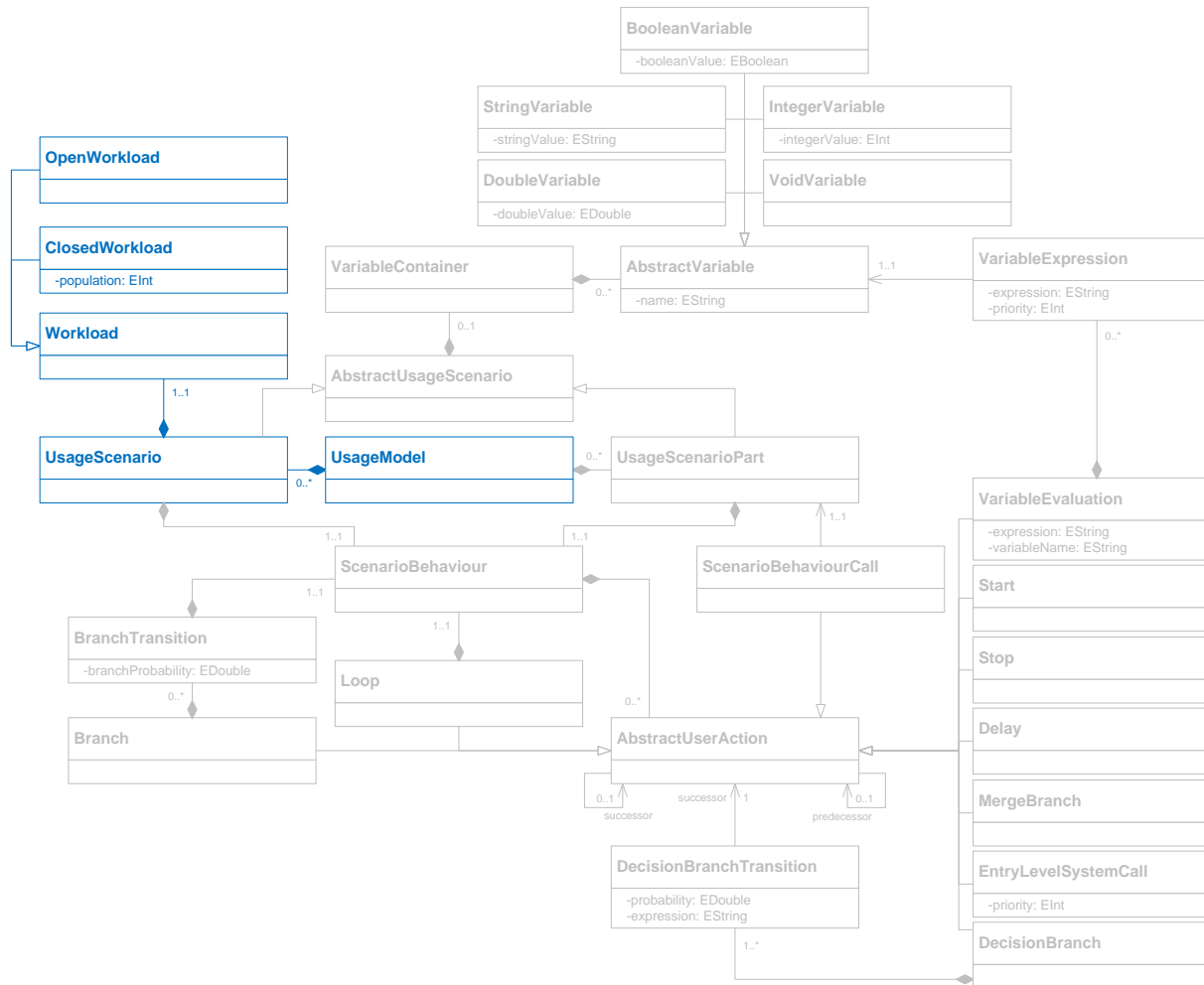
Limitations

Workarounds



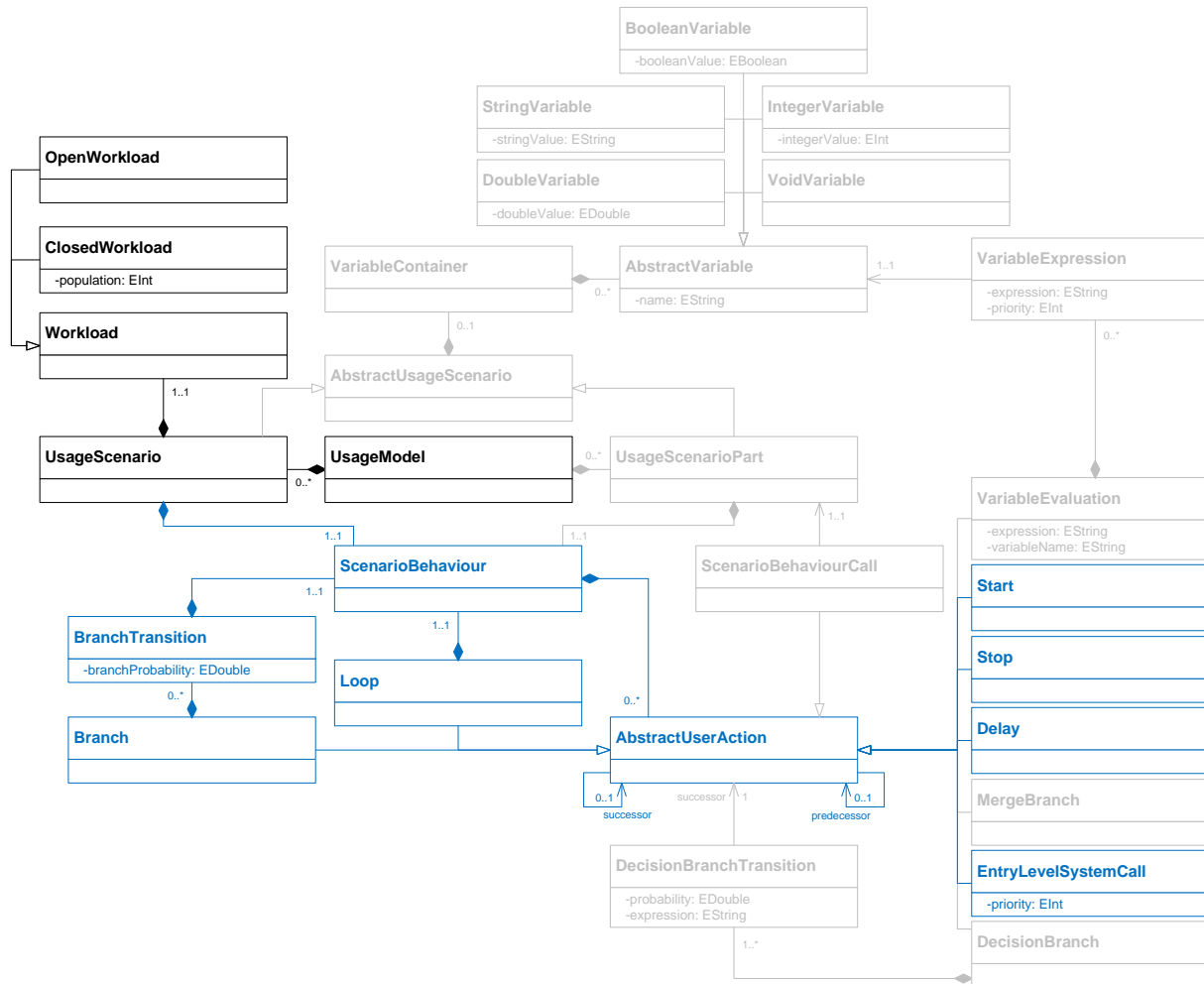
Extension of PCM Usage Model meta model

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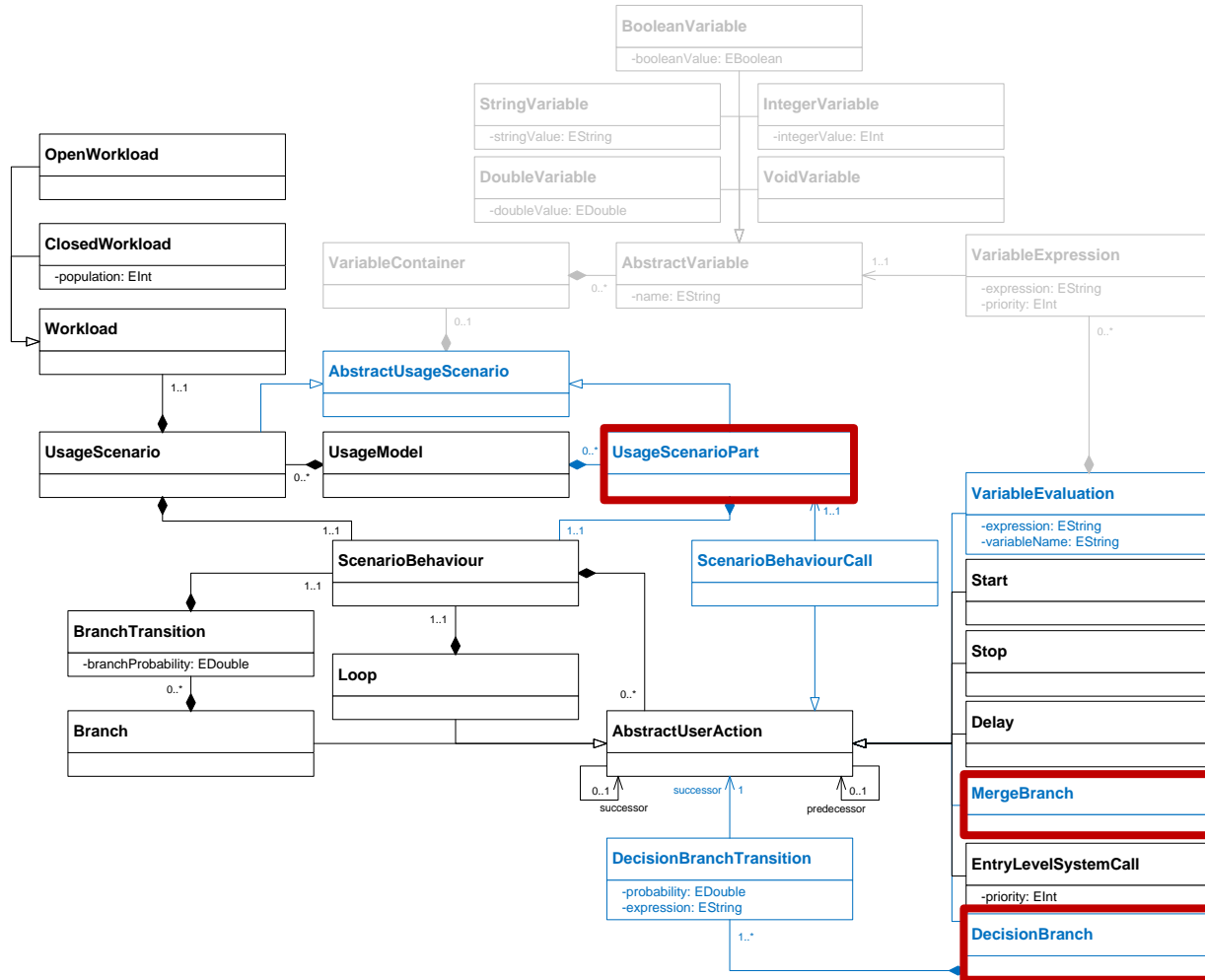
Extension of PCM Usage Model meta model

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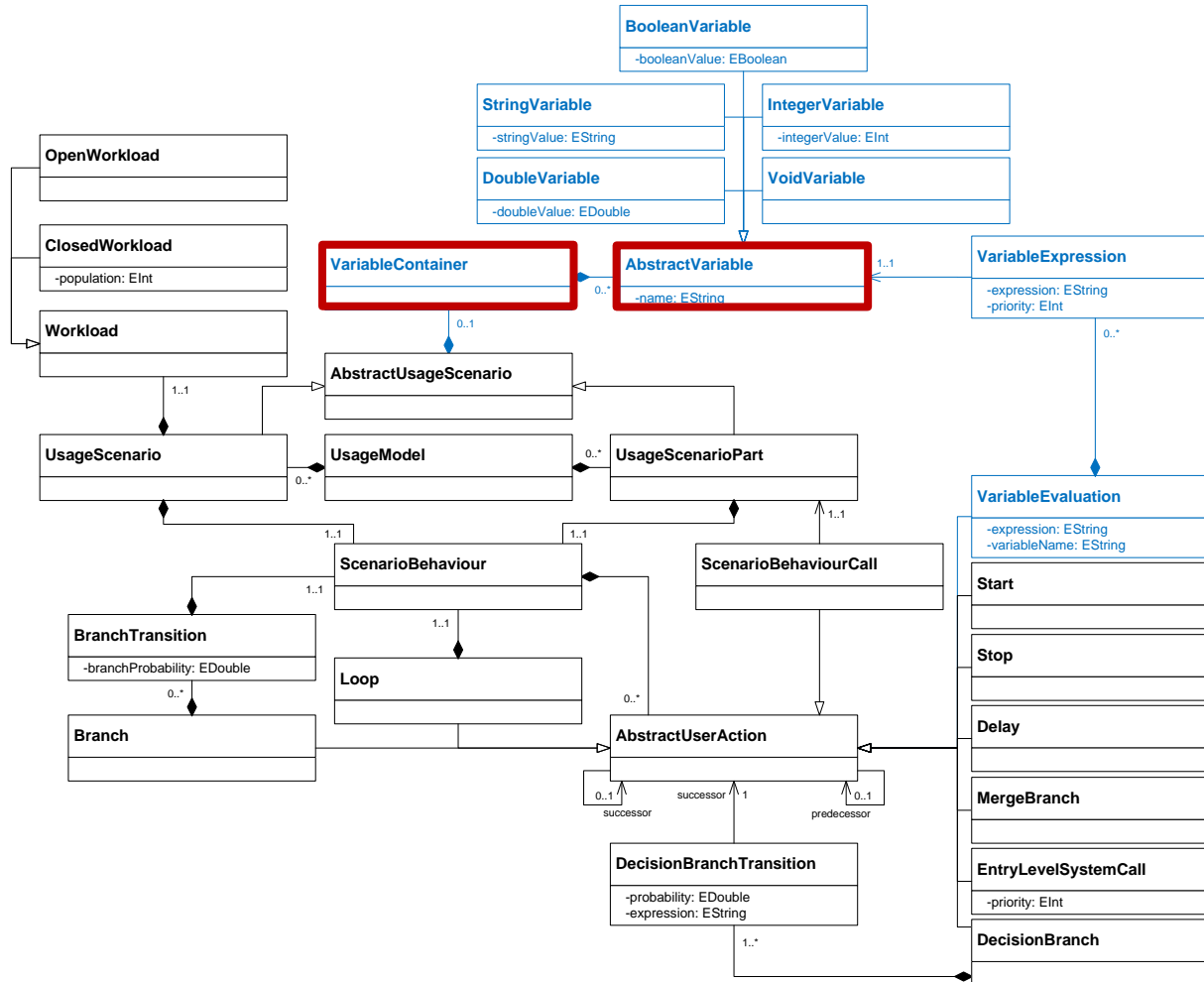
Extension of PCM Usage Model meta model

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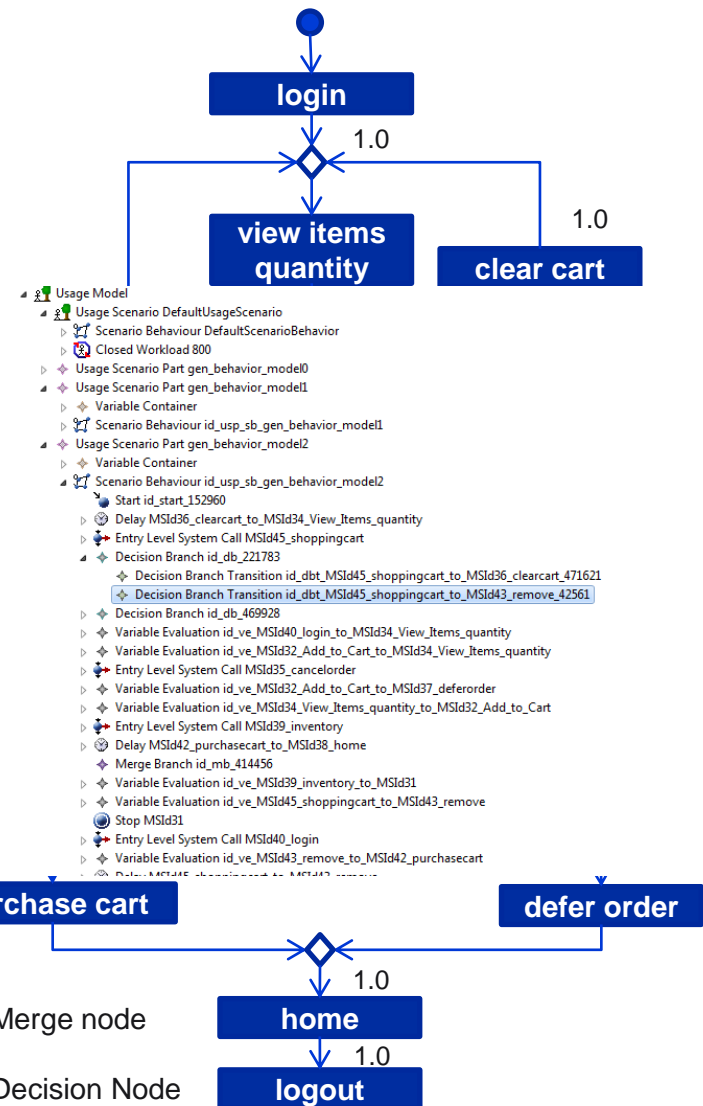
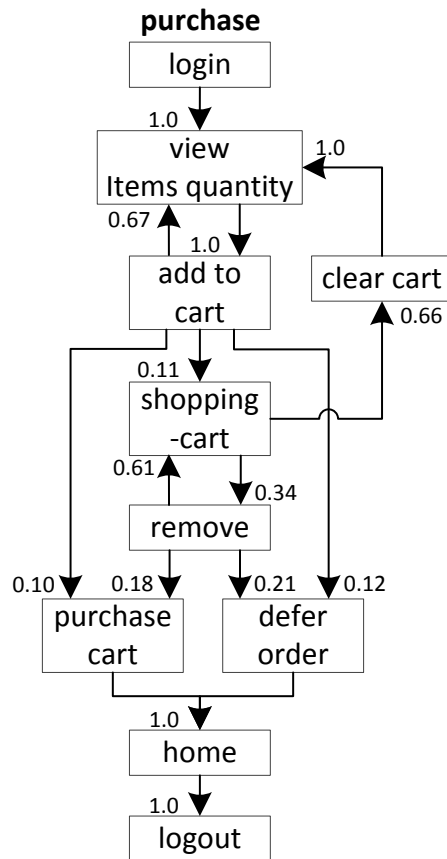
Extension of PCM Usage Model meta-model

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Extension of PCM Usage Model meta-model

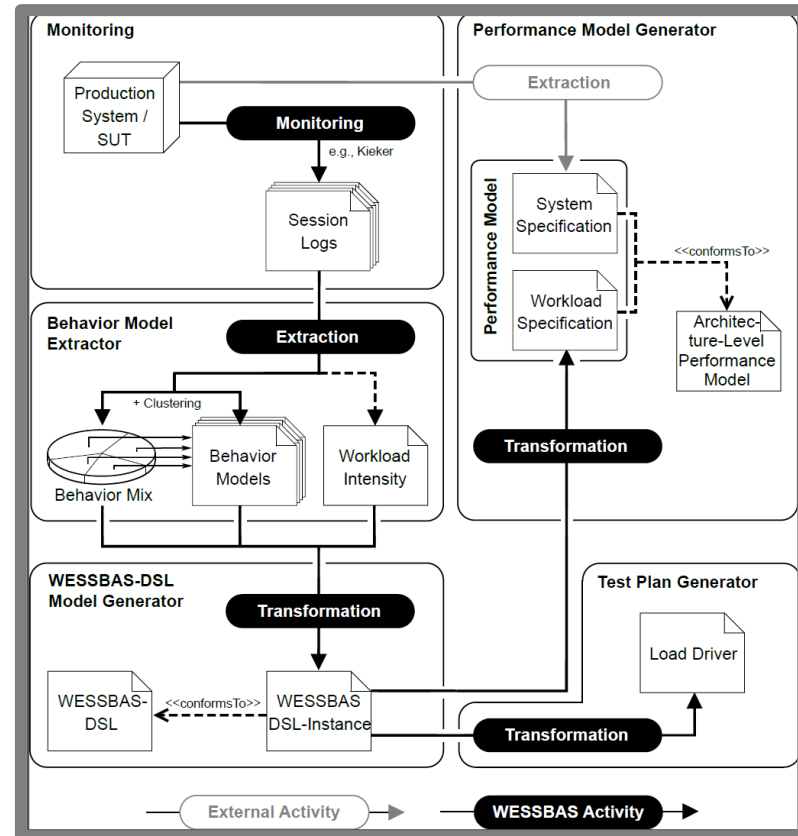
Example



Extraction of Extended PCM Usage Models

WESSBAS2PCM

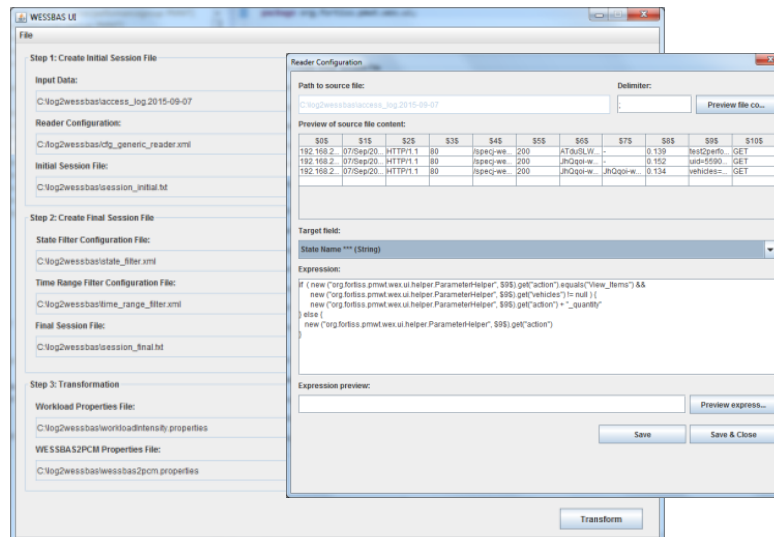
- Integrate extraction of PCM usage models into the WESSBAS approach (van Hoorn et al. 2014, Vögele et al. 2015)
- Transform WESSBAS-DSL instances into the extended PCM usage model
- A transformation of WESSBAS-DSL instances to „original“ PCM usage model already but workarounds are needed.



Evaluation

Methodology

- Execute SPECjEnterprise2010 run and collect standard Apache HTTP web logs
- Transform web logs to session log format
- Extraction of WESSBAS-DSL instances (includes clustering and guards and actions)
- Transformation of WESSBAS-DSL instances to the extended PCM usage model



Evaluation

Results

Request	Orig.	without guards and action		with guards and actions	
	MRC	SRC	PE%	SRC	PE%
1 add to cart	21.376	20.766	2,94%	21.490	0,53%
2 cancel order	342	350	2,29%	285	20,00%
3 clear cart	2.043	2.005	1,90%	2.194	6,88%
4 defer order	2.273	2.237	1,61%	2.249	1,07%
5 home	19.409	19.039	1,94%	19.009	2,10%
6 inventory	19.960	19.452	2,61%	19.609	1,79%
7 login	19.913	19.514	2,04%	19.527	1,98%
8 logout	19.194	18.838	1,89%	18.812	2,03%
9 purchase cart	2.811	2.716	3,50%	2.728	3,04%
10 remove	947	901	5,11%	736	28,67%
11 sell inventory	43.375	42.741	1,48%	42.089	3,06%
12 shopping cart	2.991	2.906	2,92%	2.932	2,01%
13 view items quantity	21.300	20.706	2,87%	21.408	0,50%
14 view items	67.886	66.518	2,06%	65.112	4,26%
Sum	243.820	238.689	2,15%	238.180	2,37%

MRC: Measured Request Count

SRC: Simulated Request Count

PE: Prediction Accuracy

Future Work

Conceptual Aspects

- Modeling of asynchronous communications
- Modeling of multiple start and end notes
- Integration of extended PCM usage model with *Integrated Business IT Impact Simulation* (IntBIIS) (Heinrich et al. 2015)

Technical Aspects


- Migrate from 3.4.1 → to PCM 4.0
- Graphical editors for extended usage model

Discussion

- Is the proposed concept interesting for SEFF as well?
- Are there further use cases for usage models?
 - Depending on extended observations



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