

fortiss



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Automatic Extraction of Session-Based Workload Specifications for Architecture-Level Performance Models

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Includes material created by Eike Schulz (Kiel University)



4th International Workshop on Large-Scale Testing (LT 2015)
co-located with 6th ACM/SPEC International Conference on Performance Engineering (ICPE 2015)

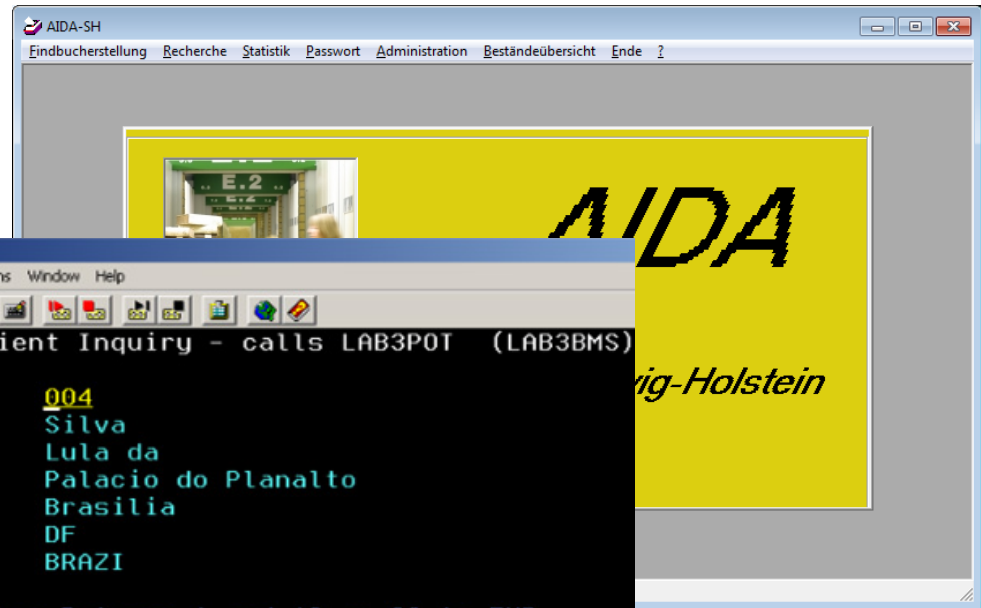


Domain

Background and Research Context

Interactive

business-critical software systems



```
Session A - [24 x 80]
File Edit View Communication Actions Window Help
Client Inquiry - calls LAB3POT (LAB3BMS)
Customer number: 004
Last name: Silva
First: Lula da
Address: Palacio do Planalto
City: Brasilia
State: DF
Country: BRAZI
Type customer Number Between 1 and 10 or 99 to END
Customer retrieved sucessfully
```

http://www.ibm.com/developerworks/websphere/techjournal/0909_barosa/0909_barosa.html

Domain

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business-critical software systems

Session:

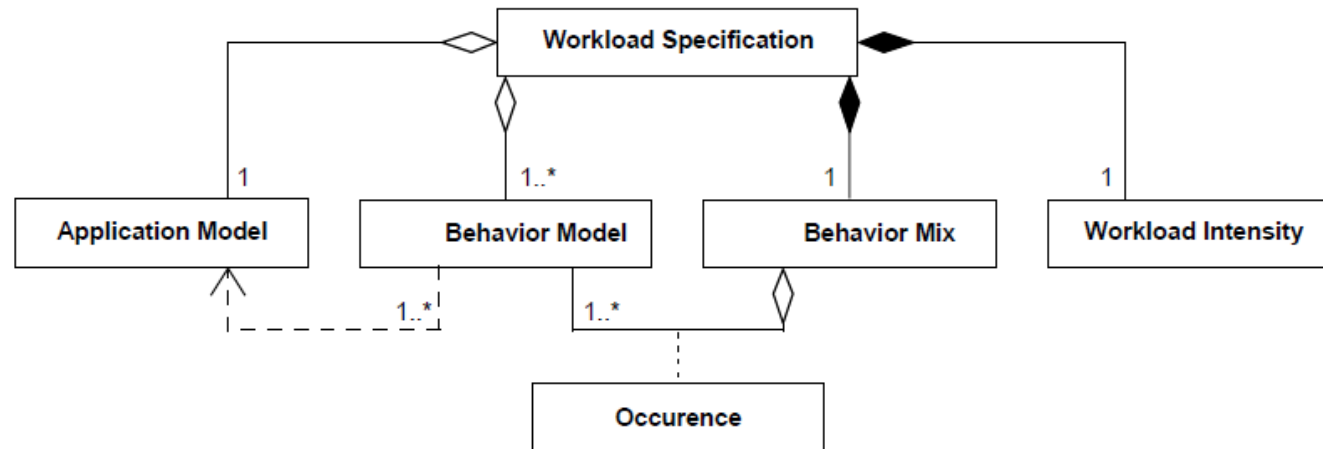
“ A series of consecutive and related requests issued by the same customer ”

http://www.ibm.com/developerworks/websphere/techjournal/010201/010201_sarosa.html

(Menascé et al. 1999)

Specifying Session-Based Workloads

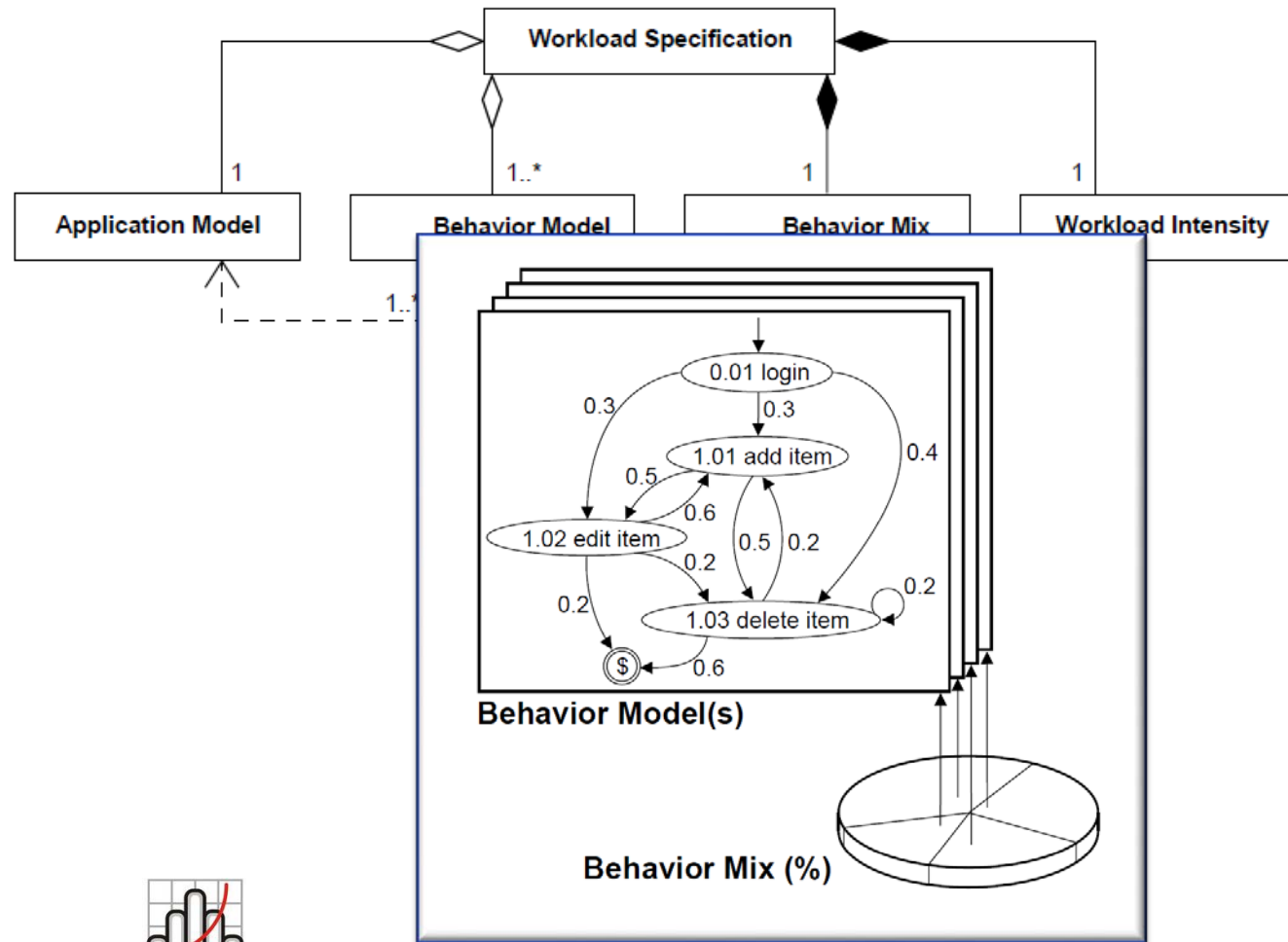
Background and Research Context



(van Hoorn et al.,) – building on (Menascé et al. 1999) and (Krishnamurthy et al. 2006)

Specifying Session-Based Workloads

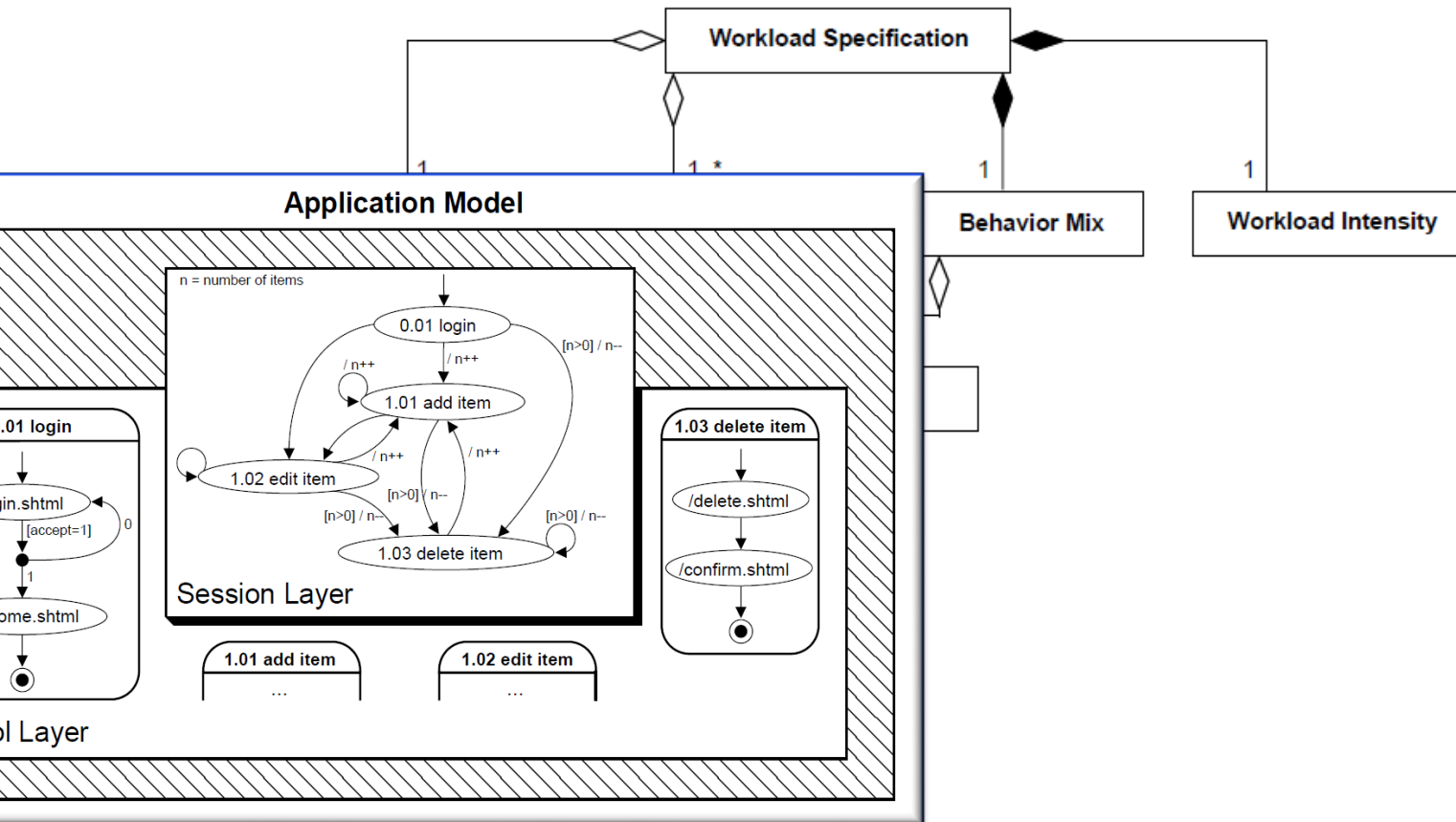
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Specifying Session-Based Workloads

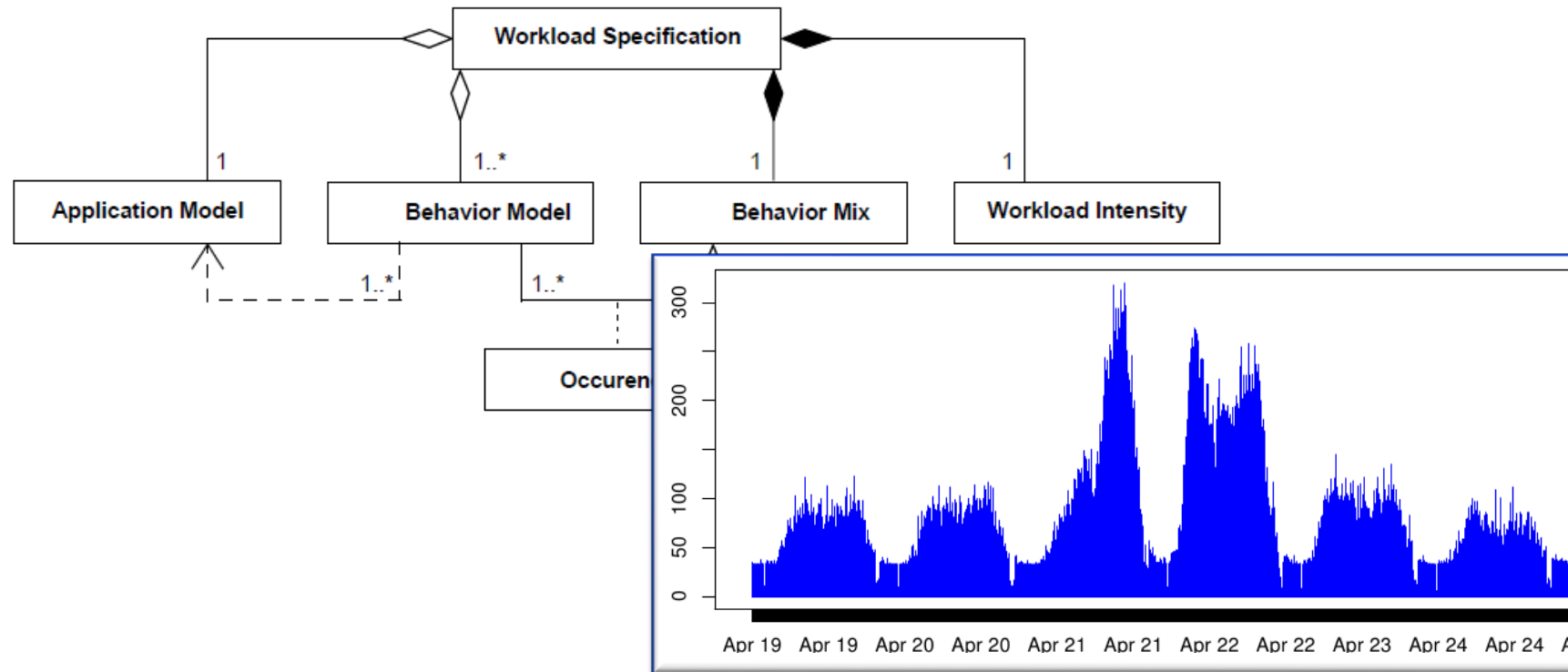
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Specifying Session-Based Workloads

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(van Hoorn et al., ) – building on (Menascé et al. 1999) and (Krishnamurthy et al. 2006)

Markov4JMeter Reference Implementation

Background and Research Context

The image shows a screenshot of the Apache JMeter Test Plan configuration window. The left pane displays a tree view of the test plan components. Several components are circled in blue and labeled as **Markov States** with arrows pointing to a central text label. These components include:

- 0.01 login
- 1.01 add item
- 1.02 edit item

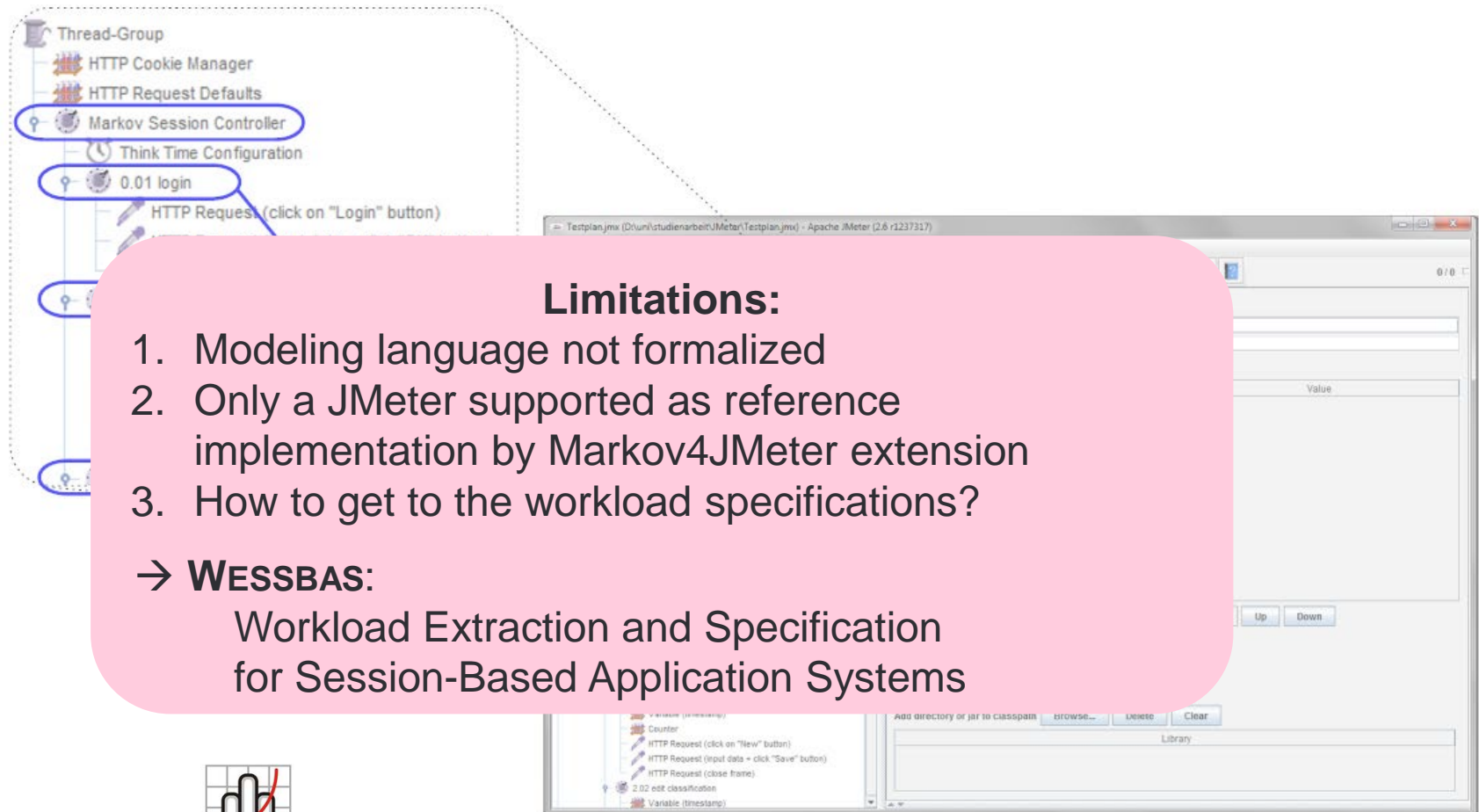
The right pane shows the configuration for the selected component, including fields for Name, Comments, and User Defined Variables. The tree view also shows other components like HTTP Cookie Manager, HTTP Request Defaults, Think Time Configuration, and various HTTP Requests.



(van Hoorn et al., )

Markov4JMeter Reference Implementation

Background and Research Context



The image shows a screenshot of the Apache JMeter GUI. On the left, a tree view of a test plan is visible, with several components highlighted by blue circles and lines: 'Thread-Group', 'HTTP Cookie Manager', 'HTTP Request Defaults', 'Markov Session Controller', 'Think Time Configuration', '0.01 login', and 'HTTP Request (click on "Login" button)'. A large pink rounded rectangle is overlaid on the center of the screenshot, containing a list of limitations and a reference to another work item. The background shows the main JMeter interface with a 'Value' field and 'Up'/'Down' buttons.

Limitations:

1. Modeling language not formalized
2. Only a JMeter supported as reference implementation by Markov4JMeter extension
3. How to get to the workload specifications?

→ **WESSBAS:**
Workload Extraction and Specification
for Session-Based Application Systems



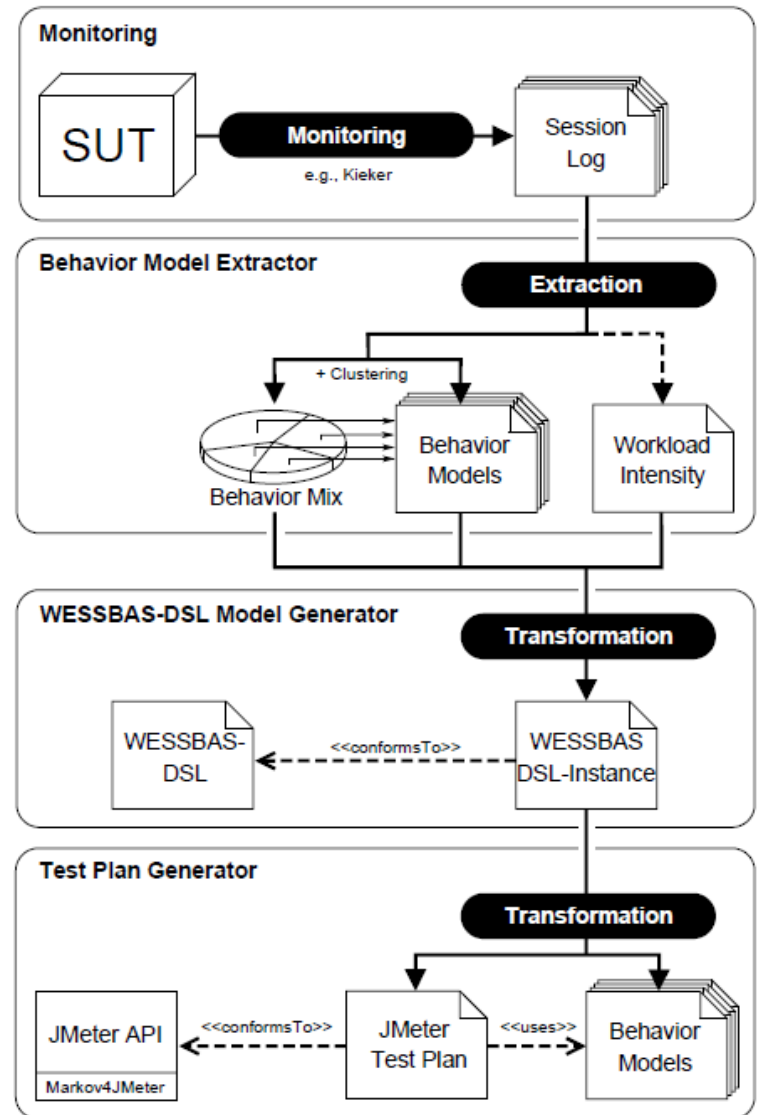
(van Hoorn et al.,

WESSBAS Approach before LT '15

WESSBAS is an acronym for Workload Extraction and Specification for Session-Based Application Systems

Tooling

1. **WESSBAS-DSL** as tool- and system-agnostic (intermediate) modeling language
2. **Extraction of WESSBAS-DSL instances** from monitoring data (employing clustering)
3. **Transformation** from WESSBAS-DSL to JMeter/Markov4JMeter test plan
4. **Evaluation** using SPECjEnterprise

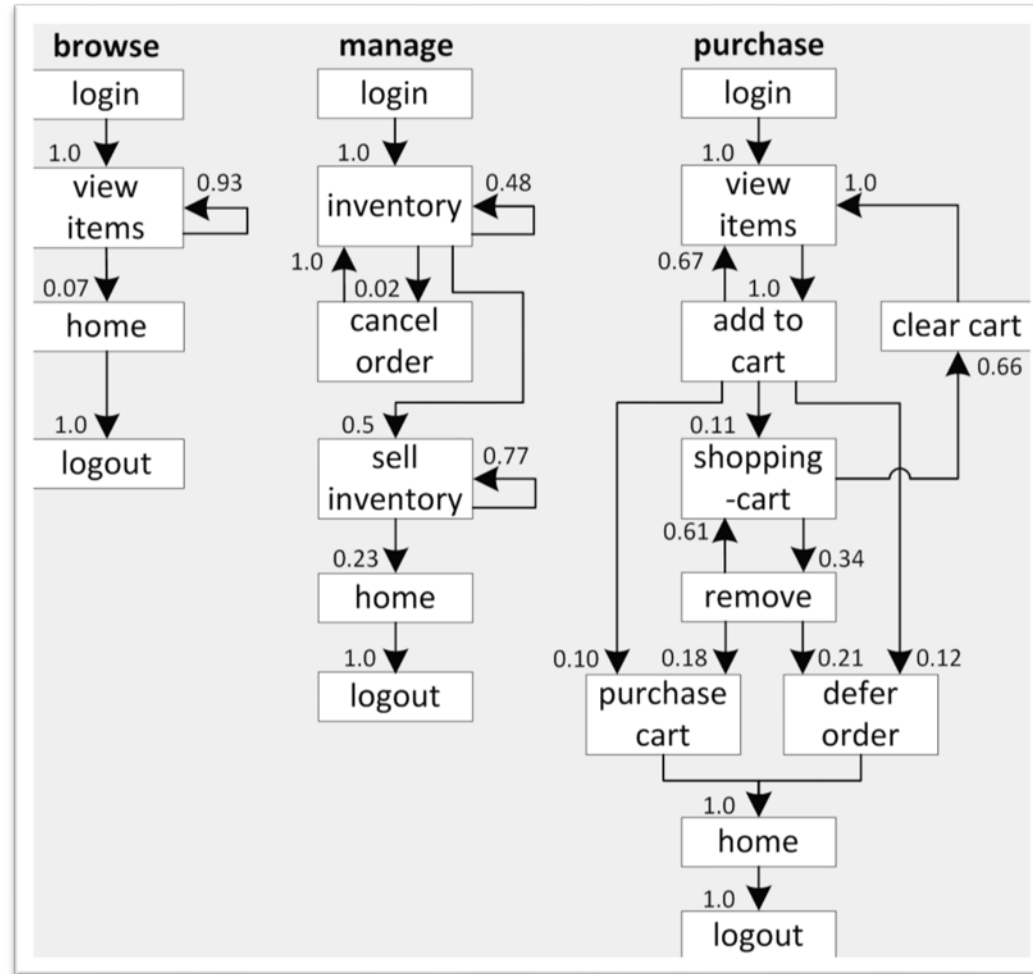


(van Hoorn et al.,  2014)

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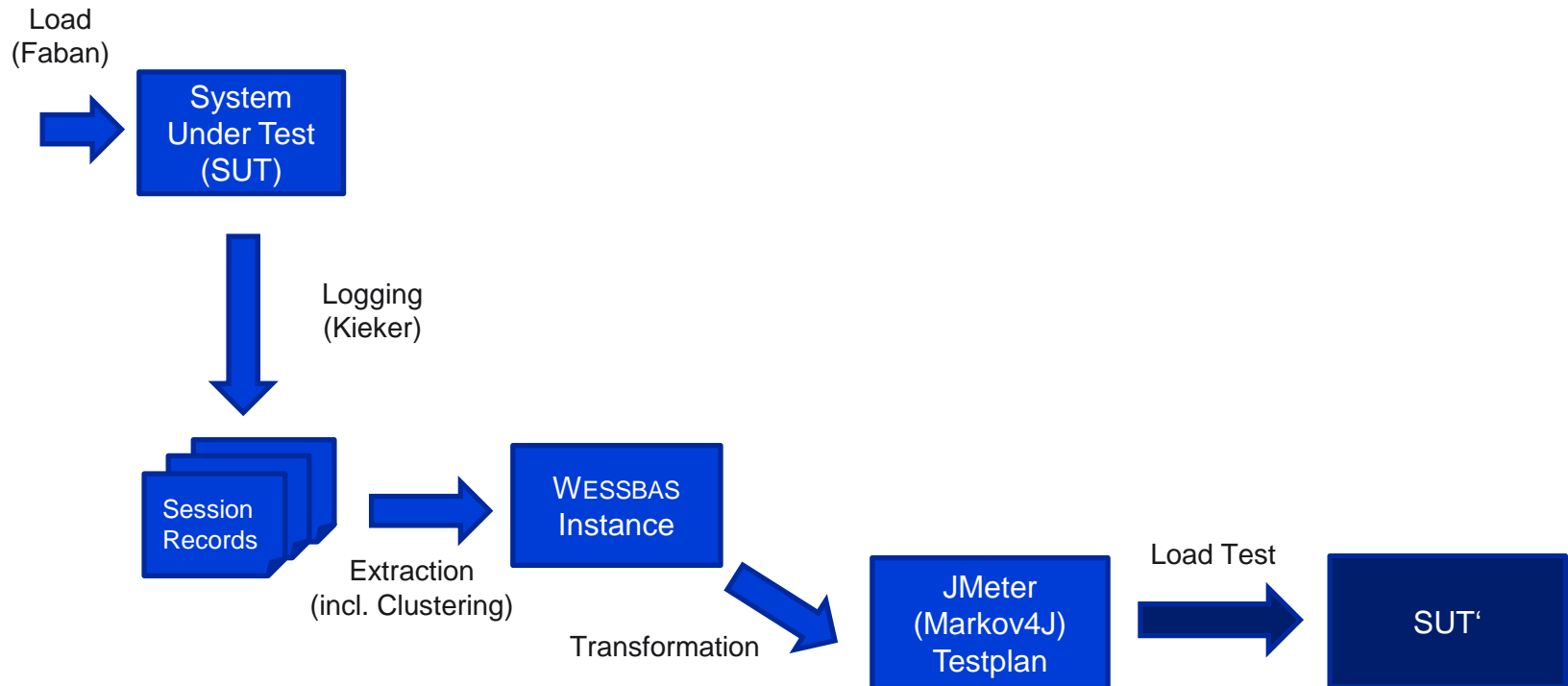
Selected Evaluation Results – SPECjEnterprise Experiments



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Selected Evaluation Results – SPECjEnterprise Experiments

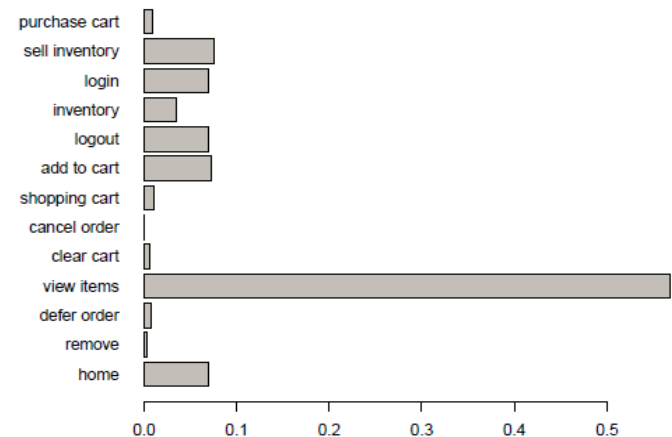
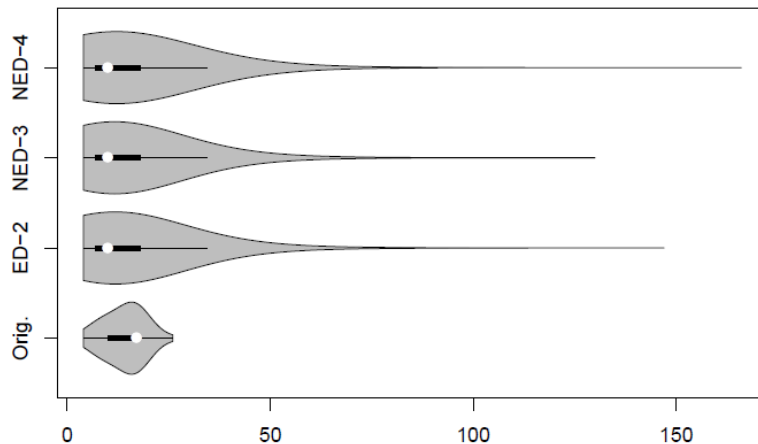


WESSBAS Approach **before** LT '15

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Selected Evaluation Results – SPECjEnterprise Experiments

1. How accurately do the clustering results match the input Behavior Mix?
 - (Not surprisingly) Errors vary between clustering algorithms, workload mixes etc.
2. What is the impact of the clustering results on the workload characteristics?

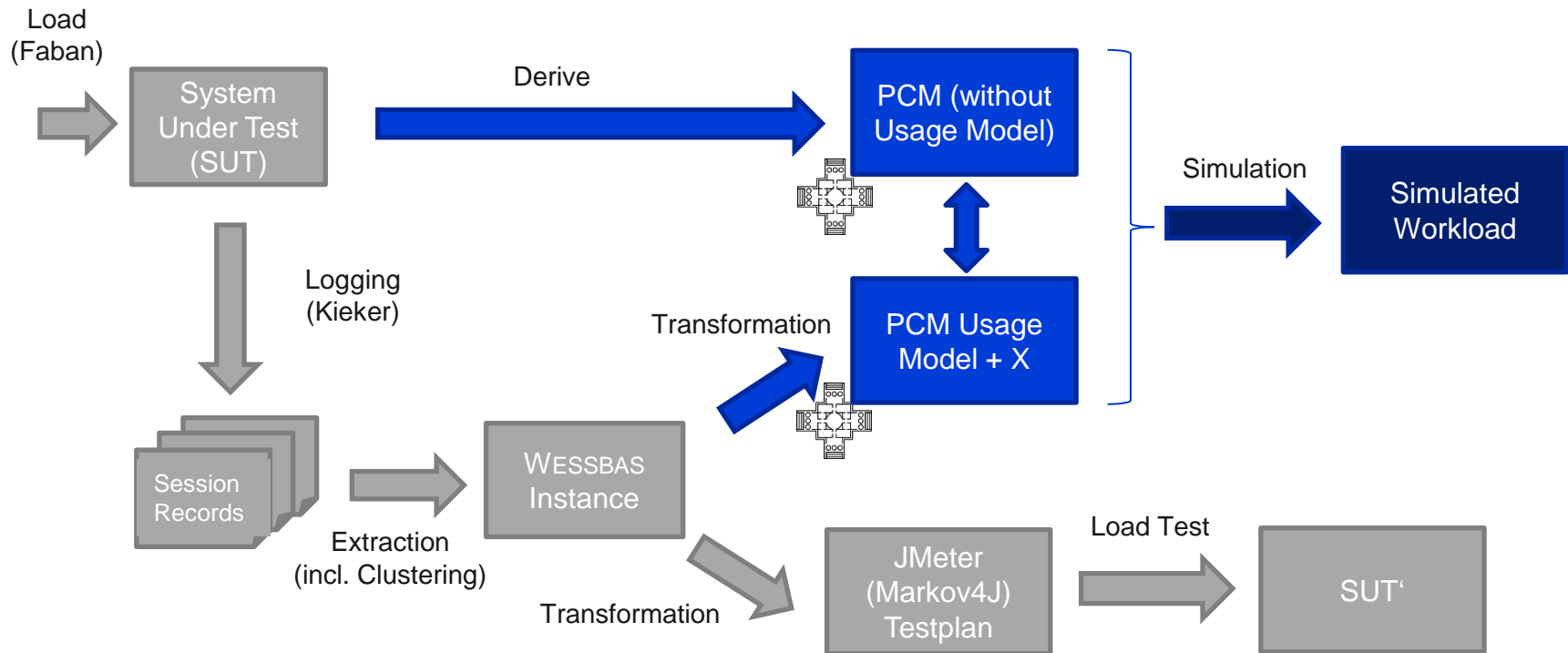


1. Workload characteristics **do not differ among each other** when using different clustering results
2. Session lengths and no. of distinct sessions **differ** from original characteristics

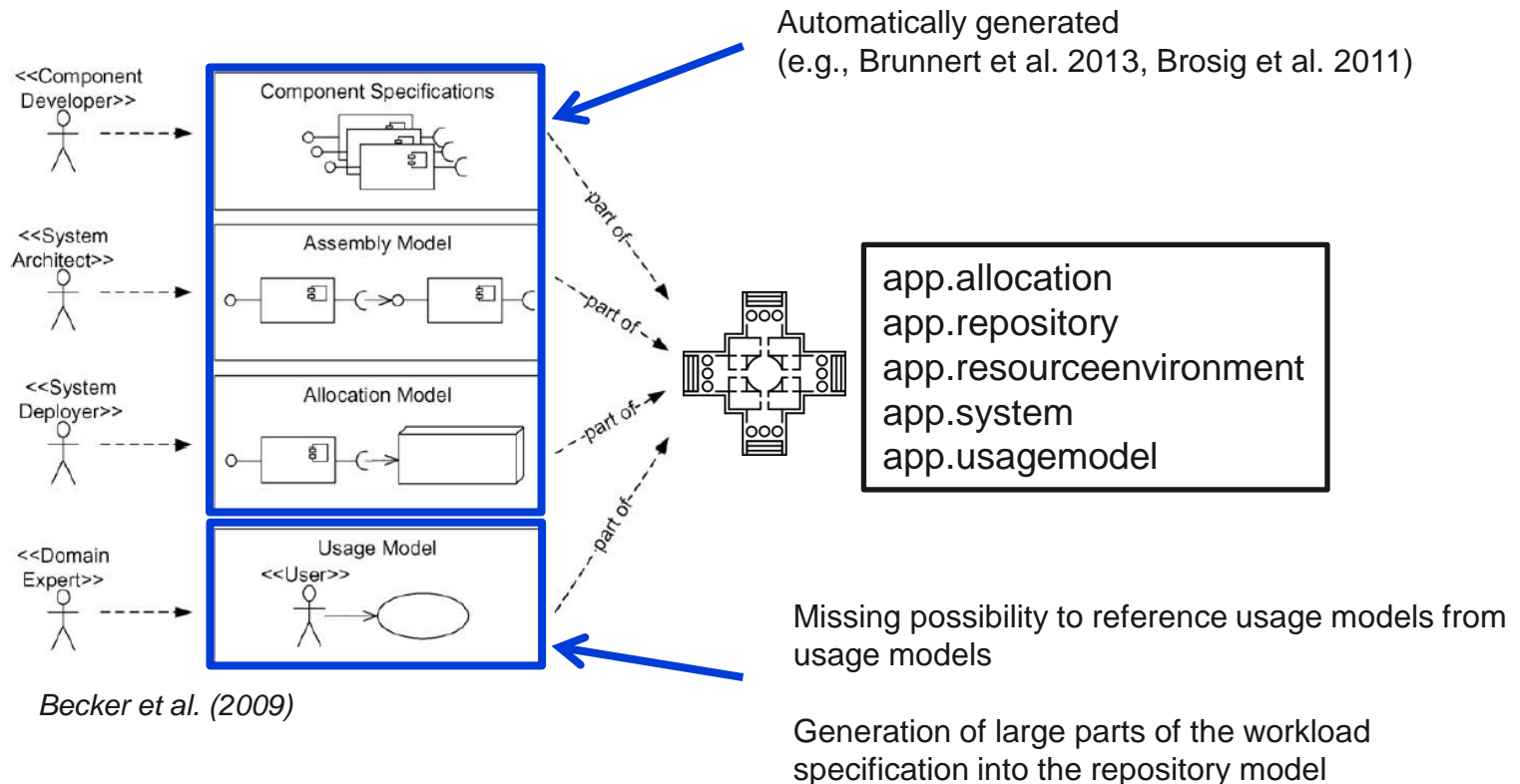
3. Server-side request counts exactly match the original characteristics

LT '15 Contribution: WESSBAS-DSL to PCM

- Longer term goal: Integration of workload modeling
- LT '15: Transformation of WESSBAS-DSL to Palladio Component Model (PCM)



Transformation into Palladio Component Models



WESSBAS-DSL	PCM Model Elements
Behavior Models	Repository Model (Basic Component, RDSEFF)
Session Layer FSMs	not required
Protocol Layer FSMs	not required
Workload Intensity	Usage Model (Closed Workload)
Behavior Mix	Usage Model (Branch)

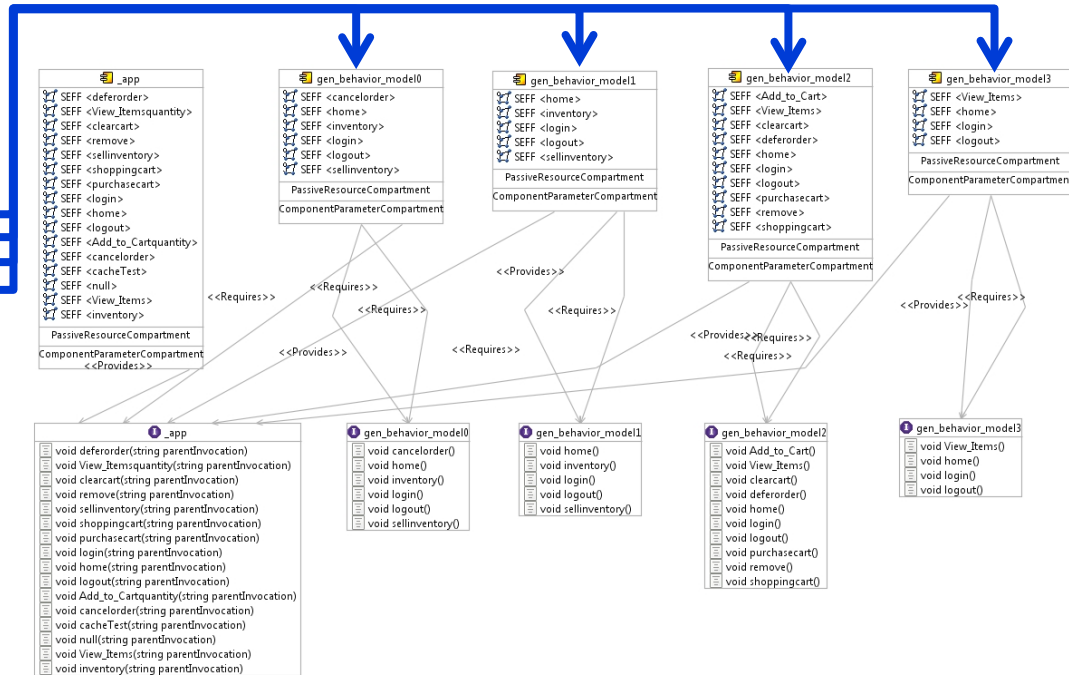
Generation into PCM Repository Model

Transformation into Palladio Component Models

WESSBAS-DSL

platform:/resource/wesba-workflow/step2--M4JDSLModelGenerator/output/workloadmodel.xml

- Workload Model
 - Constant Workload Intensity 250
 - Application Model
 - Session Layer EFSM
 - Behavior Mix
 - Relative Frequency 0.0103
 - Relative Frequency 0.2385
 - Relative Frequency 0.2462
 - Relative Frequency 0.505
 - Behavior Model gen_behavior_model0
 - Behavior Model gen_behavior_model1
 - Behavior Model gen_behavior_model2
 - Behavior Model gen_behavior_model3
 - Markov State MSId44_Add_to_Cart
 - Transition 0.9286
 - Normally Distributed Think Time 1.0
 - Transition 0.0714
 - Normally Distributed Think Time 1.0
 - Markov State MSId46_cancelorder
 - Markov State MSId47_clearcart
 - Markov State MSId48_deferorder
 - Markov State MSId49_home
 - Markov State MSId50_inventory
 - Markov State MSId51_login
 - Markov State MSId52_logout
 - Markov State MSId53_purchasecart
 - Markov State MSId54_remove
 - Markov State MSId55_sellinventory
 - Markov State MSId56_shoppingcart
 - Behavior Model Exit State MSId43



Property	Value
EId	MSId45_View_Items
Service	Service_View_Items

Generation into PCM Repository Model

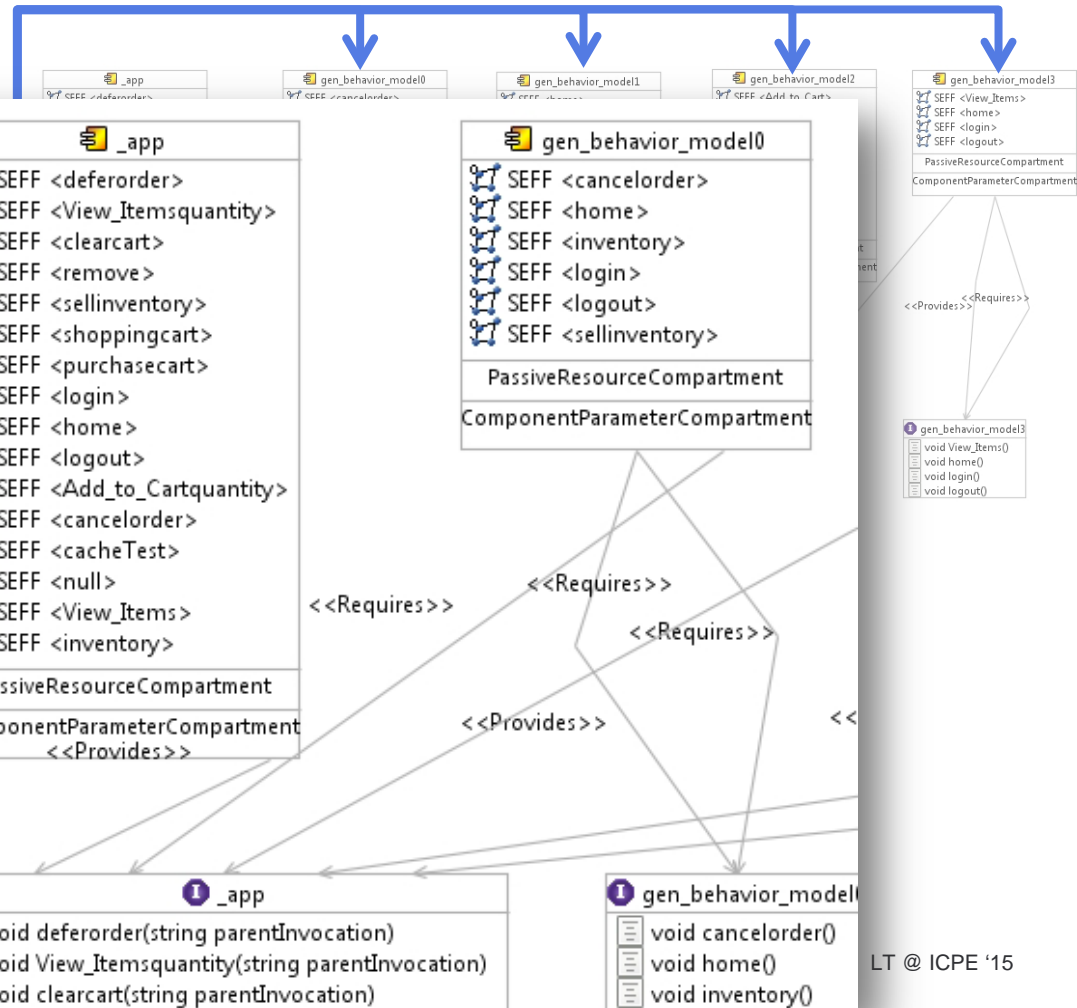
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 - Markov State MSId56_shoppingcart
 - Behavior Model Exit State MSId43

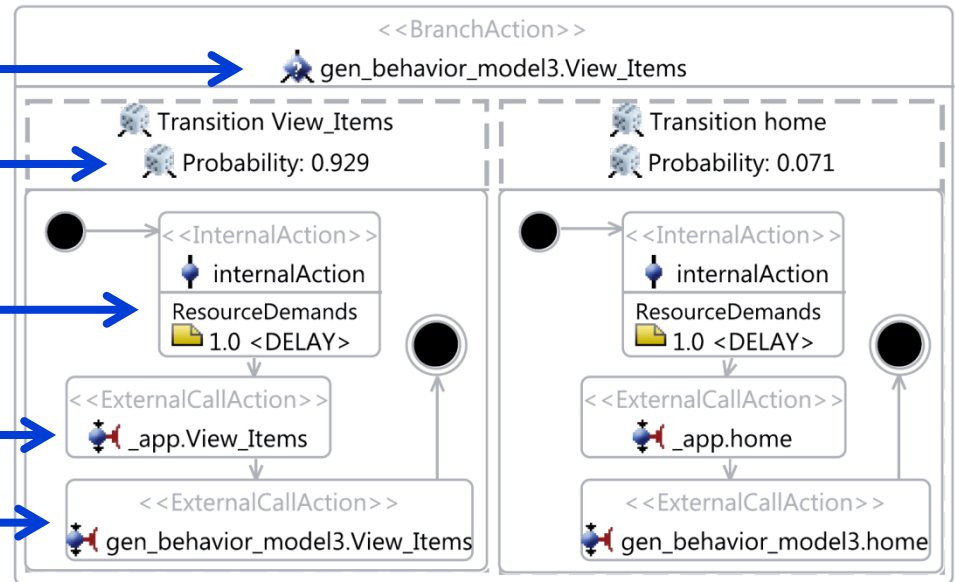
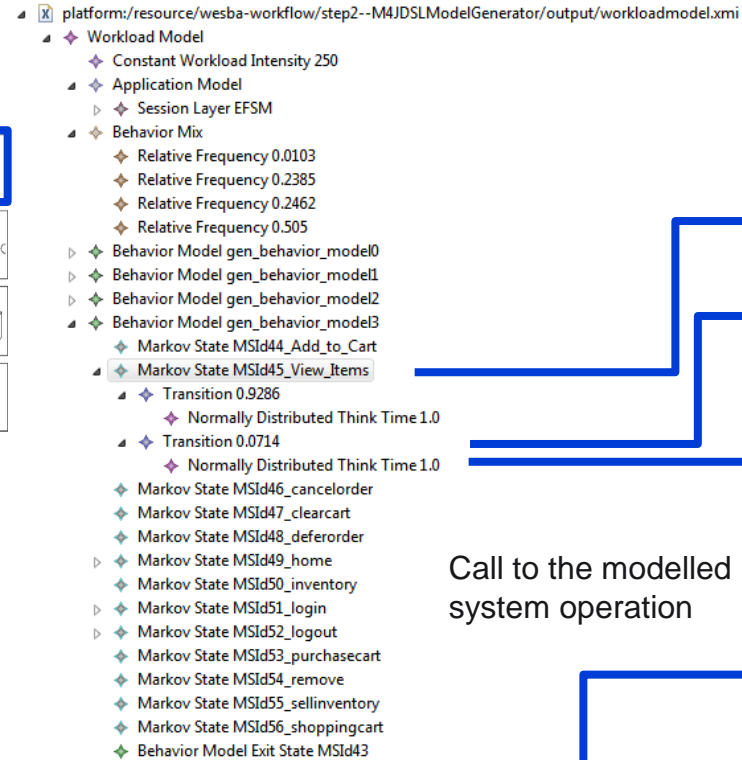
Property	Value
EId	MSId45_View_Items
Service	Service_View_Items



Generation into PCM Repository Model

Transformation into Palladio Component Models

WESSBAS-DSL



Call to the modelled system operation

Property	Value
Eld	MSId45_View_Items
Service	Service View_Items

Accuracy of PCM Workload Specification?

Evaluation

- Question: How well match the predicted workload characteristics the measured workload characteristics?
- Experimental setting:
 - Transformation and simulation of our VALUETOOLS SPECjEnterprise instances
 - Comparison of measured and predicted request counts

	Request	Orig.	2 Behavior Models		3 Behavior Models		4 Behavior Models	
		MRC	SRC	PE	SRC	PE	SRC	PE
1	add to cart	63,761	64,943	1.82%	61,812	3.15%	60,986	4.55%
2	cancel order	632	609	3.78%	661	4.39%	625	1.12%
3	clear cart	6,047	6,178	2.12%	5,927	2.02%	5,846	3.44%
4	defer order	6,782	6,873	1.32%	6,524	3.95%	6,606	2.66%
5	home	59,934	61,146	1.98%	58,747	2.02%	58,744	2.03%
6	inventory	30,596	30,539	0.19%	29,574	3.46%	29,405	4.05%
7	login	61,500	61,156	0.56%	58,747	4.69%	58,745	4.69%
8	logout	59,934	61,146	1.98%	58,747	2.02%	58,744	2.03%
9	purchase cart	8,360	8,388	0.33%	7,976	4.81%	7,836	6.69%
10	remove	3,027	2,986	1.37%	2,876	5.25%	2,949	2.64%
11	sell inventory	66,679	66,131	0.83%	63,185	5.53%	63,914	4.33%
12	shopping cart	9,074	9,164	0.98%	8,803	3.08%	8,795	3.17%
13	view items	498,601	491,812	1.38%	470,392	6.00%	475,000	4.97%
	Σ	874,927	871,071	0.44%	833,971	4.91%	838,195	4.38%

MRC: Measured Request Count
SRC: Simulated Request Count
PE: Prediction Accuracy

Future Work

- Automatic generation of application model → Executable load tests
 - Automatic learning of guards and actions
 - Generation of protocol layer
 - Modeling, extraction and generation of parameters
- Support for workload intensity → LIMBO (Kistowski et al. 2014)
- Additional transformations
 - to alternative workload generators
 - to other architecture-level performance models
 - from PCM to WESSBAS-DSL
- Online clustering to detect evolution of behavior mix
- Industrial case study
- Supplementary material (software, (meta-)models, data, scripts) publicly available online: <http://markov4jmeter.sourceforge.net/lt15>



Statements as Input for the LT '15 Discussion

1. Thought-provoking statement or discussion question about the area
(e.g., how could this work be validated?)
 - What values/use cases do you see in integrating workload modeling and extraction for measurement- and model-based performance evaluation?
2. Thought-provoking statement or discussion question about the area
(e.g., how can this work be of value to industry).
 - How can we transfer state-of-the-art load modeling/testing approaches do industrial practice?
 - Do you see a need to improve load testing practice?

References

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