Performance Predictions for Adaptive Cloud-Based Systems using FMC-QE

ADAPTIVE 2020

Stephan Kluth
FOM University of Applied Sciences
mail@stephankluth.de

Stephan Kluth

Hasso Plattner Institute for Software Systems Engineering, Potsdam (2000-2011):

- Bachelor of Science in Software Engineering, 2004
- Master of Science in Software Engineering, 2005
- Ph.D., Topic: “Quantitative Modeling and Analysis with FMC-QE”, 2011

SQS AG, Cologne (2010-2016):
IT-Consultant

FernUni Hagen, Hagen (2014-2020):
Mentor (Business Informatics, Math)

Gemeinnützige Sabine Blindow-SchulGmbH, Hannover (2016-2020):
Lecturer (IT-Security, Software-Engineering, IT-Basics)

Design-Your-Future-BildungsGmbH (2017-2020):
Head of IT, Product Owner, Business Analyst

FOM University of Applied Sciences (since 2019):
Lecturer (Business Informatics)

Certifications:

- Certified ScrumMaster
- Microsoft Certified Professional (MCP)
- ISTQB Certified Tester, Foundation Level
- ISTQB Certified Tester, Advanced Level, Test Manager

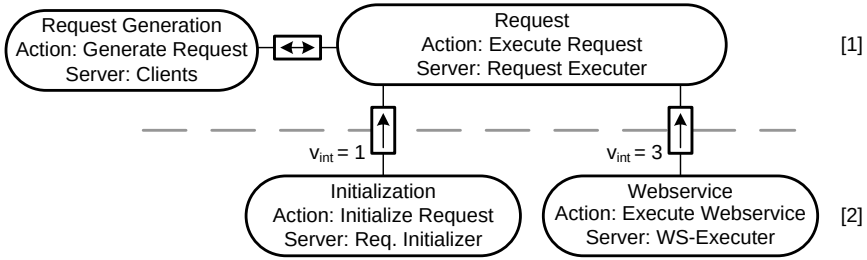
Fundamental Modeling Concepts for Quantitative Analysis

- Technique to model and evaluate quantitative behavior of systems

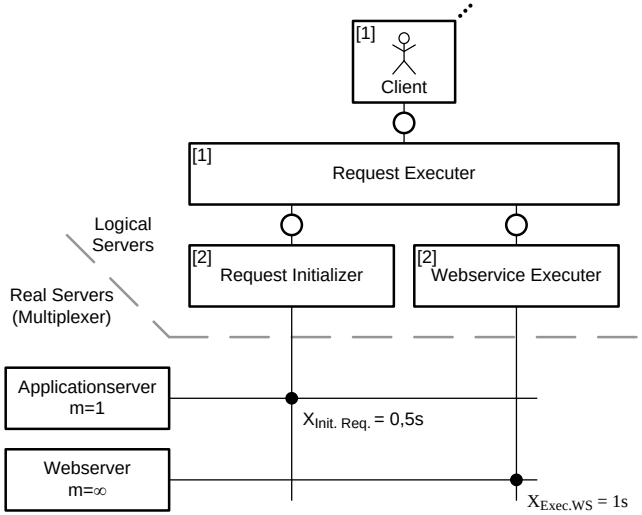
- Complexity Reduction through:
  - Hierarchical Modeling
  - Multidimensional System view based on FMC
  - Distinction of operational- and control states

- Hierarchical interpretable structure for performance prediction

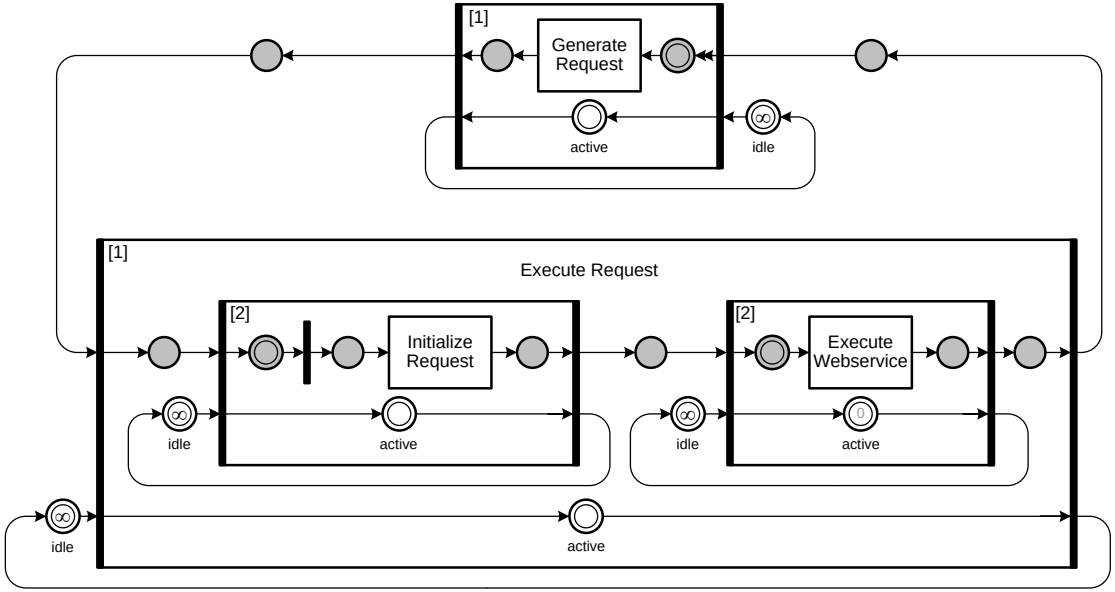
FMC-QE multidimensional system perspectives



Service Request Structures



Server Structures



Dynamic Behavior and Control Flow

FMC-QE Calculus based on:

- Little‘s Law

$$N^{[bb]} = \lambda^{[bb]} * R^{[bb]}$$

- Forced Traffic Flow Law

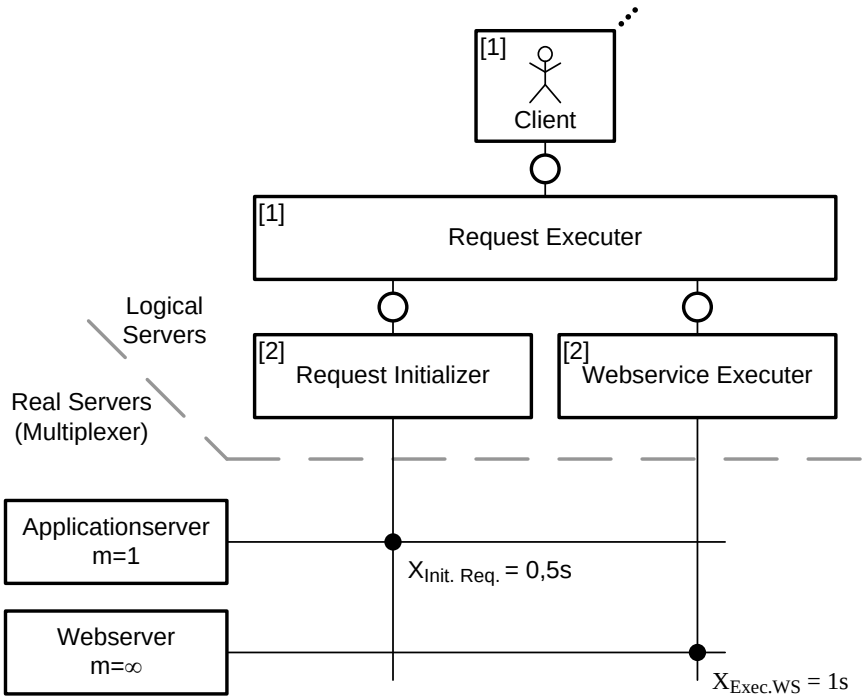
$$\lambda_{int}^{[bb]} = v_{int}^{[bb]} * \lambda_{ext}^{[bb-1]}$$

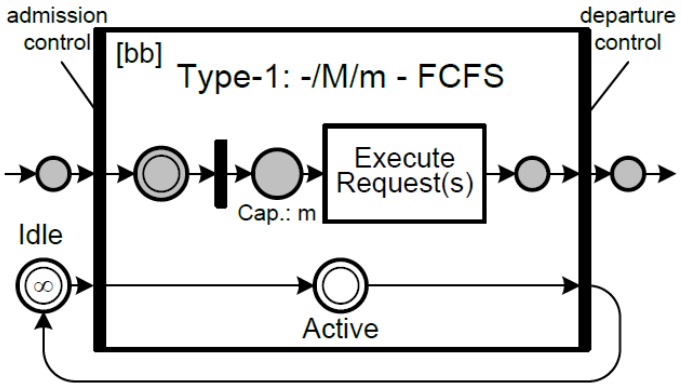
Experimental Parameters:	
n_{ges}	30
λ_{bott}	2,0000
f	0,8000
λ	1,6000

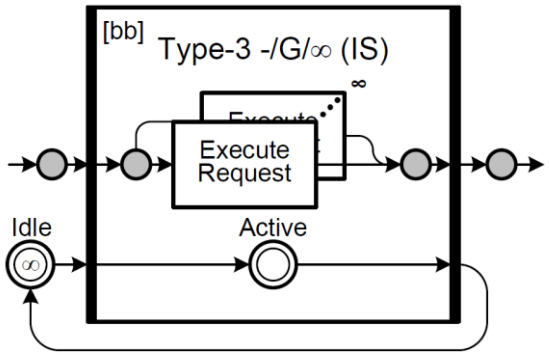
Service Request Section							Server Section					Dynamic Evaluation Section						
[bb]	$SRq_i^{[bb]}$	$p_{[bb-1],i}$	$v_{i,ext}^{[bb-1]}$	$v_{i,int}^{[bb]}$	$v_i^{[bb]}$	$\lambda_i^{[bb]}$	$Server_i$	$X_{i,measured}^{[bb]}$	$m_{i,ext}^{[bb-1]}$	$m_{i,int}^{[bb]}$	$m_i^{[bb]}$	$X_{i,mpxed}^{[bb]}$	$\mu_i^{[bb]}$	$\rho_i^{[bb]}$	$n_{i,q}^{[bb]}$	$n_{i,s}^{[bb]}$	$n_i^{[bb]}$	$R_i^{[bb]}$
2	Webservice	1	1	3	3	4,8000	Webserver	1,0000	1	1	1	1,0000	1,0000		0,0000	4,8000	4,8000	1,0000
2	Initialization	1	1	1	1	1,6000	App. Server	0,2000	1	1	1	0,5000	2,0000	0,8000	3,2000	0,8000	4,0000	2,5000
1	Request	1	1	1	1	1,6000			1	1	1		2,0000		3,2000	5,6000	8,8000	5,5000
1	Request Generation	1	1	1	1	1,6000			1	1	1	13,2500	0,0755		0,0000	21,2000	21,2000	13,2500

Multiplexer Section				
$Multiplexer_j$	m_j	$X_j^{[1]}$	$\mu_j^{[1]}$	$\mu_j^{[1]} * m_j$
App. Server	1	0,5000	2,0000	2,0000
Webserver	∞	1,0000		

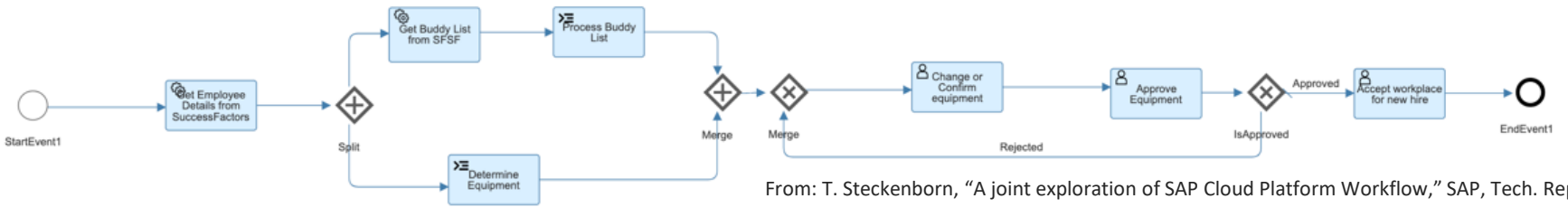
Servers cloud be represented as multiplexers



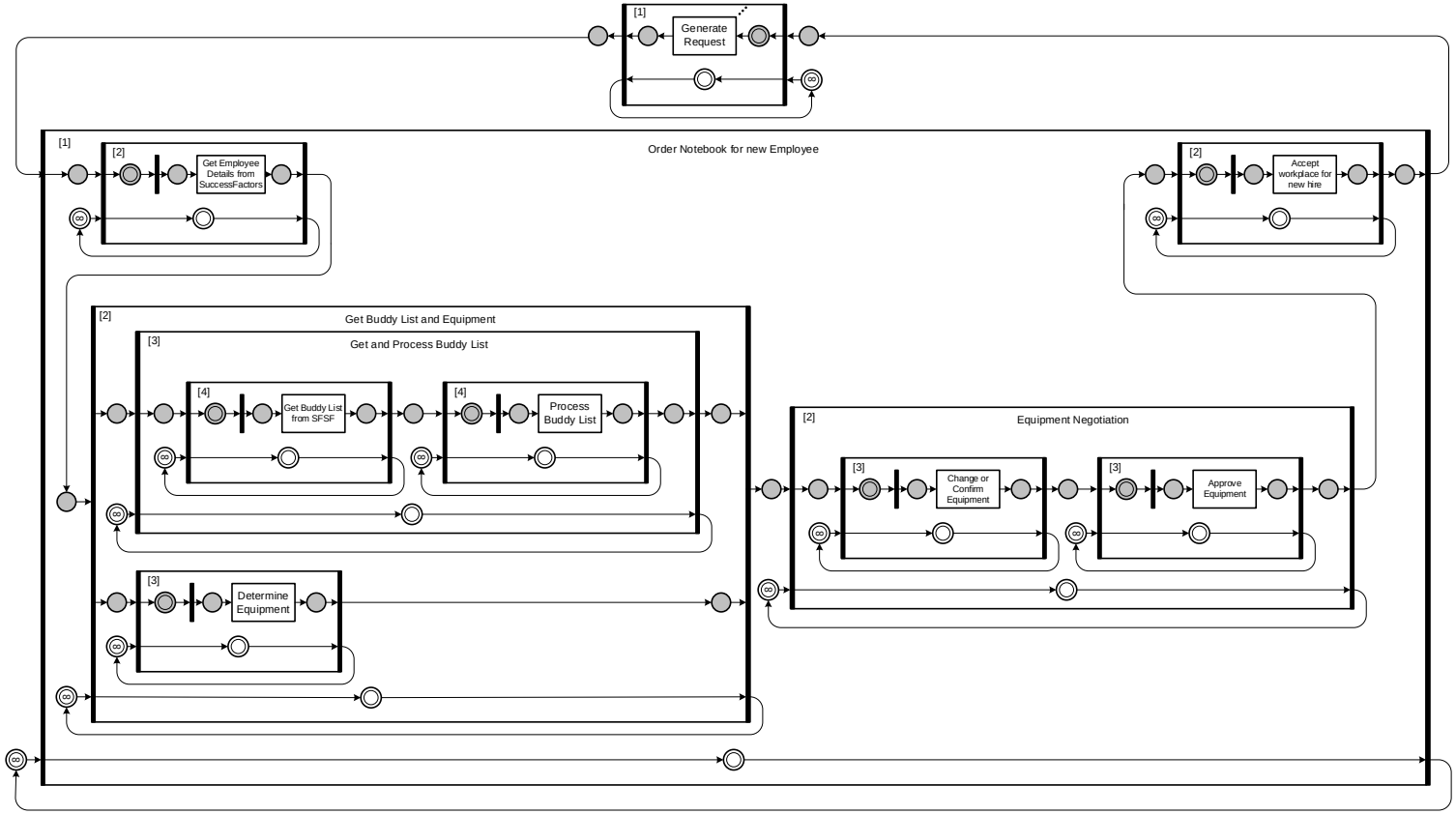




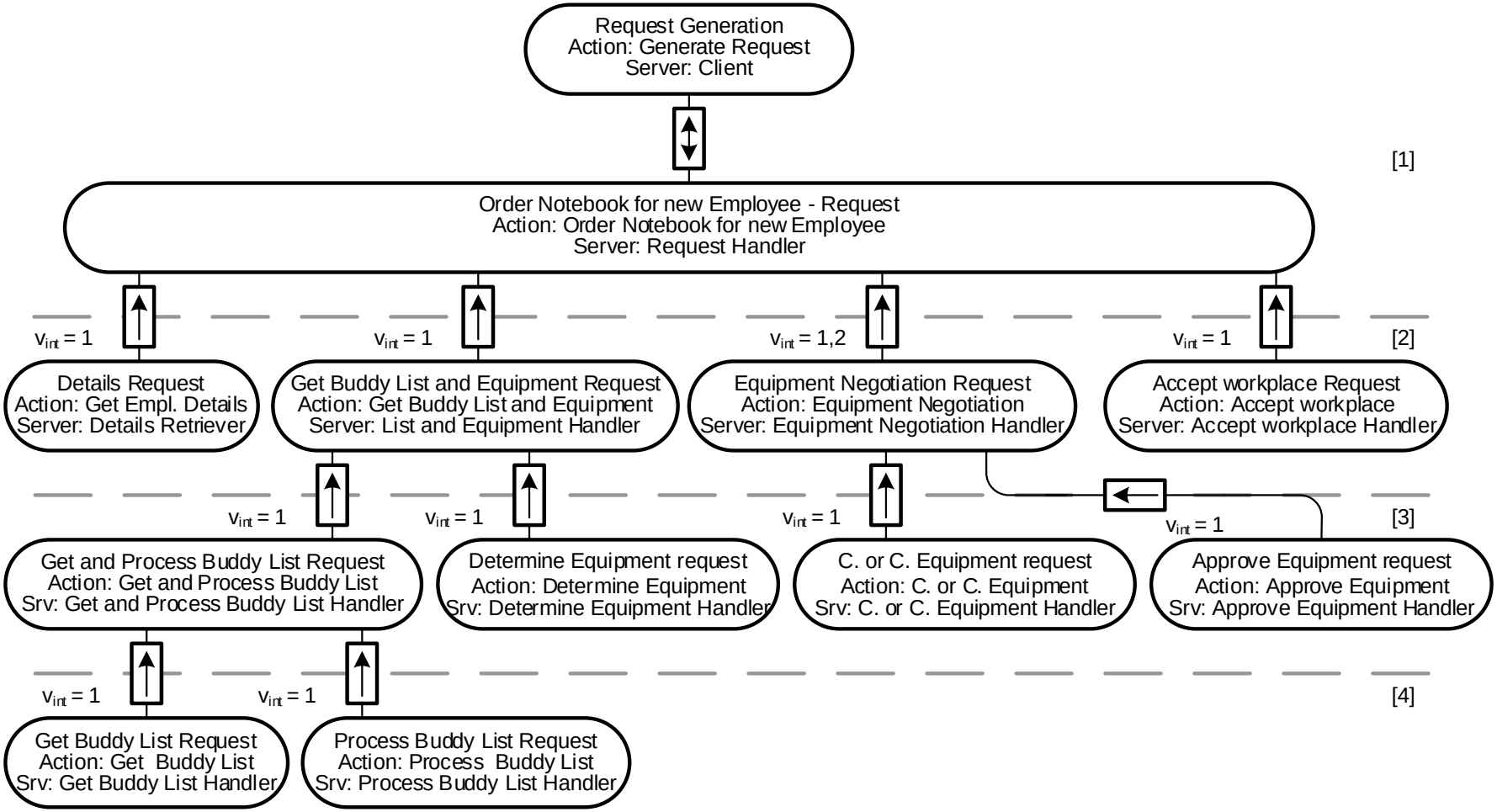
Dynamic Behavior



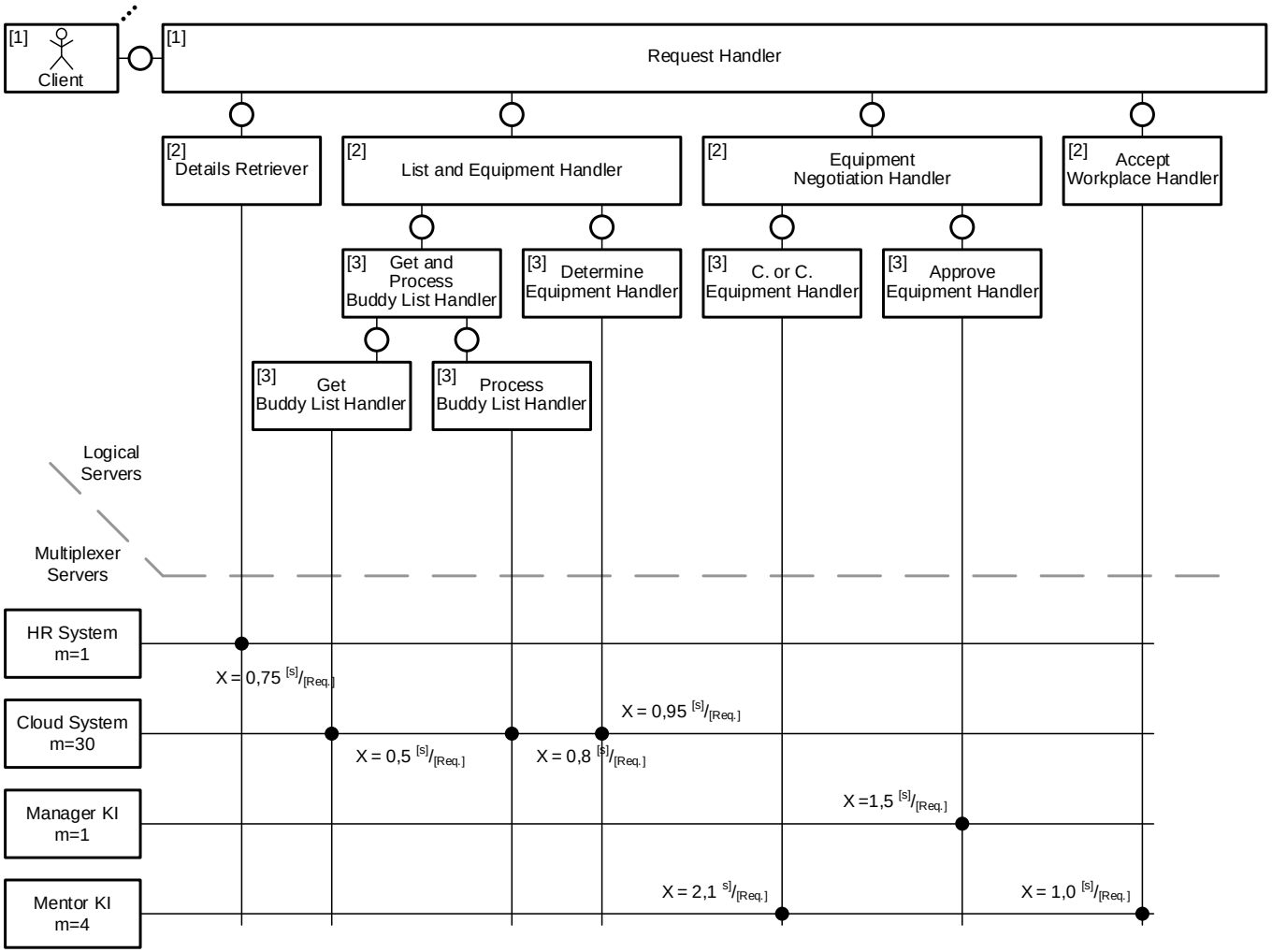
From: T. Steckenborn, “A joint exploration of SAP Cloud Platform Workflow,” SAP, Tech. Rep., 2019.



Service Request Structures



Server Structures

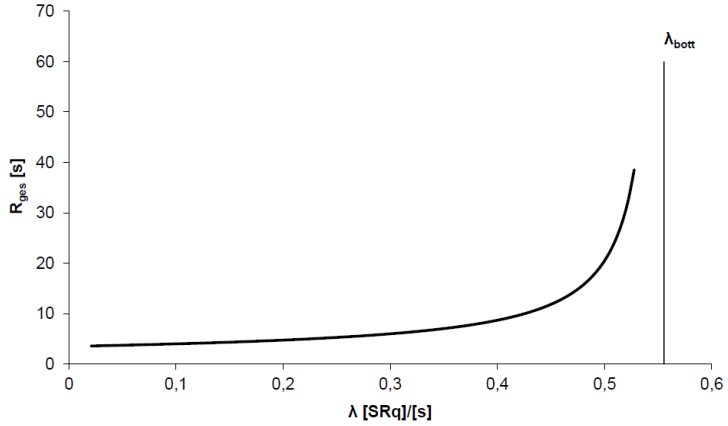


Performance Predictions

Experimental Parameters	
n_{ges}[1]	80
λ_{bott}[1]	0,5556
f	0,9500
λ[1]	0,5278

Service Request Section								Server Section						Dynamic Evaluation Section								
[bb]	i	SRq_i[bb]	$p_{p(i),i}$	$v_{p(i)}$[bb-1]	$v_{i,int}$[bb]	v_i[bb]	λ_i[bb]	$Server_i$[bb]	$m_{p(i)}$[bb-1]	$m_{i,int}$[bb]	m_i[bb]	Mpx_i	X_i[bb]	$m_{i,mpx}$[bb]	μ_i[bb]	ρ_i[bb]	$n_{i,q}$[bb]	W_i[bb]	$n_{i,s}$[bb]	Y_i[bb]	n_i[bb]	R_i[bb]
2	1	Get Employee Details from SuccessFactors	1,00	1,00	1,00	1,00	0,528	Details Retriever	1	1	1	1	0,750	1,000	1,333	0,396	0,259	0,491	0,396	0,750	0,655	1,241
4	2	Get Buddy List from SFSF	1,00	1,00	1,00	1,00	0,528	Get Buddy List Handler	1	1	1	2	0,500	30,000	60,000	0,009	0,000	0,000	0,009	0,017	0,009	0,017
4	3	Process Buddy List	1,00	1,00	1,00	1,00	0,528	Process Buddy List Handler	1	1	1	2	0,800	30,000	37,500	0,014	0,000	0,000	0,014	0,027	0,014	0,027
3	4	Get and Process Buddy List	1,00	1,00	1,00	1,00	0,528	Get and Process Buddy List Handler	1	1	1				37,500		0,000	0,001	0,023	0,043	0,023	0,044
3	5	Determine Equipment	1,00	1,00	1,00	1,00	0,528	Determine Equipment Handler	1	1	1	2	0,950	30,000	31,579	0,017	0,000	0,001	0,017	0,032	0,017	0,032
2	6	Get Buddy List and Equipment	1,00	1,00	1,00	1,00	0,528	List and Equipment Handler	1	1	1				31,579		0,001	0,001	0,040	0,075	0,040	0,076
3	7	Change or Confirm Equipment	1,00	1,20	1,00	1,20	0,633	C. or C. Equipment Handler	1	1	1	4	2,100	4,000	1,905	0,333	0,166	0,262	0,333	0,525	0,498	0,787
3	8	Approve Equipment	1,00	1,20	1,00	1,20	0,633	Approve Equipment Handler	1	1	1	3	1,500	1,000	0,667	0,950	18,050	28,500	0,950	1,500	19,000	30,000
2	5	Equipment Negotiation	1,00	1,00	1,20	1,20	0,633	Equipment Negotiation Handler	1	1	1				0,800		18,216	28,762	1,283	2,025	19,498	30,787
2	6	Accept workplace for new hire	1,00	1,00	1,00	1,00	0,528	Accept Workplace Handler	1	1	1	4	1,000	4,000	4,000	0,132	0,020	0,038	0,132	0,250	0,152	0,288
1	7	Order Notebook for new Employe	1,00	1,00	1,00	1,00	0,528	Request Handler	1	1	1				0,667		18,496	35,044	1,850	3,505	20,345	38,549
1	8	Request Generation	1,00	1,00	1,00	1,00	0,528	Client	1	1	1		113,030		0,009		0,000	0,000	59,655	113,030	59,655	113,030

Multiplexer Section			
j	$Name_j$	m_j	X_j[1]
1	HR System	1	0,750
2	Cloud System	30	1,300
3	Manager KI	1	1,800
4	Mentor KI	4	2,250



Conclusion

- hierarchical modeling and hierarchical performance calculations could derive performance values (response times or queue lengths) for distributed cloud-based systems
- performance predictions could be used to adapt Service-Level-Agreements (SLAs)
- predictions could be integrated into the algorithms of self-adaptive systems, while the hierarchical approach reduces the complexity dramatically
- performance predictions are integrated into a spreadsheet but are not limited to this
- In the future:
  - Further integrate calculations of the FMC-QE Tableau to BPMN
  - More patterns for the hierarchical modeling to transform BPMN Diagrams

References

This presentation is connected to the following publication:

Stephan Kluth:

Performance Predictions for Adaptive Cloud-Based Systems using FMC-QE

The Twelfth International Conference on Adaptive and Self-Adaptive Systems and Applications (ADAPTIVE 2020 – Nice, France, October 2020)

available through ThinkMind digital library

All further references are to be found in this publication.