UNIVERSITÄT
DUISBURG
ESSEN

Verification and Testing at Run-Time for Online Quality Prediction

Andreas Metzger, **Eric Schmieders**, Osama Sammodi, and Klaus Pohl

S-Cube Workshop 2012, Zurich

S-CUBE

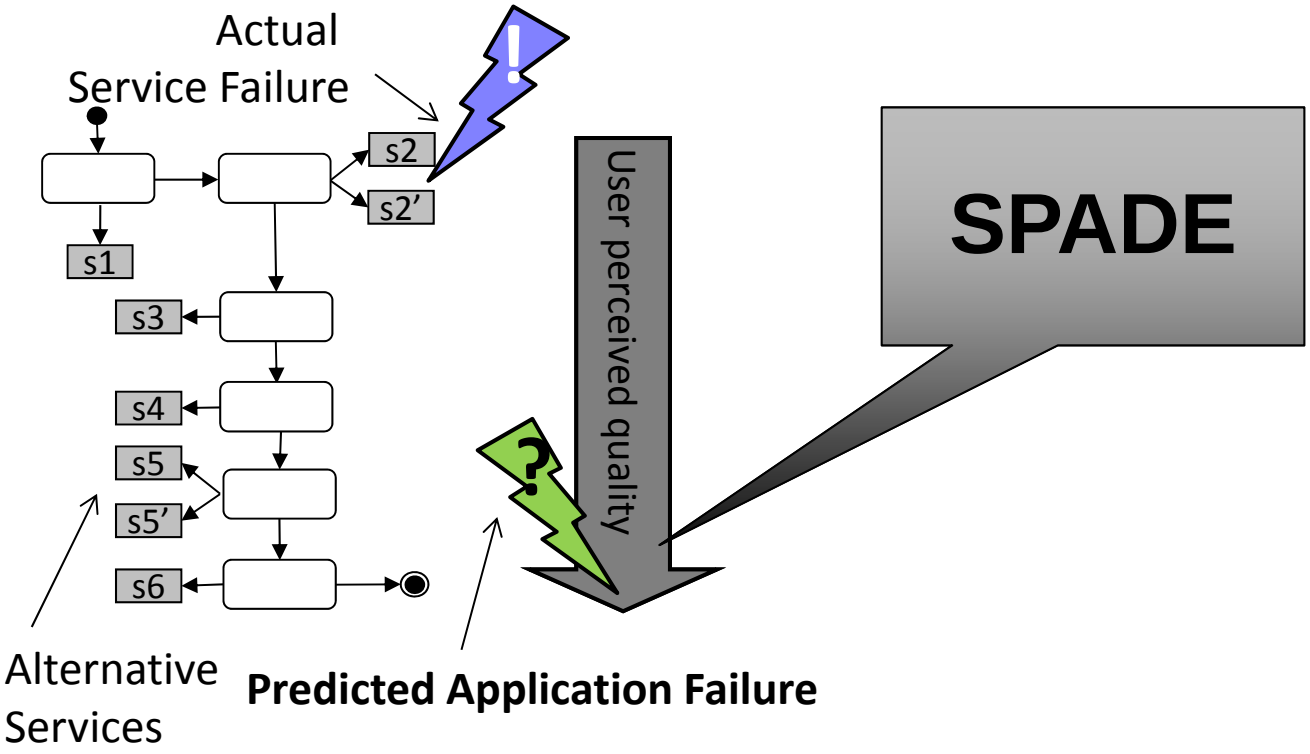
SEVENTH FRAMEWORK PROGRAMME

PALUNO
The Ruhr Institute for Software Technology

- **Motivation**
- **Application Failure Prediction with SPADE**
- **Service Failure Prediction with PROSA**
- **Conclusion & Outlook**

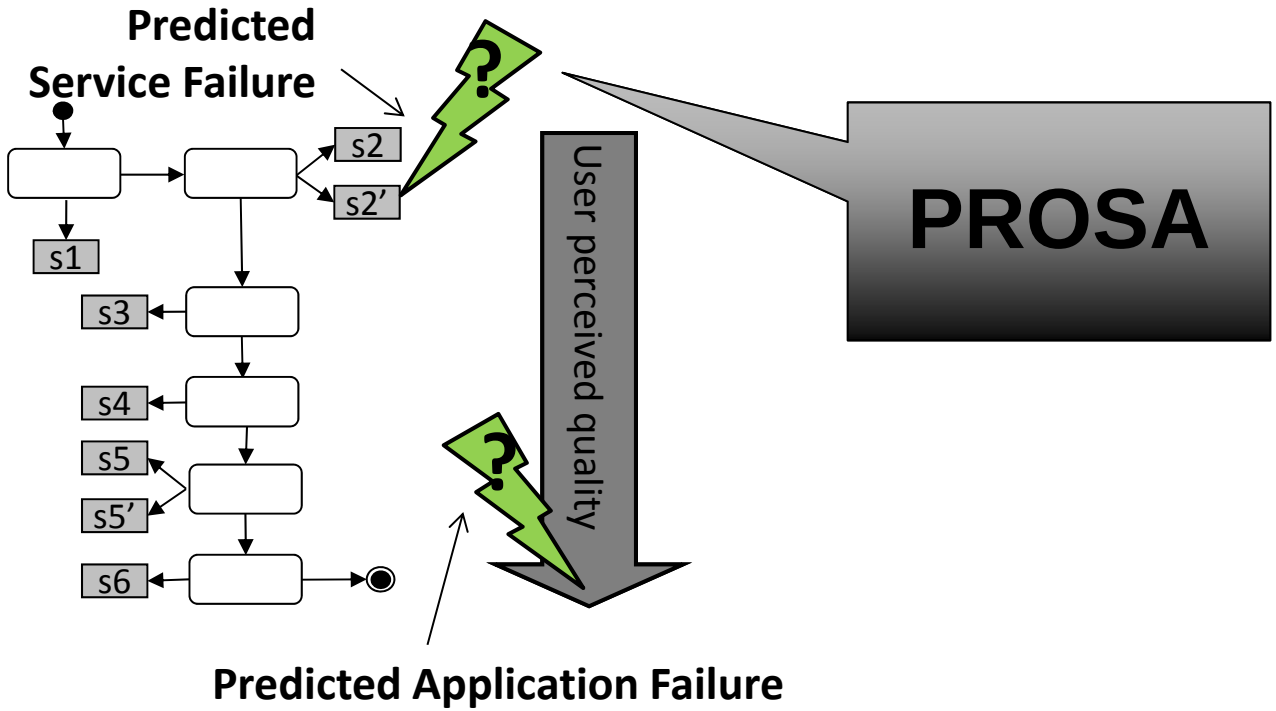
Motivation
Use of Online Quality Prediction

- **Observation 1:** Service failure needs action if (and only if) it may impacts on the expected application quality



Motivation
Use of Online Quality Prediction

- **Observation 2:** Predicting failure of individual service allows avoiding compensation/repair actions



- **Motivation**
- **Application Failure Prediction with SPADE**
- **Service Failure Prediction with PROSA**
- **Conclusion & Outlook**

Application Failure Prediction with SPADE

Related Work

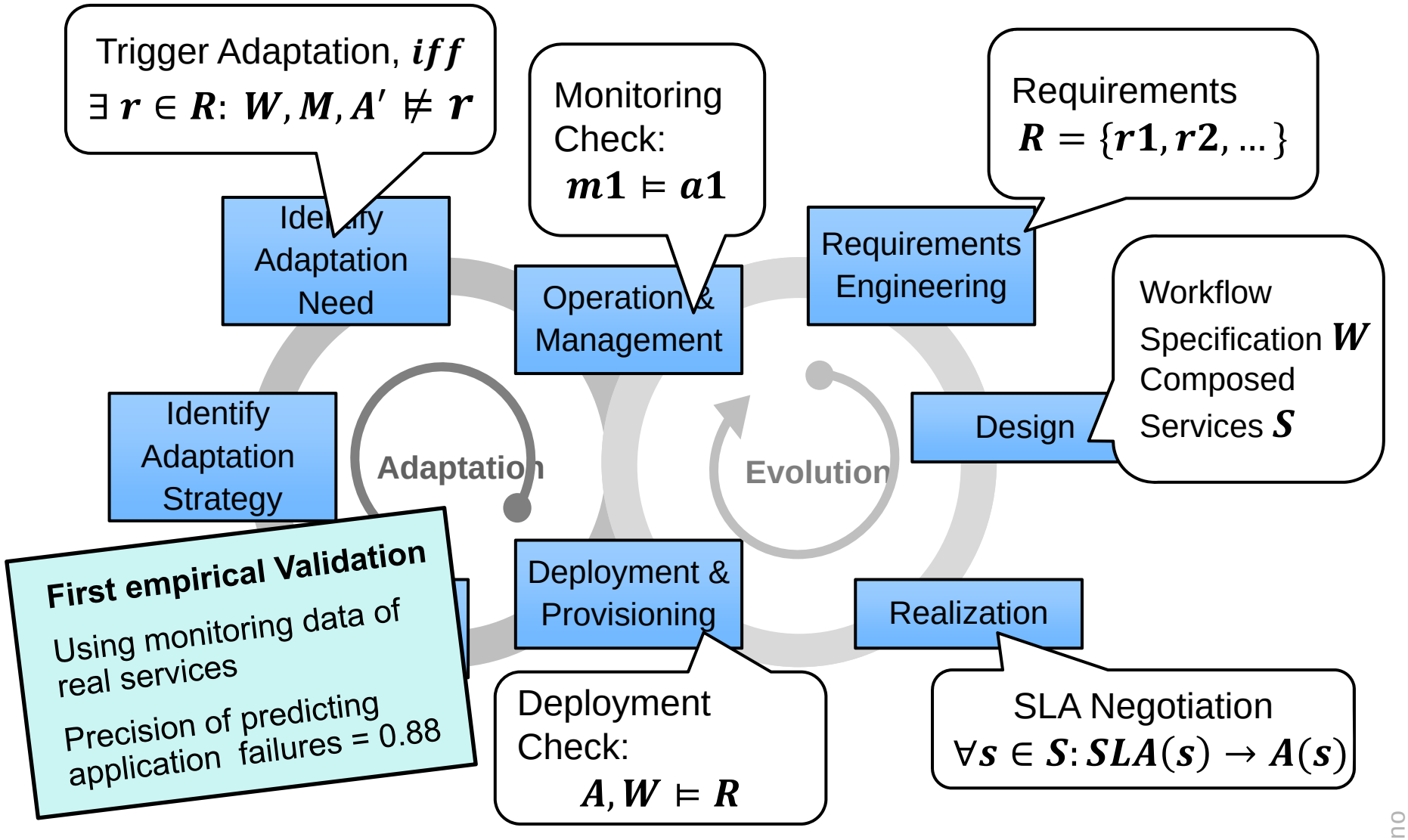
- Avoidance of failures of future instances by adapting the application model [GhezziEtAl2009, KazhamiakinEtAl2009, ZengingEtAl2011]
  - Achieved by e.g. alternating the service composition workflow
  - Focus on the model not on the instance

- Avoidance of instance failures by exploiting Machine Learning [LeitnerEtAl2009, LeitnerEtAl2010, LeitnerEtAl2011, LinEtAl2010]
  - Achieved by e.g. converting fragments, substitute services, etc.
  - Needs a large amount of training data

- Avoidance of instance failures by exploiting QoS-Aggregation and Constraint-Solving Techniques [IvanovicEtAl2011]
  - Allows to reason on the instance in order to reveal free time resources (e.g. used to determine allowed iterations)
  - Doesn't support to check the chronological order of events

Application Failure Prediction with SPADE

Assumption based Runtime Verification



- **Motivation**
- **Application Failure Prediction with SPADE**
- **Service Failure Prediction with PROSA**
- **Conclusion & Outlook**

Service Failure Prediction with PROSA

Related Work

- Online Failure Prediction of Services (c.f., [ShaoEtAl2007, ZhengEtAl2008, ShiEtAl2011])
  - Rely only on QoS data from monitoring

  ➔ Prediction may be challenged by little monitoring data

- Online Testing [PentaEtAl2007, BertonlinoEtAl2010, TsaiEtAl2008, ChanEtAl2007]

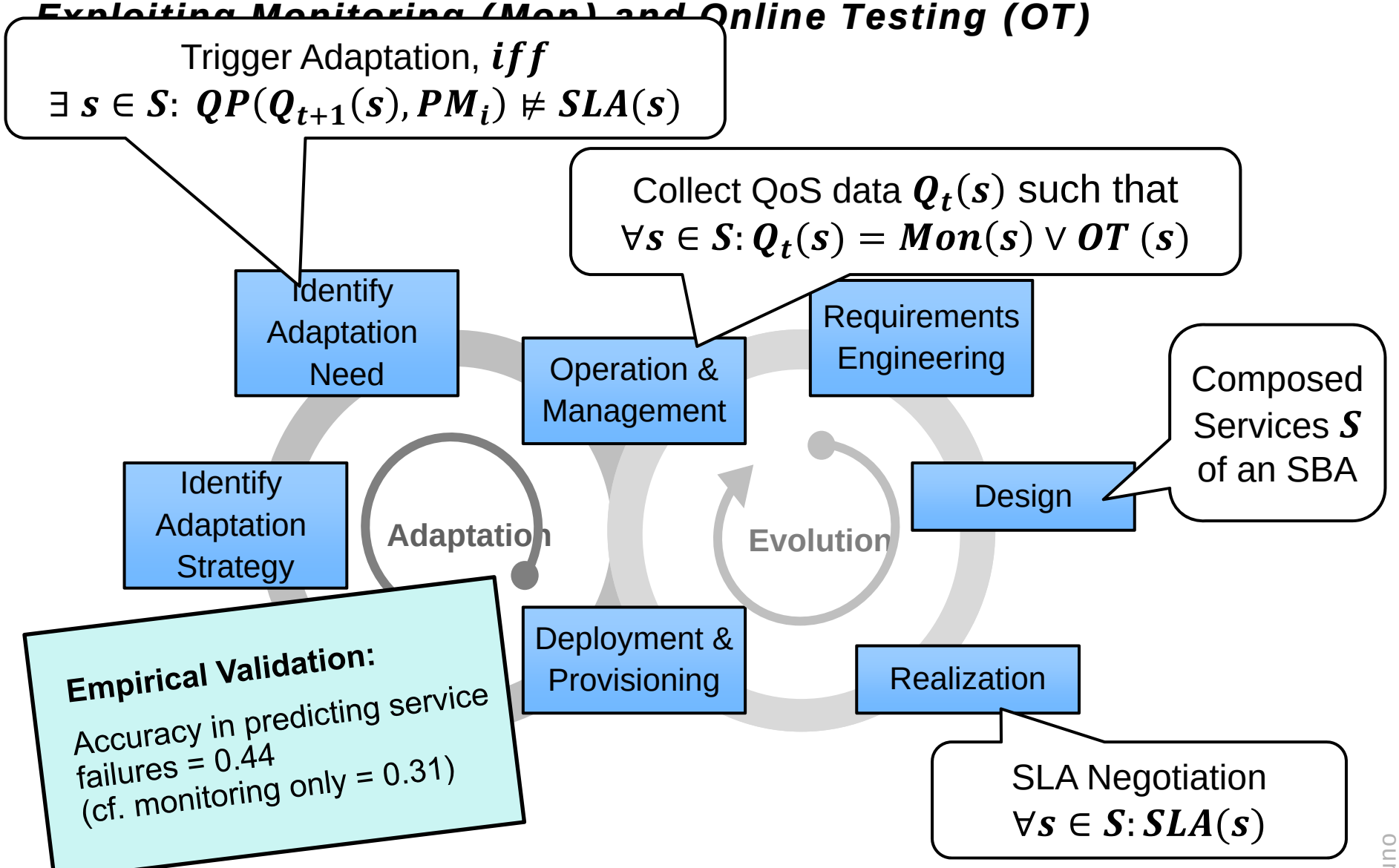
  ➔ Don't exploit online testing for online service failure prediction

- Combined Monitoring and Testing
  - Build usage profiles from monitoring data [ChallagullaEtAl2007]
  - Use monitoring data to define test cases for functional testing [BaiEtAl2008]

  ➔ Don't complement monitoring data with online testing for service failure prediction

Service Failure Prediction with PROSA

Exploiting Monitoring (Mon) and Online Testing (OT)



- Motivation
- Application Failure Prediction with SPADE
- Service Failure Prediction with PROSA
- Conclusion & Outlook

Conclusion and Outlook

- SPADE
  ➔ prediction of **failures of the application**

- PROSA
  ➔ prediction of **service failures**

- PROSPADE
  ➔ **Integrating PROSA and SPADE** to improve **failure prediction**

Thank You!

Further Reading

- Schmieders, E.; Metzger, A.
  Preventing Performance Violations of Service Compositions using Assumption-based Run-time Verification
  ServiceWave, **2011**

- Metzger, A.; Schmieders, E.; Cappiello, C.; Di Nitto, E.; Kazhamiakin, R.; Pernici, B. & Pistore, M.
  Towards Proactive Adaptation: A Journey along the S-Cube Service Life-Cycle
  MESOA: 4th International Workshop on Maintenance and Evolution of Service-Oriented Systems, **2010**

- Sammodi, O.; Metzger, A.; Franch, X.; Oriol, M.; Marco, J. & Pohl, K.
  Usage-Based Online Testing for Proactive Adaptation of Service-Based Applications
  COMPSAC, **2011**, 582-587

Funded by the EU's 7th FP under
Objective 1.2 'SSAI&E'
http://www.s-cube-network.eu/

SEVENTH FRAMEWORK PROGRAMME

S-CUBE

PALUNO
The Ruhr Institute for Software Technology

References

[ShaoEtAl2007] L. Shao and et al., “Personalized qos prediction for web services via collaborative filtering,” in Proc. of 5th ICWS, 2007.

[ZengEtAl2008] L. Zeng and et al., “Event-driven quality of service prediction,” in Proc. of 6th ICSOC, 2008.

[ShiEtAl2011] Y. Shi and et al., “A new qos prediction approach based on user clustering and regression algorithms,” in Proc. of 9th ICWS, 2011.

[BaiEtAl2008] X. Bai and et al., “Ontology-based test modeling and partition testing of web services,” in Proc. of 6th ICWS, 2008.

[Challagulla2007] V. U. B. Challagulla and et al., “A machine learning-based reliability assessment model for critical software systems,” in Proc. of 31st COMPSAC, 2007.

[PentaEtAl2007] D. Penta and et al., “Web Services Regression Testing,” in Test and Analysis of Web Services, L. Baresi and E. Di Nitto, Eds., 2007.

[BertolinoEtAl2012] A. Bertolino and et al., “Enhancing service federation trustworthiness through online testing,” Computer, vol. 45, no. 1, 2012. Service-Oriented Systems (PESOS’10), 2010.

[Tsai2008] W.-T. Tsai and et al., “On testing and evaluating service-oriented software,” Computer, vol. 41, August 2008.

[ChanEtAl2007] W. Chan, S. Cheung, and K. Leung, “A metamorphic testing approach for online testing of service-oriented software applications,” Int’l Journal of Web Services Research, vol. 4, no. 2, 2007.

[DeussenEtAl2001] P. H. Deussen, G. Din, and I. Schieferdecker, “An on-line test platform for component-based systems,” in Proc. 27th Ann. NASA Goddard Software Engineering Workshop (SEW-27’02), 2002.

[ZenginEtAl2011] Zengin, A.; Marconi, A. & Pistore, M., CLAM: cross-layer adaptation manager for service-based applications *Proceedings of the International Workshop on Quality Assurance for Service-Based Applications, ACM,* **2011**, 21-27

[CanforaEtAl200] Canfora, G.; Di Penta, M.; Esposito, R. & Villani, M. L.
A framework for QoS-aware binding and re-binding of composite web services
Journal of Systems and Software, Elsevier Science Inc., **2008**, *81*, 1754-1769

References

[GhezziEtAl2009] Ghezzi, C. & Tamburrelli, G. Tamburrelli, G. (ed.)
Reasoning on Non-Functional Requirements for Integrated Services. RE, Ieee, 2009, 0, 69-78

[KazhamiakinEtAl2009] Kazhamiakin, R.; Wetzstein, B.; Karastoyanova, D.; Pistore, M. & Leymann, F. Adaptation of Service-Based Applications Based on Process Quality Factor Analysis 2009

[LeitnerEtAl2011] Leitner, P.; Hummer, W. & Dustdar, S. Cost-Based Optimization of Service Compositions 2011

[LeitnerEtAl2010a] Leitner, P.; Michlmayr, A.; Rosenberg, F. & Dustdar, S. Monitoring, Prediction and Prevention of SLA Violations in Composite Services ICWS, 2010, 369-376

[LeitnerEtAl2010b] Leitner, P.; Wetzstein, B.; Karastoyanova, D.; Hummer, W.; Dustdar, S. & Leymann, F. Preventing SLA Violations in Service Compositions Using Aspect-Based Fragment Substitution Proceedings of the 8th International Conference on Service Oriented Computing (ICSOC 2010), University of Stuttgart, Faculty of Computer Science, Electrical Engineering, and Information Technology, Germany, Springer Berlin Heidelberg, 2010

[LeitnerEtAl2009] Leitner, P.; Wetzstein, B.; Rosenberg, F.; Michlmayr, A.; Dustdar, S. & Leymann, F.
Runtime Prediction of Service Level Agreement Violations for Composite Services
3rd Workshop on Non-Functional Properties and SLA Management in Service-Oriented Computing, co- located with ICSOC 2009, 2009

[LinEtAl2010] Lin, K.-J.; Zhang, J.; Zhai, Y. & Xu, B. The design and implementation of service process reconfiguration with end-to-end QoS constraints in SOA Serv. Oriented Comput. Appl., Springer-Verlag New York, Inc., 2010, 4, 157-168

[IvanovicEtAl2011] Ivanovic, D.; Carro, M. & Hermenegildo, M., Constraint-Based Runtime Prediction of SLA Violations in Service Orchestrations, QoS-Aggregation, *Service-Oriented Computing -- ICSOC 2011, Springer Verlag,* **2011**