

*Commenced Publication in 1973*

Founding and Former Series Editors:

Gerhard Goos, Juris Hartmanis, and Jan van Leeuwen

## Editorial Board

David Hutchison

*Lancaster University, UK*

Takeo Kanade

*Carnegie Mellon University, Pittsburgh, PA, USA*

Josef Kittler

*University of Surrey, Guildford, UK*

Jon M. Kleinberg

*Cornell University, Ithaca, NY, USA*

Friedemann Mattern

*ETH Zurich, Switzerland*

John C. Mitchell

*Stanford University, CA, USA*

Moni Naor

*Weizmann Institute of Science, Rehovot, Israel*

Oscar Nierstrasz

*University of Bern, Switzerland*

C. Pandu Rangan

*Indian Institute of Technology, Madras, India*

Bernhard Steffen

*University of Dortmund, Germany*

Madhu Sudan

*Massachusetts Institute of Technology, MA, USA*

Demetri Terzopoulos

*New York University, NY, USA*

Doug Tygar

*University of California, Berkeley, CA, USA*

Moshe Y. Vardi

*Rice University, Houston, TX, USA*

Gerhard Weikum

*Max-Planck Institute of Computer Science, Saarbruecken, Germany*

Ralf Reussner Johannes Mayer  
Judith A. Stafford Sven Overhage  
Steffen Becker Patrick J. Schroeder (Eds.)

# Quality of Software Architectures and Software Quality

First International Conference on the  
Quality of Software Architectures, QoSA 2005  
and Second International Workshop on  
Software Quality, SOQUA 2005  
Erfurt, Germany, September 20-22, 2005  
Proceedings



Springer

## Volume Editors

Ralf Reussner

Steffen Becker

University of Oldenburg, Department of Computing Science

Escherweg 2, 26121 Oldenburg, Germany

E-mail: {reussner, becker}@informatik.uni-oldenburg.de

Johannes Mayer

University of Ulm, Department of Applied Information Processing

Helmholtzstr. 18, 89069 Ulm, Germany

E-mail: johannes.mayer@uni-ulm.de

Judith A. Stafford

Tufts University, Department of Computer Science

161 College Avenue, Medford, MA 02155, USA

E-mail: jas@cs.tufts.edu

Sven Overhage

University of Augsburg

Department of Software Engineering and Business Information Systems

Universitätsstr. 16, 86135 Augsburg, Germany

E-mail: sven.overhage@wiwi.uni-augsburg.de

Patrick J. Schroeder

Milwaukee School of Engineering

Department of Electrical Engineering and Computer Science

Milwaukee, WI 53202, USA

E-mail: schroedp@msoe.edu

Library of Congress Control Number: 2005932207

CR Subject Classification (1998): D.2.4, F.3, D.4, C.4, K.4.4, C.2

ISSN 0302-9743

ISBN-10 3-540-29033-8 Springer Berlin Heidelberg New York

ISBN-13 978-3-540-29033-9 Springer Berlin Heidelberg New York

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, re-use of illustrations, recitation, broadcasting, reproduction on microfilms or in any other way, and storage in data banks. Duplication of this publication or parts thereof is permitted only under the provisions of the German Copyright Law of September 9, 1965, in its current version, and permission for use must always be obtained from Springer. Violations are liable to prosecution under the German Copyright Law.

Springer is a part of Springer Science+Business Media

springeronline.com

© Springer-Verlag Berlin Heidelberg 2005

Printed in Germany

Typesetting: Camera-ready by author, data conversion by Scientific Publishing Services, Chennai, India

Printed on acid-free paper SPIN: 11558569 06/3142 5 4 3 2 1 0

# Preface

The goal of software engineering is to achieve high-quality software in a cost-effective, timely, and reproducible manner. Advances in technology offer reductions in cost and schedule, but their effect on software quality often remains unknown. The International Conference on the Quality of Software Architectures (QoSA 2005) focused on software architectures and their relation to software quality, while the International Workshop on Software Quality (SOQUA 2005) mainly focused on quality assurance and more precisely on software testing. These events complement each other in their view on software quality.

One of the main motivations for explicitly modelling software architectures is to enable reasoning on software quality. From a software engineering perspective, a software architecture not only depicts the coarse-grained structure of a program, but also includes additional information such as the program's dynamics (i.e., the flows of control through the system) and the mapping of its components and connections to execution environments (such as hardware processors, virtual machines, network connections, and the like). In this area, QoSA 2005 is concerned with research and experiences that investigate the influence a specific software architecture has on software quality aspects. Additionally, the development of methods to evaluate software architectures with respect to these quality attributes is considered to be an important topic. The quality attributes of interest include external properties, such as reliability and efficiency, as well as internal properties, such as maintainability.

From a business-oriented perspective, software architectures are most often embedded into a greater organizational context (e.g., large enterprises) and cannot be seen in isolation from that context. Requirements that emerge from this context have a major impact on the architecture being developed and have to be dealt with by means of a business-oriented management of software architectures. In this field, QoSA 2005 aims at investigating the impact that activities like the coordination of business architecture and software architecture, business process modelling, assessment and acquisition of (COTS) components, as well as the integration or migration of legacy systems have on the quality of software architectures.

Although it is well-known that software architectures heavily influence software quality, validated research in this area is only recent. Today, even reliable experience reports that go beyond anecdotes from practitioner are rare. For a long time, the software architecture community was mainly concerned with formal specification of architectures. The use of architectures beyond the specification has only lately been taken into consideration by different communities that are producing results on the prediction of various quality attributes, software architecture evaluation, cost estimation, architectural re-use through patterns, etc. By recognizing the intrinsic relationship between the mentioned areas which share an architecture-based approach, the main idea of QoSA 2005 was to bring together researchers and practitioner from these different communities concerned with all areas relating to software architecture quality.

Quality assurance plays an important role in today's world and has gained increased importance. SOQUA 2005, which was organized within the Net.ObjectDays and co-located with QoSA 2005, mainly concentrated on this topic. Object-oriented concepts, component technology, components off the shelf (COTS), and open source software can dramatically reduce development time; however, assuring the quality of systems using these technologies is problematic.

The job of measuring, assuring, and improving the quality of software systems is getting harder with new technologies, not easier. The goal of this workshop was to bring together researchers, engineers, and practitioners to discuss and evaluate the latest challenges and breakthroughs in the field of software quality. The main focus of the workshop was on software quality assurance and more specifically on software testing. The generation of test data is still one of the most prominent problems in this area. Therefore, a number of papers presented and published are dedicated to this important problem.

In line with a broad interest, QoSA 2005 received 32 submissions. From these submissions, 12 were accepted as long papers after a peer-review process. They are published in this volume, together with an extended abstract of the invited talk by Christine Hofmeister. Five additional submissions were considered as original new research, but without having such an elaborated validation as the accepted, more mature long papers. These papers were accepted as posters and were published as short papers in the general Net.ObjectDays 2005 proceedings. Having received this high attraction encourages us to continue with shaping a community that is focused on software architecture quality and establishing QoSA as their primary conference in the future.

SOQUA 2005 attracted 17 submissions from all over the world. In total 6 papers could be accepted as long papers after a peer-review process. These papers are published in this volume, together with an extended abstract on the invited talk by T.Y. Chen. Three additional papers were accepted as short papers, which were published in the Net.ObjectDays proceedings and presented within a special joint session with the Net.ObjectDays Developer Track.

Among the many people who contributed to the success of QoSA 2005 and SOQUA 2005, we would like to thank the members of the Program Committees for their valuable work during the review process, Ch. Hofmeister for her keynote at QoSA 2005, and T.Y. Chen for his invited talk at SOQUA 2005. Additionally, we thank the organizers of the Net.ObjectDays 2005, in particular Mrs. Paradies, for their support in all organizational concerns as well as Mr. Hofmann from Springer for his support in reviewing and publishing the proceedings volume. The QoSA organizers would also like to thank the cooperating partners for their support. The SOQUA organizers are grateful to their cooperating and supporting organizations and in particular to Julia Codrington, Wolfgang Grieskamp, Chani Johnson, and Mario Winter for their support.

July 2005

Ralf Reussner  
Johannes Mayer  
Judith Stafford  
Sven Overhage  
Steffen Becker  
Patrick J. Schroeder

# Organization

## QoSA 2005

### Organizers and Program Chairs

Ralf Reussner, University of Oldenburg, Germany  
Judith Stafford, Tufts University, USA  
Sven Overhage, Augsburg University, Germany  
Steffen Becker, University of Oldenburg, Germany

### Program Committee

Colin Atkinson, University of Mannheim, Germany  
Antonia Bertolino, ISTI-CNR, Italy  
Alexander Brändle, Microsoft Research, UK  
Christian Bunse, Fraunhofer IESE, Germany  
Michel Chaudron, Eindhoven University of Technology, Netherlands  
Ivica Crnkovic, Mälardalen University, Sweden  
Peter Dadam, University of Ulm, Germany  
Viktoria Firus, University of Oldenburg, Germany  
Ulrich Frank, University of Duisburg-Essen, Germany  
Kurt Geihs, University of Kassel, Germany  
Ian Gorton, NICTA, Australia  
Volker Gruhn, University of Leipzig, Germany  
Wilhelm Hasselbring, University of Oldenburg, Germany  
Jean-Marc Jézéquel, IRISA (Univ. Rennes & INRIA), France  
Stefan Kirn, University of Hohenheim, Germany  
Juliana Küster-Filipe, University of Birmingham, UK  
Raffaella Mirandola, Università Roma “Tor Vergata”, Italy  
Jürgen Münch, Fraunhofer IESE, Germany  
Dietmar Pfahl, Fraunhofer IESE, Germany  
Frantisek Plasil, Charles University, Czech Republic  
Iman Poernomo, King’s College London, UK  
Andreas Rausch, University of Technology Kaiserslautern, Germany  
Matthias Riebisch, Technical University Ilmenau, Germany  
Bernhard Rumpe, University of Technology Braunschweig, Germany  
Christian Salzmann, BMW Car IT, Germany  
Heinz Schmidt, Monash University, Australia  
Jean-Guy Schneider, Swinburne University of Technology, Australia  
Johannes Siedersleben, sd&m AG, Germany  
Elmar Sinz, University of Bamberg, Germany  
Michael Stal, Siemens AG, Germany  
Clemens Szyperski, Microsoft Research, USA

Kurt Wallnau, Software Engineering Institute, USA  
Wolfgang Weck, Independent Software Architect, Switzerland

### **Co-reviewers**

Guglielmo De Angelis, Università di Roma, Italy  
Samir Amiry, Fraunhofer IESE, Germany  
Reinder Bril, Eindhoven University of Technology, Netherlands  
Yunja Choi, Fraunhofer IESE, Germany  
Aleksandar Dimov, Mälardalen University, Sweden  
Simon Giesecke, University of Oldenburg, Germany  
Vincenzo Grassi, Università di Roma, Italy  
Jens Happe, University of Oldenburg, Germany  
Rikard Land, Mälardalen University, Sweden  
Moreno Marzolla, Università di Venezia, Italy  
Johan Muskens, Eindhoven University of Technology, Netherlands  
Sasikumar Punnekkat, Mälardalen University, Sweden  
Daniel Schneider, Fraunhofer IESE, Germany  
Massimo Tivoli, Mälardalen University, Sweden  
Johan Fredriksson, Mälardalen University, Sweden  
Erik de Vink, Eindhoven University of Technology, Netherlands  
Timo Warns, University of Oldenburg, Germany

### **Cooperating and Supporting Partners**

Augsburg University, Germany  
Carnegie Mellon University/Software Engineering Institute (SEI), Pittsburgh, USA  
Fraunhofer IESE, Kaiserslautern, Germany  
German Computer Science Society (GI e.V.), GI AKSoftArch, Germany  
Microsoft Research, Cambridge, UK  
OFFIS, Oldenburg, Germany  
Oversoft Software, Frankfurt, Germany  
sd&m, Munich, Germany  
Tufts University, Boston, USA  
University of Oldenburg, Germany

## **SOQUA 2005**

### **Organizer**

Johannes Mayer, University of Ulm, Germany

### **Program Chairs**

Johannes Mayer, University of Ulm, Germany  
Patrick J. Schroeder, Milwaukee School of Engineering, USA

**Program Committee**

Paul Ammann, George Mason University, USA  
Arnaldo Dias Belchior, Universidade de Fortaleza, Brazil  
Giovanni Denaro, University of Milano-Bicocca, Italy  
Hans-Dieter Ehrich, Technical University of Braunschweig, Germany  
Ricardo de Almeida Falbo, Universidade Federal do Espírito Santo, Brazil  
Marie-Claude Gaudel, Université Paris Sud, France  
Wolfgang Grieskamp, Microsoft Research, USA  
Neelam Gupta, University of Arizona, USA  
Dick Hamlet, Portland State University, USA  
Thomas A. Henzinger, EPFL, Switzerland  
Pankaj Jalote, Indian Institute of Technology Kanpur, India  
Bingchiang Jeng, New York University, Taiwan  
Yves Ledru, LSR/IMAG, France  
Henrique Madeira, University of Coimbra, Portugal  
Christine Mingins, Monash University, Australia  
Oscar Pastor, Valencia University of Technology, Spain  
Mauro Pezzè, University of Milano-Bicocca, Italy  
Mario Piattini, University of Castilla-La Mancha, Spain  
Marc Roper, University of Strathclyde, Glasgow, UK  
David S. Rosenblum, University College London, UK  
Franz Schweiggert, University of Ulm, Germany  
Jan Tretmans, Radboud University Nijmegen, Netherlands  
Marcello Visconti, Universidad Tecnica Federico Santa Maria, Chile  
Mario Winter, University of Applied Sciences Cologne, Germany  
Bernard Wong, University of Technology Sydney, Australia  
Jianjun Zhao, Fukuoka Institute of Technology, Japan

**Co-reviewers**

Lars Frantzen, Radboud University Nijmegen, Netherlands  
Nikolai Tillmann, Microsoft Research, USA  
Davide Tosi, University of Milano-Bicocca, Italy  
Frédéric Voisin, Université Paris Sud, France  
Tim Willemse, Radboud University Nijmegen, Netherlands

**Cooperating and Supporting Partners**

ACM SIGSOFT, USA  
German Computer Society (GI e.V.), SIG TAV, Germany  
Microsoft Research, Redmond, USA  
Milwaukee School of Engineering, USA  
University of Ulm, Germany



# Table of Contents

---

## Keynotes

---

Reexamining the Role of Interactions in Software Architecture <i>Christine Hofmeister</i> .....	1
Are Successful Test Cases Useless or Not? <i>T.Y. Chen</i> .....	2

---

## QoSA Long Papers

---

### Software Architecture Evaluation

DoSAM – Domain-Specific Software Architecture Comparison Model <i>Klaus Bergner, Andreas Rausch, Marc Sihling, Thomas Ternité</i> .....	4
An Architecture-Centric Approach for Producing Quality Systems <i>Antonia Bertolino, Antonio Bucchiarone, Stefania Gnesi, Henry Muccini</i> .....	21

### Formal Approaches to Model-Driven QoS-Handling

A Model-Oriented Framework for Runtime Monitoring of Nonfunctional Properties <i>Kenneth Chan, Iman Poernomo, Heinz Schmidt, Jane Jayaputera</i> . . . .	38
Predicting Mean Service Execution Times of Software Components Based on Markov Models <i>Jens Happe</i> .....	53

### Modelling QoS in Software Architectures

An XML-Based Language to Support Performance and Reliability Modeling and Analysis in Software Architectures <i>Vincenzo Grassi, Raffaella Mirandola, Antonino Sabetta</i> .....	71
Formal Definition of Metrics Upon the CORBA Component Model <i>Miguel Goulão, Fernando Brito e Abreu</i> .....	88

## Software Architectures Applied

The Architect's Dilemma – Will Reference Architectures Help? <i>Martin Haft, Bernhard Humm, Johannes Siedersleben</i> .....	106
Architectural Reuse in Software Systems In-house Integration and Merge – Experiences from Industry <i>Rikard Land, Ivica Crnković, Stig Larsson, Laurens Blankers</i> .....	123

## Architectural Design for QoS

Supporting Security Sensitive Architecture Design <i>Muhammad Ali Babar, Xiaowen Wang, Ian Gorton</i> .....	140
Exploring Quality Attributes Using Architectural Prototyping <i>Jakob Eyvind Bardram, Henrik Bærbak Christensen, Aino Vonge Corry, Klaus Marius Hansen, Mads Ingstrup</i> .....	155

## Model-Driven Software Quality Estimation

On the Estimation of Software Reliability of Component-Based Dependable Distributed Systems <i>Aleksandar Dimov, Sasikumar Punnekkat</i> .....	171
Empirical Evaluation of Model-Based Performance Prediction Methods in Software Development <i>Heiko Koziulek, Viktoria Firus</i> .....	188

---

## SOQUA Long Papers

---

### Test Case Selection

Automatic Test Generation for N-Way Combinatorial Testing <i>Changhai Nie, Baowen Xu, Liang Shi, Guowei Dong</i> .....	203
Automated Generation and Evaluation of Dataflow-Based Test Data for Object-Oriented Software <i>Norbert Oster</i> .....	212

## Model-Based Testing

Automated Model-Based Testing of $\chi$ Simulation Models with TorX <i>Michiel van Osch</i> .....	227
--	-----

## Unit Testing

Jartege: A Tool for Random Generation of Unit Tests for Java Classes <i>Catherine Oriat</i> .....	242
FlexTest: An Aspect-Oriented Framework for Unit Testing <i>Dehla Sokenou, Matthias Vösgen</i> .....	257

## Performance Testing

Quality Assurance in Performance: Evaluating Mono Benchmark Results <i>Tomas Kalibera, Lubomir Bulej, Petr Tuma</i> .....	271
<b>Author Index</b> .....	289