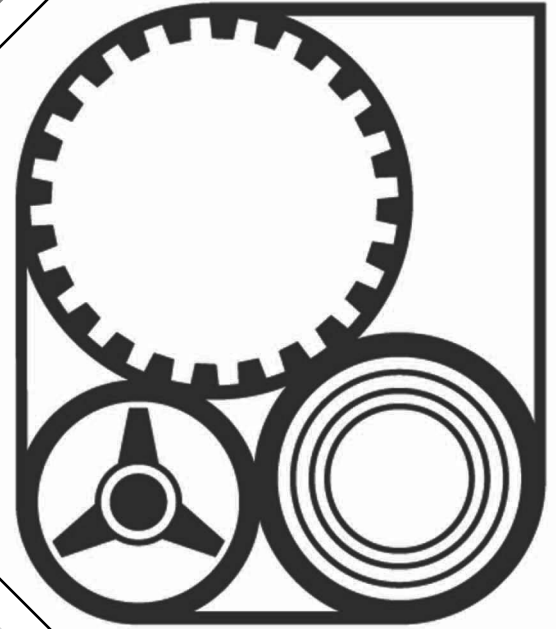


May 23-24, 2011  
Waikiki, Honolulu, HI, USA



Association for  
Computing Machinery

*Advancing Computing as a Science & Profession*



# SEAMS'11

Proceedings of the 6th International Symposium on  
**Software Engineering for Adaptive  
and Self-Managing Systems**

*Sponsored by:*

**ACM SIGSOFT & IEEE CS**

*Co-located with:*

**ICSE 2011**

**Sixth International Symposium  
on  
Software Engineering for  
Adaptive and Self-Managing  
Systems  
(SEAMS 2011)**

**Proceedings**

Holger Giese and Betty H.C. Cheng

May 23–24, 2011  
Waikiki, Honolulu, HI, USA

The Association for Computing Machinery, Inc.  
2 Penn Plaza, Suite 701  
New York, NY 10121-0701

Copyright © 2011 by the Association for Computing Machinery, Inc (ACM). Permission to make digital or hard copies of portions of this work for personal or classroom use is granted without fee provided that the copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than ACM must be honored. Abstracting with credit is permitted.

To copy otherwise, to republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permission to republish from: Publications Dept. ACM, Inc.  
Fax +1-212-869-0481 or E-mail [permissions@acm.org](mailto:permissions@acm.org).

For other copying of articles that carry a code at the bottom of the first or last page, copying is permitted provided that the per-copy fee indicated in the code is paid through the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923.

**Notice to Past Authors of ACM-Published Articles**

ACM intends to create a complete electronic archive of all articles and/or other material previously published by ACM. If you have written a work that was previously published by ACM in any journal or conference proceedings prior to 1978, or any SIG Newsletter at any time, and you do NOT want this work to appear in the ACM Digital Library, please inform [permissions@acm.org](mailto:permissions@acm.org), stating the title of the work, the author(s), and where and when published.

ACM ISBN: 978-1-4503-0575-4

Additional copies may be ordered prepaid from:

ACM Order Department	Phone: 1-800-342-6626
P.O. BOX 11405	(U.S.A. and Canada)
Church Street Station	+1-212-626-0500
New York, NY 10286-1405	(All other countries)
	Fax: +1-212-944-1318
	E-mail: <a href="mailto:acmhelp@acm.org">acmhelp@acm.org</a>

**Production:** Conference Publishing Solutions, D-94034 Passau, Germany, [info@conference-publishing.com](mailto:info@conference-publishing.com)

# Welcome to SEAMS-2011

Aloha and Welcome to Hawaii and SEAMS-2011, the *6<sup>th</sup> International Symposium on Software Engineering for Adaptive and Self-Managing Systems*, an ICSE co-located event.

An increasingly important requirement for a software-based system is the ability to self-manage by adapting itself at run time to handle changing user needs, system intrusions or faults, a changing operational environment, and resource variability. Such a system must configure and reconfigure itself, augment its functionality, continually optimize itself, protect itself, and recover itself, while keeping its complexity hidden from the user.

The topic of self-adaptive and self-managing systems has been studied in a large number of specific areas, including software architectures, fault-tolerant computing, robotics, control systems, programming languages, and biologically-inspired computing.

The objective of this symposium is to bring together researchers and practitioners from many of these diverse areas to engage in stimulating dialogue regarding the fundamental principles, state of the art, and critical challenges of self-adaptive systems. Specifically, the symposium focuses on the software engineering aspects, including the methods, architectures, algorithms, techniques, and tools that can be used to support dynamic adaptive behavior that includes self-adaptive, self-managing, self-healing, self-optimizing, and self-configuring, and autonomic software.

While this year is the first for SEAMS as a symposium, the SEAMS community has been steadily growing for the past 6 years, originally starting as an ICSE Workshop. It is particularly noteworthy that SEAMS has continued to attract and retain researchers and practitioners from a variety of adaptive systems-related areas, including interesting application areas that pose wonderful research challenges for the community. We received 77 submissions, where 21 full papers and 5 position papers were accepted for inclusion in the symposium. Each paper was reviewed by at least 3 program committee members. In short, the quality of the submissions was quite high, with a tough selection process, all of which have yielded a high-quality program.

This year we have a program that illustrates on the one hand, the maturity of the field with sessions on programming language, modeling, and framework support for the development of adaptive systems, while on the other hand, we are clearly making significant advances in techniques that provide true run-time support for adaptive activities, such as monitoring, automatic reconfiguration, and service composition. We also have a great collection of position papers that describe exciting and promising work for the adaptive systems area.

As adaptive systems become more prevalent, particularly in high-assurance applications, the need for explicitly addressing assurance in adaptive systems becomes paramount. It has become clear that many of the traditional software engineering techniques cannot be directly applied to adaptive systems due to the added level of complexity posed by the run-time requirements. As such, this year, we have a special focus on Assurance for Adaptive Systems. We launch this focus with a keynote by Professor Carlo Ghezzi (Politecnico di Milano) who will share his work and vision in this area. We follow it by a paper session comprising several papers that describe assurance techniques ranging from testing to model-driven techniques. Finally, Professor David Garlan (Carnegie Mellon University) will moderate a session comprising several researchers working on assurance for adaptive systems who will provide insight to the research challenges in this area and a preview of promising future directions.

We are extremely grateful for the efforts from numerous people who have helped to make the SEAMS debut as a symposium a huge success. First, we acknowledge the significant effort on the part of the members of the program committee who spent countless hours to review all of the papers and participated in numerous discussions. Second, we greatly appreciate Debi Brodbeck for all her patience in answering all of our questions regarding the logistics of organizing SEAMS as a symposium, a co-located ICSE event. Richard van Stadt, as always, has been wonderful in managing CyberChair and dealing with all the details associated with paper submissions, communication with authors, etc. Dirk Beyer has been very helpful in arranging the publication details for the proceedings. One of the key reasons for the large number of high quality submissions is due to the valiant and tireless publicity efforts by the Publicity Co-Chairs, Thomas Vogel and Basil Becker. Rogerio de Lemos, as the chair of the SEAMS Steering Committee, has been the ever-present force that has helped us to stay on track with so many details with organizing SEAMS. Finally, we thank all the authors who submitted papers and the participants for their contributions to the SEAMS-2011 Symposium.

Mahalo and Aloha

Betty H.C. Cheng and Holger Giese  
SEAMS Program Chair and General Chair

# Contents

## Preface

Foreword . . . . .	v
--------------------	---

## Applications

Application of Software Health Management Techniques Nagabhushan Mahadevan, Abhishek Dubey, and Gabor Karsai — <i>Vanderbilt University, USA</i> . . . . .	1
Dynamic Updating of Online Recommender Systems via Feed-Forward Controllers Valentina Zanardi and Licia Capra — <i>University College London, UK</i> . . . . .	11
Runtime Models for Automatic Reorganization of Multi-Robot Systems Christopher Zhong and Scott A. DeLoach — <i>Kansas State University, USA</i> . . . . .	20

## Modeling and Languages

Adapt Cases: Extending Use Cases for Adaptive Systems Markus Luckey, Benjamin Nagel, Christian Gerth, and Gregor Engels — <i>University of Paderborn, Germany</i> . . . . .	30
gocc: A Configuration Compiler for Self-adaptive Systems Using Goal-oriented Requirements Description Hiroyuki Nakagawa, Akihiko Ohsuga, and Shinichi Honiden — <i>The University of Electro-Communications, Japan; National Institute of Informatics, Japan</i> . . . . .	40
An Evaluation of the Adaptation Capabilities in Programming Languages Carlo Ghezzi, Matteo Pradella, and Guido Salvaneschi — <i>Politecnico di Milano, Italy</i> . . . . .	50

## Monitoring and Evaluation

Awareness Requirements for Adaptive Systems Vitor E. Silva Souza, Alexei Lapouchnian, William N. Robinson, and John Mylopoulos — <i>University of Trento, Italy; University of Toronto, Canada; Georgia State University, USA</i> . . . . .	60
Characterizing Problems for Realizing Policies in Self-Adaptive and Self-Managing Systems Sowmya Balasubramanian, Ron Desmarais, Hausi A. Müller, Ulrike Stege, and S. Venkatesh — <i>University of Victoria, Canada</i> . . . . .	70
A Framework for Evaluating Quality-Driven Self-Adaptive Software Systems Norha M. Villegas, Hausi A. Müller, Gabriel Tamura, Laurence Duchien, and Rubby Casallas — <i>University of Victoria, Canada; INRIA Lille, France; University of Los Andes, Colombia</i> . . . . .	80
Model-based Self-Adaptive Resource Allocation in Virtualized Environments Nikolaus Huber, Fabian Brosig, and Samuel Kounev — <i>Karlsruhe Institute of Technology, Germany</i> . . . . .	90

## Run-time Support

FlashMob: Distributed Adaptive Self-Assembly Daniel Sykes, Jeff Magee, and Jeff Kramer — <i>Imperial College London, UK</i> . . . . .	100
Supporting Service Composition and Real-Time Execution through Characterization of QoS Properties Marisol García-Valls, Pablo Basanta-Val, and Iria Estévez-Ayes — <i>Universidad Carlos III de Madrid, Spain</i> . . . . .	110
On the Performance of UML State Machine Interpretation at Runtime Edzard Hoefig, Peter H. Deussen, and Ina Schieferdecker — <i>Fraunhofer FOKUS, Germany; TU Berlin, Germany</i> . . . . .	118

<b>GRAF: Graph-based Runtime Adaptation Framework</b>	
Mahdi Derakhshanmanesh, Mehdi Amoui, Greg O’Grady, Jürgen Ebert, and Ladan Tahvildari — <i>University of Koblenz-Landau, Germany; University of Waterloo, Canada</i> . . . . .	128
<b>Assurance</b>	
<b>Pairwise Testing of Dynamic Composite Services</b>	
Ajay Kattapur, Sagar Sen, Benoit Baudry, Albert Benveniste, and Claude Jard — <i>IRISA, France; INRIA Rennes, France; INRIA Sophia Antipolis, France; ENS Cachan, France</i> . . . . .	138
<b>Dynamic Plans for Integration Testing of Self-adaptive Software Systems</b>	
Carlos Eduardo da Silva and Rogério de Lemos — <i>University of Kent, UK</i> . . . . .	148
<b>A CSP-based Framework for the Specification, Verification, and Implementation of Adaptive Systems</b>	
Björn Bartels and Moritz Kleine — <i>TU Berlin, Germany</i> . . . . .	158
<b>A Model-Driven Approach to Develop Adaptive Firmwares</b>	
Franck Fleurey, Brice Morin, and Arnor Solberg — <i>SINTEF, Norway</i> . . . . .	168
<b>Position Papers</b>	
<b>Elastic Executions from Inelastic Programs</b>	
Iulian Neamtiu — <i>UC Riverside, USA</i> . . . . .	178
<b>A Model-Driven Framework for Runtime Adaptation of Web Service Compositions</b>	
Georg Grossmann, Michael Schrefl, and Markus Stumptner — <i>University of South Australia, Australia</i> . . . . .	184
<b>Benchmarking the Resilience of Self-Adaptive Software Systems: Perspectives and Challenges</b>	
Raquel Almeida and Marco Vieira — <i>University of Coimbra, Portugal</i> . . . . .	190
<b>Approaching Runtime Trust Assurance in Open Adaptive Systems</b>	
Daniel Schneider, Martin Becker, and Mario Trapp — <i>Fraunhofer IESE, Germany</i> . . . . .	196
<b>On Interacting Control Loops in Self-Adaptive Systems</b>	
Pieter Vromant, Danny Weyns, Sam Malek, and Jesper Andersson — <i>Katholieke Universiteit Leuven, Belgium; George Mason University, USA; Linnaeus University, Sweden</i> . . . . .	202
<b>Frameworks</b>	
<b>A Self-Adaptive Deployment Framework for Service-Oriented Systems</b>	
Sander van der Burg and Eelco Dolstra — <i>Delft University of Technology, Netherlands</i> . . . . .	208
<b>A Multi-model Framework to Implement Self-managing Control Systems for QoS Management</b>	
Tharindu Patikirikorala, Alan Colman, Jun Han, and Liuping Wang — <i>Swinburne University of Technology, Australia; RMIT University, Australia</i> . . . . .	218
<b>Inflation and Deflation of Self-Adaptive Applications</b>	
Ryan W. Moore and Bruce R. Childers — <i>University of Pittsburgh, USA</i> . . . . .	228
<b>Author Index</b>	

## GENERAL CHAIR

Holger Giese

Hasso Plattner Institute, Germany

## PC CHAIR

Betty H.C. Cheng

Michigan State University, USA

## STEERING COMMITTEE

Betty H.C. Cheng

Michigan State University, USA

Rogério de Lemos

University of Kent, UK, *Chair*

David Garlan

Carnegie Mellon University, USA

Holger Giese

Hasso Plattner Institute, Germany

Marin Litoiu

York University, Canada

Jeff Magee

Imperial College London, UK

Hausi A. Müller

University of Victoria, Canada

Mauro Pezzè,

University of Lugano, Switzerland, and  
University of Milan Bicocca, Italy

Richard Taylor

University of California at Irvine, USA

## PUBLICITY CHAIRS

Basil Becker

Hasso Plattner Institute, Germany

Thomas Vogel

Hasso Plattner Institute, Germany

## EDITORS

Betty H.C. Cheng

Michigan State University, USA

Holger Giese

Hasso Plattner Institute, Germany



## PC Members

Colin Atkinson	University of Mannheim, Germany
Robert Baillargeon	SODIUS, USA
Luciano Baresi	Politecnico di Milano, Italy
Nelly Bencomo	University of Lancaster, UK
Yuriy Brun	University of Washington, USA
Vinny Cahill	Lero at Trinity College Dublin, Ireland
Shang-Wen Cheng	NASA/Jet Propulsion Laboratory, USA
Simon Dobson	University of St. Andrews, UK
Gregor Engels	University of Paderborn, Germany
Cristina Gacek	City University London, UK
David Garlan	Carnegie Mellon University, USA
Kurt Geihs	University of Kassel, Germany
Carlo Ghezzi	Politecnico di Milano, Italy
Svein Hallsteinsen	SINTEF, Norway
Paola Inverardi	University of L'Aquila, Italy
Jean-Marc Jezequel,	IRISA-INRIA, France
Gabor Karsai	Vanderbilt University, USA
Jeff Magee	Imperial College London, UK
Nenad Medvidovic	University of Southern California, USA
Hausi Müller	University of Victoria, Canada
John Mylopoulos	University of Trento, Italy
Sooyong Park	University of Sogang, S. Korea
Anna Perini	FBK-IRST,Ctr for Information Technology,Italy
Masoud Sadjadi	Florida International University, USA
Onn Shehory	IBM Haifa Research Lab, Israel
Roy Sterritt	University of Ulster, UK
Danny Weyns	Katholieke Universiteit Leuven, Belgium
Andrea Zisman	City University London, UK