Lecture Notes in Computer Science

Commenced Publication in 1973 Founding and Former Series Editors: Gerhard Goos, Juris Hartmanis, and Jan van Leeuwen

Editorial Board

David Hutchison Lancaster University, Lancaster, 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, Zurich, Switzerland John C. Mitchell Stanford University, Stanford, CA, USA Moni Naor Weizmann Institute of Science, Rehovot, Israel C. Pandu Rangan Indian Institute of Technology, Madras, India Bernhard Steffen TU Dortmund University, Dortmund, Germany Demetri Terzopoulos University of California, Los Angeles, CA, USA Doug Tygar University of California, Berkeley, CA, USA Gerhard Weikum Max Planck Institute for Informatics, Saarbrücken, Germany More information about this series at http://www.springer.com/series/7408

Flavio De Paoli · Stefan Schulte Einar Broch Johnsen (Eds.)

Service-Oriented and Cloud Computing

6th IFIP WG 2.14 European Conference, ESOCC 2017 Oslo, Norway, September 27–29, 2017 Proceedings



Editors Flavio De Paoli University of Milano-Bicocca Milan Italy

Stefan Schulte Vienna University of Technology Vienna Austria Einar Broch Johnsen University of Oslo Oslo Norway

ISSN 0302-9743 ISSN 1611-3349 (electronic) Lecture Notes in Computer Science ISBN 978-3-319-67261-8 ISBN 978-3-319-67262-5 (eBook) DOI 10.1007/978-3-319-67262-5

Library of Congress Control Number: 2017952388

LNCS Sublibrary: SL2 - Programming and Software Engineering

© IFIP International Federation for Information Processing 2017

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Printed on acid-free paper

This Springer imprint is published by Springer Nature The registered company is Springer International Publishing AG The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

These days, service-oriented computing and cloud computing have become pervasive in the software industry and the end-user market. We see services and the usage of cloud-based computational resources practically everywhere, regardless of particular application areas or target users. Service-oriented computing and cloud computing have gone a long way since their advent, but emerging technologies, aiming at the convergence of devices, networks, and the Internet of Things (IoT), sustain a very active research community aiming to develop these technologies further to build *smart* systems in research, business, and social contexts.

For the European research community, the European Conference on Service-Oriented and Cloud Computing (ESOCC) is the premier conference on advances in the state of the art and practice of service-oriented computing and cloud computing. The 6th event, ESOCC 2017, took place during September 27–29, 2017 at the University of Oslo, Norway, bringing together researchers and practitioners in the field.

ESOCC 2017 featured a number of events, most importantly the main research track, dedicated to the presentation of novel advances in the state of the art of service-oriented computing and cloud computing, and the industry track, dedicated to the presentation of applications and usage of services, concepts from service-oriented computing and cloud computing, and cloud-based computational resources in industry. Overall, 37 submissions were received, out of which 10 were accepted as full papers and another 6 as short papers. These papers (plus a keynote paper) are featured in these proceedings.

Each submission received at least three reviews by the members of the Program Committee (PC), with most submissions receiving four reviews. The review process was carried out in a "single blind" fashion. After the initial review phase, a discussion was initiated, which helped to further evaluate the strengths and weaknesses of the submissions. The program chairs thank the PC members and the additional reviewers for their accurate and extensive reviewing activities, which helped to improve the quality of the submissions and were also a big help to the authors of rejected papers.

This year, the conference featured a special track on the IoT, which aimed at showing how new requirements towards service-oriented computing and cloud computing arise because of the IoT. Vice versa, the second aim of this track was to show how the ESOCC community contributes to fulfilling the technical needs (and therefore the success) of the IoT.

As part of the main technical program, two inspiring keynotes were given by Stefan Tai (Full Professor and Head of Chair Information Systems Engineering at TU Berlin, Germany) and Hatay Tuna (Principal Software Architect, Azure Engineering, Microsoft). Stefan provided a talk on "Blockchain Insights", showing the potential of blockchain technologies to transform how organizations produce and capture value. Hatay gave insights on key experiences, patterns, and practices for "Design for Cloud".

Along with the main conference program, ESOCC featured a PhD symposium and an EU projects track, bringing together PhD students and EU project participants, respectively. In addition, three workshops were planned: REthinking SERvices CHallenges – Services Meet Data (IFIP WG SOS Workshop 2017), BPM@Cloud, and the 3rd International Workshop on Cloud Adoption and Migration (CloudWays). The proceedings are published separately.

The program chairs and the general chair would like to express their deep appreciation to all those who helped to make ESOCC 2017 a success. This includes the 55 PC members and the additional reviewers, the chairs and organizers of the PhD symposium, workshops, and EU projects track, as well as the many unnamed helpers who contributed in the background. We are especially grateful to the local organizing committee for their support, organizational efforts, and hospitality. Also, our thanks go to IFIP for supporting ESOCC 2017.

Finally, we thank all authors of research and industry papers, and those who presented their results, for contributing to this successful conference. With their work and dedication, ESOCC continues its tradition in advancing the field of service-oriented computing and cloud computing.

September 2017

Flavio De Paoli Stefan Schulte Einar Broch Johnsen

Organization

ESOCC 2017 was organized by the University of Oslo, Norway.

Organizing Committee

General Chair

Einar Broch Johnsen	University of Oslo, Norway
Program Chairs	
Flavio De Paoli	University of Milano-Bicocca, Italy
Stefan Schulte	TU Wien, Austria
Industry Track Chairs	
Alexander Lenk	BMW, Germany
Arne-Jørgen Berre	Sintef, Norway
Workshop Chairs	
Zoltán Ádám Mann	University of Duisburg-Essen, Germany
Volker Stolz	Bergen University College, Norway
EU Projects Chair	
Antonio Brogi	University of Pisa, Italy
Local Chair	
Ingrid Chieh Yu	University of Oslo, Norway
Website Chair	
Jacopo Mauro	University of Oslo, Norway

Steering Committee

University of Pisa, Italy
TU Wien, Austria
Eindhoven University of Technology, The Netherlands
University of Manchester, UK
University of Hamburg, Germany
University of Stuttgart, Germany
University of Milano-Bicocca, Italy
University of Lugano, Switzerland

Ernesto Pimentel	University of Málaga, Spain
Ulf Schreier	University of Applied Sciences Furtwangen, Germany
Massimo Villari	University of Messina, Italy
John Erik Wittern	IBM Thomas J. Watson Research Center, USA
Gianluigi Zavattaro	University of Bologna, Italy
Olaf Zimmermann	HSR FHO Rapperswil, Switzerland
Wolf Zimmermann	Martin Luther University Halle-Wittenberg, Germany

Program Committee

Marco Aiello	University of Groningen, The Netherlands
Vasilios Andrikopoulos	University of Groningen, The Netherlands
Farhad Arbab	CWI, The Netherlands
Luciano Baresi	Politecnico di Milano, Italy
Frank de Boer	CWI, The Netherlands
Antonio Brogi	University of Pisa, Italy
Giacomo Cabri	University of Modena and Reggio Emilia, Italy
Roberto di Cosmo	Université Paris Diderot, France
Javier Cubo	University of Malaga, Spain
Juergen Dunkel	FH Hannover, Germany
Schahram Dustdar	TU Wien, Austria
Robert Engel	IBM Almaden, USA
Rik Eshuis	Eindhoven University of Technology, The Netherlands
David Eyers	University of Otago, New Zealand
George Feuerlicht	Prague University of Economics, Czech Republic
Marisol García-Valls	Universidad Carlos III de Madrid, Spain
Ilche Georgievski	University of Groningen, The Netherlands
Claude Godart	University of Lorraine, France
Paul Grefen	Eindhoven University of Technology, The Netherlands
Heerko Groefsema	University of Groningen, The Netherlands
Thomas Gschwind	IBM Zurich Research Lab, Switzerland
Reiner Haehnle	TU Darmstadt, Germany
Martin Henkel	Stockholm University, Sweden
Einar Broch Johnsen	University of Oslo, Norway
Birgitta Koenig-Ries	Universität Jena, Germany
Oliver Kopp	University of Stuttgart, Germany
Ernoe Kovacs	NEC Europe Network Labs, Germany
Peep Küngas	University of Tartu, Estonia
Patricia Lago	Vrije Universiteit Amsterdam, The Netherlands
Winfried Lamersdorf	University of Hamburg, Germany
Kung-Kiu Lau	University of Manchester, UK
Philipp Leitner	University of Zurich, Switzerland
Jörg Lenhard	Karlstad University, Sweden
Frank Leymann	University of Stuttgart, Germany
Welf Loewe	Linnaeus University, Sweden
Zoltán Ádám Mann	University of Duisburg-Essen, Germany

Roy Oberhauser	Aalen University, Germany
Guadalupe Ortiz	University of Cádiz, Spain
Claus Pahl	Free University of Bozen-Bolzano, Italy
Flavio De Paoli	University of Milano-Bicocca, Italy
Cesare Pautasso	University of Lugano, Switzerland
Ernesto Pimentel	University of Malaga, Spain
Pierluigi Plebani	Politecnico di Milano, Italy
Stefanie Rinderle-Ma	University of Vienna, Austria
Dumitru Roman	Sintef, Norway
Alessandro Rossini	Evry Cloud Services, Norway
Ulf Schreier	University of Applied Sciences Furtwangen, Germany
Stefan Schulte	TU Wien, Austria
Maarten van Steen	University of Twente, The Netherlands
Massimo Villari	University of Messina, Italy
Ingo Weber	Data61, Australia
Erik Wilde	CA Technologies, Switzerland
John Erik Wittern	IBM Thomas J. Watson Research Center, USA
Lai Xu	Bournemouth University, UK
Gianluigi Zavattaro	University of Bologna, Italy
Olaf Zimmermann	HSR FHO Rapperswil, Switzerland
Wolf Zimmermann	Martin Luther University Halle-Wittenberg, Germany
Christian Zirpins	University of Applied Sciences Karlsruhe, Germany

Additional Reviewers

Kristof Böhmer	University of Vienna, Austria
Richard Bubel	TU Darmstadt, Germany
Mehdi Fahmideh	University of New South Wales, Australia
Alireza Farhadi	Sharif University of Technology, Iran
Andrei Furda	Queensland University of Technology, Australia
Stijn de Gouw	CWI, The Netherlands
Philipp Hoenisch	Data61, Australia
Marc Hüffmeyer	University of Applied Sciences Furtwangen, Germany
Ahmad Ibrahim	University of Pisa, Italy
Georg Kaes	University of Vienna, Austria
Alexander Lazovik	University of Groningen, The Netherlands
Ivano Malavolta	Vrije Universiteit Amsterdam, The Netherlands
Matt McLarty	ca technologies, USA
Irakli Nadareishvili	Capital One, USA
Nikolay Nikolov	Sintef, Norway
Alfonso Garcia de	University of Cádiz, Spain
Prado Fontela	
Luca Rinaldi	University of Pisa, Italy
Adrian Rutle	Bergen University College, Norway

Brian Setz Ang Sha Mirco Stocker Oktay Turetken Bjørn Marius von Zernichow University of Groningen, The Netherlands University of Groningen, The Netherlands HSR FHO Rapperswil, Switzerland Eindhoven University of Technology, The Netherlands Sintef, Norway

Contents

Keynote Paper

On or Off the Blockchain? Insights on Off-Chaining Computation and Data Jacob Eberhardt and Stefan Tai	3
Microservices and Containers	
Microservices Identification Through Interface Analysis Luciano Baresi, Martin Garriga, and Alan De Renzis	19
A Performance Survey of Lightweight Virtualization Techniques Max Plauth, Lena Feinbube, and Andreas Polze	34
Low-Level Exploitation Mitigation by Diverse Microservices Christian Otterstad and Tetiana Yarygina	49
Security	
A Formal Approach for the Verification of AWS IAM Access Control Policies <i>Ehtesham Zahoor, Zubaria Asma, and Olivier Perrin</i>	59
Foundations for Designing, Defining, Validating and Executing Access Control Policies in Cloud Environments.	75

83

Secure and Scalable Remote Access Tunnels for the IIoT:
An Assessment of openVPN and IPsec Performance
Frederic Pohl and Hans Dieter Schotten

Simeon Veloudis, Iraklis Paraskakis, and Christos Petsos

Cloud Resources

Two Are Better Than One: An Algorithm Portfolio Approach to Cloud	
Resource Management.	93
Zoltán Ádám Mann	
A Fuzzy Load Balancer for Adaptive Fault Tolerance Management	
in Cloud Platforms	109
Hamid Arabnejad, Claus Pahl, Giovani Estrada, Areeg Samir,	
and Frank Fowley	

Data Preparation as a Service Based on Apache Spark	125
Nivethika Mahasivam, Nikolay Nikolov, Dina Sukhobok,	
and Dumitru Roman	

Services

Human-in-the-Loop Simulation of Cloud Services	
Toward Automatic Semantic API Descriptions to Support Services Composition	159
On Abstraction-Based Deadlock-Analysis in Service-Oriented Systems with Recursion	168

Internet of Things and Data Streams

IoT-Based Compliance Checking of Multi-party Business Processes	
Modeled with Commitments	179
Marco Montali and Pierluigi Plebani	
Empowering Low-Latency Applications Through a Serverless Edge	
Computing Architecture	196
Luciano Baresi, Danilo Filgueira Mendonça, and Martin Garriga	
Computing Architecture	196

Industrial Applications of Service and Cloud Computing

uStorage - A Storage Architecture to Provide Block-Level Storage Through Object-Based Storage	
	213
Heart Disorder Detection with Menard Algorithm on Apache Spark Lorenzo Carnevale, Antonio Celesti, Maria Fazio, Placido Bramanti, and Massimo Villari	229
Author Index	239