

## Service-Oriented and Cloud Computing

Antonio Brogi, Wolf Zimmermann, Kyriakos Kritikos

► **To cite this version:**

Antonio Brogi, Wolf Zimmermann, Kyriakos Kritikos. Service-Oriented and Cloud Computing: 8th IFIP WG 2.14 European Conference, ESOC 2020, Heraklion, Crete, Greece, September 28–30, 2020, Proceedings. Springer International Publishing, LNCS-12054, 2020, Lecture Notes in Computer Science, 978-3-030-44768-7. 10.1007/978-3-030-44769-4 . hal-03203229

**HAL Id: hal-03203229**

**<https://hal.inria.fr/hal-03203229>**

Submitted on 21 Apr 2021

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



## Founding Editors

Gerhard Goos

*Karlsruhe Institute of Technology, Karlsruhe, Germany*

Juris Hartmanis

*Cornell University, Ithaca, NY, USA*

## Editorial Board Members

Elisa Bertino

*Purdue University, West Lafayette, IN, USA*

Wen Gao

*Peking University, Beijing, China*

Bernhard Steffen 

*TU Dortmund University, Dortmund, Germany*

Gerhard Woeginger 

*RWTH Aachen, Aachen, Germany*

Moti Yung

*Columbia University, New York, NY, USA*


More information about this series at <http://www.springer.com/series/7408>

Antonio Brogi · Wolf Zimmermann ·  
Kyriakos Kritikos (Eds.)


# Service-Oriented and Cloud Computing

8th IFIP WG 2.14 European Conference, ESOC 2020  
Heraklion, Crete, Greece, September 28–30, 2020  
Proceedings

*Editors*

Antonio Brogi   
Università di Pisa  
Pisa, Italy

Wolf Zimmermann  
Martin-Luther-Universität Halle-Wittenberg  
Halle (Saale), Germany

Kyriakos Kritikos   
University of the Aegean  
Karlovasi, Greece

ISSN 0302-9743                      ISSN 1611-3349 (electronic)  
Lecture Notes in Computer Science  
ISBN 978-3-030-44768-7              ISBN 978-3-030-44769-4 (eBook)  
<https://doi.org/10.1007/978-3-030-44769-4>

LNCS Sublibrary: SL2 – Programming and Software Engineering

© IFIP International Federation for Information Processing 2020

The chapters “Identification of Comparison Key Elements and Their Relationships for Cloud Service Selection” and “Technology-Agnostic Declarative Deployment Automation of Cloud Applications” are licensed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>). For further details see license information in the chapters.

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, expressed 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.

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

# Preface

Service-oriented and cloud computing have made a huge impact both on the software industry and on the research community. Today, service and cloud technologies are applied to build large-scale software landscapes as well as to provide single software services to end users. Services today are independently developed and deployed as well as freely composed while they can be implemented in a variety of technologies, quite an important fact from a business perspective. Similarly, cloud computing aims at enabling flexibility by offering a centralized sharing of resources. The industry's need for agile and flexible software and IT systems has made cloud computing the dominating paradigm for provisioning computational resources in a scalable, on-demand fashion. Nevertheless, service developers, providers, and integrators still need to create methods, tools, and techniques to support cost-effective and secure development as well as the use of dependable devices, platforms, services, and service-oriented applications in the cloud.

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 in Europe. The main objectives of this conference are to facilitate the exchange between researchers and practitioners in the areas of service-oriented computing and cloud computing, as well as to explore the new trends in those areas and foster future collaborations in Europe and beyond. The 8th edition of ESOCC, ESOCC 2020, was held in the city of Heraklion in Crete, Greece, during September 28–30, 2020, under the auspices of FORTH-ICS.

ESOCC 2020 was a multi-event conference aimed to cover both an academic and industrial audience. The main event was associated with the main research track, which focused on the presentation of cutting-edge research in both the service-oriented and cloud computing areas. In conjunction, an industrial track was also held bringing together academia and industry by showcasing the application of service-oriented and cloud computing research, especially in the form of case studies, from industry. Overall, 20 submissions were received, out of which 6 outstanding full and 8 short papers were accepted.

Each submission was peer-reviewed by three main reviewers, either directly from the PC members or their colleagues. Due to the high quality of the manuscripts received, additional discussions were conducted, both among the PC members as well as between the two PC chairs, before the final selection was performed. The PC chairs would like to thank all the reviewers that participated in the reviewing process not only for enabling to increase the quality of the received manuscripts but also for sharing particular ideas on how the respective work, even if rejected in its current form in the ESOCC conference, could be substantially improved.

The attendees of ESOCC had the opportunity to follow two outstanding keynotes that were part of the conference program. The first keynote was conducted by Massimo Villari, Professor and Rector Delegate for ICT as well as Head of the Computer Science

School in the University of Messina, Italy. This keynote concerned recent research advances and trends towards realizing the vision of Osmotic Computing. The second keynote was conducted by Joseph Spillner, Head of the Service Prototyping Lab and Associate Professor at Zurich University of Applied Sciences in Switzerland. This second keynote concerned the presentation of methods for developing production-ready, Function-as-a-Service applications concentrating on scalable event-driven data processing that are well-suited for highly dynamic environments with varying loads.

The additional events held in ESOCC 2020 included the PhD symposium, enabling PhD students to present their work in front of real experts, as well as the EU projects track, supplying researchers with the opportunity to present the main research results that they have achieved in the context of currently operating EU projects. Further, ESOCC 2020 included the organization of satellite workshops. All these events were accompanied by respective proceedings which were published separately.

Finally, this 8th edition of ESOCC included a novel track dedicated to the conduction of tutorials. This enabled the workshop participants to get acquainted with the latest results of specific European projects as well as of specific European research groups in a practical manner which included demonstrations of research prototypes.

The PC chairs and the general chair would like to gratefully thank all the persons involved in making ESOCC 2020 a success. This includes both the PC members and their colleagues that assisted in the reviews as well as the organizers of the industry track, the PhD symposium, the EU projects track, and the workshops. A special applause should also go to the members of the Local Organizing Committee for their devotion, willingness, and hospitality. Finally, a special thanks goes to all the authors of all the manuscripts submitted to ESOCC 2020, the presenters of the accepted papers who made interesting and fascinating presentations of their work, as well as the active attendees of the conference who initiated interesting discussions and gave fruitful feedback to the presenters. All these persons not only enabled a very successful organization and execution of ESOCC 2020, but also formulate an active and vibrant community which continuously contributes to the research in service-oriented and cloud computing. This also encourages ESOCC to continue contributing with new research outcomes to further facilitate and enlarge its community as well as have a greater impact and share in both the service-oriented and cloud computing research.

September 2020

Antonio Brogi  
Wolf Zimmermann  
Kyriakos Kritikos

# Organization

ESOCC 2020 was organized by FORTH-ICS, Greece.

## Organizing Committee

### General Chair

Kyriakos Kritikos FORTH-ICS and University of the Aegean, Greece

### Program Chairs

Antonio Brogi University of Pisa, Italy  
Wolf Zimmermann Martin Luther University Halle-Wittenberg, Germany

### Industry Track Chair

Marco Aiello University of Stuttgart, Germany

### Workshop Chairs

Christian Zirpins University of Applied Sciences Karlsruhe, Germany  
Iraklis Paraskakis City College, Greece

### EU Project Space Chairs

Pierluigi Plebani Politecnico di Milano, Italy  
Giuliano Casale Imperial College, UK

### PhD Symposium Chairs

Jacopo Soldani University of Pisa, Italy  
Massimo Villari University of Messina, Italy

## Steering Committee

Antonio Brogi University of Pisa, Italy  
Schahram Dustdar TU Wien, Austria  
Paul Grefen Eindhoven University of Technology, The Netherlands  
Winfried Lamersdorf University of Hamburg, Germany  
Frank Leymann University of Stuttgart, Germany  
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  
Ulf Schreier Hochschule Furtwangen University, Germany  
Massimo Villari University of Messina, Italy



John Erik Wittern	IBM T. J. Watson Research Center, USA
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
Giuliano Casale	Imperial College, UK
Marco Comuzzi	Ulsan National Institute of Science and Technology, South Korea
Schahram Dustdar	TU Wien, Austria
Robert Engel	IBM Almaden, USA
Rik Eshuis	Eindhoven University of Technology, The Netherlands
Ilche Georgievski	University of Groningen, The Netherlands
Paul Grefen	Eindhoven University of Technology, The Netherlands
Thomas Gschwind	IBM Zurich Research Lab, Switzerland
Martin Henkel	Stockholm University, Sweden
Einar Broch Johnsen	University of Oslo, Norway
Ernoe Kovacs	NEC Europe Network Labs, Germany
Patricia Lago	VU University Amsterdam, The Netherlands
Winfried Lamersdorf	University of Hamburg, Germany
Kung-Kiu Lau	The University of Manchester, UK
Welf Loewe	Linnaeus University, Sweden
Zoltan Adam Mann	University of Duisburg-Essen, Germany
Guadalupe Ortiz	University of Cadiz, Spain
Claus Pahl	Free University of Bozen-Bolzano, Italy
Iraklis Paraskakis	City College, Greece
Ernesto Pimentel	University of Malaga, Spain
Pierluigi Plebani	Politecnico di Milano, Italy
Dumitru Roman	Sintef, Norway
Ulf Schreier	University of Applied Sciences Furtwangen, Germany
Stefan Schulte	TU Wien, Austria
Jacopo Soldani	University of Pisa, Italy
Massimo Villari	University of Messina, Italy
Mandy Weissbach	Martin Luther University Halle-Wittenberg, Germany
Stefan Wesner	University of Ulm, Germany
Robert Woitsch	BOC Asset Management, Germany
Gianluigi Zavattaro	University of Bologna, Italy
Christian Zirpins	University of Applied Sciences Karlsruhe, Germany

# Contents

## Formal Methods

Testing Conformance in Multi-component Enterprise Application Management . . . . .	3
<i>Jacopo Soldani, Lars Luthmann, Malte Lochau, and Antonio Brogi</i>	
Formalizing Event-Driven Behavior of Serverless Applications . . . . .	19
<i>Matthew Obetz, Anirban Das, Timothy Castiglia, Stacy Patterson, and Ana Milanova</i>	
Probabilistic Verification of Outsourced Computation Based on Novel Reversible PUFs . . . . .	30
<i>Hala Hamadeh, Abdallah Almomani, and Akhilesh Tyagi</i>	

## Cloud Service and Platform Selection

Multiplayer Game Backends: A Comparison of Commodity Cloud-Based Approaches . . . . .	41
<i>Nicos Kasenides and Nearchos Paspallis</i>	
Are Cloud Platforms Ready for Multi-cloud? . . . . .	56
<i>Kyriakos Kritikos, Paweł Skrzypek, and Feroz Zahid</i>	
Identification of Comparison Key Elements and Their Relationships for Cloud Service Selection . . . . .	74
<i>Anis Ahmed Nacer, Olivier Perrin, and François Charoy</i>	

## Deployment and Workflows

Deployable Self-contained Workflow Models . . . . .	85
<i>Benjamin Weder, Uwe Breitenbücher, Kálmán Képes, Frank Leymann, and Michael Zimmermann</i>	
Technology-Agnostic Declarative Deployment Automation of Cloud Applications . . . . .	97
<i>Michael Wurster, Uwe Breitenbücher, Antonio Brogi, Lukas Harzenetter, Frank Leymann, and Jacopo Soldani</i>	
Blockchain-Based Healthcare Workflows in Federated Hospital Clouds . . . . .	113
<i>Armando Ruggeri, Maria Fazio, Antonio Celesti, and Massimo Villari</i>	

**Monitoring**

Monitoring Behavioral Compliance with Architectural Patterns  
Based on Complex Event Processing . . . . . 125

*Christoph Krieger, Uwe Breitenbücher, Michael Falkenthal,  
Frank Leymann, Vladimir Yussupov, and Uwe Zdun*

Towards Real-Time Monitoring of Data Centers Using Edge Computing . . . . 141

*Brian Setz and Marco Aiello*

Modeling Users' Performance: Predictive Analytics in an IoT Cloud  
Monitoring System . . . . . 149

*Rosa Di Salvo, Antonino Galletta, Orlando Marco Belcore,  
and Massimo Villari*

**Data Distribution and Analytics**

Multi-source Distributed System Data for AI-Powered Analytics . . . . . 161

*Sasho Nedelkoski, Jasmin Bogatinovski, Ajay Kumar Mandapati,  
Soeren Becker, Jorge Cardoso, and Odej Kao*

Blockchain- and IPFS-Based Data Distribution for the Internet of Things . . . . 177

*Simon Krejci, Marten Sigwart, and Stefan Schulte*

**Author Index** . . . . . 193