# Lecture Notes in Computer Science    12994

More information about this subseries at

Chengzhong Xu · Yunni Xia ·
Yuchao Zhang · Liang-Jie Zhang (Eds.)

# Web Services –
# ICWS 2021

28th International Conference
Held as Part of the Services Conference Federation, SCF 2021
Virtual Event, December 10–14, 2021
Proceedings

🐎 Springer

*Editors*
Chengzhong Xu
University of Macau
Macau, China

Yunni Xia
Chongqing University
Chongqing, China

Yuchao Zhang
Beijing University of Posts and
Telecommunications
Beijing, China

Liang-Jie Zhang ⓘ
Kingdee International Software Group
Co., Ltd.
Shenzhen, China

# Preface

The International Conference on Web Services (ICWS) is a prime international forum for both researchers and industry practitioners to exchange the latest fundamental advances in the state of the art and practice of web-based services, identify emerging research topics, and define the future of web-based services. All topics regarding Internet/Web services lifecycle study and management align with the theme of ICWS.

ICWS is a member of Services Conference Federation (SCF). SCF 2021 featured the following 10 collocated service-oriented sister conferences: the International Conference on Web Services (ICWS 2021), the International Conference on Cloud Computing (CLOUD 2021), the International Conference on Services Computing (SCC 2021), the International Conference on Big Data (BigData 2021), the International Conference on AI and Mobile Services (AIMS 2021), the World Congress on Services (SERVICES 2021), the International Conference on Internet of Things (ICIOT 2021), the International Conference on Cognitive Computing (ICCC 2021), the International Conference on Edge Computing (EDGE 2021), and the International Conference on Blockchain (ICBC 2021). As the founding member of SCF, the first International Conference on Web Services (ICWS) was held in June 2003 in Las Vegas, USA.

This volume presents the accepted papers for ICWS 2021, held virtually over the Internet during December 10–14, 2021. For this conference, each paper was reviewed by three independent members of the international Program Committee. After carefully evaluating their originality and quality, we accepted seven papers.

We are pleased to thank the authors whose submissions and participation made this conference possible. We also want to express our thanks to the Organizing Committee and Program Committee members for their dedication in helping to organize the conference and reviewing the submissions. We owe special thanks to the keynote speakers for their impressive speeches.

Finally, we would like to thank operations committee members Sheng He and Yishuang Ning for their excellent work in organizing this conference. We look forward to your future contributions as volunteers, authors, and conference participants for the fast-growing worldwide services innovations community.

December 2021

Chengzhong Xu
Yunni Xia
Yuchao Zhang
Liang-Jie Zhang

# Organization

## General Chairs

Hai Jin        Huazhong University of Science and Technology, China

Xiaoqing Liu        Southern Illinois University, USA

## Program Chairs

Chengzhong Xu        University of Macau, China

Yunni Xia        Chongqing University, China

Yuchao Zhang        Beijing University of Posts and Telecommunications, China

## Services Conference Federation (SCF 2021)

### General Chairs

Wu Chou        Essenlix Corporation, USA

Calton Pu (Co-chair)        Georgia Tech, USA

Dimitrios Georgakopoulos        Swinburne University of Technology, Australia

### Program Chairs

Liang-Jie Zhang        Kingdee International Software Group Co., Ltd., China

Ali Arsanjani        Amazon Web Services, USA

### CFO

Min Luo        Georgia Tech, USA

### Industry Track Chairs

Awel Dico        Etihad Airways, UAE

Rajesh Subramanyan        Amazon Web Services, USA

Siva Kantamneni        Deloitte Consulting, USA

## Industry Exhibit and International Affairs Chair

Zhixiong Chen                Mercy College, USA

## Operations Committee

Jing Zeng                    China Gridcom Co., Ltd., China
Yishuang Ning                Tsinghua University, China
Sheng He                     Tsinghua University, China

## Steering Committee

Calton Pu (Co-chair)         Georgia Tech, USA
Liang-Jie Zhang (Co-chair)   Kingdee International Software Group Co., Ltd., China

## ICWS 2021 Program Committee

Ismailcem Arpinar            University of Georgia, USA
Yacine Atif                  University of Skovde, Sweden
Amin Beheshti                Macquarie University, Australia
Ladjel Bellatreche           LISI/ENSMA University of Poitiers, France
Salima Benbernou             Université de Paris, France
Abdelghani Benharref         University of Wollongong, Australia
Nizar Bouguila               Concordia University, Canada
Bo Cheng                     Beijing University of Posts and Telecommunications,
                             China
Hadeel El-Kassabi            United Arab Emirates University, UAE
Keke Gai                     Beijing Institute of Technology, China
Abdul Kadhim Hayawi          Zayed University, UAE
Loïc Hélouët                 Inria, France
Heba Ismail                  United Arab Emirates University, UAE
Adel Khelifi                 Abu Dhabi University, UAE
Hyuk-Yoon Kwon               Seoul National University of Science and Technology,
                             South Korea
Bing Li                      Wuhan University, China
Zakaria Maamar               Zayed University, UAE
Sujith Mathew                Zayed University, UAE
Rabeb Mizouni                Khalifa University, UAE
Roy Oberhauser               Aalen University, Germany
Hadi Otrok                   Khalifa University, UAE
Sofia Ouhbi                  United Arab Emirates University, UAE
Ali Ouni                     University of Quebec, Canada
Dhaval Patel                 IBM T. J. Watson Research Center, USA
Young-Kyoon Suh              Kyungpook National University, South Korea
Ikbal Taleb                  Zayed University, UAE
Liqiang Wang                 University of Central Florida, USA

| | |
|---|---|
| Songmei Yu | Felician University, USA |
| Rui Zhang | Institute of Information Engineering, Chinese Academy of Sciences, China |
| Yuchao Zhang | Beijing University of Posts and Telecommunications, China |

# Conference Sponsor – Services Society

The Services Society (S2) is a non-profit professional organization that has been created to promote worldwide research and technical collaboration in services innovations among academia and industrial professionals. Its members are volunteers from industry and academia with common interests. S2 is registered in the USA as a "501(c) organization", which means that it is an American tax-exempt nonprofit organization. S2 collaborates with other professional organizations to sponsor or co-sponsor conferences and to promote an effective services curriculum in colleges and universities. The S2 initiates and promotes a "Services University" program worldwide to bridge the gap between industrial needs and university instruction.

The Services Sector has account for 79.5% of the GDP of United States in 2016. The world's most services oriented economy, with services sectors accounting for more than 90% of GDP. The Services Society has formed 10 Special Interest Groups (SIGs) to support technology and domain specific professional activities.

- Special Interest Group on Web Services (SIG-WS)
- Special Interest Group on Services Computing (SIG-SC)
- Special Interest Group on Services Industry (SIG-SI)
- Special Interest Group on Big Data (SIG-BD)
- Special Interest Group on Cloud Computing (SIG-CLOUD)
- Special Interest Group on Artificial Intelligence (SIG-AI)
- Special Interest Group on Edge Computing (SIG-EC)
- Special Interest Group on Cognitive Computing (SIG-CC)
- Special Interest Group on Blockchain (SIG-BC)
- Special Interest Group on Internet of Things (SIG-IOT)

# About Services Conference Federation (SCF)

As the founding member of the Services Conference Federation (SCF), the first International Conference on Web Services (ICWS) was held in June 2003 in Las Vegas, USA. Meanwhile, the First International Conference on Web Services - Europe 2003 (ICWS-Europe'03) was held in Germany in Oct, 2003. ICWS-Europe'03 is an extended event of the 2003 International Conference on Web Services (ICWS 2003) in Europe. In 2004, ICWS-Europe was changed to the European Conference on Web Services (ECOWS), which was held at Erfurt, Germany. SCF 2020 was held successfully. To celebrate its 19-year-old birthday, SCF 2021 was held virtually over the Internet on December 10–14, 2021.

In the past 18 years, ICWS community has been expanded from Web engineering innovations to scientific research for the whole services industry. The service delivery platforms have been expanded to mobile platforms, Internet of Things, cloud computing, and edge computing. The services ecosystem is gradually enabled, value added, and intelligence embedded through enabling technologies such as big data, artificial intelligence, and cognitive computing. In the coming years, all the transactions with multiple parties involved will be transformed to blockchain.

Based on the technology trends and best practices in the field, SCF will continue serving as the conference umbrella's code name for all services-related conferences. SCF 2021 defines the future of New ABCDE (AI, Blockchain, Cloud, big Data, Everything is connected), which enable IOT and enter the 5G for Services Era. SCF 2021's 10 co-located theme topic conferences all center around "services", while each focusing on exploring different themes (web-based services, cloud-based services, Big Data-based services, services innovation lifecycle, AI-driven ubiquitous services, blockchain driven trust service-ecosystems, industry-specific services and applications, and emerging service-oriented technologies). SCF includes 10 service-oriented conferences: ICWS, CLOUD, SCC, BigData Congress, AIMS, SERVICES, ICIOT, EDGE, ICCC and ICBC. The SCF 2021 members are listed as follows:

[1] The 2021 International Conference on Web Services (ICWS 2021, http://icws.org/) is the flagship theme-topic conference for Web-based services, featuring Web services modeling, development, publishing, discovery, composition, testing, adaptation, delivery, as well as the latest API standards.

[2] The 2021 International Conference on Cloud Computing (CLOUD 2021, http://thecloudcomputing.org/) is the flagship theme-topic conference for modeling, developing, publishing, monitoring, managing, delivering XaaS (everything as a service) in the context of various types of cloud environments.

[3] The 2021 International Conference on Big Data (BigData 2021, http://bigdatacongress.org/) is the emerging theme-topic conference for the scientific and engineering innovations of big data.

[4] The 2021 International Conference on Services Computing (SCC 2021, http://thescc.org/) is the flagship theme-topic conference for services innovation

lifecycle that includes enterprise modeling, business consulting, solution creation, services orchestration, services optimization, services management, services marketing, business process integration and management.

[5] The 2021 International Conference on AI & Mobile Services (AIMS 2021, http://ai1000.org/) is the emerging theme-topic conference for the science and technology of artificial intelligence, and the development, publication, discovery, orchestration, invocation, testing, delivery, and certification of AI-enabled services and mobile applications.

[6] The 2021 World Congress on Services (SERVICES 2021, http://servicescongress.org/) puts its focus on emerging service-oriented technologies and the industry-specific services and solutions.

[7] The 2021 International Conference on Cognitive Computing (ICCC 2021, http://thecognitivecomputing.org/) puts its focus on the Sensing Intelligence (SI) as a Service (SIaaS) that makes system listen, speak, see, smell, taste, understand, interact, and walk in the context of scientific research and engineering solutions.

[8] The 2021 International Conference on Internet of Things (ICIOT 2021, http://iciot.org/) puts its focus on the creation of Internet of Things technologies and development of IOT services.

[9] The 2021 International Conference on Edge Computing (EDGE 2021, http://theedgecomputing.org/) puts its focus on the state of the art and practice of edge computing including but not limited to localized resource sharing, connections with the cloud, and 5G devices and applications.

[10] The 2021 International Conference on Blockchain (ICBC 2021, http://blockchain1000.org/) concentrates on blockchain-based services and enabling technologies.

Some highlights of SCF 2021 are shown below:

– **Bigger Platform:** The 10 collocated conferences (SCF 2021) get sponsorship from the Services Society which is the world-leading not-for-profits organization (501 c(3)) dedicated for serving more than 30,000 worldwide Services Computing researchers and practitioners. Bigger platform means bigger opportunities to all volunteers, authors and participants. Meanwhile, Springer provides sponsorship to best paper awards and other professional activities. All the 10 conference proceedings of SCF 2021 have been published by Springer and indexed in ISI Conference Proceedings Citation Index (included in Web of Science), Engineering Index EI (Compendex and Inspec databases), DBLP, Google Scholar, IO-Port, MathSciNet, Scopus, and ZBlMath.

– **Brighter Future:** While celebrating 2021 version of ICWS, SCF 2021 highlights the Fourth International Conference on Blockchain (ICBC 2021) to build the fundamental infrastructure for enabling secure and trusted services ecosystems. It will also lead our community members to create their own brighter future.

– **Better Model:** SCF 2021 continues to leverage the invented Conference Blockchain Model (CBM) to innovate the organizing practices for all the 10 theme conferences.

# Contents