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Kejiang Ye · Liang-Jie Zhang (Eds.)

Cloud Computing – CLOUD 2021

14th International Conference

Held as Part of the Services Conference Federation, SCF 2021

Virtual Event, December 10–14, 2021

Proceedings

Editors

Kejiang Ye
Shenzhen Institutes of Advanced Technology,
Chinese Academy of Sciences
Shenzhen, China

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

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Preface

The International Conference on Cloud Computing (CLOUD) 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 cloud computing, identify emerging research topics, and define the future of cloud computing. All topics regarding cloud computing align with the theme of CLOUD.

CLOUD is a member of the Services Conference Federation (SCF). SCF 2021 comprised 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).

This volume presents the accepted papers for CLOUD 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, seven papers were accepted.

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

Finally, we would like to thank operation 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 in the fast-growing worldwide services innovations community.

December 2021

Kejiang Ye
Liang-Jie Zhang

Organization

CLOUD 2021 Program Chair

Kejiang Ye	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, China
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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 non-profit organization. S2 collaborates with other professional organizations to sponsor or co-sponsor conferences and to promote an effective services curriculum in colleges and universities. S2 initiates and promotes a “Services University” program worldwide to bridge the gap between industrial needs and university instruction.

The services sector accounted for 79.5% of the GDP of the USA in 2016. Hong Kong has one of the world’s most service-oriented economies, with the services sector accounting for more than 90% of GDP. As such, 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 the 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. A sister event, the First International Conference on Web Services - Europe 2003 (ICWS-Europe 2003) was held in Germany in October of the same year. In 2004, ICWS-Europe was changed to the European Conference on Web Services (ECOWS), which was held in Erfurt, Germany. The 19th edition in the conference series, SCF 2021, was held virtually over the Internet during December 10–14, 2021.

In the past 18 years, the ICWS community has expanded from Web engineering innovations to scientific research for the whole services industry. The service delivery platforms have expanded to mobile platforms, the Internet of Things (IoT), cloud computing, and edge computing. The services ecosystem has gradually been enabled, value added, and intelligence embedded through enabling technologies such as big data, artificial intelligence, and cognitive computing. In the coming years, transactions with multiple parties involved will be transformed by 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 defined the future of the New ABCDE (AI, Blockchain, Cloud, big Data, Everything is connected), which enable IOT and support the "5G for Services Era". SCF 2021 featured 10 colocated conferences all centered around the topic of "services", each focusing on exploring different themes (e.g. 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). The SCF 2021 members were as follows:

1. The 2021 International Conference on Web Services (ICWS 2021, <http://icws.org/>), which was the flagship conference for web-based services featuring web services modeling, development, publishing, discovery, composition, testing, adaptation, and delivery, as well as the latest API standards.
2. The 2021 International Conference on Cloud Computing (CLOUD 2021, <http://thecloudcomputing.org/>), which was the flagship conference for modeling, developing, publishing, monitoring, managing, and 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/>), which focused on the scientific and engineering innovations of big data.
4. The 2021 International Conference on Services Computing (SCC 2021, <http://thescc.org/>), which was the flagship conference for the services innovation lifecycle including enterprise modeling, business consulting, solution creation, services orchestration, services optimization, services management, services marketing, and business process integration and management.

5. The 2021 International Conference on AI and Mobile Services (AIMS 2021, <http://ai1000.org/>), which addressed 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/>), which put its focus on emerging service-oriented technologies and industry-specific services and solutions.
7. The 2021 International Conference on Cognitive Computing (ICCC 2021, <http://thecognitivecomputing.org/>), which put its focus on Sensing Intelligence (SI) as a Service (SIaaS), making a system listen, speak, see, smell, taste, understand, interact, and/or walk, in the context of scientific research and engineering solutions.
8. The 2021 International Conference on Internet of Things (ICIOT 2021, <http://iciot.org/>), which addressed the creation of IoT technologies and the development of IOT services.
9. The 2021 International Conference on Edge Computing (EDGE 2021, <http://theedgecomputing.org/>), which put 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/>), which concentrated on blockchain-based services and enabling technologies.

Some of the highlights of SCF 2021 were as follows:

- **Bigger Platform:** The 10 collocated conferences (SCF 2021) got sponsorship from the Services Society which is the world-leading not-for-profits organization (501 c(3)) dedicated to serving more than 30,000 services computing researchers and practitioners worldwide. A bigger platform means bigger opportunities for all volunteers, authors, and participants. In addition, Springer provided sponsorship for best paper awards and other professional activities. All 10 conference proceedings of SCF 2021 will be published by Springer and indexed in the ISI Conference Proceedings Citation Index (included in Web of Science), the Engineering Index EI (Compendex and Inspec databases), DBLP, Google Scholar, IO-Port, MathSciNet, Scopus, and ZBIMath.
- **Brighter Future:** While celebrating the 2021 version of ICWS, SCF 2021 highlighted 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 continued to leverage the invented Conference Blockchain Model (CBM) to innovate the organizing practices for all 10 collocated conferences.

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