

1- TITLE:

Towards Scalable Blockchains Using Service-Oriented Architectures

2- NAME AND CONTACT INFORMATION OF THE ORGANIZERS

Dr. Ali Dorri, Prof. Raja Jurdak, Prof. Amin Beheshti, Prof. Alistair Barros

3- ABSTRACT:

Blockchain has received widespread attention as a distributed solution for non-monetary applications due to its salient features which includes distributed management, security, anonymity, auditability, and immutability. Blockchain was initially introduced for cryptocurrencies and to track coin exchange. The wider adaptation of blockchain in various applications, including the Internet of Things (IoT), significantly increased blockchain complexity as application-specific tasks are coupled with the core blockchain algorithms. Conventional blockchains are not directly applicable in IoT due to lack of throughput, delay in storing data in the blockchain, and low scalability due to the distributed nature of the ledger which in turn increases the cost in managing the ledger. In recent years, combining blockchain and service-oriented architectures has received attention to address the outlined challenges. Cloud service providers offer Blockchain-as-a-Service (BaaS) solutions to facilitate blockchain development and reduce complexity. In this tutorial, we will investigate the benefits and limitations of the existing blockchain solutions that incorporate service-oriented architectures. We study BaaS architectures and analyse them against the core blockchain features. We then will investigate the benefits and limitations of such solutions and outline a modular blockchain architecture that benefits from service-oriented architecture while preserving the distributed management feature of the conventional blockchains. We employ energy trading as an example scenario to demonstrate the solution.

4- REQUISITE BACKGROUND OF THE TARGET AUDIENCE AND OVERVIEW OF THE TOPIC COVERED

Blockchain is a disruptive technology that has received interest from academics and practitioners in diverse domains including computer science, law, business and policy. Blockchains and their inherent combination of consensus algorithms, distributed data storage and secure protocols can be used to increase scalability, robustness and reliability for a wide range of industries. A recent article [1] has outlined that blockchain has the potential to transform 50 major industries and thus permeate to all areas of our lives. Market Reports Centre is forecasting that the blockchain market size to reach \$60.7 billion in 2024. A comprehensive study on trust in blockchain-based large scale networks will introduce new research directions and open new applications due to the enhanced security and trust. Applying this technology across different disciplines will exhibit a variety of complicated problems and new requirements, which brings more open issues and challenges for research communities. Given that conventional blockchains were first proposed for cryptocurrency applications, they are not directly applicable in large scale networks due to lack of throughput, i.e., total number of transactions that can be stored in second, long delay in storing transactions, and high resource demanding. The widespread adaptation of blockchain in various applications increases the blockchain complexity and scalability as each application introduces application specific tasks on top of the blockchain core algorithms. In recent years, multiple solutions have

been introduced to employ service-oriented architectures to address the outlined challenges. Cloud service providers, such as IBM and AWS, have started to offer BaaS solutions where blockchain core functions are managed by the service provider and the end-user benefits from the core advantages including transparency, immutability, and auditability.

This tutorial presents an opportunity for ICSOC attendees to obtain a comprehensive overview of blockchain beyond cryptocurrency and the associated challenges and applications as well as the integration of blockchain with service-oriented architecture and the limitations of such solutions. This tutorial is open to researchers, academics, students, and practitioners working in the area of the Internet of Things (IoT), blockchain technology, and service computing and anyone with a broad interest in distributed systems and pervasive computing. The required prior knowledge is minimal and should not preclude any ICSOC participants.

5 - THE TUTORIAL LENGTH:

1 hour 50 minutes

6- TUTORIAL OUTLINE: USING A BULLET LIST, WITH ESTIMATED PRESENTATION TIME FOR EACH ITEM, IN THE ORDER OF PRESENTATION

- ***Background: Blockchain Technology (30 min)***
 - *In this part we will discuss the fundamentals of blockchain technology followed by its applications beyond cryptocurrency and the challenges involved in applying blockchain in such domains. We will investigate solutions to improve the blockchain scalability and outline their limitations.*
- ***When service-oriented architectures meet blockchain (40 min)***
 - *In this part we will discuss how blockchain and service-oriented architectures can be merged. We will investigate the existing solutions including BaaS and outline their limitations.*
- ***From Monolithic to Modular Blockchains (30 min)***
 - *In this part we will investigate ways to address the challenges in the existing solutions that aim to combine blockchain and service-oriented architectures. We will study a scalable modular blockchain architecture that benefits from service computing while maintaining the distributed nature of the blockchain.*
- ***Use case: A modular blockchain architecture for distributed energy trading (10 min)***
 - *We will investigate how service-oriented architecture and blockchain can be integrated while maintaining blockchain decentralization using a use case in energy trading. In this example, users that have solar panels installed at home, can trade the surplus energy with other users in the smart grid without relying on third parties, e.g., grid operator.*

7- SHORT BIOS OF THE PRESENTERS INCLUDING THEIR EXPERTISE RELATED TO THE TUTORIAL (NO MORE THAN 100 WORDS PER PRESENTER)

Dr. Ali Dorri, Queensland University of Technology, Brisbane, Australia.

Dr Ali Dorri is a Research Fellow at Queensland University of Technology (QUT), Brisbane, Australia. He received his Ph.D. degree from the University of New South Wales (UNSW), Sydney, Australia. He was also a Postgraduate research student at CSIRO, Australia. He has

received UNSW Dean's Award for Outstanding PhD Theses. His research interest includes blockchain applications and challenges in adopting blockchain in large scale networks including the Internet of Things, smart cities, smart grid, and e-health. He delivered several talks, keynote speaks and tutorial, including a tutorial at ICBC 2019 and CCNC 2021. He has co-authored a book titled "Blockchain for Cyberphysical Systems" to be published by Artech House in 2020. He has published over 45 peer-reviewed papers. His h-index is 18 and his publications received over 3800 citations.

Prof. Raja Jurdak, Queensland University of Technology, Brisbane, Australia.

Prof. Raja Jurdak is a Professor of Distributed Systems and Chair in Applied Data Sciences at Queensland University of Technology, and Director of the Trusted Networks Lab. He received the PhD in information and computer science from the University of California, Irvine. He previously established and led the Distributed Sensing Systems Group at CSIRO's Data61, where he maintains a visiting role. He also spent time as visiting academic at MIT and Oxford University in 2011 and 2017. His research interests include trust, mobility, privacy and energy-efficiency in networks. Prof. Jurdak has over 200 peer-reviewed publications, including two authored books most recently on blockchain in cyberphysical systems in 2020. He serves on the editorial board of Ad Hoc Networks, Nature Scientific Reports, and on the organising and technical program committees of top international conferences, including Percom, ICBC, IPSN, WoWMoM, and ICDCS. He was TPC co-chair of the IEEE International Conference on Blockchain and Cryptocurrency in 2021. He is a conjoint professor with the University of New South Wales, and a Senior Member of the IEEE. He has led large scale national research projects, shared technology that in use across six continents, and commercialised his research into Australian industry.

Prof. Amin Beheshti, Macquarie University, Sydney, Australia

Prof. Amin Beheshti is a Full Professor of Data Science and the Director of AI-enabled Processes (AIP) Research Centre, School of Computing, Macquarie University. Amin is also the head of the Data Analytics Research Lab and Adjunct Academic in Computer Science at UNSW Sydney. Amin completed his Ph.D. and Postdoc in Computer Science and Engineering at UNSW Sydney and hold a Master and Bachelor in Computer Science both with First Class Honours. In addition to his contribution to teaching activities, Amin extensively contributed to research projects; where he was the R&D Team Lead and Key Researcher in the 'Case Walls & Data Curation Foundry' and 'Big Data for Intelligence' projects. Amin has been recognized as a high-quality researcher in Big-Data/Data/Process Analytics and has been invited to serve and served as Keynote Speaker, General-Chair, PC-Chair, Organisation-Chair, and program committee member of top international conferences. He is the leading author of the book entitled "Process Analytics", co-authored with other high-profile researchers in UNSW and IBM research, recently published by Springer. Amin was able to secure over \$9.8 Million Research Grants for AI-Enabled, Data-Driven, and Intelligence-Led projects.

Prof. Alistair Barros, Queensland University of Technology, Brisbane, Australia.

Prof. Alistair Barros is the Head of the Service Science Group and Acting Head of Information Systems School, Queensland University of Technology. He has a PhD from the University of Queensland and 34 years ICT experience across industry, academic, industrial

R&D and industry roles, including Global Research Leader and Chief Development Architect at SAP AG, the third largest software company worldwide. His focus is on the design, re-engineering and interoperability of large-scale enterprise systems in contemporary cyber-physical settings, leveraging Cloud, Internet-of-Things and Blockchain infrastructure. His related research interests include: conceptual modelling languages for business processes and service-based systems; microservice architecture; model-based systems re-engineering; and service optimisation techniques. He has published more than 130 articles, which include 6 edited books, and 105 peer-reviewed journals, conference and book chapter articles. He also has 18 filed US patents. He has been program committee co-chair of International Conference on Service Oriented Computing 2015 and International Conference on Business Process Management 2012. He has also led large research proposals/projects across Europe and Australia including Smart Services CRC, Internet of Services projects of EU Framework Program 7 and German BMBF, and Australian Research Council projects.

8- A LIST OF UP TO 20 MOST IMPORTANT REFERENCES TO BE COVERED IN THE TUTORIAL

- [1] "Banking Is Only The Beginning: 50 Big Industries Blockchain Could Transform, CBInsight, <https://www.cbinsights.com/research/industries-disrupted-blockchain/>
- [2] Dorri, Ali, et al. "LSB: A Lightweight Scalable Blockchain for IoT security and anonymity." *Journal of Parallel and Distributed Computing* 134 (2019): 180-197.
- [3] Dorri, Ali, et al. "MOF-BC: A memory optimized and flexible blockchain for large scale networks." *Future Generation Computer Systems* 92 (2019): 357-373.
- [4] Dorri, Ali, et al. "SPB: A secure private blockchain-based solution for distributed energy trading." *IEEE Communications Magazine* 57.7 (2019): 120-126.
- [5] Dorri, Ali, et al. "On the activity privacy of blockchain for IoT." 2019 IEEE 44th Conference on Local Computer Networks (LCN). IEEE, 2019.
- [6] Khorasany, Mohsen, et al. "Lightweight blockchain framework for location-aware peer-to-peer energy trading." *International Journal of Electrical Power & Energy Systems* 127 (2021): 106610.
- [7] Dorri, Ali, and Raja Jurdak. "Tree-Chain: A Lightweight Consensus Algorithm for IoT-based Blockchains." 2021 IEEE International Conference on Blockchain and Cryptocurrency (ICBC). IEEE, 2021.
- [8] Zamani, Mahdi, et al. "Rapidchain: Scaling blockchain via full sharding." *Proceedings of the 2018 ACM SIGSAC Conference on Computer and Communications Security*. 2018.
- [9] Samaniego, Mayra, Uurtsaikh Jamsrandorj, and Ralph Deters. "Blockchain as a Service for IoT." 2016 IEEE international conference on internet of things (iThings) and IEEE green computing and communications (GreenCom) and IEEE cyber, physical and social computing (CPSCom) and IEEE smart data (SmartData). IEEE, 2016.
- [10] Amin Beheshti, Boualem Benatallah, Alireza Tabebordbar, Hamid Reza Motahari-Nezhad, Moshe Chai Barukh, Reza Nouri: *DataSynapse: A Social Data Curation Foundry. Distributed Parallel Databases* 37(3): 351-384 (2019)
- [11] Amin Beheshti, Boualem Benatallah, Quan Z. Sheng, Francesco Schiliro: *Intelligent Knowledge Lakes: The Age of Artificial Intelligence and Big Data. WISE Workshops 2019: 24-34*