Guest Editorial Special Issue on Intelligent Blockchain for Future Communications and Networking: Technologies, Trends, and Applications

Huawei Huang, *Senior Member, IEEE*, Salil Kanhere, *Senior Member, IEEE*, Jiawen Kang, *Member, IEEE*, Zehui Xiong, *Member, IEEE*, Lei Zhang, *Senior Member, IEEE*, Bhaskar Krishnamachari, *Senior Member, IEEE*, Elisa Bertino, *Fellow, IEEE*, and Sichao Yang, *Senior Member, IEEE*

***Abstract*— Blockchain technology is becoming the cornerstone for the development and deployment of other technologies like Federated Learning (FL) and the Internet of Things (IoT), as it plays a critical role in data sharing and incentives. Blockchains supports decentralization, data-privacy protection, security, and reliability. Assuring secure data sharing in mobile computing and FL is challenging because of untrustworthy participants and unknown data quality. Blockchain provides trust in decentralized environments without requiring trusted third parties. By using smart contracts, blockchain has been able to supporting rich decentralized applications. However, the scalability of blockchain is a challenge that prevents its wide adoption by high-performance applications. To address the blockchain scalability issue, various blockchain sharding technologies and off-chain solutions have been proposed. To improve the network throughput, blockchain sharding divides the entire network into several smaller parallel groups and exploits fast consensus algorithms in blockchain shards. Off-chain solutions, such as payment channel networks (PCNs), transfer the slow on-chain transactions to the off-chain environment, in which transactions can be accelerated. Without consensus and on-chain expensive operations, off-chain scalable solutions significantly reduce transaction costs and increase transaction throughput. This special issue aims to provide a forum for the presentation of state-of-the-art research approaches that advance the construction of intelligent blockchain systems. A total of 27 articles were accepted after a two-round rigorous review process. Based on their topics, we have grouped the accepted articles into four categories: blockchain-based federated learning systems, blockchain and the IoT, blockchain scalability, and high-performance blockchains. In what follows, we introduce these articles and their contributions.**

Huawei Huang is with Sun Yat-sen University, Guangzhou 510275, China (e-mail: huanghw28@mail.sysu.edu.cn).

Salil Kanhere is with UNSW Sydney, Sydney, NSW 2052, Australia.

Jiawen Kang is with the Guangdong University of Technology, Guangzhou 510006, China.

Zehui Xiong is with the Singapore University of Technology and Design, Singapore.

Lei Zhang is with the University of Glasgow, Glasgow G12 8QQ, U.K.

Bhaskar Krishnamachari is with the University of Southern California, Los Angeles, CA 90007 USA.

Elisa Bertino is with Purdue University, West Lafayette, IN 47907 USA.

Sichao Yang is with Nakamoto and Turing Labs, New York, NY 10036 USA, and also with Columbia University, New York, NY 10032 USA.

Digital Object Identifier 10.1109/JSAC.2022.3212898

I. Blockchain and Federated Learning

ARTICLES in this category focus on blockchain-based FL systems. One article proposes a novel consensus mechanism and uses blockchain mining resources for FL training; two other articles focus on incentive mechanisms for FL, and other two investigate model aggregations in FL systems.

In [A1], Wang et al. propose an energy-recycling consensus mechanism that solves the Proof-of-Work puzzle and uses computing resources to conduct FL tasks. They extend typical blockchain components, like block structure and transaction types, and propose a new incentive for their proposed framework. The simulation results show the efficiency and effectiveness of their proposed mechanism.

In [A2], Wang et al. propose a blockchain-based incentive mechanism in a hierarchical FL setting, aiming to balance system overhead. Blockchain provides trusted environment, data privacy protection and economic incentives. They introduce a multi-layer Stackelberg game to obtain an optimal solution to the problem they propose.

In [A3], Zhang et al. investigate an incentive scheme for high-quality knowledge discovery. Specifically, they design a blockchain-based efficient and privacy-preserving quality-aware incentive scheme to achieve privacy, reliability, streamlined processing, and quality awareness. The experimental results show that their scheme has acceptable efficiency and affordable performance.

In [A4], Cui et al. propose a blockchain-based communication-efficient FL framework for fast model aggregation. They minimize the training loss subject to a limited training time to maximize the final model accuracy. The experimental results show that the proposed framework can significantly reduce communication traffic and training time.

In [A5], Nguyen et al. address a latency optimization problem for blockchain-based FL and design an offloading strategy to assist the machine learning (ML) model training. They propose a new decentralized ML model aggregation

solution to facilitate reliable ML model sharing. The numerical results show that their scheme outperforms other approaches with respect to model training efficiency, convergence rate, system latency, and robustness.

II. Blockchain and the Internet of Things

Articles in this category mainly focus on blockchain and the IoT. This category includes five articles investigating blockchain-based data sharing in the context of the IoT, one article introducing blockchain-based IoT data collection, and four articles focusing on offloading strategies; in particular, some articles focus on leveraging unmanned aerial vehicles (UAVs) for disaster assistance.

In [A6], Zhou et al. explore the service-oriented edge resource allocation in dense small-cell networks and mobile edge computing (MEC). They propose an image-sharing framework for fast image retrieval in MEC with storage limitations, while at the same time enhancing traceability and security of their framework using blockchain-based technologies.

In [A7], Wang et al. design a blockchain-enhanced federated learning market to facilitate the efficient use of data. Data sharing among trusted devices is enabled while guaranteeing high training quality given fixed budgets. Reward fairness and training security are also taken into account. The simulation results show that the proposed system significantly improves the overall system utility and the average accuracy of FL models.

In [A8], Zhang et al. explore payment channel networks to address data sharing issues in IoT settings. Aiming to improve the transaction success rate, they develop a homomorphic hashing-based transaction segmentation scheme and a multi-path routing scheme based on a multi-point relay mechanism. The simulation results show that the proposed approach achieves a high transaction efficiency and success ratio compared with baselines.

In [A9], Xue et al. study an intelligent access permission control for blockchain-based data sharing and propose an intelligent blockchain-based data-sharing scheme. They design a novel encryption scheme for flexible data authorization while guaranteeing three essential security properties. The evaluation results in both on-chain and off-chain environments show that their scheme achieves high computational and communication efficiency.

In [A10], Wang et al. integrate smart contracts and mobile devices to establish an interactive blockchain-based mobile crowdsensing system with security and fairness guaranteed. They offload the data evaluation process from the blockchain, aiming to reduce the on-chain computation costs. The simulation results show that their system can significantly cut overhead and defend against possible adversaries.

In [A11], Tang et al. explore a blockchain-based security supporting IoT data collection using UAVs. Their approach maximizes overall profits by a strategy that considers both IoT transmission and incentives. Furthermore, the proposed solution reduces the operational cost of data collection through the flexible deployment of UAVs.

In [A12], Yao et al. propose a blockchain-empowered collaborative task offloading scheme for cloud-edge-device computing. Participants can reach an agreement on task offloading by running a modified consensus algorithm. They show the superior performance of their solutions by implementing them in a commercialized blockchain platform.

In [A13], Tang et al. explore a traffic offloading problem in Space-Air-Ground integrated networks and propose a blockchain-based secure FL framework to assist traffic offloading. They further propose a node security evaluation and an enhanced practical Byzantine fault tolerance algorithm to ensure system security and improve network performance. The simulation results show that the proposed framework achieves superior performance.

In [A14], Seid et al. address the cost-saving computation offloading issue in IoT networks supported by aerial base stations. They propose a blockchain and multi-agent deep reinforcement learning integrated framework where blockchain support offloading security and the learning mechanism minimizes computation costs while maximizing the utility of UAVs.

In [A15], Liu et al. propose a framework for the blockchain-based offloading strategy to balance the fast transaction confirmation rate required by blockchain users and the transaction fees obtained by blockchain miners. The equilibrium in game theory is introduced to maximize the utility of blockchain users and miners. They also analyze two types of attack strategies to guarantee a high-level security.

III. Blockchain Scalability Issues

The articles in this category mainly focus on blockchain scalability issues, such as blockchain sharding solutions and off-chain solutions. Three articles explore blockchain sharding, whereas other three investigate different directions concerning off-chain blockchain networks, like transaction scheduling, routing, and security issues.

In [A16], Wang et al. combine a crowdsensed-data trading system with blockchain sharding, in which critical functions are recorded into a smart contract to avoid misuses. They propose a data uploading and processing mechanism for data collection and processing, and a grouping truth discovery for the data quality incentives.

In [A17], Zheng et al. propose a sharded consortium blockchain system called Meepo to achieve high cross-shard efficiency. The multi-state dependency in contract calls and strict transaction atomicity are taken into consideration. They also design a backup algorithm to enhance the robustness of blockchain shards.

In [A18], Hong et al. focus on blockchain sharding and propose a novel sharding scheme based on the idea of layered sharding. They design a cooperative cross-shard consensus to ensure the consistency of cross-shard transactions and a layered sharding optimization framework to maximize the transaction throughput.

In [A19], Luo et al. propose a priority-aware payment channel network (PCN) where transactions are scheduled with different priorities. Off-chain transactions are assigned with different priorities on each hop of their routing paths for efficient transportation and channel utilization. They also propose a multi-agent reinforcement learning-based priority-assignment algorithm.

In [A20], Du et al. explore the potential risks of the watchtower mechanism to protect the security of off-chain transactions. They propose anti-collusion multiparty smart contracts to constrain counterparts and avoid collusion with distributed watchtowers. Compared with the single watchtower mechanism, the proposed scheme improves the network throughput and reduce the false positive rate.

In [A21], Li et al. study the dynamic routing problems in off-chain network-based IoT. They propose a compact deep reinforcement learning algorithm for dynamic routing policy formulation with maximized long-term transaction efficiency. A proximal policy optimization algorithm is employed to ensure optimal routing performance. The simulation results show that the proposed approach achieves higher transaction efficiency than other baseline algorithms.

IV. High-Performance Blockchains

Articles in this category address high-performance blockchains. The five articles in this category investigate the broadcast mechanism in blockchains, the blockchain storage, arbitrage issues, transaction collision, and adaptive blockchain system, respectively.

In [A22], Wang et al. focus on the performance optimization of broadcasting in the blockchain system and propose a new broadcast mechanism, aiming to improve the system performance. An unsupervised learning algorithm and a greedy algorithm are used to optimize the peer-to-peer topology construction and broadcast algorithm. The proposed mechanism achieves low latency while guaranteeing a relatively stable cost in terms of redundant bandwidth.

In [A23], Liu et al. propose a Fee and Transaction Expiration Time (FTET) mechanism to solve the storage sustainability issue in blockchain. They analyze the heterogeneous miner interactions to find an equilibrium between storage cost and low-intensity user fee. Compared with the mining round time adjustment mechanism, the proposed mechanism achieves higher social welfare and better storage sustainability.

In [A24], Jin et al. study arbitrage issues in decentralized exchanges and provide an arbitrage detection solution on Ethereum using feature fusion and positive-unlabeled learning. They show that the proposed approach achieves a high detecting accuracy of arbitrage activities on Ethereum.

In [A25], Xu et al. explore a QoS-adjustable intelligent blockchain systems to address the transaction cardinality estimation problem. They design an efficient bit-string accessing mechanism and propose a cardinality-estimation protocol to improve estimation efficiency while guaranteeing accuracy requirements. The experimental results show that the proposed protocol is able to satisfy various system requirements on accuracy and efficiency.

In [A26], Chen et al. address the transaction-inclusion collision issue in directed acyclic graph (DAG)-based blockchain and propose a transaction inclusion protocol, aiming to reduce the transaction collision. They show that their protocol can defend against two security threats and achieve superior performance.

In [A27], Cao et al. consider that fixed regulations of the blockchain system are hard to adapt to changes in the environment and propose a new paradigm for defining the behavior of a consensus system. By adjusting the actual behavior of a consensus system to adapt to the current capacity of the Internet, the proposed paradigm can significantly improve throughput and latency metrics for Bitcoin.

V. Conclusion

This Special Issue has solicited 27 excellent articles in the direction of blockchains for future communications and networking. All those articles are organized into 4 categories in this guest editorial according to their topics, i.e., blockchain and federated learning systems, blockchain and the IoT, blockchain scalability, and high-performance blockchains. We wish the readers of this Special Issue can find inspirations when reading those outstanding articles.

Acknowledgment

The Guest Editorial team would like to express sincere appreciation to all the authors for submitting their articles to this Special Issue (SI) and all reviewers for their valuable comments and suggestions that have contributed to significantly enhance the quality of these articles. The Guest Editors are also grateful to Prof. Petar Popovski, Janine Bruttin, and Prof. Admela Jukan for their constructive suggestions and generous support throughout the whole review and publication process toward the success of this SI. Finally, the Guest Editors offer their special thanks to all the editorial staff.

Appendix: Related Articles

[A1] Y. Wang, H. Peng, Z. Su, T. H. Luan, A. Benslimane, and Y. Wu, "A platform-free proof of federated learning consensus mechanism for sustainable blockchains," 2022, *arXiv:2208.12046*.

[A2] X. Wang, Y. Zhao, C. Qiu, Z. Liu, J. Nie, and V. C. M. Leung, "InFEDge: A blockchain-based incentive mechanism in hierarchical federated learning for end-edge-cloud communications," *IEEE J. Sel. Areas Commun.*, early access, Oct. 13, 2022, doi: 10.1109/JSAC.2022.3213323.

[A3] C. Zhang, M. Zhao, L. Zhu, W. Zhang, T. Wu, and J. Ni, "FRUIT: A blockchain-based efficient and privacy-preserving quality-aware incentive scheme," *IEEE J. Sel. Areas Commun.*, early access, Oct. 10, 2022, doi: 10.1109/JSAC.2022.3213341.

[A4] L. Cui, X. Su, and Y. Zhou, "A fast blockchain-based federated learning framework with compressed communications," 2022, *arXiv:2208.06095*.

[A5] D. C. Nguyen, S. Hosseinalipour, D. J. Love, P. N. Pathirana, and C. G. Brinton, "Latency optimization for blockchain-empowered federated learning in multi-server edge computing," 2022, *arXiv:2203.09670*.

[A6] A. Zhou, S. Li, X. Ma, and S. Wang, "Service-oriented resource allocation for blockchain-empowered mobile edge computing," *IEEE J. Sel. Areas Commun.*, early access, Oct. 10, 2022, doi: 10.1109/JSAC.2022.3213343.

[A7] P. Wang et al., "Blockchain-enhanced federated learning market with social Internet of Things," *IEEE J. Sel. Areas Commun.*, early access, Oct. 13, 2022, doi: 10.1109/JSAC.2022.3213314.

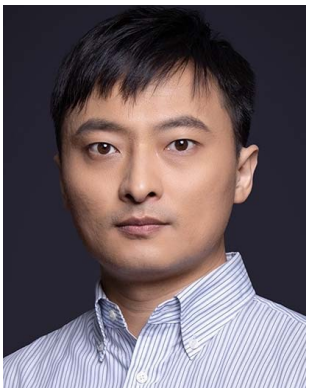
[A8] Y. Zhang, K. Gai, J. Xiao, L. Zhu, and K.-K. R. Choo, "Blockchain-empowered efficient data sharing in Internet of Things settings," *IEEE J. Sel. Areas Commun.*, early access, Oct. 12, 2022, doi: 10.1109/JSAC.2022.3213353.

[A9] L. Xue et al., "Blockchain-based data sharing with key update for future networks," *IEEE J. Sel. Areas Commun.*, early access, Oct. 10, 2022, doi: 10.1109/JSAC.2022.3213312.

[A10] W. Wang et al., "BSIF: Blockchain-based secure, interactive, and fair mobile crowdsensing," *IEEE J. Sel. Areas Commun.*, early access, Oct. 17, 2022, doi: 10.1109/JSAC.2022.3213306.

[A11] X. Tang, X. Lan, L. Li, Y. Zhang, and Z. Han, "Incentivizing proof-of-stake blockchain for secured data collection in UAV-assisted IoT: A multi-agent reinforcement learning approach," *IEEE J. Sel. Areas Commun.*, early access, Oct. 10, 2022, doi: 10.1109/JSAC.2022.3213360.

[A12] S. Yao et al., "Blockchain-empowered collaborative task offloading for cloud-edge-device computing," *IEEE J. Sel. Areas Commun.*, early access, Oct. 31, 2022, doi: 10.1109/JSAC.2022.3213358.
[A13] F. Tang, C. Wen, L. Luo, M. Zhao, and N. Kato, "Blockchain-based trusted traffic offloading in space-air-ground integrated networks (SAGIN): A federated reinforcement learning approach," *IEEE J. Sel. Areas Commun.*, early access, Oct. 13, 2022, doi: 10.1109/JSAC.2022.3213317.
[A14] A. M. Seid, J. Lu, H. N. Abishu, and T. A. Ayall, "Blockchain-enabled task offloading with energy harvesting in multi-UAV-assisted IoT networks: A multi-agent DRL approach," *IEEE J. Sel. Areas Commun.*, early access, Oct. 13, 2022, doi: 10.1109/JSAC.2022.3213352.
[A15] W. Liu, B. Cao, and M. Peng, "Blockchain based offloading strategy: Incentive, effectiveness and security," *IEEE J. Sel. Areas Commun.*, early access, Oct. 10, 2022, doi: 10.1109/JSAC.2022.3213324.
[A16] E. Wang et al., "Trustworthy and efficient crowdsensed data trading on sharding blockchain," *IEEE J. Sel. Areas Commun.*, early access, Oct. 21, 2022, doi: 10.1109/JSAC.2022.3213331.
[A17] P. Zheng, Q. Xu, Z. Zheng, Z. Zhou, Y. Yan, and H. Zhang, "Meepo: Multiple execution environments per organization in sharded consortium blockchain," *IEEE J. Sel. Areas Commun.*, early access, Oct. 12, 2022, doi: 10.1109/JSAC.2022.3213326.
[A18] Hong, "Scaling blockchain via layered sharding,"
[A19] X. Luo and P. Li, "Learning-based off-chain transaction scheduling in prioritized payment channel networks," *IEEE J. Sel. Areas Commun.*, early access, Oct. 12, 2022, doi: 10.1109/JSAC.2022.3213333.
[A20] M. Du, P. Yang, W. Tian, and Z. Han, "Anti-collusion multiparty smart contracts for distributed watchtowers in payment channel networks," *IEEE J. Sel. Areas Commun.*, early access, Oct. 17, 2022, doi: 10.1109/JSAC.2022.3213355.
[A21] Z. Li, W. Su, M. Xu, R. Yu, D. Niyato, and S. Xie, "Compact learning model for dynamic off-chain routing in blockchain-based IoT," *IEEE J. Sel. Areas Commun.*, early access, Oct. 13, 2022, doi: 10.1109/JSAC.2022.3213283.
[A22] X. Wang, X. Jiang, Y. Liu, J. Wang, and Y. Sun, "Data propagation for low latency blockchain systems," *IEEE J. Sel. Areas Commun.*, early access, Oct. 13, 2022, doi: 10.1109/JSAC.2022.3213330.
[A23] Y. Liu, S. Ke, Z. Fang, M. H. Cheung, W. Cai, and J. Huang, "A storage sustainability mechanism with heterogeneous miners in blockchain," *IEEE J. Sel. Areas Commun.*, early access, Oct. 17, 2022, doi: 10.1109/JSAC.2022.3213309.
[A24] H. Jin, C. Li, J. Xiao, T. Zhang, X. Dai, and B. Li, "Detecting arbitrage on ethereum through feature fusion and positive-unlabeled learning," *IEEE J. Sel. Areas Commun.*, early access, Oct. 13, 2022, doi: 10.1109/JSAC.2022.3213335.
[A25] H. Xu et al., "A transaction cardinality estimation approach for QoS-adjustable intelligent blockchain systems," *IEEE J. Sel. Areas Commun.*, early access, Oct. 12, 2022, doi: 10.1109/JSAC.2022.3213327.
[A26] C. Chen, X. Chen, and Z. Fang, "TIPS: Transaction inclusion protocol with signaling in DAG-based blockchain," *IEEE J. Sel. Areas Commun.*, early access, Oct. 10, 2022, doi: 10.1109/JSAC.2022.3213357.
[A27] M. Cao, H. Wang, T. Yuan, K. Xu, K. Lei, and J. Wang, "Meta-regulation: Adaptive adjustment to block size and creation interval for blockchain systems," *IEEE J. Sel. Areas Commun.*, early access, Oct. 13, 2022, doi: 10.1109/JSAC.2022.3213338.



Huawei Huang (Senior Member, IEEE) received the Ph.D. degree in computer science and engineering from the University of Aizu, Japan. He worked as a Research Fellow for the JSPS, and a Program-Specific Assistant Professor at Kyoto University, Japan. He is currently an Associate Professor with the School of Software Engineering, Sun Yat-sen University, China. He has published over 80 research papers on IEEE/ACM conferences and journals, including INFOCOM, ICDCS, IWQoS, IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS, IEEE TRANSACTIONS ON PARALLEL AND DISTRIBUTED SYSTEMS, IEEE TRANSACTIONS ON MOBILE COMPUTING, IEEE TRANSACTIONS ON COMPUTERS, IEEE TRANSACTIONS ON CLOUD COMPUTING, and IEEE TRANSACTIONS ON GREEN COMMUNICATIONS AND NETWORKING. He is a PI or a Co-PI of several research projects funded by NFSC, CCF, and Guangdong Basic and Applied Basic Research Foundation. His research interests include blockchain and distributed machine learning systems. He has served as the Operation-Committee Chair for IEEE Symposium on Blockchain at IEEE SERVICES 2021 and the TPC chair for blockchain workshops organized at multiple international conferences. He has served as a Leading Guest Editor for Blockchain Special Issues at IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS and IEEE OPEN JOURNAL OF THE COMPUTER SOCIETY.

Salil Kanhere (Senior Member, IEEE) received the M.S. and Ph.D. degrees from Drexel University, Philadelphia, PA, USA. He has held visiting positions at I2R Singapore, Technical University Darmstadt, University of Zurich, the Graz University of Technology, and RWTH Aachen University. He is currently a Professor with the School of Computer Science and Engineering, UNSW Sydney, Australia, where he leads the Information Security and Privacy Research Group. He is an Adjunct Professor at the Queensland University of Technology and is also affiliated with the UNSW Institute of Cybersecurity (IFCYBER). He has coauthored a book titled *Blockchain for Cyberphysical Systems*, published by Artech House. His research interests include the Internet of Things, cyber-physical systems, blockchain, pervasive computing, cybersecurity, and applied machine learning. He is a Senior Member of ACM. He received the Friedrich Wilhelm Bessel Research Award in 2020 and the Humboldt Research Fellowship in 2014 from the Alexander von Humboldt Foundation in Germany. He serves as the Editor-in-Chief for the *Ad Hoc Networks* journal and as an Associate Editor for the IEEE TRANSACTIONS ON NETWORK AND SERVICE MANAGEMENT, *Computer Communications*, and *Pervasive and Mobile Computing*. He has served on the organizing committee of several IEEE/ACM international conferences, including IEEE PerCom, IEEE/ACM IPSN, IEEE ICBC, IEEE DCOSS, EWSN, IEEE WoWMoM, and ACM MSWiM. He serves on the advisory board for three start-ups. He is an ACM Distinguished Speaker and an IEEE Computer Society Distinguished Visitor.

Jiawen Kang (Member, IEEE) received the Ph.D. degree from the Guangdong University of Technology, China, in 2018. He was a Post-Doctoral Researcher at Nanyang Technological University, Singapore, from 2018 to 2021. He is currently a Full Professor at the Guangdong University of Technology. He has published more than 90 research papers in leading journals and flagship conferences, including nine ESI highly cited papers and three ESI hot papers. He is the co-inventor of 15 granted patents. His research interests include blockchain, metaverse, edge intelligence, and security and privacy protection. He has won IEEE VTS Best Paper Award, IEEE Communications Society CSIM Technical Committee Best Journal Paper Award, IEEE Best Land Transportation Paper Award, and ten best paper awards of international conferences (e.g., WCNC 2020) as well. He has also severed as the Co-Chair for ICC Workshop, WCNC Workshop, ICDCS Workshop, GLOBECOM 2021 Workshop, and HPCC Workshop. He is listed in the World's Top 2% Scientists identified by Stanford University. He is also serving as an Editor or a Guest Editor for many leading journals, including IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS, IEEE TRANSACTIONS ON NETWORK SCIENCE AND ENGINEERING, and IEEE SYSTEMS JOURNAL.

Zehui Xiong (Member, IEEE) received the Ph.D. degree from Nanyang Technological University (NTU), Singapore. He was a Visiting Scholar at Princeton University and the University of Waterloo. He is currently an Assistant Professor at the Singapore University of Technology and Design, and also an Honorary Adjunct Senior Research Scientist with the Alibaba-NTU Singapore Joint Research Institute, Singapore. He is also serving as the Associate Director of Future Communications Research and Development Program. He has published more than 150 research papers in leading journals and flagship conferences and many of them are ESI highly cited papers. His research interests include wireless communications, the Internet of Things, blockchain, edge intelligence, and metaverse. He has won over ten best paper awards in international conferences and is listed in the World's Top 2% Scientists identified by Stanford University. He was a recipient of IEEE Early Career Researcher Award for Excellence in Scalable Computing, IEEE Technical Committee on Blockchain and Distributed Ledger Technologies Early Career Award, IEEE Internet Technical Committee Early Achievement Award, IEEE Best Land Transportation Paper Award, IEEE CSIM Technical Committee Best Journal Paper Award, IEEE SPCC Technical Committee Best Paper Award, IEEE VTS Singapore Best Paper Award, Chinese Government Award for Outstanding Students Abroad, and NTU SCSE Best Ph.D. Thesis Runner-Up Award. He is also serving as a Editor or a Guest Editor for many leading journals, including IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS, IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY, IEEE INTERNET OF THINGS JOURNAL, IEEE TRANSACTIONS ON COGNITIVE COMMUNICATIONS AND NETWORKING, IEEE TRANSACTIONS ON NETWORK SCIENCE AND ENGINEERING, IEEE SYSTEMS JOURNAL, and *JAS*.

Lei Zhang (Senior Member, IEEE) is currently a Professor of trustworthy systems at the University of Glasgow. He has academia and industry combined research experience on wireless communications and networks, and distributed systems for the IoT, blockchain, and autonomous systems. His 20 patents are granted/filed in more than 30 countries/regions. He published three books, and more than 150 papers in peer-reviewed journals, conferences, and edited books. He received the IEEE INTERNET OF THINGS JOURNAL Best Paper Award 2022, IEEE ComSoc TAOS Technical Committee Best Paper Award 2019, and IEEE ICEICT'21 Best Paper Award. He is the Founding Chair of IEEE Special Interest Group on Wireless Blockchain Networks in IEEE Cognitive Networks Technical Committee (TCCN). He delivered tutorials in IEEE ICC 2020, IEEE PIMRC 2020, IEEE GLOBECOM 2021, IEEE VTC 2021 Fall, IEEE ICBC 2021, and EUSIPCO 2021. He is an Associate Editor of IEEE INTERNET OF THINGS JOURNAL, IEEE WIRELESS COMMUNICATIONS LETTERS, and *Digital Communications and Networks*, and a Guest Editor of IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS.

Bhaskar Krishnamachari (Senior Member, IEEE) is currently a Professor of electrical and computer engineering at the Viterbi School of Engineering, University of Southern California. He is the Director of the USC Viterbi Center for Cyber-Physical Systems and the Internet of Things (CCI). He has expertise in designing algorithms and software for the Internet of Things, connected vehicles, distributed computing, machine learning, and blockchain technologies. He has coauthored more than 300 articles, and two text books, collectively cited more than 30,000 times (per Google Scholar). He was a co-recipient of several best paper awards, including at ACM MobiCom and ACM/IEEE IPSN. He has received the NSF CAREER Award and the ASEE Terman Award for outstanding electrical and computer engineering educators. He served as the General Co-Chair for the IEEE International Conference on Blockchain and Cryptocurrency (ICBC) in 2022. In 2011, he was listed in MIT Technology Review Magazine's TR-35 list of top 35 innovators under the age of 35, and in 2015 was named one of Popular Science magazine's "Brilliant 10." He has served as an Editor/Associate Editor for the IEEE/ACM TRANSACTIONS ON NETWORKS, *ACM Transactions on Sensor Networks*, the IEEE TRANSACTIONS ON WIRELESS COMMUNICATIONS, and the IEEE TRANSACTIONS ON MOBILE COMPUTING.

Elisa Bertino (Fellow, IEEE) is currently the Samuel D. Conte Professor of computer science at Purdue University. She works as the Director of the Purdue Cyberspace Security Laboratory (Cyber2Slab). In her role as the Director of the Cyber2Slab, she leads multi-disciplinary research in data security and privacy. Prior to joining Purdue, she was a Professor and the Department Head at the Department of Computer Science and Communication, University of Milan. She has been a Visiting Researcher at the IBM Research Laboratory (now Almaden), San Jose, CA, USA; Microelectronics and Computer Technology Corporation; Telcordia Technologies; and a Visiting Professor at Singapore Management University and the National University of Singapore. Her research interests include blockchain, cybersecurity and privacy of cellular networks and the IoT systems, and edge analytics and machine learning for cybersecurity. She is a fellow of ACM and AAAS. She received the 2002 IEEE Computer Society Technical Achievement Award for "outstanding contributions to database systems and database security and advanced data management systems," the 2005 IEEE Computer Society Tsutomu Kanai Award for "pioneering and innovative research contributions to secure distributed systems," the 2014 ACM SIGSAC Outstanding Contributions Award with citation "for her seminal research contributions and outstanding leadership to data security and privacy for the past 25 years," and the 2019–2020 ACM Athena Lecturer Award. She is the Co-Editor-In-Chief of *GeoInformatica* and has served as the Editor-in-Chief for the IEEE TRANSACTIONS ON DEPENDABLE AND SECURE COMPUTING, and an Editor of the *Synthesis Lectures on Information Security, Privacy, and Trust*.

Sichao Yang (Senior Member, IEEE) received the M.S. degree from the Department of Mathematics, University of Illinois at Urbana–Champaign, and the Ph.D. degree from the Department of Electrical and Computer Engineering, University of Illinois at Urbana–Champaign. He was a Senior Staff Engineer with Qualcomm Inc., the world's leading wireless communications chip and service provider. During his tenure with Qualcomm, he was one of the key contributors to the design and development of the 4th and 5th generation mobile communication. He also served as the Technical Leader in Qualcomm's research on vehicular network and autonomous driving and holds many invention patents. He is currently the Co-Founder and the CEO of Nakamoto & Turing Labs, a research laboratory engaged in scientific and engineering research in the fields of blockchain and artificial intelligence. He is also an Adjunct Professor with Columbia University and teaches blockchain and reinforcement learning graduate courses. He has many journals and conference papers, and also gave invited talks and tutorial sessions on IEEE conferences, including IEEE GLOBECOM and IEEE Summit on Communications Futures.