

# ULTRA-LOW-LATENCY AND RELIABLE COMMUNICATIONS FOR FUTURE WIRELESS NETWORKS



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We are delighted to introduce the special section on Ultra-Low Latency and Reliable Communications for Future Wireless Network. This issue introduces five high quality articles presenting discussions on new techniques and concepts, standards, future applications, network architectures, challenges, and promising solutions for ultra-high speed, low latency, and reliable communications in future networks. In the following, we will introduce these articles and highlight their main contributions.

The article entitled, “Communication and Computation O-RAN Resource Slicing for URLLC Services Using Deep Reinforcement Learning,” presents and discusses a two-level RAN slicing approach based on the O-RAN architecture to allocate the communication and computation RAN resources among URLLC end-devices. For each RAN slicing level, resource slicing problem as a single-agent Markov decision process is modeled, along with a deep reinforcement learning algorithm to solve it. The simulation results presented demonstrates the efficiency of the proposed approach in meeting the desired quality of service requirements.

In the article entitled, “Distributed Computation Offloading with Low Latency for Artificial Intelligence in Vehicular Networking,” the authors proposes a distributed computation offloading scheme which can be used to outsource the tasks of AI model computation to nearby vehicles and road side units in vehicular networking. Here, to alleviate the computational burden and reduce the latency of the computation at the vehicle side, the improved genetic algorithm is used to divide the computation of the sigmoid function into multiple sub-tasks.

The article entitled, “Device-to-Device Communications at the TeraHertz Band: Open Challenges for Realistic Implementation,” presents a comprehensive and interesting discussion on Terahertz channel modeling, communications, and offloading mechanisms. Here, the authors investigate the possibility to make effective use of the THz band for D2D communication.

The article, “Dimensioning Spectrum to Support Ultra-Reliable Low-Latency Communication,” presents an analysis to indicate that the bandwidth needed to meet URLLC goals can be in the order of gigahertz, beyond what is available in today’s mobile networks. Network densification can ease those bandwidth needs but requires new deployment strategies involving substantially larger numbers of sites. As an alternative, multi-connectivity and multi-operator network sharing are considered as efficient ways to reduce the demand for bandwidth without outright deployment of additional base stations.

The article, “Federated Learning Encounters 6G Wireless Communication in the Scenario of Internet of Things,” presents and discusses a novel federated learning architecture integrating 6G, called super-wireless-air federated learning framework, which enables data privacy protection and adapts to complex IoT scenarios. Further the authors present the detailed system design and key technologies of the proposed architecture.

We would like to express our sincere thanks to all the authors for submitting their articles and to the reviewers for their valuable comments and suggestions that significantly enhanced the quality of these articles. We are also grateful to Prof. Zander Lei, for the great support throughout the whole review and publication process of this series, and, of course, all the editorial staff. We hope that this special issue will serve as a useful reference for researchers, scientists, engineers, and academics in the field of Ultra-low Latency and Reliable Communications for Future Wireless Networks.

## BIOGRAPHIES

MUHAMMAD IKRAM ASHRAF (ikram.ashraf@nokia-bell-labs.com) received his M.Sc. and Ph.D. in telecommunication systems and communication engineering, respectively, from the University of Oulu, Finland. He is currently working as a Senior Research Specialist, 5G Advanced, at Nokia Bell Labs, Espoo Finland. Prior to that, he worked as an experienced researcher in Network Architecture and Protocols at Ericsson Research in Jorvas, Finland. He has contributed to several technical papers, invention disclosures, and 3GPP. His research interests include 5G Advanced, AI/ML, Industry 4.0, XR, positioning, IoT, V2X, UAV, URLLC, and TSN. He is serving as a series editor of *IEEE Communication Standards Magazine* on Ultra-Low-Latency, and Reliable Communications for Future Wireless Networks, an associate editor of *IET Quantum Communication*, and a guest editor of Elsevier’s *Journal of Industrial Information Integration* Special Issue on Data/Information Integration Techniques in Industry 4.0/5.0. Prior to that, he served as an editor of *IEEE Communication Standards Magazine*, a guest editor of *IEEE Wireless Communications*, an editor of *IEEE Transactions on Cognitive Communications and Networking*, and a guest editor of *IEEE Network*.

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editorial boards of many IEEE journals/transactions. He was the chair of the IEEE Communications Society Wireless Technical Committee and the chair of the TAOS Technical Committee. He served as an IEEE Computer Society Distinguished Speaker and is currently an IEEE ComSoc Distinguished Lecturer. He was listed as a Clarivate Analytics Highly Cited Researcher in Computer Science in 2019 and 2020.

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