future internet

MDPI

Editorial

Editorial for the Special Issue on Moving Towards 6G Wireless Technologies—2nd Edition

Alessandro Raschella * and Michael Mackay *

School of Computer Science and Mathematics, Liverpool John Moores University, Byrom Street, Liverpool L3 3AF, UK
* Correspondence: a.raschella@ljmu.ac.uk (A.R.); m.i.mackay@ljmu.ac.uk (M.M.)

Fifth-generation (5G) wireless networks have been key enablers for information societies over the last few years. Now, the sixth generation (6G) of wireless networks is under development, and the research community is preparing for the intelligent information societies of 2030 and beyond, targeting even more ambitious performance targets, such as peak data rates from 1 Tb/s, enhanced spectrum and energy efficiency, and extremely low-latency communications. The Special Issue of *Future Internet*, titled "Moving towards 6G Wireless Technologies 2nd Edition", focuses on the design, development, testing, and evaluation of 6G-enabling solutions to meet these ambitious goals. We published a total of six papers that covered a range of topics, including, among others, massive IoT applications, vehicular networks, and cell-free massive MIMO.

In paper [1], authors presented the end-to-end design, implementation, and experimental validation of three advanced Vehicle-to-Everything (V2X) use cases within a real-world 5G network environment: Cooperative Perception, Automotive Digital Twin, and Predictive Quality of Service (pQoS) for Tele-operated Driving (ToD). Trials at the 370-hectare IDIADA proving ground in Spain benchmarked 5G and Multi-access Edge Computing (MEC) against 4G and cloud alternatives. Experimental results demonstrated that 5G provides substantial performance gains, achieving average latency reductions up to 90% for V2X messages compared to 4G. Work in [2] presented a Q-learning-enhanced ad hoc on-demand distance vector (QL-AODV). This intelligent routing protocol uses reinforcement learning within the AODV protocol to support adaptive, data-driven route selection in highly dynamic aerial networks. QL-AODV offers four novelties, including a multipath route set collection methodology that retains up to ten candidate routes for each destination using an extended route reply (RREP) waiting mechanism, a more detailed RREP message format with cumulative node buffer usage, enabling informed decision-making, a normalized 3D state space model recording hop count, average buffer occupancy, and peak buffer saturation, optimized to adhere to aerial network dynamics, and a light-weighted distributed Q-learning approach at the source node that uses an ε-greedy policy to balance exploration and exploitation. In [3] the authors introduced a novel hybrid deep-learning framework, biogeography-based optimization (MOIBBO), convolutional neural networks (CNNs) and a long short-term memory (LSTM) model, aimed at optimizing secrecy energy efficiency in cell-free massive multiple-input multiple-output (CF m-MIMO)-based IoT networks. By integrating CNN for spatial feature extraction and LSTM for temporal modeling, the proposed method effectively learns dynamic network behaviors and security-aware energy management strategies. To enhance optimization efficiency, the MOIBBO algorithm was employed for hyperparameter tuning, ensuring a balance between model complexity, convergence speed, and predictive accuracy. Extensive simulation results validated the superiority of the proposed framework compared to several benchmark schemes. Work in [4]

Check for updates

Received: 9 November 2026
Accepted: 9 November 2026
Published: 12 November 2026

Copyright: © 2026 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license.

proposed a solution addressing the issues of maximizing access to massive IoT networks in future 6G networks. The authors have shown how existing approaches to the provisioning and deployment of wireless networks, both in unlicensed and cellular domains, are not suitable to address this problem without the need for prohibitive investment from operators and therefore present the need for cooperative spectrum usage as a solution. As such, authors have applied the concept of the sharing economy and reviewed the challenges and technological solutions that can be used in this context. Authors in [5] introduced a novel optimization approach based on a neural network (NN) model that is trained on genetic algorithm (GA) solutions. The simple model is easy to implement and allows for instantaneous adaptation to unexpected distribution changes. However, it has been demonstrated that NN faces difficulties in capturing the dependencies among neighboring cells. To address the problem, a classifier chain (CC), which chains multiple classifiers to learn output relationships, was integrated into the NN. Finally, Ref. [6] explored the 5G specifications to understand the most important list of identifiers and their use across Virtual Network Functions (VNFs) and points of exposure within the Core Network (CN). The authors also examined the existing literature regarding identity protections and efforts to mitigate privacy concerns targeted in the CN. Findings include the need for a trust relationship between users and their network providers to protect and safeguard their identity. While 5G technology has greater user identity protections compared to previous cellular generations, the analysis shows that several areas of concern remain, particularly in the exchange of subscriber metadata.

In conclusion, this Special Issue presented a range of papers that discuss the development and evaluation of key 6G-enabling solutions currently being addressed by the research community, which can help meet the ambitious goals of future 6G networks. We would like to thank all authors for their contributions to this Special Issue. We would also like to acknowledge all reviewers for their careful and timely reviews, which helped to improve the quality of this Special Issue.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Nasreddine, J.; Salvati, P.; Fuentes, M. Accelerating the Uptake of 5G for Automotive: Real-World Trials from the TARGET-X Project. *Future Internet* **2026**, *18*, 189. [CrossRef]
2. Ateya, A.A.; Tu, N.D.; Muthanna, A.; Koucheryavy, A.; Kozyrev, D.; Sztrik, J. QL-AODV: Q-Learning-Enhanced Multi-Path Routing Protocol for 6G-Enabled Autonomous Aerial Vehicle Networks. *Future Internet* **2025**, *17*, 473. [CrossRef]
3. Vaziri, A.; Moghaddam, P.S.; Shoeibi, M.; Kaveh, M. Energy-Efficient Secure Cell-Free Massive MIMO for Internet of Things: A Hybrid CNN–LSTM-Based Deep-Learning Approach. *Future Internet* **2025**, *17*, 169. [CrossRef]
4. Bouhafs, F.; Raschella, A.; Mackay, M.; Eiza, M.H.; den Hartog, F. Optimizing Radio Access for Massive IoT in 6G Through Highly Dynamic Cooperative Software-Defined Sharing of Network Resources. *Future Internet* **2024**, *16*, 442. [CrossRef]
5. Takabatake, W.; Shibata, Y.; Hoshino, K.; Ohtsuki, T. Time-Efficient Neural-Network-Based Dynamic Area Optimization Algorithm for High-Altitude Platform Station Mobile Communications. *Future Internet* **2024**, *16*, 332. [CrossRef]
6. Scalise, P.; Hempel, M.; Sharif, H. A Survey of 5G Core Network User Identity Protections, Concerns, and Proposed Enhancements for Future 6G Technologies. *Future Internet* **2025**, *17*, 142. [CrossRef]

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.