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GUEST EDITORIAL

Guest Editorial: Unfolding the potential of 5G technologies for future wireless networks

Abstract

With the rapid advancements in mobile Internet and smartphones, data traffic in current mobile communication systems is growing exponentially. At the same time, demands for lower latency, increased robustness, and higher energy efficiency are becoming more stringent. In response, 5G technology promises to meet these demands and is currently garnering extensive research interest from both industry and academia. 5G is not just an incremental improvement over its predecessors; it is a transformative technology designed to revolutionise mobile communications. By offering significantly higher speeds, reduced latency, and the ability to connect a massive number of devices simultaneously, 5G stands to impact a wide range of applications from autonomous vehicles to smart cities, healthcare, and beyond. Significant progress has been made in the standardisation and field deployment of 5G networks. Organisations such as the 3rd Generation Partnership Project (3GPP) have been instrumental in developing the standards that define 5G technologies. Moreover, various pilot projects and commercial deployments have been initiated around the world, showcasing the practical capabilities of 5G in real-world environments.

1 | INTRODUCTION

With the rapid advancements in mobile Internet and smartphones, data traffic in current mobile communication systems is growing exponentially. At the same time, demands for lower latency, increased robustness, and higher energy efficiency are becoming more stringent. In response, 5G technology promises to meet these demands and is currently garnering extensive research interest from both industry and academia.

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Despite the progress, several challenges remain that need to be addressed to fully realise the potential of 5G. These challenges span across different domains such as

- *Software Defined Wireless Networks (SDWN)*: SDWN allows for more flexible and efficient network management by decoupling the control plane from the data plane. Research is needed to enhance SDWN for 5G to handle the complex and dynamic nature of modern mobile networks.
- *Big Data (BD) and Internet of Things (IoT) in 5G*: The integration of BD analytics and the IoT with 5G networks can lead to smarter and more responsive systems. However, this integration poses challenges in data management, security, and scalability.
- *Energy Efficiency and Spectral Efficiency*: Energy efficiency is critical for the sustainability of 5G networks, especially with the proliferation of IoT devices. Similarly, spectral efficiency needs to be maximised to make the best use of the available frequency spectrum.
- *Interference Mitigation and Resource Management*: As the number of connected devices grows, so does the potential for interference. Effective resource management strategies are essential to mitigate interference and ensure reliable communication.

To address these challenges and support the continued development of 5G and future wireless networks, extensive research is required. Innovations in these areas will be crucial in overcoming the limitations and enhancing the capabilities of 5G networks. The current special issue is focused on research ideas, articles, and experimental studies related to '5G technologies', where we aimed to bring together academic and industrial researchers to identify and discuss the major opportunities and challenges in applying 5G technologies to the understanding and designing of modern network systems.

2 | PAPERS IN THE SPECIAL ISSUE

In this special issue, we have received 14 papers, all of which underwent peer review. Of the 14 originally submitted papers, five have been accepted. Thus, the overall submissions were of high quality, which marks the success of this special issue.

Non-orthogonal multiple access (NOMA) strategies enhance spectral efficiency in fifth and sixth-generation wireless networks, enabling large-scale access. Key components include user-grouping, power management, and decoding order. Bataineh et al. proposed an algorithm which optimises these elements to maximise spectral efficiency in NOMA uplink systems while reducing computational complexity. Traditional solutions were complex, prompting the use of the nature-inspired Lévy-flight firefly algorithm for power control and user grouping. This method improves performance and reduces complexity. Numerical evaluations show that the Lévy-flight firefly algorithm outperforms standard orthogonal multiple access and the conventional firefly algorithm in spectral efficiency and reduced system complexity.

With the rapid development of the IoT and communication technology, network multimedia has become a prominent mass media form, offering rich sensory experiences. However, issues such as insufficient original content and unintelligent information retrieval pose challenges for users. To address these, Zhang combined BD and virtual Artificial Intelligence (AI) technologies to enhance network multimedia's intelligent design. This approach significantly improved information retrieval speed and accuracy. For example, query times were reduced by 1.87 s for 1000 items and 18.16 s for 40,000 items compared to traditional methods. This method also improved the accuracy of information recommendations, enhancing user experience and expanding IoT applications.

IoT network deployments are crucial for 4G, 5G, and future 6G systems, driving massive connectivity. In 6G, IoT will integrate with new technologies such as integrated sensing and communications, creating new use cases and business models. As IoT devices and cellular networks advance, the IoT ecosystem bridges human and digital life, accelerating the transition to a hyper-connected world. Kim presented an algorithm which investigates the IoT device deployment problem to minimise transmission and computation costs among network nodes. The problem is formulated as mixed-integer non-linear programming and transformed into a mixed-integer linear programming problem. A new branch and bound (BB) method with a machine-learning function is proposed. Numerical analysis shows that the proposed BB method significantly outperforms the conventional BB method in terms of objective function values, explored nodes, and computational time.

The rapid increase in mobile device usage and the resulting data volume necessitated the utilisation of the 5G network spectrum. Currently deployed in a non-stand-alone (NSA) mode, 5G networks are supported by 4G LTE networks. This setup, combined with the vast number of mobile subscribers, challenges the selection of radio access technology (RAT) between 4G and 5G networks. Factors such as location, bandwidth requirements, and mobility influence this choice. To address this issue, Salau et al. recorded live signal measurements from 4G and 5G networks for a travelling user across multiple 5G NSA base stations. They implemented RAT selection using support vector machine, deep neural network, and eXtreme Gradient Boosting (XGBoost) algorithms. Results showed XGBoost achieved the highest accuracy of 99.64%.

The rapid evolution of IoT and wireless communication technologies is transforming our lives and work environments. IoT devices often share personal information over public networks using nearby devices, making the trustworthiness of these devices crucial for security and privacy. Roy et al. propose an autonomous decentralised trust management model that selects trustworthy devices for service transactions using the social IoT. This model leverages social relationships to assess trust among devices, estimate the trustworthiness of unknown devices, update trust values periodically, and isolate malicious nodes. Regular updates enhance performance and detect trust-related attacks. Simulation results show that this model outperforms existing trust management systems, effectively detecting and handling malicious devices by early isolation.

3 | SUMMARY

All papers selected for this special issue deal with 5G (and further 6G) technology for future wireless communications, showing that this field is steadily developing. 5G and 6G communications technologies promise ultra-high speeds, low latency, and massive connectivity, driving innovation in IoT, AI, and immersive experiences and revolutionising industries and daily life.

AUTHOR CONTRIBUTIONS

Gwanggil Jeon: As a lead guest editor, write guest editorial. Other guest editors contributed to the analysis of the published articles.

KEYWORDS

5G mobile communication, wireless channels

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We wish to express our gratitude to all the contributors who submitted novel scientific results to this special issue and to the anonymous reviewers whose expertise made this endeavour possible. We hope this effort will contribute to the further development of 5G/6G technologies and heighten interest within the scientific and technological community. Finally, we extend our appreciation to the journal's Editors-in-Chief and the Editorial Office for their unwavering support throughout this venture.

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DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

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