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Editorial

Editorial for the Special Issue on 5G Enabling Technologies and Wireless Networking

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The ongoing deployment of 5G networks is seen as a key enabler for realizing upcoming interconnected services at scale, including the massive deployment of the Internet of Things, providing V2X communications to support autonomous vehicles, and the increase in smart homes, smart cities, and Industry 4.0. The Special Issue of *Future Internet* titled "5G Enabling Technologies and Wireless Networking" focuses on 5G-enabling technologies to meet these access, efficiency, and performance requirements and facilitates coordinating wireless networks to support future deployments. We published a total of five papers that covered a range of topics from practical 5G deployment experiences in non-public and vehicular networks to applying technologies such as service chaining and self-organising Networks (SONs) to network operations. As such, we have grouped the published work into two broad categories: the first discusses practical issues related to 5G deployments while the second looks at enabling technologies and how they can supplement or extend current existing 5G networks.

In the first group, we have three papers focusing on a range of issues related to current 5G wireless networks. In the first paper [1], the authors present the results of their work to model and predict the performance of millimeter wave (mmWave) backhaul links that were deployed as part of the Liverpool 5G network. Based on the properties of the 802.11ad protocol and the physical characteristics of the environment, they simulated how each link performed with different signal-to-noise ratios (SNR) and packet error rate (PER) values and verified them against real-world deployed links. The results showed a good convergence between the simulated and real results and provide a solid foundation for further network planning and optimization. This type of practical deployment experience, particularly around non-public networks also provides useful insights into how 5G deployments can be optimised going forward. In the second paper, Ricciardi Celsi et al. [2] took a different approach and proposed a data-driven strategy for predicting customer service technical ticket reopening for 5G fiber telecommunications companies. Their main aim was to ensure that the service level agreement between the end user and service provider was satisfied in terms of the perceived quality of service. The authors made a detailed comparison of different approaches to classification—ranging from decision trees to artificial neural networks and support vector machines—and found that a Bayesian network classifier is the most accurate at predicting whether a monitored ticket will be reopened or not. This work again provides useful insights into how 5G networks can be managed as user numbers continue to grow and become denser and the potential for congestion or other issues increases. Finally, from a practical perspective, Hota et al. [3] reviewed the applications, characteristics, and challenges faced in the design of MAC protocols in 5G vehicular environments. They presented a classification of MAC protocols based on the metrics of contention mechanisms and channel access. In the first case, contention was listed as contention-based, contention-free, and hybrid, whereas channel access was categorized as being distributed, centralized, cluster-based, cooperative, token-based, or random access. The paper gives an analysis of the objectives, mechanisms, advantages/disadvantages, and simulators used in each protocol and provides a discussion on the future scope and

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open challenges for improving MAC protocol's design. This is important because vehicular networks continue to be an important use case for 5G so new insights into MAC protocol's design may lead to performance improvements in the future as these networks expand.

In the second group, we consider more theoretical supporting technologies that can be utilised to enhance the performance of existing 5G networks. The paper by Moreno et al. [4] presented a multi-objective optimization framework for service function chain deployment in the context of live-streaming in virtualized content delivery networks. Specifically, they developed an enhanced exploration, dense reward mechanism over a Dueling Double Deep Q Network (E2-D4QN) for container-based network function virtualization. Their simulation results demonstrated that their approach can provide substantial QoS/QoE performance improvements and adapt to the complexities of live-video deliveries for general-case service function chain deployments. NFV and service chaining are important concepts in networking research and are seen as fundamental concepts for future 5G networks. In addition to this, in Papidas and Polyzos [5], the authors described self-organizing network (SON) concepts and architectures and their potential to play a central role in 5G deployment, focusing on a basic SON use case applied to radio access networks (RANs). They first analyzed SON applications' rationale and operation and the design and dimensioning of SON systems before highlighting possible deficiencies and conflicts that occur via the parallel operation of functions. As part of this, they also described the strong reliance on machine learning (ML) and artificial intelligence (AI) to enable this approach. Finally, they presented and commented on recent proposals for SON deployments in 5G networks. As stated above, SON is seen as a very desirable feature in future wireless networks due to the dynamic nature of the medium and the need for continuous rapid adjustments to both maximise performances and to ensure robustness.

In conclusion, this Special Issue presented a range of papers that present an up-to-date view on the ongoing 5G roll-out and the issues that are currently being addressed in the research community. On the one hand, now that 5G is deployed, we are starting to gain important insights into how the current generation of wireless networks perform in practice and how they can be managed effectively or applied in different use cases. Meanwhile, on the other hand, we are now starting to explore how new technologies can be integrated into the 5G platform to lay the foundation for future generations as we move towards Beyond 5G and 6G networks.

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