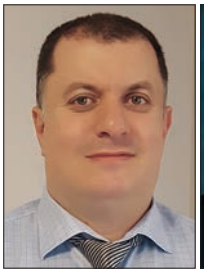
MACHINE LEARNING-ENABLED ZERO TOUCH NETWORKS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With the continued growth of IoT devices and their deployment, manually managing and connecting them is impractical and presents multiple challenges. To that end, zero touch networks (ZTNs), which rely on software-based modules instead of dedicated proprietary hardware, become a viable potential solution. The overall aim of ZTNs is for machines to learn how to become more autonomous so that we can delegate complex, mundane tasks to them. Thus, ZTNs are able to monitor networks and services and act on faults with minimal (if any) human intervention, including the early detection of emerging problems, autonomous learning, autonomous remediation, decision making, and support of various optimization objectives. As a result, ZTNs are able to offer self-serving, self-fulfilling, and self-assuring operations.

Artificial intelligence (AI), machine learning (ML), and deep learning (DL) technologies are viewed as foundational pillars for ZTNs. This is because they allow systems to be more autonomous and efficient. Moreover, they simultaneously help reduce human intervention. Having systems that are automated, intelligent, flexible, scalable, easily configurable, dynamic, secure, and privacy-preserving is "extremely" desired.

The Call for Papers for this Feature Topic (FT) attracted a good number of high-quality submissions. All submissions have been reviewed by at least three arm's-length reviewers. The articles in this FT highlight the latest research, development, and findings in the management and orchestration of ZTNs.

Networking slicing is a key enabling technology for 5G and beyond networks. It allows the network to be customized for each application or service, by chaining together different virtualized network functions (VNFs). However, the increased flexibility offered by network slicing comes at the cost of complexity in management and orchestration, which cannot be solved by traditional reactive human-in-the-loop solutions. This necessitates minimizing human intervention through the use of AI techniques (ZTN management). The first article in this FT by Saha *et al.* surveys various deep reinforcement learning (DRL)-based approaches and highlights key challenges and open issues in the effective use of DRL for network slice scaling and placement.

The second article in this FT, by Naeem *et al.*, considers the security and privacy challenges in the ZTN and service management (ZSM) paradigm. The article proposes a federated-learning-empowered semi-supervised active learning (FL-SSAL) security orchestration framework. In the proposed framework, the entropy-based active learning efficiently learns the most informative data samples for data annotation and uses unlabeled data in a semi-supervised approach that achieves higher detection accuracy with lower communication overhead.

The next-generation network infrastructure of ZTNs and their integration with the Internet of Things is introduced in the third article by Kumar *et al.* The article surveys the various deep learning and blockchain-based approaches developed to address the secure data sharing challenge encountered with ZTNs. A secure data sharing framework using deep learning and blockchain technology is proposed and evaluated.

The fourth article, by Iacoboaie *et al.*, comments on implementation experience in designing and deploying DRL for zero touch wireless local area networks (WLANs). The article discusses as well the challenges that arise when DRL is deployed in large-scale operational WLAN to achieve zero touch operation.

Zero touch solutions enabling self-X (e.g., self-configuration, self-monitoring, and self-healing) services to support pervasive AI (PAI) in 6G networks is introduced in the fifth article by Baccour *et al.* Furthermore, the article presents a horizontal and vertical end-to-end architecture framework designed for closed-loop automation of PAI management.

The state-of-the-art RL approaches that address radio resource management in radio access network (RAN) slicing is surveyed by Zangooei *et al.* in the sixth article. The article explains how different network environments can be modeled as a Markov decision process (MDP) and what RL algorithms can be used to solve them. It identifies challenges to be considered in RL-based RAN slicing and assesses how successfully they have been addressed to date.

The seventh article, by Filali *et al.*, addresses slicing challenges and solutions in radio access networks (RANs) while considering the frequent changes of environment constraints and service requirements. Furthermore, the article presents a federated DRL approach for RAN slicing where mobile virtual network operators can collaborate to improve the performance of their slicing models.

The Guest Editors deeply appreciate the reviewers for their time, effort, and insightful comments. Both Guest Editors also would like to thank Antonio Sanchez Esguevillas, Editor-in-Chief, and Alberto Perotti, Associate Editor-in-Chief for their support in organizing and finalizing this FT.

BIOGRAPHIES

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