Machine Learning-Enabled Zero Touch Networks

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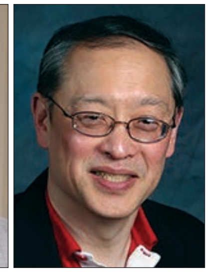

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With the continued growth of IoT devices and their deployment, manually managing and connecting them is impractical and presents multiple challenges. To that end, Zero Touch Networks (ZTNs) that rely on software-based modules instead of dedicated propriety hardware become a viable potential solution. The overall aim of zero-touch networks is for machines to learn how to become more autonomous so that we can delegate complex, mundane tasks to them. Thus, Zero Touch Networks 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 scaling, remediation, decision making, and support of various optimization objectives. As a result, Zero Touch Networks 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 Zero Touch Networks. 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 Articles 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 Zero-Touch Networks.

Application of AI and ML to IoT networks is the topic of the first two articles in the FT. The first article by Ghosh *et al.* reviews recent progress on light-weight machine learning aided strategies for context-aware IoT applications, using the options of placing intelligence at the field node, edge node or in centralized cloud storage. The article identifies requirements for fully autonomous and self-healing IoT networks, highlighting future challenges in the areas of energy, security and auto-reconfiguration.

The second article by Chi and Radwan looks to 6G IoT networks and proposes a potential new measure for performance merit in 6G AI-IoT development. This is referred to in the article as quality of things' experience (QoTE). This proposed measure would be used for evaluation of AI-IoT-based technologies and applications for network deployment in 6G.

The use of Reinforcement Learning methods is another key area for Zero Touch Networks and autonomous operation. The third article by Soto *et al.* looks at scalability and the scaling operation, a key Management and Orchestration (MANO) operation to allow networks to adapt to unexpected changes. Two prominent scaling methods, one based on data-driven Reinforcement Learning (RL) and the other based on classical control theory, are compared showing that only the data-driven approach is adaptable enough to achieve automation.

A fourth article by Sharma *et al.* focuses on the use of intent-based management in autonomous systems. It defines an intent negotiation framework which can be used to develop intent negotiation solutions for intent-driven service management (IDSM) platforms. The authors identify the processes that are necessary for intent negotiation and define a generic intent negotiation framework. The results of their research demonstrate that the proposed framework increases the intent acceptance rate by up to 38 percent with processing overheads less than 10 percent

The last two articles address identification and security issues for Zero Touch Network devices and networks. The article by Hamdaoui *et al.* proposes the novel use of MIMO diversity to mitigate the impact of channel variability for device identification over flat fading channels. The authors' research shows that use of MIMO diversity can increase the device classification accuracy by up to about 50 percent when model training and testing are done over the same channel and by up to about 70 percent when training and testing are done over different fading channels.

The last article by Kalapaaking *et al.* proposes an intrusion detection system (IDS) for a zero-touch network automation process that leverages ML and microservice technology to improve trustworthiness. Selected features are passed to different models to blend their predictions using ensemble learning. The results of experiments conducted demonstrate improved reliability of the proposed IDS across multiple different evaluation metrics.

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

Abdallah Shami (abdallah.shami@uwo.ca) is the Acting Associate Dean Research and a Professor at the ECE department at Western University, Ontario, Canada. Dr. Shami's research interests are in the area of future networks, network automation and smart systems. He is currently an Associate Editor for *IEEE Transactions on Mobile Computing*, *IEEE Internet of Things Journal*, and *IEEE Communications Surveys and Tutorials*. He was the elected Chair of the IEEE Communications Society Technical Committee on Communications Software and IEEE London Ontario Section Chair (2016–2018).

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