

## EMERGING TRENDS, ISSUES, AND CHALLENGES IN BIG DATA AND ITS IMPLEMENTATION TOWARD FUTURE SMART CITIES



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The world is experiencing a period of extreme urbanization. Moreover, this process will continue, and the global urban population is expected to double by 2050. Smart city has been proposed to improve the efficiency of services and meet residents' needs for better quality of life. Essentially, smart city integrates the Internet of Things and emerging communication technologies such as fifth generation (5G) solutions to manage the city's assets, including transportation systems, hospitals, water supply networks, waste management, and so on. Therefore, smart city is driving innovation and new technologies, especially big data technologies for the big data era. In the future smart city, there is an urgent need to address the following issues: how to design algorithms to process mass data and how to utilize big data to improve the quality of service (QoS) for future smart cities. These are a couple of the questions that need answers in order to achieve the ultimate goal of a smart city that can provide high quality of life to its citizens.

In this *IEEE Communications Magazine* Feature Topic (FT), the Guest Editors invited experts from research communities to discuss the emerging trends, issues, and challenges in big data and its implementation toward future smart cities. After a rigorous review process, 20 papers were selected to be published in this FT, seven in Part 1, another seven in part 2, and the rest in Part 3.

In the Internet of Things (IoT) for smart cities, node failure due to malicious attacks may deteriorate the performance in terms of both reliability and survivability. The first article, by T. Qiu *et al.*, "A Data-Driven Robustness Algorithm of the Internet of Things for Smart Cities," proposes a Multi-Population Genetic Algorithm (MPGA)-based approach to improve the robustness of network topology. The extensive experimental results show that the proposed approach significantly improves the robustness of topologies against malicious attacks.

It is challenging to obtain multimedia big data securely in various social network applications with the prevalence of digital devices. C. Zhu *et al.*, in "Secure Multimedia Big Data in Trust-Assisted Sensor-Cloud for Smart City," investigate secure multimedia big data application in trust-assisted sensor-cloud (TASC) for smart city, while proposing two types of TASC: TASC-S (TASC with single trust value threshold) and

TASC-M (TASC with multiple trust value thresholds). Simulation results show both TASC-S and TASC-M behave well.

To improve the performance of applications for smart cities, integrating networking, caching, and computing resources is indispensable. Y. He *et al.*, in "Software-Defined Networks with Mobile Edge Computing and Caching for Smart Cities: A Big Data Deep Reinforcement Learning Approach," propose an integrated framework that can enable dynamic orchestration of networking, caching, and computing resources. Then a novel big data deep reinforcement learning approach is proposed. Simulation results show the effectiveness of the proposed scheme.

An improvement in wireless communication and efficient content dissemination to citizens is indispensable for future smart cities. K. Machado *et al.*, in "A Socially-Aware In-Network Caching Framework for Next-Generation Wireless Networks," present a study of the spatiotemporal characteristics of New York citizens. An opportunistic network model with D2D capabilities is used to estimate temporal properties of users' proximity graph and the dissemination of content. The results demonstrate the feasibility of D2D.

To achieve precise big data analytics and make real-time decisions for future smart cities, it is challenging to efficiently deliver huge amounts of collected data to the processing servers. The next article, by Y. Bi *et al.*, "Time-Constrained Big Data Transfer for SDN-Enabled Smart City," proposes a novel architecture to support smart city services based on the software defined networking (SDN) technology, while presenting an intelligent strategy to address the time-constrained big data transfer scheduling (TBTS) issue. Simulation results demonstrate that the proposed strategy is efficient.

IEEE 802.11ax, introducing fundamental improvement of IEEE 802.11 WLANs, was approved as the next generation WLAN technology for future smart cities, which satisfies tremendous user demand and fuels future intelligent information infrastructure to serve big data transportation and diverse smart application scenarios. D. Deng *et al.*, in "IEEE 802.11ax: Highly Efficient WLANs for Intelligent Information Infrastructure," overview the new and key technology features of IEEE 802.11ax, such as OFDMA PHY, UL MU-MIMO, spatial reuse, OFDMA random access, power saving with TWT, STA-2-STA operation, and reference operations.

Fog computing offloads computation tasks to local fog servers (LFSs) to cater for the big data of the Internet of Vehicles (IoV), which overcomes the inherent defect of centralized data processing in cloud computing. W. Zhang *et al.*, in “Cooperative Fog Computing for Dealing with Big Data in the Internet of Vehicles: Architecture and Hierarchical Resource Management,” propose a cooperative fog-computing-based intelligent vehicular network (CFC-IoV) architecture for dealing with transportation big data in smart cities. Moreover, possible services for IoV applications are discussed.

In closing, we would like to thank all the people who have made contributions to this FT. We believe that the research results presented in this FT will stimulate further research and development ideas in big data and its implementation toward future smart cities.

### BIOGRAPHIES

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