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Editorial

Green Communications in Smart Cities

Naveed Ul Hassan [1,*], **Chau Yuen** [2] and **Xiaoming Chen** [3]

1 Department of Electrical Engineering, Lahore University of Management Sciences, Lahore 54792, Pakistan
2 Engineering Product Development (EPD), Singapore University of Technology and Design (SUTD), Singapore 487372, Singapore
3 College of Information Science and Electronic Engineering, Zhejiang University, Hangzhou 310016, China
* Correspondence: naveed.hassan@lums.edu.pk

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1. Introduction

As the vision of smart cities becomes a reality, the number of sensors, devices, and embedded platforms deployed in our surroundings is rapidly increasing. The communication requirements of various systems and sub-systems in smart cities that are expected to improve our well-being are also increasing. The energy requirements for providing connectivity to billions of new devices and trillions of message exchanges between these devices would contribute significantly towards greenhouse gas emissions. Green communication enabling technologies and solutions are therefore critical for sustainable, smart cities.

Green communication in a smart city is challenging due to the following reasons: massive machine type devices; a diverse range of applications with different qualities of service; traffic requirements and deployment scenarios; a wide range of equipment and hardware involved; numerous energy efficiency tradeoffs; and heterogeneous communication and networking protocols, technologies, and architectures.

2. Overview of Papers Published in Current Issue

There are thirteen articles published in this Special Issue. These papers cover a wide range of challenging problems and provide several exciting solutions. In these papers, novel algorithms and solutions are proposed in the areas of 5G communication systems, indoor and outdoor positioning, resource management and load balancing in complex heterogonous networks, and green buildings and smart power grids. Several future research directions are also identified.

Fast, reliable, and efficient communication infrastructure is critical for any smart city application and there is lot of research interest in 5G communication systems and their enabling technologies. To improve the uplink sum rate in massive multi-input-multi-output (MIMO) systems, a new pilot allocation algorithm is proposed in [1] based on a cell with the worst channel quality. A coordinated mutil-cell multicast precoding scheme for massive MIMO systems is developed in [2] assuming only statistical channel state information of users. The proposed power allocation algorithm is shown to outperform conventional uncoordinated schemes, particularly for cell-edge users. To meet the demands of future green communication, a novel, low-complexity, direction of arrival estimation algorithm is developed for massive MIMO systems in [3]. This algorithm is based on a new frame structure for downlink transmission and can fully exploit the priori information under the channel codebook feedback mechanism. An efficient three-dimensional ray tracing model for radio wave propagation at 28 GHz in an indoor environment is developed in [4]. This model provides excellent agreement between the simulated and measured data.

Device to device (D2D) communication techniques facilitate direct communication between cellular users. In 5G communication systems with a large number of small cells, such techniques can reduce the backhaul communication requirements and reduce latency. An efficient novel algorithm based on the social and physical channel characteristics of the users for peer selection in D2D communication is proposed in [5]. There is a wide choice of frequency bands in 5G communication systems. Using the concept of radio spectrum value, the selection of appropriate frequency bands in different scenarios (line of sight, non-line of sight, indoor, outdoor) to maximize the efficiency in terms of spectrum, cost, and energy for green communication in a smart city is investigated in [6].

High accuracy and energy efficient localization algorithms are also important for smart city applications. A highly accurate positioning algorithm based on dual frequency pseudo-range and carrier phase raw data from multiple Global Navigation Satellite Systems (GNSS) is developed in [7]. The algorithm makes use of the new range of smartphones, which can simultaneously receive dual-frequency signals from multiple GNSS. For indoor environments, a new collaborative method based on D2D communication is proposed in [8] to improve the positioning accuracy provided by the Wi-Fi fingerprinting method. The use of D2D communication not only increases the localization accuracy but also reduces the overall infrastructure requirements and computational complexity, and therefore contributes to achieving the objectives of green communication in smart city applications.

Modern communication networks tend to be highly heterogeneous with constantly increasing data traffic. Optimal management of network resources and load balancing are important issues in such networks. In [9], the load balancing problem is considered in cloud data centers with unbalanced network resources. Multiple virtual machine placement algorithms are proposed to save energy and costs. In [10], a new traffic flow splitting model is proposed for 5G vehicle networking terminals. The proposed strategy jointly optimizes delay and cost and provides efficient splitting of services in 5G vehicle to X (V2X) networks.

For efficient and stable operation of power grids, electricity supply has to be matched with electricity demand. However, electricity demand is highly variable and depends on weather changes as well as the energy consumption behavior of users. A short-term electricity load forecasting algorithm has been developed in [11]. Leveraging the availability of data, deep learning and data mining techniques are applied to achieve relatively high forecasting accuracy.

Large amounts of energy are consumed inside buildings and there is a growing interest in building energy management systems. To efficiently utilize diverse and unrelated information from various building systems and sub-systems for energy efficiency improvements, an ontology=based framework is proposed in [12]. Various interconnected modules and inference rules in the framework enable an understanding of the appropriate context in determining the cause of building energy inefficiency or abnormality, along with the identification of mitigating control actions.

For sustainable mobility solutions in a smart city, a bike sharing system based on pedal assisted electric bicycles is proposed for Bogota City in [13]. The proposed system includes the design of an embedded platform as well as all the required hardware. This is a highly localized and low-cost solution adapted to the local context.

All the articles in this Special Issue describe the most recent advances and developments in the domain of green communication for smart cities. We hope that readers will greatly benefit from the technical contributions in these papers. The diversity of topics will also appeal to the wider technical community.

Conflicts of Interest: The authors declare no conflict of interest.

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