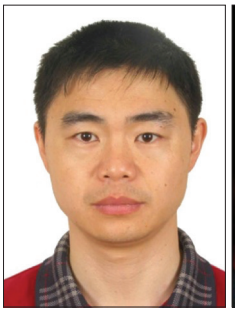
SOFTWARE DEFINED WIRELESS NETWORKS: PART 2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The concept of software defined wireless networks (SDWN) has been rapidly evolving as the solution to meet the demand for dynamic wireless services in ubiquitous computing. In SDWN, the control plane and data plane are decoupled, network intelligence is logically centralized, and the underlying network infrastructure is abstracted from the applications. Thus it highly simplifies network administration and management, which facilitates the dynamic nature of future network functions and intelligent applications while lowering operating costs through simplified hardware, software, and management. This is the second part of the "Software Defined Wireless Networks (SDWN)" Feature Topic. In Part 1, which was published in November 2015, we provided an overview of the latest major developments and progress in SDWN architecture. In this Part II, we present articles that provide fruitful insights into selected topics such as Cloud-RAN management, flexible spectrum management, SDWN security, and SDN-based self organizing strategies. We believe that it complements Part I, and together they provide a holistic overview of features and trends in future SDWN development.

Future radio access networks (RANs) of cellular systems need to provide elastic service to dynamic traffic demands. The first article, "Software-Defined Hyper-Cellular Architecture for Green and Elastic Wireless Access" by Zhou *et al.*, reviews the state of the art which aims to renovate RANs from the perspective of control traffic, decoupled air interface, and software definability. The proposed and evaluated software-defined hyper-cellular architecture (SDHCA) is addressing enabling technologies such as the separation of the air interface, green base station operation, and base station function virtualization. Further, the authors summarize several future research directions on software-defined systems.

The second article, "Securing Software Defined Wireless Networks" by He *et al.*, delves into the important issue of security in SDWN. On one hand, SDWN enables new security mechanisms. On the other hand, new threats are introduced due to the separation of the control plane and data plane and its centralized logic. In lieu of these, the authors discuss threat vectors for SDWN, as well as design issues in making it secure. Security requirements of SDWN are analyzed, with security attacks and countermeasures summarized. Future research directions are often manifested.

The Cloud-RAN architecture enables dynamic configuration of base stations via virtualization technology. The third article, "Elastic Resource Utilization Framework for High Capacity and Energy Efficiency in Cloud-RAN" by Pompili *et al.*, proposes to utilize this introduced freedom to alleviate the issue of decreased energy efficiency of small cell networks by dynamically adapting to fluctuations in per-user capacity demand. The authors advocate for the need for co-location models for provisioning and allocation of virtual base stations (VBS), and propose different VBS architectures. The advantages of VBS clustering are demonstrated, which can enhance efficiency and capacity via collaborative communication techniques.

With the advent of SDWN technology, dynamic spectrum management becomes a feasible option. In the fourth article, "A Software-Defined Wireless Network Enabled Spectrum Management Architecture" by Wang *et al.*, spectrum management architecture design, which can reap the benefits of SDWN, is systematically investigated. Design principles and key challenges in realizing SDWN-enabled spectrum management architecture are discussed, and a general architecture with a new baseband virtualization design is developed. A prototype based on the IEEE 802.11 protocol is built and used to demonstrate the efficiency of the proposed architecture.

The fifth article, "Synergistic Spectrum Sharing in 5G HetNets: A Harmonized SDN-Enabled Approach" by Akhtar *et al.*, proposes a hierarchical architecture enabled by SDN that facilitates reliable and dynamic spectrum sharing in 5G cellular networks. The two key components of the proposed HSA framework are the macrocell BSs and the SDN controller. The task-sharing between the BSs and the controller harmonizes network operation and alleviates the SDN controller's scalability concerns. The article also presents an efficient resource management algorithm conceived for future 5G networks.

In the last article, "SDN Meets SDR in Self-Organizing Networks: Fitting the Pieces of Network Management" by Ramirez-Perez *et al.*, the authors combine the two popular paradigms of software defined networking (SDN) and software defined radio (SDR) under a unified management framework based on self organizing networks (SON). The proposed framework leverages programmable control planes and data planes, calls for the convergence of computing, communications, and networking research into one domain, and emphasizes the need for an open and extensible protocol interface that combines the main features of current protocols such as OpenFlow, MIH, and XMPP.

We are confident that these six articles will add value to current research activities and provide an overall direction for those researchers interested in this topic.

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