Editorial: First Quarter 2014, IEEE Communications Surveys & Tutorials

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I WELCOME you to the first issue of ComST in 2014. This issue includes twenty six articles covering different aspects of communication networks. In particular, these articles cover various issues in wireless communications and networking, devices, networks, and applications for energy-efficient communications, security in communication networks, mobile cloud computing and context-aware computing, and networking protocols. A brief account for each of these articles is given below.

WIRELESS COMMUNICATIONS AND NETWORKING

The advances in wireless technology have enabled the proliferation of connected intelligent devices. In this context, providing fairness among the devices in accessing the network services is an important issue that must be addressed. The paper titled "Fairness in Wireless Networks: Issues, Measures and Challenges" by Huaizhou Shi, R. Venkatesha Prasad, Ertan Onur, and I. G. M. M. Niemegeers, presents a survey on different fairness studies by summarizing and comparing the state-of-the-art fairness models. The notion of fairness is defined and different quantitative measures of fairness are discussed. For wireless networks, the fairness issues at the different layers of the transmission protocol stack are described. The authors finally discuss the major research challenges in fairness management and outline possible future research directions.

Hybrid-Automatic-Repeat-reQuest (H-ARQ) has become an important technique for cooperative wireless communications. The paper titled "Hybrid Automatic-Repeat-reQuest Systems for Cooperative Wireless Communications" by Hoang Anh Ngo, and Lajos Hanzo, reviews the recent advances in H-ARQ and investigates its performance. The paper also proposes a relay-switching regime based on H-ARQ scheme, which is capable of increasing the achievable system throughput. The scheme is studied assuming both perfect and imperfect channel state information. Finally, general design guidelines for designing H-ARQ systems and future research directions for H-ARQ aided cooperative systems are provided.

Cooperative diversity has gained significant attention of researchers as a technique that enhances the reliability in wireless networks. In a cooperative diversity system, intermediate nodes exist between the transmitter and the receiver to deliver multiple copies of a message at the receiver via independently fading channels. In this context, the paper titled "MAC Protocols for Cooperative Diversity in Wireless LANs and Wireless Sensor Networks" by Rana Azeem M. Khan and Holger Karl, presents a survey on cooperative diversity-enabled medium access control (MAC) protocols for WLANs and wireless sensor networks (WSNs). The paper discusses their types, merits and demerits. Also, possible design considerations for development of advanced cooperative MAC protocols are discussed.

Base station densification through the deployment of femtocells has been considered a viable solution to meet the ever-increasing requirement of high data rates and enhanced quality-of-service (QoS) in cellular wireless networks. The introduction of densely deployed femtocells, however, poses several challenges for mobility management (MM) between the network tiers, especially the macro-tier and the femto-tier. Motivated by this issue, the paper titled "Mobility Management for Femtocells in LTE-Advanced: Key Aspects and Survey of Handover Decision Algorithms" by Dionysis Xenakis, Nikos Passas, Lazaros Merakos, and Christos Verikoukis, presents a review on the key aspects and research challenges of MM support in two-tier cellular networks. The state-of-the-art MM procedures in the current LTE-A systems are highlighted to better understand the solutions and open issues posed in practical systems. In addition, the existing handover (HO) decision algorithms are overviewed for two-tier macrocell-femtocell networks. Finally, possible research directions are outlined.

Cognitive Radio Networks (CRNs) have emerged as a viable solution to mitigate the problems of spectrum scarcity and spectrum underutilization in wireless communications systems. In this context, researches on both single-hop and multi-hop CRNs have gained significant momentum in the research community. The paper titled "Routing Metrics of Cognitive Radio Networks: A Survey" by Moustafa Youssef, Mohamed Ibrahim, Mohamed Abdelatif, Lin Chen, and Athanasios V. Vasilakos, presents a survey on the up-to-date routing metrics for multi-hop CRNs. The paper begins by addressing the challenges in designing good routing metrics for multi-hop CRNs. Then it outlines the existing metrics and the way they are used in different routing protocols followed by a comparison between them through a case study. The paper finally ends with a discussion on the open issues in designing advanced routing metrics for multi-hop CRNs.

The concept of cross-layer design has been introduced in the context of wireless networks to improve the communication performance by sharing information among the different layers. In this context, the paper titled "A Survey of Cross-Layer Designs in Wireless Networks" by Bo Fu, Yang Xiao, Hongmei (Julia) Deng, and Hui Zeng, surveys and classifies

different aspects of cross-layer design in wireless networks. Furthermore, the paper summarizes the challenges in cross-layer design and highlights future research directions.

Channel coding and iterative decoding are among techniques to achieve high data rates with low bit error rate in any communication system. In this context, extrinsic information transfer (EXIT) charts provide an elegant tool to study iteratively decoded systems and analyze their convergence behavior. Motivated by the above, the paper titled "EXIT Charts for System Design and Analysis" by Mohammed El-Hajjar and Lajos Hanzo, provides a tutorial on EXIT charts. The paper starts by providing an overview of the iterative decoding principle and the concept of soft information exchange. The paper then highlights the concept of EXIT charts and their properties and outlines further applications of EXIT charts.

Energy-efficient Communications Devices, Networks, and Applications

It has been reported that the information and communications technology (ICT) industry contributes to 2% of global carbon emissions and this percentage will increase in future. Wireless communications systems, especially the cellular systems share a significant part of this contribution. Therefore, energy-efficient radio resource management is a critical issue in cellular networks. The paper titled "A Survey of Energy Efficient Resource Management Techniques for Multicell Cellular Networks" by Jaya B. Rao and Abraham O. Fapojuwo, reviews the current state-of-the-art of energy-efficient radio resource management in multicell wireless networks. The paper considers techniques to mitigate inter-cell interference (ICI) and maximize the energy efficiency (EE) in homogeneous, heterogeneous, and cooperative multicell networks. The paper, at the end, outlines challenges in designing energy-efficient schemes and outlines possible future research directions.

Greening wireless networks by reducing their power consumption is a critical research issue. In addition, different wireless devices have strict limitations on power consumption. In this context, duty cycling, which is a technique that turns a device's radio on and off to conserve energy, has been introduced, specially for wireless sensor networks. Similar techniques can also be used even in cellular networks. The paper titled "Survey and Taxonomy of Duty Cycling Mechanisms in Wireless Sensor Networks" by Ricardo C. Carrano, Diego Passos, Luiz C. S. Magalhães, and Célio V. N. Albuquerque, reviews the literature related to duty cycling techniques in wireless sensor networks and classifies them. It outlines the pros and cons of the different duty cycling techniques and possible future research directions.

There is a proliferation of wireless devices such as sensors and actuators, which are battery powered. To extend the lifetime of these devices, new alternatives for power sources should be sought. One of the promising techniques for these devices is to collect energy from the ambient environment, which is known as energy harvesting. In this context, the paper titled "Reincarnation in the Ambiance: Devices and Networks with Energy Harvesting" by R. Venkatesha Prasad, Shruti Devasenapathy, Vijay S. Rao, and Javad Vazifehdan, reviews

various types of energy harvesting techniques together with recommendations for the design of energy harvesting nodes and their operation in networks. The paper finally outlines some challenges and future research directions.

Data centers used in the content delivery networks consume huge amount of energy and thus generate heavy demand on the various energy sources available. Therefore, power management for data centers is becoming increasingly important. Emerging smart grid technology provides a promising solution for dynamic and efficient power management of data centers. In this context, the paper titled "A Survey on Geographic Load Balancing Based Data Center Power Management in the Smart Grid Environment" by Ashikur Rahman, Xue Liu, and Fanxin Kong reviews the state-of-the-art power management methodologies, specifically those based on geographic load balancing (GLB). Different mathematical tools used for modeling the power management solution are discussed. Then the paper outlines some potential weaknesses that need to be addressed in future research.

Mobile learning has emerged as a revolutionary way for education and is expected to outperform e-learning. Mobile learning has become easier thanks to the proliferation of smart phones and tablet devices that are becoming more powerful and affordable and also enabling the learners to access educational content anywhere and anytime. Mobile learning faces several challenges among which the most important one is the limitation in the battery-power of the mobile devices. Therefore, various energy saving solutions have been proposed to prolong the operational time of the devices. In this context, the paper titled "Energy-Aware Mobile Learning: Opportunities and Challenges" by Arghir-Nicolae Moldovan, Stephan Weibelzahl, and Cristina Hava Muntean, presents a survey on adaptive mobile learning systems and how they can be leveraged to be energy aware. The paper then discusses the applicability and shortcomings of these approaches for mobile learning.

Security in Communications Networks

For gathering information pertaining to different monitoring and control applications, WSNs are popular due to their ease of deployment. However, the security of WSNs can be compromised due to the lack of proper defense mechanisms. Therefore, any security threats to the WSNs should be detected and dealt with. In this context, the paper "A Survey of Intrusion Detection Systems in Wireless Sensor Networks" by Ismail Butun, Salvatore D. Morgera, and Ravi Sankar, reviews the recent progress in intrusion detection systems (IDSs) for WSNs. After introducing IDS, a brief review of IDS techniques proposed for mobile ad-hoc networks (MANETs) is provided together with its applicability for WSNs. IDSs proposed for WSNs are then presented followed by a comparison among them along with their merits and demerits. Finally, the paper outlines some possible future research directions.

LTE and LTE-A technologies have been ratified by the 3GPP as the candidate mobile technologies to accommodate the rapid increase in mobile data usage and the development of wireless communications and multimedia applications. For a variety of offered services, ensuring and guaranteeing security

has become a challenge for LTE and LTE-A systems. The paper titled "A Survey on Security Aspects for LTE and LTE-A Networks" by Jin Cao, Maode Ma, Hui Li, Yueyu Zhang, and Zhenxing Luo, gives an overview of the security architecture in LTE and LTE-A networks and identifies its shortcomings and drawbacks. Several classical solutions to overcome the outlined shortcomings are reviewed and potential research issues are outlined.

Advancements in Internet technologies connecting an unprecedented number of communication devices have given rise to the possibility of huge number of network attacks. In this context, network intrusion and anomaly detection has become a significant research area. The paper titled "Network Anomaly Detection: Methods, Systems and Tools" by Monowar H. Bhuyan, D. K. Bhattacharyya, and J. K. Kalita, presents a literature review on various aspects of network anomaly detection techniques. Different network attacks are outlined. In addition, the existing network anomaly detection methods are described and compared. Tools that can be used by network defenders are discussed. Finally, some research directions in network anomaly detection are outlined.

MOBILE CLOUD COMPUTING AND CONTEXT-AWARE COMPUTING

To enhance the computation capabilities of mobile devices, the concept of cloud-based mobile augmentation (CMA) has emerged in which resource-rich clouds are used for the execution of resource-intensive mobile applications. Through CMA, mobile devices can perform huge computations and store huge amount of data (which is beyond their limited capabilities) at these clouds. In this context, the paper titled "Cloud-Based Augmentation for Mobile Devices: Motivation, Taxonomies, and Open Challenges" by Saeid Abolfazli, Zohreh Sanaei,Ejaz Ahmed, Abdullah Gani, and Rajkumar Buyya, surveys the mobile augmentation domain and presents a taxonomy of CMA approaches. The shortcomings and vulnerabilities of CMA approaches are introduced. Finally, the impacts of CMA approaches on mobile computing are outlined together with possible future research directions.

Recently, in the paradigm of cloud computing, the issue of heterogeneity in mobile cloud computing (MCC) has become significant. In the core of such a non-uniform MCC, enabling interoperability and integration among heterogeneous platforms is a challenging task. Significant amount of research efforts are required to understand and achieve convergence between mobile computing and cloud computing. In this context, the paper titled "Heterogeneity in Mobile Cloud Computing: Taxonomy and Open Challenges" by Zohreh Sanaei, Saeid Abolfazli, Abdullah Gani, and Rajkumar Buyya, defines MCC and explains its major challenges. Heterogeneity in MCC is discussed and taxonomized from different aspects. Finally, the impact of heterogeneity on the design of MCC is outlined together with an inspection of possible future research directions and open challenges.

Another issue with MCC is related to application modeling. As traditional smartphone application models do not support the development of applications that can take advantage of the features offered through cloud computing, specialized mobile cloud application models are needed. The article titled "A Survey of Mobile Cloud Computing Application Models" by Attaur Rehman Khan, Mazliza Othman, Sajjad Ahmad Madani, and Samee Ullah Khan, presents the mobile cloud architecture. It then outlines different application models with their classification and the latest advances in mobile application models. Finally, the paper outlines some future research directions.

As we are moving towards the Internet of Things (IoT), the number of deployed sensors worldwide is growing at an exponential rate. These deployed sensors are reporting and generating huge amounts of data. To make the most out of this huge amount of data, it should be accompanied with context information. The paper titled "Context Aware Computing for the Internet of Things: A Survey" by Charith Perera, Arkady Zaslavsky, Peter Christen, and Dimitrios Georgakopoulos, surveys context-awareness from an IoT point of view. The fundamentals of IoT paradigm and context-awareness are introduced followed by the assessment of some of the proposed context-aware computing techniques. Finally, based on the assessment, the paper highlights some design guidelines accompanied by proposals for future research directions.

NETWORKING PROTOCOLS

Frequency spectrum and bandwidth are valuable resources that should be used efficiently. Hence, unnecessary transmission of data should be reduced, if not eliminated completely, to use the transmission bandwidth as efficiently as possible. In this context, data redundancy elimination (DRE) is an elegant technique that reduces the amount of data to be transmitted or stored by identifying and eliminating redundant or replicated data elements with a reference to the unique data copy. The paper titled "On Protocol-Independent Data Redundancy Elimination" by Yan Zhang, and Nirwan Ansari, surveys the state-of-the-art protocol-independent DRE techniques deployed in wireline as well as cellular wireless networks. The system architecture and processing of protocol-independent DRE techniques are outlined together with the main techniques that can enhance the DRE performance.

Distributed networking solutions have always been more attractive than centralized ones in terms of scalability and computational complexity. In this context, peer-to-peer (P2P) systems have become popular and are replacing the traditional client-server models in the sense that, the peer sometimes takes the role of a client and in some other times may take the role of a server. An important issue that arises in P2P networks is how to balance the load among different peers. Hence, load balancing techniques have been proposed to ensure fairness of load distribution among participating peers. The paper titled "Survey on Load Balancing in Peer-to-Peer Distributed Hash Tables" by Pascal Felber, Peter Kropf, Eryk Schiller, and Sabina Serbu, presents a survey on load management solutions in distributed hash table (DHT)-based P2P systems. Different approaches are classified according to the level at which they operate.

Software-defined networking (SDN) is a technique that decouples the control and data planes of a network, where a software-based controller instructs a switch to forward packets. In this context, OpenFlow has been proposed as a standard

for communication between the switches and the software-based controller. The paper titled "Network Innovation using OpenFlow: A Survey" by Adrian Lara, Anisha Kolasani, and Byrav Ramamurthy, outlines the different capabilities of Open-Flow. In addition, challenges in the large-scale deployment of OpenFlow-based networks are discussed and some future research directions are outlined.

Self-organized networks (SON) with the capabilities of self-configuration, self-optimization and self-healing offer a viable solution to the control and management of next generation heterogeneous networks. One question that can be posed for the SONs is how to act and react. Several examples exist in social species that can inspire the operation of SONs. In other words, SONs can exhibit some features from swarm intelligence. In this context, the paper titled "On Swarm Intelligence Inspired Self-Organized Networking: Its Bionic Mechanisms, Designing Principles and Optimization Approaches" by Zhongshan Zhang, Keping Long, Jianping Wang, and Falko Dressler, presents a survey on different criteria of bio-inspired techniques and examines different algorithms proposed for artificial SON systems with their advantages, drawbacks, and design challenges. It also discusses some guidelines for designing bio-inspired algorithms. The paper finally ends with some recommendations for future research directions.

MANETs are infrastructure-less networks where nodes can move around freely. In such a network, nodes can communicate directly without the need for a base station. In addition, one node can act as a relay that transfers messages between some source and destination. Due to high mobility and random motion of nodes, guaranteeing a path between a source and a destination is a challenging task. In addition, no guarantees on end-to-end delays can be provided. In this context, ensuring the reliability of data transmission between source and destination and ensuring that the network does not become congested due to heavy traffic load is an important issue. The paper titled "Transfer Reliability and Congestion Control Strategies in Opportunistic Networks: A Survey" by Bambang Soelistijanto and Michael P. Howarth, surveys the state-of-the-art proposals for transfer reliability and storage congestion control in opportunistic MANETs. Mechanisms for providing transfer reliability are discussed. The requirements for storage congestion control are identified and categorized according to the number of message copies transferred in the network. Finally, the paper outlines some future research directions.

Delay-tolerant networks (DTNs) are networks where nodes are continuously moving and an end-to-end connection between the source and the destination is not guaranteed. In addition, links are periodically shut down to conserve energy. In this paradigm, nodes can connect directly or relay data between source and destination. Most of the routing protocols for such networks use the "store-carry-forward" strategy to transmit messages when a complete path between the source

and destination does not exist. In such a scenario, the relay node stores the message. The social relations among nodes can be exploited in such networks. The paper titled "A Survey of Social-Aware Routing Protocols in Delay Tolerant Networks: Applications, Taxonomy and Design-Related Issues" by Kaimin Wei, Xiao Liang, and Ke Xu, surveys the state-of-the-art social-aware routing protocols, which utilize social relationships among nodes. The paper then focuses on understanding social relations among nodes. In addition, it creates a classification for social-aware routing protocols according to the sources of social relations. Finally, several open issues and research challenges are outlined.

Multimedia streaming to mobile devices is required for many Internet applications. However, a problem arises here due to the fact that the battery power of mobile devices is limited. Hence, many research efforts have been spent in order to develop energy-conserving schemes for multimedia streaming to mobile devices. The paper titled "Energy Efficient Multimedia Streaming to Mobile Devices — A Survey" by Mohammad Ashraful Hoque, Matti Siekkinen, Jukka K. Nurminen, surveys the state-of-the-art energy-efficient solutions for wireless multimedia streaming to mobile hand-held devices. These schemes are categorized according to the Internet protocol stack they use and different traffic scheduling and multimedia content adaptation mechanisms. Finally, several directions for future research are outlined.

I hope that you enjoy reading this issue and find the articles useful. Last but not least, I highly encourage you to submit your work which fit within the scope of ComST. For detailed instructions on the preparation and submissions of manuscripts to ComST, please check the URL below:

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