Editorial: Fourth Quarter 2014 IEEE Communications Surveys and Tutorials

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I WELCOME you to the fourth issue of ComST in 2014. This issue includes 20 articles covering different aspects of communication networks. In particular, these articles cover various issues in wireless sensor networks, wireless communications and smart grid, and Internet and security. A brief account for each of these articles is given below.

Wireless Sensor Networks

A wireless sensor network (WSN) is a network of spatially distributed autonomous sensor nodes that range in number from a few to several hundreds or even thousands. These sensors are deployed to monitor physical or environmental conditions, such as temperature, sound, pressure, etc., and to cooperatively pass their sensed data through the network to a processing location. Such networks are used in many industrial and consumer applications. Sensor devices should be inexpensive and small and have a long lifetime. Therefore, it is important to develop very efficient software and hardware solutions. For this reason, protocols for sensor networks should be carefully designed so as to make the most efficient use of the limited resources in the sensor devices in terms of energy, computation, and storage. In this context, the article titled "A Survey on Testbeds and Experimentation Environments for Wireless Sensor Networks" by Jens Horneber and Anton Hergenroder provides a survey on different methodologies followed to build testbeds and experimentation environments. The article reviews the emerging testbed requirements and outlines the state-of-the-art solutions. Moreover, it discusses common design decisions concerning architectures and experimentation support in current testbeds.

In the same context of WSNs, the article titled "Congestion Control Protocols in Wireless Sensor Networks: A Survey" by Charalambos Sergiou, Pavlos Antoniou, and Vasos Vassiliou presents a survey on different algorithms for congestion control for reliable data delivery in WSNs. The article starts by studying congestion in WSNs and then outlines different schemes used for controlling congestion in WSNs. It reviews and classifies the state-of-the-art congestion control mechanisms. Also, it sheds light on possible future research topics.

The article titled "Survey on the Characterization and Classification of Wireless Sensor Networks Applications" by Luis M. Borges, Fernando J. Velez, and Antonio S. Lebres puts together important information about the classification and characterization parameters of WSN applications. It starts by identifying some parameters known as "characterization parameters," then organizing them into different categories, and using them to classify and categorize different WSN applications. Moreover, the article provides a holistic overview of the relationship among different categories of characterization parameters.

In the same context of WSNs, the article titled "Machine Learning in Wireless Sensor Networks: Algorithms, Strategies and Applications" by Mohammad Abu Alsheikh, Shaowei Lin, Dusit Niyato, and Hwee-Pink Tan presents a survey on machine learning methods adopted in WSNs. The article presents an in-depth review of the proposed techniques in the literature and outlines the advantages and disadvantages of each proposed algorithm. The paper also provides a concise guide to aid WSN designers in developing suitable machine learning solutions for their specific problems.

Wireless Communications and Smart Grid

Device-to-device (D2D) communication enables formation of ad hoc networks underlaying cellular networks by sharing the same radio resources. D2D communication technology is a promising technology for enhancing spectrum utilization, increasing cellular capacity, improving user throughput, and extending the battery lifetime of user devices. In D2D communication, instead of using uplink and downlink radio resources in the cellular mode, a direct connection between users is established to enable peer-to-peer (P2P) communication. Some example applications of D2D communication include multimedia downloading, video streaming, online gaming, and P2P file sharing. In this context, the article titled "A Survey on Device-to-Device Communication in Cellular Networks" by Arash Asadi, Qing Wang, and Vincenzo Mancuso presents a survey on D2D communication. The article deeply investigates the variety of works done in the field of D2D communication and identifies open problems and possible future research directions.

Orthogonal frequency-division multiplexing (OFDM) is a frequency-division multiplexing (FDM) scheme utilized as a digital multicarrier modulation method for communication. In OFDM, a large number of closely spaced orthogonal subcarriers are used to carry data. The data are divided into several parallel data streams or channels, one for each subcarrier. Each subcarrier is modulated with a conventional modulation scheme (such as quadrature amplitude modulation or phase-shift keying) at a low symbol rate, maintaining total data rates similar to conventional single-carrier modulation schemes in the same bandwidth. OFDM is a very popular scheme for wideband digital communication (both for wireless or wired

Digital Object Identifier 10.1109/COMST.2014.2369651

communications) used in applications such as digital television and audio broadcasting and broadband internet access. The primary advantage of OFDM over single-carrier schemes is its ability to cope with severe channel conditions (for example, attenuation of high frequencies, narrowband interference, and frequency-selective fading due to multipath) without complex equalization filters. However, for an efficient employment of the OFDM technique and proper detection of the transmitted signal at the receiver, good estimation of the OFDM channel between the transmitter and the receiver is a necessity. In this context, the article titled "Channel Estimation for OFDM" by Yinsheng Liu, Zhenhui Tan, Hongjie Hu, Leonard J. Cimini, and Geoffrey Ye Li presents a survey on OFDM channel estimation tecnhiques, starting from the classical techniques based on channel frequency response to the state-of-the-art ones. The article concludes by outlining some challenges for future investigation.

Smart grid refers to a modernized electrical grid with added hardware and software that uses advanced information and communications technology to gather and act on information, such as information about the behaviors of suppliers and consumers, in an automated fashion. This autonomous responsiveness helps in improving the efficiency, reliability, economics, and sustainability of the production and distribution of electricity. In addition to achieving an optimal day-to-day operational efficiency, this enables the electrical grid to react in a timely manner to events that impact the electrical power grid. Smart grid allows for more accurate real-time monitoring, ensures the optimization of power flows, and enables two-way communication between the utility and customer sides. Also, it promotes a more environment-friendly energy generation via the incorporation of renewable energy sources into the grid. Residential smart metering is foreseen as a critical part of this evolution that brings the smart grid into our homes, transforming them into the smart homes of the future. Although enormous benefits are expected from such evolution, great security risks exist that are worth investigating. The article titled "Survey in Smart Grid and Smart Home Security: Issues, Challenges and Countermeasures" by N. Komninos, E. Philippou, and A. Pitsillides presents a survey on the issues related to security in smart grid and smart homes. The article discusses different threats that are possible for smart grids and smart homes. Then, it outlines different techniques proposed in the literature to handle such threats. Finally, it highlights some possible future research directions.

Energy efficiency in cellular networks is a growing concern for cellular operators to not only maintain profitability but also reduce the overall environmental effects. This emerging trend of achieving energy efficiency in cellular networks is motivating the standardization authorities and network operators to continuously explore future technologies in order to bring improvements in the entire network infrastructure. Motivated by this, the article titled "Quantifying Potential Energy Efficiency Gain in Green Cellular Wireless Networks" by Kemal Davaslioglu and Ender Ayanoglu presents a survey on green cellular wireless networks. The article starts by describing the shortcomings of the conventional cellular networks based on the carbon footprint they generate. It discusses how much such footprint is expected to grow with the increase in mobile traffic. The authors point out that the base stations are the biggest source for energy inefficiency in conventional cellular networks. The authors discuss multitier networks and point out the potential of exploiting mobility patterns in order to use base station energy judiciously. Finally, the article lists some of the lessons learnt and highlights possible future research directions.

In the same context of energy efficiency, the article titled "Dynamic Resource Provisioning for Energy Efficiency in Wireless Access Networks: A Survey and an Outlook" by Lukasz Budzisz, Fatemeh Ganji, Gianluca Rizzo, Marco Ajmone Marsan, Michela Meo, Yi Zhang, George Koutitas, Leandros Tassiulas, Sofie Lambert, Bart Lannoo, Mario Pickavet, Alberto Conte, Ivaylo Haratcherev, and Adam Wolisz presents another survey. It studies the state-of-the-art algorithms for energy efficiency proposed for the two most common wireless access technologies, namely, cellular networks and WLANs. The article classifies them and offers a comparison among the different algorithms. In addition, the article studies the applicability of those schemes for typical network scenarios that include cooperation between both access technologies.

In order to enhance network capacity, there has been an increasing interest in deploying relays, distributed antennas, and small cellular base stations (e.g., metrocells, picocells, and femtocells) indoors in residential homes and offices as well as outdoors in amusement parks and busy intersections. These new network deployments, comprised of a mix of low-power nodes underlying the conventional homogeneous macrocell network are usually referred to as heterogeneous cellular networks (HCNs). By deploying additional small cells within the local-area range and bringing the network closer to users, HCNs can significantly boost the overall network capacity through better spatial resource reuse. In HCNs, research efforts have focused primarily on interference mitigation. In this context, the article titled "Recent Advances in Radio Resource Management for Heterogeneous LTE/LTE-A Networks" by Ying Loong Lee, Teong Chee Chuah, Jonathan Loo, and Alexey Vinel presents a survey. The article starts by presenting a comprehensive survey of the radio resource management (RRM) schemes that have been studied in recent years for LTE/LTE-A HCNs with a special emphasis on femtocells and relay nodes. Moreover, the article classifies and analyzes the different RRM schemes. Finally, the paper proposes possible future research directions.

Free-space optical communication (FSO) is an optical communication technology that uses light propagating in free space to wirelessly transmit data for telecommunications or computer networking. "Free space" means air, outer space, vacuum, or something similar. This contrasts with using solids such as an optical fiber cable or an optical transmission line. The technology is useful where the physical connections are impractical due to high costs or other considerations. Free-space point-to-point optical links can be implemented using infrared laser light, although low-data-rate communication over short distances is possible using LEDs. Infrared Data Association (IrDA) technology is a very simple form of free-space optical communications. The reliability of FSO units has always been

a problem for commercial telecommunications particularly in long ranges due to atmospheric turbulence-induced fading and sensitivity to weather conditions. In this context, the article titled "Survey on Free Space Optical Communication: A Communication Theory Perspective" by Mohammad Ali Khalighi and Murat Uysal surveys the state of the art of FSO communication systems. It starts by describing the FSO channel models and transmitter/receiver structures. Then, it provides the details on information theoretical limits of FSO channels and system design methods to approach these limits. Specific topics include advances in modulation, channel coding, spatial/cooperative diversity techniques, adaptive transmission, and hybrid RF/FSO systems.

Cognitive radio (CR) technology has been proposed as a technology that will enable the wireless industry to improve spectrum efficiency by exploiting the underutilized licensed spectrum. A CR network is capable of learning the surrounding environment and dynamically adapting its operating parameters through spectrum sensing, adaptive transmission, and software and hardware reconfigurability, to make the best use of the available spectrum. In this context, the article titled "Medium Access Control Protocols in Cognitive Radio Networks: Overview and General Classification" by Liljana Gavrilovska, Daniel Denkovski, Valentin Rakovic, and Marko Angjelichinoski presents an extensive overview of the state-of-the-art advances in medium access control (MAC) protocols for cognitive radio networks. It identifies their basic characteristics and maps them into the cognitive-MAC cycle. The survey also highlights the role of regulative and standardization activities on the cognitive-MAC cycle.

Internet and Security

A vehicular *ad hoc* network (VANET), a subclass of Mobile Ad Hoc networks (MANETs), uses cars or vehicles as mobile nodes to create a mobile network. These networks have no fixed infrastructure, and instead, they rely on the vehicles themselves to provide network functionality. A VANET turns every participating car into a wireless router or node, allowing cars approximately 100–300 m of each other to connect and, in turn, creates a network with a wide range. As cars fall out of the signal range and drop out of the network, other cars can join in, connecting vehicles to one another so that a mobile Internet is created. Proposed applications for VANETs have very diverse properties and often require nonstandard communication protocols. Moreover, the dynamics of the network due to vehicle movement further complicates the design of an appropriate communication system. In-network aggregation mechanisms have been proposed for VANETs that aim at improving communication efficiency between vehicles by summarizing information exchanged among them. In this context, the article titled "In-Network Aggregation for Vehicular Ad Hoc Networks" by Stefan Dietzel, Jonathan Petit, Frank Kargl, and Bjorn Scheuermann presents a survey on in-network aggregation techniques for VANETs. Moreover, the paper proposes a generic model to describe and classify the different proposed in-network aggregation techniques.

Computer networks are typically built from a large number of network devices with many complex protocols implemented on them. Network operators are responsible for configuring policies to respond to a wide range of network events and applications. They have to manually transform these high-level policies into low-level configuration commands while adapting to changing network conditions. Often, they also need to accomplish very complex tasks with access to very limited tools. In addition, they have to rapidly create, deploy, and manage novel services in response to the endless user demands. This has driven the research toward programmable networking. A programmable network can be defined as a network in which the behavior of network devices and flow control are handled by software that operates independently from network hardware. One form of a programmable network is what is known as a Software-Defined Network (SDN). SDN promises a simplified network management by enabling network automation, fostering innovation through programmability, and decreasing CAPEX and OPEX by reducing costs and power consumption. The article titled "A Survey and a Layered Taxonomy of Software-Defined Networking" by Yosr Jarraya, Taous Madi, and Mourad Debbabi presents a survey on the relevant research efforts exerted to realize SDN networks. It first provides an introduction to SDN together with its architecture and main components. Then, it outlines and classifies the state-of-the-art SDN-related research works. The article then highlights possible problems that may arise due to the adoption of SDN.

In the same context of SDN, the article titled "A Survey on Software-Defined Network (SDN) and OpenFlow: From Concept to Implementation" by Fei Hu, Qi Hao, and Ke Bao presents a comprehensive survey on the important topics in SDN/OpenFlow implementation, including the basic concept, applications, language abstraction, controller, virtualization, Quality of service (QoS), security, as well as its integration with wireless and optical networks. The article offers a thorough discussion of the different proposed schemes with their merits and demerits.

Network tomography is the study of a network's internal characteristics using information derived from end point data. The word tomography is used to link the field, in concept, to other processes that infer the internal characteristics of an object from external observation, as is done in magnetic resonance imaging or positron emission tomography (even though the term tomography strictly refers to imaging by slicing). One of the enabling technologies for network tomography is network coding (NC). NC originally emerged as a technique for optimizing the flow of digital data in a network by transmitting digital evidence about messages. The "digital evidence" is itself a composite of two or more messages. When the bits of a digital evidence arrive at the destination, the transmitted message is deduced rather than directly reassembled. In this way, NC is able to improve network throughput. From network tomography's point of view, NC can be used to introduce topology-dependent correlation that can be further exploited in topology estimation. Compared with traditional methods, network tomography with NC has many advantages such as the improvement of tomography accuracy and the reduction of complexity in choosing monitoring paths. In this context, the

article titled "A Survey on Network Tomography with Network Coding" by Peng Qin, Bin Dai, Benxiong Huang, Guan Xu, and Kui Wu presents a survey. It starts by introducing the problem of tomography with NC and then proposes a taxonomy of the criteria to classify various proposed methods. In addition, the article outlines the state-of-the-art research efforts in network tomography with NC.

A social networking service is a platform to build social networks or social relations among people who share interests, activities, backgrounds, or real-life connections. A social network service consists of a representation of each user (often a profile), his or her social links, and a variety of additional services. Social networks are web-based services that allow individuals to create a public profile, to create a list of users with whom to share connections, and view and cross the connections within the system. Common examples of social networks include Facebook, Google+, LinkedIn, etc. Due to the popularity of social networks, maintaining user security and privacy becomes a challenging task. Motivated by this, the article titled "Online Social Networks: Threats and Solutions" by Michael Fire, Roy Goldschmidt, and Yuval Elovici presents a tutorial on security threats and solutions relevant to online social networks (OSNs). The article offers a detailed discussion on the different security and privacy risks, which threaten the well-being of OSN users in general, and children in particular. Moreover, it reviews the state-of-the-art solutions, which are capable of providing protection, security, and privacy for OSN users. The article then discusses some recommendations and highlights possible future research directions.

Flow monitoring is an essential tool that enables network administrators to monitor traffic in high-speed networks. Flow monitoring gains its popularity due to its capability of focusing on the whole flow of packets, rather than individual packets. Hence, it is considered more scalable than traditional packet-based traffic analysis. In this context, the article titled "Flow Monitoring Explained: From Packet Capture to Data Analysis with NetFlow and IPFIX" by Rick Hofstede, Pavel Celeda, Brian Trammell, Idilio Drago, Ramin Sadre, Anna Sperotto, and Aiko Pras presents a tutorial covering all aspects of flow monitoring. The article discusses the flow monitoring architecture and then goes on to packet observation techniques. It studies different flow metering and export tools and data collection methodologies. Finally, the article highlights possible future research challenges and directions.

A federated identity in information technology is the means of linking a person's electronic identity and attributes, stored across multiple distinct identity management systems. In other words, the "federation" of identity describes the technologies, standards, and use-cases, which serve to enable the portability of identity information across otherwise autonomous security domains. The ultimate goal of identity federation is to enable users of one domain to securely access data or systems of another domain seamlessly, and without the need for completely redundant user administration. Until recently, identity federation technologies were mainly applicable to web and network access services. However, new technologies have emerged, like the Cloud and Grids, which have motivated the service providers to consider new solutions capable of satisfying identity federation for any almost kind of Internet service. This has been called identity federation beyond the web. Motivated by this, the article titled "Identity Federations Beyond the Web: A survey" by Alejandro Perez-Mendez, Fernando Pereniguez-Garcia, Rafael Marin-Lopez, Gabriel Lopez-Millan, and Josh Howlett presents a survey. The article starts by studying in detail two main proposals for federating any other kind of (non web-based) Internet service. These are: Application Bridging for Federated Access Beyond web (ABFAB) and Federated Kerberos (FedKERB), currently being discussed to provide a solution for this new type of federations, known as Identity Federations beyond the Web. Finally, the article shows a fair comparison between both alternatives.

In computer networks, network management refers to the activities, methods, procedures, and tools that pertain to the operation, administration, maintenance, and provisioning of networked systems. Network management is essential to command and control practices and is generally carried out of a network operations center. The article titled "Network Management Challenges and Trends in Multi-Layer and Multi-Vendor Settings for Carrier-Grade Networks" by A. Martinez, M. Yannuzzi, V. Lopez, D. Lopez, W. Ramirez, R. Serral-Gracia, X. Masip-Bruin, M. Maciejewski, and J. Altmann provides a tutorial where it starts by examining in detail the interoperability challenges of managing multilayer and multivendor carrier-grade networks. The article then outlines the state of the art in this area, with an emphasis on industrial advances. Moreover, the article studies the Multi-Technology Operations System Interface (MTOSI) as well as OpenFlow, and analyzes their potential impacts. The article then highlights the shortcomings of current carrier-grade management proposals and identifies a set of features that may pave the way for new management products.

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 fits 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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