

# Editorial: Second Quarter 2015

## IEEE Communications Surveys and Tutorials

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**I** WELCOME you to the second issue of the IEEE COMMUNICATIONS SURVEYS AND TUTORIALS (ComST) in 2015. This issue includes 27 articles covering different aspects of communication networks. In particular, these articles cover various issues in wireless networks, energy efficiency and health issues in wireless networks, vehicular, ad hoc, and sensor networks, Internet, security, and programmable networks, and video and multimedia. A brief account for each of these articles is given below.

### WIRELESS NETWORKS

Current wireless systems use disjoint time or frequency segments to transmit and to receive. On the other hand, a communication link with the capability to support connections in both transmit and receive directions at the same time is called full-duplex (or two-way) link. When transmission and reception take place in the same frequency band, it is referred to as “in-band full-duplexing.” Realization of two-way wireless has challenged the research community for many years. Full-duplex communication is currently used in many applications, e.g., wired telephones, digital subscriber line, wireless with directional antennas, and free-space optics. The impact of full-duplex links in these applications is limited to doubling the rate by providing two symmetrical pipes of data flowing in opposite directions. In contrast, in multiuser wireless systems, due to the broadcast nature of transmission (everyone hears everyone else), full-duplex capability has the potential to do more than merely doubling the rate, e.g., it facilitates networking, collaborative transmission, and security. On the other hand, wireless relay networks have been used in wireless networks, where the source and destination are interconnected by means of some intermediate nodes. In such a network, the source and destination cannot communicate to each other directly because the distance between the source and destination is greater than the transmission range of both of them, or the direct link between them experiences a deep fade, hence the need for intermediate node(s) to relay. Wireless networks that employ both technologies have received a lot of attention from both academia and industry to further improve the performance of next-generation wireless networks. In this context, the paper titled “In-Band Full-Duplex Relaying: A Survey, Research Issues and Challenges,” by Gang Liu, F. Richard Yu, Hong Ji, Victor C. M. Leung, and Xi Li, presents a survey. The paper starts by providing a brief survey on some

of the works that have already been done for in-band full-duplex relaying (FDR) and discusses the related research issues and challenges. The paper then identifies several important aspects of in-band FDR: basics, enabling technologies, information-theoretical performance analysis, key design issues, and challenges.

Machine-to-machine (M2M) is a broad label that can be used to describe any technology that enables networked devices to exchange information and perform actions without the manual assistance of humans. M2M is considered an integral part of the Internet of Things (IoT). It brings several benefits to industry and business in general as it has a wide range of applications such as industrial automation, logistics, smart power grid, smart cities, health, and defense for both monitoring and control purposes. In this context, the paper titled “M2M Communications in 3GPP LTE/LTE-A Networks: Architectures, Service Requirements, Challenges, and Applications,” by Fayeze Ghavimi and Hsiao-Hwa Chen, presents a survey on architectural enhancements for providing M2M services in 3GPP networks and reviews the features and requirements of M2M applications. In addition, the paper addresses the issues related to the diverse random access overload control to avoid congestion caused by random channel access of M2M devices. The paper then addresses different application scenarios to illustrate futuristic M2M applications. Finally, the paper identifies possible enabling technologies and points out the directions for future M2M communications research.

In wireless networks, multiple-input and multiple-output (MIMO) is a method for multiplying the capacity of a radio link using multiple transmit and receive antennas to exploit multipath propagation. This multipath propagation is achieved due to the spatially separated antennas existing in a dense multipath scattering environment, provided that the antenna elements are sufficiently far apart for the sake of experiencing independent fading. On the other hand, multicarrier (MC) modulation is a method of transmitting data by splitting it into several components and sending each of these components over separate carrier signals. The individual carriers have narrow bandwidth, but the composite signal can have broad bandwidth. The advantages of MC techniques include relative immunity to fading caused by transmission over more than one path at a time (multipath fading), less susceptibility than single-carrier systems to interference caused by impulse noise, and enhanced immunity to intersymbol interference. In this context, the paper titled “Unified MIMO-Multicarrier Designs: A Space-Time Shift Keying Approach,” by Mohammad Ismat Kadir, Shinya Sugiura, Sheng Chen, and Lajos Hanzo, presents a survey. The paper starts by providing a brief review of the family of MIMO

systems, which is followed by the design of space–time shift keying (STSK) systems in the context of MC modulation-based transmissions. In addition, several MC modulation schemes are addressed such as orthogonal frequency-division multiplexing (OFDM), MC code-division multiple access (MC-CDMA), orthogonal frequency-division multiple access (OFDMA), and single-carrier frequency-division multiple access (SC-FDMA). Moreover, a brief introduction is provided to MC differential STSK (MC DSTSK) employing both conventional differential detection (CDD) and multiple-symbol differential sphere decoding (MSDSD) for the sake of dispensing with channel estimation (CE). Finally, the paper offers a range of future research ideas.

Over the last few years, data traffic over cellular networks has seen an exponential rise, primarily due to the explosion of smartphones, tablets, and laptops. This increase in data traffic on cellular networks has caused an immediate need for offloading traffic for optimum performance of both voice and data services. Mobile data offloading, or simply data offloading, refers to the use of complementary network technologies and innovative techniques for delivery of data originally targeted for mobile/cellular networks in order to alleviate congestion and make better use of available network resources. The objective is to maintain quality-of-service (QoS) for customers, while also reducing the cost and impact of carrying capacity-hungry services in mobile networks. It is expected that mobile data offloading will become a key issue in the near future as the data traffic on mobile networks continues to increase rapidly. The paper titled “Data Offloading Techniques in Cellular Networks: A Survey,” by Filippo Rebecchi, Marcelo Dias de Amorim, Vania Conan, Andrea Passarella, Raffaele Bruno, and Marco Conti, presents a comprehensive survey of data offloading techniques in cellular networks and extract the main requirements needed to integrate data offloading capabilities in today’s mobile networks. The paper then groups the existing strategies into two main categories, namely, delayed and nondelayed offloading. In addition, the paper describes the novel functionalities needed to implement mobile data offloading in the access network. Finally, the paper offers some future research challenges that need to be addressed.

A conventional single-hop wireless system uses direct transmission where a receiver decodes the information only based on the direct signal transmitted by the source. On the other hand, a multi-hop cooperative transmission network is composed of three nodes, namely, a source, a destination, and a third node supporting the communication between the source and the destination denoted as relay. In this system, if the direct transmission of a message from the source to the destination is not (fully) successful, the overheard information from the source is forwarded by the relay to reach the destination. This is referred to as cooperative transmission. Lately, there has been growing interest in the design and evaluation of cooperative routing protocols, which consider the availability of cooperative transmission at the physical layer. In this context, the paper titled “Cooperative Routing in Wireless Networks: A Comprehensive Survey,” by Fatemeh Mansourkiaie and Mohammed Hossam Ahmed, presents a survey of the existing cooperative routing techniques. In addition, the paper provides a taxon-

omy of different cooperative routing protocols and outlines the fundamental components and challenges associated with cooperative routing objectives. Finally, the paper sheds light on possible future research directions.

Radio over fiber (RoF) refers to a technology whereby light is modulated by a radio signal and transmitted over an optical fiber link to facilitate wireless access. More specifically, in RoF systems, wireless signals are transported in optical form between a central station and a set of base stations before being radiated through the air. Each base station communicates over a radio link with at least one mobile station located within the radio range of the base station. This has the advantage of keeping all the equipment and other protocols in a centralized place, which greatly reduces the equipment and maintenance cost of the network. In this context, the paper titled “Performance Improvement and Cost Reduction Techniques For Radio Over Fiber Communications,” by Varghese Antony Thomas, Mohammed El-Hajjar, and Lajos Hanzo, provides a survey. The paper starts by an overview of the ROF architecture and then outlines the different ROF techniques designed for improving the required system performance. Finally, the paper concludes by describing the ROF techniques conceived for reducing the ROF system installation costs.

The IEEE 802.11 standard defines the media access control (MAC) and a set of physical-layer (PHY) specifications for implementing wireless local area networks (WLANs). They are created and maintained by the IEEE LAN/MAN Standards Committee (IEEE 802). The base version of the standard was released in 1997 and has had subsequent amendments. The standard and amendments provide the basis for wireless network products using the Wi-Fi brand. The 802.11 standards have gained huge popularity due to many reasons, which include the use of unlicensed spectrum, the reduction of cost due to economies of scale, their ease of management, and the ability of the IEEE 802.11 Standard Group to maintain the development of subsequent amendments to overcome limitations as they are detected. This huge popularity has triggered a vast amount of experimentally driven research works that are based on commercially-of-the-shelf (COTS) devices. In this context, the paper titled “Experimenting with Commodity 802.11 Hardware: Overview and Future Directions,” by Pablo Serrano, Pablo Salvador, Vincenzo Mancuso, and Yan Grunenberger, presents a survey on the most prevalent works carried out with 802.11 COTS devices and categorizes them in terms of performance studies, enhancements, services, and methodology. The paper then identifies those research areas that require further investigation.

To address the explosive growth in data demands driven by smartphones, tablets, and other media-hungry devices, network operators will have to significantly increase the capacity of their networks, as well as reduce the cost/bit delivered by perhaps two orders of magnitude. An important new development is the deployment of heterogeneous base stations underlying a traditional (macro) cellular network. In such a heterogeneous network, various classes of low power nodes (LPNs) are distributed throughout the macro cell network. There are various types of LPNs, including micro base stations (BSs), pico BSs, femtocells, relays, and distributed antenna systems. In

heterogeneous network (HetNet) deployments, the overlay macro cell provides a wide area coverage umbrella, whereas the LPNs are deployed in a more targeted manner to alleviate coverage dead zones and, more importantly, traffic hot zones. In this context, the paper “Recent Advances in Underlay Heterogeneous Networks: Interference Control, Resource Allocation, and Self-Organization,” by Mugen Peng, Chonggang Wang, Jian Li, Hongyu Xiang, and Vincent Lau, surveys the state-of-the-art system architecture designs, theoretical performance analysis, and key technologies to improve spectral efficiency (SE) and energy efficiency (EE) in underlay HetNets. More specifically, the paper categorizes the key technologies into spatial interference coordination for transmission, interference cancelation for reception, radio resource allocation optimization, and self-organizing networks. The paper outlines a number of issues related to SE and EE performance analysis and optimizations that need further investigation. Moreover, the paper stresses out that more rigorous investigation is required to transform the well-established cellular paradigm into a cloud computing framework. Then the paper introduces the novel energy harvesting concept, which is expected to enable the possibility of achieving better SE and EE performances. Finally, the paper highlights possible future research directions.

SC-FDMA, a modified version of OFDMA, is a promising technique for high data rate uplink communications. SC-FDMA has similar throughput performance and essentially the same overall complexity as OFDMA. However, a principal advantage of SC-FDMA is the peak-to-average power ratio (PAPR), which is lower than that of OFDMA. This is necessary for mobile terminals owing to the limited battery size that they have. In this context, the paper titled “Advances in Cooperative Single-Carrier FDMA Communications: Beyond LTE-Advanced,” by Jiayi Zhang, Lie-Liang Yang, Lajos Hanzo, and Hamid Gharavi, presents a literature review. The paper starts by studying the principles of SC-FDMA techniques and then investigates a variety of cooperative relaying schemes designed particularly for the SC-FDMA uplink networks. Moreover, the paper pays special attention to the optimum exploitation of the resources when considering relay selection, power allocation, and subband allocation, as well as novel signal processing algorithms at the relays. Finally, the paper provides some design guidelines and recommendations to be followed when proposing cooperative SC-FDMA schemes.

#### ENERGY EFFICIENCY AND HEALTH ISSUES IN WIRELESS NETWORKS

RF energy is currently broadcast from billions of radio transmitters around the world, including mobile telephones, handheld radios, mobile base stations, and television/radio broadcast stations. The ability to harvest RF energy from ambient or dedicated sources enables wireless charging of low-power devices, which results in benefits to product design, usability, and reliability. In this context, the paper titled “Wireless Networks with RF Energy Harvesting: A Contemporary Survey,” by Xiao Lu, Ping Wang, Dusit Niyato, Dong In Kim, and Zhu Han, presents an extensive literature review on the research progresses in wireless networks with RF energy

harvesting capability, referred to as RF energy harvesting networks (RF-EHNs). In addition, the paper offers a review on circuit design as well as the state-of-the-art circuitry implementations, together with the necessary communication protocols required for RF-EHNs. In addition, various key design issues in the development of RF-EHNs, according to the network types, are highlighted. Finally, the paper highlights some possible future research directions.

Exposure to electromagnetic (EM) fields is not a new phenomenon. However, during the 20th century, environmental exposure to man-made electromagnetic fields has been steadily increasing as growing electricity demand, ever-advancing technologies, and changes in social behaviour have created more and more artificial sources. Everyone is exposed to a complex mix of weak electric and magnetic fields, both at home and at work, from the generation and transmission of electricity, domestic appliances and industrial equipment, to telecommunications and broadcasting. The paper titled “A Survey and Tutorial of Electromagnetic Radiation and Reduction in Mobile Communication Systems,” by Yusuf A. Sambo, Fabien Hélot, and Muhammad Ali Imran, provides a comprehensive survey and tutorial on EM radiation exposure from mobile communications systems. The paper then discusses measures that can be taken to limit EM radiation exposure from mobile systems. Moreover, the paper outlines some of the international projects and techniques that are dedicated for studying and reducing EM radiation exposure and transmit powers of mobile communications systems.

The requirement of a huge improvement in capacity of next-generation mobile communications systems due to the increasing volume of mobile data traffic has raised the sustainability issues in terms of monetary costs and ecological footprint. Network deployment and running costs are steadily rising due to high energy consumption by the network equipments. This issue is becoming even more prominent due to the recent trend of increasing price of energy. Some projections indicate that next-generation Internet applications will require electricity in amounts that cannot be generated or transported to major metropolitan areas. This has drawn the attention toward green wireless networks as a solution to have low-cost and eco-friendly next-generation mobile networks. In this context, the paper titled “On Green-Energy-Powered Cognitive Radio Networks,” by Xueqing Huang, Tao Han, and Nirwan Ansari, provides a survey on the different energy efficient cognitive radio techniques and how to optimize green energy powered wireless networks. Moreover, since the arrival rate of green energy, which highly depends on the environment of the energy harvesters, is rather random and intermittent, the paper discusses how to optimize and adapt the usage of green energy according to the opportunistic spectrum availability. Finally, the paper discusses some of the research challenges that face the design of cognitive radio networks which are powered by energy harvesters.

Most of the previous studies have focused on improving both system capacity and data rates, while neglecting the increasing demand of cellular networks for energy. Energy efficiency in cellular networks has recently received significant attention from both academia and industry. This is due to the importance

of reducing the operational expenditures and maintaining the profitability of cellular networks, in addition to making these networks “greener.” In this context, the paper titled “Energy-Efficient Base-Stations Sleep-Mode Techniques in Green Cellular Networks: A Survey,” by Jingjin Wu, Yujing Zhang, Moshe Zukerman, and Edward Kai-Ning Yung, presents a survey. The paper starts by outlining the significance of green mobile networking by showing some facts and figures. In addition, the paper studies some of the state-of-the-art research efforts that have been done in the area of green cellular networks that incorporate the idea of the “sleep mode” in the base stations. The paper then assesses some of the simplifying assumptions that have been followed in those research efforts and shows their impact on the network performance. Finally, the paper sheds light on some potential future research directions.

#### VEHICULAR, AD HOC, AND SENSOR NETWORKS

A vehicular ad hoc network (VANET), a subclass of mobile ad hoc networks (MANETs), uses cars or vehicles as mobile nodes, as well as fixed roadside nodes, to create a wireless network. These networks have no fixed infrastructure and instead rely on the nodes themselves to provide network functionality. A VANET turns every participating node into a wireless router, allowing nodes approximately 100–300 m of each other to connect and, in turn, create a network with a wide range. In such a highly dynamic and mobile wireless network, it is required to deliver different messages in a fast, reliable, and efficient manner. Hence, routing algorithms, which allow packets to be routed from the sender to the receiver via a set of intermediate nodes with a high level of quality of service, are required. In this context, the paper titled “Bio-Inspired Routing Algorithms Survey for Vehicular Ad Hoc Networks,” by Salim Bitam, Abdelhamid Mellouk, and Sherali Zeadally, presents a survey on a class of routing algorithms that are bio-inspired. The paper reviews the bio-inspired routing algorithms for the VANET environment. In particular, the authors help identify the key features, strengths, and weaknesses of these algorithms and compare them by using various criteria. Moreover, the authors propose a unified formal model of the bio-inspired multimodal approaches applied to VANET routing. Finally, the authors outline some possible future research directions.

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, which are deployed to monitor physical or environmental conditions, such as temperature, sound, pressure, etc., and to cooperatively pass their data through the network to a main location. Sensor devices should be inexpensive, small, and have a long lifetime, which makes it important to develop very efficient software and hardware solutions. On the other hand, cognitive radio (CR) technology has been proposed as a technology that will enable the wireless industry to improve spectrum efficiency by exploiting the under-utilized licensed spectrum. A CR network is capable of learning the surrounding environment and dynamically adapting the operating parameters through spectrum sensing, adaptive transmission, and software and hardware reconfigurability, to make the best use of the available spectrum.

It is foreseen that equipping WSNs with CR capabilities will be beneficial. This necessitates, however, the development of advanced and intelligent radio resource allocation schemes to perform dynamic and efficient spectrum allocation among sensor nodes and to optimize the energy consumption of each individual node in the network. The paper titled “A Survey on Radio Resource Allocation in Cognitive Radio Sensor Networks,” by Ayaz Ahmad, Sadiq Ahmad, Mubashir Husain Rehmani, and Naveed Ul Hassan, presents a survey on the state-of-the-art methods for radio resource allocation (RRA) in CRSNs. The paper categorizes the existing RRA methods in CRSNs into centralized, cluster-based, and distributed methods. In addition, the paper offers new performance criteria to classify the exiting RRA methods. These criteria include energy efficiency, throughput maximization, QoS assurance, interference avoidance, fairness and priority consideration, and hand-off reduction. Finally, the paper shed light on possible future research directions.

In a vehicular network (VN), nodes usually have high mobility. Moreover, there exist a lot of obstacles like buildings that produce a highly variable network topology, as well as more frequent partitions in the network. Hence, traditional protocols for MANETs are not suitable for VANETs. Delay tolerant networks (DTNs) appear as an alternative approach that is capable of dealing with VANET characteristics and make them applicable to VN for intelligent transportation systems. In this context, the paper titled “DTN Protocols for Vehicular Networks: An Application Oriented Overview,” by Sergio M. Tornell, Carlos T. Calafate, Juan-Carlos Cano, and Pietro Manzoni, provides a survey on different proposals for vehicular delay tolerant networks (VDTNs) proposed in the literature. The paper offers taxonomy of the different VDTN proposals according to the type of knowledge needed to route messages. Moreover, the paper proposes some applications where VDTNs can be applicable and evaluate the suitability of the different proposals for each specific application. In addition, the paper discusses some methodologies that can be employed to evaluate the DTN protocols performance.

The recent wave of sensor-rich Internet-enabled smart mobile devices has opened the door for a novel paradigm for monitoring the urban landscape known as participatory sensing. Using this paradigm, ordinary citizens can collect multimodal data streams from the surrounding environment using their mobile devices and share the same using existing communications infrastructure. The data contributed from multiple participants can be combined to build a spatiotemporal view of the phenomenon of interest and also to extract important community statistics. Given the ubiquity of mobile phones and the high density of people in metropolitan areas, participatory sensing can achieve an unprecedented level of coverage in both space and time for observing events of interest in urban spaces. However, in order to guarantee a stable scale of participants and to improve the accuracy/coverage/timeliness of sensing results, there should be some way to attract participants by paying rewards as a return, which is known as an incentive mechanism. In this context, the paper titled “A Survey of Incentive Mechanisms for Participatory Sensing,” by Hui Gao, Chi Harold Liu, Wendong Wang, Jianxin Zhao, Zheng Song, Xin Su,

Jon Crowcroft, and Kin K. Leung, provides a survey on the state-of-the-art of incentive strategies used in participatory sensing. Moreover, the paper highlights possible research directions for incentive strategies.

#### INTERNET, SECURITY, AND PROGRAMMABLE NETWORKS

The IoT is the network of physical objects (things) or cyber-physical systems (CPSs) embedded with electronics, software, sensors, and connectivity to enable it to achieve greater value and service by exchanging data with the manufacturer, operator, and/or other connected devices. Each CPS or thing is uniquely identifiable through its embedded computing system and is able to interoperate within the existing Internet infrastructure. A thing, in the IoT, can be a person with a heart monitor implant, a farm animal with a biochip transponder, an automobile that has built-in sensors to alert the driver when tire pressure is low, or any other natural or man-made object that can be assigned an IP address and provided with the ability to transfer data over a network. While many CPSs are human-centric applications where humans are an essential part of the system, unfortunately, most of these systems still consider the human as an external and unpredictable element to the control loop. Hence, to better satisfy human requirements, a closer tie is required between CPSs and the human element in terms of a human-in-the-loop control that takes into consideration human intents, psychological states, emotions, and actions inferred through sensory data. In this context, the paper titled “A Survey on Human-in-the-Loop Applications Towards an Internet of All,” by David Sousa Nunes, Pei Zhang, and Jorge Sá Silva, presents a detailed survey on the state-of-the-art research efforts toward human-in-the-loop CPSs. The paper offers a new taxonomy of the general roles of the human component together with an analysis of the requirements for these types of systems.

In a publish/subscribe system, subscribers register their interest in an event, or a pattern of events, and are subsequently asynchronously notified of events generated by publishers. Such a system has been proved to be an adequate solution to build large-scale communications infrastructures due to their intrinsic asynchronous communications and decoupling. In addition, many variants of the publish/subscribe system have recently been proposed, each variant being specifically adapted to some given application or network model. Recently, there has been an increasing interest in security aspects in publish/subscribe services. This is due to the emergence of several cyber attacks targeting most mission-critical publish/subscribe systems. This requires the adopted publish/subscribe service to be equipped with proper means to protect the exchanged data, to preserve its correct behavior, and to face possible attack scenarios. In this context, the paper titled “On Security in Publish/Subscribe Services: A Survey,” by Christian Esposito and Mario Ciampi, presents an extensive survey and a brief introduction to the principles of securing event notification, and an analysis of relevant state-of-the-art secure publish/subscribe services and overviews the current marketed products. In addition, the paper presents the main challenges that are still unresolved, which need further investigation.

Android is a mobile operating system (OS) based on the Linux kernel and currently developed by Google. With a user interface based on direct manipulation, Android is designed primarily for touchscreen mobile devices such as smartphones and tablet computers, with specialized user interfaces for televisions (Android TV), cars (Android Auto), and wrist watches (Android Wear). The OS uses touch inputs that loosely correspond to real-world actions, like swiping, tapping, pinching, and reverse pinching to manipulate on-screen objects, and a virtual keyboard. Owing to its popularity, there has been an exponential rise in Android malware applications lately. Therefore, maintaining security in Android operating systems has become a challenging task. In this context, the paper titled “Android Security: A Survey of Issues, Malware Penetration, and Defenses,” by Parvez Faruki, Ammar Bharmal, Vijay Laxmi, Vijay Ganmoor, Manoj Singh Gaur, Mauro Conti, and Muttukrishnan Rajarajan, provides a survey. The paper starts by studying Android security enforcement and its issues, Android malware growth, malware penetration, and anti-analysis techniques used by malware authors to bypass analysis methods. The paper analyzes and assesses the different proposed methodologies and provides a platform for researchers towards proposing next-generation Android security, malware analysis, and malicious app detection methods.

A programmable network can be defined as a network in which the behavior of network devices and flow control is handled by software that operates independently from network hardware. This enables network operators to efficiently configure networks with policies to respond to a wide range of network events and applications. Moreover, it eliminates the need to manually transform these high-level policies into low-level configuration commands while adapting to changing network conditions. One form of a programmable network 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. In this context, the paper titled “Programmable Networks—From Software-Defined Radio to Software-Defined Networking,” by Daniel F. Macedo, Dorgival Guedes, Luiz F. M. Vieira, Marcos A. M. Vieira, and Michele Nogueira, provides a survey on the most recent research initiatives on programmable networks. The paper starts by characterizing programmable networks and separating it into three planes: data, control, and management planes. The paper then discusses the modern programmable network architectures. The paper concludes with final considerations, open issues, and future challenges.

The key motivation behind the CR technology is to increase spectral utilization and to optimize the use of radio resources. As CR is emerging as a strong technological opportunity, research and development is being promoted rapidly throughout the wireless industry and in the academic research arena. The successful deployment of CR technologies will depend on the design and implementation of essential security mechanisms to ensure the robustness of networks and terminals against security attacks. CR may introduce entirely new classes of security threats and challenges, including download of malicious

software, licensed user emulation, and selfish misbehaviors. An attacker could disrupt the basic functions of a CR network, cause harmful interference to licensed users, or deny communication to other CR nodes. In this context, the paper titled “Advances on Security Threats and Countermeasures for Cognitive Radio Networks: A Survey,” by Rajesh K. Sharma and Danda B. Rawat, provides a survey on state-of-the-art research results and approaches proposed for CR security to protect both unlicensed secondary users (SUs) and licensed primary users (PUs). Moreover, the paper outlines the recent advances in security threats/attacks and countermeasures in CR, focusing more on physical layer, and categorizes them. In addition, the paper offers some recommendations that can be followed while implementing countermeasures to enhance CR security. Finally, the paper discusses some open challenges.

Since the beginning of the nineties, the Internet has undergone impressive growth. This growth can be appreciated in terms of the equipment, such as routers and links, that has been added, as well as the numbers of users and the value of commerce that it supports. In parallel to this expansion, over the past decade, the networking research community has shown a growing interest in discovering and analyzing the Internet topology. Some researchers have developed tools for gathering network topology data, whereas others have tried to understand and model the Internet’s properties. These research efforts are crucial and have many benefits that range from the design and evaluation of new protocols to the vulnerability analysis of Internet infrastructure. In this context, the paper titled “A Survey of Techniques for Internet Topology Discovery,” by Reza Motamedi, Reza Rejaie, and Walter Willinger, provides an extensive survey and taxonomy on some of the main research studies on the discovery and characterization of the Internet topology and assesses them. Moreover, the paper helps to identify some of the research areas that are worth further investigation.

Automatic dependent surveillance—broadcast (ADS-B) is a surveillance system being implemented worldwide by many aviation authorities that offers a great leap forward in aircraft surveillance capabilities. More specifically, it is a cooperative surveillance technology in which an aircraft determines its position via satellite navigation and periodically broadcasts it, enabling it to be tracked. The information can be received by air traffic control ground stations as a replacement for secondary radar. It can also be received by other aircrafts to provide situational awareness and allow self-separation. However, there is an inherent lack of security measures in the ADS-B protocol that renders it vulnerable to security attacks. In this context, the article titled “On the Security of the Automatic Dependent Surveillance-Broadcast Protocol,” by Martin Strohmeier, Vincent Lenders, and Ivan Martinovic, provides an extensive survey. The paper starts by outlining the various attacks and problems that have been reported in relation to ADS-B security. Then, it studies the different research efforts that have been done to tackle these issues and provides a performance assessment of security measures that have been developed more generally for related wireless networks such as sensor networks and vehicular ad hoc networks. Finally, the paper highlights possible future research directions.

Smart metering is an advanced feature of smart power grid. It allows distribution system operators to monitor their energy grid at a much higher sampling rate and granularity than in traditional electrical grids. Energy suppliers can use the near-real-time consumption data to control their production more efficiently and to offer their customers pricing schemes based on current offer and demand. However, this enhanced capability of monitoring customers’ behaviors and consumption poses some privacy concerns. In this context, the paper titled “Privacy-Aware Smart Metering: A Survey,” by Soren Finster and Ingmar Baumgart, presents a survey. The paper presents the different approaches followed to deal with the problem of customer privacy protection in the smart grid. The paper shows that the privacy problem in the smart grids can be further divided into the problems of metering for billing and metering for operations. Different approaches for the posed problems are then outlined. The paper also highlights possible future research directions.

## VIDEO AND MULTIMEDIA

In digital signal processing, data compression, source coding, or bit-rate reduction involves encoding information using fewer bits than the original representation. This is beneficial because it helps to reduce resource usage, such as data storage space or transmission capacity. Data compression is subject to a space–time complexity tradeoff. For instance, a compression scheme for video may require expensive hardware for the video to be decompressed fast enough to be viewed as it is being decompressed, and the option to decompress the video in full before watching it may be inconvenient or require additional storage. The design of data compression schemes involves tradeoffs among various factors, including the degree of compression, the amount of distortion introduced, and the computational resources required to compress and decompress the data. In this context, the paper titled “A Tutorial and Review on Inter-Layer FEC Coded Layered Video Streaming,” by Yongkai Huo, Cornelius Hellge, Thomas Wiegand, and Lajos Hanzo, presents a survey on the state-of-the-art of layered video compression techniques. Specifically, the paper reviews the existing layered video compression standards, followed by the introduction of packet-level layer-aware (LA) forward error correction (FEC) codes. The paper then outlines the family of bit-level interlayer (IL) forward error correction (FEC) schemes and analyzes their benefits. Finally, the paper offers some design guidelines that must be taken into considerations when designing any IL-FEC scheme.

Video quality is a characteristic of a video passed through a video transmission/processing system and is a formal or informal measure of perceived video degradation (typically, compared to the original video). Video processing systems may introduce some amount of distortion or artifacts in the video signal, which negatively impacts the user’s perception of a system. For many stakeholders such as content providers, service providers, and network operators, the assurance of video quality is an important task. Hence, the process “Video quality evaluation” is introduced. Video quality evaluation can be defined as a process that is performed to describe the quality

of a set of video sequences under study. Video quality can be evaluated objectively (by mathematical models) or subjectively (by asking users for their rating). In addition, the quality of a system can be determined offline (i.e., in a laboratory setting for developing new codecs or services), or in-service (to monitor and ensure a certain level of quality). In this context, the paper titled “From QoS to QoE: A Tutorial on Video Quality Analysis,” by Yanjiao Chen, Kaishun Wu, and Qian Zhang, provides an extensive survey on the evolution of video quality assessment methods. Specifically, the paper analyzes and assesses their characteristics, merits and demerits. Moreover, the paper offers a discussion about quality-of-experience (QoE)-based video application. Finally, the paper identifies some future research directions for QoE.

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