

Editorial: Fourth Quarter 2013, IEEE Communications Surveys & Tutorials

Ekram Hossain, *Editor-in-Chief*

I WELCOME you to the fourth issue of the IEEE Communications Surveys and Tutorials (ComST) in 2013. This issue includes twenty six articles covering different aspects of communication networks. In particular, these articles cover various issues in wireless communications systems, cellular, wireless LAN and cognitive radio network design, traffic modeling, routing and broadband Internet, fault detection, security, and privacy in communication networks. A brief account for each of the articles included in this issue is given below.

WIRELESS COMMUNICATIONS AND SYSTEMS

The propagation environments have fundamental impacts on the performance of wireless communications systems. The paper titled “A Survey of Wireless Communications and Propagation Modeling in Underground Mines” by Arghavan Emami Forooshani, Shahzad Bashir, David G. Michelson, and Sima Noghianian, presents a survey on the underground propagation channel modeling in mining applications. Along with the different modeling techniques, their implications on the wireless communications system design are discussed. The authors also discuss the emerging applications for wireless communications for mining operations and highlight future research directions.

Hybrid Automatic Repeat reQuest (HARQ) and channel coding are two major techniques to enhance the reliability of communication links. Turbo coding is a widely deployed channel coding scheme due to its capacity achieving performance. However, combining turbo coding with HARQ may introduce significant complexity to the decoding process. Motivated by the wide deployment of HARQ techniques and turbo coding in wireless communications systems, the paper titled “A Survey and Tutorial on Low-Complexity Turbo Coding Techniques and a Holistic Hybrid ARQ Design Example” by Hong Chen, Robert G. Maunder, and Lajos Hanzo, provides a tutorial on the design of low-complexity turbo codes and HARQ techniques and reviews the related literature.

Peak-to-Average power ratio (PARP) is a fundamental problem that arises in orthogonal frequency division multiplexing (OFDM) systems, which increases both the complexity and cost for the design of power amplifiers. Motivated by the increased popularity of OFDM-based systems and the requirement of cheap wireless terminals, the paper titled “Peak-To-Average Power Ratio Reduction in OFDM Systems: A Survey And Taxonomy” by Yasir Rahmatallah and Seshadri Mohan presents a survey on the literature related to the PARP

problems and the proposed solutions. After providing the definition of the PARP problem and the different metrics used to evaluate the PARP reduction, the authors provide a taxonomy of the PARP reduction schemes. The authors also highlight some potential research directions.

The ever increasing user population demanding ubiquitous broadband wireless coverage brings significant challenges for the current cellular network architecture from from the perspectives of both the core network and the access network. Millimeter-wave radio transmissions at the access networks supported by fiber systems at the core network (denoted as radio over fiber [RoF]) is expected to take the cellular network architecture to the next level and fulfill the imposed capacity demand. Motivated by the high capacity, security, and cost efficiency of RoF systems, the paper titled “Millimeter-Wave Frequency Radio over Fiber Systems: A Survey” by Joaquín Beas, Gerardo Castañón, Ivan Aldaya, Alejandro Aragón-Zavala, and Gabriel Campuzano presents a review of the related literature. The authors also discuss future research directions.

Compared to the radio frequency communication, optical communication offers a much higher capacity. Therefore, the increasing capacity demand and population of wireless users are pushing the academia and industry towards optical systems. Free space optics (FSO) and visible light communication (VLC) are two opportunities to provide wireless optical networking. The paper titled “LIGHTNETs: Smart LIGHTing and Mobile Optical Wireless NETWORKS — A Survey” by Abdullah Sevincer, Aashish Bhattarai, Mehmet Bilgi, Murat Yuksel, and Nezhir Pala presents a tutorial and a literature review for the FSO and VLC systems. The authors discuss the pros and cons of the two systems and investigate the potential integration between them. The authors also point out future research directions.

CELLULAR, WIRELESS LAN, AND COGNITIVE RADIO NETWORKS

Universal frequency reuse is expected to boost up the spectral efficiency of cellular networks in an effort to fulfill the ever-increasing capacity demand. However, it imposes new challenges in terms of interference mitigation and coordination. The challenge is more acute in the case of orthogonal frequency-division multiple access (OFDMA) networks due to the high degrees of freedom existing in the resource allocation process. The paper titled “A Survey on Inter-Cell Interference Coordination Techniques in OFDMA-Based Cellular Networks” by Abdelbaset S. Hamza, Shady S. Khalifa, Haitham S. Hamza, and Khaled Elsayed reviews the literature

related to the inter-cell interference coordination in OFDMA-based cellular networks. The authors present a classification of the research efforts on inter-cell interference coordination in the literature and highlight future research directions.

Although opportunistic scheduling has been a hot research topic for almost two decades, it has not been widely implemented yet due to the associated scheduler complexity. However, the increasing capacity demand necessitates an optimized utilization of the wireless spectrum and it is driving the implementation of opportunistic schedulers in practical wireless systems. Motivated by the increased interest to implement opportunistic schedulers in the next generation cellular networks, the paper titled “A Survey on Opportunistic Scheduling in Wireless Communications” by Arash Asadi and Vincenzo Mancuso surveys the literature related to opportunistic scheduling in wireless systems. The authors show that the available research on opportunistic scheduling is mature enough for the implementation phase. The authors also point out some future research extensions.

Although the wireless spectrum is a scarce resource for wireless communications, many investigations and field measurements have reported that the wireless spectrum is highly underutilized. The main reason for the spectrum underutilization is the exclusive and static frequency planning and assignment. Opportunistic spectrum access is foreseen as the most efficient and promising solution for the scarcity and underutilization paradox of the wireless spectrum. In this context, the paper titled “Decision-Theoretic Distributed Channel Selection for Opportunistic Spectrum Access: Strategies, Challenges and Solutions” by Yuhua Xu, Alagan Anpalagan, Qihui Wu, Liang Shen, Zhan Gao, and Jinglong Wang reviews the literature related to distributed opportunistic spectrum access in wireless networks. The authors discuss the pros and cons of the different techniques used for distributed opportunistic spectrum access in wireless networks and highlight future research directions.

The tremendous success and massive implementation of the IEEE 802.11-based wireless local area networks (WLANs) are driving research in both the industry and academia to enhance their performance. Particularly, the quality of service (QoS) performance, which was not guaranteed in the earlier versions of the IEEE 802.11 WLAN, has to be enhanced to support multimedia applications. In this context, the paper titled “PHY/MAC Enhancements and QoS Mechanisms for Very High Throughput WLANs: A Survey” by Emna Charfi, Lamia Chaari, and Lotfi Kamoun reviews the efforts invested in the literature to enhance the QoS in the IEEE 802.11-based WLANs. The authors also discuss open research problems and point out future research directions.

Greening the wireless networks by reducing their power consumption has become a critical research agenda worldwide. In the case when different wireless terminals located in a close proximity seek the same content from a remote server, they can cooperate together to enhance their performance and reduce energy consumption. In this context, the paper titled “Energy-Aware Cooperative Content Distribution over Wireless Networks: Design Alternatives and Implementation Aspects” by Lina Al-Kanj, Zaher Dawy and Elias Yaacoub reviews the literature related to energy-awareness in cooperative

content distribution wireless networks. The authors discuss related standardization activities and point out future research directions.

As has been mentioned before, opportunistic spectrum access is foreseen as the most efficient solution to overcome the underutilization of the scarce spectrum imposed by the static and exclusive frequency assignment. Opportunistic spectrum access can be implemented in a distributed fashion via cognition. Cognitive radios are intelligent radios that are able to monitor the surrounding environment, learn from past experience, adapt their parameters, and operate in the most efficient manner. Therefore, concepts such as learning and reasoning are fundamental for the cognitive radio design and implementation. In this context, the paper titled “Learning and Reasoning in Cognitive Radio Networks” by Liljana Gavrilovska, Vladimir Atanasovski, Irene Macaluso, and Luiz A. DaSilva reviews the efforts invested in the literature to implement the concepts from artificial intelligence to cognitive radio. The authors also discuss future research directions.

TRAFFIC MODELING, ROUTING, AND BROADBAND INTERNET

Recently, the popularity of video streaming applications has increased significantly. Variable bit rate (VBR) control for video traffic offers a constant quality for the video streaming when the delay constraint is not so strict. For the design and performance assessments of networks supporting VBR video applications, it is important to develop precise models for the VBR video traffic. The paper titled “A Survey of VBR Video Traffic Models” by Savera Tanwir and Harry Perros presents a literature review as well as a classification for the VBR video traffic modeling techniques.

For the video traffic flow over packet-switched networks, it is crucial to know the sizes of video frames in order to reserve the appropriate amount of resources and fulfill the video traffic requirements. In a VBR video transport, there are significant variations in the video frame sizes which make it difficult for the packet switching devices to efficiently comply with the video traffic constraints. Therefore, traffic forecasting schemes are key enablers for the dynamic resource adaptation for video traffic which lead to an efficient operation of the packet switching devices. In this context, the paper titled “Video Bandwidth Forecasting” by Rami J. Haddad, Michael P. McGarry, and Patrick Seeling reviews the related literature on the forecasting schemes for video bandwidth in packet-switched networks. The authors compare the accuracy of the different bandwidth forecasting schemes used in the literature and point out future research directions.

Efficient path computation is a core requirement for fulfilling the traffic engineering (TE) objectives in core networks. Motivated by the importance of path computations and the inefficiencies that arise from the distributed nature of the path computation along with the topology invisibility issues, the Internet Engineering Task Force (IETF) introduced the Path Computation Element (PCE) architecture. In this architecture, the path computations are provisioned by a dedicated network element called the PCE to overcome the topology invisibility and distributed provisioning issues. In this context, the paper titled “A Survey on the Path Computation Element (PCE)

Architecture” by Francesco Paolucci, Filippo Cugini, Alessio Giorgetti, Nicola Sambo, and Piero Castoldi surveys the existing literature related to the PCE architecture and presents the related standardization activities.

Locator/Identifier split is a key solution proposed to solve the scalability issues in the Internet. This solution splits the IP address functionality into two separate functions, namely, end host identifiers and network attachment locators. While the identifiers are only locally recognized addresses, the locators are globally unique addresses, and hence, can be used to globally route data to the designated network. The Locator/Identifier split requires fast, efficient, and secure mapping systems that link the identifiers to their corresponding locators. In this context, the paper titled “Survey of Mapping Systems for Locator/Identifier Split Internet Routing” by Michael Hoefling, Michael Menth, and Matthias Hartman reviews the mapping systems proposed in the literature for the Locator/Identifier split Internet routing. The authors overview the key aspects for the mapping systems, present a taxonomy for the related literature, and point out future research directions.

Defined by the IETF, the resource reservation protocol (RSVP) guarantees a delay bound for delay-constrained traffic over the Internet. The RSVP guarantees the delay bound by reserving sufficient resources over all links and nodes interconnecting the traffic source to the destination. Since its introduction by the IETF, lots of modifications and alterations have been done to the RSVP, to either overcome the inherent protocol deficiency or extend it for new services. In this context, the paper titled “A Survey on the Evolution of RSVP” by Flavius Pana and Ferdi Put reviews the literature related to the RSVP protocol and highlights its evolution over the time. The article also discusses open research challenges and highlights future research directions.

Network virtualization is a key solution to decouple the Internet infrastructure from the Internet services to overcome the *Internet ossification problem*. Network virtualization is implemented via virtual network embedding algorithms which are responsible for mapping the virtual resources to physical network resources. Therefore, the efficiency of network virtualization depends on the underlying embedding algorithms. Motivated by the importance of network virtualization for the development of Internet, the paper titled “Virtual Network Embedding: A Survey” by Andreas Fischer, Juan Felipe Botero, Michael Till Beck, Hermann de Meer, and Xavier Hesselbach surveys the algorithms proposed in the literature to embed virtual networks on a substrate infrastructure. The article also presents a taxonomy of the existing literature and highlights some future directions.

Internet service providers (ISPs) aim at increasing their digital subscriber line (DSL) data rates to provide video, HDTV, and 3D TV services to their clients. However, increasing the data rates on the current twisted pair DSL infrastructure introduces significant performance degradations due to the associated crosstalk effects. Vectored DSL is an efficient solution to mitigate the crosstalk effects from DSL using twisted pair copper links. The high cost to replace the entire copper links by optical fibers and the requirement to provide much higher data rates on the current DSL infrastructure have resulted in an increased attention to the vectored DSL.

In this context, the paper titled “Vectored DSL: Potential, Implementation Issues and Challenges” by Christopher Leung, Sean Huberman, Khuong Ho-Van, and Tho Le-Ngoc reviews the literature related to crosstalk mitigation schemes for vector DSL. The authors discuss various vectored DSL schemes used in the downstream and upstream communications and discuss their implementation challenges.

The huge bandwidth consumed by analog TV, the advances in the TV provider and consumer electronics, and the demand for high quality TV broadcasting have motivated the migration towards digital TV. In digital TV, the broadcasted signals are digitally processed (e.g., using source and channel coding) which significantly increase the transmission quality and spectrum utilization. In this context, the paper titled “A Survey of Digital Television Broadcast Transmission Techniques” by Mohammed El-Hajjar and Lajos Hanzo presents a survey on digital TV transmission techniques. The authors survey the TV evolution since its development and compare the different standards developed for digital TV implementation in different countries. The authors also give a design example for the terrestrial digital video broadcasting system used in Europe and highlight future directions.

The high performance gains achieved via network coding have motivated a lot of research efforts in this field. The main idea of network coding is that instead of sequentially relaying packets via intermediate nodes, the network nodes can combine the incoming packets to maximize the traffic flow in the network. In addition to increasing the network capacity, network coding is expected to increase the network reliability, scalability, and security. In this context, the paper “Network Coding Theory: A Survey” by Riccardo Bassoli, Hugo Marques, Jonathan Rodriguez, Kenneth W. Shum and Rahim Tafazolli reviews the theoretical approaches used in the literature to model, analyze, and design network coding. The article presents the required mathematical preliminaries for network coding, surveys the different theoretic approaches to implement network coding, presents a taxonomy of the existing literature, and points out potential research directions.

The lack of a payment service integrated to the identity federations’ services impedes its penetration to the commercial domain. That is, commercial service providers will require an integrated payment system in order to offer their products to their federated customers. Motivated by the economic benefits, increased security, and flexibility offered by the integration between identity federations and payment services, the paper titled “A Survey of Payment Approaches for Identity Federations in Focus of the SAML Technology” by David J. Lutz and Burkhard Stiller surveys the literature related to the integration solutions. The authors analyze electronic payment approaches and identity federation mechanisms as well as the techniques proposed in the literature to bridge these two aspects. A special focus is given to the Security Assertion Markup Language (SAML)-based solutions. The authors also discuss related security and privacy issues.

FAULT DETECTION, SECURITY, AND PRIVACY

Wireless sensor networks (WSNs) are mostly deployed in an unplanned and unsupervised manner in severe operating environments. Therefore, WSNs are vulnerable to different

types of failures which may decrease their efficiency, lifetime, and benefits. A precise diagnosis is the foundation for efficient and fast fault recovery and highly increases the robustness, lifetime, and reliability of WSNs. In this context, the paper titled “Fault Diagnosis in Wireless Sensor Networks: A Survey” by Arunanshu Mahapatro and Pabitra Mohan Khilar presents a literature review on the fault diagnosis techniques for WSNs. The authors provide a technique-based taxonomy of the literature and a comparison among the different fault diagnoses techniques.

Due to its ad hoc and multi-hop nature of connectivity, the performance of mobile ad hoc networks (MANETs) highly depends on the performance of the individual devices. For instance, routing at the network layer in a MANET depends on relaying the data over intermediate nodes from the source to the destination. Therefore, in addition to the exposure vulnerability of the routed data which threatens its privacy and integrity, malicious behaviour from some nodes in the network can significantly degrade the MANET performance. Motivated by the vulnerability of MANETs to security threats, the paper titled “A Survey of MANET Intrusion Detection & Prevention Approaches for Network Layer Attacks” by Adnan Nadeem, and Michael P. Howarth surveys the efforts invested in the literature to detect and prevent network layer attacks in MANETs. The authors first define the different types of attacks in MANETS and provide a taxonomy of the existing literature. The authors also point out future research directions.

Designing a detection and defence mechanism against distributed denial of service (DDoS) flooding attacks is a significant challenge for the Internet service providers. In a DDoS attack, many computers over the Internet are used by an attacker to flood the resources of a designated network element (usually a server) or a set of network elements. Hence, it is very difficult to deal with these multi-source and distributed attacks using the techniques used for the single source attack. In this context, the paper titled “A Survey of Defense Mechanisms Against Distributed Denial of Service (DDoS) Flooding Attacks” by Saman Taghavi Zargar, James Joshi, and David Tipper surveys the efforts invested in the literature to develop comprehensive defense mechanisms against the DDoS attacks. The authors explore the scope of DDoS attacks, compare the different defense mechanisms, and highlight future research directions.

The increasing amount of attacks using phishing emails motivate the development of a comprehensive solution to defend against these attacks. In this context, the paper titled

“A Survey of Phishing Email Filtering Techniques” by Ammar Almomani, B. B. Gupta, Samer Atawneh, A. Meulenber, and Eman Almomani surveys the efforts invested in the literature to develop filtering techniques for phishing emails. The article discusses the problems due to the phishing emails, reviews the proposed solutions, and highlights future trends.

The phishing emails are special type of the phishing attacks which exploit the vulnerabilities of the system users to intrude into a secured system. The broad nature of the phishing attacks along with the human factor, which they exploit, make it difficult to detect and prevent them. In this context, the paper titled “Phishing Detection: A Literature Survey” by Mahmoud Khonji, Youssef Iraqi, and Andrew Jones reviews the literature related to phishing detection and prevention. The authors define and categorize the phishing attacks, discuss and compare the solution techniques, and highlight potential research directions.

I hope that you enjoy reading this issue and find the articles useful. Last but not the 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:

<http://dl.comsoc.org/livepubs/surveys/>.

I will be happy to receive your comment and feedback on our journal.



Ekram Hossain, Ph.D., P. Eng.

Editor-in-Chief

IEEE Communications Surveys & Tutorials

Email: Ekram.Hossain@ad.umanitoba.ca

Web: <http://home.cc.umanitoba.ca/~hossaina>