Editorial: Fourth Quarter 2020 IEEE COMMUNICATIONS SURVEYS AND TUTORIALS

I WELCOME you to the fourth issue of the IEEE COMMUNICATIONS SURVEYS AND TUTORIALS in 2020. This issue includes 22 papers covering different aspects of communication networks. In particular, these articles survey and tutor various issues in "Wireless Communications," "5G and Vehicular Communications," "Internet of Things," "Network Security," and "Miscellaneous." There are three papers in the miscellaneous category which survey the issues in Molecular Communications, Multimedia Networks, and Optical Networks. A brief account for each of these papers is given below.

I. WIRELESS COMMUNICATIONS

The massive connectives required in the future networked society and industries rely heavily on a variety of short-range wireless communications, particularly Wireless-Fidelity (Wi-Fi) communications in diverse residential and industrial environments. To support emerging applications such as 4K/8K videos and high-resolution VR (Virtual Reality)/AR (Augmented Reality), Wi-Fi users expect to support a maximum throughput of at least 30 Gbps, which is approximately three times the maximum throughput of Wi-Fi 6 (IEEE 802.11ax). Besides, the IEEE standards development group recognizes the requirements to reduce transmission latency and jitter of extremely high-speed Wi-Fi communications in both consumer and industry applications. As a result, high-throughput and stringent delay requirements are driving the development of new changes to the Wi-Fi standard known as IEEE 802.11be Extremely High Throughput (EHT) or Wi-Fi 7. This new Wi-Fi 7 standard aims at further improving the Wi-Fi system performances by leveraging both current and emerging Wi-Fi technologies to ensure the competitiveness of IEEE 802.11 in the coming years. In this context, the paper titled "IEEE 802.11be Wi-Fi 7: New Challenges and Opportunities" by Cailian Deng, Xuming Fang, Xiao Han, Xianbin Wang, Li Yan, Rong He, Yan Long, and Yuchen Guo presents the first comprehensive survey on Wi-Fi 7, by providing an in-depth analysis of the most recent standardization activities and progress, as well as the latest research advancement of the related technologies. Moreover, this survey also identifies several open technical issues to be investigated and a few promising research directions to promote the future development of Wi-Fi 7.

With the availability of massive data sets, high performance computing platforms, as well as sophisticated algorithms and software toolkits, AI has achieved remarkable successes in many application domains, e.g., natural language processing, computer vision, and healthcare. AI tasks are computationally intensive and normally trained, developed, and deployed at cloud data centers. Given the fast growth of intelligent end-devices, it is expected that a large number of high-stake applications (e.g., drones, autonomous cars etc.) will be deployed at the edge of wireless networks in near future. As such, pushing inference and training processes of AI models to edge nodes becomes essential to support edge AI-enabled applications with privacy and security guarantees subject to limited communication, computation, hardware, and energy resources constraints. In this context, the paper titled "Communication-Efficient Edge AI: Algorithms and Systems" by Yuanming Shi, Kai Yang, Tao Jiang, Jun Zhang, and Khaled B. Letaief presents a tutorial to investigate the communication challenges and solutions from the algorithm level and system level. For the communication-efficient edge AI algorithms design, the paper has carried out a thorough investigation on various optimization algorithms and various approaches to reduce communication round and reduce the required communication bandwidth in each iteration round. For the communication-efficient edge AI systems design, the paper overviews the main system architectures of edge AI, including the data partition based edge training system, model partition based edge training system, computation offloading based edge inference system, and the general edge computing system.

Future wireless networks are envisioned to support a large number of connected users and a variety of applications that require very high data rates, almost perfect reliability, as well as ultra-low latency. Non-orthogonal multiple access (NOMA) schemes, where multiple users can share the same resource block have recently emerged as an alternative to the traditional orthogonal multiple access schemes to improve spectral efficiency, user fairness, and reduce the network latency. When the power domain is used to separate the users, it is referred to as the power-domain NOMA (PD-NOMA) scheme. While NOMA is seen as a key enabler to meet the demands on future wireless networks, several other communications schemes and technologies can be integrated with NOMA to realize additional benefits in the system performance. In this context, the paper titled "A Survey of Rate-Optimal Power Domain NOMA With Enabling Technologies of Future Wireless Networks" by Omar Maraqa, Aditya S. Rajasekaran,

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Saad Al-Ahmadi, Halim Yanikomeroglu, and Sadiq M. Sait presents a survey. The paper provides a thorough up-to-date survey of the integration of the PD-NOMA scheme with seventeen enabling technologies of future wireless networks, where the adopted system models, the utilized optimization techniques, the main lessons learned about such integration, and several directions for future research are discussed in detail along with highlighting the associated merits and/or trade-offs. Furthermore, an elaborate investigation of the role of machine learning in these NOMA-enabled schemes is presented.

The rapidly changing communication network dynamics and user demands have pushed the network generation boundaries beyond the fifth generation. The existing frequency bands, despite efficient communication techniques, still cannot fulfill these requirements. This has led to exploring the new frequency bands with high bandwidth availability which can fulfill the future demands of high data rate support both at the frontend and backend of the communication network. The Terahertz band in this regard has great potential to provide Terabits per second links to achieve ultra-high throughput and ultra-low latency for future applications like autonomous driving and Datacentres. However, the unique features of the Terahertz band like high path loss results in the shorter communication distance and antenna directionality requirements. Due to which, the traditional Medium Access Control (MAC) protocols cannot be used directly. The use of directional antennas requires efficient beam management for channel access and fast beam tracking mechanisms for applications involving mobility. The coordination and scheduling mechanisms are also required to allocate a fair amount of time to each user to access the channel. Therefore, new MAC protocols are required to efficiently utilize the spectrum resource and take advantage of huge bandwidth availability in the Terahertz band. In this context, the paper titled "MAC Protocols for Terahertz Communication: A Comprehensive Survey" by Saim Ghafoor, Noureddine Boujnah, Mubashir Husain Rehmani, and Alan Davy provides an extensive survey of MAC protocols for Terahertz communication networks with their requirements and design challenges for future applications. The design issues and requirements for Terahertz MAC protocols are also highlighted for the researchers, which need to be considered for efficient MAC protocol design. The existing protocols are also classified based on the scale, communication, and channel access mechanism and are critically analysed to make a better selection of MAC protocol. Different applications are also discussed which requires the Terabits per second links with their requirement towards the MAC protocols. Finally, the challenges and future research directions are highlighted.

Conventionally, the radio environment remains uncontrollable and is not accounted for in wireless network optimization. The signal propagation typically experiences reflections, diffractions, and scattering before reaching the receiver with multiple randomly attenuated and delayed copies of the original signals in different paths. Such a random radio environment becomes a major limiting factor for network performance maximization. A novel concept of intelligent reflecting surface (IRS) has been recently introduced in wireless communications to further push the limit. The IRS is composed of a large array of passive scattering elements. Each element can be controlled individually to change the reflection of the incident RF signals upon the scattering elements. By a joint phase control of all scattering elements, the signal reflections can be arbitrarily tuned to create a desirable multipath effect. As such, the IRS can turn the radio environment into a smart space that can assist information sensing, analog computing, and wireless communications. In this context, the paper titled "Towards Smart Wireless Communications via Intelligent Reflecting Surfaces: A Contemporary Survey" by Shimin Gong, Xiao Lu, Dinh Thai Hoang, Dusit Niyato, Lei Shu, Dong In Kim, and Ying-Chang Liang presents a survey on recent applications and design aspects of the IRS in the future wireless networks. Firstly, the basic concepts of the IRS and its reconfigurability are introduced. Then, focusing on different network scenarios, the paper elaborates new design problems in IRS-assisted wireless networks and summarizes different design aspects for researchers to further explore this area. Furthermore, the paper highlights practical challenges and future research directions for realizing IRS-assisted wireless networks in beyond 5G communications.

II. 5G and Vehicular Communications

The exponential growth of the number of mobile devices and explosive increase in data traffic have led to more diverse and demanding requirements for the next-generation development of wireless communication systems, such as high data rate, high spectral efficiency, and low latency, among others. To satisfy these requirements, from the duplex perspective, 5G NR supports dynamic time division duplex (D-TDD) as a way of improving performance by obtaining duplexing flexibility. D-TDD is a concept of TDD that schedules uplink and downlink traffic in an adaptive manner according to the traffic condition. Thanks to its duplexing flexibility, the D-TDD system has low latency and high spectral efficiency. However, D-TDD systems are subject to the problem of cross-link interference (CLI), which must be addressed before these advantages can be fully exploited. In this context, the paper titled "Dynamic TDD Systems for 5G and Beyond: A Survey of Cross-Link Interference Mitigation" by Hyejin Kim, Jintae Kim, and Daesik Hong presents a survey of recent technical papers and 3GPP specifications for D-TDD systems. First, the paper starts by explaining the concept of D-TDD systems and introducing CLI, which is the major problem faced by the D-TDD system. Then, the paper provides the research papers and standardization documents which propose CLI mitigation schemes and signaling approaches to efficiently implement the CLI mitigation schemes. Furthermore, the paper provides an overview of the information-theoretic performance analysis of D-TDD systems. Finally, the survey concludes with providing potential future research directions for D-TDD systems in 5G and beyond.

Connected vehicles (CVs) will enable safer and more comfortable driving experience with expected service scenarios, such as intelligent driving, vehicle-to-cloud (V2C) cruising, and high-definition map generation. The development of CVs is largely dependent on the information and

communication technologies which have fueled a plethora of innovations in various areas, including computing, communication, and caching. Computation offloading techniques, such as cloud, edge, and fog computing, can help CVs process computation-intensive large-scale computing tasks and improve the performance of many CV applications. In this context, the paper titled "Architectural Design Alternatives Based on Cloud/Edge/Fog Computing for Connected Vehicles" by Haoxin Wang, Tingting Liu, BaekGyu Kim, Chung-Wei Lin, Shinichi Shiraishi, Jiang Xie, and Zhu Han presents a tutorial and survey. First, the paper starts by presenting an overview introduction to the design of CV systems. Then, the paper summarizes the service requirements and design considerations of using cloud/edge/fog computing for CV applications. Furthermore, the paper summarizes and compares existing architectural design alternatives in the literature, which is intended to provide useful insights and guidelines to future architectural design of cloud/edge/fog computing for CVs. Finally, the paper discusses a range of open research issues to be tackled by future research studies.

Internet of Vehicles (IoV) has emerged as a key architecture that promises to enable data transmission in the Intelligent Transportation Systems. The current data transmission protocol still heavily relies on the TCP/IP protocol stack. However, due to the very properties of IoV, such as distributed operation, limited bandwidth, node mobility, and dynamic network topology, traditional TCP/IP protocols can hardly meet the increasing technical requirements and daily demands in IoV. Fortunately, the promising Named Data Networking (NDN) technology has recently emerged as a novel paradigm to facilitate content-centric data sharing for IoV, which provides a good choice to improve data sharing efficiency in vehicular environments. Especially, the introduced content store module in NDN, can greatly improve networking performance. In this context, the paper titled "Caching in Vehicular Named Data Networking: Architecture, Schemes and Future Directions" by Chen Chen, Cong Wang, Tie Qiu, Mohammed Atiquzzaman, and Dapeng Oliver Wu presents a survey. First, the paper starts by providing an overview of previous works on content caching in Vehicular Named Data Networking (VNDN). Then, this paper further elaborates on the importance of cache selection and replacement strategies in VNDN framework. Furthermore, an in-depth survey of the existing cache selection and replacement schemes in VNDN is given. Next, further challenges during caching design are elaborately analyzed taking the specific characteristics of VNDN into account. Finally, the paper discusses the potential research directions.

III. Internet of Things

The Internet of Things (IoT) is revolutionizing the world of telecommunication by bridging diverse technologies, enabling new applications and connecting billions of objects. Many standards and communication protocols have been developed to support a wide range of IoT applications. Recently, the cellular system is considered as a potential candidate to provide long-range connectivity using low power devices. In this respect, the 3rd generation partnership project (3GPP) introduced the new cellular technology standard called narrowband Internet of Things (NB-IoT) to enable IoT connectivity through the wide-area cellular networks. This new technology will compete with other existing low power wide area (LPWA) technologies like LoRa whilst sharing the same common features, such as the low battery consumption, low-cost devices, and a large coverage. However, the complexity of this new technology compared to the others (non-3GPP) resides in its design specifications that are mixed with the LTE standard making the learning of such technology more difficult. In this context, the paper titled "A Tutorial on NB-IoT Physical Layer Design" by Matthieu Kanj, Vincent Savaux, and Mathieu Le Guen presents a tutorial focused on the physical layer design of the NB-IoT system of the 3GPP Release 13. First, the paper starts with a general presentation of the NB-IoT system with its related physical channels and signals for both base station and user equipment sides. Then, the paper elaborates on each of the downlink and uplink physical channels and signals by adding detailed examples for transmission/mapping processes. Finally, the tutorial concludes with a presentation of the newly introduced features by 3GPP in Release 14 and 15 with a focus on the features that are related to physical layer. The paper offers the possibility to researchers and engineers to quickly learn the features of NB-IoT system without delving into the complex specifications of 3GPP.

The Internet of Things (IoT) plays an important role in our daily lives, and it is increasingly becoming an attractive space for cyber attacks. In particular, malware infection of IoT devices is a major issue, which can lead to serious consequences for user safety and privacy. Almost in every aspect, these small devices, often employed as interconnected groups, perform critical operations. As such, even a single compromised device in such a group can pose a security threat, e.g., by either disrupting communications within the group or sharing critical information to unauthorized parties. Remote attestation is a promising tool to face malware attacks, by enabling (remote) identification of compromised devices. In particular, remote attestation allows a device (a prover), to authenticate its underlying software configuration or data to a remote verifier. Unfortunately, while remote single device attestation is well studied and easy to deploy, group or, even worse, swarm device attestation is hard to scale. Therefore, researchers are proposing innovative solutions for secure and scalable collective attestation in static and dynamic networks. In this context, the paper titled "Collective Remote Attestation at the Internet of Things Scale: State-of-the-Art and Future Challenges" by Moreno Ambrosin, Mauro Conti, Riccardo Lazzeretti, Md Masoom Rabbani, and Silvio Ranise presents a survey where the goal of this article is to present an in-depth discussion of the state of the art in collective IoT device attestation and outline open issues and future directions.

The Industrial Internet of Things (IIoT) uses various sensors with data perception and collection functions to obtain key data in industrial processes, and employs big data mining and analysis technology to monitor and optimize industrial processes in real time, thereby greatly improving industrial operation efficiency, reducing costs and resource consumption,

and realizing intelligence of industrial processes. By introducing the edge computing into IIoT, scattered storage and computing resources in the IIoT are well integrated, the occupation of transmission resources is greatly reduced, and the overall operating efficiency of the IIoT system is improved. The paper titled "Edge Computing in Industrial Internet of Things: Architecture, Advances and Challenges" by Tie Qiu, Jiancheng Chi, Xiaobo Zhou, Zhaolong Ning, Mohammed Atiquzzaman, and Dapeng Oliver Wu presents a tutorial and survey. First, the paper interprets the concepts of Industrial Internet of Things, Industrial Internet, Cyber-Physical System, etc., and conducts a survey and summary of related literature reviews. Next, the paper proposes a reference architecture for edge computing in IIoT, and discusses advances in routing, task scheduling, data storage and analytics, security, and standardization. Furthermore, the challenges and opportunities of edge computing in IIoT are proposed. Finally, the paper introduces some typical application scenarios of edge computing in IIoT, including prognostics and health management (PHM), smart grid, manufacturing, intelligent connected vehicles (ICV), and smart logistic, etc.

With the advent of the Industrial Internet of Things (IIoT), we enter a new industrial era where highly specialized industrial processes become more capable, more flexible, and cheaper. With these increasing numbers of connected industrial devices, comes the need for security and management services that can satisfy a wide variety of requirements while maintaining the benefits of a connected industry. As a result, the last few years have seen a surge of interest in IIoT security research by the academic community, divided over many domains. One such development has been the introduction of the Fog Computing paradigm, which aims to provide Cloud functionality further along the Cloud-Edge spectrum to both improve performance and security. With industrial applications ranging wildly, from assembly-line robots to power grid management, there is a need to survey and analyze common security requirements among all industrial applications. In this context, the paper titled "A Systematic Survey of Industrial Internet of Things Security: Requirements and Fog Computing Opportunities" by Koen Tange, Michele De Donno, Xenofon Fafoutis, and Nicola Dragoni provides a systematic survey analyzing the recent growth in IIoT security research, as well as providing a systematic and comprehensive survey of security requirements identified in the investigated works. The survey concludes with a discussion putting these requirements in the light of Fog Computing, to explore the possibilities brought to the table by this new paradigm.

The revolution in the field of information and communication has created a wealth of opportunities for advanced technologies, especially Internet of Things (IoT) and Cloud computing. Due to the limited resources of IoT devices, they always delegate IoT application tasks to Cloud computing, which gives birth to the Cloud of Things (CoT) paradigm. The CoT provides a flexible, robust cloud computing environment for processing and managing IoT services, showing great potentials to improve the system performance and efficiency of service delivery. However, the conventional CoT infrastructures tend to be ineffective due to the centralized communication architectures with central cloud computing. Moreover, the centralized network infrastructure results in higher communication latency and power consumption for IoT devices due to long data transmission, which hinders the large-scale deployments of CoT in practical scenarios. In this context, the paper titled "Integration of Blockchain and Cloud of Things: Architecture, Applications and Challenges" by Dinh C. Nguyen, Pubudu N. Pathirana, Ming Ding, and Aruna Seneviratne provides a survey on the integration of blockchain in CoT called BCoT. Blockchain can enable completely new cloud storage functions which are strongly resistant to data modifications. Instead of relying on traditional cloud data centres, blockchain builds a fully decentralized IoT storage system without requiring a central authority. The BCoT background, integration motivations, and the conceptual BCoT integrated architecture are presented. Then, the paper presents the updated review on the use of BCoT models in various application domains. Finally, key research challenges and future research directions are discussed.

Although 5G is all about enabling revolutionary use cases, the maritime Internet of Things (IoT) has not yet received sufficient attention that it deserves in the 5G community. Just for any other IoT application, machine-type communication (MTC) is the key to the materialization of the maritime IoT concept. It is foreseeable that maritime MTC will emerge as an imperative component in the evolving landscape of the communication technology beyond 5G. However, maritime MTC faces many practical challenges, mainly in ubiquitous connectivity and service continuity, traffic nonuniformity, service-centricity and adaptability, device heterogeneity, simplicity and reliability, capacity and scalability, interoperability, and radio spectrum internationality. Under this context, the paper titled "Machine-Type Communication for *Maritime* Internet of Things: A Design" by Michael Mao Wang, Jingjing Zhang, and Xiaohu You presents a concrete design of a maritime machine-type communication system that addresses challenges and requirements with a focus on the network architecture, protocol structure, radio spectrum, and air interface of such a unique communication system. Finally, the paper identifies the potential pitfalls to avoid in the future development of maritime MTC technologies.

Networked microgrids (NMGs) provide a promising solution for coordinating microgrids, accommodating heterogeneous distributed energy resources (DERs), and fostering smart grid applications in power systems. NMGs integrate multi-source electrical networks and multiple information networks as the proliferation of DERs call for more efficient and reliable control communication, and computation strategies. Distributed control and communication infrastructures are expected to play an important role in exploiting the merits of NMGs. However, the performance of distributed control and communication in NMGs depends highly on the communication network's reliability, which is characterized by the timeliness, availability, and accuracy of data. The advancements in communication and computational technologies in recent years may also introduce new challenges and opportunities to the distributed control of NMGs. In this context, the paper titled "Distributed Control

and Communication Strategies in Networked Microgrids" by Quan Zhou, Mohammad Shahidehpour, Aleksi Paaso, Shay Bahramirad, Ahmed Alabdulwahab, and Abdullah Abusorrah provides the first systematic and technical roadmap for implementing distributed control in NMGs, which signals its superiorities over centralized control in terms of efficiency, reliability, resilience, scalability, and privacy-preserving. The paper describes how to tailor advanced communication-based distributed control techniques for NMGs and solve issues in practical power system applications. The paper also investigates the potentials of applying emerging techniques such as 5G networks, edge computing, software-defined networking, and deep reinforcement learning in the operation and control of NMGs. The proposed roadmap is put into practice and validated in a utility-scale project, for networking two microgrids located at Illinois Institute of Technology and Bronzeville to form a microgrid cluster in Chicago, USA.

Utilizing intelligent terminals to obtain user locations, location-aware computing and location-based services (LBS) have greatly changed people's lifestyles. LBS refers to value-added services that obtain user geographical locations through positioning algorithms and provide users with corresponding services. Positioning technology is an important research direction for future smart cities and Internet of Things. The position fingerprint method is intelligent, it makes full use of the multipath effect and dependence on environmental factors, and matches the position fingerprint to obtain the location through the establishment of a fingerprint database. It avoids the errors inherent in measuring distance and effectively improves the localization accuracy. In this context, the paper titled "Indoor Intelligent Fingerprint-Based Localization: Principles, Approaches and Challenges" by Xiaoqiang Zhu, Wenyu Qu, Tie Qiu, Laiping Zhao, Mohammed Atiquzzaman, and Dapeng Oliver Wu presents a tutorial and survey. The paper provides a detailed overview of the indoor positioning technologies and presents the architecture of intelligent localization with the abilities of self-learning and self-adaptation. Moreover, the paper summarizes a range of recent studies of the different intelligent localization technologies for different fingerprint signals, which are intended to highlight their characteristics and provide the technical development defects. Finally, the paper discusses a range of open problems to be tackled by future trends and proposes the corresponding solutions.

IV. Network Security

Next-generation wireless networks are increasingly evolving toward pervasive and ubiquitous systems, unleashing new capabilities in a variety of environments and application scenarios. This trend started in the late 1990s thanks to the rise of Wireless Sensor Networks, and it is nowadays magnified by the advent of the Internet of Things (IoT), Cyber-Physical Systems (CPS), and, more recently, 5G networks. Further, recent pilot studies indicate that energy harvesting (EH) techniques, such as ambient backscatter and RF energy harvesting, are crucial enabling technologies for the sixth generation (6G) wireless networks. However, despite their appealing features and significant advantages, the integration of EH sources generally widens the attack surface of wireless networks and cyber-physical systems. In this context, the paper titled "Security in Energy Harvesting Networks: A Survey of Current Solutions and Research Challenges" by Pietro Tedeschi, Savio Sciancalepore, and Roberto Di Pietro presents a survey on security issues, applications, approaches, and open research challenges characterizing wireless networks and embedded systems powered via Energy Harvesting sources. The provided complete background, the results therein reported, and the highlighted open research issues, could finally unleash the full potential of EH technologies, toward the large-scale adoption of EH sources in wireless networks.

As a new, fast, reliable and flexible network form, the sixth-generation (6G) communication network is entrusted high hopes to cope with the challenges brought by the rapid development of smart terminals and new applications driven by artificial intelligence. In the 6G vision described by the researchers, various intelligent application scenarios using machine learning (ML) technology not only bring heterogeneous connections, a large amount of information storage and operation, but also bring many privacy challenges. On one hand, a secure ML structure or the correct application of ML can protect privacy. On the other hand, ML may be attacked or abused, resulting in privacy violation. It is worth noting that the application of ML on communication in 6G may be a double-edged sword to privacy in many cases, rather than absolute invasion or protection of privacy. In this context, the paper titled "When Machine Learning Meets Privacy in 6G: A Survey" by Yuanyuan Sun, Jiajia Liu, Jiadai Wang, Yurui Cao, and Nei Kato presents a tutorial and survey. First, the paper starts by providing an overview of the 6G, privacy and ML. Then, the paper summarizes privacy violation and protection on ML as well as privacy violation and protection via ML. Furthermore, the paper expounds communication application based on ML which can protect privacy in proper use and infringe privacy when abused. Finally, the paper discusses new trends and open issues about privacy and ML in 6G.

With the technological advances in automotive on-board facilities and cloud computing, including vehicular networks, Vehicular Cloud Computing (VCC) technology has become a promising solution to autonomous vehicular clouds of computing, communications, sensing, and the related use of considerable computational resources. However, achieving security and privacy in VCC is challenging due to the special characteristics of VCC such as involvement of vehicles into multiple clouds, dynamic and temporary nature of clouds, joining of new vehicles into VCs and revocation of vehicles from various clouds, and trust issues among vehicles in VCs since different vehicles belong to different individuals in VCC. In this context, the paper titled "Security and Privacy Challenges in Connected Vehicular Cloud Computing" by Arooj Masood, Demeke Shumeye Lakew, and Sungrae Cho presents a tutorial and survey. First, the paper starts by providing an overview of VCC architecture, features analysis, application scenarios, and detailed VCC architectural components. Then, the paper presents security and privacy issues in VCC in a layered

approach, at a complete system level, and with respect to the emerging applications in VCC. In addition, the paper provides discussions on the research progress of security and privacy solutions. Furthermore, the paper proposes threats identification taxonomy based on the layered VCC architecture. Finally, the paper discusses a range of open problems to be tackled by future research.

V. MISCELLANEOUS

Recent advances in biology, nanotechnology, and medicine have created the need for communication between devices with sizes on the order of tens of nanometer to tens of micrometer, i.e., nanomachines. A network of communicating nanomachines can help realize new revolutionary applications such as real-time health monitoring and targeted drug delivery. Since conventional communication techniques are not well suited for communication at nano- and microscale, molecular communication (MC), where molecules are used as information carriers, has been proposed as an enabling bio-inspired communication mechanism. Specifically, synthetic MC system (MCSs) employing biological components as transmitters and receivers or as interfaces with natural biological MCSs are considered to be promising candidates for the realization of MCSs. Efficient design and relevant analysis of synthetic MCSs require a solid understanding of the underlying biological building blocks and the potential benefits and limitations they introduce for the entire communication system. In this context, the paper entitled "A Survey of Biological Building Blocks for Synthetic Molecular Communication Systems" authored by Christian Söldner, Eileen Socher, Hans-Georg Breitinger, Andreas Burkovski, Kathrin Castiglione, and Heinrich Sticht, who are experts in Biology and Biological Engineering, and Vahid Jamali, Wayan Wicke, Arman Ahmadzadeh, and Robert Schober, who are experts in Communication Engineering provides an overview of biological components that can potentially serve as transmitter, receiver, and signaling particles in synthetic MCSs. The properties, limitations, and applications of the proposed synthetic MCSs are discussed in detail and new research directions for the implementation and the theoretical design and analysis of MCSs are presented.

The latest increase in immersive multimedia applications, including virtual reality (VR) and 360° videos, require support for high-quality delivery of video content. 360° videos have specific requirements related to frame rate, resolution and image quality in comparison to the regular videos. In addition, these videos have increasing demands in terms of ultra-high network bandwidth resources and ultra-low response delay to support a high-quality streaming experience. Unfortunately the best effort Internet does not offer the expected delivery support, affecting users' immersive experience. In this context, adaptive video delivery solutions help to improve the 360° video streaming experience both over wireless and wired access networks. The paper titled "A Survey on Adaptive 360° Video Streaming: Solutions, Challenges and Opportunities" by Abid Yaqoob, Ting Bi, and Gabriel-Miro Muntean surveys diverse solutions for the traditional video streaming in general and 360° video streaming in particular. It discusses content preparation, processing, and network-assisted adaptive and cooperative transmission to the end-user display devices. Moreover, the paper covers several research challenges with a focus on viewport prediction approaches, QoE assessment, and the impact of other constraints on 360° video network delivery. Finally, the paper also highlights several potential research avenues involving 360° video streaming and that of other related media such as VR.

The explosive consumption of bandwidth put real challenges on the current optical networks for increasing the bandwidth while respecting the end user service agreement in terms of signal quality. Recently, machine learning (ML) techniques have been used extensively to satisfy the requirements of the next generation intelligent optical networks. They have become a hot topic in the development of optical performance monitoring (OPM) and modulation format identification (MFI) techniques to help building self-reconfigurable, adaptive, flexible, and efficient optical networks. In this context, the paper titled "Machine Learning Techniques for Optical Performance Monitoring and Modulation Format Identification: A Survey" by Waddah S. Saif, Maged A. Esmail, Amr M. Ragheb, Tariq A. Alshawi, and Saleh A. Alshebeili presents a comprehensive survey on using ML for impairments monitoring and modulation formats classification in optical networks. First, the paper discusses the benefits of using ML algorithms in optical networks. Then, it addresses the optical impairments and modulation formats being monitored and classified, respectively, in optical networks. Also, it presents the existing status of optical networks in terms of MFI and OPM including standards, monitoring parameters, and available commercial products and their limitations. Moreover, the paper extensively reviews the available ML-based techniques for MFI, OPM, and joint MFI/OPM, highlighting their performance, advantages, and limitations. Finally, the paper elaborates on future research directions, open issues, and recommendations for the potential implementation of ML-based OPM and MFI techniques.

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.

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