IEEE access special section editorial
Kaleem, Zeeshan; Rehmani, Mubashir Husain; Imran, Muhammad Ali; Shakir, Muhammad Zeeshan; Jamalipour, Abbas; Ahmed, Ejaz

Published in:
IEEE Access

DOI:
10.1109/ACCESS.2018.2885257

Published: 26/12/2018

Document Version
Publisher's PDF, also known as Version of record

Link to publication on the UWS Academic Portal

Citation for published version (APA):

General rights
Copyright and moral rights for the publications made accessible in the UWS Academic Portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

Take down policy
If you believe that this document breaches copyright please contact pure@uws.ac.uk providing details, and we will remove access to the work immediately and investigate your claim.
IEEE ACCESS SPECIAL SECTION EDITORIAL:
MISSION CRITICAL PUBLIC-SAFETY COMMUNICATIONS: ARCHITECTURES, ENABLING TECHNOLOGIES, AND FUTURE APPLICATIONS

Disaster management organizations such as fire brigades, rescue teams, and emergency medical service providers have a high priority demand to communicate with each other and with the victims by using mission-critical voice and data communications [item 1) in the Appendix]. In recent years, public safety agencies and organizations have started planning to evolve their existing land mobile radio system (LMRS) with long-term evolution (LTE)-based public safety solutions which provides broadband, ubiquitous, and mission-critical voice and data services. LTE provides high bandwidth and low latency services to the customers using internet protocol-based LTE network. Since mission critical communication services have different demands and priorities for dynamically varying situations for disaster-hit areas, the architecture and the communication technologies of the existing LTE networks need to be upgraded with a system that has the capability to respond efficiently and in a timely manner during critical situations.

The third generation partnership project (3GPP) objective is to preserve the considerable strengths of LTE while also adding features needed for public safety. Moreover, 3GPP Release 13 has recently included the Mission-critical push-to-talk (MCPTT) functionality into LTE standard. In this standard, MCPTT enables the feature of direct mode communication, an added device discovery feature which will help the users to find other users in the vicinity either by using network-assisted mode or direct-mode discovery without the assistance of network. In addition, relay capability has been added to provide services for an out-of-coverage user who needs to connect to a fixed existing network via device [item 2) in the Appendix]. The existing network may be updated by adding unmanned air vehicles (UAV) that can increase the chance of providing a link to the users in the event of no network coverage in disaster areas [item 3) in the Appendix]. Moreover, 3GPP has identified the device-to-device (D2D) communications as the key driver in the emergency situation. The main motivation of considering D2D communications for public protection, disaster relief and mission-critical situations is its capability of providing emergency services by using network-assisted scenario or by acting as a relay to transmit information from one end to another end, similar to the ad-hoc network [item 4) in the Appendix], [item 5) in the Appendix].

This Special Section in IEEE ACCESS is intended to provide a platform for researchers and practitioners from both academia and industry in the area of mission critical public safety networks. We published 2 invited articles from highly reputed researchers working in public safety communications.

The first invited article, authored by A. El-Keyi, O. Üreten, H. Yanikomeroglu and T. Yensen, is “LTE for Public Safety Networks: Synchronization in the Presence of Jamming” which introduces an algorithm for timing synchronization, cell identity detection, and carrier frequency offset estimation for long-term evolution systems that proves robust against partial-band interference and/or jamming. The second invited article, Base Station Ordering for Emergency Call Localization in Ultra-Dense Cellular Networks, authored by H. Elsawy, W. Dai, M. Alouini and M. Z. Win, proposes the base station ordering localization technique for emergency call localization in cellular networks. Results show that reporting the order of six neighboring base stations is sufficient to localize the agent within 10% of the cell area.

In this Special Section, we also include an additional 19 high-quality articles from leading research groups around the world working on different research aspects of public safety networks.

The first contribution, co-authored by Ahmad, et al., is “LTE-Railway User Priority-Based Cooperative Resource Allocation Schemes for Coexisting Public Safety and Railway Networks,” addresses the issues of resource allocation and co-channel interference management for coexistence of and cooperation between the LTE-based public safety network (PS-LTE) and LTE-based high-speed railway (LTE-R) network. The next article, entitled “Multi-Cell Cooperative Outage Compensation in Cloud-RANs based 5G Public Safety Network,” co-authored by Mengjun Yin et al., propose an efficient multi-cell
cooperative outage compensation convergence for the scene where more than one radio remote units are destructed in C-RAN-based PS-LTE network. This scheme compensates the network using both cooperative transmission and power adjustment.

Ali Malik et al., in their article entitled “Optimisation Methods for Fast Restoration of Software-Defined Networks” represent a step toward tackling these two issues in the context of single link failures. The main contribution lies in the definition of new algorithms that aim to enhance the problem of finding alternative paths in large-scale networks with minimal cost and time-update factors. The article entitled “M3-Cast: A Novel Multicast Scheme in Multi-channel and Multi-rate WiFi Direct Networks for Public Safety,” co-authored by Khan et al., investigates the problem of selecting the most favorable channel and rate for a multicast communication system in the context of public safety using a WiFi direct 802.11 network. M3-Cast protocol proposed to not only choose the most favorable communication channel and transmission rate, but also considers the implementation details of the underlying WiFi direct technology, thereby optimizing the overall system performance.

An algorithm to predict user location in 5G networks by using received signal strength measurements is presented in the article co-authored by Alee Khan et al., “Location Awareness in 5G Networks Using RSS Measurements for Public Safety Applications.” The relative coordinates of users are computed using Isomap, then the relative coordinates of users are transformed by Procrustes analysis. Guillén-Gámez et al., in their article entitled “A Proposal to Improve the Authentication Process in m-Health Environments,” presented a way of authenticating the identity of each patient, doctor or any stakeholder involved in the process by using a software application that analyzes their faces through the cameras integrated in their devices. The selection of an appropriate facial authentication software application requires a fair comparison between alternatives through a common database of face images.

In the article entitled “Modeling Unreliable Operation of mmWave-Based Data Sessions in Mission-Critical PPDR Services” by A. Ometov et al., authors first presented the important use cases, challenges, and requirements in the context of next-generation mobile networking for PPDR applications. They also argue that many emerging services may be supported by the novel communication technology operating in millimeter-wave spectrum. The next article “QoS-Aware Frequency-Based 4G + Relative Authentication Model for Next Generation LTE and Its Dependent Public Safety Networks” co-authored by Baskaran et al., proposes the 4G plus relative authentication model (4G + RAM), which is composed of Privacy-protected evolved packet system authentication and key agreement protocol for the initial authentication (PEPS-AKA) and 4G plus frequency-based re-authentication protocol for the re-authentication of known and frequent users (4G + FRP). The 4G + RAM supports seamless communication with a minimum signaling load on core elements and conceals users’ permanent identifiers to ensure user privacy.

In the article entitled “Public Safety Communications above 6 GHz: Challenges and Opportunities” by Mezzavilla et al., authors briefly introduced the public safety communications services and requirements. Moreover, the potential of the frequencies above 6 GHz for public safety communications and the open problems that need to be solved in order to pave this way has been discussed. Fadi Al-Turjman et al., in their article entitled “Seamless Key Agreement Framework for Mobile-Sink in IoT Based Cloud-Centric Secured Public Safety Sensor Networks” presented a strategy of mobile-sink for the extension of user authentication over cloud-based environments. A seamless secure authentication and key agreement (S-SAKA) approach using bilinear pairing and elliptic-curve cryptosystems is presented. The proposed S-SAKA approach satisfies the security properties, and as well as being resilient to node capture attacks, it also resists significant numbers of other well-known potential attacks related with data confidentiality, mutual authentication, session-key agreement, user anonymity, password guessing, and key impersonation.

The next article “A Stackelberg-Game Approach for Disaster-Recovery Communications Utilizing Cooperative D2D,” co-authored by Chu et al., investigates disaster-recovery communications utilizing two-cell cooperative D2D communications where they partitioned into healthy and disaster areas. User equipment in the healthy area aims to assist a user in the disaster area to recover wireless information transfer via an energy harvesting relay. The results provided a sustainable framework for disaster recovery. In the article entitled “Heterogeneous Public Safety Network Architecture Based on RAN Slicing” by Marabissi et al., authors propose a heterogeneous network communication architecture where both infrastructures and spectrum are shared between public safety and commercial operators thus reducing deployment costs and times, and addressing the main challenges of public safety communications. The shared radio access network is managed by means of network slicing and resources virtualization. Moreover, the proposed architecture is based on a three-tier scheduler that allows it to manage different network layers and different RAN slices.

Kumbhar et al., in their article entitled “Exploiting LTE-Advanced HetNets and FeICIC for UAV-Assisted Public Safety Communications,” design a public safety communications LTE-Advanced HetNet for various path loss models and deployment mechanism for unmanned air base stations (UABSs). This improves the system-wide spectral efficiency by applying cell range expansion to UABSs and mitigating the inter-cell interference. The next article, “Using Firefighter Mobility Traces to Understand Ad-Hoc Networks in Wildfires,” co-authored by Cabrero-Barros et al., investigates and simulates the mobility traces of a fire department during 30 wildfires. The analysis shows interesting insights into the communication range and the type of network in these scenarios.
In the article entitled, “To Smart City: Public Safety Network Design For Emergency” by Wan et al., authors propose a system structure composed of a central agent and three layers: unmanned aerial vehicle (UAV) layer, multi-robot layer and sensor network layer. The UAVs act as moving sensors and conveyors in the air. They provide the overall rough monitoring data from the air and transport robots to the emergency occurring places. Viamonte et al., in their article entitled “A Distributed Man-Machine Dispatching Architecture for Emergency Operations Based on 3GPP Mission Critical Services,” design the mission critical “bot” concept as an entity capable of gathering environmental/situational information and triggering certain automated actions without the need of human intervention. They proved that in certain circumstances these bots can help quickly resolve emergency situations and complement traditional centralized coordination from dispatch control rooms.

In the article entitled “Autonomous Self-Backhauled LTE Mesh Network With QoS Guarantee” co-authored by Favraud et al., the authors present a novel radio access network infrastructure architecture that enables multi-hop LTE mesh networking for nomadic and autonomous base stations via in-band self-backhauling. Furthermore, the authors investigate the coordination and orchestration functionality within the proposed architecture and propose a hierarchical resource scheduling algorithm in order to efficiently meet quality of service requirements for real-time traffic while maximizing the throughput for elastic flows. In the article entitled “Accurate 3D Localization Method for Public Safety Applications in Vehicular Ad-hoc Networks” co-authored by Ansari et al., the authors present improved subspace algorithm proposed for time of arrival measurements in VANETs localization. The proposed method gives a closed-form solution, and it is robust for large measurement noise, as it is based on the Eigen form of a scalar product and dimensionality. Furthermore, they developed the Cramer–Rao Lower Bound (CRLB) to evaluate the performance of the proposed 3-D VANETs localization method. Simulation results show that the proposed 3-D VANETs localization method is better than the literature methods, especially for fewer anchors at road side units and large noise variance.

In the last article entitled “CHESS-PC: Cluster-HEad Selection Scheme with Power Control for Public Safety Networks,” co-authored by Ansari et al., the proposed scheme utilizes Fuzzy C-Means (FCM) as a clustering tool. The results show that the proposed scheme significantly reduces the power consumption of the network. The proposed scheme achieved an efficiency improvement of 30.24% and 20.46% compared with non-clustering based and FCM clustering-based conventional schemes.

To conclude, we would like to sincerely thank all the authors for submitting their articles to our Special Section, and the large number of reviewers who kindly volunteered their time and expertise to help us curate a high-quality Special Section on this important and timely topic. We would also like to thank the IEEE ACCESS Editor-in-Chief Professor Michael Pecht and other staff members of IEEE ACCESS for their continuous support and guidance.

ZEESHAN KALEEM, Lead Guest Editor
Electrical and Computer Engineering Department
COMSATS University Islamabad, Wah Campus,
Wah 47040, Pakistan

MUBASHIR HUSAIN REHMANI, Guest Editor
Department of Computing and Mathematics
Waterford Institute of Technology
Waterford, X91 KOE K Ireland

MUHAMMAD ALI IMRAN, Guest Editor
School of Engineering, University of Glasgow
Glasgow G12 8QQ, U.K.

MUHAMMAD ZEESHAN SHAKIR, Guest Editor
School of Computing, Engineering and Physical Sciences
University of the West of Scotland
Paisley PA1 2BE, U.K.

ABBAS JAMALIPOUR, Guest Editor
School of Electrical and Information Engineering
The University of Sydney
Camperdown, NSW 2006, Australia

EJAZ AHMED, Guest Editor
Centre for Mobile Cloud Computing Research
Department of Computer System & Technology
University of Malaysia
Kuala Lumpur 50603, Malaysia

APPENDIX

RELATED WORKS


ZEESHAN KALEEM is currently an Assistant Professor in electrical engineering with COMSATS University Islamabad, Wah Campus. He has published over 35 technical journal and conference papers in reputable venues and also holds 18 US and Korean Patents. He worked closely with leading R&D Korean groups and industries, such as the Electronics and Telecommunications Research Institute, Contela, SK Telecom, South Korea, and ITRC, to develop system-level simulators for testing 5G and beyond solutions. His current research interests include public safety networks, 5G system testing and development, and unmanned air vehicle communications. He consecutively received the National Research Productivity Award awards from the Pakistan Council of Science and Technology, (2016–2017) and (2017–2018). He is a co-recipient of the Best Research Proposal Award from SK Telecom. He is serving as an Associate Technical Editor for prestigious Journals/Magazines, including the IEEE Communications Magazine, the IEEE ACCESS, Sensors, and the IEEE/KICS JOURNAL OF COMMUNICATIONS AND NETWORKS.

MUBASHIR HUSAIN REHMANI (M’14–SM’15) received the B.Eng. degree in computer systems engineering from the Mehran University of Engineering and Technology, Jamshoro, Pakistan, in 2004, the M.S. degree from the University of Paris XI, Paris, France, in 2008, and the Ph.D. degree from the University Pierre and Marie Curie, Paris, in 2011. He has served as an Assistant Professor at the COMSATS Institute of Information Technology, Wah Cantonment, Pakistan, for five years. He is currently with the Telecommunications Software and Systems Group, Waterford Institute of Technology, Waterford, Ireland. He received the Best Researcher of the Year 2015 of the COMSATS Wah Award, in 2015. He received the certificate of appreciation, “Exemplary Editor of the IEEE Communications Surveys and Tutorials for the year 2015” from the IEEE Communications Society. He received the Best Paper Award from the IEEE ComSoc Technical Committee on Communications Systems Integration and Modeling from the IEEE ICC 2017. He consecutively received the research productivity awards (2016–2017) and was also ranked # 1 in all Engineering disciplines by the Pakistan Council for Science and Technology, Government of Pakistan. He also received the Best Paper Award from the Higher Education Commission, Government of Pakistan, in 2017. He is currently an Area Editor of the IEEE COMMUNICATIONS SURVEYS AND TUTORIALS. From 2015 to 2017, he has served as an Associate Editor for the IEEE COMMUNICATIONS SURVEYS AND TUTORIALS. He is currently serving as an Associate Editor for the IEEE Communications Magazine, the Journal of Network and Computer Applications (JNCA) (Elsevier), and the Journal of Communications and Networks. He is also serving as a Guest Editor for Ad Hoc Networks (Elsevier) journal, Future Generation Computer Systems (Elsevier) journal, the IEEE TRANSACTIONS ON INDUSTRIAL INFORMATICS, and Pervasive and Mobile Computing (Elsevier) journal. He has authored/edited two books published by IGI Global, USA, one book published by CRC Press, USA, and one book with Wiley, U.K.

MUHAMMAD ALI IMRAN is currently a Professor of wireless communication systems with research interests in self-organized networks, wireless networked control systems, and the wireless sensor systems. He heads the Communications, Sensing and Imaging CSI Research Group, University of Glasgow. He is an Affiliate Professor with The University of Oklahoma, Norman, OK, USA, and also a Visiting Professor at the 5G Innovation Centre, University of Surrey, U.K. He has over 18 years of combined academic and industry experience with several leading roles in multi-million pounds funded projects. He holds 15 patents and has authored/co-authored over 400 journal and conference publications. He was an editor of two books and an author of over 15 book chapters. He has successfully supervised over 40 postgraduate students at Doctoral level. He has been a consultant to international projects and local companies in the area of self-organized networks.
MUHAMMAD ZEESHAN SHAKIR is currently an Assistant Professor with the University of the West of Scotland (UWS), U.K. Before joining UWS, in Fall 2016, he has been with Carleton University, Canada, Texas A&M University at Qatar, and the King Abdullah University of Science and Technology (KAUST), Saudi Arabia, on various national and international collaborative projects. Most of his research has been supported by industry partners such as Huawei, TELUS, and sponsored by local funding agencies such as Innovate UK, Natural Sciences and Engineering Research Council of Canada, Qatar National Research Fund, and KAUST Global Research Fund. His research interests include design, development, and deployment of diverse wireless communication systems, including hyper-dense heterogeneous small cell networks, Green networks, and 5G and beyond-5G (B5G) technologies such as D2D communications, the IoT, and Networked-flying platforms. He has published over 90 technical journal and conference papers and has contributed to seven books, all in reputable venues. He is an editor of two research monographs and also the co-author of a research monograph entitled *Green Heterogeneous Wireless Networks* (Wiley and IEEE Press). He has been/is serving as the Chair/Co-Chair/Member of several workshops/special sessions and is in the technical program committees of different IEEE flagship conferences, including GLOBECOM, ICC, VTC, and WCNC. He has been serving as an Editor of *Physical Communications* (Elsevier) Journal and the *IEEE Communications Magazine* and has served as the lead Guest Editor/Guest Editor for the *IEEE Communications Magazine*, the IEEE WIRELESS COMMUNICATIONS, and the IEEE ACCESS. He is serving as the Chair of the IEEE ComSoc Emerging Technical Committee on Backhaul/Fronthaul Networking and Communications. He is an active member of the IEEE ComSoc and the IEEE Standard Association.

ABBAS JAMALPOUR (S’86–M’91–SM’00–F’07) received the Ph.D. degree in electrical engineering from Nagoya University, Japan. He is currently a Professor of ubiquitous mobile networking with the University of Sydney, Australia. He has authored seven technical books, eleven book chapters, over 450 technical papers, and holds five patents, all in the area of wireless communications. He is a fellow of the Institute of Electrical, Information, and Communication Engineers and the Institution of Engineers Australia, an ACM Professional Member, and an IEEE Distinguished Lecturer. He was the Editor-in-Chief of the IEEE WIRELESS COMMUNICATIONS, the Vice President-Conferences, and a member of the Board of Governors of the IEEE Communications Society. He has been an editor of several journals. He is a recipient of a number of prestigious awards, such as the 2016 IEEE ComSoc Distinguished Technical Achievement Award in Communications Switching and Routing, the 2010 IEEE ComSoc Harold Sobol Award, and the 2006 IEEE ComSoc Best Tutorial Paper Award. He was the General Chair or Technical Program Chair for a number of conferences, including the IEEE ICC, GLOBECOM, WCNC, and PIMRC. He is an elected member of the Board of Governors, the Executive Vice-President, the Chair of the Fellow Evaluation Committee, and the Editor-in-Chief of the Mobile World and the IEEE Vehicular Technology Society.

EJAZ AHMED received the Ph.D. degree in computer science from the University of Malaya, Malaysia. His areas of interests include mobile cloud computing, mobile edge computing, the Internet of Things, cognitive radio networks, big data, and smart cities. His research experience spans over 11 years. He has received several performance awards during his research career. He is an Associate Technical Editor/Editor of the IEEE COMMUNICATIONS SURVEYS AND TUTORIALS, the *IEEE Communications Magazine*, the IEEE ACCESS, the *Journal of Network and Computer Applications* (Elsevier), Future Generation Computer Systems (Elsevier), and KSII TIIS.