Vehicular Networking


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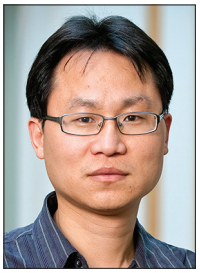
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Vehicular networking provides the communication backbone for connecting vehicles with monitoring systems and other vehicles to exchange all types of information for safe and guided driving. Vehicle-to-infrastructure (V2I or v2i) is a bi-communication model that provides vehicles with road information delivered using infrastructure wireless nodes and vehicles over an ad hoc network (VANET). Similarly, vehicle-to-vehicle (V2V) communication allows motor vehicles to exchange locations and speeds with each other over wireless links to prevent collisions and traffic congestion. Vehicular networking employs dedicated short-range communications (DSRC) devices that operate in the 5.9 GHz band with bandwidth of 75 MHz and an approximate range of 300 meters. Wi-Fi is also a candidate technology to support data transmissions in vehicular communications. Recently, autonomous cars emerged as unmanned auto-driven vehicles that can connect to the environment and navigate to destinations without human intervention. This model of vehicular networking is referred to as vehicle-to-everything (V2X) communications. Cellular-V2X (C-V2X) is one of the next-generation technologies that stream data to vehicles over a cellular band for automated driving solutions. The initial C-V2X standard was completed by the 3rd Generation Partnership Project (3GPP) as part of Release 14 and 15. However, the emergence of fifth generation (5G) networks that support multiple radio interfaces of various technologies over many bands motivate new scenarios for V2X communications. Autonomous vehicle communications is supported by 5G as part of the Ultra-reliable and Low Latency Communications (URLLC) service slice. This means that we expect vehicles to be able to connect to 700, 3400-3800 MHz bands to comply with the transmission systems for the URLLC spectrum band. This implies new work that is necessary to define what could be the final architecture for V2X within 5G networks. In addition, the enablers for advanced safety features are higher throughput, higher reliability, multiple-bands and precise positioning, and very low latency. Those requirements are undergoing study as part of the incoming 3GPP Release 16.

Vehicular networking is classified as a mission critical service since it affects human safety. Therefore, new strict requirements are imposed on 5G V2X to provide the necessary information for autonomous cars to work independently and safely. One of the improvements to boost terrain visualization is using the features of virtual reality (VR) and augmented reality (AR) that help combine digital stored reality for roads, buildings, and pedestrians with vehicle real-time locations. This imposes high capacity demands for automotive video streaming, considering 3D mapping and precise positioning. For instance, downloading live streams in 8K pixel resolution requires a significant increase in bandwidth and high computational power to process such traffic. These technologies and their subsequent requirements have not been fully defined from the vehicular networking perspective. Therefore, there is a long way for standards to develop, and this series will provide the forum for ideas, proposals, and evaluations.

This issue includes two articles. The first article, entitled "Intelligent and Connected Vehicles: Current Situation, Future Directions, and Challenges" by Jiajia Liu and Jianhao Liu, investigates autonomous driving, including its current situation, future directions and challenges. The authors explain the enabling modules to achieve safe and efficient autonomous cars considering wireless connectivity, decision making, control engineering required, and security concerns for future driverless vehicles.

The second article, entitled "Multi-Access Edge Computing: The Driver Behind the Wheel of 5G-Connected Cars" by Fabio Giust, Vincenzo Sciancalepore, Dario Sabella, Miltiades C. Filippou, Simone Mangiante, Walter Featherstone, and Daniele Munaretto, studies multi-access edge computing (MEC) and considerations for V2X, including low latency and high bandwidth requirements. The authors show the ability of MEC to create a standard computing environment at the network edge to meet the requirements of the telco and automotive industries. The article discusses the European Telecommunications Standards Institute (ETSI) MEC ISG ongoing discussions and contributions toward new V2X standards.

Biographies

Anwer Al-Dulaimi [M'11, SM'17] (anwer.aldulaimi@ieee.org) received the Ph.D. degree in electrical and electronic engineering from Brunel University, London, UK in 2012. Currently, he is a technical product owner in the R&D department at EXFO, Toronto, Canada. His research interests include 5G, dynamic spectrum access, cloud networks, and V2X. He is the chair of the IEEE 1932.1 Working Group "Standard for Licensed/Unlicensed Spectrum Interoperability in Wireless Mobile Network" and editor of the IEEE 5G Initiative Series.

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