Chapter 11
Optimizing 5G in V2X Communications:
Technologies, Requirements, Challenges, and Standards

Shimaa Abdelnaby AbdelHakeem
Chungbuk National University, South Korea

Anar Abdel Hady
School of Engineering and Applied Science, Washington University in St. Louis, USA & Electronics Research Institute, Giza, Egypt

HyungWon Kim
Chungbuk National University, South Korea

ABSTRACT

Recently, the automotive industries have accelerated the deployment of Cellular V2X as a motivation to integrate vehicular communication with NewRadio-5G (NR-5G) technology. Nowadays, two critical technologies are concurrently supporting V2X communication: IEEE802.11p and cellular technologies. C-V2X is standardized and designed by the Third Generation Partnership Project (3GPP) for automotive services. C-V2X supports two communication modes through a single platform to provide Wifi-short-range and cellular-long-range communication. Wifi-short-range communication doesn't require network subscription or coverage while the cellular-long-range requires network subscription and coverage. LTE-V2X is the current standard of C-V2X which completed in March-2017 as the 3GPP-Release 14 and enhanced to support the upcoming 3GPP-Release 16 which support the NR-5G capabilities, enhancement, and services. In this chapter, the authors propose the Optimizing of 5G with V2X and analyzing the current V2X standards, introducing the evolution of 5G, challenges, features, requirements, design, and technologies.

INTRODUCTION

Intelligent Transportation Systems (ITS) recently depend on V2X communications with many industrial cooperative efforts. Vehicles, infrastructures, and pedestrians communicate wirelessly to gather and exchange information about the road environment within real time as shown in Figure 1. For that, a lot of dangerous and critical accidents can be avoided as the communicating vehicles are computers with extended onboard sensors. Dedicated Short Range Communications (DSRC) (Kenney et al., 2011) is designed as a standard for Wireless Access in Vehicular Environments (WAVE) which supports the V2X communications specially safety-applications. DSRC protocol stack and messages format are defined by the cooperation between European Telecommunications Standards Institute (ETSI) and IEEE, for ETSI, V2X has two types of messages: Cooperative Awareness Messages (CAMs) and Decentralized Environmental Notification Messages (DENMs) (Xu et al., 2004). CAMs messages are exchanged periodically every 100ms, to share the road status within a specific communication range while DENMs are only triggered by accident events to alert the road drivers.

Many industrial projects, research organizations, and too much regulatory efforts have been cooperated to enhance and deploy the V2X services in different countries, one of these projects are the Car 2 Car Communication Consortium (C2C-CC) (CAR2CAR et al., 2019) in Europe and Crash Avoidance Metrics Partnership (CAMP) in America (Shulman et al., 2007). DSRC protocol stack has a lot of disadvantages such as collisions due to the hidden node and asynchronous problems which degrade the total performance. One of the critical issues of DSRC is the cost-effectiveness of the Road Side Units' (RSUs) deployment, as well as that, DSRC has no clear steps about evolution, latency, network coverage, and network security.

The mobile industry has made significant progress within the last years as the Long Term Evolution (LTE) technology has been introduced to support different communication types including unicast and broadcast modes which can enhance V2X applications (Sun et al., 2016). Moving from DSRC vehicular technology to LTE based V2X is defined in the Third Generation Partnership Project (3GPP) standardization. 3GPP is planned to enhance V2X performance satisfying the industrial market within its Release

Figure 1. V2X Communication modes
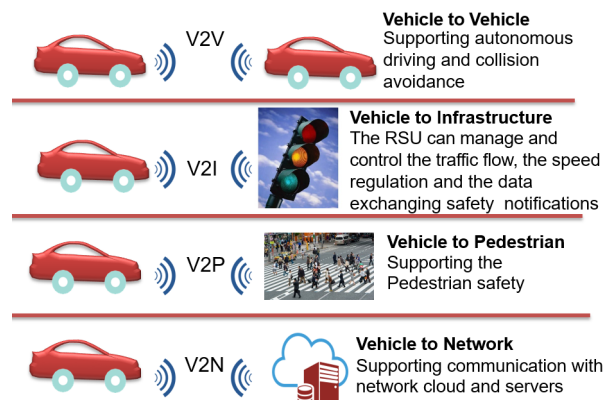
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