Accepted Manuscript

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PII: S0140-3664(16)30304-8
DOI: 10.1016/j.comcom.2016.09.002
Reference: COMCOM 5378

To appear in: *Computer Communications*

Received date: 8 September 2015
Revised date: 9 June 2016
Accepted date: 4 September 2016

Please cite this article as: Christopher Chembe, Rafidah Md Noor, Ismail Ahmedy, Micheal Oche, Douglas Kunda, Chi Harold Li, Spectrum Sensing in Cognitive Vehicular Network: State-of-Art, Challenges and Open Issues, *Computer Communications* (2016), doi: 10.1016/j.comcom.2016.09.002

Spectrum Sensing in Cognitive Vehicular Network: State-of-Art, Challenges and Open Issues

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Abstract

Vehicular Ad Hoc Network (VANET) is envisaged to play an important role in the safety of drivers and passengers when moving on the roads. However, VANET still faces many challenges before it could be deployed. One such challenge is shortage of radio frequency spectrum channels. VANET has been allocated 7 channels for dedicated short range communication at 5.9GHz band. The 7 channels are likely to get congested in high vehicle densities when many vehicles are contending for the same medium. Consequently, affecting the transmission of safety and emergency messages. To alleviate the problem of scarcity channels, dynamic spectrum access (DSA) through cognitive radio (CR) technology has been proposed. One of the core functions of a CR is to identify spectrum holes in licensed frequency bands that can be accessed by unlicensed users through spectrum sensing. In VANET, spectrum sensing is challenging because of the mobility nature of vehicles, dynamic topological changes as well as other unique characteristics not found in other networks. However, these challenges have not been fully studied and how they affect spectrum sensing in cognitive vehicular network (CVN). In this paper, we discuss challenges associated with spectrum sensing in CVN. We describe the primary system activity model used by many schemes proposed in literature. Furthermore, we present an in depth analysis of state-of-art cooperative spectrum sensing techniques for CVN from 2010 to May 2016. In addition, we present some of the open issues in spectrum sensing for CVN.

Keywords: Spectrum Sensing, Cognitive Radio, VANET, Cognitive Vehicular Network.

1. Introduction

Vehicular Ad Hoc Network (VANET) is envisaged to play an important role in Intelligent Transportation System (ITS). ITS applications are envisioned to reduce congestion on the road, increase the safety of drivers and provide comfort to passengers. For instance, a vehicle can get online feedback on the condition of the road such as slippery curves in order to avoid accidents. To support such applications, VANET defines two type of communication [1, 2, 3]. First is vehicle to vehicle (V2V) communication in which vehicles on the road communicate to each other in ad hoc manner. The second is vehicle to infrastructure (V2I) communication. V2I allows vehicles on the road to establish communication links with stationary road side infrastructures.

With the growing number of applications and services being developed for wireless communications, demand for bandwidth has been growing steadily. For example, it is envisioned that by 2020, there will be more than 50 billion devices connected to the Internet mostly through wireless communication [4, 5]. This poses a major challenge on the already scarce radio frequency spectrum. For instance, the Federal Communications Commission (FCC) in the USA has allocated almost all the channels in the communicable frequency bands to licensed users. Free frequencies are shared among various user groups [6]. ITS applications have been allocated 75MHz at 5.9GHz band for dedicated short range communication (DSRC) for V2V and V2I transmission [7]. The 75MHz is divided into 7 channels of 10MHz each. However, these channels can get congested, especially during peak hours or accident scenarios, where the number of vehicles contending for the same channels increases [8, 9]. In such situations, delivery of delay sensitive safety and emergency messages becomes difficult. Different solutions have been proposed in the literature to overcome these setbacks. One of such solution is to use protocols which guarantee quality of service based on priority. Safety and emergency messages given high priority [10, 11]. Another congestion control mechanism is to adjust contention window (CW) in the MAC layer of IEEE802.11p to accommodate increase in vehicle density [12]. For example, authors in [13] propose a reverse back-off mechanism to adjust the CW based on expiration of

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