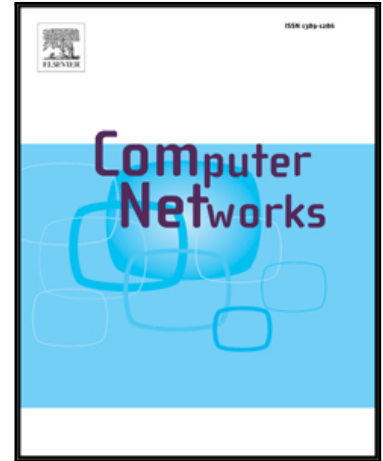


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On the Performance of Cognitive Internet-of-Vehicles with Unlicensed User-Mobility and Licensed User-Activity

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Abstract

Internet of Vehicles (IoV) is regarded as an emerging concept for intelligent transportation cyber-physical systems. Due to the limited number of channels available in IEEE 802.11p DSRC/WAVE standard for vehicular communications, time-critical emergency messages in IoV could suffer from delays. Thus, cognitive radio enabled IoV has potential to overcome this problem, where vehicles (i.e., unlicensed vehicular users *aka* unlicensed secondary users) access RF spectrum other than 802.11p spectrum in an opportunistic manner by sensing and identifying the idle channels licensed to primary users without causing any harmful interference to primary users. In cognitive IoV, unlicensed vehicular users rely on spectrum sensing to find idle bands for opportunistic IoV communications. Existing spectrum sensing algorithms either consider low mobility or stationary (no mobility) of unlicensed vehicular users. Furthermore, joint impact of unlicensed vehicular user mobility and primary user activity have not considered while evaluating the performance of spectrum sensing for opportunistic communications. In this paper, we analyze and evaluate the combined impact of unlicensed vehicular user mobility and licensed user activity for cognitive IoV where each vehicle is assumed to be equipped with a wireless device capable of communication and spectrum sensing for wide-band spectrum regime including IEEE 802.11p. We formally study the performance of the proposed approach for cognitive IoV using mathematical analysis by considering a speed of the vehicles, activities of the primary users and distance between licensed and unlicensed users. Then, numerical results obtained from simulations are used to evaluate the performance of the proposed approach. Results show that the unlicensed vehicular user mobility and primary user activity have a higher impact on misdetection probability than that on false alarm probability. Furthermore, communication range, speed, travel direction and distance between unlicensed vehicular users and licensed primary users affect the overlapping time period for spectrum sensing to find idle channels for opportunistic communications. We also study the dynamic spectrum access for opportunistic communications in terms of expected transmission time, achievable per-user rate and expected transmission count for successful communications.

Index Terms

Cognitive Internet of Vehicles, IoV, vehicular user mobility, unlicensed vehicular users, licensed primary users.

I. INTRODUCTION

Vehicular communications in Internet of Vehicles (IoV) is regarded as a backbone for intelligent transportation systems [1]. IEEE 802.11p standard is proposed for wireless vehicular communications where, out of 7 channels, 1 channel is used as a common control channel and 6 remaining channels are used for actual vehicular data communications. Vehicular communication in IoV helps disseminate the traffic information with an aim of helping to reduce traffic accidents, jams, and cost associated with fuel consumption and lost productivity, to help many infotainment applications, and to help improve the overall traffic management. However, these 7 channels dedicated to vehicular communications could be easily overloaded specially when vehicle density is high such in urban areas or congested areas. Recent studies have shown that the many networks are not fully utilizing their licensed spectrum most of the time [2], [3]. However, there is no wireless spectrum left for further development of new wireless services and applications leading the spectrum scarcity [4]. When massive number of vehicles are expected to be communicating with each other and/or to the Internet, IoV is expected to a major contributing factor in spectrum scarcity in the near future.

Dynamic spectrum access in the cognitive radio network is a new paradigm to enhance the spectrum utilization where unlicensed secondary users sense the wireless spectrum to find spectrum opportunities for opportunistic communications without causing any harmful interference to licensed primary users (PUs) [2]. To leverage the

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