Distributed Channel Coordination in Cognitive Wireless Vehicle-to-Vehicle Communications (Invited Paper)

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***Abstract*- Currently, a dedicated frequency band is assigned to each of a number of wireless technologies, artificially causing spectrum shortage for new services. It is expected that cognitive radio technology, which can adaptively detect spatial and temporal changes in use over various frequencies, will facilitate achieving efficient wireless resource sharing. However, in ad hoc cognitive communications, such as vehicle-to-vehicle (V2V) communication, since the existence of a common control channel cannot be assumed due to a lack of infrastructure, distributed channel coordination is invariably needed. As a preliminary step toward cognitive wireless V2V communication, in this paper, we focus on one-hop V2V communication and propose a distributed channel coordination scheme that exploits the different characteristics of various frequencies, in terms of both the data transmission rate and the range. Furthermore, in order to evaluate the effectiveness of the proposed scheme, we develop a channel utilization model in which the utilization of each channel changes temporally and spatially due to both primary (licensed) and secondary (unlicensed, opportunistic) usage. The simulation results demonstrate that the proposed scheme can reliably utilize unused frequency(-ies), even under temporal and spatial changes.**

I. INTRODUCTION

Currently, dedicated frequency bands are assigned for many types of wireless technologies (2.4/5 GHz: WLAN, 810 MHz/1.9 GHz (Japan): Cellular, 2.5 GHz: WiMAX, etc), exclusively. In the future ubiquitous network, a number of emerging wireless technologies, such as vehicular networks, will be deployed and new dedicated frequency bands will be required for these technologies, thereby inducing further shortage of wireless resources (frequency bands).

On the other hand, the utilization of different frequency bands exhibits independency and dissimilarity. Figure 1 shows an example of actual measurement results of spectrum usage for a certain time and location [1]. Although the amplitude of signal strength of some frequency bands, such as those used for cellular networks, indicate heavy use, other parts indicate sparse or medium use, which are commonly referred to as ``white spaces" [1].

The utilization of each band changes temporally and spatially. For example, the ratio decreases during the nighttime but increases during business hours, reflecting temporal change. On the other hand, the ratio in urban areas is quite high, whereas that of the rural areas is low, reflecting spatial change. Therefore, a new communication paradigm, cognitive radio [1], has been proposed in order to facilitate efficient wireless resource management.

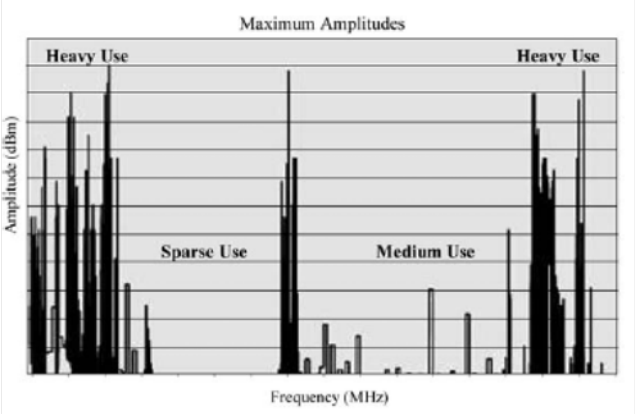

Fig.1: Spectrum utilization [3].

In cognitive radio, there are two types of users: the primary user and the secondary user. The primary user holds a license for the dedicated frequency band, but secondary user does not hold any license and uses cognitive radio to access the temporarily-unused frequency band. Therefore, secondary users should vacate the current frequency band and switch to a new band, when the primary user begins communication. In the United States, the Federal Communications Commission (FCC) has recently approved the unlicensed use of TV white space spectrum for wireless applications and devices. IEEE 802.22 [2] is the first standardization effort to define unlicensed operations in the TV spectrum, and the IEEE 1900 Standards Committee [3] has been discussing unlicensed operation in the overall spectrum bands.

In cognitive wireless ad-hoc networks, since there is no infrastructure such as access points of WLANs and base stations of cellular networks, centralized control is not appropriate for cooperation among nodes. On the other hand, the predetermination of communication parameters, such as communication channel and data rate, and further coordination, such as switching to a new band, caused by the appearance of primary users is extremely difficult. Furthermore, spatial