MCAST: Mobility-aware Channel-Availability based Channel Selection Technique

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Abstract—A key issue in cognitive radio networks is the design of a channel selection technique that guarantees to utilize the highest available channel in presence of the dynamic activity of primary users. Usually, the channel selection techniques that operate in this kind of network are based on the channel-availability probability. In the static primary user's scenario, this probability can be a priori known or simply estimated from the channel occupancy history. However, in the mobile primary user's scenario, this probability dynamically varies in time due to the changes of the primary user's position. In order to exploit the dynamic variation of the channel availability, in this paper we design a novel Mobility-aware Channel-Availability based channel Selection Technique (MCAST) that ensures to select the channel with the highest channel availability probability in a given temporal interval. The simulation results highlight the benefits of the proposed technique in presence of primary user's mobility. Moreover, we evaluate the effectiveness of MCAST in a scenario of practical interest by adopting this technique in a recently proposed routing metric designed for this network.

Index Terms—Cognitive Radio, PU Mobility, Channel Availability Probability.

I. Introduction

In Cognitive Radio Networks (CRNs), the channel selection techniques are usually based on the knowledge of the Channel-Availability Probability (CAP), i.e., the probability that the channel is available for the unlicensed users, referred to as Cognitive Users (CUs), without causing interference against the licensed users, referred to as Primary Users (PUs). In fact, this knowledge enables the CU to select the channel with the highest availability. Usually, the CAP coincides with the probability that at a certain time the PU is inactive, and can be a priori known or simply estimated from the channel occupancy history [1]. However, this assumption is valid when the PU is static.

On the other hand, in the mobile PU scenario, the CAP dynamically varies in time due to the changes of the PU position. For instance, if at a certain time the CU is outside the protection range[1] of an arbitrary PU, then the CAP is independent from whether the PU is inactive or not. Due to the PU mobility, after a certain interval of time, the CU might be inside the protection range of the PU, then the CAP depends on the probability that the PU is inactive. Since the best performance is guaranteed by the channel with the highest CAP assumed at a given time, a fundamental key issue in CRNs is the design of a channel selection technique that ensures to select the best channel by exploiting the dynamic variation of the channel availability caused by the PU mobility.

Basically, most of the works in literature consider the static PU scenario where the CAP does not vary in time. In [4], the authors propose an opportunistic multi-channel Medium Access Control (MAC) with QoS provisioning for distributed CRNs, where CUs use the previous channel scanning results to select those channels with the highest CAP. In [5], the authors propose an opportunistic periodic MAC protocol where the CUs cooperate each other to share the channel-availability information. In [1], the authors propose a routing metric that aims to minimize the interference caused by the CUs against the static PUs. In [6], the authors propose an optimal routing metric for CRNs where the channel is selected based on channel occupancy history. Finally, there are some other channel selection strategies that have been proposed in literature by using the assumption of static PU activity [7], [8], [9].

However, the design of a channel selection technique that accounts for the CAP in presence of PU mobility has not yet been addressed in literature, only in [2], it addressed the concept of CAP in mobile scenario. For this reason, we design a novel Mobility-aware Channel-Availability based channel Selection Technique (MCAST) that ensures to select the channel with the highest CAP in a given temporal period.

Specifically, the contribution of this work can be summarized as follows. First, we derive the channel-availability estimation method in presence of PU mobility. Then, we prove that the proposed channel selection technique takes advantage from the dynamic variation of channel-availability caused by the PU mobility and, consequently, outperforms the traditional method which is only based on the PU temporal activity. The simulation results highlight the benefits of the proposed technique. Moreover, we evaluate the effectiveness of MCAST in a scenario of practical interest by adopting this

[1] It is defined as the maximum distance between the PU and the CU at which the CU transmission does not interfere the PU communication on an arbitrary channel. It is determined by the PU transmission range and by the CU interference range [2].