International Journal of Computing and Digital Systems
2025, VOL. 17, NO. 1, 1–10

http://dx.doi.org/10.12785/ijcds/1571087751

A Multi-Radio Channel Hopping Rendezvous Scheme in Cognitive Radio Networks for Internet of Things

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Received 21 October 2024, Revised 10 November 2024, Accepted 11 November 2024

Abstract: With the rapid expansion of the Internet of Things (IoT), the demand for wireless spectrum is increasing exponentially, both in licensed and unlicensed bands. The existing fixed spectrum assignment policy creates a bottleneck as the spectrum that is not in use remains unutilized or underutilized. To overcome this issue, cognitive radio technology has emerged as a promising solution to spectrum assignment issues. In a Cognitive Radio Network (CRN), unlicensed users or secondary users (SUs) must meet on an available channel to establish a communication link for necessary information exchange. This process is known as rendezvous. However, SUs are unaware of each other if no centralized controller is involved. Channel Hopping (CH) is a rendezvous technique without the involvement of any centralized controller. Most of the existing CH algorithms are based on single radio SUs. As the cost of wireless transceivers is declining, multiple radios can be employed for rendezvous performance improvement. This paper proposes a multi-radio matrix-based CH algorithm that involves employing two radios with each SU instead of one. Compared with existing single radio algorithms, the proposed CH algorithm performs better by lowering the upper bounds on time to rendezvous. Our paper presents a comprehensive analysis of the benefits of incorporating an additional radio, demonstrating how this innovation leads to more efficient and timely rendezvous, thereby enhancing the overall communication capabilities within CRNs.

Keywords: Cognitive Radio, Rendezvous, Common Control Channel, Channel Hopping

1. INTRODUCTION

Current trends in the expansion of wireless devices indicate significant development in the Internet of Things (IoT) area. An increase in wireless devices comes with increased demand for wireless spectrum in the licensed and unlicensed ISM bands. While freely available unlicensed bands are becoming overburdened, the licensed bands are not being used efficiently due to the fixed spectrum assignment policy [1]. Cognitive Radio Networks (CRNs) have been vastly researched and proven to solve the problems encountered in efficiently utilizing wireless spectrum. Dynamic spectrum access enables CRNs to enhance the functionality of many Internet of Things (IoT) devices by mitigating spectrum scarcity issues. The rapid increase in IoT devices focuses on improving spectrum use for reliable communication. They oppose static spectrum assignments; CRNs present opportunities for dynamic use of underutilized frequency bands by IoT devices, improving spectrum utilization. Such access techniques are crucial for applications demanding low latency and reliability in communication, e.g., healthcare monitoring and smart grid applications [2]. By sporadically choosing comparatively less congested channels, CRNs increase IoT communications' ability while minimizing interference and ensuring steady data transmission. This adaptive feature is essential in fluctuating spectrum conditions. Additionally, CRNs support the scalability of IoT networks through dynamic spectrum allocation, which allows for accommodating an increasing number of devices without any restrictions imposed by static spectrum allocation [3]. Besides, CRNs integrate heterogeneous networks that support various standards and protocols in communicating different IoT devices. This enhances IoT systems' overall capabilities and operational capacity by providing interoperability. Indeed, CRNs offer an adaptable framework that is elegant, reliable, scalable, and efficient for IoT to operate in spectrum environments that are becoming in-

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