UNIVERSITI TEKNOLOGI MARA

ENHANCEMENT OF CLUSTERING ROUTING PROTOCOL WITH ADDITION OF Q-ROUTING IN COGNITIVE RADIO AD HOC NETWORKS

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ABSTRACT

As the need for huge capacity, high throughput and low latency from users keeps on growing, the current deployment of 5G spectrum continues to reveal the system's fundamental limitations in comparison to its original expectations. An effective routing protocol must be effectively designed to utilise its maximum radio spectrum capacity and adaptable across diverse application domains by simultaneously utilise various new techniques and technologies such as Cognitive Radio Ad Hoc Networks (CRAHNs) which continue to experience rapid growth. The evolving landscape of CRAHNs poses challenges for identifying optimal routing protocols, as some existing solutions fail to address the unique complexities of these networks. To harness the spectrum efficiently, there is a requirement for large-sized clusters to accommodate more nodes. However, maintaining stability in such large clusters becomes a challenge. Therefore, in order to achieve network scalability while maintaining network stability, a resolution must be discovered in increasing the number of nodes within large clusters. The issue can be resolved while preserving CRAHNs stable and scalable by improving a revised cluster-based routing protocol. The protocol makes use of the capabilities of a Q-routing scheme created specifically for cluster routing in CRAHNs, where performance of networks is the main objective, along with management on the topology of a cluster network. Q-learning, a Reinforcement Learning approach, serves as the foundation for the Q-routing scheme, which aims to improve stability and scalability in dynamic environments. Four performance metrics which are packet delivery ratio, hop count, routing overhead, and throughput are used to evaluate the performance of the revised routing protocol using OMNeT++ by comparing it to AODV. From the simulation results, the revised cluster-based routing protocol effectively selects shorter and more reliable routes, as shown by improved packet delivery ratio, throughput, fewer hops, and lower routing overhead results. As the number of hosts increased, the revised cluster-based routing protocol significantly outperformed AODV in different performance metrics. Clustering and Q-Routing together have greatly improved the routing protocol's overall performance while significantly enhanced the scalability and stability in CRAHNs. This improvement holds the potential to facilitate effective spectrum utilisation and support a variety of application domains in subsequent designs. It is essential to note that simulation results are scenario-dependent, varying across layers and types of traffic. Consequently, while these results provide valuable insights, their accuracy may not fully capture the nuanced behaviour of CRAHNs routing protocols. Future work should prioritise implementing these simulations in real-world scenarios to obtain more accurate assessments of network performance.

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TABLE OF CONTENTS

CHAPTER 1
INTRODUCTION

1.1 Research Background

As a consequence of the increasing number of mobile subscribers, wireless communications such as Bluetooth, Wi-Max, Wi-Fi and cellular systems have evolved immensely (Rajpoot & Tripathi, 2022). Wireless communication depends on static spectrum allocation which would be approved with a license for every user that uses the spectrum band on a lengthy-term period. Although the licensed user does not utilise the spectrum, the unlicensed user is not permitted from using it. With the assistance of appropriate guard bands, static spectrum allocation reduces the user inferences. While the allocation of the static spectrum is initially effective, it faces significant challenges as the demand for spectrum continues to rise (Sharma & Sarma, 2024). This increasing demand contributes to the issue of spectrum scarcity. Furthermore, the static allocation scheme inherently leads to underutilisation of the spectrum, as it does not adapt towards varying usage patterns and needs. The Federal Communications Commission (FCC) therefore accepted that unlicensed users may use licensed spectrum bands to overcome the spectrum scarcity. Thus, this led to the development of a dynamic spectrum allocation system and cognitive radio networks (CRNs) were the key technologies for this (Mondal et al., 2024).

Cognitive radio (CR) is a wireless technology that evolving and aims at improving the quality of wireless communication by coping with the scarcity problem and spectrum congestion through the opportunistic use of an underused licensed spectrum (Sumithra & Suriya, 2024). Cognitive radio networks (CRNs) implement CR technology that allows unlicensed users often known as secondary users (SUs) to share an unlimited part of a licensed spectrum dynamically when not used by licensed users that are known as primary users (PUs). There are two types of CRNs which are infrastructure-based and infrastructure-less. Infrastructure-less CRNs often known as cognitive radio ad hoc networks (CRAHNs) comprises dedicated mobile SUs performing spectral management decisions that refer to local sensing information and interacting with each other in a multi-hop way free from any CR base-station controller.