AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

Electronics and Communications Engineering Department

Enhancement Proposals of Routing Protocols Performance in Cognitive Radio Networks

A Thesis

Submitted in partial fulfillment of the requirements of the degree of

Doctor of Philosophy in Electrical Engineering

(Electronics and Electrical Communications Engineering)

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Statement

This thesis is submitted to Ain Shams University for the degree of Doctor of Philosophy in Electrical Engineering (Electronics and Communications Engineering).

The work included in this thesis is carried out by the author at the Electronics and Communications Engineering Department, Faculty of Engineering, Ain Shams University, Cairo, Egypt.

No part of this thesis is submitted for a degree or a qualification at any other university or institution.

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Thesis Summary

The radio spectrum is one of the most heavily employed and costly natural resources due to the rapid growth of wireless technologies. The cognitive Radio (CR) has been proposed as a promising technology to solve the problem of radio spectrum scarcity and spectrum underutilization by allowing unlicensed users to opportunistically access the available licensed bands. In Cognitive Radio Ad-Hoc Networks (CRAHNs), which operate with absence of centralized management, data routing is one of the most important issues that needs intensive study and to be taken into account. Moreover, in CRAHNs the routing protocol is very challenging due to cognitive users (CUs) mobility, primary users (PUs) activity or mobility, link degradation or node fault. Also, the network performance is severely degraded due to a large number of path failures. In addition, with the unique characteristics of CRAHNs, another main issue is related with the establishment of appropriate path for data transmission which does not cause harmful interference to PUs' transmission and reflect accurate path characteristic in order to improve network performance.

In this thesis we study and analyze three of the most common CRAHN routing protocols, namely, Cognitive Ad-hoc On-demand Distance Vector (CAODV), SpEctrum Aware Routing protocol for Cognitive ad-Hoc networks (SEARCH), and Weighted Cumulative Estimation of Transmission Time (WCETT). The analysis is carried out using NS-2 simulator to evaluate and compare the network performance under the same environment conditions with varying number of nodes to study the effect of nodes density and traffic load.

Also, based on Cognitive Ad-hoc On-demand Distance Vector (CAODV) routing protocol, a new routing protocol named, Mobility and Activity Based Routing Protocol (MABRP) is proposed. In the proposed protocol we concentrate on reliability and expiration time of links. The proposed protocol performance is evaluated via NS-2 simulator. The used metrics for performance comparison between the MABRP and CAODV routing protocols are packet delivery ratio (PDR), end-to-end delay, hop count, and routing overhead under the same environment conditions with varying number of PUs in different CUs mobility scenarios. The results, observed that the MABRP provides better performance in terms of PDR and providing lower average end-to-end delay with a slight increase in overhead.

The performance of MABRP and Cognitive Ad-hoc On-demand Distance Vector (CAODV) are evaluated in two different scenarios: mobile PUs scenario, and static PUs scenario. The availability of a routing channel dynamically varies in time due to the changes of the PUs relative positions. The performance evaluation is carried out using NS2 simulator. Finally, we evaluate the performance of MABRP against three other protocol approaches CAODV, SpEctrum Aware Routing for Cognitive ad-Hoc networks (SEARCH), and Weighted Cumulative Estimation of Transmission Time (WCETT). Simulation results reveal that the proposed algorithm provides better performance in terms of higher PDR, with a slight increase in routing overhead, and delay especially in Low PUs activity.

Key words: Cognitive Radio Networks; CRAHNs; Routing Protocol; Mobility; Primary Users' Activity.

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