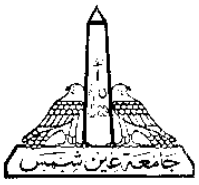

AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

Electronics Engineering and Electrical Communications

“Performance Enhancement for Multi-Relay Based Cognitive Radio Network”

A Thesis submitted in partial fulfilment of the requirements of the degree of

Doctor of Philosophy in Electrical Engineering

(Electronics Engineering and Electrical Communications)

by

Wafaa Rady Mahmoud

Master of Science in Electrical Engineering

(Electronics Engineering and Electrical Communications)

Faculty of Engineering, Ain Shams University, 2012

Supervised By

Prof. Salwa Hussein El-Ramly

Prof. Hesham Mohamed El Badawy

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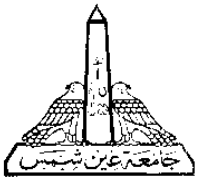
Cairo - (2018)



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Date: 8 December 2018

Statement

This thesis is submitted as a partial fulfilment of Doctor of Philosophy in Electrical Engineering Engineering, Faculty of Engineering, Ain shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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Thesis Summary

Recently, wireless communication systems and corresponding frameworks have encountered a tremendous amount of services and applications in wireless networks. Since the allocated radio spectrum is congested because of the fast development in the wireless applications and services, it has brought about spectrum lack and low utilization. Cognitive Radio (CR) technology is the ongoing innovation that coincides and collaborates towards achieving a superior gain from the limited accessible spectrum range. This thesis examines the performance of Underlay Spectrum Sharing (USS) of cognitive radio relay network with considering statistical Quality of Service (QoS) provisioning and interference power constraints. The network performance is discussed through two system models. The first system model shows the performance assessment for Cognitive Cooperative Multiple Relays Network (CCMRN) with imperfect channel state information. In the underlay spectrum sharing, cognitive radios have limited coverage area to keep interference defence for the licensed users. Multiple cooperative relays have demonstrated advantage for permitting reliable communication with an expansion in the radio coverage area. In this thesis, the performance of an underlay CCMRN is assessed in case of imperfect Channel State Information (CSI). CCMRN will be treated as a secondary network with multiple Decode and Forward (DF) relays, whereas the Secondary User (SU) source (SS) will select a single relay from the available set of relays. The relay selection process depends on obtaining maximum end-to-end Effective Capacity (C_{eff}) as seen by the SU. By assuming cooperation between the licensed primary network and the unlicensed secondary network, the SU and the selected Secondary Relay (SR) can share the spectrum with occupying two orthogonal channels of two different Primary Users (PU)s. According to the interference power constraint of the PU, the SU's allowed maximum power transmission will be obtained. Network performance is assessed in terms of the SU maximum

end-to-end C_{eff} as well as Outage Probability (P_{out}). Mathematical expressions for C_{eff} and P_{out} are derived for practical multipath Rayleigh faded channel. The analytical results illustrate the effect of the Imperfect CSI (ICSI) on the performance metrics with applying various constraints such as the number of available relays, average interference power, and statistical SU delay QoS.

Moreover, the second proposed system model examines the performance of Multisource Multirelay-Cognitive-Radio Network (MMCRN). Also, spectrum sharing is used to realize better spectrum utilization while limiting the interference level on the PU with an average interference power constraint. One source and one relay are selected for SU-transmission based on maximizing the SU-C_{eff} of the transmission channel. Practically, this thesis studies the MMCRN with assuming ICSI of the interference link between the SS and the PU Destination (PD). Performance analysis measurement in terms of SU-C_{eff} is derived for the enhanced system model when there is an average interference power constraint and with considering ICSI. The proposed numerical analysis demonstrates the quasi-optimal number of relays that should be used to obtain an efficient SU-C_{eff}. The obtained results investigate the effect of the interference channel imperfection on the performance metric with different parameters such as the number of SSs and the constraint of statistical delay of SU.

Key words:

Effective capacity, imperfect channel state information, outage probability, underlay cognitive cooperative multiple relays network.

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Table of Contents

List of Figures