بسم الله الرحمن الرحيم

MONA MAGHRABY

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

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التوثيق الإلكتروني والميكروفيلم

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
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MONA MAGHRABY

AIN SHAMS UNIVERSITY
FACULITY OF ENGNEERING
ELECTRONICS AND COMMUNICATION ENGINEERING DEPARTMENT

Throughput Enhancement of Multicarrier Cognitive M2M Networks Using NOMA Techniques

A thesis
Submitted in Partial Fulfillment of the Requirements of the Degree of Doctor of Philosophy in Communication Engineering

Submitted by

Eng. Eslam Samy El Sayed Mohamed El Mokadem

M.Sc. of Communication Engineering, 2014

Supervised by

Prof. Hadia Mohamed Said El Hennawy

Dr. Ahmed Mahmoud El Kassas

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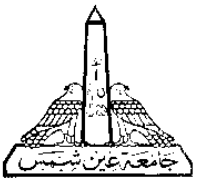

AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

Electronics and Communications

Throughput Enhancement of Multicarrier Cognitive M2M Networks Using NOMA Techniques

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Date: 3 October 2020

To My Father,

To My Mother,

To My Wife's mother,

To My Wife,

To My Kids,

I present to you this Thesis

May I by this express my deepest gratitude and love.

Thanks

Without you, I could not have reached this successful step in my life

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Eslam Samy El-Sayed Mohamed El-Mokadem

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STATEMENT

This thesis is submitted for the degree of Doctor of Philosophy to the Department of Electronics and Communication Engineering, Faculty of Engineering of Ain Shams University, 2020.

The work included in this thesis was carried out by the author in the Department of Electronics and Communication Engineering, Ain Shams University.

No part of this thesis has been submitted for a degree or a qualification at any university or institute.

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Published Papers

1- Eslam samy elmokadem, Ahmed Mahmoud El-Kassas, Talaat A.Elgarf , Hadia El-Hennawy ," BER Performance Evaluation for the Downlink NOMA System over Different Fading Channels with Different Modulation Schemes" *2019 5th International Conference on Science and Technology (ICST)*. IEEE, 2019.

2- Eslam Samy EL-Mokadem, Ahmed Mahmoud El-Kassas, Talaat A. Elgarf, and Hadia El-Hennawy. "Throughput enhancement of cognitive M2M networks based on NOMA for 5G communication systems." International Journal of Communication Systems: e446, 2020

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SUMMARY

The use of cellular networks will be increasing in the future technological world owing to the growth of a vast number of applications. Fifth generation (5G) of mobile communication systems is developed to become an all-encompassing solution to fundamentally every broadband wireless communication need of the current decade. One of the most prominent applications using the 5G system is the Internet of Things (IoT) which places a completely new set of demands on the 5G networks. Machine to machine (M2M) communications is one of the promising applications for the future technological world to realize IOT in future 5th generation networks, which can drive to new job opportunities in different fields such as healthcare, intelligent transport systems, vehicular, smart grids, environmental monitoring, smart houses, building automation, etc. M2M systems must meet many challenges due to the massive number of devices participating, the small amount of transmitted data, transmissions in dynamic environments and architectures, high data traffic and quality of service (QoS) demands for example bandwidth, scalability, coverage, lifetime, and latency. Numerous cellular and non-cellular wireless technologies such as general packet radio service (GPRS), long-term evolution (LTE), LTE-advanced (LTE-A), Wi-Fi, Zigbee, Bluetooth, etc. are considered for M2M communications. But they are insufficient to sustain

the future requirements of M2M systems. Adding intelligence in the future M2M communication systems is one of the main research directions to meet the requirements in a cost-effective way. This prerequisite can be met utilizing cognitive radio technology (CR).

CR networks have stood out as efficient systems to relax the spectrum lack and spectrum under-utilization problems in wireless communication systems. Which is going to the most oppressing problem in the future. The main goal of CR is to achieve the spectrum access dynamically by learning its around environments and adapting its operating parameters. In the conventional schemes of CR, the secondary user (SU) can obtain the empty channel only when the primary user (PU) is absent and has to leave the channel if the PU is detected.

On the other side, NOMA has been suggested as a multiple access scheme to be utilized with the 5th generation of wireless communication systems. It can support massive connectivity utilizing non-orthogonal resource allocation while simultaneously decreasing latencies by its grant-free scheduling. In NOMA, multiple clients are allowed to share the same frequency at the same time but are differentiated according to the power domain.

The goal of this thesis is to merge between the two technologies,(CR technology and NOMA technology) by proposing a cooperative CR network based on Non-orthogonal multiple access (CCR-NOMA) to allow multiple secondary users (SUs) to share the same frequency at the same time but are differentiated according to the power domain. This will improve spectrum efficiency of 5G communications and the transmission performance of CR network.

The first main contribution of this thesis is to investigate the bit error rate (BER) Performance of downlink NOMA technique with various modulation techniques namely Binary phase shift keying (BPSK), Quadrature phase shift keying (QPSK), and Quadrature amplitude shift keying (QAM) under the effect of various fading channels. The performance of transmission modes are evaluated by calculating the BER of different number of User Equipment receivers (UEs) in downlink NOMA system from near User Equipment (NU) up to far user Equipment (FU) versus signal to noise ratio (SNR) under the effect of Additive white Gaussian noise (AWGN), Rician fading and Rayleigh fading channel with

different modulation schemes.to have some insightful results about the Quality of service (QoS) of each individual user.

The second main contribution is suggesting a cooperative CR network-based on NOMA (CCR-NOMA) for M2M communication and performing deep analysis for the parameters used in this system (detection thresholds, sensing durations, transmission rates, and powers). The analysis is performed for two separate cases; non-cooperative and cooperative spectrum sensing scenarios using (Energy Detection technique (ED) in CR-NOMA. The analysis showed that the proposed scheme, cooperative CR network-based on NOMA (CCR-NOMA) for M2M communication is better than non-cooperative CR network-based on NOMA (CRNOMA), which is the expected result.

Furthermore, the channel sensing performance of the ED technique in CCR-NOMA has been evaluated by deriving a closed-form expression between the achievable throughput and sensing time for the CCR-NOMA system. The same analysis for the case of CCR-OFDMA is reproduced for the sake of comparison. The comparison showed that our proposed scheme, CR-NOMA system for M2M communication outperforms the CR-OFDMA system for M2M communication for the same non-cooperative and cooperative spectrum sensing and physical layer parameters. This means that our proposed CCR-NOMA may replace the old CR-OFDMA as a multiple access technique for 5G of mobile communication systems.

Keywords: Cognitive radio (CR), Cooperative Spectrum Sensing, Internet of Things (IOT), NOMA Performance, Nonorthogonal Multiple Access, 5G, M2M, CCR-NOMA

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