Faculty of Electronic and Computer Engineering

ENHANCEMENT OF MEDIUM ACCESS CONTROL PROTOCOL WITH VARIOUS SERVICES UTILIZING CAPTURE EFFECT

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**A thesis submitted
in fulfillment of the requirements for the degree of Master of Science in Electronic Engineering**

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DECLARATION

I declare that this thesis entitle “Enhancement of Medium Access Control Protocol with Various Services Utilizing Capture Effect” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : ……………………………………

Name : Nur Qalbi Binti Jalaudin

Date :……………………………………

APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Master of Science in Electronic Engineering.

Signature : ……………………………………

Supervisor Name : Dr. Mohd Riduan Bin Ahmad

Date : …………………………………...

DEDICATION

To my beloved mother, father, husband, our lovely daughter, son and my family.

ABSTRACT

In recent years there has been considerable interest in the development of standards for Wireless Local Area Networks (WLANs). In particular, IEEE 802.11 standard has now been extended to several variants of WLAN standards. For this reason, much of the research work for the enhancement of MAC protocol for WLAN is generally is based on the behaviour of the IEEE 802.11 standard. Hence, this thesis focuses on the enhancement of MAC protocols, particularly the Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) protocol for variants of WLAN standard. In this thesis, the protocols have been analysed in terms of throughput and transmission delay by using an improved analytical approach simulated in Matlab. The saturation throughput analysis of CSMA/CA is controlled by using slotted analytical model combined with capture effect probability model. The performances of MAC protocols with propagation loss and shadowing scenarios are analysed. The proposed modification significantly reduced the probability of collision and provide better performance. The capture effect 10dB and retransmission 5 times has been achieved for the overall performance of the protocol, which shows almost 0.69% improvement at the average transmission delay and 0.80% at the throughput. The maximum throughput of MAC protocols is dependent on the normalized propagation delay. In other word, smaller normalized propagation delay gives better performance of throughput. Moreover, shorter distance has higher throughput and lower transmission delay for both path loss and shadowing scenarios when compared to the longer distance. Furthermore, the performance of average transmission delay for MAC protocols with capture effect is better than the MAC protocols without capture effect. These results can be used as a useful guide to scientist and engineers before the communication network is deployed to transfer data to the gateway or control centre.

ABSTRAK

Dalam tahun-tahun kebelakangan ini telah banyak minat dalam pembangunan piawaian untuk Rangkaian Kawasan Tempatan Wayarles (WLAN). Khususnya, piawaian IEEE 802.11 kini telah diperluaskan kepada beberapa varian standard WLAN. Atas sebab ini, banyak kerja penyelidikan untuk peningkatan protokol MAC untuk WLAN pada umumnya adalah berdasarkan tingkah laku piawai IEEE 802.11. Oleh itu, tesis ini menumpukan kepada peningkatan protokol MAC, terutamanya protokol Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) untuk varian standard WLAN. Dalam tesis ini, protokol telah dianalisis dari segi celusan dan kelewatan penghantaran dengan menggunakan pendekatan analisis yang lebih baik yang disimulasikan dalam Matlab. Analisis ketepuan celusan CSMA/CA dikawal dengan menggunakan model analitik bergulung digabungkan dengan model kebarangkalian kesan tangkapan. Prestasi protokol MAC dengan kehilangan perambatan dan senario pembayang dianalisis. Pengubahsuaian yang dicadangkan dapat mengurangkan kebarangkalian pelanggaran dan memberikan prestasi yang lebih baik. Kesan tangkapan 10dB dan penghantaran semula 5 kali telah dicapai untuk prestasi keseluruhan protokol, yang menunjukkan peningkatan hampir 0.69% pada kelewatan penghantaran purata dan 0.80% pada celusan. Pemprosesan maksimum protokol MAC bergantung pada lengah perambatan normal. Dalam erti kata lain, lengah perambatan normal yang lebih kecil memberikan prestasi celusan yang lebih baik. Selain itu, jarak yang lebih pendek mempunyai celusan yang lebih tinggi dan kelewatan penghantaran yang lebih rendah untuk kedua-dua kehilangan laluan dan pembayang senario apabila dibandingkan dengan jarak yang lebih panjang. Selain itu, prestasi kelewatan penghantaran purata bagi protokol MAC dengan kesan tangkapan lebih baik daripada protokol MAC tanpa kesan tangkapan. Hasil ini boleh digunakan sebagai panduan berguna kepada saintis dan jurutera sebelum rangkaian perhubungan digunakan untuk memindahkan data ke get laluan atau pusat kawalan.

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LIST OF ABBREVIATIONS

ACK	-	Acknowledgement
CSMA	-	Carrier Sense Multiple Access
CSMA/CA	-	Carrier Sense Multiple Access with Collision Avoidance
CTS	-	Clear to Send
dB	-	decibel
FCS	-	Frame Check Sequence
GHz	-	Giga Hertz
IEEE	-	Institute of Electrical and Electronic Engineering
LLC	-	Logical Link Control
m	-	meter
MAC	-	Medium Access Control
MATLAB	-	Math Works Computer Programming software
MAN	-	Metropolitan Area Network
MPDU	-	Medium Access Control Protocol Data Unit
MAPs	-	Mesh Access Points
MHz	-	Mega Hertz
PHY	-	Physical
PLCP	-	Physical Layer Convergence Procedure
RTS	-	Request to Send
WLAN	-	Wireless Local Area Network
WAN	-	Wide Area Network
WMN	-	Wireless Mesh Network

LIST OF PUBLICATIONS

The research papers produced and published during the course of this research are as follows:

1. Jalaudin, N. Q., Ahmad, M. R., Aziz, M. Z. A. A., Esa, M. R. M., 2019. The Performance of IEEE 802.11g with Capture Effect for Lightning Remote Sensing. *International Journal of Engineering and Advanced Technology (IJEAT)*. Letter of Accepted is shown in Appendix A.[Scopus][Accepted]

2. Jalaudin, N. Q., Ahmad, M. R., Aziz, M. Z. A. A., Esa, M. R. M., Isa, A. A. M., 2019. The Performance of Medium Access Control Protocol with Capture Effect for Lightning Remote Sensing. *IOP Conference Series : Earth and Environmental Science*, Vol : 228.[Accepted]

3. Vigneswara, R. G., Tuani, A. F., Zakaria, Z., Othman, A. R., Jalaudin, N. Q., 2014. A Review on Various of Software Defined Radios (SDRs) in Radio Communication. *International Journal of Research in engineering and Technology (IJRET)*, 3(12), pp.1-6.[Accepted]

CHAPTER 1

INTRODUCTION

This chapter presents an overview on the research background of the project, problem statements, objectives and scopes of the project. This chapter briefly describes the flow of this research. The organization of this thesis is also briefly described at the end of this chapter.

1.1 Research background

In a telecommunication or computer network where participants communicate through a common physical medium, how we should coordinate their action so that certain performance goals can be met? In the literature, this is known as the multiple access, with the corresponding protocols and mechanisms called as medium access control (MAC).The problem of multiple access arises when the underlying medium is broadcast in nature, where messages from a station can be heard by other station that are in the listening area (Gummalla. Ajay Chandra Limb.John O, 2000).

In physical layer technique, when more than one stations starts a transmission at the same time, all the transmitted frames will be lost. While, MAC layer protocols is to coordinate transmissions by competing stations to allow for sharing the common medium (Litwin, 2001). The communication between two nodes is to deploy a point-to-point link between the nodes such as connecting them with a cable is the most basic method. There is no interference between nodes and resource sharing is not required at the point-to-point channels. However, setting point- to point is not always possible. In wireless medium is