



Faculty of Engineering

**Study of Distributed Coordination Function (DCF) and Enhanced DCF (EDCF) in IEEE 802.11 MAC Protocols for Multimedia Applications**

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**Bachelor of Engineering with Honors  
(Electronics & Computer Engineering)  
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**STUDY OF DISTRIBUTED COORDINATION FUNCTION (DCF) AND  
ENHANCED DCF (EDCF) IN 802.11 MAC PROTOCOLS FOR MULTIMEDIA  
APPLICATIONS.**

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This project is submitted in partial fulfillment of  
The requirements for the degree of Bachelor of Engineering with Honors  
(Electronic and Computer Engineering)

Faculty of Engineering  
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2010

Dedicated to my beloved family and friends

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# ABSTRAK

IEEE 802.11e Kawalan Kemasukan Medium (*MAC*) merupakan satu penambah-baikkan kepada piawaian IEEE 802.11 rangkaian kawasan tempatan tanpa wayar (*WLAN*) untuk menyokong kualiti servis (*QoS*). 802.11e *MAC* adalah berdasarkan kepada kawalan berpusat dan juga capaian medium secara bertanding. Projek ini meliputi penilaian mekanisma capaian medium secara bertanding yang diperbaiki iaitu Fungsi Penyelarasan Pengedaran yang Ditingkatkan (*EDCF*), berbanding dengan 802.11 *MAC*, Fungsi Penyelarasan Pengedaran (*DCF*) yang asal. Tiga jenis trafik multimedia dipertimbangkan dalam projek ini adalah suara, video dan data. Penilaian tersebut dilaksanakan menggunakan simulasi NS-2 (versi 2.34) di dalam Ubuntu, sebuah sistem operasi Linux. Metrik-metrik yang digunakan dalam penafsiran ini adalah jumlah hasil proses, masa tangguh, ketaran dan jumlah kehilangan paket. Berdasarkan pada graf bagi keempat-empat metrik ini, prestasi *EDCF* dan *DCF* telah ditafsirkan. Selain itu, had kemampuan *EDCF* dapat dikenalpasti melalui simulasi menggunakan bilangan aliran trafik yang dimanipulasikan. Melalui kajian simulasi ini, kesimpulan yang didapati ialah *EDCF* boleh menyediakan capaian medium yang berbeza untuk setiap jenis trafik. Hasil simulasi menunjukkan prestasi *EDCF* adalah lebih baik berbanding dengan *DCF*.

# ABSTRACT

IEEE 802.11e Medium Access Control (MAC) is an enhancement to the legacy IEEE 802.11 standard's Wireless Local Area Network (WLAN) ideally to support Quality-of-Service (QOS). The 802.11e MAC is both centrally-controlled and contention-based channel accesses based. This project covers evaluation of the contention-based channel access mechanism, called Enhanced Distributed Coordination Function (EDCF), in comparison with the 802.11 legacy MAC, Distributed Coordination Function. Three different types of multimedia traffic are considered namely, voice, video and data. The evaluation was performed using ns-2 simulator (version 2.34) on Linux Ubuntu. The metrics used in the evaluation are throughput, delay, jitters and packet loss. The graphs from the metrics benchmarked the performance of EDCF and DCF evaluation. Through this simulation study, EDCF conclusively provides differentiated channel access for various multimedia traffic types. Simulation results proved that comparatively EDCF performs better performance than legacy DCF.



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# LIST OF ABBREVIATION

ACK	-	Acknowledge
AIFS	-	Arbitration Interframe Spacing
AP	-	Access Point
BSS	-	Base Service Set
CBR	-	Constant Bit Rate
CFB	-	Contention Free Burst
CSMA	-	Carrier Sense Multiple Access
CTS	-	Clear To Send
$CW_n$	-	Contention Window
DCF	-	Distributed Coordination Function
DDRR	-	Distributed Deficit Round Robin
DFS	-	Distributed Fair Scheduling
DIDD	-	Double Increment Double Decrement
DIFS	-	DCF Interframe Spacing
DWFQ	-	Distributed Weighted Fair Queuing

EDCF	-	Enhanced Distributed Coordination Function
EIFS	-	Extended Interframe Spacing
FTP	-	File Transfer Protocol
HTTP	-	Hypertext Transfer Protocol
IEEE	-	Institute of Electrical & Electronics Engineers
IFS	-	Interframe Spacing
IP	-	Internet Protocol
ITU-T	-	ITU Telecommunication Standardization Sector
LAN	-	Local Area Network
LLC	-	Logical Link Control
MAC	-	Media Access Control
MSDU	-	MAC Service Data Unit
$N_x$	-	Node
NAV	-	Network Allocation Vector
NS-2	-	Network Simulator 2
PCF	-	Point Coordination Function
PHY	-	Physical

PIFS	-	PCF Interframe Spacing
QoS	-	Quality of Service
RTS	-	Request To Send
SIFS	-	Short Interframe Spacing
STA	-	Station
TCL	-	Tool Command Language
TCP	-	Transmission Control Protocol
TXOP	-	Transmission Opportunity
TCP/IP	-	TCP for Transport Control Protocol/Internet Protocol
UDP	-	User Datagram Protocol
WLAN	-	Wireless Local Area Network

# CHAPTER 1

## INTRODUCTION

### 1.1 Introduction

The IEEE 802.11 wireless local area network (WLAN) technology has been a worldwide preference in terms of affordability, simplicity and flexibility convenience. This leading deployed wireless technology provides a network environment that is ubiquitously found in various locations such as café, offices, airport and universities for conventional data applications along with multimedia applications sharing. This high demand by public is concurrent with the significant growth in multimedia application usage such as teleconferencing, media transfer, streaming videos and online gaming.

The IEEE 802.11 Working Groups had employed various task groups that are actively developing improved revisions of the standard [1][2]. This standard comprises of the Physical Layer (PHY) and Medium Access Control (MAC) specifications for WLAN [3]. Improvements include allocation of higher data rates to be used under the PHY specifications.

However, high data rate alone does not guarantee support of Quality of Service (QoS) requirements needed in applications such as real time voice, video and audio. The lack of real time QoS support in WLAN has led to studies of Distributed Coordination Function (DCF) mode of 802.11 MAC using data application models on an ad hoc simulator [4]; the architecture and scheduling problems in supporting real time traffic are addressed based on the optional Point Coordination Function (PCF) mode of 802.11 MAC [5] [6]; service differentiation issues based on DCF are investigated in [7] and [8] by varying the MAC parameters for different traffic.

The ad-hoc simulator's architecture is basically similar to the IEEE 802.11e task group in defining the new Enhanced Distributed Coordination Function (EDCF) [9] MAC access method as a standard for QoS enhancement of 802.11 MAC.

## 1.2 Problem Statement

The legacy 802.11 is governed by two access methods; the Distributed Coordination Function (DCF) and Point Coordination Function (PCF). With QoS support being the center of interest, DCF in legacy 802.11 is noted for being unable to support the concept of differentiating frames with different priorities. Ideally, the DCF is expected to provide a channel access with equal probabilities to all stations contending for the channel access in a circulated manner. That being said, equal access probabilities are not desirable among stations with different priority frames. The emerging Enhanced DCF (EDCF) is designed to provide differentiated, distributed channel accesses for frames with different priorities. As proposed, EDCF provides better performance enhancement for real time traffic as compared to DCF. Thus, a study is required to analyze to what extent EDCF is better over DCF and what are the limitations of EDCF for various multimedia traffic scenarios under ITU-T requirements [10].

### **1.3 Project Objective**

The objective of this project is as followed

- i. To understand and learn to use Network Simulator (NS-2) Software
- ii. To evaluate and compare the network performance of Enhanced Distributed Coordination Function (EDCF) versus legacy Distributed Coordination Function (DCF) access mechanisms in IEEE 802.11 Wireless LANS by means of a comprehensive set of well known traffic patterns (voice, video and data) and NS-2 as a simulation tool [11].
- iii. To provide quantitative results on how the 802.11e standard makes a difference in QoS architecture governed WLAN.
- iv. To determine the limitation of nodes for individual traffic type that can fulfill ITU-T requirements for EDCF.

### **1.4 Scope of Project**

This project focuses on DCF and EDCF access mechanism that are the basic of 802.11 and 802.11e MAC access protocol respectively. By using both DCF and EDCF, the evaluation of each traffic type is carried out individually with different number of traffic nodes.

## **1.5 Project Outlines**

The Final Year Project Report records the project's overall progress from the preliminary idea development till the project execution and analysis. It is essentially divided into five chapters, which are introduction; literature review; methodology; results, analysis and discussion and, conclusion and recommendations. The brief information of each chapter is described below:

Chapter 1 reviews the aims and purpose of the project as to its relevance, practicality and appeal. The introduction also assesses the description of the approach to the problem and its context. It also explains the brief outline of the structure of the following chapters.

Chapter 2 summarizes and reviews the overall studies and researches which are related to the project. The literature review covered several researches regarding MAC protocol, the mechanisms of DCF & EDCA, IEEE 802.11e and IEEE 802.11n standards.

Chapter 3 discusses the methodology development as well as the NS-2 simulation tool that is thoroughly used in this project.