BORANG PENGESAHAN STATUS TESIS

JUDUL: **OPTIMIZING HANDOFF DELAY IN WLAN**

Sesi pengajian: **2010/2011**

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OPTIMIZING HANDOFF DELAY IN WLAN

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This report is submitted in partial fulfilment of the requirements for Master of Computer Science (Internetworking Technology)

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY
UNIVERSITI TEKNIKAL MALAYSIA MELAKA
2010

DECLARATION

I hereby declare that this project report entitle **"OPTIMIZING HANDOFF DELAY IN WLAN"** is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of other degrees.

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APPROVAL

I hereby declare that i have read through this project report and in my opinion this project report is sufficient in terms of scope and quality for the award of the degree of master of Computer Science (Internetworking Technology).

Signature:.....

Supervisor:.....DR ABDUL SAMAD B. SHIBGHATULLAH

Date:.....23/11/2010

DEDICATION

To my beloved mother and late father

ACKNOWLEDGEMENT

I just have completed my thesis. First of all, I would like to take this opportunity to express my appreciation to the organization and individuals who kindly contributed for my final year project in UTeM. With the cooperation and contributions from all parties, the objectives of the project; soft-skills, knowledge and experiences were gained accordingly even this is just a part of the whole project. Furthermore, I would like to thank my supervisor, Dr. Abdul Samad bin Shibghatullah for the proper guidance, cooperation and involvement throughout my Final Year Project. His effort to ensure the success and the ability of students under his responsibility can be developed well was admirable and appreciable. Moreover, I would like to extend my sincere acknowledgement to my parent and family who have been very supportive for the past six months. Their understanding and support in term of moral and financial were entirely significance towards the project's completion. Last but not least, my appreciation goes to my fellow student in UTeM, especially for who are from FKEKK and FTMK on their willingness to give helps, opinions and suggestions on some matters. The advices and technical knowledge are very precious and helpful for me while completing my final year project.

ABSTRACT

Continuous connectivity is one of the important requirements of Institute of Electrical and Electronics Engineers (IEEE) 802.11 Wireless Local Area Networks (WLAN) which allows user's mobility while utilizing the network. Consequently, many handoffs may occur as the mobile station (STA) is moving while accessing the network resources located at the distribution system side. The handoff originally associated from base station to another base station in the WLAN networks would affect the performance of multimedia applications which is sensitive to delay such as voice and video. This research proposed a new mechanism called Active Selective Context Caching (ASCC) which is able to reduce the delay of the re-association phase by eliminating the extra time consumed by the Inter Access Point Protocol (in order to transfer the context information of a STA from the old AP to the new associated AP). This elimination can be achieved by transferring the context information of a STA reactively from the old AP to the new AP prior to the re-association phase (during the discovery phase). The simulation's results show that by using the ASCC mechanism, the re-association delay can be reduced from an average of 27ms (in regular IEEE 802.11 handoff mechanism using conventional IAPP) to an average of 1.6ms (using ASCC) which is an improvement of ~94% of the total re-association delay.

ABSTRAK

Kesinambungan berterusan merupakan antara syarat penting dari *Institute of Electrical and Electronics Engineers (IEEE) 802.11* kepada rangkaian tanpa wayar (WLAN) yang membolehkan pengguna memanfaatkan rangkaian. Akibatnya, banyak *handoff* boleh berlaku seperti stesen mobile (STA) bergerak ketika mengakses sumber rangkaian yang terletak di sisi sistem pengedaran. Secara umumnya, *handoff* dari stesen dasar berhubung dengan stesen dasar yang lain di rangkaian WLAN akan mempengaruhi prestasi aplikasi multimedia yang sensitif terhadap penangguhan seperti suara dan video. Penyelidikan ini mencadangkan mekanisme baru iaitu *"Active Selective context Caching" (ASCC)* yang boleh mengurangkan kelewatan fasa *re-association* dengan mengurangkan masa tambahan yang digunakan oleh *Inter Access Point Protocol* (dalam rangka untuk memindahkan maklumat konteks STA dari yang lama ke AP yang baru). Pemotongan ini dapat dicapai dengan memindahkan maklumat konteks STA dari AP lama ke AP baru sebelum tahap *re-association* (semasa fasa penemuan). Keputusan simulasi menunjukkan bahawa dengan menggunakan mekanisme ASCC, penangguhan kembali *re-association* dapat dikurangkan dari purata 27ms (mekanisme handoff IEEE 802.11 "biasa" menggunakan IAPP konvensional) dengan purata 1.6ms (menggunakan ASCC) yang merupakan peningkatan ~ 94% dari jumlah penangguhan *re-association*).

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LIST OF ABBREVIATIONS

AAA	-	Authentication Authorization and Accountant
ASCC	-	Active Selective Context Caching
AP	-	Access point
BSS	-	Infrastructure Basic Service Set
BSSID	-	Infrastructure Basic Service Set Identifier
CT	-	Context Threshold
dBm	-	Decibel-MilliWatt
DS	-	Distribution system
ESS	-	Extended Service Set
GHz	-	Gigahertz
HT	-	Handoff Threshold
IAPP	-	Inter Access Point Protocol
IBSS	-	Independent Basic Service Set
IEEE	-	Institute of Electrical and Electronics Engineers
IP	-	Internet Protocol
ISP	-	Internet Service Provider
LAN	-	Local Area Network
Mbps	-	Megabit per second
Ms	-	Millisecond
MAC	-	Medium Access Control
New AP	-	STA newly selected access point to associate
NED	-	Network description language
NG	-	Neighbour Graph
NIC	-	Network Interface Card

NOG	-	Non-Overlap Graph
NTP	-	Network Time Protocol
Old AP	-	The last associated access point of a STA
OMNeT++	-	Objective Modular Network Test-bed in C++
PHY	-	Physical layer
QoS	-	Quality of Service
RF	-	Radio frequency
RSS	-	Received Signal Strength
RSSI	-	Received Signal Strength Identifier
SNR	-	Signal-to-noise ratio
SSID	-	Service Set Identifier
STA	-	Mobile station
TA	-	Time Active scans
VoIP	-	Voice over Internet Protocol
WEP	-	Wired Equivalent Privacy
WiFi	-	Wireless Fidelity
WLAN	-	Wireless Local Area Network
WNIC	-	Wireless Network Interface Card

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Guglielmo Marconi, an Italian inventor, invented the wireless telegraph in 1896. Telegraphic signals are successfully sent across the Atlantic Ocean in 1901 and his invention has now become one of the most advance technologies over the last century (William Stallings, 2004). Advances in wireless technologies have led to the emergence of the radio, the television, the cellular phone, and communication satellites. All types of information can be sent and shared to almost every corner of the world. In recent years, a great deal of attention has been focused on satellite communications, wireless networking and cellular technology.

One of the most popular technologies that have gained attention from researchers all over the world is Wi-Fi (Wireless Fidelity), a wireless technology based on the IEEE 802.11 standards. A considerable effort, research and development are underway to enhance its usefulness and functionalities. Wi-Fi has changed the conventional wired way of accessing network resources. It is now being deployed not only to home-based LANs but also office-based LANs and publicly available hot spots, which are areas around a central antenna in which people can access to the Internet with a wireless card equipped laptop. Without the limitation offered by the wired connection, wireless client

is able to move while accessing the network. The use of multimedia and real-time application such as video conferencing, IP telephony and interactive online games has continued to grow rapidly. The performance of wireless connectivity is affected with the emergence of such applications especially when the tendency of moving is high. Seamless connection is desired in order to avoid unpredictable packet loss, delay and jitter when wireless client moves out of its original radio range to a radio range covered by another base station. Thus, wireless handoff and mobility management appears to be a very challenging problem confronting network researchers.

1.2 Problem Statement

Each of the projects has their own problem to be discussed before starting the project. By realizing the problem statement it easy to know the purpose of doing this project and what are the problem to be solved. In recent year, real-time application and multimedia application have grown rapidly due to the increasing bandwidth offered by advance network technologies. The emergence of wireless technology enables users to access to the network through radio frequency. Wireless connectivity allows mobile users to move while performing a task or accessing to entertainment resources. The Station mobility is also possible but the performance of bandwidth hungry application degraded or disconnected when station moves beyond its originally associated base station. Thus, mobility management and handoff latency becomes one of the greatest concerns in deploying a wireless network while maintaining data transmission during handoffs where the station connects to a newly selected access point (AP) is difficult. The security features used in wireless networks indirectly increase the overall handoff latency with real-time and multimedia applications are sensitive to handoff latency and require an uninterrupted network connectivity to avoid delay, jitters and disconnection. Besides that, many protocols involves in secure transfer of station service state information from the originally associated AP to the new selected AP further increases handoff latency due to re-association. The selections of APs to which the service state of

station will be transferred generally do not consider whether the station has visited the radio range covered by the specific AP. Therefore, resources may be wasted because more bandwidth and memory will be used. Lastly, because of that problem the designing a better handoff mechanism that allows seamless mobility is extremely important and this research focuses on building an enhanced handoff mechanism to further improve the handoff latency.

1.3 Significant of Study

The mobility management and handoff latency becomes one of the greatest concerns in deploying a wireless network. The task for maintaining data transmission during handoffs where the station connects to a newly selected access point (AP) is difficult. Real-time and multimedia applications are sensitive to handoff latency and require an uninterrupted network connectivity to avoid delay, jitters and disconnection. Because of that problem, the designing a better handoff mechanism that allows seamless mobility is extremely important.

1.4 Limitations of the Study

This study only focuses on the handoff of the wireless AP between other AP. Mobile stations of wireless client is able to move while accessing the network. The performance of wireless connectivity is affected with the emergence of such applications especially when the tendency of moving is high. Seamless connection is desired in order to avoid unpredictable packet loss, delay and jitter when wireless client moves out of its original radio range to a radio range covered by another base station. This is important because multimedia and real-time application such as video conferencing, IP telephony and interactive online games has continued to grow rapidly.

1.5 Objectives of the Research

The objectives of this thesis are as follows:

1. To analyse a more efficient handoff mechanism that reduces both the latency and the packet loss during the re-association phase.
2. To design and simulate the proposed handoff mechanism using OMNeT++ simulator.
3. To test and evaluate the efficiency of the proposed handoff mechanism.

1.6 Research Methodology

The research will begin with the literature review of the IEEE 802.11 standards to study the fundamental concepts of wireless network. This will be followed by the study of the common wireless handoff process used by most of the manufacturers. Then, some of the current and existing handoff mechanisms, which are proposed by researchers, to reduce the Medium Access Control (MAC) layer handoff latency will be studied in order to identify the advantages and disadvantages of those mechanisms.

After identifying the advantages and disadvantages of the existing mechanisms, a new handoff mechanism which aims to reduce the MAC layer (layer two) handoff latency will be proposed in order to solve the problems found during the literature review of the previous work. Then, the proposed handoff mechanism will be analysed in order to identify its design requirements. This will be followed by the designing of the proposed mechanism. Subsequently, and in order to implement the proposed mechanism, the OMNeT++ simulator will be used for this purpose. A brief overview on OMNeT++ simulator will be conducted to explain the basic concepts of this network simulator as well as the reasons for chosen it. Finally, the proposed mechanism will be

tested using two testing methods namely: unit testing and integration testing in order to verify the correctness and completeness of the proposed mechanism.

1.7 Chapter outline

This thesis contains a total of five chapters and each addressing a distinct point related to carrying out this research project. A brief outline of chapters is as follows:

Chapter 1 provides an overview of the research. Then, we define the objectives and the scope of this thesis. Finally, we discuss the methodology which is used in this thesis.

Chapter 2 covers the basic concept and general background of IEEE 802.11 WLANs standards. The security features, regular handoff mechanisms used in the standards are reviewed, followed by various existing handoff mechanisms and algorithms proposed by researchers to reduce the overall layer 2 handoff delays. Then, the problems of existing handoff mechanisms are identified.

Chapter 3 covers the analysis of the new proposed handoff mechanism, Active Selective Context Caching (ASCC). After that, we describe the design of the ASCC mechanism. Then, the changes to the IEEE 802.11 and the Inter Access Point Protocol (IAPP) standards are discussed as well.

Chapter 4 at first reviews the network simulator, OMNeT++, and its basic modeling concepts. This is followed by, the architecture of OMNeT++ as well as INET Framework Model. The system testing, which aims to verify the correctness and completeness of the proposed handoff mechanism, is described. It is followed by the simulation results, and discussion which describes the simulation conducted to evaluate the proposed handoff mechanism. The simulation plan is defined, followed by the

parameter setting and performance metrics used for evaluation. The simulation results are then presented and discussed.

Chapter 5 summarizes the efforts and conclusion of this research. Additionally, suggestions for future work are outlined to further improve this research.

CHAPTER 2

LITERATURE REVIEW

The basic concept and background information of IEEE 802.11 WLANs standards were covers in this chapter and security features used in WLANs are presented. The handoff mechanisms and techniques in IEEE 802.11 wireless networks are reviewed, followed by various existing handoff mechanisms and algorithms to reduce the overall layer 2 handoff delays. Besides, the role of Inter-Access Point Protocol (IAPP) during handoff is described. Finally, the problems of existing handoff mechanisms are identified.

2.1 IEEE 802.11 WLANS

A study shows that there were nearly 80 million wireless users nationwide in 1999, but the number increased to 204 million users in 2006 (Port Networks, 2007). The IEEE 802.11 architecture consists of several components that interact to provide a wireless LAN that supports station mobility transparently to upper layers and the specification for wireless LANs (WLANs) was developed by the IEEE 802.11 working group. The basic service set (BSS) may form a component of an extended form of network (extended service set ESS) that is built with multiple BSSs interconnected to a backbone distribution system (DS) via an AP. Besides that, the smallest building block