AN ENHANCEMENT OF HANDOFF LATENCY REDUCTION MECHANISM FOR MOBILE INTERNET PROTOCOL VERSION 6 (MIPV6)

BY

MOSHARROF HUSSAIN MASUD

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Kulliyyah of Engineering
International Islamic University
Malaysia

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ABSTRACT

Mobile Internet Protocol Version 6 (MIPv6) is envisioned for next generation networks to achieve seamless communication as it has more suitable features than the existing version. However, MIPv6 is not yet deployed for some limitations like handoff latency and security that degrades Quality of Service (QoS). Therefore, two different handoff latency solutions are proposed for MIPv6 networks. Handoff latency solution 1 consists of two parts related to Layer 2 (L2) and Layer 3 (L3), using fuzzy logic to reduce latency of L2 scanning phase, and a Parallel Duplicate Address Detection (PDAD) to reduce the address configuration time in L3. Solution 2 is incorporated with IEEE 802.21-MIH (Media Independent Handover) assisted with MIPv6 which configures the alternative interface while the mobile node (MN) is using an active interface without disturbing the current session. These two mechanisms are evaluated using performance metrics of handoff latency and packet loss. The performance of the mechanisms is evaluated using OMNeT++ and MATLAB. The overall handoff latency is reduced from standard 1300 ms to 500 ms using solution 1, a 60% reduction, with packet loss reduction of 70%. The second solution reduces both handoff latency and packet loss by 75%.

خلاصة البحث

ومن المتوقع المحمول بروتوكول الإنترنت الإصدار (MIPv6) 6 لشبكات الجيل القادم لتحقيق التواصل السلس كما أن لديها **أكثر** من مناسبة ميزات الإصدار الموجود. ومع ذلك، لا يتم نشر حتى الآن MIPv6 لبعض القيود مثل الكمون عمليتي التحول والأمن التي تحط من جودة الخدمة. (QoS) لذلك، يقترح الكمونين عمليتي التحول مختلف الحلول لشبكات. MIPv6 الكمون عمليتي التحول الحل 1 يتكون من جزأين المتعلقة طبقة (L2) 2وطبقة (L3) 3، وذلك باستخدام المنطق الضبابي للحد من الكمون L2المسح المرحلة، وكشف مواز العنوان المكرر (PDAD)لتقليل الوقت في تكوين عنوان. L3وهو مدرج حل 2 IEEE 802.21مع) MIH-وسائل الإعلام المستقلة تسليم (ساعد في تكوين MIPv6 التي واجهة بديلة في حين أن عقدة المحمول (MN)يستخدم واجهة بالموقع دون إزعاج الدورة الحالية. يتم تقييم هاتين الآليتين باستخدام مقاييس الأداء من الكمون عمليتي التحول وفقدان الحزمة .يتم تقييم أداء آليات استخدام + + OMNeT وMATLAB. يتم تقليل زمن الوصول عمليتي التحول الشامل من1300ms إلى 500ms ملل القياسية باستخدام الحل 1، تخفيض من60٪، مع الحد من الخسائر حزمة70٪. الحل الثاني كل من الكمون يقلل عمليتي التحول وفقدان حزمة بنسبة 75٪.

APPROVAL PAGE

I certify that I have supervised and read this study and that in my opinion; it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Master of Science (Computer and Information Engineering).

....
Farhat Anwar
Supervisor

....
Omer Mahmoud Mohamed
Co-supervisor

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Master of Science (Computer and Information Engineering).

....
Wajdi Al-Khateeb
Internal Examiner

....
Nor Kamariah Nordin
External Examiner

This dissertation was submitted to the Department of Electrical and Computer Engineering and is accepted as a fulfilment of the requirement for the degree of Master of Science (Computer and Information Engineering).

....
Othman O. Khalifa
Head, Department Electrical & Computer Engineering

This dissertation was submitted to the Kulliyyah of Engineering and is accepted as a fulfilment of the requirement for the degree of Master of Science (Computer and Information Engineering).

....
Md. Noor Salleh
Dean, Kulliyyah of Engineering

DECLARATION

I hereby declare that this dissertation is the result of my own investigations, except otherwise stated. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at IIUM or other institutions.

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"To my beloved parents, my siblings and my family members for their inspiration, encouragement, guidance and facilitating for me to be where I am today"

This dissertation is especially dedicated to all of you.

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LIST OF ABBREVIATIONS

3G	Third Generation
3GPP2 –	3rd Generation Partnership Project 2
4G	Fourth Generation
ADAD	Advanced Duplicate Address Detection
AP –	Access Point
AP	Access Point
AR	Access Router
BER	Bit Error Ratio
BU	Binding Update
CAR	Cross-layer Address Resolution
CIR	Carrier to Interference Ratio
CN –	Corresponding Node
CoA –	Care-of-Address
CoT	CoA Test
CoTi	CoA Test Init
DAD –	Duplicate Address Detection
DHCP –	Dynamic host Configuration Protocol
DNS –	Domain Name Service
END	Enhanced Neighbor Discovery
EUI	Extended Unified Identifier
FHD	Fuzzy logic-based Handoff Decision
FMIPv6 –	Fast Mobile Internet Version 6
FN –	Foreign Network
FNDD	Fast Neighbor Discovery DAD
FQDA	Fuzzy logic theory based Quantitative Decision Algorithm
FTP –	File Transport Protocol
GPRS –	General Packet Radio Service
GPS	Global Positioning System
GSM –	Global System for Mobile
HA –	Home Agent
HMIPv6 –	Hierarchical Mobile Internet Protocol Version 6
HoA –	Home Address
HoT	Home Test
HoTi	Home Test of Init
ICMP –	Internet Control Message Protocol
IETF –	Internet Engineering Task Force
IP –	Internet Protocol
IPTV	Internet Protocol Television
IPv6 –	Internet Protocol Version 6
ITU –	International Telecommunication Union
L2	Layer 2
L3	Layer 3

LCoA	Link Care of Address
LMA	Local Mobility Anchor
MAC	Media Access Control
MAG	Mobility Access Gateway
MAP	Mobile Node Attachment Point
MAP	Mobility Anchor Point
MD	Movement Detection
MFRB	Modular Fuzzy Rule Based
MICS	Media Independent Command Service
MIES	Media Independent Event Services
MIH –	Media Independent Handoff
MIIS	Media Independent Information Service
MIP	Mobile Internet Protocol
MIPv4	Mobile Internet Protocol Version 4
MIPv6	Mobile Internet Protocol Version 6
MIPv6	Mobile Internet Protocol Version 6
MLD-	DAD Multicast Listener Discovery – Duplicate Address Detection
MN –	Mobile Node
NA	Neighbor Acknowledgement
ND	Neighbor Discovery
NDRA	Neighbor Discovery Relay Agent
NGN –	Next Generation Network
NIC –	Network Interface Card
NS	Neighbor Solicitation
NS	Neighbor Solicitation
NSR	Noise Signal Ratio
NUD	Neighbor Unreachability Detection
ODAD	Optimistic Duplicate Address Detection
OS –	Operating System
OSI –	Open System Interconnection
PDAD –	Parallel Duplicate Address Detection
PDAD	Proactive Duplicate Address Detection
PMIpv6	Proxy Mobile Internet Protocol Version 6
QoS –	Quality of Service
RA	Router Acknowledgement
RCoA	Regional Care of Address
RIP	Regional Information Point
RO	Route Optimization
RS	Router Solicitation
RSSI	Received Signal Strength Indicator
SAP	Serving Access Point
SCTP –	Stream Control Transmission Protocol
SHC	Smooth Handoff Controller
SMTP –	Simple Mail Transfer Protocol
TA	Tentative Address
TCP –	Transmission Control Protocol
TCP/IP –	Transmission Control Protocol / Internet Protocol
UDP –	User Dataram Protocol

UMTS –	Universal Mobile Telecommunication System
VoIP	Voice over Internet Protocol
WiFi –	Wireless Fidelity
WiMAX –	World interoperability for Microwave Access
WLAN –	Wireless Local Area Network

CHAPTER ONE

INTRODUTION

1.1 OVERVIEW

The next generation wireless communication system is envisioned to be fully Internet Protocol version 6 (IPv6) based in order to support increasing mobile users. Mobility in IPv6 (MIPv6) (Johnson et al., 2011) was introduced into the network by the Internet Engineering Task Force (IETF) so that a Mobile Node (MN) could have mobility from one Access Point (AP) to another AP seamlessly. However, seamless and ubiquitous connection is a great challenge in mobile environments where heterogeneous technologies are collaborating with each other. In such scenario, mobile users need to be connected with different types of technologies while they are roaming. The continuous growth of wireless communication systems poses problems for seamless connectivity like handoff delays, packet loss and jitter rise when the MN is moving. To address these issues, this chapter aims to present the background of the technologies, research motivation, the problem statement, the research objectives, the research methodologies, the research scope and finally the significant of the study.

1.2 BACKGROUND

Global System for Mobile communication (GSM) is the most widely-used communication system that supports wireless mobility around the globe. It has many functionalities like flexibility of providing reliable voice mail, high speed data, fax, SMS, seamless roaming between GSM systems and other features. However, researchers have mentioned that the drawbacks of GSM is its limitations for data transmission and high cost. With more pressure to advance existing technology due to users' demand, GSM technology is finding it difficult to support cheap, flexible, scalable and more interactive services for its limited bandwidth in the wireless communication system. To overcome GSM's limitations, General Packet Radio Service (GPRS) is introduced based on the Internet Protocol (IP) technology to support data service with reduced cost. Another type of IP based wireless technology that was introduced to also address this issue is the Wireless Local Area Networks (WLAN) especially Wireless Fidelity (WiFi) and World Interoperability for Microwave Access (WiMAX). All these technologies have advantages and limitations which is usually a trade-off between capacity, mobility and cost. Mobile users are increasing and demanding the support of real time applications on their devices, therefore many standardization groups in communication system such as 3rd Generation Partnership Project 2 (3GPP2) and International Telecommunication Union (ITU) have defined that the core of the next generation mobile network will be fully IP based (Vivaldi, 2003).

IP was designed initially to support communication between fixed end points (Rasam, 2011). An MN wishing to connect to the Internet is expected to have an IP address for further communications. This IP address can be configured either following stateful or stateless approaches. Stateful approach is when the MN configures the IP address with the help of Dynamic Host Configuration Protocol (DHCP) server residing in its home network while stateless approach is when the MN configures the IP address with the assistance of network prefixes from the nearest routers/gateway. In IP version 6 (IPv6) networks, only stateless auto-configuration is considered. This initially registered router is known as Home Agent (HA) of that device or the MN and the address is called Home Address (HoA). When the MN wishes to move from its HA to any Foreign Network (FN), it needs to configure a Care-of-Address (CoA) from the FN. To handle mobility management seamlessly, the IETF standardized few protocols where Mobile IPv6 (MIPv6) is the pioneer that supports global coverage.

1.3 RESEARCH MOTIVATION

Nowadays, there are different network technologies such as, IEEE 802.11a/b/g or WiFi, IEEE 802.16 or WiMAX, GPRS, Universal Mobile Telecommunication System (UMTS) which are converging their infrastructure with the core network of IPv6. When the MN is moving from one AP to another AP, it is known as handoff. The time required to perform this handoff is referred to as handoff latency. There are two types of handoff latency in MIPv6 network, namely; horizontal and vertical. If the MN moves within the same technological AP coverage area, it is known as horizontal handoff latency, for example, the movement of WLAN to WLAN or WiMAX to WiMAX. On the other hand, if the MN moves between AP's using different technologies it is referred to as vertical handoff latency such as WLAN to WiMAX or UMTS to WLAN. The horizontal handoff is quite simple and does not take long time to be processed. However, vertical handoff is a complicated process and takes longer time to communicate seamlessly. Seamless communication is important for network-enabled applications to operate continuously at the desired Quality of Service (QoS) in a wired or wireless IP network, especially for real time applications such as audio and video streaming. In either case, the change of IP address has to be configured on-the-fly so that the ongoing session is not interrupted.

1.4 PROBLEM STATEMENT

When the MN moves from one subnet area to another, it is unable to receive a packet from Corresponding Node (CN) and vice versa until it configures a new CoA and completes the registration procedure on that subnet. The time required to complete these procedures is known as handoff latency which is responsible for making the MN temporarily unreachable from the network. Real time applications like audio and video streaming are sensitive to the unreachability of the MN during handoff. The address configuration and registration process in homogeneous network is quite simple where as in heterogeneous network it is a complex process. Researchers have proposed solutions to reduce the handoff latency in the form of Hierarchical MIPv6 (HMIPv6), Fast MIPv6 (FMIPv6) and Proxy MIPv6 (PMIPv6).

1.5 RESEARCH OBJECTIVES

The main objective of this research is to develop an enhanced handoff reduction mechanism based on MIPv6 to satisfy the main requirements of real time applications. The detailed objectives are:

1. To investigate handoff latency problems in MIPv6.
2. To develop mechanisms to minimize handoff latency of MIPv6.
3. To evaluate and benchmark the proposed mechanisms with current standard MIPv6 based on simulation.

1.6 RESEARCH SCOPE

The main focus of this thesis is to highlight the problems in homogeneous as well as heterogeneous networks of MIPv6 in terms of handoff delay and packet loss. This thesis intends to address the limitations of L2 especially the scanning phase and L3 problems. It proposes two mechanisms both for L2 and L3 which are incorporated with IEEE 802.21-Media Independent Handover (MIH). The proposed mechanisms implemented on fuzzy logic for L2 and OMNeT++ (www.omnetpp.org) simulator being used for L3 evaluation.

1.7 RESEARCH METHODOLOGY

In order to achieve aforementioned objectives, the methodologies followed in this research are as follows:

1. Study the existing mechanisms: In this phase the existing techniques are revised to explore the limitations and open issues while an MN is moving.
2. Design and implementation of the proposed enhancements to overcome the limitations of existing as mentioned in the objectives.
3. Evaluation of the proposed mechanism using OMNeT++ simulator and MATLAB Fuzzy Toolbox.
4. The overall scheme is benchmarked with MIPv6 using OMNeT++ simulator.

The overall methodology depicted in Figure 1.1. The first solution is the combination of L2 and L3 where the second solution is related to the MIH standard. To achieve the objectives of this research, a network simulator OMNeT++ and MATLAB fuzzy tool box have installed on windows platform. Two algorithms have proposed for both solutions and evaluated on simulator for performance analysis. The performance evaluation continues until achieving satisfaction of the objectives. The report writing started after the successful completion of the simulation task for L2, L3 and MIH module.

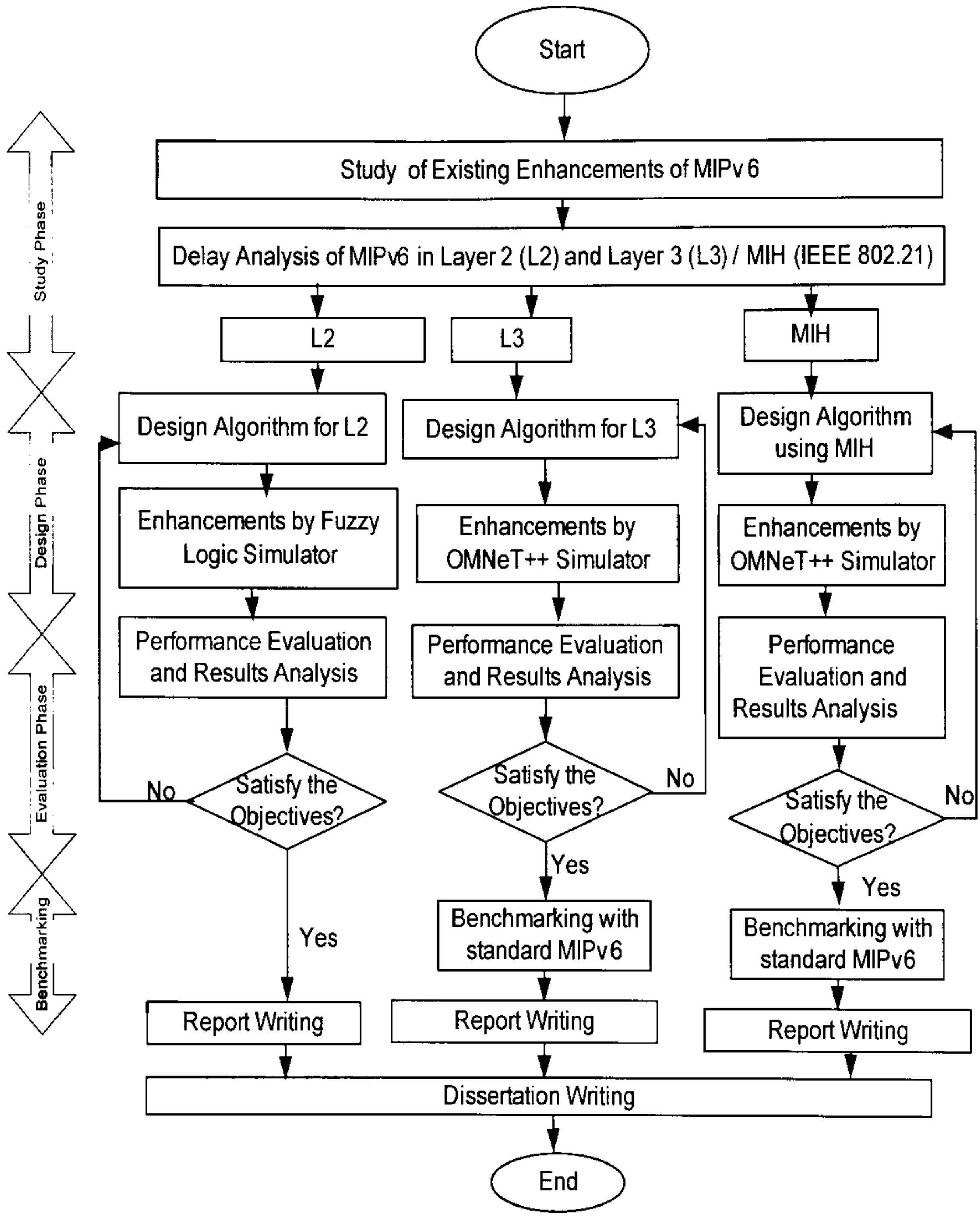

Figure 1.1: Flowchart of Research Methodology