ENHANCEMENT OF HOST-BASED AND NETWORK-BASED MOBILITY MANAGEMENT PROTOCOLS IN WIRELESS MESH NETWORK

by

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LIST OF SYMBOLS

bps	bit per second
-	De-queue
d	drop
dBm	decibel-milliwatts
+	En-queue
kbps	kilo bit per second
Mbps	Mega bit per second
m	meter
ms	mili second
m/s	meter per second
r	receive
s	send

LIST OF ABBREVIATIONS

2G	Second Generation
3G	Third Generation
4G	Fourth Generation
AAA	Authentication, Authorisation and Accounting
ACK	Acknowledgement
AHRA	Ad Hoc Routing Agent
AP	Access Point
AR	Access Router
ARP	Address Resolution Protocol
AWK	Aho Weinberger Kernighan
BAck	Binding Acknowledgement
BDT	Bi-Directional Tunneling
BSS	Basic Service Set
BU	Binding Update
CBA	Corresponding Binding Acknowledgement
CBU	Corresponding Binding Update
CBR	Constant Bit Rate
CDMA	Code Division Multiple Access
CMM	Centralised Mobility Management
CN	Corresponding Node
CoA	Care of Address
DAD	Duplication Address Detection
DHCP	Dynamic Host Configuration Protocol

DMM	Distributed Mobility Management
DDNS	Dynamic Domain Name System
DNS	Domain Name System
EHCF	Extended Handover Control Function
FA	Foreign Agent
FBAck	Fast Binding Acknowledgement
FBU	Fast Binding Update
FHMIPv6	Fast Handover for Hierarchical Mobile Internet Protocol version 6
FMIPv6	Fast Handover Mobile Internet Protocol version 6
FNA	Fast Neighbour Advertisement
FTP	File Transfer Protocol
GMM	Global Mobility Management
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communications
HA	Home Agent
HAdd	Hierarchical Address
HAck	Handover Acknowledgement
HI	Handover Initiation
HI-HAck	Handover Initiation Handover Acknowledgment
HMIPv6	Hierarchical Mobile Internet Protocol version 6
HNP	Home Network Prefix
IBSS	Independent Basic Service Set
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IGMP	Internet Group Management Protocol

InterNIC	Internet Network Information Center
IP	Internet Protocol
IHL	Internet Protocol Header Length
iMANET	Internet based Mobile ad hoc Network
IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
IPng	Internet Protocol next generation
ISP	Internet Service Provider
Kbps	Kilobit per second
LAN	Local Area Network
LBAck	Local Binding Acknowledgment
LBU	Local Binding Update
LCoA	Local Care of Address
LMA	Local Mobility Anchor
LGD	Link Going Down
LR	Localised Routing
LRA	Localised Routing Acknowledgment
LRI	Localised Routing Initiation
LTE	Long Term Evolution
LTS	Long Term Support
M-2-M	Machine-to-Machine
MAC	Media Access Control
MAG	Mobile Access Gateway
MAHO	Mobile Assisted Handoff
MANET	Mobile Ad Hoc Network

MAP	Mobility Anchor Point
Mbps	Megabit per second
MCHO	Mobile Controlled Handoff
MIP	Mobile Internet Protocol
MIH	Media Independent Handover
MIPv4	Mobile Internet Protocol version 4
MIPv6	Mobile Internet Protocol version 6
MN	Mobile Node
MLD	Multicast Listener Discovery
MSOCKS	Mobile Socket Service
NAM	Network Animator
nAR	New Access Router
NAT	Network Address Translation
NCHO	Network Controlled Handoff
NEMO	Network Mobility
NLCoA	Next Link Care of Address
NOAH	NO Ad Hoc routing Agent
NS-2	Network Simulator 2
OFDMA	Orthogonal Frequency Division Multiple Access
OLSR	Optimised Link State Routing
O-FH	Optimised Fast Handover
O-FMIPv6	Optimised Fast Handover Mobile Internet Protocol version 6
O-LMA	Optimised Local Mobility Anchor
O-MAG	Optimised Mobile Access Gateway
OPNET	Optimised Network Engineering Tool

OS	Operating System
OSI	Open Systems Interconnection
oTCL	Object-oriented Tool Command Language
pAR	Previous Access Router
PBack	Proxy Binding Acknowledgement
PBU	Proxy Binding Update
PDR	Packet Delivery Ratio
pHoA	Proxy Home of Address
PLCoA	Previous Link Care-of-Address
PMIPv6	Proxy Mobile Internet Protocol version 6
PPP	Point to Point Protocol
PRD	Pre-handover Route Discovery
PrRtAdv	Proxy Router Advertisement
QI	Quality Indicator
QoS	Quality of Service
RA	Router Advertisement
RCoA	Regional Care of Address
RIP	Routing Information Protocol
RIPng	Router Information Protocol next generation
RO	Route Optimisation
RO-PMIPv6	Route Optimisation for Proxy Mobile Internet Protocol version 6
RS	Router Solicitation
RSSI	Received Signal Strength Indication
RtSolPr	Router Solicitation for Proxy Advertisement
SCTP	Stream Control Transport Protocol

SIGMA	Seamless IP diversity based Generalised Mobility Architecture
SIP	Session Initiation Protocol
SMIP	Seamless Mobile Internet Protocol
SSID	Service Set Identification
TDMA	Time Division Multiple Access
ToS	Type of Service
TCL	Tool Command Language
TCP	Transfer Control Protocol
UMTS	Universal Mobile Telecommunications System
UDP	User Datagram Protocol
VANET	Vehicular ad hoc Network
VoIP	Voice over Internet Protocol
WEI	Word Error Indicator
Wi-Fi	Wireless Fidelity
WiMAX	Worldwide interoperability Microwave Access
WLAN	Wireless Local Area Network
WMN	Wireless Mesh Network
WSN	Wireless Sensor Network

ABSTRAK

Sejak kebergantungan manusia ke arah Internet, ini telah meningkatkan penggunaan Internet dengan pantas dan mengakibatkan masalah kesesakan dan sambungan Internet terputus-putus. Rangkaian Mesh Tanpa Wayar (WMN) telah diperkenalkan untuk mengatasi masalah sambungan Internet terputus-putus dan menampungkan kawasan luar bandar bagi meningkatkan skala liputan rangkaian secara berkesan dengan kos pembinaan yang lebih rendah. Walau bagaimanapun, dalam WMN, tiada protokol pengurusan mobiliti yang khusus yang dilantik untuk mengendalikan pengurusan lokasi dan pengurusan penyerahan nod mudah alih (MN). Di samping itu, MN juga menghadapi kesukaran untuk memilih protokol pengurusan mobiliti yang sesuai untuk melaksanakan proses penyerahan sama ada di dalam domain atau antara domain disebabkan protokol pengurusan mobiliti pada masa kini perlu mengendalikan pengurusan mobiliti untuk kedua-dua domain. Protokol pengurusan mobiliti yang tunggal perlu mengendalikan maklumat beacon dan pengiktirafan untuk pengurusan di dalam kedua-dua domain. Matlamat tesis ini adalah: pertama, penilaian prestasi dan perbandingan bagi pelbagai protokol pengurusan mobiliti dalam persekitaran WMN. Protokol pengurasan mobiliti *Host-Based* dan *Network-Based* disatukan dalam persekitaran WMN dan dilaksanakan secara berasingan untuk mengendalikan mobiliti kedua-dua domain. MIPv6 dan FMIPv6 dipilih untuk mengendalikan senario dalaman rangkaian manakala untuk senario antara rangkaian, HMIPv6, FHMIPv6 dan PMIPv6 dilantik untuk mengendalikan operasi. Keputusan prestasi menunjukan bahawa FMIPv6 mempunyai prestasi yang lebih baik daripada MIPv6 dalam senario dalaman rangkaian. Bagi senario antara rangkaian, PMIPv6 adalah lebih baik berbanding dengan HMIPv6 dan FHMIPv6. Kedua, meningkatkan prestasi bagi FMIPv6 dalam senario dalaman rangkaian. Optimasi FMIPv6 (O-FMIPv6) diperkenalkan dengan skim penyerahan cepat yang baru berdasarkan FMIPv6 untuk beroperasi dalam senario dalam rangkaian. Untuk mekanisme penyerahan cepat yang baru, apabila MN merasakan kekuatan isyarat sendiri menjadi rendah, MN mengiklankan kepada rangkain jiran untuk keperluan melampirkan ke titik akses yang mempunyai kekuatan isyarat yang lebih tinggi. Ini dapat mengurangkan kekangan penyerahan. Ketiga, mengoptimumkan laluan bagi PMIPv6 (RO-PMIPv6) dengan skim pengoptimuman laluan baru dengan pengubahan bagi LMA dan MAG. Hanya LMA yang terlibat akan memaklumkan kepada titik akses hierarki yang berbeza dan CN sebelum dan selepas proses penyerahan dilakukan. Ini dapat mengurangkan masa proses penyerahan dan dengan itu mengurangkan latensi penyerahan dan meningkatkan kecekapan komunikasi tanpa wayar. Bagi kedua-dua pengurusan pengerakan domain, kelewatan hujung-ke-hujung, nisbah penghantaran paket (PDR) dan kadar pengeluaran diukur untuk menunjukkan pengoptimuman bagi O-FMIPv6 dan RO-PMIPv6. Akhir sekali, keputusan menunjukkan bahawa domain dalaman dengan O-FMIPv6 dan antara domain dengan RO-PMIPv6 mengoptimumkan prestasi pengurusan mobiliti. Bagi O-FMIPv6 melakukan 2.2% lebih rendah dalam kelewatan hujung-ke-hujung, 3.7% lebih tinggi dalam PDR dan 5.4% lebih tinggi dalam kadar pengeluaran dibandingkan dengan standard FMIPv6. Bagi RO-PMIPv6 melakukan 58.3% lebih rendah dalam kelewatan hujung-ke-hujung, 2% lebih tinggi dalam PDR dan 2.7% lebih tinggi dalam kadar pengeluaran berbanding standard PMIPv6. Dengan pengurusan mobiliti yang dioptimumkan, dipercayai dapat mengurangkan latensi, meningkatkan kadar pengeluaran dan mengurangkan gangguan. Dengan kriteria ini, tujuan masa depan komunikasi wayarles semasa bergerak dipercayai dapat memudahkan komunikasi antara manusia.

ABSTRACT

Since the dependency of human toward the Internet, this has rapidly raise the usage of Internet which may cause congestion and intermittent connection issues. The Wireless Mesh Network (WMN) was introduced to overcome the intermittent connection issues and caters rural area in order to effectively increase the scalability of network with lower construction cost. However, in WMN, there is no specific mobility management protocol that is appointed to handle the location management and handoff management of Mobile Node (MN). Besides that, the MN also faces the difficulties in choosing the suitable mobility management protocols to perform the handover process either in inter or intra domains since the current mobility management protocol handles both intra and inter domains mobility management. Single mobility management protocol needs to handle beacon update and acknowledgement for inter and intra mobility managements. This causes significant delay and distortion which decrease the efficiency of wireless communication. Having known this issue, the aims of this thesis are: firstly, performance evaluation and comparison of various mobility management protocols in WMN environment. The Host-Based and Network-Based mobility management protocols are consolidated in WMN environment and separately implemented and handles the inter and intra mobilities. MIPv6 and FMIPv6 are chosen to operate in intra network scenario while for inter network scenario, HMIPv6, FHMIPv6 and PMIPv6 are appointed to handle the operation. The performance results show that the FMIPv6 have better perform than MIPv6 in intra network scenario. While for inter network scenario, the PMIPv6 is outperformed which compares to HMIPv6 and FHMIPv6. Secondly, the target is to enhance the performance of standard FMIPv6 in intra network scenario. The Optimise FMIPv6 (O-FMIPv6) was introduced with new fast handover scheme based on the standard FMIPv6 to operate in intra network scenario. For enhanced fast handover mechanism, when the MN senses lower signal strength, MN advertises to the neighbour network for the need to attach to the new higher signal strength access point. MN informs the new access point of the need to change to the new access point before the process of handover. Thus, this can reduce the handover latency of handover processes. Thirdly, it is to propose route optimise PMIPv6 (RO-PMIPv6) with new route optimisation scheme which modifies the LMA and MAG entitles. When there is a need to connect to different hierarchical access points, only LMA involves to inform the different hierarchical access points and CN before and after the handover process is performed. This can reduce the time of handover process and thus decreases the handover latency and increases the wireless communication efficiency. For both intra and inter domains mobility management over WMN, the end-to-end delay, packet delivery ratio (PDR) and throughput are measured to show the optimisation of the proposed O-FMIPv6 and RO-PMIPv6. Lastly, the results show that the designed intra domain mobility with O-FMIPv6 and the inter domain mobility with RO-PMIPv6 enhanced the mobility management performances. The O-FMIPv6 performs 2.2% lower in end-to-end delay, 3.7% higher in PDR and 5.4% higher in throughput as compared with standard FMIPv6. The RO-PMIPv6 performs 58.3% lower in end-to-end delay, 2% higher in PDR and 2.7% higher in throughput as compared with standard PMIPv6. With this enhanced mobility management, it is believed that with the implementation of the designed mobility management protocols, this can reduce latency, increase throughput and decrease distortion. With these criteria, the future aims of wireless communication while moving is made possible which eases the communication between human.

CHAPTER 1

INTRODUCTION

1.1 Introduction

The existence of communication over the Internet is as a very powerful platform that has forever change the way human communicate each other. Furthermore, the innovations of the social web and mobile technology have changed the way people utilise the Internet. For an example, the creation of Facebook had found out new ways to communicate. As of the middle of 2017, Facebook had 2 billion monthly active users (Internet World Stats, 2017). The tremendous demands for the social market are pushing the booming the development of mobile communications to growth faster than ever before. The mobile communication's technology enables human to possibly reach the Internet using the mobile devices within the fastest duration. Based on the research report from Internet World Stats, the world human population on January 2017 have reached 7.476 billion; the Internet users reach 3.773 billion which about 50% penetration. The unique mobile user's penetration reaches 66% which about 4.92 billion. The forecast expected that the unique mobile user's population will reach 71% by 2019 (Internet World Stats, 2017). Based on the research report, the mobile Internet becomes the main trend of the Internet usage and mobile devices become part of human life.

The dependency of human toward the Internet has raised the usage of Internet which causes congestion and intermittent connection issues that rise rapidly (Montavont & Noël, 2002). Present telecommunication infrastructures also have some coverage issues as it cannot cover specific areas in its coverage area such as alpine area, underground facilities, and forest region. Furthermore, people from rural areas have been receiving limited coverage from entire major telecommunication service providers (Liew, Yeo, Ab, & Othman, 2004). Lack of connectivity in rural areas is caused by poor infrastructure as most rural areas have to depend on service tower that is miles away from their service province to receive signal. Cost of upgrade at this phase could cause a fortune and it is less profitable based on business and market point of view.

Finding the ways to solve the intermittent connection problem, the wireless mesh networks (WMN) rise up to overcome this obstacle. A generic WMN is comprised of a combination of static mesh routers and mobile mesh nodes. Mesh routers form a wireless multi-hop backbone network. Some mesh routers function as the gateways and are connected via wired links to the Internet. Mesh routers are dedicated nodes for routing wireless traffic either from mobile mesh nodes to the wired Internet or between mobile mesh nodes. Mobile mesh nodes access the network via a mesh router which serves as the access point (AP). With the help of multi-hop connectivity among mesh routers, the number of required Internet entry points can be reduced. Therefore, WMN can cover a large area with low deployment cost (Ian. F. Akyildiz & Wang, 2005).

Besides that, WMN can be accessed by municipal forces that make uses of cars, or community networks can be accessed by subscribers with hand-held devices. These considerations push for the support of mobility. Mobility management is the fundamental technology used to automatically support mobile terminals which are accepting the Internet services while simultaneously roaming freely without the disruption of communications (Johnson, Perkins, & Arkko, 2004). The interconnection of mobility management and wireless mesh network can be facilitated through merging mobility management scheme with WMN (Rongsheng, Chi, & Yuguang, 2007). The handover quality is one of the most indispensable testing items in each field trial test.