A COMPARISON OF MOBILE NODE'S HANDOFF BETWEEN MOBILE IPV6 AND FAST HANDOVER PROTOCOL

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Shayma Sinan, Mahamod Ismail, and Kasmiran Jumari

Department of Electric, Electronics, and Systems Engineering, Faculty of Engineering, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor

Email: shay_sinan@yahoo.co.uk.

ABSTRACT

Mobile IP is standard protocol to support mobility for today and future networks, although it suffers from handoff delay when a mobile node changes its point of attachment in the network. This delay might cause packet loss resulting interruption for various types of applications especially real-time applications. In this research, we conducted a performance evaluation of Mobile IPv6 and fast handover to investigate the parameters of mobile node in both protocols during handover. The study was carried out using an open source Network Simulator ns-2 to study and analyse the behaviour of fast handover and Mobile IPv6 protocols based on various parameters such as throughput, and handoff latency.

1. INTRODUCTION

Nowadays growth in the number of mobile clients using laptops and notebook PCs for connecting to the Internet and the World Wide Web (WWW) is increasing rapidly. Although, Mobile IP [1] provides a framework for users roaming outside their home network who need to keep connectivity all the time, it is not designed for fast movement management. The MN needs to inform its home agent whenever it moves. If it moves fast and frequent from one subnet to another, it needs to send a message - including the new location - on every move. It takes time for the home agent to get this message. Until the home agent knows its exact current location, the packets addressed to the MN's old location will be lost. The worst thing is when the home agent is far away from the MN, since the loss and delay of packets to the MN will be significant. Also, sending network update messages frequently will result in excessive battery power consumption, which is unacceptable for portable small wireless devices. To fix these problems and provide continuous communication to the mobile device in the next generation Internet Protocol, IETF has currently standardized a protocol called Mobile IPv6 [2]. It is derived from the current used protocol Mobile IPv4 with some adapted mechanisms for Mobile IPv6.

1.1. MOBILE IPV6

Mobile IPv6, as Mobile IPv4, makes a mobile's movement (i.e., change of IPv6 address) transparent to the upper layer protocols and applications on the mobile node (MN) as well as on correspondent nodes (CN). MIPv6 uses the same concepts of home networks and home addresses as in MIPv4. Each MIPv6 mobile node has a home network and an IPv6 home address assigned to the MN within the network prefix of its home network. The MN's IPv6 home address does not have to change regardless of where the mobile is. A CN can always address packets to a MN's IPv6 home address. Mobile IPv6 ensures that a MN can receive the packets addressed to its home address regardless of where the mobile is [3].

In Mobile IPv6, any MN is identified by its home address regardless of its point of attachment to the Internet. When the MN is located away from the home network, it is associated with a care-of-address (CoA). The Mobile IPv6 protocol requires registration of care-of-addresses with a home agent (HA), thereby giving the home agent a mobile node's current attachment point to the Internet. The home agent then tunnels all the packets received for the mobile node to the node's present care-of-address. All correspondent nodes in Mobile lPv6 maintain a mapping of the mobile node's home address along with its current care-of-address. The mobile node is responsible for updating the mapping at the correspondent node by sending binding update messages whenever it receives tunnelled packets from the home agent.

The key benefit of Mobile IPv6 is that even though the MN changes locations and addresses, the existing connections through which the MN is communicating are maintained [2]. To accomplish this, connections to MNs are made with a specific address that is always assigned to the MN, and through which the MN is always reachable. Mobile IPv6 provides Transport layer connection survivability when a node moves from one link to another by performing address maintenance for MNs at the Internet layer.

The mobility of a mobile node can be divided into two types [4]: macro mobility and micro mobility. Macro mobility deals with inter-domain mobility, the movement of a mobile node across different administrative domains or geographical regions. Micro or local mobility deals with intra-domain mobility, the movement of a mobile node within a single domain or region.

Though MobileIPv6 offers a simple and scalable scheme for macro mobility, it suffers from significant network overhead in increased delay, packet loss and signaling costs if a mobile node frequently changes its point of attachment to a network within the same administrative domain. The cause of this overhead is the delay in completing the registration with the home agent. Micro mobility protocols are designed to solve this problem associated with micro mobility patterns.

1.2. MICRO MOBILITY PROTOCOLS

The purpose of micro mobility protocols is to minimize signaling load and handoff latency for local domain handoffs. Depending on the way they handle the mobile node in the local domain, micro mobility protocols are divided into two types [4].

1) Tunnel-Based Protocols:
   In these protocols, normal IP routing will be used to transmit packets to the mobile node. To allow this a few specialized nodes (mobility agents) store the information related to the mobile node's current access router. Packets are tunneled from the mobility agent to the mobile node. Such protocols include Hierarchical Mobile IPv6, Mobile lPv6 Regional Registrations and Fast Handovers for Mobile IPv6.
2) Per Host Forwarding Schemes:
   In these protocols a new routing protocol will be introduced and used in all access routers. These protocols dynamically track each mobile node as it moves from one access router to another, using forwarding entries in appropriate routers at each handover. Such protocols include Cellular IPv6 and HAWAII.

1.3. FAST HANDOVERS FOR MOBILE IPV6 (FMIPV6)

From micro mobility protocols, Fast Handover for Mobile IPv6 has been chosen in this research to study and investigate. In Fast Handovers for Mobile IPv6 [5], the mobile node configures a new CoA before it moves towards a new access router so it can use its new CoA immediately after its connection to the new access router. If this anticipated registration fails, the mobile node performs the traditional handoff process. Moreover, fast handover establishes a packet forwarding system between the old and the new access router.

Acquiring a new CoA involves the anticipation of a handover. This anticipation can be made from the exchanged messages at the physical level or simply by receiving relevant information from level 2. The objective is to carry out the handoff at level 3 before that at layer 2 is completed [6]. The handover process consists of 3 phases: handover initiation, tunnel establishment and packet forwarding. The handover can be initiated either by the mobile node or by the network. In network initiated handover, the old access router receives an indication that the mobile node is about to move and receives information about the new access router to which the mobile node will be moved. In mobile node initiated handover, the information will be sent to the mobile node from the L2 events or from the policy rules.

In a mobile node initiated handover, the mobile node sends a Router Solicitation for Proxy (RtSolPr) message to its access router. In response, the access router sends a Proxy Router Advertisement (PrRtAdv) message. The mobile node formulates a new prospective CoA (NCoA) and sends a Fast Binding Update (FBU) message. The purpose of the FBU is to authorise the current/previous access router

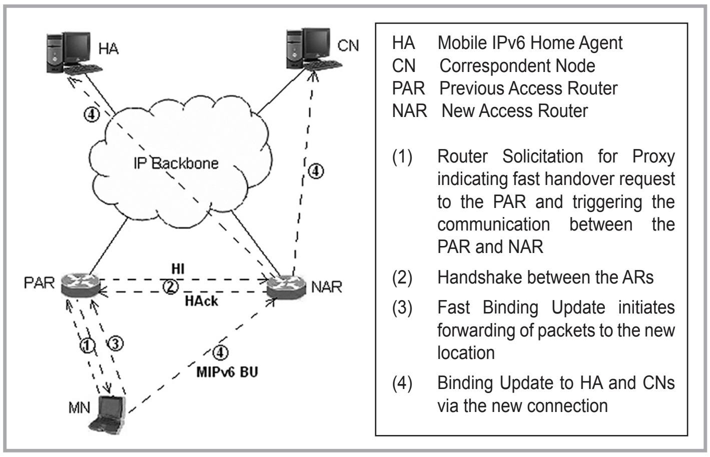

Figure 1: FMIPv6 handover process

(PAR) to bind previous CoA (PCoA) to NCoA, so that arriving packets can be tunneled to the new location. Upon receiving FBU, PAR verifies if NCoA is acceptable to NAR through the exchange of Handover initiate (HI) and Handover Acknowledge (HAck) messages. Then PAR sends back the Fast Binding acknowledgment (FBack) message to the mobile node. This means that packet tunneling would already be in progress by the time the mobile node hands over to NAR. The mobile node announces its attachment after performing handoff through a Fast Neighbor Advertisement (FNA) message and starts using NCoA.

In a network initiated handover, the PAR sends an unsolicited PrRtAdv containing the link address, IP address and subnet prefixes of the NAR when the network decides that a handover is imminent. The mobile node processes this PrRtAdv to configure a new care of address on the new subnet, and sends an FBU to PAR prior to switching to the new link. The mobile node encapsulates the FBU in the FNA while sending the FBU. After receiving the FBU, the PAR forwards the packets to the mobile node on its current link. Figure 1 shows FMIPv6 Handover process.

2. RELATED WORKS

Several mechanisms have been proposed to enhance the handoff performance of Mobile IPv6. Hierarchical architecture in [7] aims to reduce the registration time between mobile nodes and home agents. Hierarchical Mobile IPv6 minimises the registration delay of mobility by handling local movements locally and hiding them from home agents. A Mobility Anchor Point (MAP), a new mobile IPv6 node, is used to maintain the binding with the MN. MAP replaces Mobile IPv4's foreign agent, and works as a local home agent for MNs. A MN is assigned with two care-of-addresses, called Regional Care-of-Address (RCoA) and On-Link Care-of-Address (LCoA). RCoA is an address on MAP's sub-network; it is used by the mobile node as care-of-address during registration. LCoA is same as the care-of-address in the Mobile IPv6. While moving between subnets inside the MAP's domain, MN only change its LCoA. This hides the movements from its home agent. The hierarchical Mobile IPv6 is an enhancement of Mobile IPv6. Although it reduces the amount of signalling required and improves handover speed for mobile connections, hierarchical mobile IPv6 doesn't minimise the handover latency that MIPv6 suffered.

An enhanced buffer management scheme was proposed for fast handover to improve the buffer utilization on routers as well as to support QoS services during a handoff process[8]. They combine Hierarchical architecture and fast handover mechanism to reduce the handoff latency caused by network layer handoff. To achieve seamless connectivity for mobile nodes during their movement, they include an efficient buffer management mechanism in fast handover protocol.

The security in fast handover was discussed in [9] by proposing signalling localisation to increase performance of Internet connectivity using context transfer management[9]. This mechanism shows that fast handovers with context transfer at the network layer can support uninterrupted voice over IP (VoIP).

3. STUDY FOCUS

Although, Mobile IPv6 maintains the existing connections of MN after it changes its locations and addresses, it suffers from problems with fast moving hosts. This research aims to study the effect of transferring data during MN's movement on the performance of fast handover, and compare it with the performance of MIPv6. The study was carried out using an open source Network Simulator ns-2 [10] to study and analyse the behaviour of fast

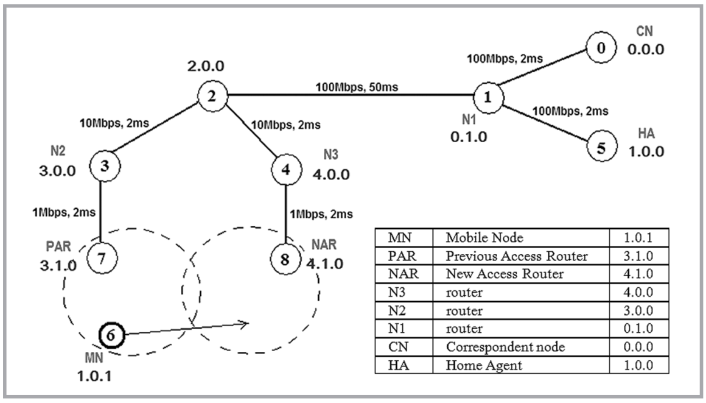

Figure 2: Network topology with hierarchical addresses of the nodes

Table 1: Simulation information

Node configuration			
Number of wireless nodes	4 (1 mobile node & 3 (wired + wireless))		
Number of wired nodes	5		
Address type	Hierarchical routing		
Placement of Nodes			
Node	**X**	**Y**	
CN	80.0	5.0	
N1	120.0	10.0	
HA	160.0	5.0	
MN	160.0	5.1	
N4	120.0	15.0	
N3	155.0	60.0	
N2	85.0	60.0	
PAR	85.0	135.0	
NAR	155.0	135.0	
Links setup			
Location	**Bandwidth**	**Delay**	**Queue type**
PAR → N2	1Mbps	2ms	Drop tail
NAR → N3	1Mbps	2ms	Drop tail
N2 → router	10Mbps	2ms	RED
N3 → router	10Mbps	2ms	RED
router → N1	100Mbps	50ms	RED
N1 → CN	100Mbps	2ms	RED
N1 → HA	100Mbps	2ms	RED
Type	**Duplex link**		
Simulation settings			
Start time	0s		
Stop time	80s		
Type of traffics	TCP		
TCP packet size	512 bytes		
TCP interval	0.05s		
TCP window size	32		

handover and Mobile IPv6 protocols based on some parameters such as throughput, and handoff latency.

4. SIMULATION AND ANALYSIS

A study of performance analysis of MIPv6 has been conducted in order to show the problems faced in MIPv6 handoff especially in term of handover latency. So, these drawbacks can be solved. The simulation was done using Network Simulator NS2.31 with FHMIP extension [11] for fast handover and MobiWan patch [12] for MIPv6. A small network topology is created as shown in Figure 2.

The scenario consists of one mobile node, two base stations, four routers, one home agent, and a corresponding node. The types of traffics used are TCP traffics. The link characteristics namely the bandwidth (megabits/s) and the delay (milliseconds), are shown beside the wired link. In this topology, nodes CN, N1, N2, and N3 are wired nodes, while nodes PAR, NAR, and HA are (wireless + wired) nodes. As a final node, MN is a special node which is a wireless node (i.e. a NOAH node with wired-routing turned off). More information about the simulation parameters are shown in Table 1.

Some parameters are calculated using the trace file obtained, such as handoff latency and throughput of receiving packets.

4.1 HANDOVER LATENCY

The handover latency has been measured as the interval between the last packet received through the previous access router and the first packet received through the new access router. However, from the simulation of MIPv6, see Figure 3, which takes a time of 80 seconds, the mobile node received the last data packet (pkt 238) at 31.91s, through the access router before it moved to a new access router. After connecting to a new access router, the mobile node received its first data packet (pkt 239) through this router at 32.96s. So, Handover latency = 32.96 – 31.91 = 1.05 second

Packet ID	Time (sec)	
0	20.003	
.....	.....	
237	31.85	
238	31.91	Last data packet (in PAR)
239	32.96	First data packet (in NAR)
240	32.00	
.....	.....	

Figure 3: Handover latency in mobile IPv6

For FMIPv6, the MN handoff occurs when the last data packet (pkt 6072) is received at 41.23s through the previous access router before it moved to a new access router. After connecting to a new access router, the mobile node received its first data packet (pkt 6073) through this router at 41.25s. So, Handover latency = 41.25 – 41.23= 0.02 second.

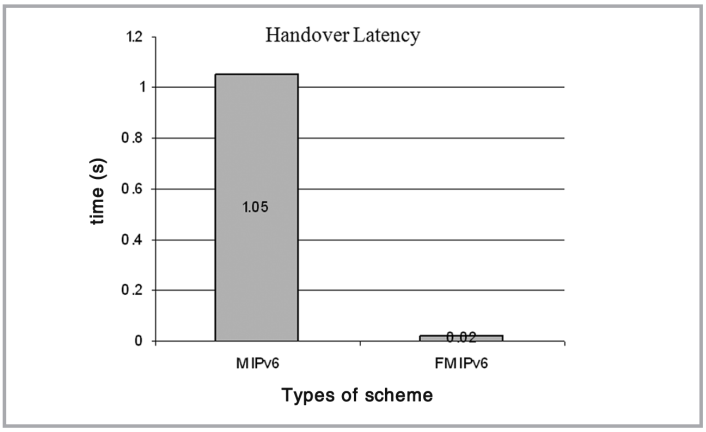

Figure 4: Handover latencies of MIPv6 and FMIPv6

As seen from the calculations, the handover latency in MIPv6 is considered very high because the mobile node requires long time to sends and receives IPv6 datagrams when it enters a foreign domain. While in case of FMIPv6, the handover latency is lower than MIPv6 and consider sufficient for real-time applications environment. Handover latencies of MIPv6 and FMIPv6 are illustrated in Figure 4.

4.2 THROUGHPUT

Throughput is defined as total packets transmitted divided by the total transmitted packets excluding the control packets. Throughput of MIPv6 and FMIPv6 are shown in Figures 5 and 6, respectively. From Figure 5, it can be seen that the throughput of receiving packets in Mobile IPv6 is approximately 85 and it is vibrated around this value. On the other hand, Figure 6 presents the throughput of receiving packets in FMIPv6. Obviously the high amount of the throughput is clear compared to that of Mobile IPv6; it reaches to about 250 with a fall to 120 when the handover occurred at 41s.

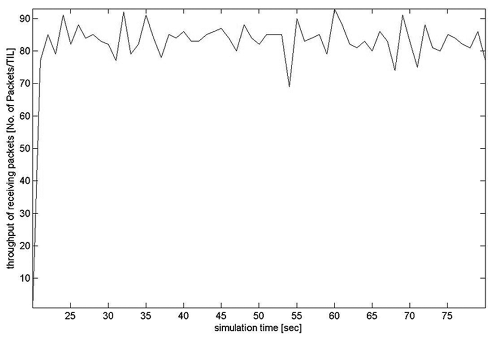

Figure 5: Throughput of receiving packets in MIPv6

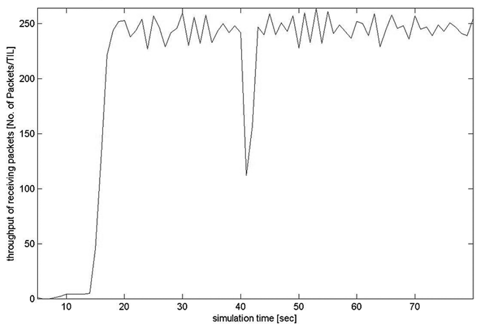

Figure 6: Throughput of receiving packets in FMIPv6

5. CONCLUSIONS

Throughput is defined as total packets transmitted divided by the total transmitted packets excluding the control packets. Throughput of MIPv6 and FMIPv6 are shown in Figures 5 and 6, respectively. From Figure 5, it can be seen that the throughput of receiving packets in Mobile IPv6 is approximately 85 and it is vibrated around this value. On the other hand, Figure 6 presents the throughput of receiving packets in FMIPv6. Obviously the high amount of the throughput is clear compared to that of Mobile IPv6; it reaches to about 250 with a fall to 120 when the handover occurred at 41s. ■

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PROFILES

ENGR. SHAYMA SINAN

Shayma Senan is currently a MSc. Student at Electrical, Electronics and System Engineering Department, Universiti Kebangsaan Malaysia. She received the B.Sc. (Hons.) degree in Computer and Information Engineering from International Islamic University, Malaysia in 2004. Her research interests include Mobile IPv6, mobile communication and wireless networking. She attended and participated in many conferences, workshops and activities in fields of IPv6 and communication.

ENGR. MAHAMOD ISMAIL

Mahamod Ismail is currently an Associate Professor with the Department of Electrical, Electronics and System Engineering, Universiti Kebangsaan Malaysia. He received the B.Sc. (Hons) degree in Electrical and Electronics from University of Strathclyde, U.K. in 1985, the M.Sc. degree in Communication Engineering and Digital Electronics from UMIST, Manchester U.K. in 1987, and the Ph.D. (Mobile and Personal Communication) from University of Bradford, U.K. in 1996. He was with first Malaysia microsatellite team building Tiungsat-1 in Surrey Satellite Technology Ltd. (SSTL) in Surrey, U.K. from June 1997 to March 1998. He also becomes Guest Professor in Computer Engineering with Gerhad Mercator Universitat Duisburg in Summer Semester 2002. His research interests include mobile communication and wireless networking. He served as the chapter chair of IEEE Communication Society, Malaysia in 2003-2004 and currently holding IEEE Educational Activities portfolio. He is the author of about 100 scientific publications including book chapters, international journal and conference papers.

ENGR. KASMIRAN JUMARI

Kasmiran Jumari is currently a Professor at the Department of Electrical, Electronic and Systems Engineering, and a Director of Computer Center at Universiti Kebangsaan Malaysia. He received his BSc. (Hons) degree from Universiti Kebangsaan Malaysia in 1976, the MSc from University of Aberdeen in 1977, and the PhD from University of Kent, UK in 1985. He served as a head of Dep. of Electrical, Electronics and System Engineering at UKM from November 1985 to March 1991, and a Deputy Dean in Engineering Faculty from November 1992 to April 1995. His research interests include Applications of Image Processing in Surveillance Systems and Implementation of Distributed Internet Security. He is the author of more than 100 scientific publications including book chapters, international journals and conference papers.