Enhancement of FMIPv6 by Utilising Concurent Binding Update Process

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***Abstract*— The world is progressing toward the Mobile Internet Protocol Television (MIPTV) era where people are able to watch television while roaming. The MIPTV technology requires high bandwidth and low latency handover. This paper enhances the binding updates process in the Fast Handover Mobile IPv6 (FMIPv6) to improve its handover process performance in term of secureness and robustness, by implementing concurant binding update process thru the use of the International Mobile Subscriber Identifier (IMSI). Simulation results show that the proposed idea reduces the handover latency to about 63% compared to standard FMIPv6.**

***Keywords*—**

1. INTRODUCTION

According to [1] most of mobile multimedia (e.g.: Mobile IPTV) technical obstacles are related to the wireless links. To guarantee the mobile IPTV works normally, a minimum bandwidth of 2-3 Mbps needs to be provided due to the characteristic of the mobile IPTV services. The limitations of wireless technology itself become problems in efforts to porting the traditional IPTV features into the mobile format. The most challenging yet disturbing limitation is the handover process, which occurs when users do a movement from one area into another area. This process may disturb the reception of data and therefore it distresses the mobile IPTV users and produces undesired time improvidence.

Mobility in Internet Protocol version 6 (IPv6) is basic for upcoming services. Reducing the effect of handover potentially will reduce the data loss possibility and decrease the latency time.

Current protocols such as Fast Handover Mobile IPv6 (FMIPv6), Proxy Mobile IPv6 (PMIPv6), and Hierarchical Mobile IPv6 Mobility Management (HMIPv6), use the MAC address for authentication in their binding update processess to perform Duplicate Address Detection (DAD) process. In this process, the home agent binding update and corresponding node binding update process have to be done sequentialy. This work proposes the use of the International Mobile Subscriber Identity (IMSI) for the authentication process, as such we can perform the binding update processes concurently as shown in Figure 1.

This paper is organised as follows. Section 2 provides related works on handover protocols in mobile IPv6. Section 3 discusses the detail of the proposed enhancement of FMIPv6. Section 4 presents the experiment set up, results along with discussion. We conclude the paper in Section 5.

2. RELATED WORKS

MIPv6 defines an IP-layer mobility management scheme to provide Mobile Nodes (MN) with continuous Internet access while they move from one domain of Access Point (AP) to another. This process of changing AP is called as handover. During this process the MN may be unable to neither send nor receive packets due to the delay of the handover process [2].

MIPv6 [3] consists of four entities: the Home Agent (HA), Mobile Node (MN), Correspondent Node (CN) and Access Router (AR). HA function is to assign MN a home address which serves as home origin identification. All data from CN is routed to MN via HA if MN still in HA area, but when MN roams to foreign area then the Foreign Agent (FA) is responsible to route the data from CN. However, the MN has to be authenticated first before receiving a temporary address called Care of Address (CoA) provided by the FA.

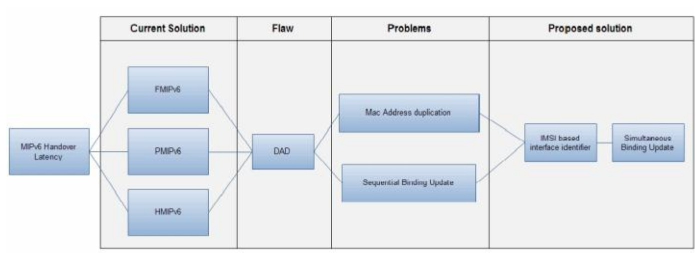

Fig.1 Schematic diagram of the proposed enhancement

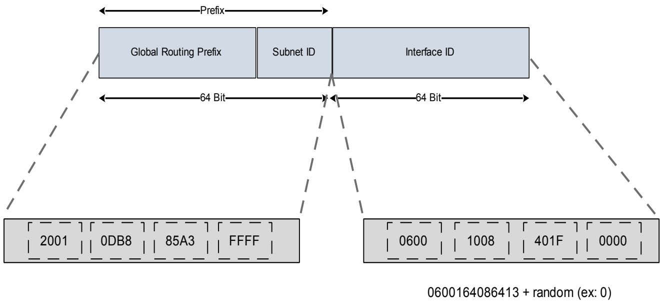

Fig.2 Creation of Care of Address using IMSI [7].

FMIPv6 proposed by [4]and [5] uses an approach to reduce the handover latency by managing the movement detection and early handover signaling. FMIPv6 uses the PAR (Previous Access Router) and the NAR (New Access Router) to connect nodes. The PAR is a node where MN is currently attached. Before performing a handover process CN sends packets to MN through the PAR node and vice versa. Once MN requestsa handover, the PAR node creates a tunnel to the NAR in order to send the current packets from CN, and NAR buffers the packets temporarily until the MN is completely attached to the NAR.

The International Mobile Subscriber Identifier (IMSI).is a unique identification number that is linked with the Global System for Mobile communications (GSM) and the Universal Mobile Telecommunication System (UMTS) network. IMSI is stored as a 64 bit in the S**ubscriber** Identity Module (SIM) and usually has 15 digits length, but it is possible to use shorter length [6]. In this paper, the Care-of Address (CoA) is formed by using [AP-ID, AP-INFO] tuple which the AP-ID part is given by Proxy Router Advertisement (PrRtAdv) and the AP-INFO part is generated by the IMSI. This model assures the Interface ID's uniqueness [7] (see Figure 2).

3. THE ENHANCEMENT OF FMIPV6

The proposed enhancement shows in Figure 3 modifies the FMIPv6 operation during handover by sending concurently the Fast Binding Update (FBU) messages from MN to both HA and CN. Furthermore, the FBU message will be processed at nearly same time at HA and CN. As soon as MN receives the beacon from the NAR, the MN sends the Router Solicitation to PAR and waits for Router Advertisement from PAR. After receiving the packet, MN sends the FBU packet to the PAR containing an interface ID generated from the IMSI number and a random number.

The FBU packet was forwarded to the HA in order to produce an early Binding Update for HA. The Binding Update process in CN can be done because at the time a FBU packet carries Home Test Initialization (HoTI) sent to HA, a Care of Test Initialization (CoTI) packet is sent from NAR to CN. As soon as the FBU packet is received by HA, it continues to forward again the packet to CN to process once more as Binding Update for CN Binding Update.

Having received the FBU message, the PAR sends a Handover Initiate (HI) NAR to start the FBU procedure. The FBU message contains the same message with the HI message that defined by FMIPv6. The PAR sends the acknowledgement packet called Handover Acknowledgement (HAck) to confirm the initiation process. Once the HAck packet received by the PAR, it will send the FBU acknowledgement packet to both NAR and MN and start forwarding the packet from CN to the NAR. In this step NAR buffers the packets, so once the MN has attached to the NAR it can be delivered. This step has to be done to avoid the data loss and to make sure that MN gets the exact packets. Immediately after the PAR receives Binding Acknowledge message from the CN, the PAR starts to receive packets from CN, and the NAR stops forwarding the packets. MN starts to receive the packet right after Unsolicited Network Advertisement received by the PAR.

The FBU can be used by both CN and HA to initiate the Binding Update process because this message includes the prospective NAR address, which is generated by the MN using the information provided by Router Advertisement message. This message has the same format of the ordinary Binding Update but provids different mobility option., so basically it can be used by CN to initiate the binding update process. The HA sends a Binding Update message to the CN based on the FBU. As a result the MN does not need to send the Binding Update message to CN. The registration time is considered as delay time. By processing this way the HA and the CN registration can be processed at the same time. Consequently, the delay time can be reduced.

By implementing the IMSI-based interface identifier forming method, the Duplicate Address Detection (DAD) process can be removed. Hence the overall handover latency can be reduced. The proposed enhancement modifies the mobile IPv6 header format for the FBU to carry a HoTI Message, and additional network advertisement packet sent to the NAR. The packet carried the CoTI packet will be forwarded to CN. As both HoTI and CoTI are received, CN can start the correspondent node Binding Update process. The modified FBU message contains Home Init Cookie.

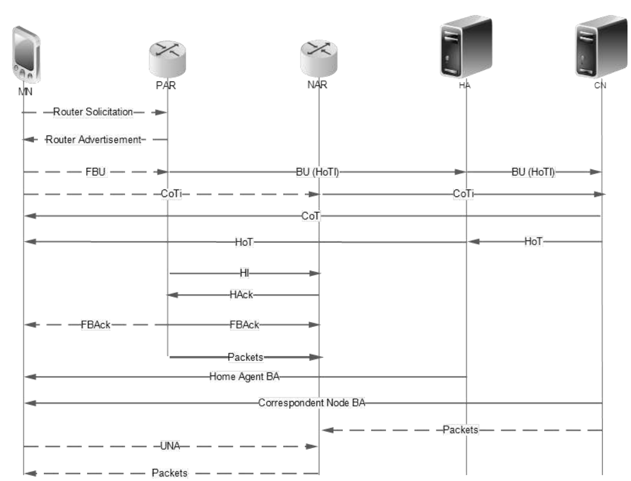

Fig.3 The Enhanced FMIPv6

4. EXPERIMENT AND RESULTS

We simulate both, the proposed enhancement and FMIPv6 using Omnet++ that has the ability in providing a real Mobile IPv6 environment [8]. We measure the dropped packet a well as the scalability of the processing time. The simulation topology consists of 3 ARs and 1 AP as HA, 2 servers as CNs, and 1 MN. The MN increases up to 30 for mass handover experiment. Table 1 shows the simulation paramenters.

4.1. Packet Drop

The packet drop may occur during the packet buffering in PAR. A neighbor discovery operation relating a neighbor's address resolution (i.e, Neighbor Solicitation and Neighbor Advertisement) usually result in considerable delay. We discover that the proposed enhancement and FMIPv6 have same packets drop rate of 6%. This fact shows that the capability to handle packet drop is as same as FMIPv6.

4.2. Processing Time Latency

Figure 4 shows the average of handover completion time of FMIPv6 and the enhanced FMIPv6. FMIPv6 requires longer time during the first handover, while the enhanched FMIPv6 takes the shortest time which is 1 sec on the 5^{th} and 12^{th} handover. The fact shows that the handover latency of the proposed enhanced FMIPv6 is stable and always below the latency of the MIPv6. The Latency mean of the enhanced FMIPv6 and the FMIPv6 is 1.00250018 sec and 1.59127012 sec, respectively. Meaning that the enhanced FMIPv6 reduces the latency by 37%.

Table 1. Omnet++ Simulation Parameters.

Entity	Parameter	Value
HA	IP address, SSID, Channel	10:AA::1:A0:1, HOME, 1
Access Router1	IP address, SSID, Channel	10:AA::1:A1:1, AP1, 2
Access Router2	IP address, SSID, Channel	10:AB::1:A2:2, AP2, 3
Access Router3	IP address, SSID, Channel	10:AE::1:A3:3, AP3, 4
MN	Speed, Mobility	1-20 mps, Rectangle, Turtle, RWP
CN1	IP address	10:FF::A1:FF
CN2	IP address	10:FF::A2:FF
General	Neighbor Discov min. interval	0.03 s
	Neighbor Discov max. interval	0.07 s
	Packet Size	100 – 1024 Kb

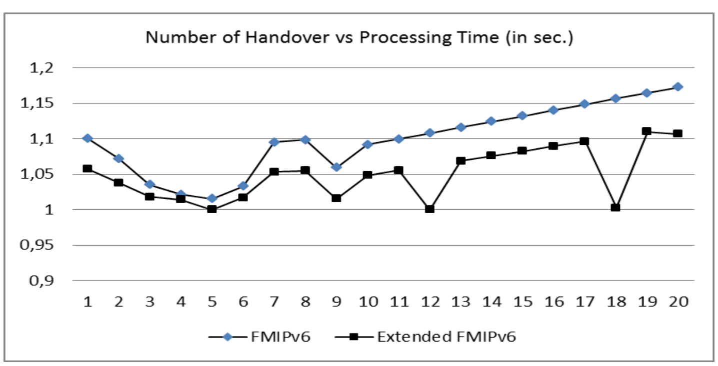

Fig.4 Processing time for various number of handover process in a router

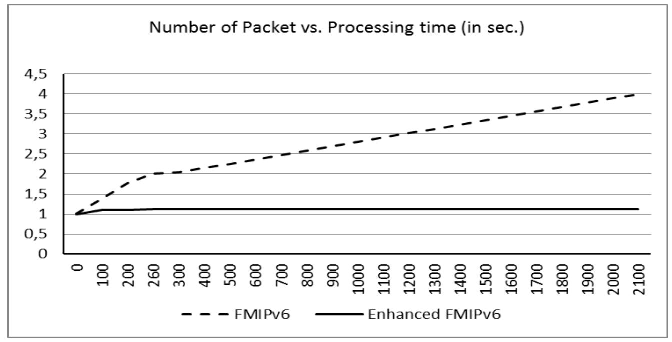

Fig.5 Mass handover latency.

4.3. Mass Handover Processing Time Comparison

To compare the performance of enhanced FMIPv6 and the FMIPv6 in term of mass handover latency and scalability, we have put a scenario where 10 MNs reques handover at the same time with different sizes of packets, then we measure the handover processing time (latency). Figure 5 shows the results that the enchanced FMIPv6 is scalable and produces a stable latency with increased number of packets.

5. CONCLUSION

We have an enhanced FMIPv6 by introducing a concurent HA and CN binding update processes. The handover latency is reduced to 63% of the FMIPv6 latency.

Further investigations on signal cost analysis and security of the proposed enhanced FMIPv6 are considered as our future works.

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