SM-IPTV: A Research on Optimized Handover Routing Architecture for Seamless Multimedia Convergence Service over Wireless Networks

Sung-Gyu Kim and Byungjoo Park*

Department of Multimedia Engineering, Hannam University
133 Ojeong-dong, Daeduk-gu, Daejeon, Korea
*sgkim@hnu.kr, bjpark@hnu.kr**
**Correspondent Author: Byungjoo Park* (bjpark@hnu.kr)*

Abstract

IPTV is convergence broadcasting and communication. Mobile devices used wireless network such as Smart Phone, Lap-top, PDA and etc. These days, IPTV and mobile devices users increased drastically and together with this, the technology development increases as well. Mobile IPTV technology issues to address enabling IPTV services to be efficiently applied on mobile devices. Handover mean is moving mobile device to other base station from present base station. Handover most happened in Mobile network. When performing handover, there is a long handover delay in standard Mobile IPv6. So, Standard MIPv6 has many problems such as Packet loss, out-of sequence and etc. In other words, wireless network should solve many problems to provide Service of good quality. In this paper, we proposed Handover scheme over standard Mobile IPv6. It can provide Service of good quality to users. Mobile IPTV technology issues to address enabling IPTV services to be efficiently applied on mobile devices.

Keywords: *IPTV, Mobile IPTV, MIPv6, Multimedia Packet Transmission*

1. Introduction

Mobile IPTV which provides IPTV to wireless terminal is an issue. It is led by IPTV that provides two-way service by amalgamating broadcasting and communication, technical progress of wireless terminals that use wireless network, and growing demands. Mobile IPTV is a service that grafts IPTV's bi-directional property onto Mobile terminals' roving property and it makes users can watch media contents they want anywhere and anytime.

Many home and abroad institutes are on study on Mobile IPTV service technology but many limitations that unavoidably occur from the wireless communication make their studies hard. When users travel sections that use totally different networks, it causes the gap of bandwidth. The gap and the incompleteness of hand-over technology lead the loss of packet and delayed date transmission. There are more problems related to different performances of different users' terminals to be improved to offer smooth services.

2. Related Works

2.1 MIPv6 (Mobile IPv6)

In MIPv6, MN (Mobile Node) starts communication with its own address, HoA (Home Address), in the Home Network. In other words, when MN is on Home link, it communicates with fixed node and MN its own HoA (Home). But when the MN moves, it cannot maintain communication with only HoA. It creates new temporary address, CoA (Care of Address), which shows the location of MN and maintain communication on the new link. CoA is automatically created by DAD after combining Router Prefix value of new area and the interface address of MN.

Figure 1 shows the standard process of MIPv6 handover. The MN moved to a new network informs the NAP (New Access Point) and NAR (New Access Router) of its moving, creates NCoA (New CoA) through DAD, registers its NCoA to HA (Home Agent) and CN (Correspondent Node) by BU (Binding Update) message, and receives packet. When MN's register to CN is completed, CN can send new MN packet without HA. This can solve triangle routing occurs in home network and reduce some of loss of packet. However, the standard MIPv6 needs long delayed time in a handover. MN in MIPv6 would not be able to receive packet temporarily and it would cause loss of packet. In the registering process of HA and CN the order of data can be mixed up and it would cause the reverse of packet order that transferred to MN.

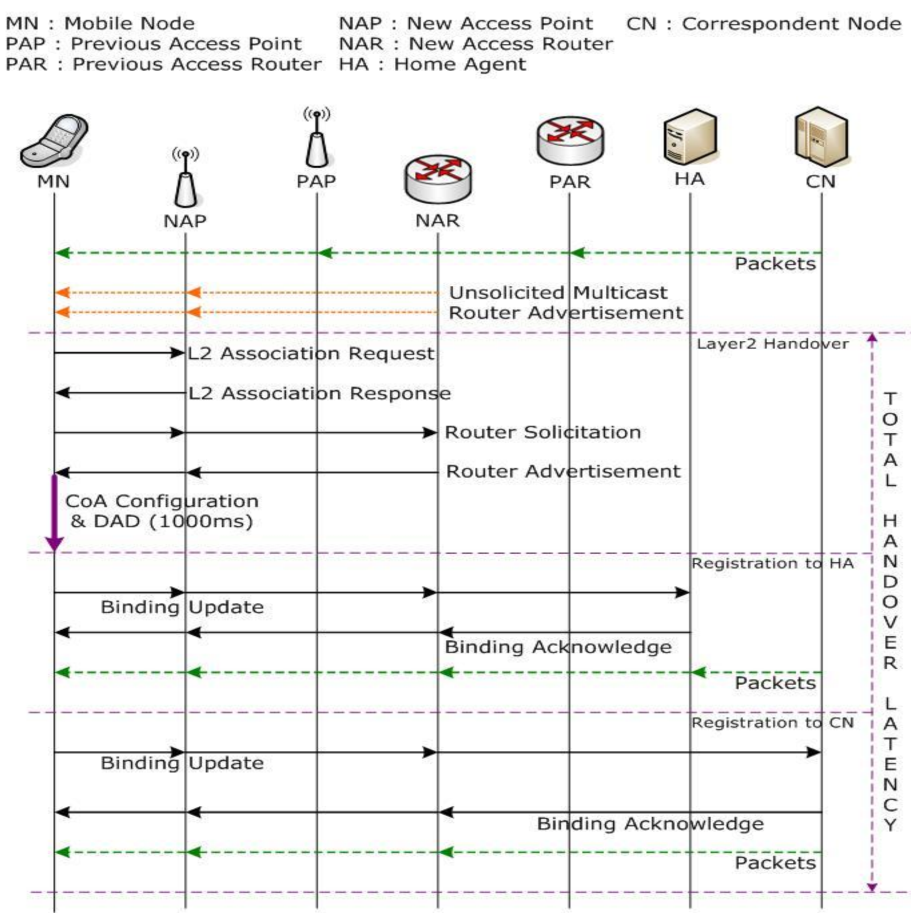

Figure 1. MIPv6 Handover Procedure

2.2 HMIPv6 (Hierarchical MIPv6)

MIPv6 should have the system of that MIN informs its present position to HA and CN by BU message with new certification process. But frequent MN moving to new network increases AR (Access Router)s and HA in the new area, and CN messages to be handled. HMIPv6 is suggested to solve these problems with MIPv6 by introducing the highest routing structure of its level structure that controls movements in its domain. So, the highest router of level structure, MAP (Mobility Anchor Point) handles the process of certification and registration caused by local movements. The information that MN and MAP are standard in domain is saved in the Binding Cache of HA and CN. When the MN moves in MAP domain, HA and CN do not participate in MN movement.

HMIPv6 handles handover of MN by using two kinds of CoA, RCoA (Regional Care of Address) and LCoA (on-Link Care of Address). RCoA is the domain level CoA that is made of the Prefix base on the MAP domain, and LCoA is the link level CoA that is made of the Prefix base on the AR. It means that they are divided into LCoA, the address in the AR serve-net area which belongs to MAP and RCoA, the arrival address of MN's HA and CN. MAP intercepts the packet transferred to RCoA of MN from HA and CN and transfers LCoA of MN by tunneling.

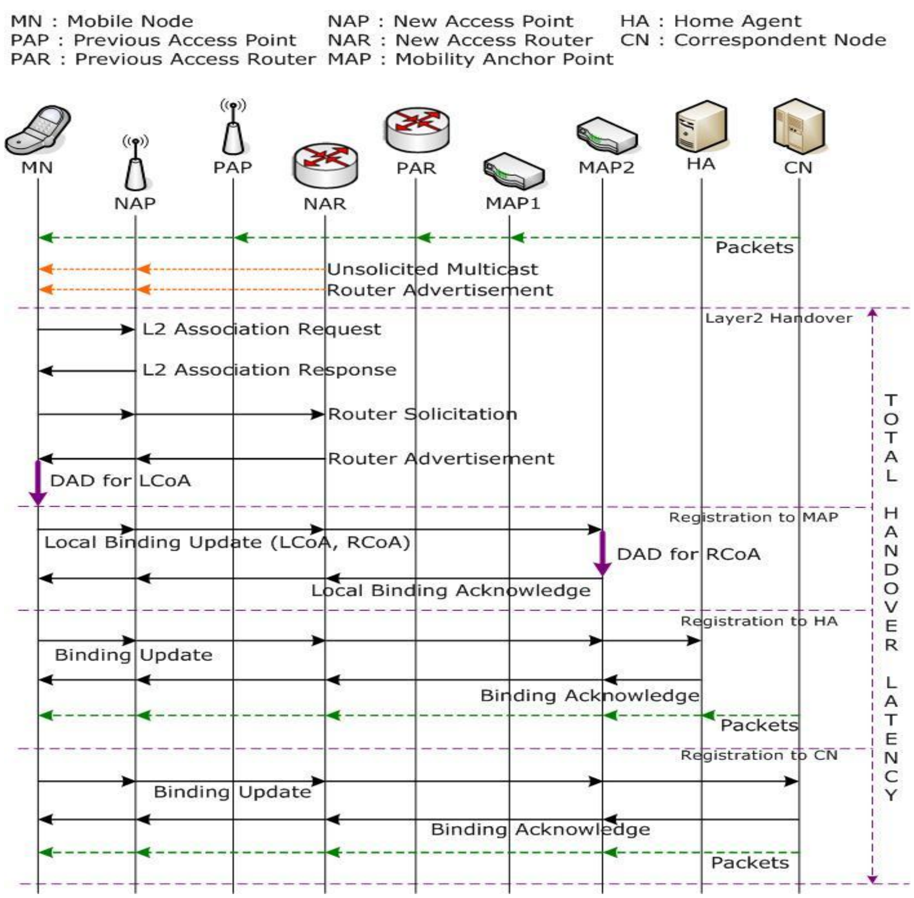

Figure 2. HMIPv6 Handover Procedure

2.3 HMIPv6 handover Processing Procedure

Figure 2 is hand-over handling process in HMIPv6. MN moved to new MAP domain receives RA (Router Advertisement) messages from new AR. It creates new LCoA based on the Prefix of AR and performs DAD of MN and LCoA process. When MN moves in the same MAP area, LCoA is also recreated newly. And it creates new RCoA based on the Prefix of MAP that is included in MAP option of RA message. Until MN moves to another MAP domain, RCoA is not changed. MN send LBU (Local Binding Update) message to MAP. LBU message includes two newly created addresses of RCoA and LCoA. MAP that received LBU message performs DAD investigation into RCoA address. MAP confirms that the RCoA address of MN is the only one in domain saves two addresses of MIN in its Binding Cache. And then MAP intercepts the packets arriving RCoA of MN, and transfers them to LCoA of MN by tunneling. At this time, MAP uses PNA (Proxy Neighbor Advertisement) message. After saving RCoA and LCoA of MIN to in Binding Cache of MAP, MN send BU message including HoA and RCoA to HA to register the position of HA and MN. After saving HoA and RCoA of MN, HA send Binding Acknowledgement message to MIN in response to MN, when the arrival address of MN is RCoA. MAP intercepts packets transferred from HA to MN, tunneling them to LCoA of MIN and transfers packets. After MN informs HA of its current location and completes all the registration process, MN registers the location to CN abd finishes all the hand over process. HMIPv6 reduced hand over delay time by decreasing signaling for moving MN in the same MAP domain through network level structure.

3. Proposed SM-IPTV (Strengthen Mobile-IPTV)

3.1 New add on messages

3.1.1 NIM (Neighbor Information Message): Each the adjacent ARs connected by wire use NIM message and interchange its own information at regular distance. In the switched information, MN's data handled by each AR is included in it. The switched data is temporarily saved to buffer installed to each AR and renewed periodically.

3.1.2 RNM (Router Notifying Message):

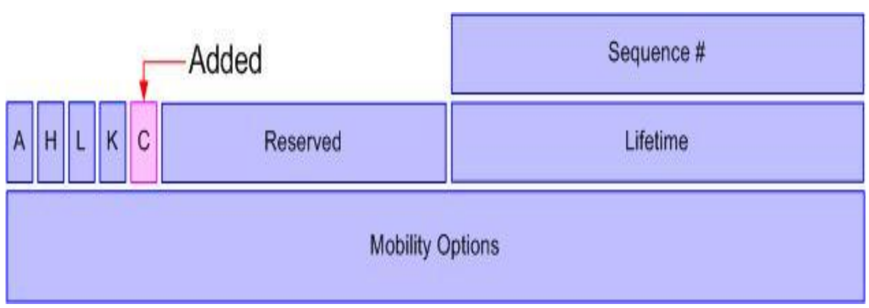

Figure 3. Concise Binding Update Message

3.1.3 CBU (Concise Binding Update): CBU message is that HA instead of MN offers NCoA of MN to H/E, and figure 3 is the form of CBU message suggested in the thesis. It can arrange BU messages through Sequence fields in time sequencing. Lifetime composed of 16bits shows how long NCoA should be linked. Maximum value is 262.140 seconds. when MN doesn't change NCoA, it should be updated if the Lifetime goes by. A ‘A’ bit is established when MN needs to be confirmed about whether or not the BU message is received. 'H'bit will set up when it is judged that a receiving node is HA. When 'L' bit is configured, it means to provide additional information necessary to MN's address-setting. Although CoA is changed, if 'K' is configured, MN can maintain a security connection continually. As 'C' bit is an added bit in this paper, it is configured if received node is judged as a H/E.

3.1.4 CBA (Concise Binding Acknowledge):

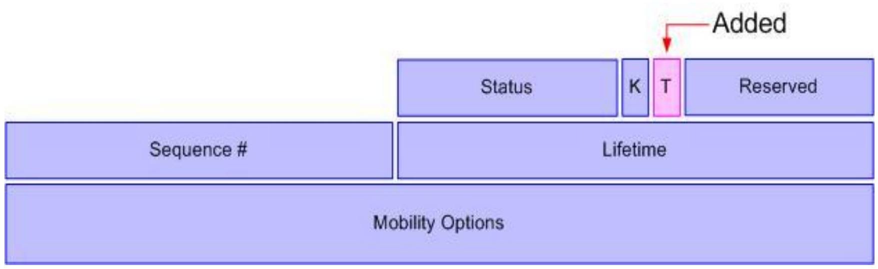

Figure 4. Concise Binding Acknowledge Message

CBA message is a responding message of CBU, and figure 4 shows the form of CBA message. As Binding Acknowlege(BA) is a responding message of BU, it informs the result for BU message. The result of BU message is appeared by Status field. If 'H' is configured as a 0, a protocol used to establish SA should be re-implemented. 'T' field is a bit to identify whether or not CBU message suggested in this thesis is able to be used.

3.2 Handover Processing Procedure

Figure 5 shows a hand-over processing sequence on SM-IPTV suggested in this thesis. Proposed method is that each of ARs contiguous with each other shares information periodically through NIM message, and it saves and renews to buffer temporarily. MN's data involved in each Router is included in NIM message. So, PAR and NAR know MN's information, located in mutual area, in advance regardless of MN's movement. If MN is moved to overlapping area of each of AR, it can detect its own movement. Before MN sensing the move transfers to new area, it transmits RNM message to PAR and informs to move to its own NAR. PAR which receives RNM message ceases the transmission of packet to MN and stores to a its buffer temporarily. MN moved to new area transmits L2 Association Request message to NAP and informs its movement to NAP, and then MN receives L2 Association Response message in response to it. After that, it sends Router Solicitation message to NAR and receives, Router Advertisement, response message, and then it gets the Prefix value of NAR. MN combines Prefix value of NAR and its own MAC address and creates NCoA, and then it judges an availability of NCoA performing a DAD process. When MN conducts a Layer2 Handover process, PAR transmits Tunneling Request message to NAR. A packet temporarily saved to its own buffer by tunnel is sent to NAR. NAR temporarily saves the packet, received from PAR, to its own buffer. MN which creates NCoA registers its own NCoA to HA through BU message. HA which receives BU message transmits CBU message to H/E. CBU message is that HA instead of MN registers NCoA to H/E. As H/E is a response message, it transmits CBACK message to HA, and HA which receives it responds to MN with BA message. If this process is finished, H/E transmits a packet, which sends to PAR, to NAR. NAR temporarily stores a packet, which comes from H/E, to buffer. If NAR transmits all packets, which is received from PAR, to MN, it sends packets, which comes from H/E, to MN. As PAR which transmitted all packets to NAR does not need to connect a tunnel any more, it cancels a tunnel by sending a DeTunneling message to NAR, and all hand-over procedure suggested in SM-IPTV is finished. SM-IPTV suggested in this thesis has restricted a protocol, which manages hand-over more effectively by improving the sharing information and tunneling of between each routers, the method of a binding updates.

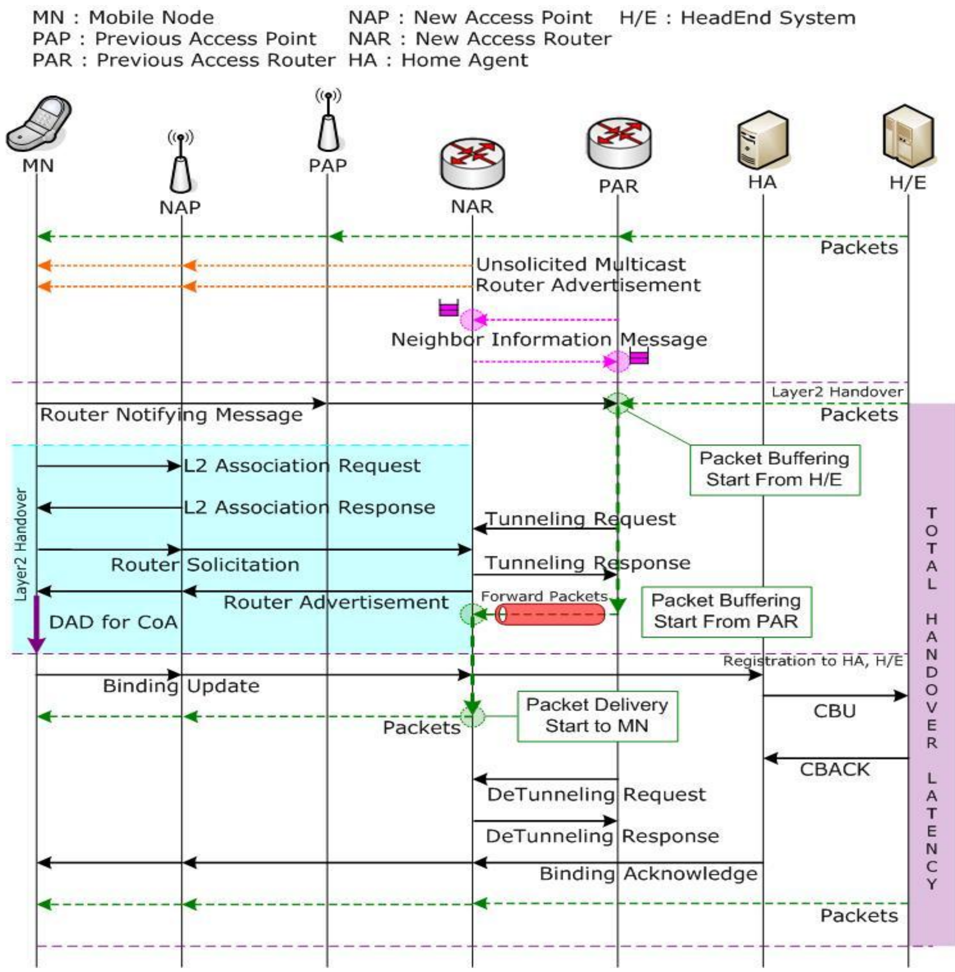

Figure 5. SM-IPTV Handover Procedure

4. Performance Analysis and Comparison

4.1 Total Handover Latency

An standard MIPv6 and HMIPv6 has been compared and analyzed with SM-IPTV suggested in this thesis for performance analysis. In case of an established MIPv6 and HMIPv6, it occurs the packet loss. So, there is a problem for MN that a missed packet should be retransmitted again. In case of SM-IPTV suggested in this thesis, it does not happen the packet loss through tunnelling so that it will not occur the delay for re-transmitting. When all hand-over delay time to compare with a performance analysis receives same number of packets, it is computed including the packet re-transmitting time to take the whole packets without loss. Also in the SM-IPTV, a signal associated with tunnelling which happens at the same time during processing Layer2 Handover is computed by a message which takes more long time.

Table 1 is to define a parameter for performance analysis. The message which arises when conducting a hand-over process is divided by section. Using the setting of table 1, T_{MIPv6} is an entire hand-over delay time of MIPv6, T_{HMIPv6} is an entire hand-over delay time of HMIPv6, and the entire hand-over delay time of SM-IPTV suggested in this thesis is defined as a $T_{SM\text{-}IPTV}$. β shows the re-transmission rate for happening packet loss.

Table 1. Performance Analysis Parameters

Symbol	Description	Value
t_1	MN ↔ AP	50ms
t_2	AP ↔ AR	40ms
t_3	AR ↔ AR, MAP	60ms
t_4	AR, MAP ↔ HA	50ms
t_5	AR, MAP ↔ CN, H/E	50ms
t_{CoA}	Form CoA	1000ms
α	Signal Weighting Factor	-
β	Packet re-transmission rate	-

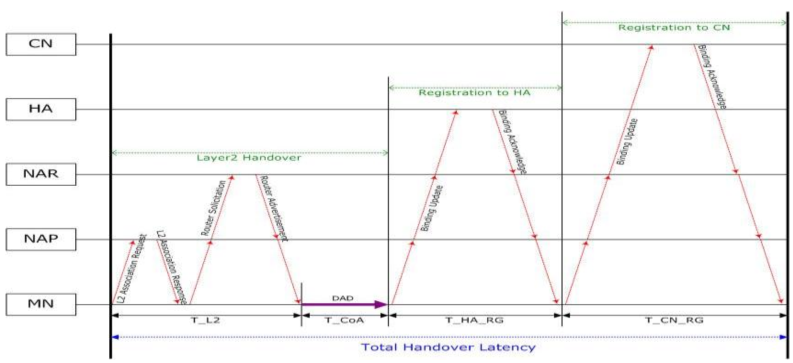

Figure 6. MIPv6 Time Diagram

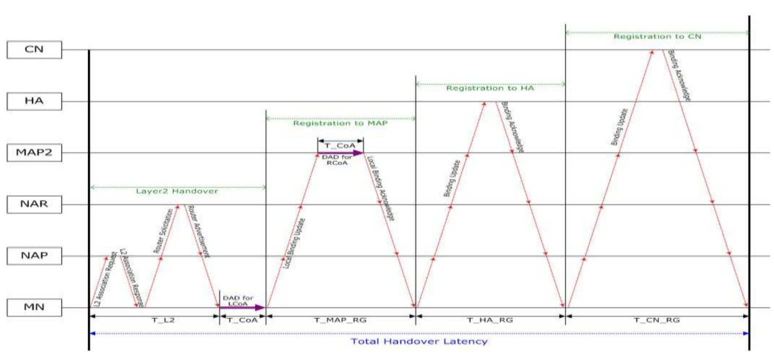

Figure 7. HMIPv6 Time Diagram

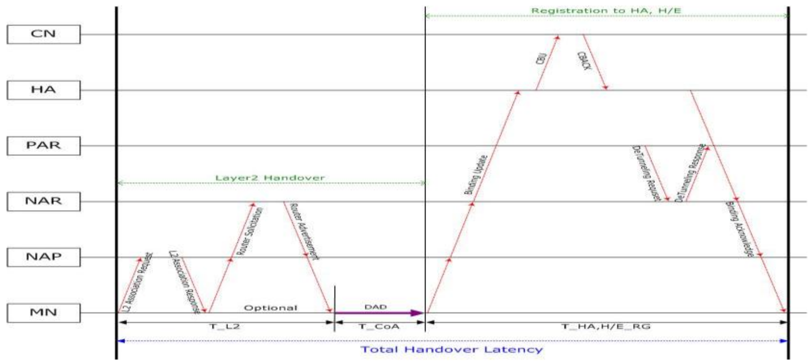

Figure 8. SM-IPTV Time Diagram

$$\mathbf{T_{MIPv6}} \quad \mathbf{(1)}$$
$$= \alpha_{T\_L2} + T_{CoA} + T_{\_HA\_RG} + T_{\_CN\_RG}$$
$$= \alpha(4t_1 + 2t_2) + t_{CoA} + 4t_1 + 4t_2 + 2t_4 + 2t_5 + \beta(t_1 + t_2 + t_5)$$

$$\mathbf{T_{HMIPv6}} \quad \mathbf{(2)}$$
$$= \alpha T_{\_L2} + T_{MAP\_RG} + 2T_{CoA} + T_{\_HA\_RG} + T_{\_CN\_RG}$$
$$= \alpha(4t_1 + 2t_2) + 2t_{CoA} + 6t_1 + 6t_2 + 6t_3 + 2t_4 + 2t_5 + \beta(t_1 + t_2 + t_3 + t_5)$$

$$\mathbf{T_{SM\text{-}IPTV}} \quad \mathbf{(3)}$$
$$= \alpha T_{\_L2} + T_{CoA} + T_{\_HA\_RG} + T_{\_H/E\_RG}$$
$$= \alpha(4t_1 + 2t_2) + t_{CoA} + 2(t_1 + t_2 + t_3 + t_4 + t_5)$$

Figure 6 shows the Time Diagram, a required process of when the hand-over is occurred in established MIPv6, and the expression 1 is its mathematization. Figure 7, when a hand-over is occurred on the established HMIPv6, is process. Shows a consuming process which is expressed to Time Diagram, and the formula 2 is its mathematization. Figure 8 is to show Time Diagram, which is a required process of when a hand-over is happened on SM-IPTV suggested in this thesis, and the expression 3 is its mathematization.

4.2 Total Handover Latency Analysis

Figure 9, when β is a fixed value in MIPv6, HMIPv6, and SM-IPTV suggested in this thesis, shows a change of the whole hand-over delay time according to an increase of α value. Figure 10 is a graph compared with a whole hand-over delay time according to an increase of β value when α is a fixed value. Figure 11 is a graph compared with a change of the whole hand-over delay time when the values of α, β are increased. If a hand-over is occurred in SM-IPTV suggested in this thesis, a packet transfer is achieved by tunneling of between AR, and thus a packet loss is not caused. Therefore, the time to retransmit for a lost packet is unnecessary. As a result, when a β value which shows re-transmission rate of packet loss in case of an established MIPv6, HMIPv6 is increased, the whole hand-over delay time is also as well. However in case of SM-IPTV suggested in this thesis, the whole hand-over delay time is not changed according to an increase of β value.

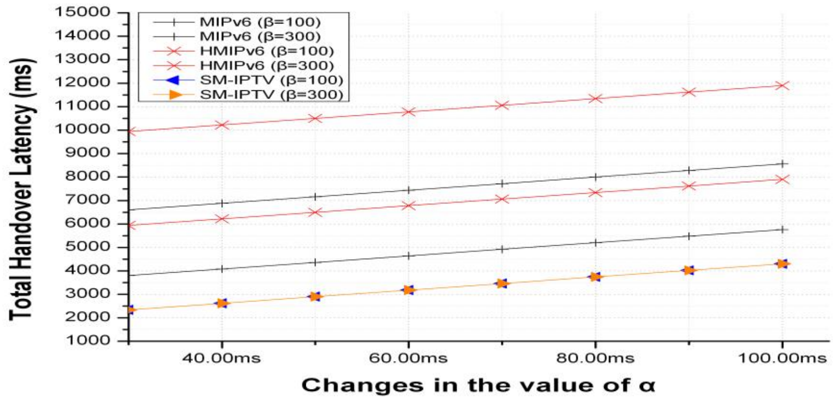

Figure 9. Comparison of α values based on increasing delay time

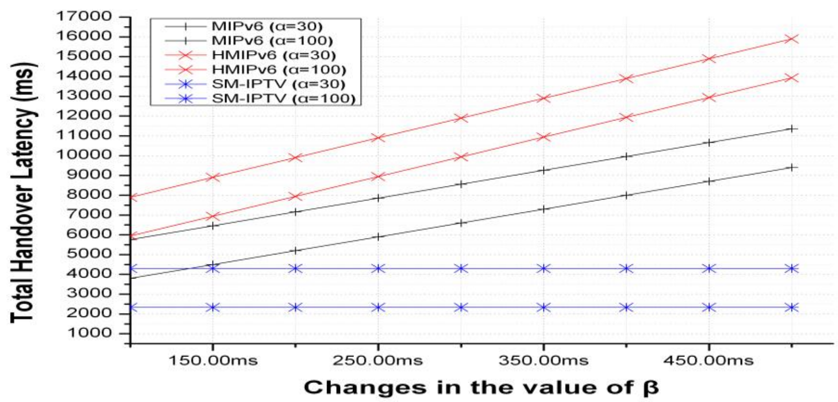

Figure 10. Comparison of β values based on increasing delay time

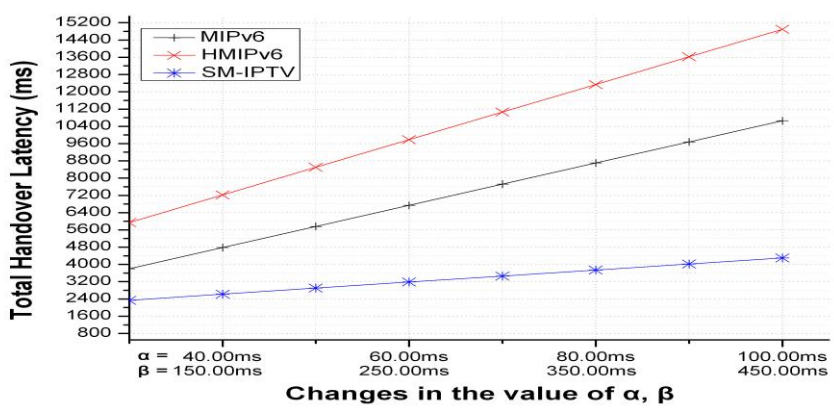

Figure 11. Comparison of α, β values based on increasing delay time

5. Conclusion

A hand-over structure which can provide more effective IPTV service than it based on the MIPv6 was studied and suggested in this thesis. But if the DAD time (1000ms) forming a large part of the whole hand-over delay time will be solved, it will be able to provide better service to all users. From now on these problems will be settled by continual studies.

Acknowledgements

This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (2010-0024401, 2011-0026286, 2012-0007273).

References

[1] D. Johnson, C. Perkins and J. Arkko, “Mobility Support in IPv6”, IETF RFC 6275, **(2011)** July.

[2] R. Koodli, Ed., “Fast Handover for Mobile Ipv6”, IETF RFC 4068, **(2005)** July.

[3] H. Soliman, C. Castelluccia, K. El Malki and L. Bellier, “Hierarchical Mobile IPv6 Mobility Management (HMIPv6)”, IETF RFC 4140, **(2005)** August.