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PBOP: A Design Methodology of Novel Network-based Mobility Management Architecture for Seamless Multimedia Services

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Abstract

PMIPv6 is a network-based mobility management protocol and plays roles for IP mobility management instead of the host. And the elements for IP mobility in a network are responsible for host mobility. This network basis is another approach to solve problems related with IP mobility. PMIPv6 can be seen as the extension of MIPv6 signaling and HA function because it performs mobility management for the mobile nodes connected to the network. However, since PMIPv6 conducts management for mobility as MAG takes MN's roles, frequent MAG transfers between networks induce packet loss and delay handover time. This article suggests how to treat high-speed handover support among access routers located within the same domain using the IAPP (Inter Access Point Protocol) and also how to support prompt and effective handover using the reverse binding mechanism.

Keywords: *Mobile IPv6, Proxy Mobile IPv6, IPv6, Reverse Binding Update, IAPP*

1. Introduction

Recently, users in the wireless internet environment have more and more needs, so internet environment for wireless transfers has also been developed gradually. However, the current IPv4-based address system started to exhibit its limitations regarding the increase of demand on terminals. And to solve this problem, IETF institutionalized IPv6, the next-generation internet protocol. As research on IPv6 has been actively conducted, they have constantly discussed how to standardize the resources of IPv6-based mobility. Nowadays, the representative IP mobility protocol standardized from IETF is MIPv6 (Mobile IPv6). Several institutions have been trying its realizations in many ways so far to increase the distribution of MIPv6, it has been difficult to distribute it widely due to its discontinuance of sessions resulted from its long handover delay, waste of wireless link resources, or mobile carriers' nonpreference for it. In order to solve this problem, a network mobility-based PMIPv6 (Proxy Mobile IPv6) is suggested. PMIPv6 is the one that extends the signaling messages between the nodes in MIPv6 and a home agent. Because it conducts mobility management for the mobile nodes connected to the network, PMIPv6 can be seen as the extension of MIPv6 signaling and HA function. This extension of function has allowed designing mobility support to be independent and has supported mobility within the network domain at the performance of handover; thus, it can treat the signal instead in the network not involved in any signal. However, the handover delay time resulted from frequent transfers between networks may affect the packet loss and network load. This article suggests how to reduce packet loss

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resulted from the frequent transfers between IAPP-based MAGs and also how to optimize routes promptly and efficiently through reverse binding.

2. Related Works

2.1. IAPP(Inter Access Point Protocol)

Handover delay time may differ by the types of handover, and during the handover, the moving terminal cannot give or receive any data. To realize this handover process, either the beacon or router advertisement should be realized diversely in the wireless network. In case of IEEE 802.11, the AP delivers a beacon frame advertisement message within the wireless LAN regularly, we can see whether the handover has started or not. In this way, the IAPP is focused on supporting the moving terminal's mobility. And it is intended to solve the problems like a disconnected link between the wireless APs previously connected before the occurrence of handover or the handover blank time taking place when it is attempted to be connected to a new AP with the function provided by the IAPP. When a new AP is found, the IAPP begins to search for a new AP around in order to switch it with another channel, and when it is found, it should re-authenticate the AP according to the prioritized order list. The process to treat the re-authentication for the AP involves the authentication including the information from the previous AP, and for the authentication, it is needed to ask for a responding message for the reconnection. In brief, the IAPP protocol is utilized for the process that the AP communicates mutually with the AP in the general distributed system, and it is advantageous in that it can reduce the amount of signaling that occurs whenever the moving terminal moves around. This communication system consists of the AP (Access Point), RADIUS (Remote Authentication Dial IN USER), and the server.

2.2. PMIPv6 (Proxy Mobile IPv6)

PMIPv6 is a network-based mobility management protocol. It has allowed network developers to design mobility support independently, and unlike MIPv6, it supports mobility within a network domain, so at the performance of handover, it can treat the signal in the network instead without any involvement in a signal.

Figure 1 presents the procedure of how the network-based mobility management protocol, PMIPv6, moves for handover. PMIPv6 has allowed designing mobility support to be independent, and unlike MIPv6, it supports mobility within a network domain, so at the performance of handover, it can treat the signal in the network instead without any involvement in a signal. The nodes having the function as a mobile IP client for that IP mobility help activate the function of PMIPv6 in a network, and the reuse of HA function supports the use of mobility signals. Despite such advantage of it, PMIPv6 may result in packet loss or error in route optimization due to the frequent transfers between networks.

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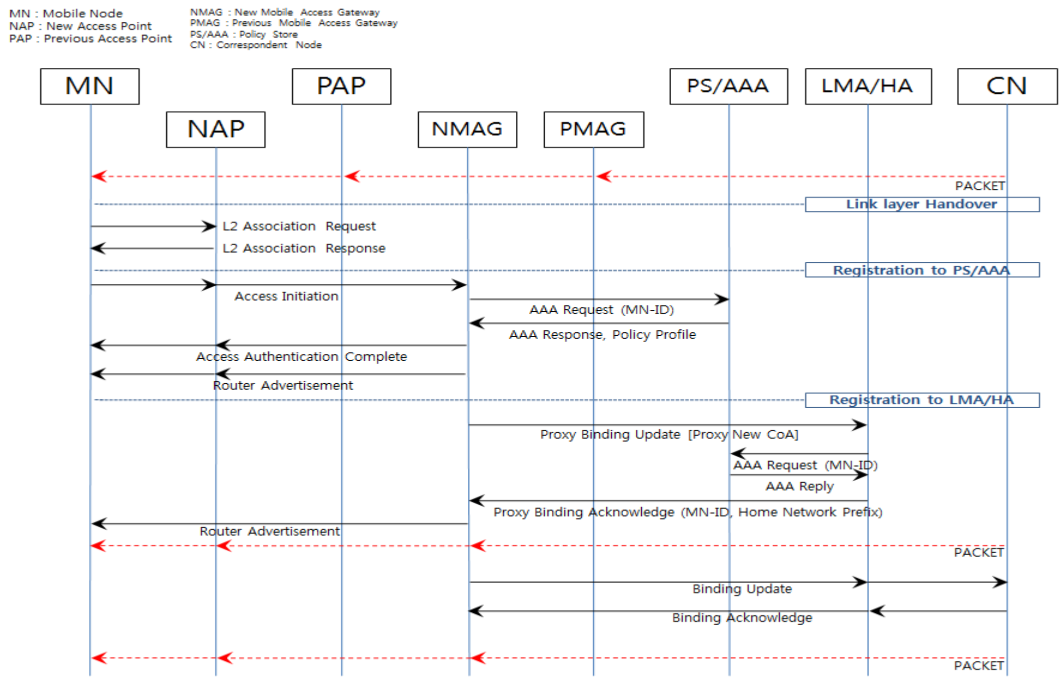

Figure 1. PMIPv6 Handover Procedure

3. Proposed PBOP-PMIPv6

3.1. Handover Processing Procedure

According to the PBOP-PMIPv6 procedure suggested in this article, the AP (Access Point) and the MAG (Mobile Access Gateway) should be able to use the IAPP (Internet Access Point Protocol) service and the MN should have a part that is overlapped within the same domain. Also, the beacon frame is one of the 802.11 management frames and allows the AP to conduct an advertisement regularly to the MN. Based on the regular advertisement messages, the MN performs the L2 (Layer) handover when the intensity of signals previously receiving the service gets weakened. At this time, the APs located at the wireless overlap use the IAPP Packet Message to send the MAG information and terminal information to the NAPs (New Access Points) around. The NAPs receiving this send the MN information to the MAG that each of them is connected to, and because the MAG receiving it must perform the PS (Policy Store) to the LMA address to provide the service for the terminal, it sends a requesting message to the AAA server and then acquires the profile information about the next terminal. This prior sharing of information between the APs allows the moving terminal to perform the handover promptly at the transfer.

Figure 2 shows PBOP-PMIPv6's handover procedure. The MAG presently detecting that it is being farther away from the link searches for the signals around from the beacon frame conducting transmission regularly at the AP, and while the handover is being done, the beacon message is buffered to the AP. Based on those signals, the MN sends the Access Initiation Message to the NMAG1 and performs the authentication process via AAA authentication. When the authentication is finished, it sends the MN the responding message to it and also transmits the PBU (Proxy Binding Update) Message to inform that the handover has taken place to the CN. The message contains necessary items corresponding to the

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Mobility Option. The CN receiving the PBU message sends the PBACK (Proxy Binding Acknowledge) Message to the NMAG1. The NMAG1 receiving the message sends the LMA the Fast Update Message from the PMAG in order to check whether the format of the message and registration of location between the NMAG1 and LMA conform to the PBU

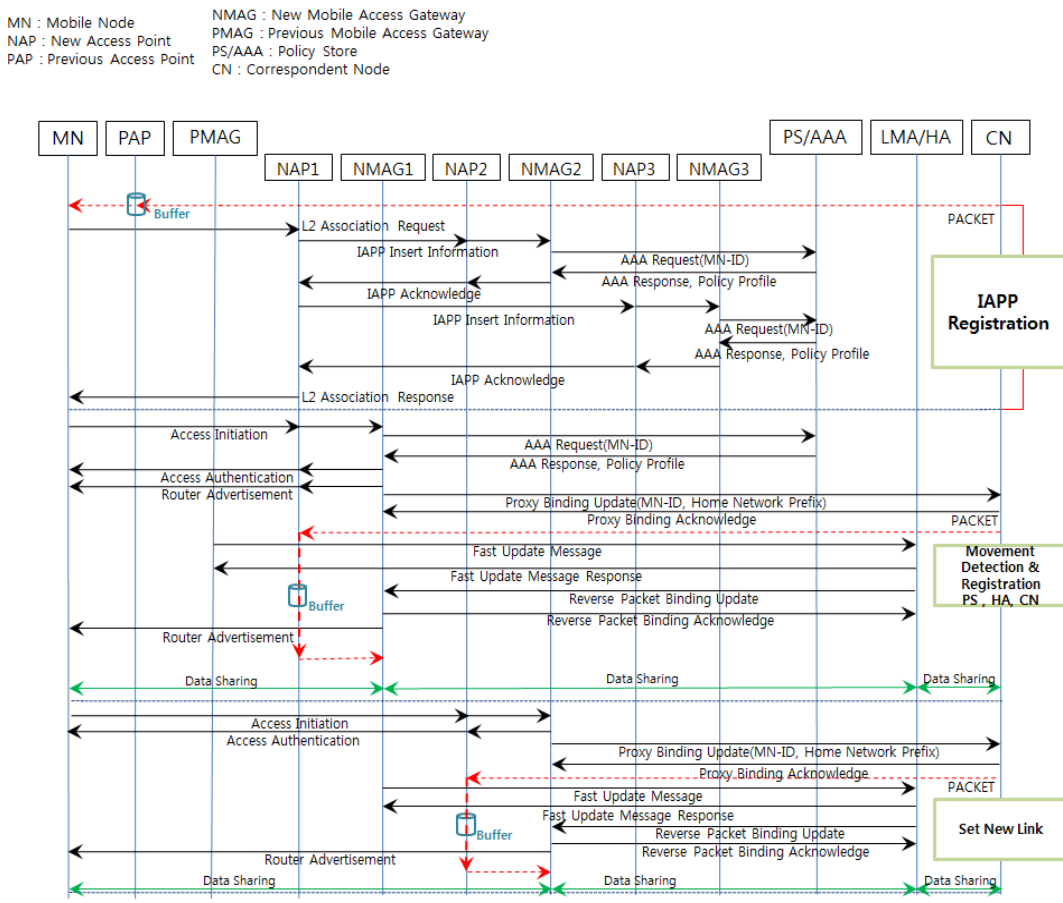

Figure 2. PBOP-PMIPv6 Handover Procedure

previously existing. Until this procedure is completed, the packet sent from CN to MN is buffered at the NAP1 and stored in the form of a queue. As a response to the packet received from the NMAG1, the Fast Update Message Response Message is sent to the PMAG, and at this time, if the mobile node is neither identified from the mobile node identifier option or does not exist, an option field is added to the Fast Update Message Response Message to block the message heading from MAG to LMA. The PMAG that has checked the responding message from the NMAG1 sends the Reverse Packet Binding Update Message to the NMAG1 in order to see if there is any error in security or renewal of location of a router where the handover takes place, and as a response to it, it sends the Reverse Packet Binding Acknowledge Message to the LMA. Sending the responding message to the LMA means that there is no error existing in the message. Once the RA (Router Advertisement) message is sent to the MN, a bidirectional tunnel between the NMAG1 and LMA is generated, so it is possible to perform data transmission reliably among the MN, NMAG1, and the CN. And with this, all the handover procedure is completed. Unless the format of the message

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corresponds to that of the previously existing PBU Message, the buffered message gets discarded. If the handover takes place via another router where the MN is overlapped, it can be omitted because the procedures to share data among NAPs through the IAPP and to conduct AAA authentication have been performed in advance. This can reduce the packet loss resulted from the frequent handover of moving terminals. And it is possible to identify the Sequence Number needed for the signaling message between MAGs through the IAPP that has been problematic in previous PMIPv6, which has realized more efficient handover.

4. Performance Analysis and Comparison

4.1. The Existing / Suggested Method's Time Diagram & Formula

This article has compared the handover delay time between the previously existing PMIPv6 and newly suggested PBOP-PMIPv6 in order to conduct performance comparison more effectively on the process procedure suggested here in his paper based on PMIPv6's handover procedure and description of problems regarding it. Also, this article has analyzed the handover delay time by setting up the packet transmission time as its major parameter.

Figure 3 and Figure 4 shows the sections where PBOP-PMIPv6's handover takes place with a Time Diagram. According to T_L2 Figure, you can notice a weakness that the delay time increases due to the authentication procedure between the AP and MAG that takes place in the overlapped zone at first; however, you can also see that a tremendous amount of time is saved in the handover procedure that takes place afterwards.

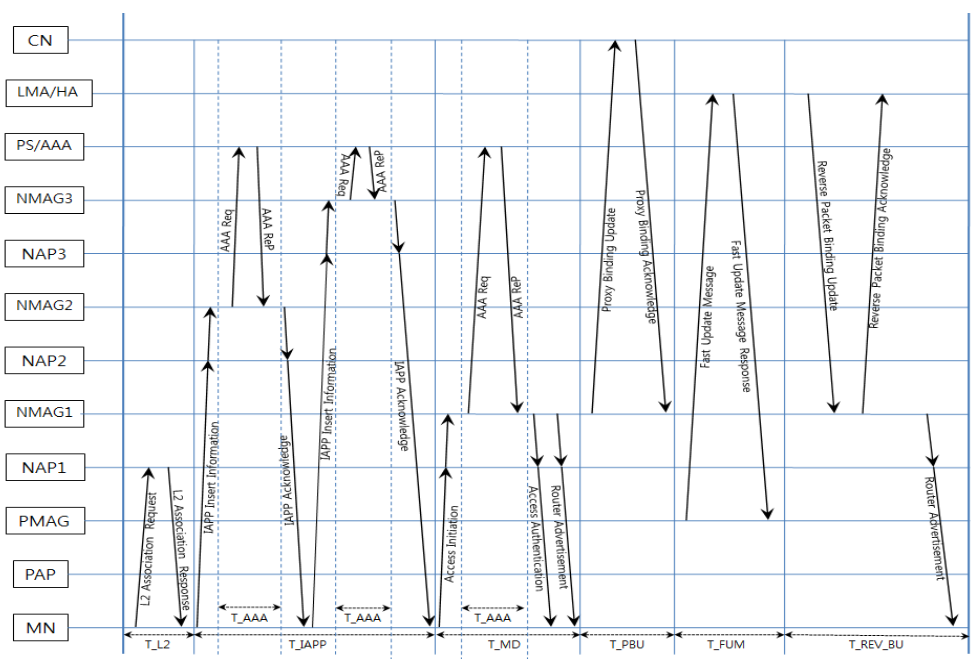

Figure 3. PBOP-PMIPv6 Time Diagram(1)

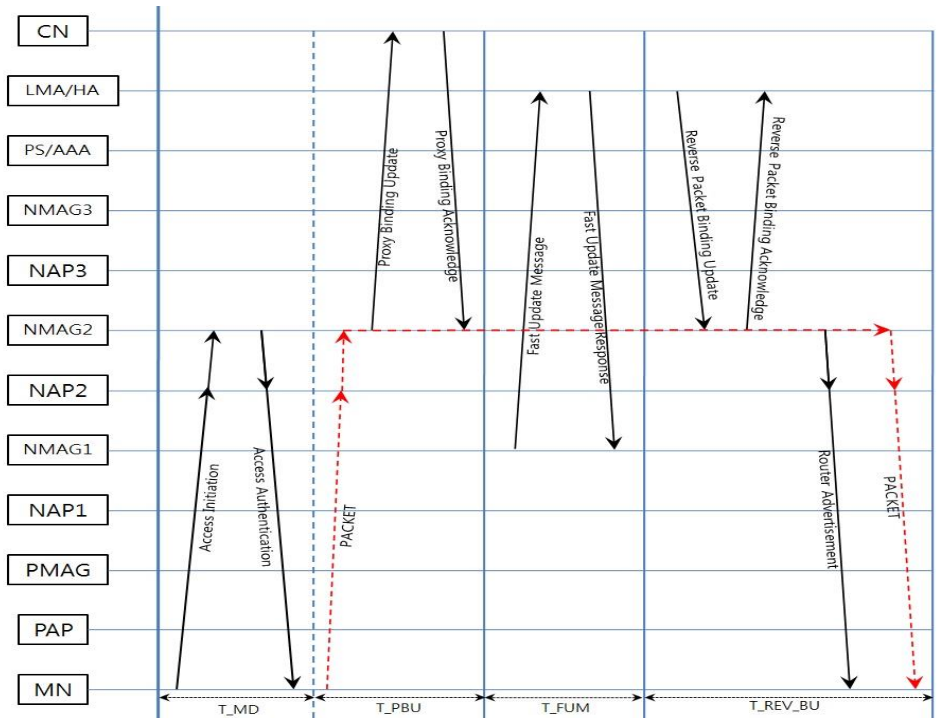

Figure 4. PBOP-PMIPv6 Time Diagram(2)

$$\mathbf{T_{PBOP\text{-}PMIPv6}} \quad \mathbf{(1)}$$
$$= T_{L2} + T_{\_IAPP} + T_{\_MD} + T_{\_PBU} + T_{\_FUM} + T_{\_REV\_BU}$$
$$= 2(5t_1 + 4t_2 + 3t_3 + t_4 + 3t_5)$$

$$\mathbf{T_{PBOP\text{-}PMIPv6}} \quad \mathbf{(2)}$$
$$= T_{MD} + T_{\_PBU} + T_{\_FUM} + T_{\_REV\_BU}$$
$$= 3t_1 + 3t_2 + 2t_4 + 4t_5$$

4.2. Total Handover Latency Analysis

Table 1 shows the value that defines the parameter to analyze the performance. As you can see from the table, it shows the time occurring in each of the sections as a value to conduct performance analysis. The message transmission time and the amount of signaling remain the same in order to help your understanding on the performance analysis. Formula 1 and Formula 2 present the message transmission time defined for each section as a form of a formula. Figure 5 shows the handover delay time changing by the frequency of transfer of PBOP-PMIPv6 with a graph. As shown in the graph, there is no big difference when the handover takes place at first; however, as the frequency of moving increases, the width of handover delay time gets larger gradually. Also, this article has conducted comparison with previous PMIPv6 in order to support your understanding of PBOP-PMIPv6's performance analysis. As a result, as in Figure 6, it has been proved that as the handover frequency increases, PBOP-PMIPv6 becomes more efficient.

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Table 1. Performance Analysis Parameters

Symbol	Description	Value
t1	MN ↔ AP	20ms
t2	AP ↔ MAG	40ms
t3	MAG ↔ AAA	30ms
t4	MAG ↔ CN	100ms
t5	MAG ↔ LMA	50ms

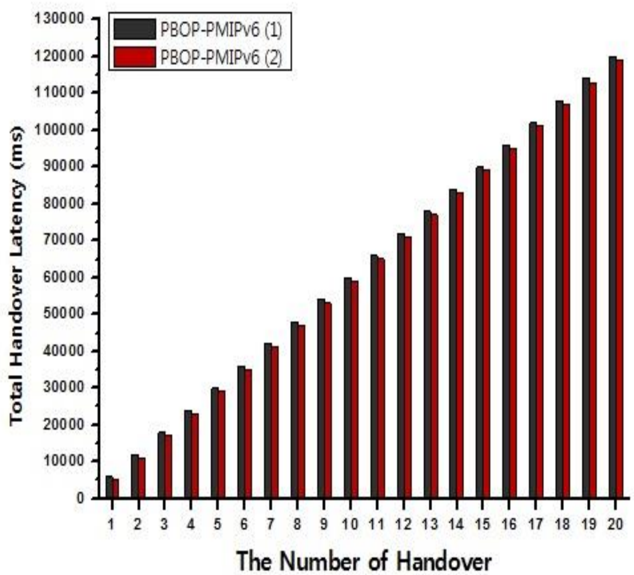

Figure 5. PBOP-PMIPv6 Time Diagram(2)

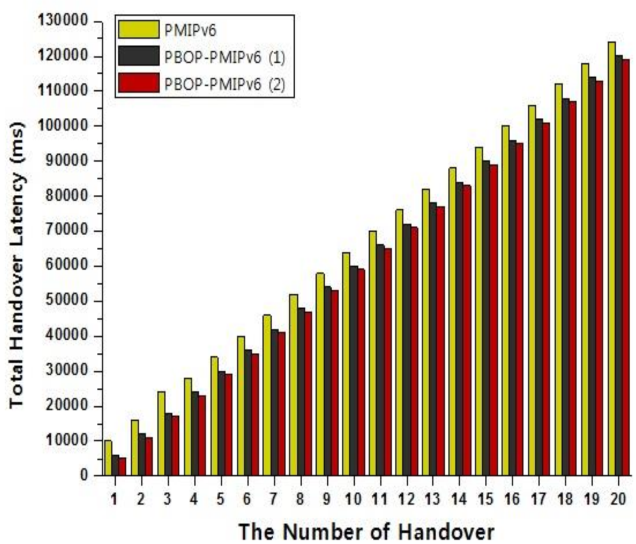

Figure 6. PBOP-PMIPv6 Time Diagram(2)

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5. Conclusion

This article has suggested efficient as well as improved IP mobility within a domain where PMIPv6, network mobility management, is overlapped. And this can reduce the packet loss resulted from handover. In addition, it is also possible to reduce authentication time needed to perform handover by sharing information among the overlapped APs in advance. Also, it is expected that it will be possible to shorten the handover time by supporting route optimization effectively through Reverse Binding Update and informing the CN of the address of the terminal to be serviced afterwards in advance through the Policy Profile brought from the AAA/Policy Store when the handover takes place in Layer 3. It will be necessary to conduct follow-up research continually afterwards on route optimization in order to improve PMIPv6's performance further.

Acknowledgments

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