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Review on Handover mechanisms for PMIPv6

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Abstract— With the rapid growth of the number of mobile devices, the demand of getting the Internet services anytime and anywhere is becoming increasingly urgent. Mobile IP protocols provide mobility support for IP nodes at the network layer. Proxy Mobile IPv6 (PMIPv6) as one of the most promising technologies for the next generation IP network, has attracted much attention in academia and industry. PMIPv6 is a network-based mobility management protocol solution that provides network based mobility management by relying on MIPv6's signaling and the reuse of the home agent functionality through a proxy mobility agent in the network. Network-based mobility management overcomes the weakness of current host-based mobility management such as Mobile Node (MN) modification, signaling overhead and handover latency. To provide low handoff latency, resolve the packet loss problem, reduce signaling cost most of the Extensive research work has been done. In this paper, we will review on the various optimized mechanisms for Proxy Mobile IPv6.

Keywords- Proxy Mobile IPv6, Localized Routing, Multi-Access, Fast handoff, Packet loss, F-PMIPv6.

I. INTRODUCTION

With the rapid growth of the number of mobile devices, the demand of getting the Internet services anytime and anywhere is becoming increasingly urgent. Mobile IP protocols provide mobility support for IP nodes at the network layer. The roaming facility is provided to the users using mobile IP by the help of two models: Network-based and Host based. The Internet Engineering Task Force (IETF) proposed a host-based mobility management protocol, called Mobile IPv6 (MIPv6) protocol [1], for mobile nodes (MNs) to maintain continuous service when they move among different foreign networks. However, MIPv6 does not provide good service for real-time applications because it causes long disruptions during handoff. Recently, the IETF NETLMM working group developed a network-based localized mobility management protocol called Proxy Mobile IPv6 (PMIPv6) to reduce the handoff latency of MIPv6. Moreover, PMIPv6 provides the IP with the mobility to support MNs without requiring its participation in any mobility-related signaling. Unfortunately, PMIPv6 still suffers from the packet loss problem and long authentication latency during handoff. Therefore, to provide low handoff latency, resolve the packet loss problem, reduce signaling cost most of the Extensive research work has been done. In this paper, we will summarize the various handover mechanisms for Proxy Mobile IPv6.

This Paper organized as follows: Section II discusses Optimized PMIPv6 (O-PMIPv6) which contribute in performing all operations in parallel by using similar triggers as with F-PMIPv6.Section III summarize FH-PMIPv6 via analytical model, to show that the FH-PMIPv6 provides a better solution than existing schemes. Next to it section IV reviews on How HF-PMIPv6 mechanism reduce the handover latency, the signaling cost and the packet delivery cost compared to the F-PMIPv6 reactive mode.

II. OPTIMIZED PMIPV6 (O-PMIPV6)

Due to the nature of PMIPv6 and F-PMIPv6, the MN and CN communicate with each other through non-optimal paths [8]. Therefore, a lot of research has been done to establish Route Optimization between the MN and CN and reduce handover delay. These studies have been done separately and, to the best of our knowledge, there is no previous work combining localized routing and handover management simultaneously, without reducing the performance of the network and degrading end-users perceived quality of service. In fact, in ongoing work within IETF NETEXT, the LR is re-established after the basic operation of PMIPv6, not in parallel.

To solve the above limitations, Introducing the Optimized PMIPv6 (O-PMIPv6) protocol. The idea behind this solution is to make the F-PMIPv6 signaling participate in the route optimization establishment the moment that the MN handover is triggered by the network. Using this solution, the MN will be able to handover while maintaining its LR. In other words, there is no need to establish a new LR session. The basic idea is to transmit the LRI/LRA information using the HI/HACK messages that F-PMIPv6 uses to perform the MN handover. By doing that, we keep the same benefits that F-PMIPv6 introduces to the basic PMIPv6 such as handover delay improvement and reduced packet loss in addition to the LR session handover at the same.

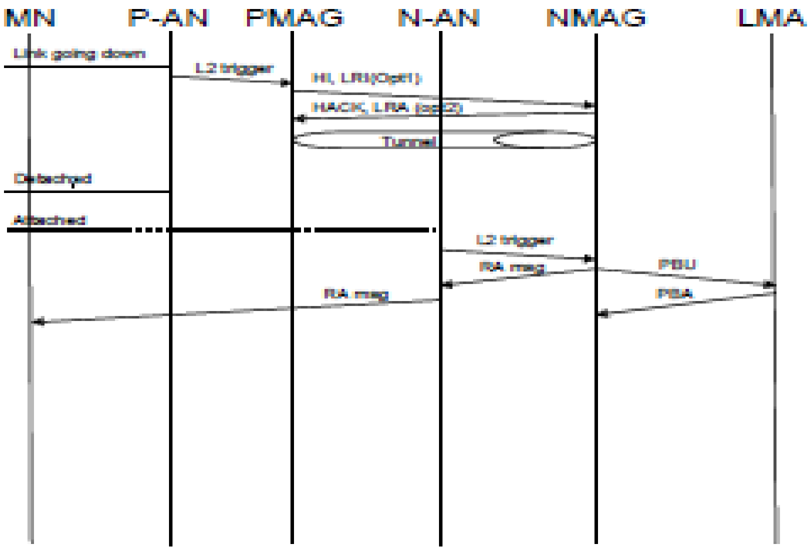

Fig. 1: Signaling flow for mobility protocols with LR

Fig. shows the message flow for O-PMIPv6. When the PMAG detects that the MN is about to perform a handover, it sends a HI message to the NMAG. The HI message contains, in addition to the typical HI message, LRI message. Basically, it is another mobility option in the HI header which facilitates the establishment of the LR with the CN. Including the MN information in the LRI message is optional as it is already included in the original HI message. The remote PCoA of the CN is included in the LRI message which makes it possible for the NMAG to resume communication with the remote MAG over the optimal path. In addition, the remote MAG (i.e. CMAG or the MAG through which the correspondent node is connected to) is informed of the NMAG through LRI message to update its LR information. This is needed when the PMAG, NMAG and CMAG happen to be all different MAGs. Upon attachment of the MN to the NMAG, the NMAG exchanges PBU/PBA messages with the LMA and sends the RA message containing the same prefix as described by the PMIPv6 and F-PMIPv6. The above process results in shorter handover delay and minimized packet loss as proved by FPMIPv6 [12]. However, the optimal path is already established for all the packets (LR) between the MN at the new location and it's CN which is the main added benefit for O-PMIPv6.

III. FAST HANDOFF IN PROXY MOBILE IPV6 NETWORKS (FHPMIPV6)

Proxy Mobile IPv6 (PMIPv6) is a network-based localized mobility management protocol, to support mobility management without the participation of MNs in any mobility-related signaling. Unfortunately, PMIPv6 still suffers from the packet loss problem and long authentication latency during handoff. This is because PMIPv6 doesn't use any buffer mechanism during the handoff procedure and performs the authentication and registration phases separately. Thus we describe fast handoff in Proxy Mobile IPv6 networks (FHPMIPv6) which uses the buffer mechanism to avoid the packet loss, simultaneously performs the authentication and registration phases to reduce the handoff latency, and uses a double buffer mechanism to avoid the out-of- sequence packet problem. Fig. 2 shows the detailed flowchart of the proposed scheme. The dotted line represents the signal flow and the solid line represents the data flow.

3.1. Handoff Procedure

To resolve the long handoff latency of all existing handoff schemes for PMIPv6 networks, researcher proposes a novel fast handoff procedure which consists of the pre-handoff and the fast handoff procedures. We use a predictive handoff mode to notify the target MAG about the handoff information (i.e., MNID and authentication information) in advance. Then, FHPMIPv6 simultaneously performs the authentication and registration phases to reduce the handoff latency.

3.1.1. Pre-Handoff Procedure

As mentioned previously, the MAG is responsible for detecting the movements of an MN and performs mobility-related signaling with the LMA in place of the MN. The pre-handoff phase is commenced when the MN is going to leave the range of the serving MAG (i.e., MAG1). First, MAG1 sends a handoff initial (HI) message to the target MAG (i.e., MAG2). The HI message includes the AAA initiation information of MN (i.e., MN-ID) and the address of the target MAG. Then, MAG2 sends back a handoff acknowledgement (HACK) message to MAG1, and builds a bi-directional tunnel between MAG1 and MAG2. The buffer of MAG2 prepares to buffer packets when the bi-directional tunnel is built.

3.1.2. Fast Handoff Procedure

When the MN moves outside the transmission range of the MAG1, the MAG1 starts forwarding the MN's packets to MAG2 which buffers the packets to prevent packet loss.MAG2 can perform the authentication phase immediately without waiting the AAA initiation message of MN since MAG2 already obtains this information in pre-handoff procedure. Consequently, MAG2 sends the AAA request which includes MN-ID to authenticate the MN and simultaneously sends the PBU message which piggybacks DeReg PBU message to refresh the binding cache entry of LMA. That is, the target MAG (i.e., MAG2) performs the registration phase on behalf of the DeRegistration phase of previous MAG (i.e., MAG1) to reduce the signal cost. Moreover, the authentication and registration phases are simultaneously performed so the executing time of these phases is overlapped. On receipt of the PBU message, the LMA sends a PBA message, including the HNP of the MN, deletes the old binding cache entry, creates a new binding cache entry, and sets up a bi-directional tunnel to the new MAG (i.e., MAG2). Afterward the LMA transmits the packet to MAG2 through the new path, and MAG2 buffers these packets for the MN. At the same time, the AAA server authenticates the MN

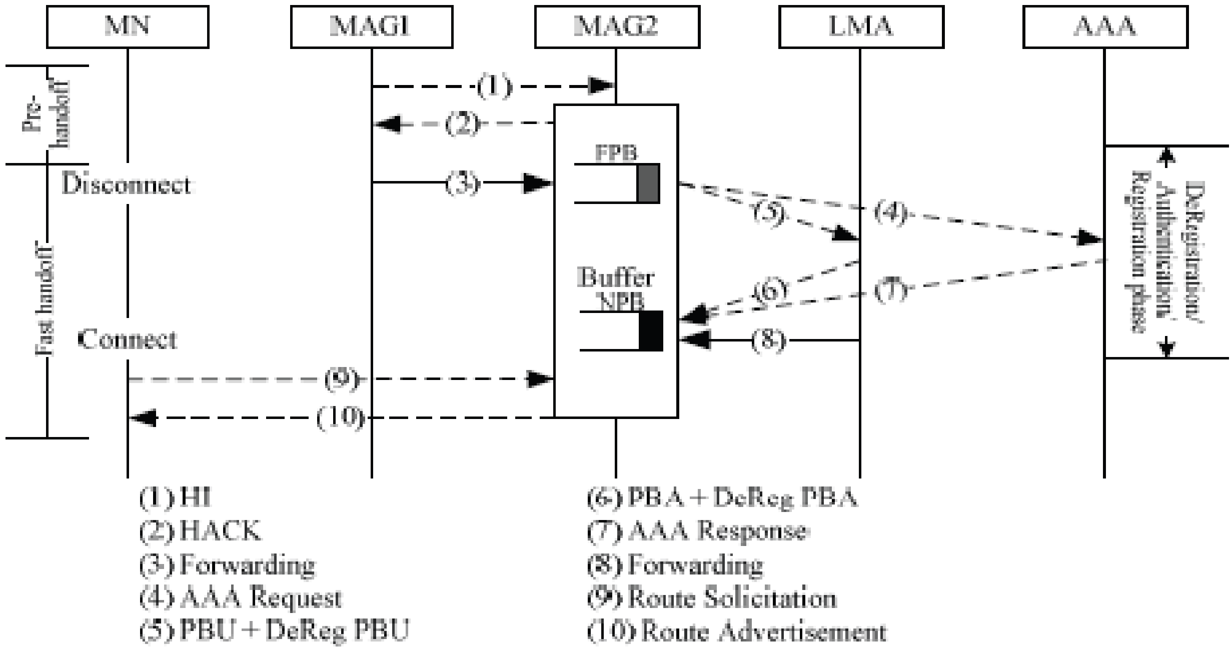

Fig2. : The handoff procedure in FH-PMIPv6

and replies the AAA response to MAG2. MAG2 immediately sends an RA message to the MN when it detects the MN's attachment. When receiving the RA message, the MN checks the RA message for determining where the MN locates in. The MN retains the original address if the MN moves in the same LMD. Otherwise, the MN configures the global IPv6 address on its interface from the HNP. Finally, the MN downloads the buffered packets from MAG2. To summarize, here is the use the piggyback scheme to reduce the signal cost and simultaneously perform the authentication and registration phases to reduce the handoff latency.

3.2. Double Buffer Mechanism

Researcher proposes a double buffer mechanism for the MAG in FH-PMIPv6. The packet buffer of MAGs can be classified as forwarding packet buffer (FPB) and new packet buffer (NPB). FPB stores packets from the old link before the new route is built, while NPB stores packets from the new link after the new route has been built. In the policy of double buffer mechanism, packets in the FPB will be transmitted prior to those in the NPB. Consequently, the MN will receive the packets in sequence.

IV. HYBRID-MODE FAST HANDOVERS FOR PMIPV6 (HF-PMIPV6)

To overcomes some weaknesses of F-PMIPv6, Researcher propose a HF-PMIPv6 mechanism. HF-PMIPv6 utilizes a decision table to detect the mobility mode (i.e., predictive or reactive mode). If the mobility mode is predictive, H-FPMIPv6 establishes a tunnel like F-PMIPv6 between the PMAG and the N-MAG to prevent packet loss. If the mobility mode is reactive, HF-PMIPv6 performs handover directly without setting up a tunnel to reduce the extra handover latency, the signaling cost and the tunnel transmission cost. Figure 3 and Figure 4 illustrate the detail message flows of the HF-PMIPv6 predictive and reactive modes. In Figure 4, HF-PMIPv6 is in the predictive mode. Assume that the MN-ID of the MN is MN-1, the details are described as follows:

The MN reports its MN-ID (i.e., MN-1) and the information of the new AP (i.e., NAP-ID) to the PMAG. Assume that the P-MAG receives the report message and decides to perform the handover procedure. The P-MAG retrieves the N-MAG's information from the NAP-ID and sends a Handover Initiate (HI) message which contains an MN-ID (i.e., MN-1), a "P" flag and the MN's HNP to the N-

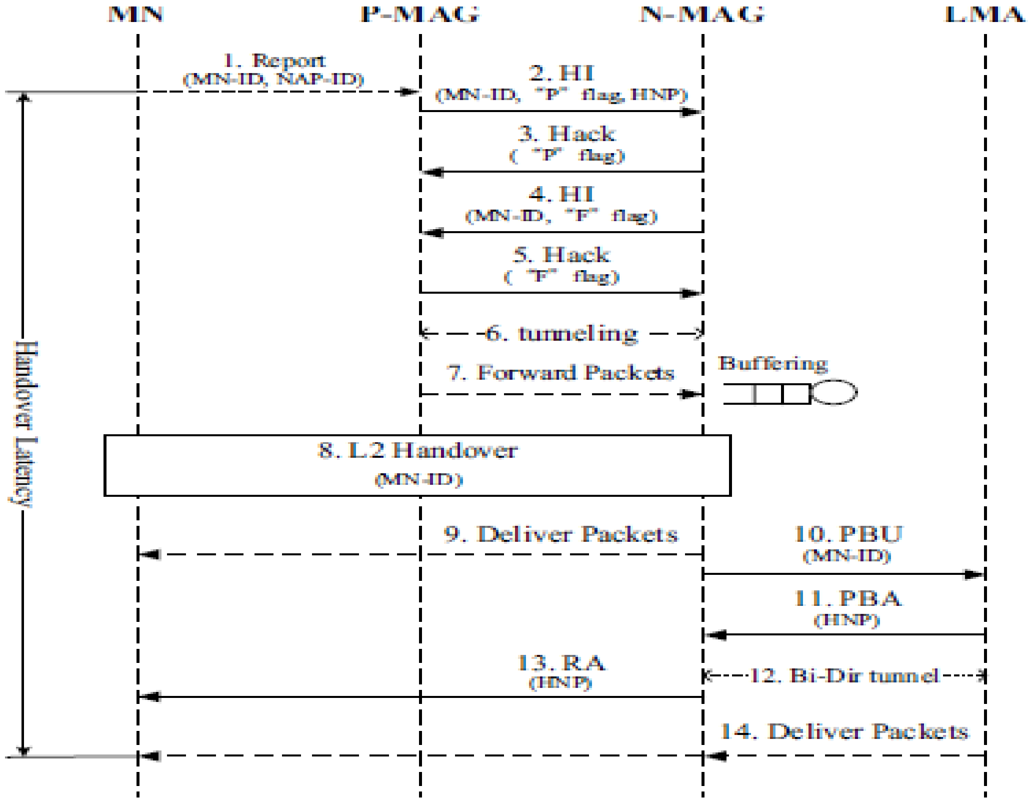

Fig. 3 : The message flow of HF-PMIPv6 predictive mode

MAG. Upon receipt of the HI message which contains the MN-ID (i.e., MN-1), the N-MAG stores the MN-ID into the decision table. The N-MAG replies a Handover Acknowledge (HAck) message which contains a "P" flag to the PMAG. The N-MAG prepares the buffer space for the upcoming packets and sends another HI message which contains MN-ID (MN-1) and an “F” flag to the P-MAG. The “F” flag represents the “Forwarding” flag. This message informs the PMAG to start transferring these packets that is destined to the MN to the N-MAG. Upon receipt of the HI message, the P-MAG replies a HAck message with "F" flag and establishes the tunnel to the N-MAG. Upon receipt of the HAck message, the N-MAG establishes the tunnel to the P-MAG. At this point, a bidirectional tunnel established between the P-MAG and the N-MAG. When the P-MAG receives the packet sent to the MN, it modifies the outer IP header of the packet and then forwards the packet to the N-MAG. The NMAG stores this packet in the buffer until the MN connects to the N-MAG. The MN performs the Layer-2 handover procedures MN’s information including MN-ID (MN-1).The N-MAG uses the MN-ID (MN-1) to query the decision table. Since the MN-ID (MN-1) is found in the decision table, the N-MAG forwards the buffered packets to the MN. The N-MAG transfers the buffered packets to the MN. The packet transmission path from the CN to the MN is CN-LMA-PMAG-NMAG-MN. After the N-MAG starts to transfer the buffered packets to the MN, it deletes the MN-ID (i.e., MN-1) entry from the decision table. The N-MAG sends a PBU message to the LMA to update the MN’s binding. Upon receipt of the PBU message, the LMA updates the binding and changes the tunnel from the P-MAG to the N-MAG and replies a PBA message. Upon receipt of the PBA message, the N-MAG sets up a tunnel to the LMA. At this point, the bidirectional tunnel has been set up. Then the N-MAG sends the Router Advertisement (RA) message to the MN containing MN’s HNP. The packet transmission path changes from LMA-PMAG-NMAG-MN to LMA-NMAG-MN, and vice versa

In Figure 4, HF-PMIPv6 performs handover directly in reactive mode without setting up a tunnel between P-MAG and N-MAG. Since the N-MAG does not establish the additional tunnel to the P MAG, the handover latency, the signaling cost and the tunnel transmission cost can be reduced. The details of the message flow are described as follows:

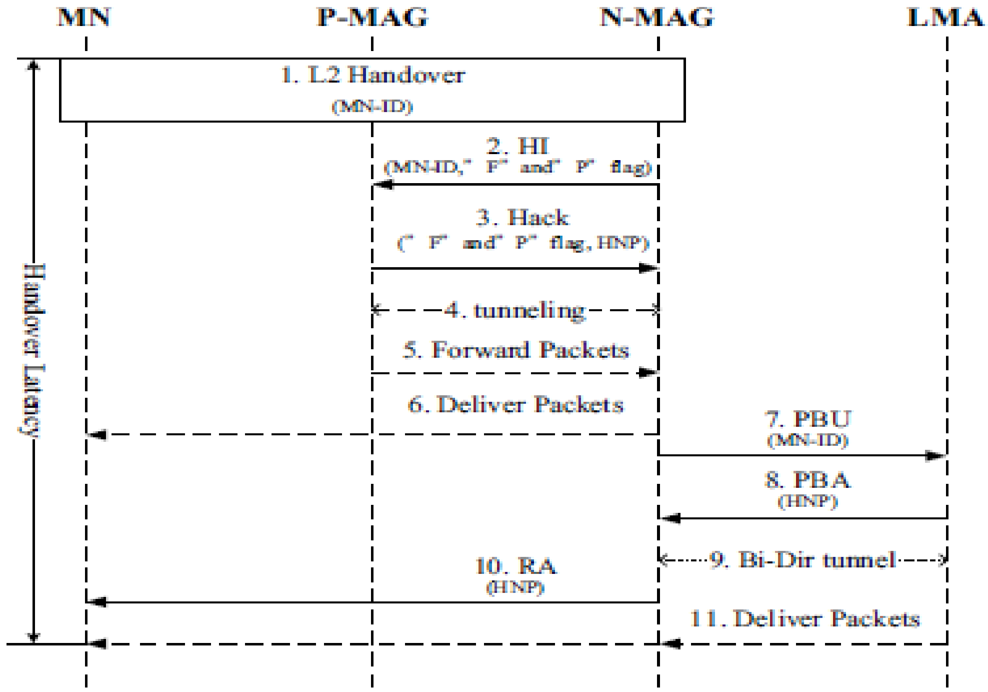

Fig. 4: The message flow of HF-PMIPv6 reactive mode

An MN moves to the N-MAG's access link and the N-MAG retrieves the MN-ID (MN-1).The N-MAG queries the decision table by using the MN-ID (i.e. MN-1) and cannot find any matched entry. The N-MAG sends a PBU message containing the MN-ID (MN-1) to the LMA to update the MN's current location. Upon receipt of the PBU message, the LMA replies a Proxy Binding Acknowledgement (PBA) message containing the MN's Home Network Prefix (HNP) to the N-MAG. The LMA also updates its binding cache entry and sets up a tunnel to the N-MAG. When the N-MAG receives the PBA message, it also sets up a tunnel to the LMA. At this point, the bidirectional between the LMA and the N-MAG is established. Then the N-MAG sends the Router Advertisement (RA) message to the MN containing MN's HNP. The LMA forwards the packets sent from the Correspondent Nodes (CNs) to the N-MAG through the bi-directional tunnel. After the N-MAG receives these packets, it forwards these packets to the MN through its access link.

V. CONCLUSION

Proxy Mobile IPv6 (PMIPv6) has been developed by the IETF as a network-based mobility management protocol to support the mobility of IP devices. Although several proposals have been made for optimize hand over delay, signaling cost, and network utilization, thus most of the researchers has been worked to mainly solve the issues of long handover delay and packets loss during handover. In this paper, we reviews on some mechanisms to reduce the hand over delay for PMIPv6.In OPMIPv6,it gives the network operator a huge improvement to multiple performance factors such as localized routing handover delay, signaling cost, and LMA utilization.FH-PMIPv6 uses the buffer mechanism to avoid the packet loss, uses the piggyback to decrease the signaling cost and simultaneously performs the authentication and registration phases to reduce the handoff latency. In addition, there is a double buffer mechanism in FHPMIPv6to avoid the out-of-sequence packet problem. A Hybrid mode for F-PMIPv6 (HFPMIPv6) mechanism is to improve the handover performance of F-PMIPv6. HF-PMIPv6 utilizes a decision table to detect the mobility mode (i.e., predictive mode or reactive mode). HFPMIPv6 enhances the fast handovers for network-based mobility management.

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