Fast Location Opposite Update Scheme for Minimizing Handover Latency 
over Wireless/Mobile Networks

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ABSTRACT
Mobile IP (Internet Protocol) allows a mobile node to send and receive packets with its home IP address, regardless of the IP address of its current point of attachment in the Internet. Since Mobile IP induces the handover latency due to mobility management operations, fast handover algorithms have been studied to reduce the latency. In this paper, we optimize the handover procedure in Fast Handover for Mobile IPv6 (FMIPv6) scheme using reverse Binding mechanism. We will explain and discuss the scheme that supports a fast handover effectively in standard Mobile IPv6 (FMIPv6) by optimizing the associated data and the flow of the signal during handover. A new signaling message, Fast Packet Binding Update (PBU), and Reverse PBU, are defined and utilized to hasten the handover procedure.

Keywords: MIPv6, FMIPv6, Binding Update, Fast Handover, Seamless.

1. INTRODUCTION
Mobile Internet Protocol version 6 (IPv6) allows an IPv6 node to be mobile—to arbitrarily change its location on an IPv6 network—and still maintain reachability. Connection maintenance for mobile nodes is not done by modifying Transport layer protocols, but by handling the change of addresses at the Internet layer using Mobile IPv6 messages, options, and processes that ensure the correct delivery of data regardless of the mobile node's location [1].

The MIPv6 facilitates to reduce the signaling overhead and delay concerned with the location update, in which an MN sends a local Binding Updates (BU) to the local MAP, rather than the Home Agent (HA) and Correspondent Nodes (CN). On the other hand, the Fast Handover for MIPv6 (FMIPv6) uses bi-directional tunnels between ARs and exploits various L2 triggers for supporting fast handover and further minimizing service disruption during handover.

In this paper we proposed a robust Fast handover scheme for MIPv6 using reverse binding mechanism to overcome such ineffectiveness of standard. This paper briefly describes and discusses the robust fast handover scheme in MIPv6 using reverse binding mechanism.

2. RELATED WORKS AND PROBLEMS
A. Handover Procedure in Mobile IPv6
We can define the handover procedure like as movement detection, new CoA configuration, DAD and binding update. To process Movement Detection, an MN detects that it has moved to a new subnet by analyzing the router advertisement periodically sent by
the access router (AR). The MN can also request the AR to send a router advertisement by sending a router solicitation. To initiate CoA configuration and DAD, the information contained in the router advertisement will allow the MN to create a new CoA. As specified in IPv6 [6], the MN first needs to verify the uniqueness of its link-local address on the new link. The MN performs DAD on its link-local address. Then, it may use either stateless or stateful address autoconfiguration [7] to form its new CoA.

![Figure 1. MIPv6 Handover Procedure](image)

1) Movement Detection: The primary aim of movement detection is to identify L3 handovers. In MIPv6, movement detection generally uses Neighbor Unreachability Detection to determine when the default router is no longer bi-directionally reachable, in which case the mobile node must discover a new default router on a new link.

However, this detection only occurs when the mobile node has packets to send, and in the absence of frequent Router Advertisements or indications from the link-layer, the mobile node might become unaware of an L3 handover. After a change of Link Layer connection the MN must detect any change at the IP Layer before it can signal the change to the network. In MIPv6 this uses RS and RA to detect changes of IP network prefix. This is part of the standard Router Discovery Protocol [6]. The Router Discovery Protocol of IPv6 Neighbor Discovery contains built-in timers. These timers prevent a router from sending immediate responses to RS in order to prevent multiple nodes from transmitting at exactly the same time and to avoid long-range periodic transmissions from synchronizing with each other. These are significant delays since they interfere with the MIPv6 movement detection algorithm thus preventing mobility signaling for up to 1000ms [1] [6].

2) Duplicate Address Detection (DAD): In MIPv6, after completing movement detection an MN should generate a new CoA using IPv6 stateless address autoconfiguration upon moving to the new link [6] [7]. After generation of the CoA an MN should perform DAD for testing the new CoA’s uniqueness within the new link. The duration required to complete DAD is up to 1 second. This delay is inherent to MIPv6.

B. Fast Handover for Mobile IPv6

FMIPv6 is designed to address issues related to IP layer movement detection, CoA configuration and BU in MIPv6. It exploits various L2 triggers to prepare an NCoA at the nAR in advance while being connected to oAR’s link. Upon receiving a L2 trigger, FMIPv6 starts to ‘anticipate’ or prepare for the forthcoming handover beforehand. It assumes that the oAR is configured with a table containing the MAC addresses of its own and the neighboring Point-Of-Attachments (PoA) and the corresponding subnet prefixes of the neighbouring ARs. During the anticipation phase, the oAR assists in the NCoA formation by resolving subnet prefixes based on the table and the L2 identifier reported by the MN. There are three FMIPv6 signaling messages involved in the anticipation phase: Router Solicitation for Proxy Advertisement (RtSolPr), Proxy Router Advertisement (PrRtAdv) and Fast Binding Update (FBU). These messages are used for aiding IP movement detection and NCoA configuration. Through the RtSolPr and PrRtAdv messages, the MN formulates the NCoA when it is still present on oAR’s link. Hence the latency due to new prefix discovery suffered by FMIPv6 is eliminated.

The MN could immediately use the prospective address after attaching to the nAR’s link when the MN
has received a Fast Binding Acknowledgement (FBack) message prior to its mobility to the new link (i.e. Predictive Mode of operation).

Figure 2. FMIPv6 Handover Procedure

This reduces long binding update latency suffered by FMIPv6. In the event, the MN moves upon receiving the FBack, and the NCoA would be usable only after it sends the Unsolicited Neighbor Advertisement (UNA) message and the FBU to the oAR from the nAR’s link (i.e. Reactive Mode). In any case, the oAR starts tunnelling packets arriving for PCoA to NCoA. Such a tunnel is established by the Handover Initiate (HI) and Handover Acknowledgement (HAck) messages. Apart from that these message could also be used for the ARs to transfer resident contexts, such as access control, QoS, header compressions etc. There is no requirement of foreign Agents in Mobile IPv6. As mentioned previously, Neighbor Discovery and Address Auto-configuration features enable mobile nodes to function in any location without the services of any special router in that location.

There is no ingress filtering problem in Mobile IPv6 (In Mobile IPv4 this happens because the correspondent node puts its home address as the source address of the packet). In Mobile IPv6, the correspondent node puts the care-of address as the source address and having a Home Address Destination option, allows the use of the care-of address to be transparent over the IP layer. When using the FMIPv6 based mobility management, there are still rooms for improvement in reducing the handover latency and handover packet loss:

**Neighboring access network discovery:** The FMIPv6 doesn’t address any radio access network discovery mechanism. Discovering the available PoAs by actively searching/scanning all the channels provided by the neighboring networks takes a considerable amount of time, which has a significant contribution to the overall handover latency.

**Information exchange with neighboring ARs:** The method by which neighbouring ARs exchange the information that enables the construction of PrRtAdv messages is not specified in the original FMIPv6. The IETF SEAMOBY WG produced the Candidate Access Router Discovery (CARD) protocol [2] to address this issue. The CARD protocol allows MNs to dynamically construct and populate their own CAR (Candidate Access Router) tables, which contain the mapping between the L2 PoA ID and corresponding IP addresses of the Candidate ARs. However, the use of CARD protocol so far is very limited for the reason that it will need additional support and upgrade to routers. Also, CARD enables a MN to gather attributes associated with target subnets so that a suitable AR could be selected for handover. But it does not provide the MN with appropriate L2 information in order to tackle the issue of radio access discovery that FMIPv6 faces. In [3], a mechanism to build (AP-ID, AR-Info) between ARs in hierarchical structure is described. However such mechanism is still very pre-mature and would require the ARs to be upgraded.

**The Cost of Anticipation:** In FMIPv6, the L2 handover is triggered by degrading link conditions. There is no guarantee that the MN will be connected to the oAR long enough to send and receive all FMIPv6 messages. When anticipation is used, the MN may not have sufficient time to update the oAR with the FBU. As a result, if the MN has already lost connection with oAR,
then the MN is forced to operate in the reactive mode and the handover latency will increase consequently.

**The Ping Pong Movement:** Time taken by the signaling exchange of the three FMIPv6 anticipation messages (RtSolPr, PrRtAdv and FBU) is long enough to increase the uncertainty of a MN’s movements. For example, the handover may take place earlier than originally anticipated by the link layer. The border between overlapping cells may change dynamically due to the objects (e.g., buildings, trees etc) blocking the signals between the APs and MN. Due to the intrinsic dynamic nature of wireless channels, the MN may not move to the originally anticipated PoA. It may not move after all, or it may move somewhere else. That is to say that the MN would ping-pong between cells. Hence premature forwarding of data by the oAR (upon reception of an FBU) could be harmful because the MN may not move to the anticipated PoA. As a result there will be packet losses and long handover latencies.

**C. Fast Handover and Triggers in FMIPv6**

Mobile IP supports MN to maintain connectivity to the Internet during its handover from one AR to another. During handover operation Mobile IP involves movement detection, IP address configuration, and location update. This combined handover latency may preclude MN from real-time and throughput sensitive applications [3].

When MN moves from PAR to NAR, handover occurs. When packets are lost during the handover, they are retransmitted by higher-level protocols. If L2 connection between MN and previous AP (PAP) fails, then L3 connection between MN and PAR also fails. L2 and L3 handovers are started at this point. After L2 handover, MN receives Router Advertisement (RA) message or sends Router Solicitation (RS) message to NAR via new AP (NAP). Then MN requests new CoA to NAR and registers to HA. After authentication from HA, L3 handover is completed. Since router discovery delay is closely related to L2 system, an efficient L3 handover algorithm is necessary to reduce delay due to the route re-establishment.

**3. Proposed Handover Scheme**

In this section, we describe our proposed scheme to reduce the total latency and network load resulting from movement detection and tunneling for the fast handover in Fast Mobile IPv6 networks.

3.1. Handover procedure for FMIPv6 with reverse binding mechanism

The main goal of the proposed scheme is to incorporate the reverse binding mechanism to MIPv6 to enhance the fast handover procedure and to overcome such ineffectiveness by defining the signaling messages between NAR and HA in FMIPv6 fast handover. The proposed scheme utilizes only pre-established bi-directional tunnels between NAR and HA.

The Fast MIPv6 handover using Reverse Binding Mechanism consists of the following messages.

(a). The mobile node (MN) sends a Router Solicitation for Proxy (RtSolPr) to find out about neighboring ARs.

(b). The MN receives a Proxy Router Advertisement (PrRtAdv) containing one or more [AP-ID, AR-Info] tuples.

(c). MN sends a Fast Binding Update (FBU) to the Previous Access Router (PAR).

(d). PAR sends a Handover Initiate (HI) message to the New Access Router (NAR), A duplicate address detection for Care of Address (CoA) within (a000ms) & set tunneling.

(e). NAR sends a Handover Acknowledge (HAck) message to the PAR.

(f). PAR sends a Fast Binding Acknowledgement message to the MS on the new link. The FBAck is also optionally sent on the previous link if the FBU was sent from there.

(g). MN sends Fast Neighbor Acknowledgement (FBAck) to the NAR after attaching to it.

(h). PAR starts packet forwarding message to NAR, and then the packet buffering start.

(i). MN sends a router solicitation with Fast Neighbor Advertisement (FNA) to NAR.

(j). After the NAR received the outer solicitation with Fast Neighbor Advertisement (FNA), it sends an outer Advertisement FNA to MN.

(k). NAR sends a tunneled Packet to MN.

(l). NAR sends a Enhanced PBU to the CN.
(m). CN received the Enhanced Packet and sends a Enhanced Packet Binding Acknowledgement to the CN.
(n). PAR sends a Fast Update message to HA.
(o). After HA received the Fast Update message, it sends a Fast Update message response to PAR.
(p). HA sends a Reverse Packet Binding Update to NAR.
(q). After NAR received the Reverse Packet Binding Update, it replies a Reverse Packet binding Acknowledgement to HA.
(t). HA sends the packet to MN.

3.2. Movement Detection

The primary aim of movement detection is to identify the L3 handovers. Movement detection generally uses Neighbor Unreachability Detection to determine when the default router is no longer bi-directionally reachable, in which case the mobile node must discover a new default router on a new link.

4. CONCLUSIONS

This paper has described Robust Fast handover scheme using Reverse Binding mechanism as new scheme applied in MIPv6 for supporting a fast handover effectively.

5. 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). Byungjoo Park is Correspondent author of this paper.

6. REFERENCES