A Fast Handover Protocol for Mobile IPv6 Using Mobility Prediction Mechanism*

Dae Sun Kim[1] and Choong Seon Hong[2]

[1] School of Electronics and Information, Kyung Hee Univerity
1 Seocheon, Giheung, Yongin, Gyeonggi 449-701 KOREA
dskim@networking.khu.ac.kr

[2] School of Electronics and Information, Kyung Hee Univerity
1 Seocheon, Giheung, Yongin, Gyeonggi 449-701 KOREA
cshong@khu.ac.kr

Abstract. Mobile IPv6 enables mobile node to roam transparently in any network. It shows good performance for macro mobility but it is not proper for supporting micro mobility because of large latency. Accordingly, IETF (Internet Engineering Task Force) mobileip WG(Working Group) suggests Fast Handover Protocol and HMIPv6(Hierarchical Mobile IPv6) for micro mobility management. However, HMIPv6 has some problems of scalability if the mobility anchor point handles too many mobile nodes, and fast handover protocol has problem that mobile node can not send an L3 packet once it has started an L2 handover. So existing protocols currently do not support a suitable handover mechanism to allow a fast moving mobile node to change its point of attachment from one network to another. In this paper, we propose a fast handover mechanism to use mobility prediction table over wireless LAN for fast moving mobile node. We evaluated packet loss in our proposed mechanism using mobility prediction with various fast handover schemes. Simulation results show effectiveness of our scheme.

1 Introduction

Nowadays, wireless network access services are increasingly gaining popularity since wireless communication has many advantages. As allowing movements during communications and network access at a fair rate among nodes, the movement of mobile nodes between access points (APs) that belong to a common subnet is managed by a layer 2 protocol and does not involve layer 3 mechanism. On the other hand, if a mobile node connects to an AP of another subnet, the IPv6 [2] address of the mobile node (MN) is not topologically valid. Therefore, this kind of movement has to be managed by a specific L3 protocol [1].

This paper introduces a Hierarchical Mobile IPv6 which optimizes movement in an administrative domain and Fast Handover Protocol[4] which anticipates the

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movement in order to start the handover earlier. These protocols are discussed in the next section. Then we propose fast handover mechanism using mobility prediction table over Wireless LAN in section 3. Finally, we give some concluding remarks.

2 Related Work

2.1 Hierarchical Mobile IPv6

Hierarchical Mobile IPv6 (HMIPv6)[3] is the enhancement of Mobile Internet Protocol versions 6 (MIPv6)[1][2] that is designed to reduce the amount of signaling required and to improve handoff speed for mobile connections. HMIPv6 is a proposed standard from the Internet Engineering Task Force (IETF). MIPv6[1] defines a means of managing global mobility, but doesn't address the issue of local mobility separately. Instead, it uses the same mechanisms for local and global mobility support. So, it is not efficient scheme for local mobility support. HMIPv6 adds another level, built on MIPv6 that separates local from global mobility. In HMIPv6, global mobility is managed by the MIPv6 protocols, while local handoffs are managed locally.

A new node in HMIPv6 called the Mobility Anchor Point (MAP) [3] serves as a local entity to aid in mobile handoffs. The MAP can be located anywhere within a hierarchy of routers. In contrast to the foreign agent, there is no requirement for a MAP to reside on each subnet. The MAP helps to decrease handoff-related latency because a local MAP can be updated more quickly than a remote home agent.

Using MIPv6, a mobile node sends location updates to any node which it corresponds with each time, and when it changes its location at intermittent intervals. This involves a lot of signaling and processing, and requires a lot of resources. Furthermore, although it is not necessary for external hosts to be updated when a mobile node moves locally, these updates occur for both local and global moves. By separating global and local mobility, HMIPv6 makes it possible to deal with either situation appropriately. These are shown in Fig.1

However, the problem of scalability occurs if the mobility anchor point handles too many MNs. Considering several mobility anchor points per domain that are at the same level could resolve the scalability problem, since these mobility anchor points could share the number of MNs. However this method is still under discussion since it causes some problems such as the discovery of the other mobility anchor point selection of one mobility anchor point for the MN, and load balancing among multiple mobility anchor points.

2.2 Fast Handover

The Fast Handover Protocol is an extension of Mobile IPv6 that allows an access router (AR) to offer services to an MN in order to anticipate the layer 3 (L3) handover. The movement anticipation is based on the layer 2 (L2) triggers. An L2

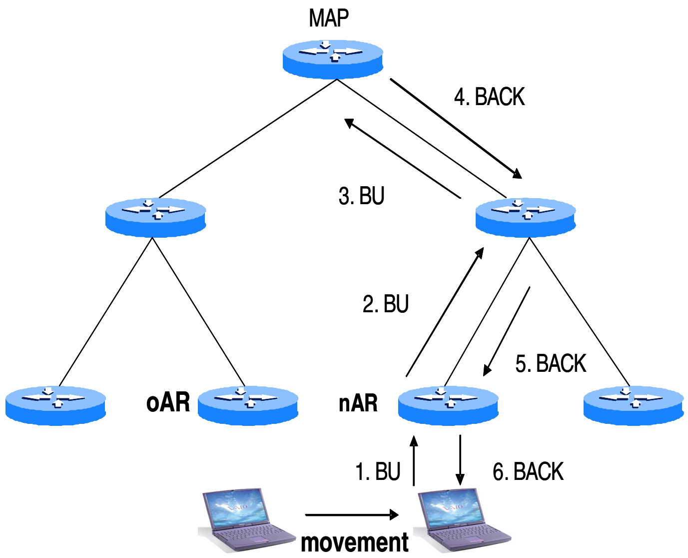


Fig. 1. Hierarchical Mobile IPv6 Operation

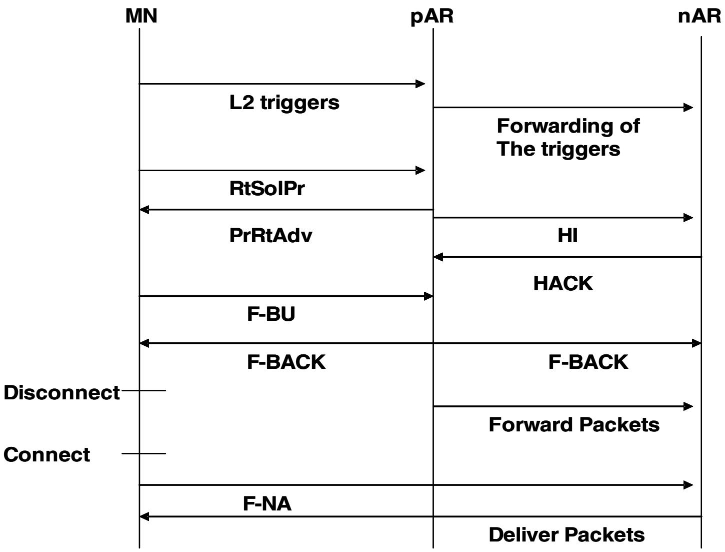


Fig. 2. The message sequence diagram of anticipated handover mechanism

trigger is information based on the link layer protocol, below the IPv6 protocol, in order to begin the L3 handover before the L2 handover ends. An L2 trigger and the link layer identification are roles of different entities.[6] The main L2 triggers are shown in Table 1.

Table 1. Main L2 Trigger

name	recipient	information
Link Up	nAR or MN	MN or nAR MAC address
Link Down	oAR or MN	MN or oAR MAC address
Mobile trigger	MN	nAR MAC address
Source-network trigger	oAR	MN and nAR MAC address
Target-network trigger	nAR	MN and oAR MAC address

Anticipated Handover. In anticipated handover, the MN or the current AR receives an L2 trigger indication that the MN is about to perform an L2 handover. This trigger must contain information allowing the target AR identification. If the MN receives the L2 trigger, it must initiate the handover and request fast handover to its AR. The current AR then sends a valid IPv6 address for the new subnet to both the MN and the target AR for validation. Then the target AR controls if the address is unique in its subnet and sends the validation result to the current AR. If the address is valid, the current AR forwards the authorization to the MN and target AR. Then when the MN establishes the connection with the new AR, it can immediately use the new care of address as the source address in the outgoing packets and send a binding update to the home agent and correspondent node. To minimize the loss of packets, the old AR forwards all the packets intended to the MN to the new AR [4]. These are shown in Fig.2. However, the anticipated handover must be controlled by the network, since the MN can not send an L3 packet once it has started an L2 handover.

3 Proposed Handover Scheme

There are two ways to provide a suitable handover mechanism for mobile node. The Service area is separated into Fast Handover Zone (FH-Zone) and Soft Handover Zone (SH-Zone). These are shown in Fig. 3.

FH-Zone is an area in which Mobile Node moves fast (i.e., roadway). The other way about SH-Zone is where Mobile Node moves slow (i.e., airport, school, street).

3.1 Handover in SH-Zone

Mobile Node moves slowly in SH-Zone. Therefore MN has enough time to register it mobility information to its Home Agent and Correspondent Node. HMIPv6

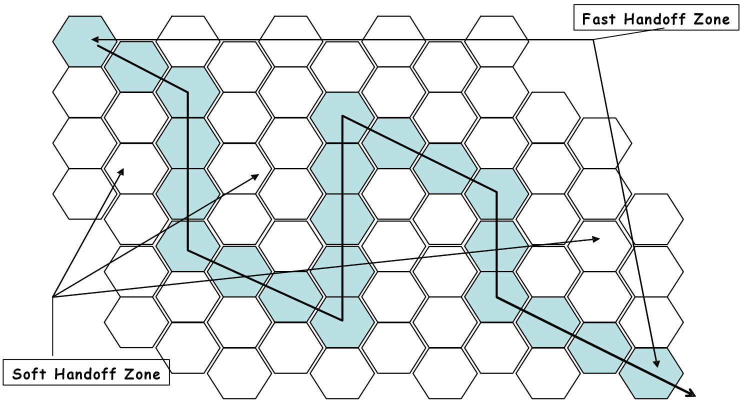


Fig. 3. Fast Handover Zone and Soft Handover Zone

reduced handover latency by using MAP;fast handover gets new care of address more than Mobile IPv6. So, in this paper we adopt hybrid mechanism that combined HMIPv6 and fast handover protocol for enhancing the performance in factors such as packet loss and handover latency.

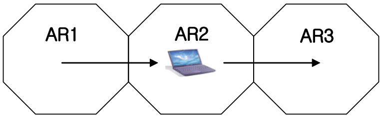
3.2 Handover in FH-Zone

FH-Zone Handover makes use of Mobility Prediction Table (MPT). MPT is a simple table for MN predicted mobility.

Table 2. Mobility Prediction Table (MPT)

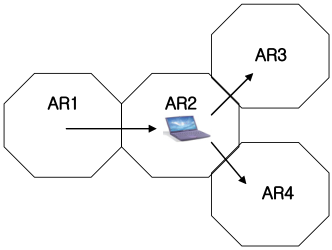
	AR List	
Previous	Current	Next

An AR sends list of FH Zone's ARs within router advertisement message to MN. Then MN updates MPT. An example of the MPT is shown in Table.2. AR List field is FH-Zone's AR List. AR List is IP address of FH-Zone's AR. Previous filed designates a router before an MN reaches current cell. The router designated by current field means the node that MN is staying now. The node in next field is the router that MN is going to move. If an MN moves from AR1 to AR2, the MN predicts AR3 as next cell. These are shown in Fig.4. If an MN moves from AR1 to AR2, the MN looks at MPT's next field and decides next cell AR3 and AR4. A scenario for these operations is shown in Fig.6.



AR List		
previous	current	next
AR1	AR2	AR3

Fig. 4. Example of decided next one cell



AR List		
previous	current	next
AR1	AR2	AR3, AR4

Fig. 5. Example of decided next cells more then two

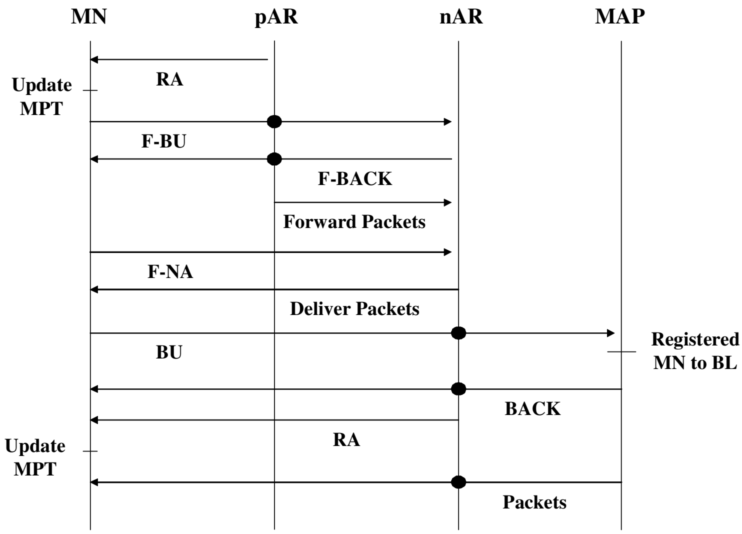


Fig. 6. The message sequence diagram of FH-Zone handover mechanism

Protocol Operation. Figure 6 shows the operation of FH-Zone Handover mechanism.

1. pAR sends RA(Router Advertisement) to MN which contains the list of FH-Zone's AR
2. MN updates its MPT

3. MN sends F-BU(Fast Binding Update) to pAR(previous AR) when MN passes middle of cell. F-BU is to solicit pAR to bind PCoA to NCoA, so that arriving packets can be tunneled to the nAR (next AR)
4. In response, the pAR sends F-BACK(Fast Binding Acknowledgment) which contains new CoA. Then pAR delivers packets to MN
5. MN sends F-NA(Fast Neighbor Advertisement) to nAR. Then nAR forwards packets to MN
6. MN sends BU(Binding Update) to MAP(Mobilitiy Anchor Point)
7. MAP registers MN to the binding list after receiving BU from MN

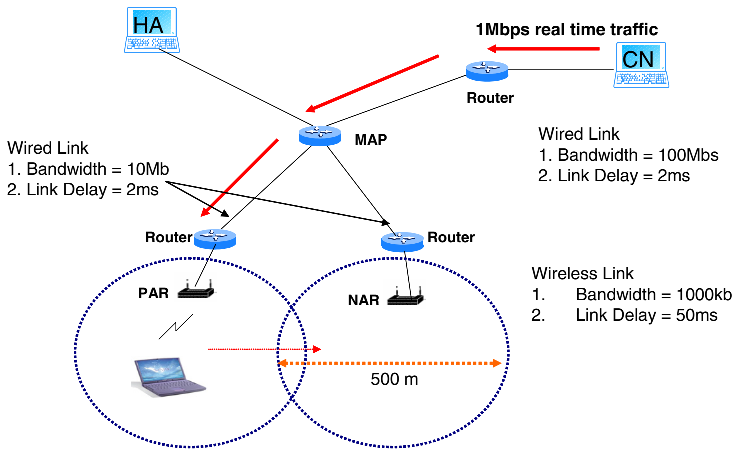


Fig. 7. Simulation network architecture

4 Simulation of Proposed Mechanism

For the purpose of the performance evaluation of proposed mechanism, we used a simulation network as shown in Fig. 7. In this simulation network we used nine units, including HA, CN, MAP, Router, AR and MN. For simulation network, we used wired links that have bandwidth of 10Mps and link delay of 2ms, and wireless links that have bandwidth of 1Mps and link delay of 50 ms, respectively. Also, a simulator is implemented by using NS-2 to evaluate the packets loss of the fast handover and hierarchical mobile IPv6 as well as our proposed scheme.

We compare Fast handover, Hierarchical Mobile IPv6, and a Combined Fast Handover/HMIPv6 protocol with our proposed scheme. The simulation scenario supposes that MN moves to nAR with increasing speed.

Fig 8 and Fig 9 compare single user and multiple users when overlap region is 50m. In Fig 8 the results in four mechanisms are similar until the speed

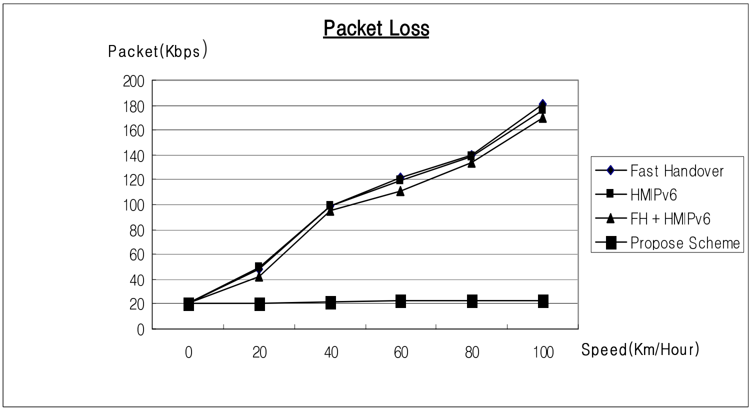


Fig. 8. Packet loss (overlap region: 50m, single user)

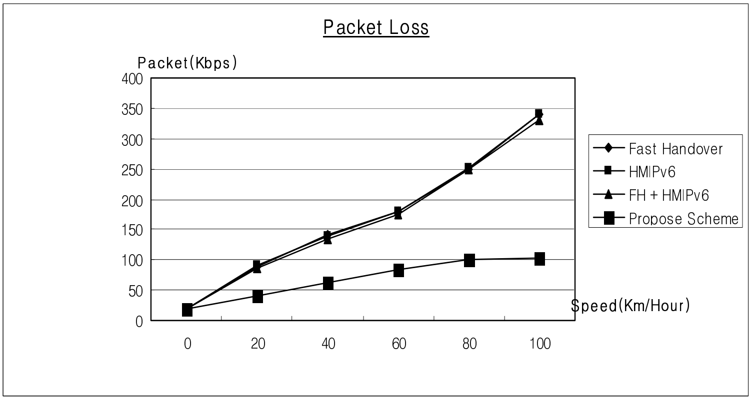


Fig. 9. Packet loss (overlap region: 50m, multiple users(5))

20km/hour because overlap region is wide. Our proposed scheme shows good performance when the speed is more than 20km/hour, because we used MTP to get new care of address in proposed scheme. In Fig 9 the result is worse than figure 8 because of much traffic occurred in restricted bandwidth by multiple users at the same time. Fig 10 and Fig 11 compare single user and multiple users when overlap region is 20m. In Figs 8 and 9, overlap region is narrow. So, the results are worse than those of figure 10 and figure 11 that accommodate 20m as overlap region. Those figures show that size of overlap region is important element in handover. Conclusively, our proposed scheme represents prominent results when comparing with others.

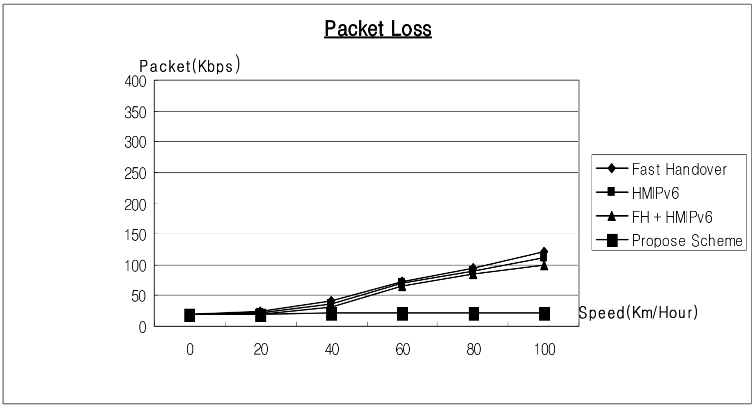


Fig. 10. Packet loss (overlap region: 20m, single user)

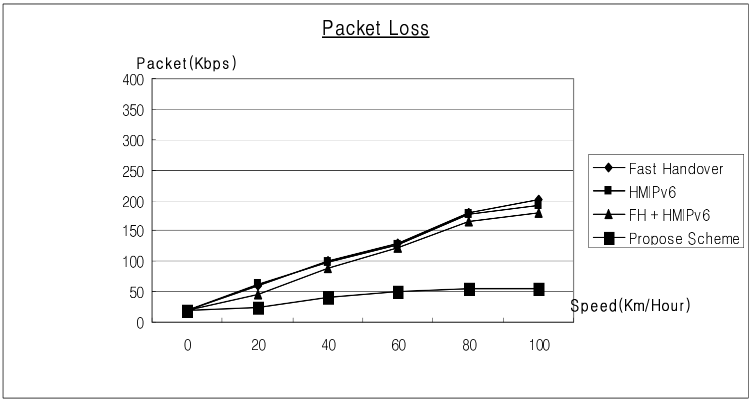


Fig. 11. Packet loss (overlap region: 20m, multiple users(5))

5 Conclusions

In this paper we proposed a fast handover mechanism using mobility prediction table over wireless LAN for fast moving mobile node. First, we used the mechanism that combines HMIPv6 and Fast Handover Protocol in SH-Zone Handover where a mobile node (MN) moves slowly in SH-Zone. Second, fast handover-zone handover uses a mobility prediction table (MPT). MPT contains list of FH-Zone's access router. So an MN predicts next cell to use MPT. As measuring packet loss with fast handoff of an MN, we confirmed that the proposed mechanism has much less packet loss than existing mechanisms.

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