

A Seamless Multicast Scheme for supporting Global Mobility in Proxy Mobile IPv6 Networks

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Abstract— Recently, Proxy Mobile IPv6 (PMIPv6) networks have been studied as the mobility management protocol to effectively use limited wireless resources. And the multicasting, which is a core technology of the Internet broadcast system such as mobile IPTV, has been widely discussed mainly based on PMIPv6 network. However, since the PMIPv6 is basically designed for local mobility management, it cannot support directly global mobility management between different PMIPv6 domains. Moreover, multicasting based on PMIPv6 network causes disconnection of services because it does not solve problems of packet loss during binding and group joining procedure. Hence, we propose a seamless multicast scheme which supports global mobility in PMIPv6 networks. The proposed scheme achieves lower latency because it performs fast binding and group joining procedure, and possible supports global mobility due to adds signaling between LMAs. Also, it does not cause about packet losses due to performing buffering at LMA. We proved the performance using the simulations.

Keywords— Proxy Mobile IPv6, Multicast Mobility, Global Mobility, Seamless Service, Packet loss

I. INTRODUCTION

Recently, communication business rapidly changed from wired network market to mobile network market. Especially, mobile network environment is gaining attention nowadays, as the portable device such as smart phones and PDAs have been popular recently. A VOD, VoIP was mainly service in mobile network. But nowadays, mobile broadcast like a mobile IPTV is gaining attention in mobile network.

Mobile IPTV is IP-based service unlike existing mobile service as a DMB, and more adapted service to next generation network based on All-IP network. These mobile IPTV have weakness such as service disconnection problem. It caused changing IP address while mobile moves. To solving this problem, the IETF (Internet Engineering Task Force) proposed Mobile IPv6 (MIPv6) [1] for more effective mobility.

MIPv6 is a mobile-controlled mobility management protocol. But MIPv6 has problems such as adapting MIPv6 protocol stack on mobile device and having too many signalling for mobility. To solving these problem, IETF NETLMM (Network-based Localized Mobility Management) WG (Working Group) proposed Proxy Mobile IPv6 (PMIPv6) [2].

Basically, PMIPv6 is a network-controlled mobility management protocol. PMIPv6 provides mobility to Mobile Node (MN) using Mobile Access Gateway (MAG) and Local

Mobility Anchor (LMA). MAG performs signalling about MN's movement. LMA performs as a MN's agent. When MN has moved, MAG notices that MN is moving, and MAG decides it is handover or not. If it is handover, MAG performs handover procedure between LMA. This handover procedure could reduce many signals between MAG and MN. But if PMIPv6 domain is got too wider, routing overhead is too bigger. So, PMIPv6 has a problem that assumes movements only inner PMIPv6 [2]. This problem is critical weakness that adapted next generation multimedia service such as mobile IPTV. Therefore PMIPv6 is considered to perform local mobility and global mobility, without delay and packet loss. Hence, we proposed a seamless multicast scheme which supports global mobility in PMIPv6 networks.

The remainder of the paper is organized as follows. In section 2, as the related works, we will explain about the PMIPv6 network and existing multicast schemes supporting global mobility in PMIPv6 networks. In section 3, we will explain about the seamless multicast scheme for global mobility. Next, in section 4, Simulation result of the proposed scheme will be explained. And then, in section 5, we will conclude this paper.

II. RELATED WORKS

A. Proxy Mobile IPv6

PMIPv6 is proposed to solving problem of existed host based mobility protocol as a network based mobility protocol [2].

Existed host based mobility protocol have some weaknesses that it needs many signaling in order to provide the mobility of the mobile devices, and this makes limited link resource overloaded. However, to remedy the weaknesses of MIPv6, PMIPv6 makes the network mainly perform the signaling that is needed to provide the mobility of the Mobile Node (MN) instead of MN. So, MN can be provided the mobility without implementation of the complicated signaling function.

PMIPv6 defined MAG, LMA as a router for providing MN's mobility control [2]. MAG performs as typically access router that it provides mobility to MN through observing movement and performing MN's location update. LMA performs as HA (Home Agent) in MIPv6. It manages MN's location information. So it transmits data from outer network to MN's access router MAG. Therefore, LMA is Proxy for MN. Figure 1 shows the PMIPv6 network.

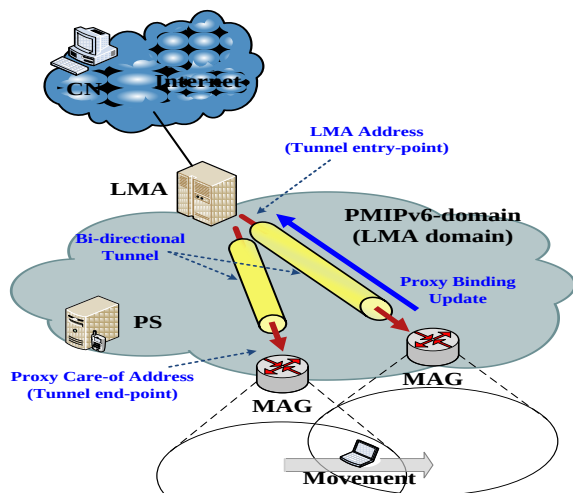


Figure 1. PMIPv6 network

B. Supporting Global Mobility in PMIPv6

As a Introduction, PMIPv6 is protocol that focusing mobility between PMIPv6 domains. Therefore, there is not protocol definition for supporting global mobility. Actually, it is predictable that MN frequently moves to outer domain, because we cannot assume MN has moved only between PMIPv6 networks in real place. So it is necessary to research for providing PMIPv6 global mobility. And IETF NETLMM WG has researched this problem.

C. Mobility between PMIPv6 and MIPv6

IETF NETLMM WG is standardizing global mobility between PMIPv6 to MIPv6[3]. It processed when MN(has a HA) moves PMIPv6 network, LMA sends Binding message to MN's HA.

Figure 2 shows specification for PMIP-MIP Interaction.

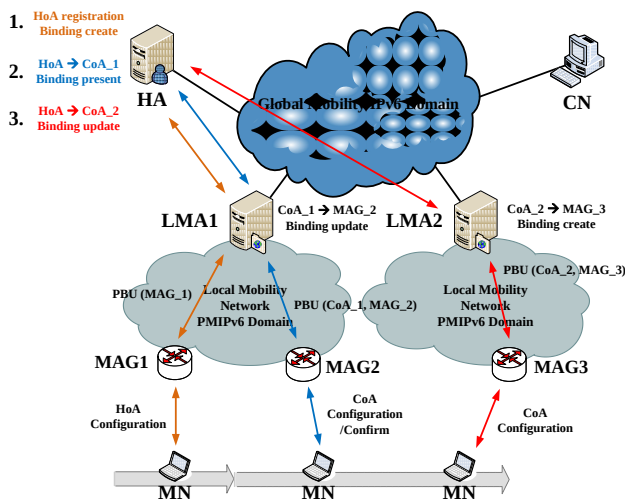


Figure 2. PMIP-MIP Interaction

At first, MN joins to MAG1. MAG1 that knows MN's joining by link layer signal, sends PBU(Proxy Binding Update) message to LMA1 for Binding Update. Then LMA1 registers MN's address and completes Binding. Existing PMIPv6 protocol completes Binding by this procedure. But in global mobility, after Binding procedure, LMA1 has to perform binding Update to HA for MIPv6 network. After Binding Update between HA and LMA1, LMA1 sends PBA message to MN through MAG1 and all Binding procedure is complete.

If MN moves to MAG2, it doesn't have to Binding Update because it is not global mobility. But MN's COA(Care-of-Address) has to change MAG2's address. Therefore MAG2 requests Binding to HA through LMA1.

If MN moves to MAG3, LMA2 requests HA to Binding. Because, PMIPv6 domain is changed. Then HA recognizes that MN moves to new network, and COA is changed MAG3's address. Finally, MN doesn't perform any signalling by MN's movement and receiving service without global mobility problems.

D. Define new agent

IETF NETLMM WG proposed new global mobility that combines MIPv6 signalling with PMIPv6. This proposal has PMIPv6 protocol's benefits, but it also has unnecessary delay caused additional signals between LMA and HA. Therefore new method(I-PMIP) that new agent operation added to router, is proposed for solving this problem[4]. This method doesn't use HA but first joining LMA performs as MN's HA.

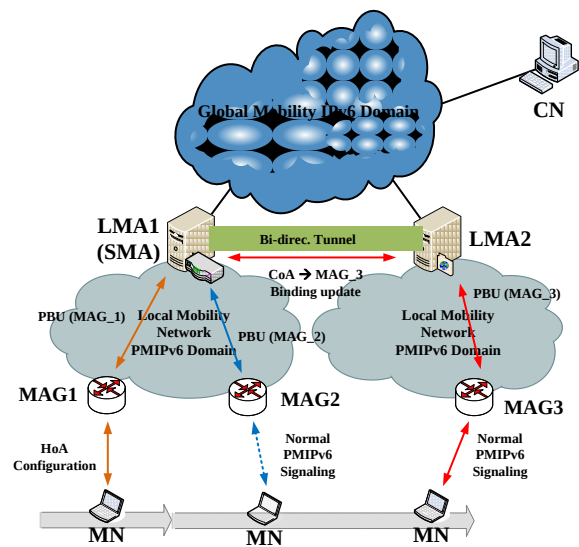


Figure 3. I-PMIP operation

Figure 3 shows I-PMIP operation. Basically same operation when MN first joins to LMA1. But as a figure 3, when a moving MN joins to MAG3, LMA2 requests LMA1 to send MN's Binding. This is important on this method. At this procedure, LMA1 that MN's first joining LMA, is called

SMA(Session Mobility Anchor) and it provides seamless session to MN.

All data that sending to MN, is transmitted via SMA, because SMA performs as a MN's HA. So, when MN moves away on PMIPv6 domain include SMA, new PMIPv6 domain's LMA request Binding to this SMA. Then bi-directional tunnel is set between SMA and new LMA. All data are transmitted to MN via bi-directional tunnel.

E. Problems of PMIP-MIP Interaction and I-PMIP

PMIP-MIP Interaction adds MIPv6 signals to PMIPv6 signals for supporting global mobility. But adding MIPv6 signal occur unnecessary delay. Because even if performs intra mobility, binding procedure has to be performed between LMA and HA even at intra mobility. In addition, in case of multicast, since group joining delay depends on binding delay between LMA and HA, service disconnection time is increased.

In contrast to the PMIP-MIP Interaction, I-PMIP does not occur unnecessary delay. But, when global mobility has occurred frequently, I-PMIP has delay that continually performs binding procedure to SMA. And I-PMIP also performs group joining procedure after complete binding procedure. So it causes service disconnection problem.

Therefore, we proposed effective global mobility scheme without binding to HA or new agent and multicast scheme without packet loss.

III. PROPOSED SCHEME FOR GLOBAL MOBILITY AND SEAMLESS MULTICAST IN PMIP

A. LMA option message for global mobility

In this section, we explains newly added message for supporting global mobility without HA and new agent. This added message supports LMAs identify each other without HA and new agent.

Type	Length	Dist.	Pref.	r	Reserved
Valid lifetime					
LMA's Global Address (128 bits)					

Figure 4. LMA option message format

Basically, a router sends RA(Router Advertisement) message to all other routers for sharing its information. We add message of Figure 4, in RA message as option. Using this option, LMA configures LMA entry consist of LMA's global addresses. LMA's entry is configured by distance(Hop Count) field in message format. Therefore, using this message, LMAs share each address and inform MN's movement.

B. Seamless multicast for global mobility

Figure 5 shows seamless multicast for global mobility

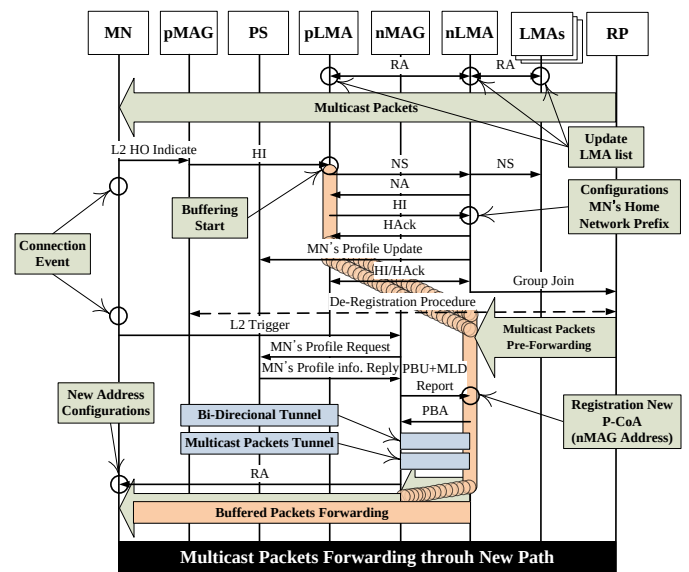


Figure 5. Seamless multicast for global mobility

MN first joins to MAG, then its LMA(Previous LMA, p-LMA) provides multicast service to MN via MAG. It assumes LMAs have LMA entry by using new option message in RA.

When MN moves away from p-MAG to other domain, it performs Figure 5 procedure.

MN recognizes decreasing signal strength from current AP. MN informs handover to its p-MAG via AP. Then p-MAG sends HI(Handover Initiate) message to p-LMA about MN's handover. This HI message includes n-MAG's address as MN's new MAG. A p-LMA checks its own MAG entry whether n-MAG's address is included same domain. If n-MAG's address is not same domain, p-LMA pretends MN's global mobility. Then p-LMA sends NS(Neighbor Solicitation) message to LMAs that it is included a list of LMA entry. And LMAs that received NS from p-LMA, check each own LMA entries. If one of LMAs discovers n-MAG's address from its own MAG entry, it sends NA(Neighbor Advertisement) message to p-LMA. Then p-LMA knows MN moves which LMA. And p-LMA sends HI message to n-LMA for fast handover procedure. In this HI message, includes MN's ID and multicast information. After receiving HI message from p-LMA, n-LMA sends HACK(Handover Acknowledgement) and pretends MN's handover.

On the other hand, p-LMA starts buffering multicast data that will forward to MN, when receive HI message from p-MAG.

It is for seamless multicast service without data loss. P-LMA continues buffering until n-LMA send Hack message to p-LMA. If p-LMA receives Hack message, p-LMA sends buffered data to n-LMA.

During buffered data is transmitted to n-LMA, n-LMA updates newly configured MN's information to PS(Policy

Store) server. After updating, n-LMA informs that update procedure is completed to p-LMA by HI message. After that, n-LMA performs group rejoining procedure. Then n-LMA receives multicast data from source. And n-LMA also buffered data from p-LMA sending.

When MN handovers to n-MAG, n-MAG accesses to PS server and request MN's information. After that, n-MAG sends PBU message to n-LMA for MN's binding update. At this time, n-MAG sends MLD(Multicast Listener Discovery) report message[5](n-MAG could know MN's multicast information through PS server) to n-LMA at same time. After receiving PBU and MLD messages, n-LMA could know MN is joined its own domain then send PBA message to n-MAG. And n-LMA starts two channel configuration procedure. One of them is Bi-Directional Tunnel for existed PMIPv6 protocol, another tunnel is Multicast Packet Tunnel as we defined.

After channel configuration procedure, n-LMA sends buffered data to MN through n-MAG. Finally, MN has been moved global mobility and received seamless multicast service.

IV. SIMULATION

In order to evaluate the performance of proposed handover scheme, we use the NS-2 network simulator[6]. Figure 6 shows the topology used for the simulation.

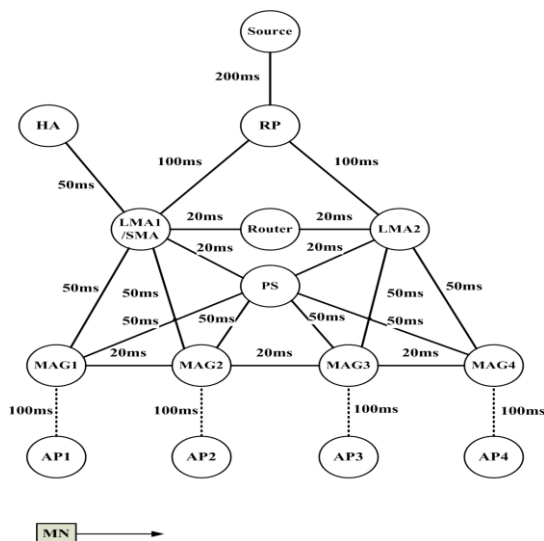


Figure 6. Simulation topology for multicast handover

Table 1. Simulation Parameter

Parameter	Value
Simulation time	300 sec
Distance between MAGs	5km
Link bandwidth	2Mbps
Velocity of MN	60m/s
Bit rate	CBR
Packet size	1Kbyte

Multicast routing protocol	PIM-SM
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Table 1 is simulation parameter. We measured UDP datagram ID, TCP sequence number, UDP and TCP throughput for simulation.

Figure 7 is measured UDP datagram that MN received from source. As Figure 7, in P-M Interaction, MN cannot receive the UDP datagram from 120.2 second to 122.5 second. This data loss occurs because global mobility delay and multicast group joining procedure delay. In P-M Interaction, multicast group join procedure delay is caused it performs after binding procedure.

And I-PMIP's data loss occurs from 120.2 second to 122.1 second. It is caused global mobility binding is complete at LMA1 unlike P-M Interaction. But, data loss occurs from datagram ID 62231 to 62250 in I-PMIP.

Otherwise, in proposed scheme, it received UDP datagram for disconnecting time from 120 second to 120.7 second by using buffering. So, we could observe that proposed scheme is possible to providing seamless service.

These results effects UDP received performance as Figure 8 UDP throughput. In figure 8, P-M Interaction's UDP throughput is falling down to 0 during 2000ms. Because it occur global mobility delay and multicast group joining procedure delay. And I-PMIP's UDP throughput is falling down to 0 during 1600ms. Because it occur global mobility delay between SMA and multicast group join procedure delay. But proposed scheme has throughput falling time only 790ms and does not falling down throughput to 0 by using buffering.

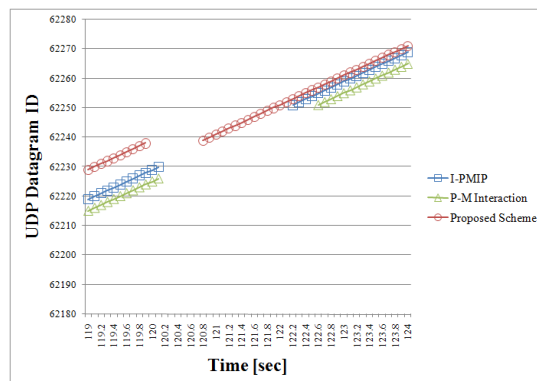


Figure 7. Comparison of UDP datagram ID

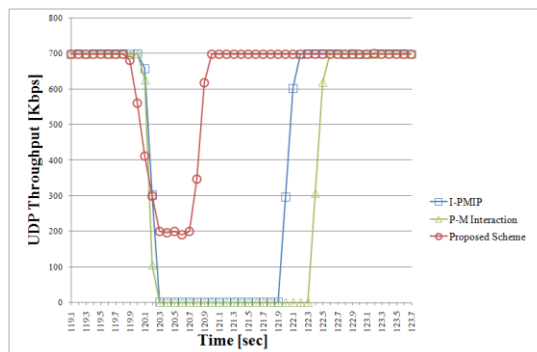


Figure 8. Comparison of UDP Throughput

Figure 9 shows comparison of TCP throughput with three methods. TCP throughput result is very similar UDP.P-M Interaction is falling down to 0 during 2000ms. And I-PMIP is falling down to 0 during 1600ms. But in proposed scheme, it shows that is not falling down to 0, even if throughput is falling down during 800ms. As a result, these throughput results show the proposed scheme is more effective than other two methods.

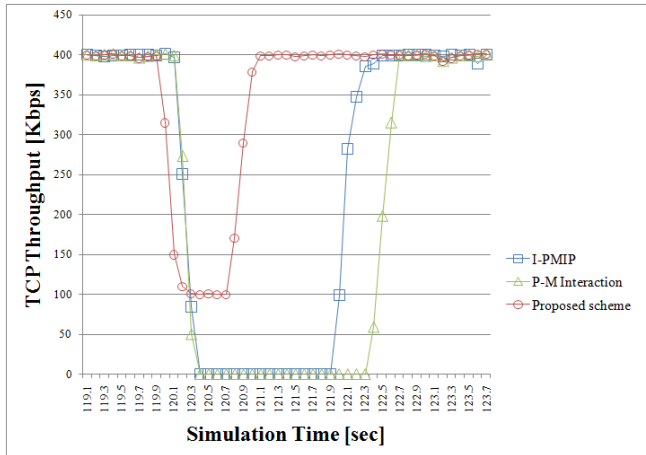


Figure 9. Comparison of TCP Throughput

V. CONCLUSION

In this paper, we propose a new multicast scheme which supports global mobility and provides seamless service in PMIPv6 networks. Before discussing the proposed scheme, we explained existing global mobility schemes in PMIPv6 network. Existing global mobility schemes have weakness which performs binding by HA or new agent. It is caused long term delay that after binding, starts multicast group joining procedure. But proposed scheme could support global mobility without additive global binding. Because LMAs could identify each other using LMA option format in RA message. In addition, LMA could prevent data loss using buffering procedure during global mobility procedure.

Using the NS-2 simulation, we showed that the proposed scheme reduces unnecessary delay than existing global mobility methods. Therefore, we thought more effective that it will be adapted to real PMIPv6 network.

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