

A Scheme for Supporting Global and Local Mobility Management in NGN

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Abstract— This paper proposes a new mobility management (MM) scheme for seamless service in IP-based Next Generation Network (NGN). The proposed scheme supports local mobility as well as global mobility, which overcomes problems from existing schemes, such as PMIPv6 or just MIPv6. This paper verifies that the proposed scheme has lower handover latency time than the others by using numerical analysis.

Keywords— NGN, Mobility Management, Location Registration, Handover

I. INTRODUCTION

The development of next generation wireless systems, which are characterized by seamless worldwide communication and support of various multimedia services, has been accelerated along with the development of wireless internet. Therefore, a variety of mobility schemes have been studied at research institutes and universities such as ETRI and CBNU as well as international standardization organizations such as ITU-T, 3GPP, IETF [1][2].

Especially, the IETF has progressed various studies about mobility as well as Mobile IP (MIP) to continue an IP session. The MIP supports mobility for user session but it has some problems such as considerable handover latency, power consumption, high packet loss, signalling overhead, and an extensive MIPv6 functionality in the IPv6 stack of a MN. Therefore, IETF NETLMM WG has developed Proxy MIP (PMIP) to solve the problems of MIP. The PMIPv6, which is a network-based MM scheme, supports mobility for IPv6 nodes with the help of proxy mobility agents in the network. With the protocol, a MN can provide service continuity without any mobility function. Once the protocol was deployed, it's not necessary to do any changes on the MN for mobility. However, the PMIPv6 uses the MIP to support global MM between different Access Networks (ANs) because it was designed to provide local MM within an AN. So, it has same problems by the MIP [2][3][4][5][6].

The ETRI and CBNU have worked Access Independent Mobility Service (AIMS), which is a MM scheme using MPLS for seamless service. It delivers signalling messages fast by L2.5 switching based on MPLS LSP. However, the

AIMS can be used only for global mobility. Therefore, a study for local MM in AIMS is needed in the future [1].

The above-mentioned existing schemes support limited MM. So, new mobility schemes that support mobility irrespective of a MN's movement should be developed by future studies.

In this paper, we propose a new MM scheme that can support local mobility as well as global mobility in the NGN. This scheme intends to solve the problems of the existing schemes and reduce latency time required during handover.

The remainder of this paper is organized as follows. Section 2 describes the related works about PMIPv6 and AIMS. Next, section 3 presents the proposed scheme. Then, section 4 shows the result of performance analysis. Finally, conclusions are given in section 5.

II. RELATED WORKS

This section introduces PMIPv6 of IETF and AIMS of ETRI and CBNU. It explains the overview of each scheme regarding network architecture, network elements and mobility operation.

A. PMIPv6

The PMIPv6, which is designed to support network-based MM was recently accepted as a standard by the IETF. In the PMIPv6, a MN does not participate in any IP mobility-related signalling and the network is responsible for managing IP mobility on behalf of the MN [2].

The PMIPv6 domain has two new network functional entities called Local Mobility Agent (LMA) and Mobile Access Gateway (MAG). The LMA, which is a local HA of the MN hosts MN's home network prefix, manages the MN's binding association and forward traffic to and from the MN while it moves within the PMIPv6 domain [6]. The MAG is a network entity that handles all mobility-related signalling on behalf of the MN. The MN is connected to the PMIPv6 domain via the MAG. It tracks the movement of the MN, authenticates it and initiates the required mobility signalling with the LMA. Furthermore, the MAG establishes a bidirectional tunnel with the LMA for enabling the MN to use an address from its home network prefix [6].

Figure 1 shows the architecture of a PMIPv6 domain. When a MN first enters a PMIPv6 domain and attaches to an access link, the MAG determines whether the MN is authenticated for

the PMIPv6 domain or not. After successful authentication, the MAG registers the location of the MN with the LMA using Proxy Binding Update (PBU) message. Upon receiving the PBU, the LMA allocates an HNP, creates a binding cache entry for the MN, and sends a binding registration reply, Proxy Binding Acknowledge (PBA) message, including the HNP. At this time, a bi-directional tunnel is established between the LMA and the MAG for packet delivery. This tunnel is shared by many MNs connected to the same MAG and LMA. This tunnel is only released either when tunnel lifetime expires or when there is no MN sharing the tunnel. When the MN moves to a new MAG area, the new MAG performs new location registration with the LMA, and other tunnel is established between the LMA and the new MAG for the MN [3].

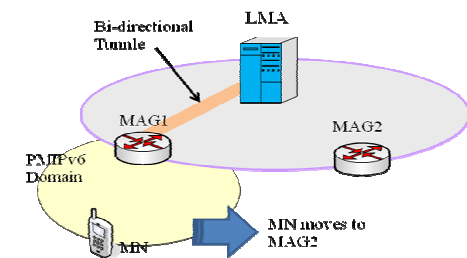


Figure 1. Architecture for the PMIPv6 network

Once a MN is in a PMIPv6 domain, the serving network assigns a unique home network prefix, and conceptually this prefix always follows the MN wherever it moves within the PMIPv6 domain [6].

B. AIMS

AIMS, which is a MM scheme based on MPLS has jointly studied at ETRI and CBNU in Korea.

Figure 2 shows the architecture of AIMS network. The Mobility Information Control Server (MICS), central address manager, manages MAC address, permanent IP address (IP_PA), and local IP address (IP_LA) of a MN as well as Handover Control Agent (HCA)'s IP address, and manages binding information related to communication between the MN and the Correspondent Node (CN). The HCA, local address manager, manages MAC address, IP_PA, and IP_LA of a MN, and encapsulates packets for data transmission. The Access Point (AP) forwards a MN's MAC address to HCA when a MN enters into its area. The LSPs between HCAs and MICS are used to transmit MM signalling message [1].

In case of initial location registration, when a MN enters into the AP#1 area, the AP#1 catches the MN's MAC address and then sends Location Report message to the HCA#1. The HCA#1 creates a record for the MN in its Local Address Management Table (L-AMT), and sends Location Registration message to the MICS, sending Address Inform message (with MN's IP_LA) to the MN. And the MICS creates a record for the MN in its Central Address Management Table (C-AMT). The MICS has MAC address and IP_LA of the MN, as well as the HCA#1's IP address. During the processing of the MICS, the MN sends Address

Inform ACK message (with MN's IP_PA) to the HCA#1 in response to Address Inform message from the HCA#1. When the HCA#1 receives the Address Inform ACK message, it sends Address Update message (with MN's IP_PA) to the MICS [1].

In case of handover between different ANs, when a MN moves from the AN#1 to the AN#2, the AP#2 catches the MN's MAC address and sends Location Report to the HCA#2. The HCA#2 creates a record for the MN in its L-AMT, writes the MN's MAC address and IP_LA, and sends Location Registration message to the MICS, sending Address Inform message to the MN. The MICS updates the record of the MN in its C-AMT, and sends Location Response message to the HCA#2, while sending other Location Response message to HCA#3 that keeps the connection with the MN. In consequence, the fast handover of the MN can be supported by the HCA and the MICS [1].

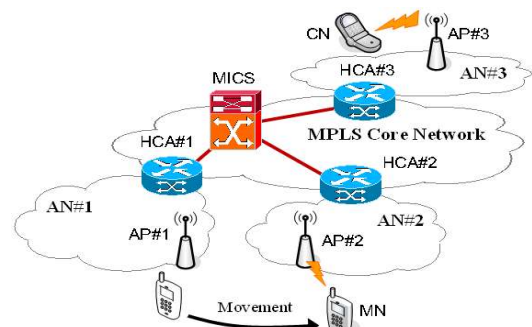


Figure 2. Architecture for the AIMS network

III. PROPOSAL

This section presents the network configuration and message flows of the proposed scheme for providing seamless mobility in NGN. This proposed scheme is based on an existing study that was worked before [1]. In compare with [1], this proposed scheme supports local mobility and reduces a MN's function for mobility. The message flows for supporting mobility have three procedures regarding initial location registration, local handover and global handover.

A. Network Configuration

Figure 3 shows the architecture of the proposed scheme.

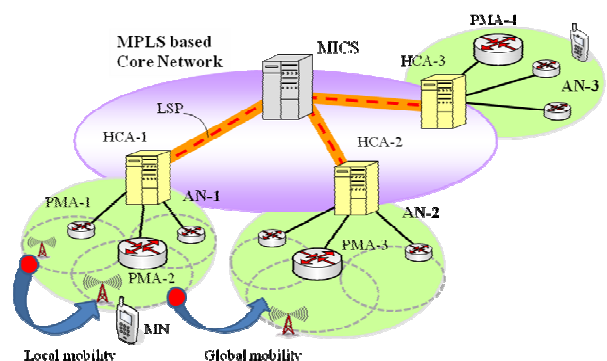


Figure 3. Architecture for the network of proposed scheme

The Mobility Information Control Server (MICS), which is central address manager, manages global mobility between different ANs and binding information related to communication between the MN and the CN. The HCA, which is local address manager, manages local mobility within an AN. Then, the PMA is initially connected with the MN in a network. The LSPs between HCAs and MICS are used to transmit MM signalling message.

B. Initial Location Registration

Figure 4 shows the procedure of initial location registration.

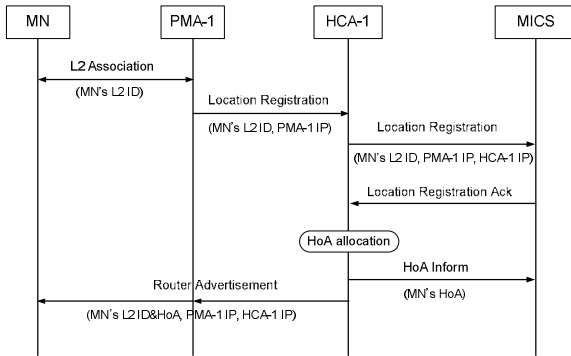


Figure 4. Initial location registration procedure

When a MN enters into a local region within an AN, the MN is connected with the PMA-1 by L2 association. Next, the PMA-1 sends Location Registration message to the HCA-1. The HCA-1 creates a record for the MN in its Local Mobility Management Table (L-MMT), and sends Location Registration message to the MICS. Then, the MICS creates a record for the MN in its Core Mobility Management Table (C-MMT). The MICS has the MAC address of the MN and the PMA-1 IP address, as well as the HCA-1's IP address. After the processing, the MICS sends Location Registration Ack message to the HCA-1. At that time, the HCA-1 allocates the MN's HoA and then informs the MICS of the address. Simultaneously, it sends Router Advertisement message.

C. Local Handover

Figure 5 shows the procedure of handover in case that a MN moves within an AN.

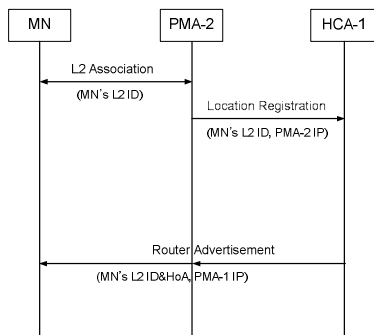


Figure 5. Local handover procedure

When a MN moves from the PMA-1 to the PMA-2, the MN is connected with the PMA-2 by L2 association. Next, the PMA-2 sends Location Registration message to the HCA-1. The HCA-1 identifies the MN's information stored in the L-MMT. Then, with Location Registration Ack message, it sends the MN's HoA and the PMA-1's IP address that is Home-PMA (H-PMA) of the MN to the PMA-2. And the PMA-2 sends Router Advertisement message with the MN's HoA and the PMA-1's IP Address.

D. Global Handover

Figure 6 shows the procedure of handover in case that a MN moves between different ANs.

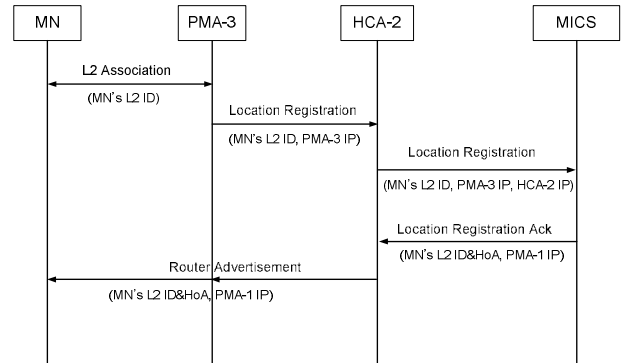


Figure 6. Global handover procedure

When a MN moves from the HCA-1 to the HCA-2, the MN is connected with the PMA-3 by L2 association. Next, the PMA-3 sends Location Registration message to the HCA-2. The HCA-2 creates a record for the MN in its L-MMT, and sends Location Registration message to the MICS. The MICS identifies the MN's information stored in the C-MMT. Then, with Location Registration Ack message, it sends the MN's HoA and the PMA-1's IP address that is H-PMA of the MN to the HCA-2. And the HCA-2 sends Router Advertisement to the PMA-3. Then, the PMA-3 sends Router Advertisement message with the MN's HoA and the PMA-1's IP Address.

IV. PERFORMANCE ANALYSIS

This section presents the performance analysis for the existing and proposed scheme. We compare the proposed scheme with PMIP in terms of handover delay when a MN moves between heterogeneous networks. In case of global handover, PMIP follows MIP operation.

We consider the same network topologies for the performance analysis of two schemes [7][8][9][10]. In case of PMIP, it is considered that the HA exists within the core network because it should support mobility between heterogeneous networks, especially in NGN environment.

And we only consider the processing time of network element in terms of handover delay because we assume the transmission time is same for all schemes. For performance analysis, we use M/M/1 queuing model, and the total processing time of each network element depends on the number of layers.

According to [1][11][12], let M_x be the set of messages processed in a network element x , and the utilization of a network element x , ρ_x , is obtained by

$$\rho_x = \sum_{l \in M_x} (\lambda_l / \mu_l) \quad (1)$$

Where λ_l and μ_l are the mean arrival rate and the mean service rate of messages of type l . We assume that the mean arrival rate of message l is equal for all messages in a network element. This assumption implies

$$\lambda_l = \lambda_x \text{ for all } l \in M_x \quad (2)$$

where λ_x is the mean arrival rate of any message in network element x . From Eq. (1) and (2), the mean sojourn time of message l in a network element x , σ_l , is obtained by

$$\sigma_l = 1 / \{\mu_l(1 - \rho_x)\} \text{ with } l \in M_x \quad (3)$$

We define the total service time in a network element x , s_x .

$$s_x = \sum_{l \in M_x} (1 / \mu_l) \quad (4)$$

That is, s_x is the time that is spent to process all messages arriving in the network element x during each scenario. The total service time in each scenario, S , is then expressed as

$$S = \sum_{x \in E} s_x \quad (5)$$

where E is the set of network elements. Therefore, the total service time for each scheme is presented in Table 1. (a) s_{L2} : packet service time of MAC layer. (b) s_{L3} : packet service time in MAC and network layers. (c) s_{L3+DB} : packet service time by operating database plus s_{L3} service time.

Table 1. Expression for total service time (S)

Scheme	Expression
PMIPv6	$6s_{L3} + 1s_{L3+DB} + 2(n-1)s_{L3}$
Proposed	$4s_{L3} + 1s_{L3+DB} + 2(n-1)s_{L3}$

We assume that the processing time of each layer's header in a network element is in proportion to that of IP header, and that the database (DB) processing delay in Table 2 is same as the processing time of IPv6 header. We derive the processing delay in each layer from the processing time of each layer's header [1][11], and the service time in each

network element according to element type can be calculated as Table 2.

Table 2. Service time in network element

Scheme	Expression
s_{L2}	2.59 ms
s_{L3}	10 ms
s_{L3+DB}	17.4 ms

Given that the reference arrival rate of a message at a network element for each scenario is λ , we define the effective call arrival rate, λ_x^{eff} , of a message.

$$\lambda_x^{eff} = \lambda / s_x \quad (6)$$

From Eq. (3) and (6), the total processing time of each scheme is presented in Table 3, where n is the hop number between access and core network elements. We assume that n is 5 and evaluate the handover latency time of each scheme.

Table 3. Expression for total processing time

Scheme	Expression
PMIPv6	$\{6s_{L3} + 1s_{L3+DB} + 2(n-1)s_{L3}\} / (1 - \lambda)$
Proposed	$\{4s_{L3} + 1s_{L3+DB} + 2(n-1)s_{L3}\} / (1 - \lambda)$

Figure 5 shows the proposed scheme's handover delay is lower than one of PMIP.

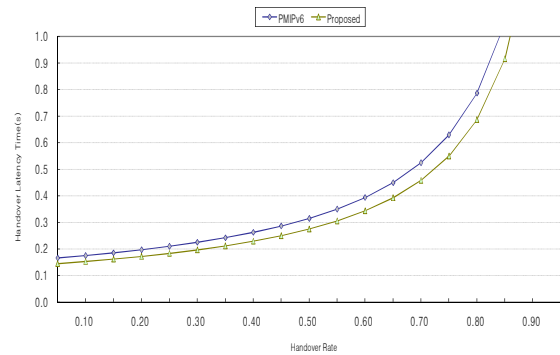


Figure 7. Handover Latency Time vs. Handover Rate

V. CONCLUSION

This paper proposes a new MM scheme for seamless service in IP-based NGN. The proposed scheme supports local mobility as well as global mobility, which overcomes problems from existing schemes, such as PMIP or MIP. For the performance comparison between existing and proposed scheme, we calculated handover latency time of two schemes using M/M/1 queueing system. As a result of numerical analysis, the proposed method shows the better performance in terms of handover latency time than the PMIP.

In our future works, we may consider and define more correct parameter values for performance evaluation. Then, we will consider the performance regarding various factors except to handover latency time.

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