Implementation of 802.21 for Seamless Handover Across Heterogeneous Networks

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Abstract. MIH (Media Independent Handover)[1] is the standard technology of IEEE 802.21. It gives seamless handover to mobile terminals that have multiple wireless interfaces. Recently, many mobile terminals having multiple wireless interfaces are emerging on the market. Thus, the handover technology, which makes it possible to hand-over between heterogeneous networks, is attracting the attention of network operators. In this article, we explain IEEE 802.21 framework and its laboratory implementation and compare between IEEE 802.21-based handover and non-802.21-based handover. We performed laboratory experiments on handover between IEEE 802.11 (WiFi) access networks and IEEE 802.3 (Ethernet) using MIH Functions. We also analyzed and compared 802.21-assisted handover and non-802.21-assisted handover.

Keywords: IEEE 802.21, MIH, Seamless handover.

1 Introduction

Recently, there have been an increasing number of products on dual-mode terminals that have CDMA and WLAN access interface. However, handover between heterogeneous access network is not automatically operated.

Seamless handover is an indispensable capability of the next-generation network. As Figure 1 shows, in NGN, there are many access networks and there is one core network. So, if we want to offer voice services in NGN, it is very important to support seamless handover between many heterogeneous access networks.

It is very hard to offer such seamless handover between heterogeneous access networks because many heterogeneous access networks have different mobility mechanisms and they have various QoS quality and security requirements. In addition to that, applications such as VoIP and streaming services have tight performance requirements like end-to-end delay and packet-loss.

Handover decision is very important for mobility management. We can reduce delay using pre-retrieved network information and a well-ordered handover policy. In this case, inter-operation between network and terminal and another network component is needed. The IEEE 802.21[1] standard defines the framework that is needed to exchange information between handover participants to provide mobility. It also defines functional components doing handover decision.

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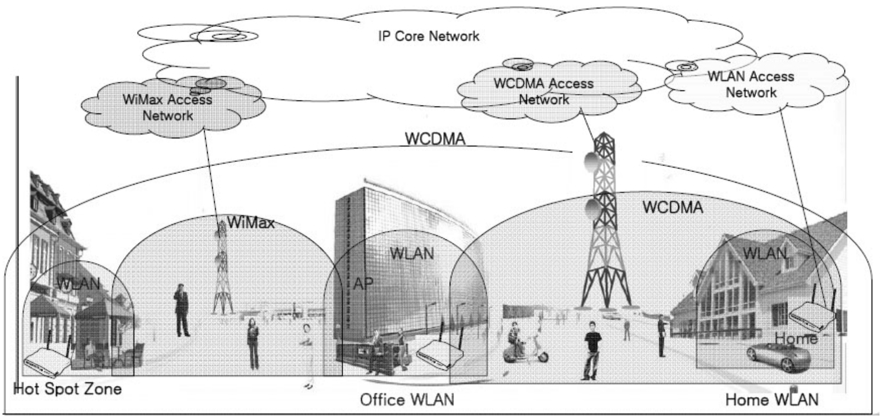

Fig. 1. Network architecture of NGN

In this article, we discuss the IEEE 802.21 framework and its laboratory implementation. We also discuss our experimental results on handover between 802.11 (WiFi) access networks and between 802.16 (WiMax) access networks and 802.11 access networks.

2 802.21 Framework

The IEEE 802.21 framework offers the method and procedure for handover between heterogeneous networks. This handover procedure uses the information from both mobile terminal and network infrastructures. The IEEE 802.21 framework informs the available network nearby of the mobile terminal and helps the mobile terminal to detect and select the network. This information includes link layer information.

The core of 802.21 lies in MIHF (Media Independent Handover Function). MIHF consists of intermediate functionalities residing between layer2 and layer3. It presents

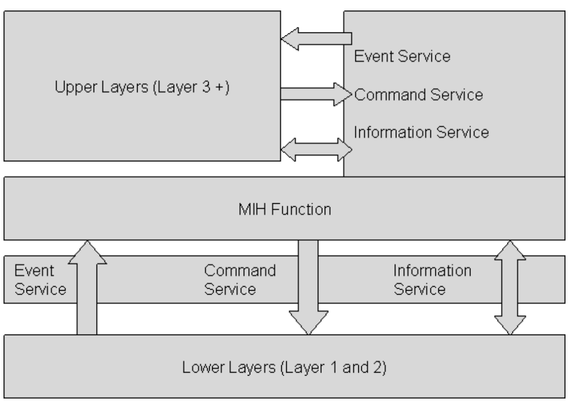

Fig. 2. Media independent handover framework

homogeneous interfaces independent from access technologies [2]. This interface charges the communication between the upper layer and the lower layer. Figure 2 shows the media independent handover framework.

MIHF provides three services; namely MIES (Media Independent Event Service), MICS (Media Independent Command Service), MIIS (Media Independent Information Service).

2.1 MIES

MIES proffers the local or remote event to the upper layer. Figure 3 shows the MIES. The MIES supports the transfer, filtering and classification of dynamic changes on the link layer.

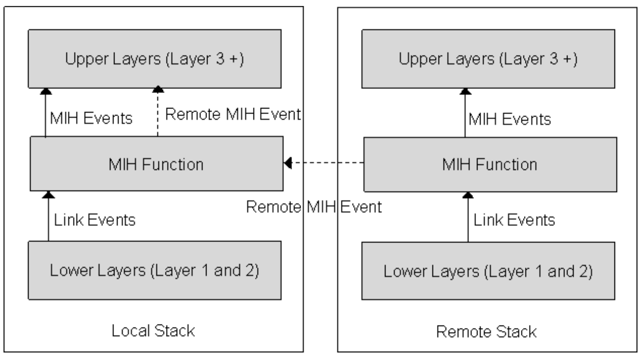

Fig. 3. Media independent event service

2.2 MICS

The MICS offers the functions for managing and controlling the link layer. If the MIH application wants handover and mobility, it can control the MAC layer by using MICS. Figure 4 shows the MICS block.

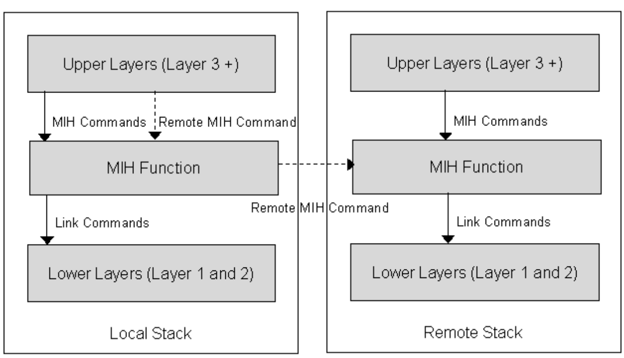

Fig. 4. Media independent command service

2.3 MIIS

The MIIS offers information that is needed to perform the handover. This information includes nearby available access networks. Using this information, the mobile terminal makes a decision on the handover. Figure 5 shows an examples of MIIS message.

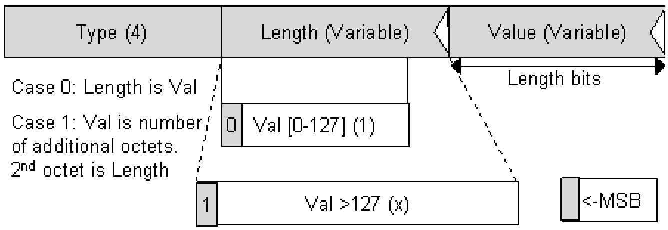

Fig. 5. TLV messages (octets)

2.4 SAP

SAP is an abbreviation for Service Access Point. It is an API that makes it possible to communication between the lower and upper layers. Figure 6 shows the 802.21 reference model on various heterogeneous networks.

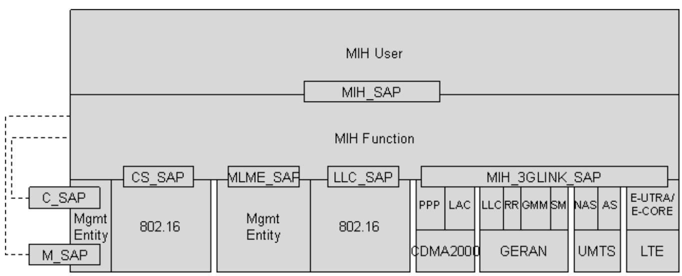

Fig. 6. IEEE 802.21 SAP reference model

3 Implementation of 802.21

In this paper, we implemented 802.21 based on the Linux platform. We made the 802.11 access point and information server using a Linux box. We used a notebook PC as the mobile terminal that can access the 802.11 and 802.16 networks. We experimented on handover between 802.11 (WiFi) networks and we also experimented on handover between 802.11 and 802.16 (WiMax) access networks.

3.1 Implemenation of PoA MIHF

PoA (Point of Attachment) is the function that makes it possible for a mobile terminal to access wireless media, and it is the component of the network structure. PoA MIHF performs the transportation of messages passing among mobile terminals and between the mobile terminal and other PoA MIHF or Information server and analyzes the messages passing them.

Figure 7 shows the 802.11 PoA MIHF block diagram and Figure 8 shows the messages between the Mobile node and the PoAs.

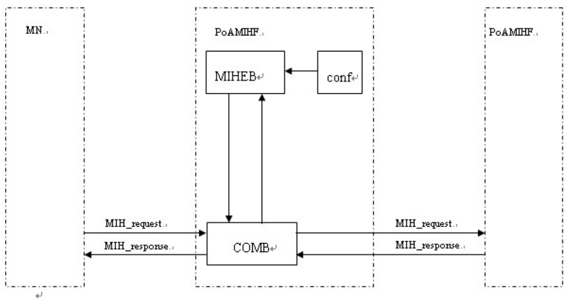

Fig. 7. Block diagram of PoA MIHF

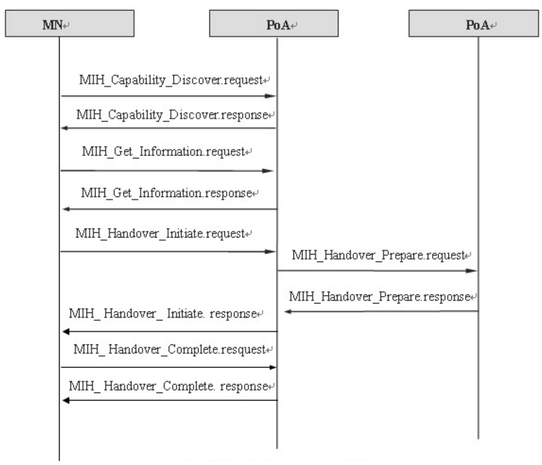

Fig. 8. Flow of MIH messages

3.2 Implemenation of MN MIHF

MN (mobile node) MIHF support handover linked to MjSIP[3] and Linux device driver interface. Figure 9 shows the interaction between MjSIP (application) and MN MIHF through the Linux device driver interface and other PoA MIHF.

3.3 VoIP Application

In this paper, we performed an experiment using MjSIP that enables video/audio communication based on SIP. MjSIP processes session creation and manages dialog.

It can support video/audio communication using RTP. We chose this application to experiment on handover when we communicated voice on an ip network. MjSIP calls or receives the MIH messages based on JNI. Using this interface, MjSip can access the MIHF driver as described in 3.2

Fig. 9. Message flow between MIHF

3.4 Handover Experiments

Figure 10 shows the experimental environment that performs handover between 802.11 access networks.

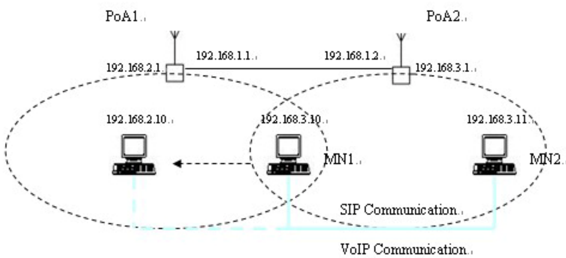

Fig. 10. Service architecture using IP network

Mobile node 1 communicates with Mobile node 2 using VoIP. MN1 has two WLAN interfaces (WLAN0, WLAN1). At first MN1 communicates with MN2 using WLAN0. As MN1 escapes from PoA2's access area, it queries if there is an available access network near PoA2. Its procedures are shown in figure 7. After receiving MIH_GET_INFORMATION_RESPONSE, MN1 activates its other WLAN interface (WLAN1) and sets the necessary parameters, which are received from the previous MIH response to access PoA1's access network. When the preparations for accessing PoA1's network is complete, MN1 sends "RE-INVITE" to the SIP proxy server using ip that is set for PoA1's access network. It updates MN1's ip binding. And then the media session is re-established. At last, it shuts down WLAN0.

Figure 11 shows the experimental environment for testing handover between an 802.11 access network and an 802.3 access network.

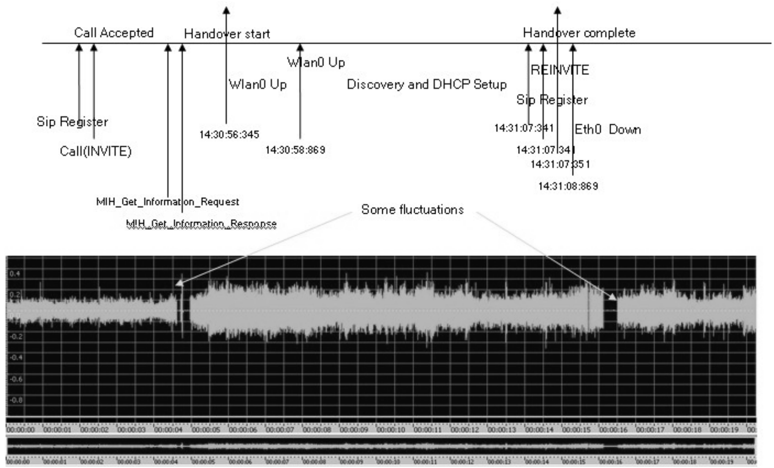

Fig. 11. Experimental result of 802.21-assisted handover

Figure 12 shows the experimental result for 802.21-assisted handover and Figure 12 shows the experimental result for non-802.21-assisted handover. As can be compared from these graphs, packet loss and delay time are greatly different. 802.21-assisted handover greatly improves packet loss and delay time.

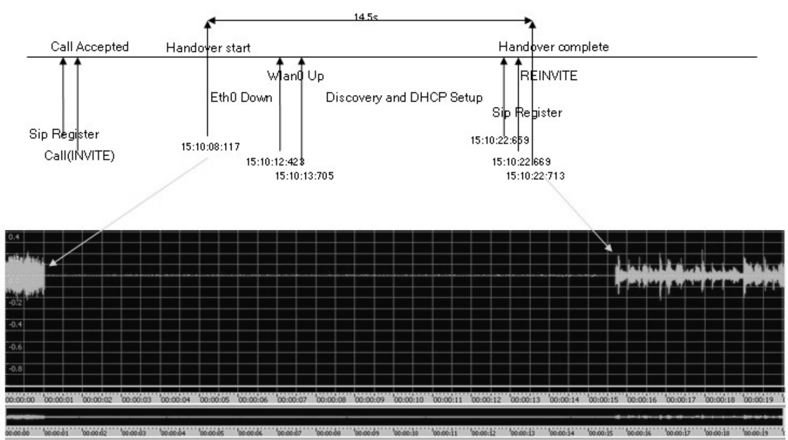

Fig. 12. Experimental result of non- 802.21-assisted handover

4 Summary and Conclusion

As communication networks evolve to NGN, communications based on ALL-IP networks is emerging. It is necessary to support seamless handover between heterogeneous networks for service quality. In addition to that, there will be more multi-mode terminals and the demand for mobile VoIP will be increasing. So, the functions of

802.21 that support seamless handover in heterogeneous access networks are essential. In this paper, we discussed several functional components of the framework and their roles in supporting handover. We explained the laboratory implementation of 802.21 and handover experiments using 802.21. We also compared 802.21-assisted handover and non-802.21-based handover. As the experimental results show, 802.21-assisted handover provides seamless handover by reducing delay and packet loss during handover to a level that is acceptable for mobile VoIP and streaming traffic.

In this paper, we analyzed 802.21-assited handover. But handover policies and other techniques that improve handover packet loss and delay such as fast-handover [4] will affect packet loss and delay time. Another important issue is how to make the information server and gather the geographical network information.

In the future, we will conduct experiments on handover between various wireless access networks, and we will measure the delays at each handover step to create an optimized handover policy. These experimental results will be an important data for seamless mobile ip communication.

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