모바일 WIMAX 네트워크 기반의 모바일 IPTV를 위한 IPv6 핸드오버 성능

트렁 민 부이*, 무스타파 잠만 차도 후이*, 뚜안 응웬*, 장영민* 정회원, 김영일**, 류원**

IPv6 Handover Performance for Mobile IPTV over Mobile WiMAX Networks

Bui Minh Trung*, Mostafa Zaman Chowdhury*, Tuan Nguyen*, Yeong Min Jang* *Regular Members*
Young-Il Kim**, and Won Ryu**

요 약

IP기반의 무선 네트워크에서 원활한 IPTV 서비스를 지원하기 위해, 뚜렷한 중단이 IPTV 사용자들을 불쾌하게 만들기 때문에 지연 또는 중단시간을 최소화해야 한다. 다수의 프로토콜들이 이동성의 문제를 해결하기위해 제안되었지만 모바일 IPTV 서비스를 지원하기 위한 효과적이고 원활한 핸드오버 방법은 아직 풀어야 할 문제이다. 모바일 WIMAX는 IPTV 서비스를 지원할 수 있는 액세스 네트워크에서 무선으로 해결하는 방법을 제안한다. 본 논문의 목표는 모바일 WIMAX가 가능한 IPv6에서의 핸도오버 과정 동안 지연시간의 몇 가지 이유를 확인하는 것, 기존의 표준화에 의해 주어진 몇 가지 최적의 시나리오에 의한 핸드오버 지연을 개선방법을 제안한다.

Key Words: IPv6, WiMAX, handover, mobile IPTV.

ABSTRACT

To support seamless IPTV services in IP-based wireless network, delay or interruption time must be minimized because noticeable interruption will make IPTV service users unhappy. A number of protocols have been proposed for solving mobility problem. However effective seamless handover mechanism to support mobile IPTV services yet to be solved. Mobile WiMAX offers a wireless solution in the access networks that can support IPTV services. Goal of this paper is to identify some reasons of delay time during handover process in an IPv6 capable Mobile WiMAX and to perform handover delay of some optimization scenarios given by existing standardization and proposed improvement.

I. Introduction

Internet Protocol Television (IPTV) is gaining recognition as a viable alternative for the delivery of video by telecommunications and cable companies [1]. It features bandwidth efficiencies, and management; therefore, it is ideally suited for broadcast, multicast, unicast interactive, and multimedia services (IMS - IP multimedia). As the IPTV technology uses standard networking protocols, it promises lower costs for operators and lower prices for users. Using set-top boxes with broadband Internet connections, video can be streamed to households more efficiently than current coaxial cable. In general, mobile IPTV services can be classified by their type of content and services [1], [2] as:

- On-demand content
- Live content

*Department of Electronics Engineering, Kookmin University, Seoul, Korea (yjang@kookmin.ac.kr), 교신저자 : 장영민
**Electronic and Telecommunications Research Institute (ETRI), Korea,
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접수일자 : 2011년 9월 1일, 수정완료일자 : 2011년 10월 31일, 최종게재확정일자 : 2011년 12월 2일

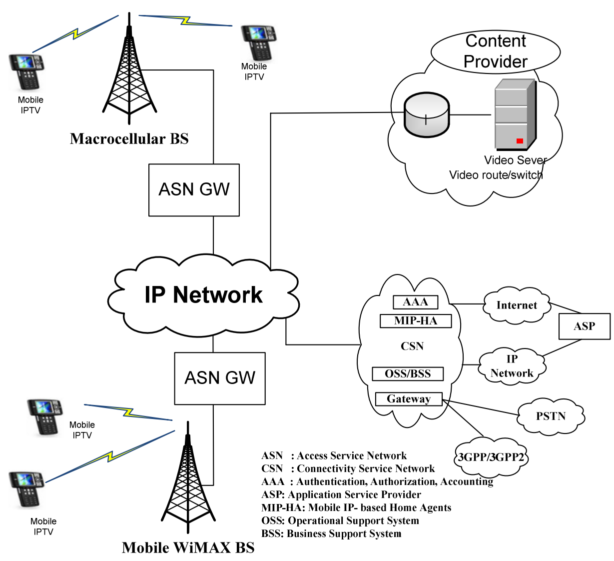

Fig. 1. Network architecture for the Mobile IPTV connected Mobile WiMAX.

- Managed services
- Unmanaged services

For the successful deployment of the mobile IPTV services the following key requirements need to be addressed [1]:

- Capability requirements for mobile terminals: size display, power processor, and limited storage
- Bandwidth requirements become broad enough to accommodate High Definition quality video services.
- Guarantee the wireless link till connect although temporal reflectors and obstacles around the mobile terminals can affect the received signal and cause burst packet losses.
- Deployment wireless network to cover all geographical area with no dead spots, services are restricted in some area.

WiMAX is the commercial name of network solutions based on the IEEE 802.16 standard. Defined by the IEEE 802.16 working group in 2004 [3], this specification is constantly assessed, tested improved. Since fixed, IEEE 802.16 based network solutions started to appear in 2004, intensive work has been undertaken to provide mobility support. As a result in late 2005, a mobility-supporting specification was released [4]. Mobile WiMAX, has gained much attention recently for its capability to support high transmission rates in cellular environments and QoS for different applications. Beyond what the standard can define, in order to effectively support video streaming, VoIP, and data services, proprietary radio resource management, including multi connection assignment, scheduling controls, and call admission controls, are essential [5]. To support seamless IPTV services in IP-based wireless networks, delay or interruption time must be minimized because noticeable interruption will make IPTV service users unhappy. Therefore, a seamless handover mechanism is very important to support mobile IPTV services over wireless networks.

Mobile WiMAX offers a wireless solution in the access networks that can support mobile IPTV services. The standards of the IEEE 802.16 family provide fixed and mobile broadband wireless access (BWA) and promise to deliver multiple high-data-rate services over large areas. Figure 1 shows the basic network architecture for the mobile IPTV services over Mobile WiMAX networks. Video servers/encoders store audio/video (A/V) contents which are encoded and compressed from live and pre-recorded programs. Video servers/encoders are either centralized or distributed in core networks.

Goal of this paper is to identify main reasons of delay time during handover process in an IPv6 capable Mobile WiMAX and to perform handover delay of some optimization scenarios given by existing standardization and proposed improvement. Then we discuss about Mobile WiMAX capacity when supporting for mobile IPTV service.

This paper is organized as follow. Section II describes the related works. In Section III, IPv6 handover scheme of mobile IPTV over Mobile WiMAX is considered, and the proposed handover scheme to reduce the handover delay is presented in Section IV. In Section V, we presented the handover simulation performance. And finally, conclusions are discussed in Section VI.

Ⅱ. Related Works

In IEEE 802.16 [4], the handover process can be divided into two phases: handover process and network re-entry [6]. The first phase includes three steps: neighbor discovery, scanning, and handover decision. In the neighboring discovery step, the mobile subscribe (MSS) recognizes signal strength becomes weak and decides to perform scanning process. The MSS obtains the neighbor base stations (BSs) information from the Mobile Neighbor Advertisement (MOB-NBR_ADV) message which is broadcasted by the serving BS. Then, in the next step the MSS selects the candidate BSs according to this information, and performs synchronization all of the candidate BSs to determine the target BS it will associate with. The MSS sends the Identification (HO-IND) message to serving BS for determent target BS. The target BS can be determined using several metrics, such as received signal strength, available bandwidth, the other priority parameters, etc. After the target BS is selected, the MSS disconnects all communications with the serving BS and synchronizes with the target BS. DCD/UCD messages are used to exchange the parameters for the downlink and uplink. There are two kinds of ranging supported in IEEE 802.16: contention based ranging and non-contention based ranging. In the last phase, the MSS performs the re-entry process and completes the authorization and registration processes.

To reduce the handover delay time, there are many proposed approaches in the several literatures. In [7], the authors proposed a predict algorithm to estimate the target BS using mean CINR and arrival time difference. Using preamble, delay can be reduced by skipping the unnecessary neighbor BS scanning. The handover latency can be reduced signi ficantly. But using this algorithm, the MSS cannot receive all physical information from the BSs. In [8], the MSS stores the frequency information and uses this information to estimate the frequency of target BS. In [9], the relay station is used to optimize the scanning process. In [10], the author modifies the Downlink message to Fast DL-MAP_IE message to help the MSS receives the downlink traffic when the uplink is not synchronized with the target BS. Some cross-layer solutions to reduce handoff latency have been proposed in recent years. In [11], the authors reduce the handoff latency using information about the service flow on the MSS and in [12], handover latency is minimized using an efficient authentication scheme. In [13], the authors proposed a priority algorithm to reduce the scanning BSs list using the efficient mobility pattern.

After finishing network re-entry in a new location, an IPv6 node, working on the top of the MSS stack, has to make handover in IPv6 and higher layers. That process can be arranged using a stateless [14] or stateful [15] automatic configuration procedure. In [16], the detail reconfiguration is described.

Ⅲ. IPv6 Handover Scheme

In the initial, the MSS must prepare for handover process. Figure 2 shows handover acquisition process. This process includes the neighbor discovery and scanning steps:

• *Neighbor Discovery* : The MSS receives Neighboring Advertisement (MOB_NBR-ADV) message which contains information related to the other BS nearby. This message is periodically broadcasted through the IP network.

• *Scanning* : After obtaining neighboring BSs' information from serving BS and recognizing that the current BS's signal strength is becoming weak, MSS decides to perform scanning and synchronization process by sending Scanning Request (MOB_SCN-REQ) message. The BS responds Scanning Respond (MOB_SCN-RSP) message to accept the MSS for performing the scanning process. After scanning completes, MSS gains knowledge about the neighboring BSs. Using various metrics (signal strength, signal to noise ratio, etc.), MSS sorts the BS list. This process may take long time when MSS is being in the dense BS area. We will focus on this problem in the next section.

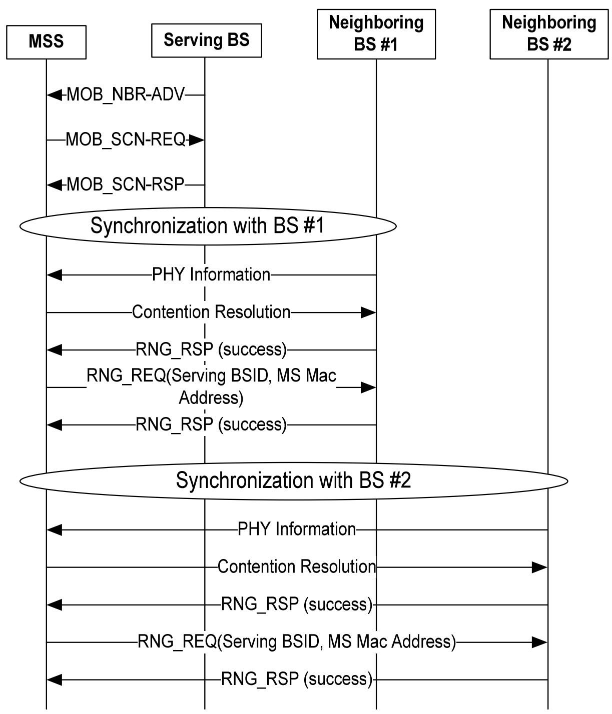

Fig. 2. Handover acquisition process.

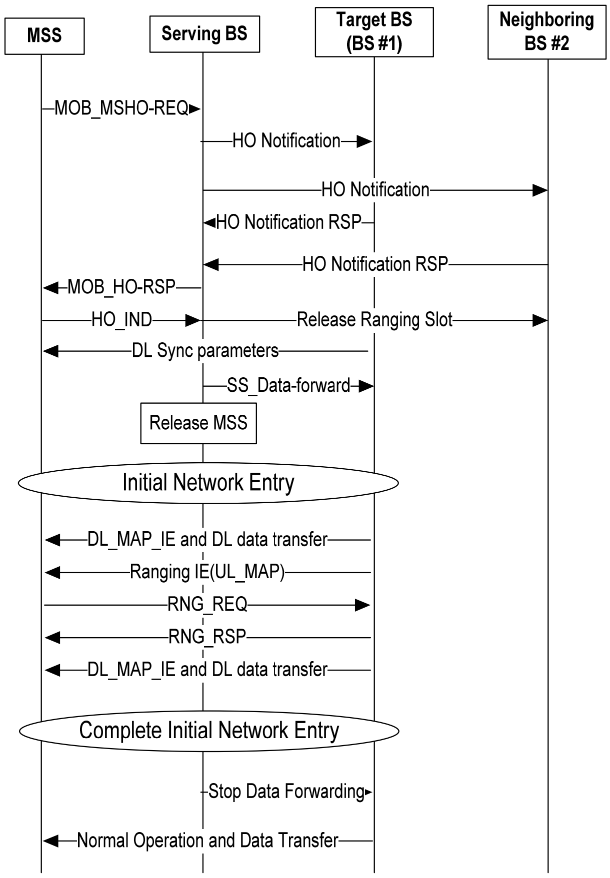

Fig. 3. Handover and network re-entry process.

After finishing the previous steps, the MSS continues to perform the handover and network re-entry process. Figure 3 shows handover and network re-entry process.

• *Handover* : After synchronization process, MSS has a list of neighboring BSs and their characteristics. MSS sends a list of desired target BSs to its serving BS through Handover Request (MOB_MSHO-REQ) message. The serving BS can modify this list and send it back in Handover Respond (MOB_HO-RSP) message. After that, MSS sends Handover Identify (HO_IND) message to identify target BS. After this transmission, serving BS forwards data to target BS and releases MSS.

• *Network Re-entry* : MSS adjusts the radio elements depending on station's frequency and modulation, and then performs network re-entry. Delay in this process can be decreased significantly when reducing some unnecessary message that that will be discussed in the Section V.

In the ideal case, handover process implements BSs managed by same operator, the network operator knows current MSS location and so that MSS does not need to change the IP address. On the other hand, MSS must complete network re-entry and the higher layer (i.e. IPv6), must be reconfigured. According to IPv6 standards [14] - [16], the following steps are necessary:

• *Stateless auto-configuration* : MSS routes to be configured properly by using Router Advertisement (RA) message. This message can be announced periodically by routers or requested by MSS - sending SOLIT message.

• *Stateful configuration* : Configuration process requires obtaining such parameters as IPv6 addresses, DNS configuration, SIP domains and server. Only some basic parameter can be auto-configured. Stateful configuration is implemented according to DHCP for IPv6 (as DHCPv6).

• *Location update* : After finishing two previous steps, MSS must inform its home agent of new attached point. After completing this step, the communication process is able to implement normally.

Ⅳ. Proposed Handover Scheme to Reduce the HO Delay in the Dense WiMAX BSs

In previous section, we just only consider scenarios that MSS comes to area of one BS. In this section, we consider dense WiMAX BSs scenario, with the meaning that MSS comes to overlapped area of more than one BS. Figure 5 shows our proposed dense WiMAX BSs scenario. In this scenario, when leaving the connecting with the serving BS, MSS comes to area of three BSs nearby. In this case, when MSS recognizes received signal strength from the serving BS becomes weak, it performs the neighboring discovery process. MSS discovers other three BSs which have signal strong enough for connecting. And MSS performs the scanning and synchronization process with all three BSs. With each BS, MSS exchanges some messages to get information and then makes handover decision. Figure 2 shows the messages that will be exchanged in the synchronization process. During the exchanging of messages, if some messages are missing, the loop circuit performs until waiting timeout [4]. Therefore, delay in this process may be increased by large amount if there are many BSs in the MSS coming area, and if communication environment is so bad - reason of message missing.

One solution to solve this problem is to optimize the waiting timeout that how to get the best performance. In [4], they do not issue any waiting timeout, so that the waiting time out can be optimized for the specific service system. Another solution is reducing the synchronization BSs list from the neighboring BSs list with condition guarantee the communication quality. In this section, we propose a priority algorithm for reducing the BSs list that MSS performs in the synchronization process.

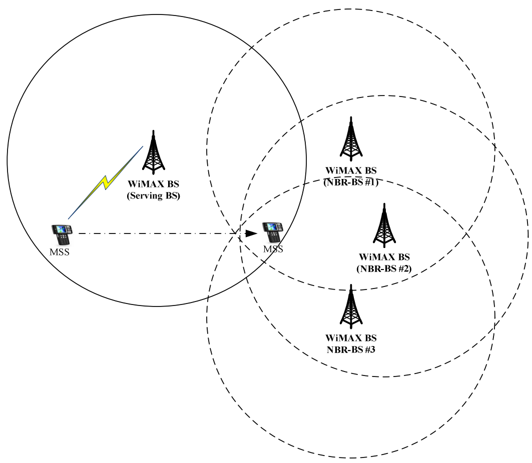

Fig. 4. An example of dense Mobile WiMAX BSs scenario.

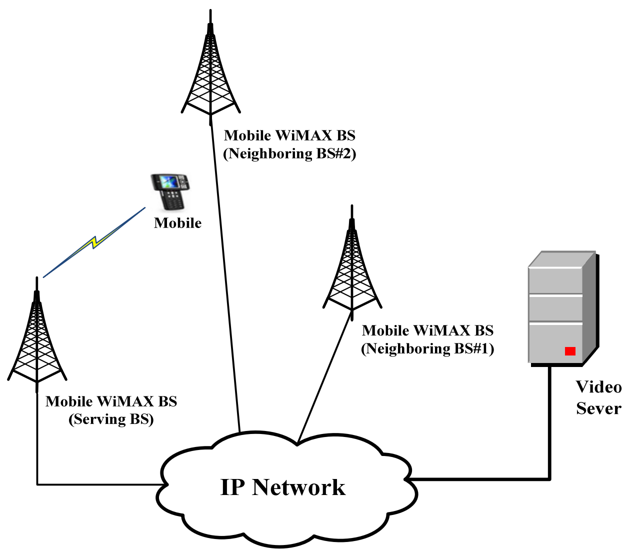

Fig. 5. Simulation model to perform the handover delay.

In this proposed scheme, we concentrate how to reduce the synchronized list using localization acknowledgement. This idea is based on the direction of MSS's movement when it is being in the overlapped area. In our scenario, when MSS comes to that area, it performs scanning process and decides to connect with best BS - depending on various metrics (signal strength, signal to noise ratio, etc.).

In Figure 4, We assume MSS decides to connect with BS #3 at that time, because it's good performance. But MSS does not move to BS #3, it moves to BS #1 as assumption. In that case, MSS only connects with BS #3 for a short time and recognizes again signal becomes weaken. Then it performs the scanning process again. That problem will increase the number of unnecessary handovers and handover time, therefore decreasing the performance of system. In that case, if MSS priors to connect with BS #1, the performance will be better.

To solve this problem, we propose the method to make handover decision with priority using direction acknowledgement. We assume that Neighboring Advertisement (MOB-NBR_ADV) message contains the localization information of neighboring BSs. The serving BS can get the localization information of neighboring BSs through the access network and then periodically broadcasts to MSS. MSS can know the localization by itself, so that it can calculate its moving direction. After receiving the localization information of BSs and comparing with its moving direction, MSS makes a priority scanning list depend on localization and sends to serving BS through Scanning Request message. Next state, serving BS sends the Scanning Respond message to accept the MSS for performing the scanning processes. MSS performs scanning process from the beginning of localization list. If it meets certified BS, it will stop the scanning process and send Identification (HO_IND) message to serving BS. In the worst case, MSS performs scanning process with all neighboring BSs. But worst case appears with low probability. In the best case, MSS only performs scanning process one time and decides to connect with target BS, therefore reducing the handover time significantly.

V. Handover Performance Measurement

In this section, we consider some scenarios to analyze the handover latency. With each scenario, we analyze the delay of each process

A. Handover Scenarios

Some scenarios proposed by [6] are applied for mobile IPTV case. With each scenario, we take care about handover, re-entry, and location update time. The scenarios category as:

1) Standard : MSS must performs total all process provided by mobile WiMAX standard (IEEE 802.16e) without any optimization.

2) Optimized standard : A set of possible optimization provided by IEEE 802.16e. If there is available priority knowledge, some steps can be omitted: basic capability negotiation (SBC-REQ/SBC-RSP), registration (REG-REQ/REG-RSP) and key exchange (multiple PKM-REQ/PKM-RSP) and service flow creation (DSA-REQ/DSA-RSP/DSA-ACK).

3) Skip initial DHCPv6 delay : Purpose of this initial time is to reduce the congestion following a power outage. In this scenario, this feature is removed.

4) Rapid-commit : Reducing the number of discovering message exchanged between DHCPv6 server and client from four messages to two messages

5) Skip DAD (Duplicate Address Detection) : A configured address detection mechanism. But this feature was not designed for mobility case, so that we can omit this process.

Figure 5 shows simulation model to perform the handover delay. In this model, three Mobile WiMAX BSs and video sever connect to the IP network. This simulation uses Numbat - one packet of OMNET simulator, extensible simulation environment for mobile, IPv6 capable IEEE 802.16e stations [6]. In this model, handover initiates after a constant time interval (3 second) of starting the communication process. Purpose of this model is to simple handover process simulation and focus on handover producing itself.

Figure 4 shows the dense WiMAX BSs scenario for our simulation model, with mean that there is more than one BS in the mobile coming area. In this model, there are two cases of scanning: full scanning process provided by existing standardization and reducing scanning process using localization and direction acknowledgement. Purpose of this model is to find out the efficiency improvement of proposed scheme when MSS comes to the many BS area.

B. Performance Analysis

With each scenario, we take care about delay time of each process in total handover process and delay time of two cases: handover process without location update (governed by same operator case) and total handover (governed by different operator case). In first case, delay time includes delay of handover and re-entry process. In second case, delay time includes delay of handover, re-entry and location update process. Each handover scenario is simulated in the same time (100ms), and delay time is calculated by average number of handover delay. The chosen simulation time is long enough for handovers performance measurement.

Figure 6 shows handover delay time comparison for different scenarios in the case of without location update. In this figure, we see that delay time of four last scenarios is same in without location update case. Because each scenario has same optimization of handover and re-entry process provided by existing standardization. Figure 7 shows the total handover delay time comparison for different scenarios. In Figure 7, each scenario delay is smaller than previous one. Because each scenario is optimization of previous one in location update process.

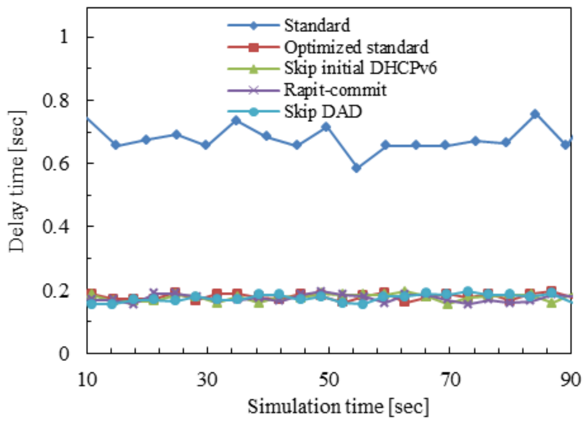

Fig. 6. Handover delay time comparison for different scenarios in the case of without location update.

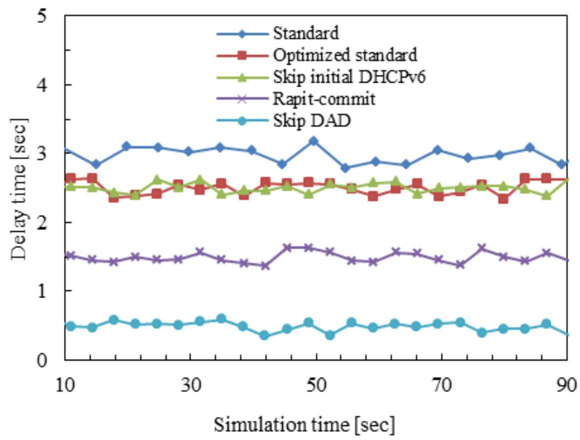

Fig. 7. Total handover delay time comparison for different scenarios.

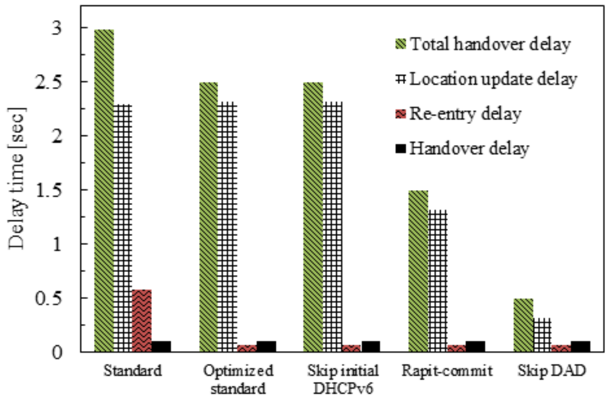

Fig. 8. Comparison of delay time of each handover process.

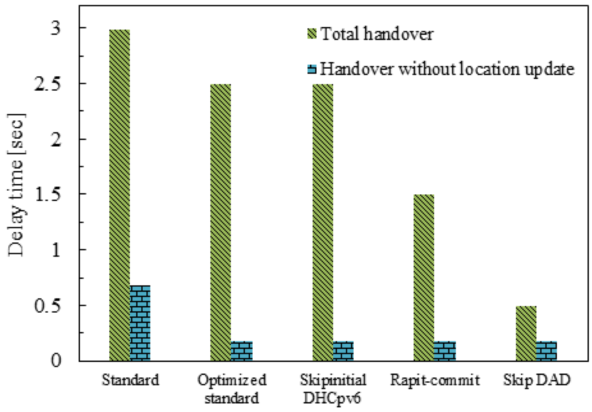

Fig. 9. Comparison of delay of total handover and handover without location update process delay.

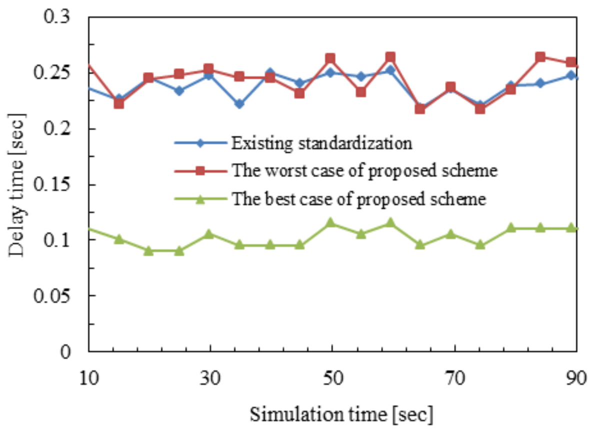

Fig. 10. Handover performance of the proposed scheme.

We calculate the average delay for of each of the processes of every scenario in Figure 8. The figure shows the comparison of delay time of each handover process. In Figure 9, we calculate average delay of total handover and handover without location update process. Figure 8 shows that delay of handover and re-entry process is very small comparison to location update delay. So that, there is a big difference between delays of total handover and handover without location update process in Figure 9.

From Figures 6-9, we verified the main causes of the handover delays. We also showed various handover process delays. Figure 10 shows the handover process performance of the proposed scheme. In the worst case, the performance of delay time is same with existing standardization case, because MSS performs scanning process with all neighboring BSs. In the best case, the MSS only performs scanning process one time, therefore latency is reduced significantly

VI. Conclusions

Analysing and simulating delay of each process in WiMAX IPv6 handover shows the general observing about the reasons of the delay time. We gathered the genaral knowledge about handover process and analysised each step and it's latency in the whole process. Simultaneously, the new priority scheme is proposed to reduce the latency in the dense BSs scenario. This proposal can be implemented in the real mobile IPTV system and can enhance the performance of system. Performance of existing standardization and proposed improvements is evaluated by using the real scenario simulation environment. Through simulation results, we see that Mobile WiMAX with IPv6 capable is the good candidate for mobile IPTV system. The research also indicates the main reasons of delay in multi-operator environment – location update process.

참 고 문 헌

[1] S. Park, and S. Jeong, "Mobile IPTV Approaches, Challenges, Standards, and QoS Support", IEEE Computer Society, May/June 2009.

[2] S. Park, S. Jeong, and Cheolju Hwang, "Mobile IPTV Expanding the Value of IPTV", In proc. of International Conference on Networking, Aug. 2008.

[3] IEEE working group, "IEEE 802.16-2004 : IEEE Standard for Local and Metropolitan Area Networks – Part 16 : Air Inter-face for Fixed Broadband Wireless Access Systems", Oct. 2004.

[4] IEEE working group, "IEEE 802.16-2004 : IEEE

Standard for Local and Metropolitan Area Networks - Part 16: Air Interface for Fixed and Mobile Broadband Wireless Access Systems", Dec. 2005.

[5] J. She, F. Hou, P. Ho, and L. Xie "IPTV over WiMAX: Key Success Factors, Challenges, and Solutions", IEEE Commun. Magazine, Aug. 2007.

[6] T. Mrugalski, and J. Wozniak, "Numbat-extensible simulation environment for mobile, IPv6 capable IEEE 802.16 stations", In Proc. of Australasian Telecommunication Networks and Applications Conference, Dec. 2007.

[7] D. Lee, K. Kyamakya, and J. Umondi, "Fast Handover Algorithm for IEEE 802.16e Broadband Wireless Access System", In Proc. of International Symposium on Wireless Pervasive Computing, 2006.

[8] P. Boone, M. Barbeau, and E. Kranakis, "Strategies for Fast Scanning and Handovers in WiMAX 802.16", In proc. of International Conference on Access Networks and Workshops, 2007.

[9] Z. Becvar, P. Mach, and R. Bestak, "Optimization of Handover Scanning Procedure in WiMAX Networks with Relay Stations", In Proc. of Int. Symposium on Wireless Pervasive Computing, 2008.

[10] S. Choi, G. Hwang, and T. Kwon, "Fast handover Scheme for Real-Time Downlink Services in IEEE 802.16e BWA System", In Proc. of IEEE Vehicular Technology Conference, 2005.

[11] H. Fattah and H. Alnuweiri, "A New Handover Mechanism for IEEE 802.16e Wireless Networks", In proc. of International Wireless Communications and Mobile Computing Conference, 2008.

[12] H. Sun, S Chang, Y. Lin, and S. Chiou, "Efficient Authentication Schemes for Handover in Mobile WiMAX", In proc. of International Conference on Intelligent Systems Design and Applications, 2008.

[13] Z. Zhenxia, P. Richard, B. Azzedine, and L. Bjorn, "Reducing Handoff Latency for WiMAX Networks Using Mobility Patterns", In proc. of Wireless Communications and Networking Conference, 2010.

[14] S. Thomson, and T. Narten, "IPv6 Stateless Address Autoconfiguration", RFC2462, Internet Engineering Task Force, Dec. 1998.

[15] R. Droms, Ed. "Dynamic Host Configuration Protocol for IPv6 (DHCPv6)", RFC3315, Internet Engineering Task Force, July 2003.

[16] J. Wozniak, K. Nowicki, and T. Mrugalski, "Mobile users issues, in micro and macro scale, in IP networks", SIS2004, Lodz, Sept. 2004.

저 자

Bui Minh Trung

He received B.Sc. in Telecommunication from Ho Chi Minh city University of Technology (HCMUT), Vietnam in 2010. His current research interests focus on convergence networks, QoS provisioning, sensor network, femtocell networks, VLC networks. and mobile IPTV.

Mostafa Zaman Chowdhury

He received his B.Sc. in Electrical and Electronic Engineering (EEE) from Khulna University of Engineering and Technology (KUET), Bangladesh in 2002. In 2003, he joined the EEE department of KUET as a faculty member. He received his M.Sc. in Electronics Engineering from Kookmin University, Korea in 2008. Currently he is working towards his Ph.D. degree in the department of Electronics Engineering at the Kookmin University. His research interests include convergence networks, QoS provisioning, mobile IPTV, femtocell networks, and VLC networks.

Tuan Nguyen

He received his B.Sc. in Electronics and Telecommunications from Hanoi University of Science and Technology (HUST), Vietnam in 2011. Currently he is working towards his M.Sc. degree in the department of Electronics Engineering at the Kookmin University. His research interests include convergence networks, VLC, and peer-to-peer networks.

Yeong Min Jang *Regular Members*

He received the B.E. and M.E. degree in Electronics Engineering from Kyungpook National University, Korea, in 1985 and 1987, respectively. He received the doctral degree in Computer Science from the University

of Massachusetts, USA, in 1999. He worked for ETRI between 1987 and 2000. Since Sept. 2002, he is with the School of Electrical Engineering, Kookmin University, Korea. His research interests are IMT-advanced, radio resource management, and convergence networks.

Young-Il Kim

He received the BS and MS degree in Electronics Engineering from Kyung Hee University, Korea, in 1985 and 1988, respectively. He received the doctoral degree in Electronics Engineering from Kyung Hee University, Korea, in 1996. He worked for Samsung Electronics between 1985 and 1986. Since 1988, he is with ETRI, Daejeon, Korea where currently he is working as a team leader of Smart Screen Convergence Research Department.

Won Ryu

He received the BS degree in computer science and statistics from Pusan National University, Busan, Korea, in 1983, and the MS degree in computer science and statistics from Seoul National University, Seoul, Korea, in 1988. He received his PhD degree in information engineering from Sungkyunkwan University, Kyonggi, South Korea, in 2000. Since 1989, he has been a managing director with the Smart Screen Convergence Research Department, ETRI, Daejeon, Korea. Currently, his research interests are IPTV, Smart TV, IMT-advanced, and convergence services and networks.