수직 핸드오버를 통한 Mobile WiMAX MMR system의 성능분석

정회원 배 문 한*, 김 영 일**, 종신회원 김 석 찬***,
정회원 이 동 헌*** , 오콘바이르*

Performance Analysis of Mobile WiMAX MMR System with Vertical Handover

Mun Han Bae*, Young il Kim**, ***Regular Members,*** Suk Chan Kim***, ***Lifelong Member***
Dong Heon Lee**** ***Regular Member,*** B.Otgonbayar

요 약

핸드오버는 multi-hop relay 시스템에서 이동성을 제공하기 위해 필요하다. 핸드오버의 주요 목적은 MS가 한 BS의 air-interface에서 다른 BS의 air-interface로 이동할 때 연속 연결을 제공하는 것이다.

특히 이종기계간의 핸드오버는 차세대 네트워크에 필수적이다. Mobile WiMAX MMR system에서의 수직 핸드오버 기술은 기술자들이 Mobile WiMAX system을 overlaid cell환경으로 가져오는데 매우 유용하다.

이 기술은 Micro cell(Frequency 1,FA1) and Macro cell(Frequency 2,FA2)사이에 놓인 Ubiquitous 환경에서 시스템 성능향상을 위해 MRS를 다른 시스템으로 핸드오버 하는 기술에 적용될 것이다. 이 논문에서 FA1과 FA2 주파수를 사용하여 제안된 조건들에 따라 MRS들이 수직 핸드오버를 수행했다. 그리고 중심에 있는 Macro cell과 그것을 싸고 있는 6개의 Macro cell들의 BS나 섹터로부터 받은 간섭 및 성능을 분석한다.

Key Words : 핸드오버, Multi-Hop Relay, Mobile WiMAX, MRS

ABSTRACT

Handover is needed in multi-hop relay systems to support mobility. The main purpose of handover is to provide the continuous connection when a MS migrates from the air-interface of one BS to another air-interface provided by another BS. Especially the handover between different systems is essential to next generation network. Vertical Handover technology in Mobile WiMAX MMR system is very useful for operators to introduce to Mobile WiMAX system in an overlaid cell environment. This technology will be applied to technology which hands MRS(Mobile Relay Station) over to different systems for system performance enhancement in Ubiquitous environment overlaid between Micro cell(Frequency 1,FA1) and Macro cell(Frequency 2,FA2). In this paper, FA1 and FA2 are used in order to perform Vertical Handover of MRS(Mobile Relay Station) according to suggested conditions. interferences from neighboring BS or other sectors of 6 macro cells surrounding center Macro cell are analyzed and throughputs are measured according to suggested conditions.

※ 이 논문은 ETRI, PNU의 공동연구에 의하여 진행되었음.
* 몽골국제대학교 정보기술학과(baemhss@miu.edu.mn)
** ETRI IPTV구조연구팀, 부산대학교 통신시스템 연구실(sckim@pusan.ac.kr)
논문번호 : KICS2009-04-172, 접수일자 : 2009년 4월 24일, 최종논문접수일자 : 2009년 10월 30일

Ⅰ. Intorduction

Future mobile wireless communication system is envisioned to provide very high data rates and spectral efficiency in addition to ubiquitous coverage that do not appear to be feasible with the existing cellular architecture.

The achievable Carrier to Interference and Noise Ratio(CINR) decreases with an increasing link distance. Shadowing and non line-of-sight (NLOS) communications further reduce the received signal quality. For Coverage extension through settlement of shadowing zone and data throughput enhancement,[1]-[3] it is easy to increase number of base station. Of course if a number of user increase according to base station increase, increase of base station is effective, but the number of user is saturated already in advanced nations.

So a relay station is one method in order to solve this problem. Mobile Multi-hop Relay concept is a well-accepted economical approach and is introduced in order to improve transfer rate of user and extension of service area of conventional mobile communication system or portable internet system and made representatively standard regular applied to Mobile WiMax in IEEE 802.16j[4]-[6] and activity in order to adopt IMT-Advanced WiMAX in future is being performed in IEEE 802.16m.

IEEE 802.16j is an amendment to the IEEE 802.16 broadband wireless access standard to enable the operation of multi-hop relay stations (RS). Other important technology is to provide the continuous connection when a MS migrates from the air-interface of one BS to another air-interface provided by another BS[7]. Handover is needed in multi-hop relay systems to support mobility.

Different nets may use different technologies for access, LAN, WaveLAN, Bluetooth, GPRS etc. According to this, a future system should also have functions for switching between technologies without a broken connection as result.

Vertical handover refers to a network node changing the type of connectivity it uses to access a supporting infrastructure, usually to support node mobility. For example, a suitably equipped laptop might be able to use both a high speed wireless LAN and a cellular technology for Internet access. Wireless LAN connections generally provide higher speeds, while cellular technologies generally provide more ubiquitous coverage. Thus the laptop user might want to use a wireless LAN connection whenever one is available, and to 'fail over' to a cellular connection when the wireless LAN is unavailable.

Vertical handover between WLAN and UMTS (CDMA2000) have attracted a great deal of attention in all the research areas of the 4G wireless network, due to the benefit of utilizing the higher bandwidth and lower cost of WLAN as well as better mobility support and larger coverage of UMTS.

The remainder of the paper is organized as follows. Section II contains Concept of Handover. Section III contains System model such as Macro/Micro cell figuration, Vertical Handover environment for simulation, flowchart and parameter. Section IV includes Simulation results and Section V contains conclusion of this paper.

Ⅱ. Concept of Handover

Figure 1 illustrates horizontal/vertical handover and Macro/Micro cell concept[8].

When MS goes into neighbor cell with same

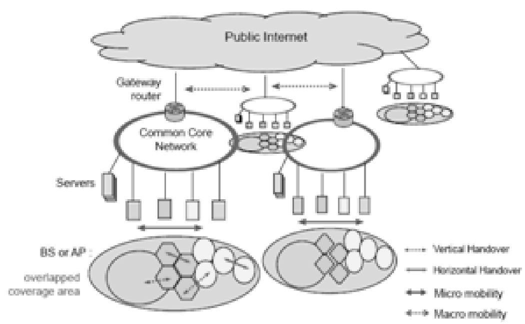

Fig.1. Handover and Macro/Micro cell concept[8]

frequency in same access networks, MS tries to do horizontal handover. When MS goes to neighbor cell with different frequency in different system, MS tries to do vertical handover. In case of horizontal handover, IP address need to change and access technology, network interface, QoS parameter are not changed, In case of vertical handover, IP address and access technology need to change and network interface, QoS parameter also can be changed.

Ⅲ. System model

3.1. Macro/Micro cell figuration

Figure 2 illustrates configuration of Wrap-around 19cells. There are 3 sectors per cell. Every cell radius is 1.5km and there are 19 micro cells in one macro cell. one macro cell (red dotted circle) of 6km radius is put into 6 surrounding macro cells as shown in Figure 3 which is to calculates interferences induced by BSs and sectors of surrounding 6 macro cells.[9]

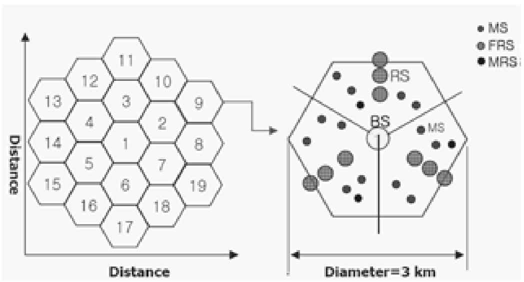

Fig. 2. Wrap-around 19cells configuration

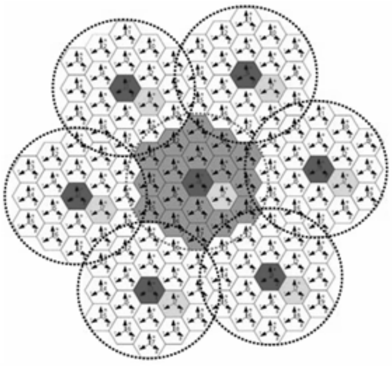

Fig. 3. 6 macro cells surrounding center Macro cell in order to analyze interferences induced by them

3.2. Vertical Handover environment for simulation

Figure 4 illustrates Vertical HandOver(VHO) according to different conditions. In simulation, the frequency FA2 is used through doing vertical handover of MRSs according to suggested condition.

A variation of throughputs of non-transparent RS system using FA1 and a variation of throughputs of MSs which receive services from MRS using FA2 are analyzed.

From figure 4, VHO conditions are defined as

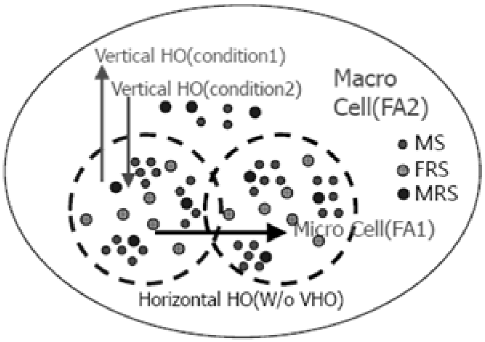

Fig. 4. Vertical Handover according to conditions

Table 1. VHO conditions

Conditions	Details
w/o VHO	A system without VHO between Micro cell and Macro cell. In this case, MRS (or MS) does Horizontal handover from existing Micro cell to neighbor Micro cell.
Condition1 (w/ VHO)	A system which performs VHO from Micro to Macro cell. 1) When drop time is more than 15 frame(half of 150ms HO drop time) due to SINR degradation. 2) When the speed of MRS increases more than 80Km/h.
Condition2 (w/ VHO)	A system which performs VHO from Macro to Micro cell 1) When drop time is more than 15 frame(half of 150ms HO drop time) due to SINR degradation. 2) When the speed of MRS decreases less than 80Km/h.
Condition1,2 (w/ VHO)	A system doing VHO when condition1 and 2 are satisfied.

following table 1.

In order to perform the simulation for MRS vertical handover, the flow chart is made as shown in Figure 5. Along with VHO conditions mentioned in table 1, the simulation parameters for vertical handover are shown in Table 2. MRS(Mobile Relay Station) and FRS(Fixed Relation Station) are put into simulation parameters. As a result, sector and user throughputs according to position of MS(Mobile station) and MRS are measured.

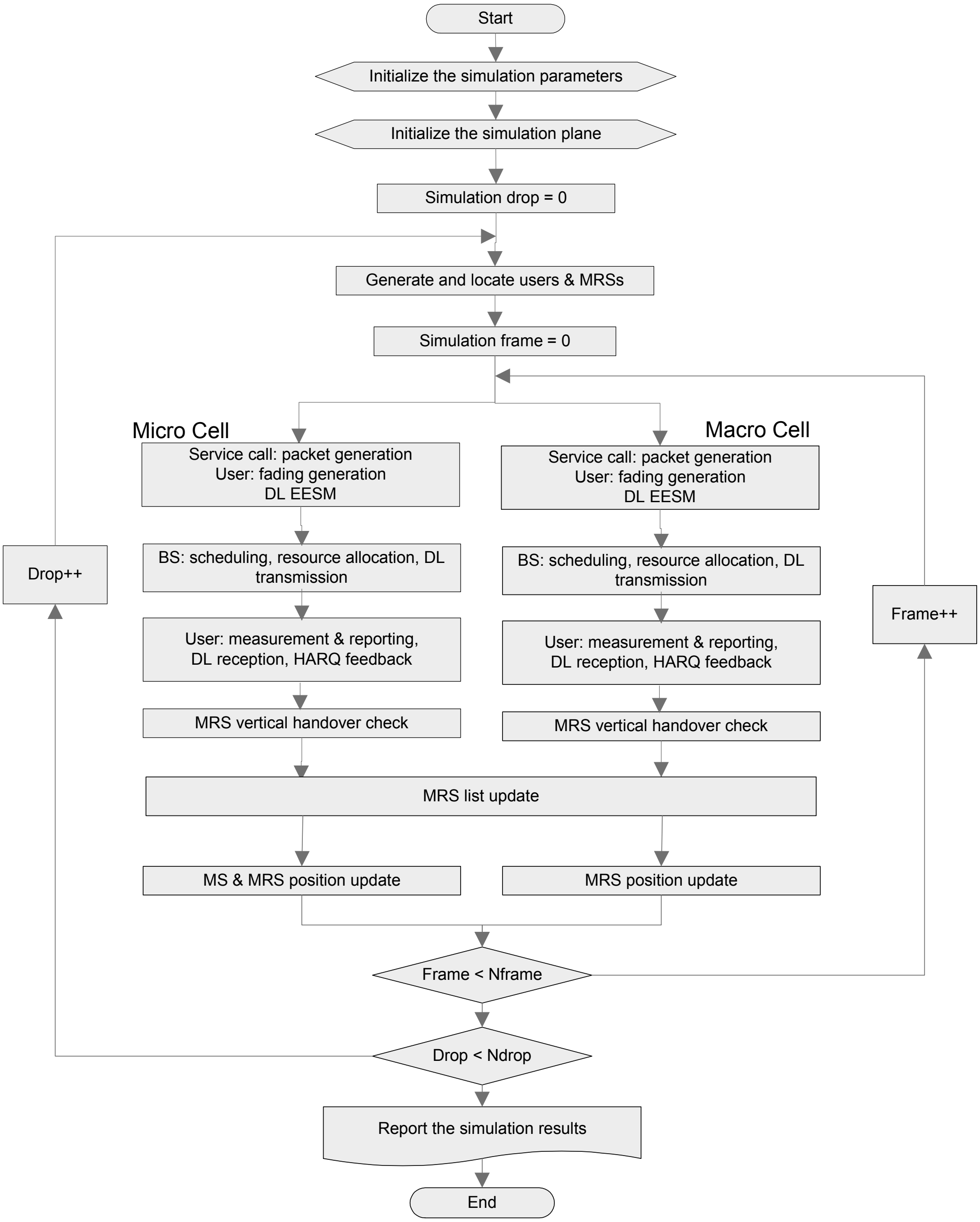

Fig. 5. Flow chart for Simulation for MRS VHO

Table 2. Simulation Parameters for vertical handover[10]

Description : Specification(Downlink)
- Cell environment : 19 cells - Micro cell radius : 1500[m] - Overlay Macro cell radius: 6000[m] - AMC level: QPSK ~ 64QAM - Number of RSs: 2 FRSs per sector - Initial number of MRSs: 1 MRS per sector in Micro cell 2 MRSs per sector in Macro cell - MSs per MRS: 5 MSs per MRS - Initial number of MS: Micro cell: 5 MSs + 5MSs(=1 MRS) per sector Macro cell: 10 MSs (=2 MRS) per sector - Configuration: 2 tiers 19 cells, 3 sectors/cell - Frame structure: Non-transparent - RS location: non-transparent : 1000, 1500 [m] - Number of users per sector: 5 - Pathloss type(BS-RS / BS,RS-MS): urban, LOS/NLOS[9] - Multipath type: ITU-R Pedestrian A (3 km/h, 25 %), B (10 km/h, 25 %), Vehicular A (60 km/h, 25 %), B (120 km/h, 25 %)[12] - Shadow modeling: spatial correlation, cross correlation - Shadowing standard deviation: Type E : 8 [dB] [13] - BS/RS/MRS/MS antenna structure: 1 × 1 (SISO) - BS/RS/MS / MRS height: 30 / 30 / 1.5 / 5[m] - BS/RS/MS /MRS transmit power per sector: 20 / 5 / 0.2 / 1 [W] - BS/RS/MS/MRS maximum antenna gain: 14 / 10 / 0 / 10 [dBi] - Noise Figure: 9 [dB] - DL/UL ratio: 2:1(DL=28 symbols, UL=14 symbols) - Scheduling / traffic model: round robin / full buffer - Frequency reuse: (1, 1, 3) [11]

Ⅳ. Simulation results

4.1. Optimal Macro cell size

In simulation, the optimal Macro cell size is analyzed to maximize throughputs of system(or sector) and user. Figure 6 illustrates sector throughput which can be thought as system performance and User throughput of MSs receiving from MRS in a vehicle according to Macro cell radius.

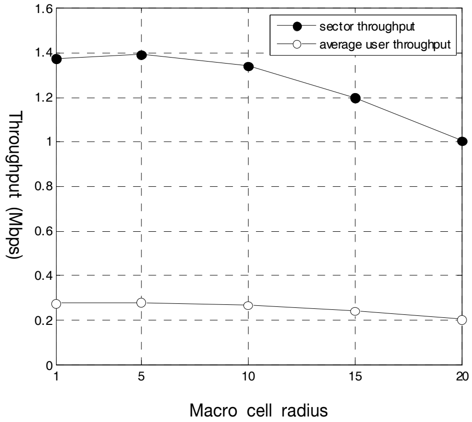

Fig. 6. Sector and User throughput according to Macro cell radius

When Macro cell size is 5 km, it shows maximum throughput. The smaller cell radius becomes, the smaller the throughput becomes. If a cell radius becomes bigger, throughputs decrease because there is no interference from neighbor sector but amounts of signal decrease become bigger by path loss when MRS is far from BS.

In less than 5 km, interference from BS of other sector or interference among MRSs makes throughput low compared to 5 km.

4.2. Sector Throughput vs. VHO Conditions

The system (or sector) throughput is analyzed. Figure 7 illustrates a comparison of sector throughput performance according to VHO conditions.

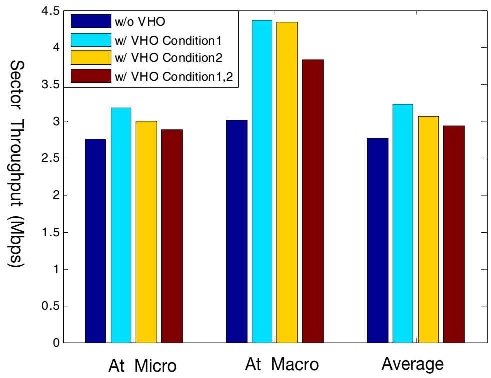

Fig. 7. Sector throughput comparison according to VHO conditions

On the left graphs (at Micro cell), Overall system throughputs are improved through VHO. This is because MRS's interference decreased through MRS's VHO into Macro cell (FA2).

On the center graphs (at Macro cell), there are MSs in vehicle which receives services from MRS in Macro cell and sector throughput of Macro cell is improved through VHO. This is because MRSs of Micro cell went to Macro cell and Macro cell is serviced to more users.

On the right graphs (at Micro & Macro), all sector throughputs of Micro and Macro cell are improved through VHO. Performance through VHO under condition1 is best improved.

Comparing the blue bar with the rest of the bars in that graph, Overall throughputs of all systems are improved through VHO in case of a Micro cell as well as a Macro cell.

4.3. User Throughput vs. VHO conditions

Figure 8 illustrates user throughput received from MRS. On the left graphs, user throughput received from MRS is improved in a Micro cell rather than w/o VHO. The blue bar of condition1 shows good performance. This is because the MRS which didn't receive services due to low SINR in Micro cell shifted to Macro cell through VHO.

On the center graphs, w/o VHO system illustrates high user throughput among user throughputs received from MRS because there are only two MRS per sector in w/o VHO system. If there is VHO, user's throughput decreases because MRSs increase in Macro cell.

On the right graphs, throughput of user of condition1 improved.

To summarize in view of sector and user throughputs, sector throughput and average user throughput are improved through VHO under condition1.

But a sector throughput and an average user throughput are degraded through VHO under condition2 and 1,2.

Condition2 is not good because low velocity of the MRSs, which do not have good SINRs in Macro cell, caused the vertical handover to be ineffective. Throughput of Conditions1, 2 is degraded due to frequent VHO.

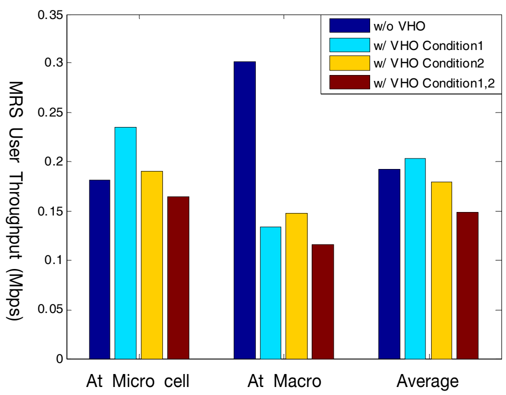

Fig. 8. User throughput received from MRS

4.4. User Throughput in Micro cell

Figure 9 illustrates user's throughputs received from BS and FRS in Micro cell.

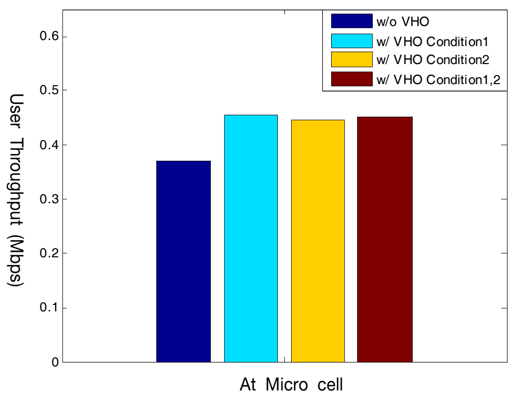

Fig. 9. User throughputs received from BS and FRS in Micro cell

Average User throughputs are improved because system interferences decrease due to VHO of MRS.

V. Conclusion

When a Macro cell size goes to 5 km, it shows the maximum throughput. The smaller cell radius becomes, the smaller the throughput becomes.

Comparing condition1 with rest of conditions such as w/o VHO, condition2 and condition1,2, Overall throughputs of all systems under condition1 are improved through VHO.

Condition1 shows good performance; this is because MRS which didn't receive services due to low SINR in micro cell shifted to Macro cell through VHO. Average User throughputs are improved because system interferences decrease due to VHO of MRS.

REFERENCE

〔1〕 R. Pabst, BH. Walke, D C. Schultz, P. Herhold, H. Yanikomeroglu, S.Mukherjee, H. Viswanathan, M. Lott, W. Zirwas, M. Dohler, H. Aghvami,D D. Falconer, and G P. Fettweis, "Relay-based deployment concepts for wireless and mobile broadband radio," IEEE Commun. Magazine, Sep., 2004, pp.80-89.

〔2〕 Y.I. Kim, J.C. Shin, J.H. Ahn, "Trend of IEEE 802.16 Mobile Multi-hop Relay", Electronic trend analysis, 2006, June.

〔3〕 Andrew Sendonaris, Elza Erkip, Behnaam Aazhang, "User cooperation diversity- Part II: implementation aspects and performance analysis," IEEE Trans. Commun., Vol.51, No.11, Nov., 2003, pp.1939-1948.

〔4〕 C. Hoymann, M. Dittrich, and S. Goebbles, "Dimensioning and capacity evaluation of cellular multihop WiMAX networks," in Proc. of IEEE Mobile WiMAX, Mar., 2007

〔5〕 R. Pabst, B. H. Walke, D.C. Schultz, et al, "Relay-based deployment concepts for wireless and mobile broadband radio," IEEE Communication Magazine, Vol.42, pp.80-89, Sep., 2004.

〔6〕 H. Yanikomeroglu, "Cellular multihop communi -cations: infrastructure-based relay network architecture for 4G wireless systems," 22nd Queen's Biennial Symposium on Communications, Queen's University, Kingston, Ontario, Canada, 1-3 June, 2004.

〔7〕 M. Feng, H. Wang, T. Chen, "System level modeling and algorithms for a B3G system employing OFDMA," IEEE Mobility Conference 2005. The 2nd International Conference on Mobile Technology, Application and Systems. Guangzhou, China, 15-17 Nov., 2005.

〔8〕 Chuanxiong Guo, Zihua Guo, Qian Zhang, Wenwu Zhu, "A Seamless and Proactive End-to-End Mobility Solution for Roaming across Heterogeneous Wireless Networks", Dec., 2003.

〔9〕 Gamini Senarath, Wen Tong, Peiying Zhu, Hang Zhang, David Steer, Derek Yu, Mark Naden, and Dean Kitchener Nortel,"Multi-hop Relay System Evaluation Methodology", IEEE 802.16j-06/013r3.

〔10〕 Brian Cho, "WiBro/Mobile WiMAX Performance Evaluation", Intel.

〔11〕 3GPP TR 25.892, "Feasibility Study for Orthogonal Frequency Division Multiplexing (OFDM) for UTRAN enhancement (Release 6)", V6.0.0, Jun, 2004.

〔12〕 IEEE 802.16.3c-01/29r4, "Channel Models for Fixed Wireless Applications" July, 21, 2001

〔13〕 Mobile WiMAX-Part I: A Technical Overview and Performance Evaluation Prepared on Behalf of the WiMAX Forum March, 2006.

배 문 한 (Bae Mun Han) 정회원

1987년 2월 고려대학교 재료공학과 학사

1989년 2월 고려대학교 재료공학과 석사

1989년 2월 태일정밀(주) 근무

1994년 6월~2003년 11월 삼성전기 근무

2004년 8월 몽골 국제대학교 IT학과장

2005년 11월 Mongolia University of Science and Technology 박사과정

2009년 9월 박사논문완료

<관심분야> Mobile WiMAX, 프로그램, 이동통신

김 영 일 (Young Il Kim) 정회원

1985년 경희대학교 전자공학 학사
1988년 경희대학교 전자공학 석사
1996년 경희대학교 전자공학 박사
1985년~1986년 삼성전자
1988년~현재 한국전자통신연구원 책임연구원, 모바일 IPTV구조연구팀
1994년 정보통신기술사, 1995년 전기통신기술사
2007년 MUST(Mongolian University of Science and Technology) 명예교수
2007년 과학기술연합대학원대학교(UST)겸임교수
2008년 한밭대학교 겸임교수, 북경교통대(Beijing Jiaotong University) 고문교수
<관심분야> Wireless 시스템설계 및 PHY/MAC계층 설계 및 성능분석

김 석 찬 (Suk Chan Kim) 종신회원

1993년 2월 부산대학교 전자공학과 학사
1995년 2월 한국과학기술원 전기 및 전자공학과 석사
2000년 2월 한국과학기술원 전기 및 전자공학과 박사
2000년 7월 한국전자통신연구소(ETRI) 연구원
2001년 7월 Princeton대학교 박사후 과정
2002년 2월 Lehigh대학교 박사후 과정
2002년~현재 부산대학교 전자공학과 부교수
2008년~현재 부산대학교 반도체설계교육센터 센터장
<관심분야> 이동통신, 통신신호처리, OFDM, UWB

이 동 헌 (Lee Dong Heon) 정회원

2007년 2월 부산대학교 전자전기정보컴퓨터공학부 졸업
2009년 2월 부산대학교 전자전기공학과 석사
<관심분야> SLS, 채널추정, 통신시스템

오콘바이르 (MUST, 몽골교수) 정회원