

The Simulation Model of Multicast and Broadcast Service in the Mobile WiMAX for Qualnet

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Abstract- Currently, the multimedia stream service provided by broadband wireless networks has emerged as an important technology and attracted much attention in the research of mobile IPTV which provide common content or program to multiple subscribers by using IP multicast service. Multicast and broadcast services (MBS) are described in the Mobile WiMAX standard. The Qualnet network simulator is a more prevailing and powerful simulation for IEEE802.16 and IEEE802.11 wireless networks, including wireless LANs and sensor network. However, the network module has not been included to Multicast and Broadcast Service for IEEE802.16e standard or Mobile WiMAX in Qualnet. Hence, in this paper, we purpose to design a simulation model of IEEE802.16e standard for Multicast and Broadcast Service with the point-to-multipoint (PMP) mode.

Keywords- IEEE802.16e, Mobile WiMAX, Multicast and Broadcast Service, Qualnet

I. INTRODUCTION

Nowadays, the trend of communication system is migrating from wired networking to wireless networking. According to this tendency, Mobile WiMAX has been developed to avoid the limitation of the existing wireless communication system such as bandwidth problem and so on. The main idea of Mobile WiMAX is broadband wireless communication and mobility. Mobile WiMAX offers high speed Internet service which provides various information and multimedia data with high data rate on broadband regardless of place and time. Despite the fact that the services are based on multimedia data transmission, it is difficult to transmit a large amount of data to each group of user in wireless environment because of limited bandwidth. To avoid this restriction, multicast and broadcast service (MBS) was initiated in Mobile WiMAX. The MBS concept is defined in IEEE802.16e standard [1] which is supports mobility. The attributes of MBS refer to efficient mechanisms transmitting same data to multiple users using shared system resources. To support MBS, the system needs to include MBS controller managing overall MBS operation, MBS contents server transmitting the encoded data, etc. MBS contents server is a logical network entity that manages the MBS service in multicast and broadcast network area.

The most applicable network simulator is network simulator

Qualnet which is a commercial spin-off from the GloMoSim simulator, which is based on C++ programming. All protocol are implemented in a series of C++ files, and called by the simulation kernel. One of advantages of Qualnet is that it is more scalable. During the simulation time, it enables the user can see the all signals being transmitted and received at each node, which assists in the understanding of what is happening in a freshly manner. Qualnet simulator used the three main programs such as the analyzer and the packet tracer. When simulator runs the given simulation, analyzer displays the simulation results and packet tracer aids to realize the path of a packet through the network. There is also a protocol developer in the GUI, however, it is much more powerful to develop protocols from C++ coding [7].

Qualnet allows investigation and evaluation of fixed and mobile WiMAX devices, applications and networks. WiMAX channel model of Qualnet includes co-channel interference, urban pathloss, fading, shadowing and mobility effects. Through detailed models, unrivaled speed and scalability, Qualnet [9] provides an environment for controlled and repeatable experimentation that leads to improved network performance and a better end-user experience. Key Features of Qualnet WiMAX are following:

- Support for 802.16d (Fixed Wireless) and 802.16e (Mobile Wireless)
- Adheres to IEEE802.16-2004 and IEEE802.16-2005 specifications
- Full source code (in C/C++) for fixed and mobile WiMAX simulation models
- Detailed OFDMA model
- ARQ, Admission Control
- Sleep mode/Idle mode, Paging and Power Control
- CDMA-based ranging and bandwidth request of OFDMA
- UGS, rtPS, nrtPS, ertPS and BE QoS
- Dynamic burst profiles and data rates (AMC-Automatic Modulation and Coding)

Qualnet simulates 802.16 and 802.16e networks using detailed MAC and PHY models.

II. MULTICAST AND BROADCAST SERVICE FOR MOBILE WiMAX

A. *WiMAX for OFDMA Frame Structure with MBS Zone*
Following the IEEE 802.16e standard, PHY supports Time Division Duplex (TDD), Frequency Division Duplex (FDD), and Half-Duplex FDD operation. Figure 1 shows the OFDM frame structure with MBS Zone for a TDD implementation. Each frame is divided into Down Link (DL) and Up Link (UL) sub-frames separated by Transmit/Receive and Receive/Transmit Transition Gaps (TTG and RTG, respectively) to prevent DL and UL transmission collisions [2]. In this frame, to provide optimum system operation, the following control information is used.

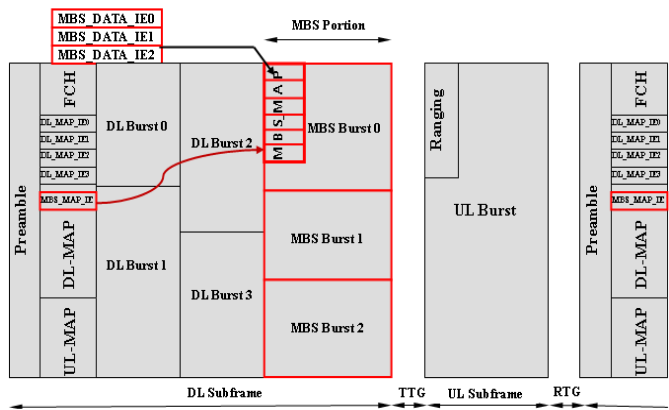


Figure 1. WiMAX OFDMA frame structure with MBS Zone

The downlink subframe begins with a preamble that is used for physical-layer procedures such as time and frequency synchronization and initial channel estimation. The frame control head (FCH) follows the downlink preamble which supplies the frame configuration information such as MAP message length, the modulation and coding scheme and usable sub-channels. Multiple users are allocated data regions within the frame, and these allocations are specified in the DL-MAP and UL-MAP messages that are broadcast following the FCH in the downlink subframe and provide the sub channel, slot allocation and other control information for the DL and UL sub-frames respectively. The Uplink ranging sub-channel is allocated for mobile stations (MS) to perform closed-loop time, frequency, and power adjustment as well as bandwidth requests.

The MBS MAP is indicate MBS zone PHY configuration and defines the location of each MBS zone via the OFDMA Symbol Offset parameter. MBS MAP message includes one or more information elements called the MBS_DATA_IE, Extended_MBS-DATA_IE and MBS_DATA_Time_Diversity which list the MCIDs included in the upcoming MBS transmission and its also indicate to next event of MBS_MAP as well as the location of MBS bursts. When MBS_MAP is sent connection need be described in DL_MAP, but MBS_MAP_IE is substituted instead. MBS_MAP_IE is indicates location of MBS Zone in DL subframe [1]. MBS

data bursts may include different content channels, each content channels mapping to different MCIDs.

B. *Multicast Broadcast Service in Mobile WiMAX system*
In Multicast and Broadcast service (MBS) system, data is transmitted to multiple users. Transmitting the same data to multiple users allows network resources to be used efficiently. Two types of access to multicast and broadcast services (MBS) may be supported such as single-BS access and multi-BS access. Figure 2 and 3 are illustrates Single BS Access and Multi BS Access and their main comparisons are shown in Table I. Single-BS access is implemented over multicast and broadcast transport connections within one BS, while multi-BS access is implemented by transmitting data from Service Flow(s) over multiple BS. MS may support both Single-BS and Multi-BS access. ARQ is not applicable to either single-BS MBS or multi-BS-MBS[1]. In addition, both of systems are supported by encryption and decryption.

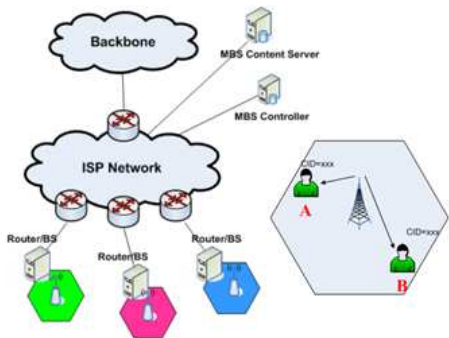


Figure 2. Network architecture for Single-BS-MBS

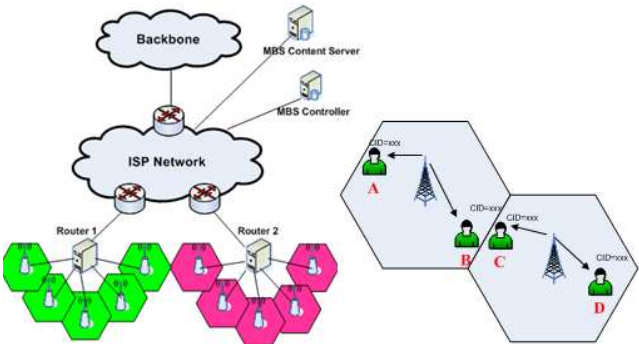


Figure 3. Network architecture for Multi-BS-MBS

Table 1. The comparison of the MBS access modes[3]

Single-BS-MBS	Multi-BS-MBS
MBS within one BS	MBS synchronized across multiple BSs
Non MBS zone	MBS zone
Transport CID	Multicast CID
No macro-diversity gain	Macro-diversity gain
ARQ is not supported	
Encryption & decryption are supported	

1) Single-BS Access. The BS may provide the MS with single-BS access by establishing a multicast traffic connection with each MS to be associated with the service or a broadcast transport connection [1]. The single-BS-MBS service may use the any available traffic CID value. The CID dedicated for the service is the same for all MS on the same channel that participate in the connection. The data transmitted on the connection with the given CID shall be received and processed by the MAC of each involved MS.

2) Multi-BS Access. In a Multi-BS MBS system, several BSs in the same geographical area transmit the same broadcast/multicast messages at the same time on the same frequency channel. These BSs actually belong to MBS_ZONE. An MBS_ZONE is a unique identifier, which is transmitted from each BS of the set on the DCD message [5]. During a Dynamic Service Addition (DSA) procedure, an MBS connection for multiple MBS contents can be established by using an MBS Contents Identifier TLV encoding in DSA-REQ or DSA-RSP message sent by the BS. This means that when the MS sends DSA-REQ message with the MBS service request, the BS may respond to it with DSA-RSP message including an MBS Contents Identifier TLV encoding. The BS may also send the MS a DSA-REQ message including an MBS Contents Identifier TLV encoding in order to make an establishment of an MBS connection. Logical Channel ID, which pairs with Multicast CID in MBS_DATA_IE, is allocated to each MBS Contents IDs in the order that it is included in TLV value. As a result, an MS can receive multiple MBS messages for an MBS connection with different MBS contents distinguished by Logical Channel ID belonging to a Multicast CID [1].

3) The establishment of Multicast and Broadcast Service. For MBS Service, Multicast and Broadcast Service flow is same as unicast services in Mobile WiMAX and which is administrated by DSx (Dynamic Service Addition, Change and Delete) messaging procedure used to create, change and delete a service flow for each MS and BS. In other to carry significant service flow information such as quality of service (QoS), service flow identifier (SFID) and MBS contents identifier, MS and BS exchange DSx messages each other. In addition, DSx messaging also provides a MS with the MBS Zone identifier (MBS Zone ID) for subscribed service to indicate a MBS service area through which a MCID and SA for a MBS service flow are valid. Figure 4 shown as call flow of MBS Service of Mobile WiMAX (IEEE802.16e). In a characteristic manner, due to multicast and broadcast service includes multiple content channels, IEEE802.16 standards also define group of DSx messages. These messages can activate, change or delete multiple connections and service flows using single message exchange to reduce system overhead and latency. A BS supporting MBS service includes list of MBS zone identifier(s) to which it belongs. One BS may belong to multiple MBS zone of the same or different sizes and coverage [4]. In addition, MCID is unique for MBS zone.

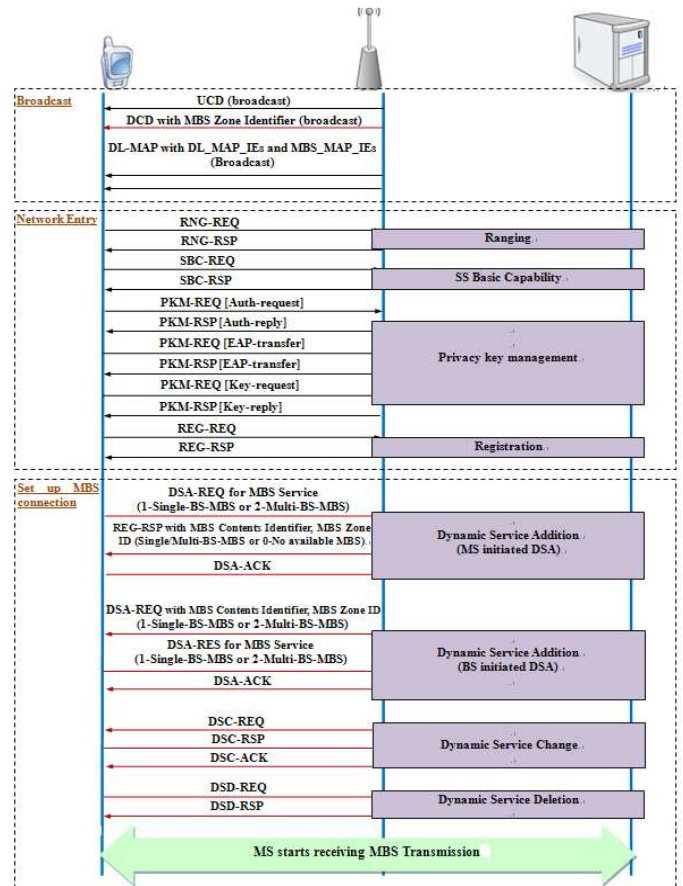


Figure 4. Call flow of MBS Service of Mobile WiMAX

III. THE SIMULATION MODEL FOR QUALNET

A) Modification and Consideration of Qualnet C++ code for Multicast and Broadcast Service in the Mobile WiMAX.

In this paper, we purpose to modify Qualnet C++ code for Multicast and Broadcast Service. Therefore, we focus on the IEEE802.16e (Mobile WiMAX) standard documents. According to standard, MBS service may develop into WiMAX module in the Qualnet network simulator. In short, modification proposal of multicast and broadcast service in the WiMAX is shown in table 2.

Table 2. Modification proposal for MBS Service in Mobile WiMAX

Advanced Wireless Source Codes	MBS modification	Multicast and Broadcast Service
1. Mac_dot16.h Mac_dot16.cpp	MacDot16BuildDsaReqMsg MacDot16BuildDsaRspMsg MacDot16BuildDsaAckMsg	MBS_Contents_ID (Service Flow-TLV Encoding) MBS_Zone_ID (Service Flow-TLV Encoding) MBS_Service (Service Flow-TLV Encoding)
2. Mac_dot16_bs.h Mac_dot16_bs.cpp	MacDot16BsHandleDsaRequest MacDot16BsHandleDsaRsp MacDot16BsHandleDsaAck MacDot16BsBuildMacFrame MacDot16BsScheduleMacFrame MacDot16BsBuildMBSMapPdu	MBS_Contents_ID (Service Flow-TLV Encoding) MBS_Zone_ID (Service Flow-TLV Encoding) MBS_Service (Service Flow-TLV Encoding) New Mac Frame MBS_MAP_Message (Type 62)
3. Mac_dot16_ss.h Mac_dot16_ss.cpp	MacDot16HandleDsaReqPdu MacDot16HandleDsaAckPdu MacDot16SsHandleMBSMapPdu	MBS_Contents_ID (Service Flow-TLV Encoding) MBS_Zone_ID (Service Flow-TLV Encoding) MBS_Service (Service Flow-TLV Encoding) MBS_MAP_Message (Type 62)
4. Mac_dot16_sch.h Mac_dot16_sch.cpp	MacDot16ScheduleDLSubframe	New DL Subframe
5. Mac_dot16_phy.h Mac_dot16_phy.cpp	MacDot16PhyAddMBSDataIE MacDot16PhyGetMBSDataIE MacDot16PhyAddMBSMapIE MacDot16PhyGetMBSMapIE	MBS_MAP_IE MBS_DATA_IE

To modify the multicast and broadcast service of mobile

WiMAX, below named as advanced wireless source codes are should be chosen in Qualnet C++ source codes.

B) Analysis of Simulation results in Qualnet. The MAC802.16 model of Qualnet has implemented features defined in both IEEE802.16 and IEEE802.16e. In Qualnet network simulator, we designed a Simulation model for Multicast and Broadcast Service in the Mobile WiMAX (IEEE802.16e). Our model consists of Base Station (BS), Mobile Station (MS), Router and Content Provider. According to Multi-BS-MBS access, BS1 and BS2 belong to Router 1 in the MBS Zone1 and BS3 belongs to Router 2 in the MBS Zone2. Figure 5 illustrates the Simulation model of Mobile WiMAX MBS Service for Qualnet. Here constant bit rate (CBR) traffic source is used for unicast transmission and multicast constant bit rate (MCBR) traffic source is used for MBS Service transmission. This two traffic starts at 1.0 sec and ends 5.0 min. The field configuration used is 1500m x 1500m field with 11 nodes. The various simulation values are shown in table 3.

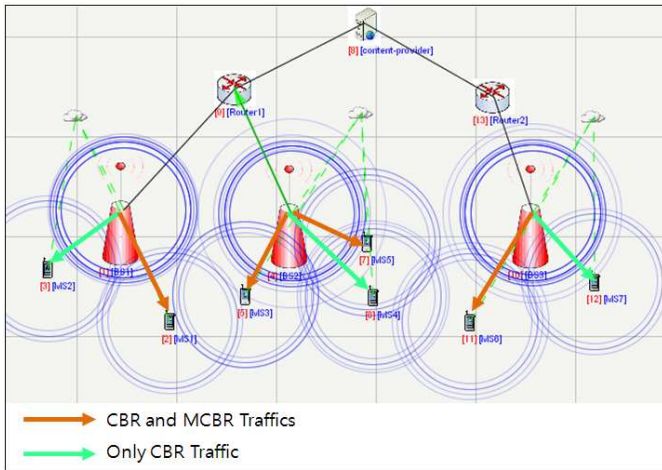


Figure 5. The simulation model of WiMAX MBS Service in Qualnet

Table 3. Simulation parameter values (IEEE802.16e)

	Parameters	Values
1.	Channel Frequency	2.4GHz
2.	Channel Bandwidth	20MHz
3.	Simulation Area	1500x1500
4.	Simulation time	5 min
5.	Number of Nodes	11
6.	Users in the Zone 1	MS1-MS5
7.	Users in the Zone 2	MS6-MS7
8.	Packet size	512
9.	Node placement	Uniform
10.	Traffic type	MCBR and CBR
11.	FFT size	2048
12.	Cyclic prefix factor	8.0
13.	Antenna type	Omni-antenna
14.	Radio propagation method	Two ray ground
15.	Multicast Group Address	255.0.0.1, 255.0.0.2

16.	Simulation start time	1 sec
17.	Simulation end time	5 min
18.	Multicast Protocol	DVMRP(IGMP)

C) Simulation Results

The proposed simulation model has been tested in the Qualnet simulation environment. We investigate the Client's Throughput when between MS and BS traffics are CBR and MCBR. Figure 6 shows simulation results of Multi-BS-MBS access of MBS service in the Mobile WiMAX (IEEE802.16e).

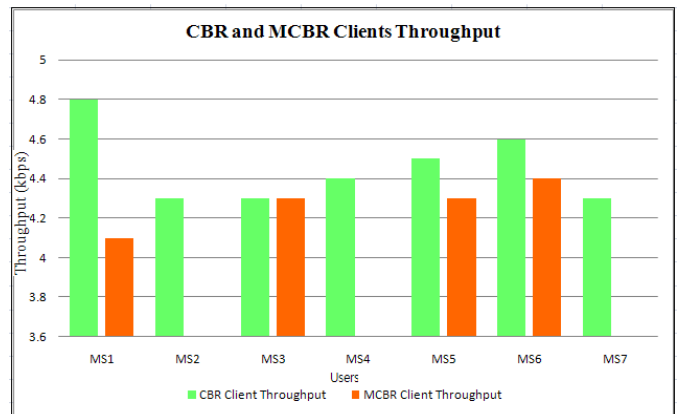


Figure 6. Analysis of simulation results

IV. CONCLUSION

In this paper we investigate the MAC simulation model of multicast and broadcast service in the Mobile WiMAX for Qualnet simulator. This simulation model of Qualnet would be more useful for developing Multicast and Broadcast Service of Mobile WiMAX for Mobile IPTV service. In addition, we purpose to modify Qualnet C++ code for Multicast and Broadcast Service in the IEEE802.16e. For the future work, we will continue to study Multicast and Broadcast Service of IEEE802.16e in the Qualnet and in particular, we will focus on the MBS Handover model in the Mobile WiMAX for developing Mobile IPTV service.

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