

Performance Analysis of MBS Handover for Mobile WiMAX

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Abstract— Nowadays, the multimedia stream service provided by broadband wireless networks has become an important technology and many researchers are focusing on the mobile IPTV which provide common content or program to multiple subscribers by using IP multicast service. Enhanced multicast and broadcast services (E-MBS) in Mobile WiMAX standard is point-to-multipoint access services described for transmission of a common set of multimedia data packets to group users. Multicast and broadcast services (MBS) handover procedure is described in the Mobile WiMAX standard as well. Since IEEE802.16m is still developing, the performance evaluation is based on current running standard of Mobile WiMAX (IEEE802.16e). This paper addresses the MBS handover of MBS zone for Mobile IPTV. We evaluate the performance metrics such as handover latency and data loss performance for MBS handover. In addition, we modify our simulation model of MBS service for the analyzing performance of MBS zone handover in Qualnet.

Keywords—Multicast and Broadcast Service (MBS), Handover, Mobile WiMAX.

I. INTRODUCTION

Recently, multimedia broadcasting over wireless systems became a fast growing application. Mobile WiMAX is most promising technology for multimedia broadcasting by its' great features such as broadband bandwidth, mobility, reliable high throughput via OFDMA MIMO air interface, flexible radio resources allocation, low power consumption. 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 attributes of MBS refer to efficient mechanisms transmitting same data to multiple users using shared system resources. The term broadcast refers to the ability to deliver contents to all users. Multicast, on other hand, refers to content that are directed to specific group of users that have the associated subscription for receiving such services. 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 MBS concept is defined in IEEE802.16e standard [1] which is supports

transmission of common set of multimedia data packets to group users.

The MBS concept is defined in IEEE802.16e standard [1] which is supports mobility. IEEE802.16e typically performs hard handovers which disconnect all connections with the serving BS before joining new connection with to target BS. Accordingly, during the handover process, MBS packets that sent by serving BS are may not be transmitted to mobile users. We called that is the service interruption. For unicast, packets can be delivered and forwarded from the serving BS to the target BS.

To decrease the handover delay in Multicast Broadcast System, the IEEE802.16 standard defines an MBS zone [3], which is a group adjoining BSs are transmitting the same MBS multimedia content to multiple users. In an obvious manner, the lager MBS zone is can be get better quality of MBS. However, the handover delay cutback comes at the cost of amplified MBS traffic, which may waste the link capacity of the air interface because all the BSs in the same MBS zone should broadcast the same MBS packets regardless of existence of an MBS user. It means that the BSs that do not have a user for a particular MBs content should still transmit the MBS packets because they belong to the same MBS zone. In short, the handover probability and handover delay usage are two conflicting criteria in MBS zone handover.

In this paper, we analyze the MBS zone handover where a two MBS zones are organized for MBS service area and then packets are transmitted only

In the rest of this paper is organized as following. Section II provides a background of the MBS handover process of Mobile WiMAX and section III describes the simulation model of MBS Zone Handover and the performance analysis and simulation result are given in section IV. We summarize our results in section V.

II. HANDOVER PROCESS AND ANALYSIS OF MBS SERVICE

A. E-MBS service in Mobile WiMAX

For mobile WiMAX, there are four logical entities, in other word mobile WiMAX comprise of mobile station (MS), base station (BS), access service network (ASN) gateways and connectivity service network (CSN) elements such as home agent, authentication, authorization, and accounting etc. In other to support multicast and broadcast service (MBS) a new functional entity, multicast and broadcast service controller (MBSC) is defined, which is typically locates in CSN and

processes multicast broadcast data streams for transmission to access network gateway and base stations. The MBSC comprises a MBSC core processor for establishing time synchronization information used by the access service network gateways or base stations to synchronously transmit data streams [5]. Figure 1 shown as MBS content distribution overview.

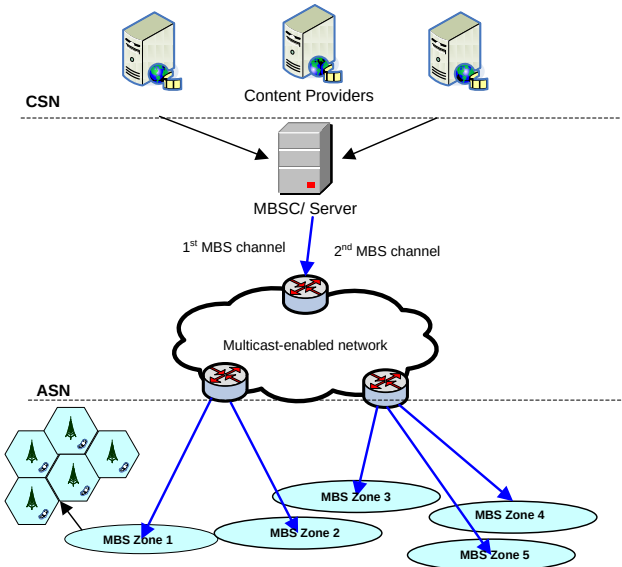


Figure 1. MBS content distribution overview

To enhance the MBS performance especially for the cell edge users who suffer most of the fading channel conditions, MBS transmissions are synchronized at the symbol level across all BSs within MBS zone. In this case, MS collects signals from different BSs and combines them to obtain a gain. This transmission mode is named macro diversity mode. In macro diversity mode, MBS burst positions, dimensions and transmission parameters are same across all BSs within the same MBS zone. In non macro diversity mode, MBS transmissions are coordinated at the same frame across all BSs within MBS zone. The set of MAC SDUs carrying MBS content is identical in the same frame in all BS in same MBS zone.

B. E-MBS Handover Process

In this section, we address the IEEE802.16m standard [2] for E-MBS handover process. For the IEEE 802.16, every connection between a BS and an MS is use to connection identifier (CID). All BSs belong to same MBS zone have unique multicast connection identifier (MCID) and the same security key for MBS data packets. MBS handovers classify into intra-MBS zone handovers and inter-MBS zone handovers. Moreover, if MS moves from one MBS zone to another (inter-MBS zone handover), a new connection ID and MBS Zone ID is needed. In order to organize inter zone handover procedure, step one would be done. The MBS signaling messages without MAC layer handover are shown as figure 2. IEEE802.16m MAC layer handover is out of scope. E-MBS handover procedure of IEEE802.16m is based on IEEE802.16e handover procedure. For the Intra E-MBS

zone handover, we do not need to MBS handover procedure. According to [2], AMS sends AAI_REG-REQ message to discover E-MBS service and ABS sends response message like AAI_REG-RSP that supports any of E-MBS service for AMS. The discovery and registration procedures of E-MBS service are managed by upper layer signaling. If an AMS can register multicast and broadcast services, the serving ABS or the AMS may initiate the DSA procedure for multicast and broadcast connections. Similar to unicast service in IEEE802.16, E-MBS service flows are managed through DSx messaging procedure. To establish, change and delete E-MBS service flow, the ABS or AMS may sends DSA, DSC and DSD messaging respectively[1-2]. In addition the E-MBS service flow may be established by through upper layer signaling without using DSx. The DSx message exchange between AMS and ABS carries the relevant E-MBS service flow information such as E-MBS IDs, FIDs, E-MBS zone IDs and E-MBS carrier information (physical carrier index). Mobile users can be received the security key using security exchange messages such as AAI_PKM_REQ and AAI_PKM_RSP. The security exchange messages are transmit between BS and MS. In addition, the new configuration broadcast message for E-MBS service defined by IEEE802.16m standard which is named AAI_MBS_CFG message. In other to prepare for subsequent E-MBS operation, the AMS receives E-MBS related configuration information through AAI_SCD message and AAI_E-MBS-CFG message.

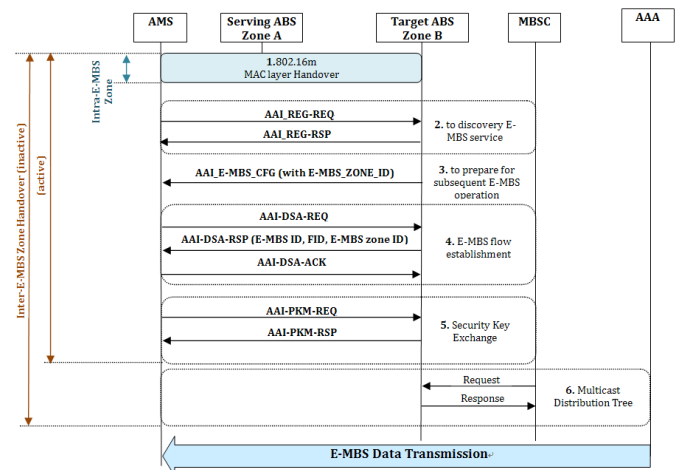


Figure 2. E-MBS Handover procedure

III. SIMULATION MODEL FOR MBS ZONE HANDOVER IN QUALNET

A. Simulation Scenario of MBS zone handover

This section describes the simulation scenario of MBS zone handover. Ideal cell is assumed for each site while considering one, two, three and four cells in one MBS zone. Each site sectorized by a directional antenna. Mobile stations are randomly (uniformly) distributed throughout each cell and move with given speed along with defined trajectories in IEEE802.16m standard. Moreover, speed of the mobile stations in the simulations changes into three speeds such as

3km/h, 30km/h and 120km/h.

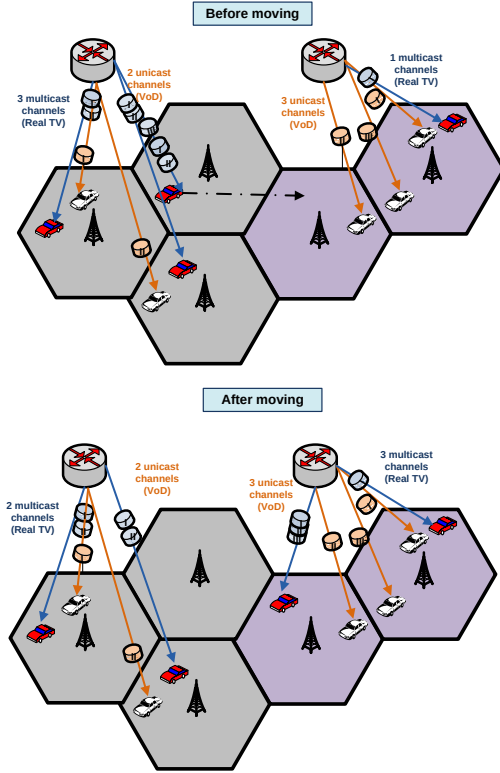


Figure 3. Scenario of MBS zone handover

B. Frame structure for MBS zone handover

According to IEEE802.16m standard, PHY supports Time Division Duplex (TDD) and Frequency Division Duplex (FDD) for 7, 8.75, and 5/10/20 MHz bandwidth mode. Figure 4 shows the OFDMA frame structure with E-MBS Zone for a TDD implementation. Each frame is divided into Down Link (DL) and Up Link (UL) subframes separated by Transmit/Receive and Receive/Transmit Transition Gaps (TTG and RTG, respectively) to prevent DL and UL transmission collisions. [1-2]. In this section, we described the frame structure for MBS zone handover makes in previous section.

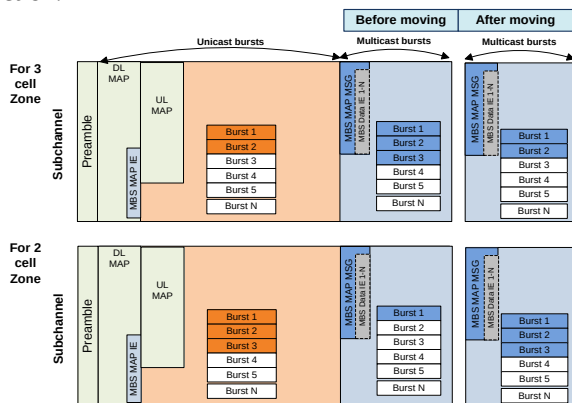


Figure 4. Frame structure for simulation model

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

An extensive Qualnet C++ code for MBS zone handover has been presented in this letter. We purpose to modify Qualnet C++ code for MBS zone handover. Therefore, we focus on the IEEE802.16e (Mobile WiMAX) and IEEE802.16m standard documents. According to standard, MBS service may develop into WiMAX module in the Qualnet network simulator. The modification proposal of MBS zone handover is shown in the WiMAX is shown in table 2. To modify the MBS zone handover of mobile WiMAX, below named as advanced wireless source codes are should be chosen in Qualnet source codes.

TABLE 1. MODIFICATION PROPOSAL FOR MBS ZONE HANDOVER

Advanced Wireless Source Codes	MBS Zone Handover Modification	Multicast and Broadcast Service
1. Mac_dot16.h Mac_dot16.cpp	MacDot16BuildDsaReqMsg MacDot16BuildDsaRspMsg MacDot16BuildDsaAckMsg	MBS_Contents_ID(TLV Encode) MBS_zone_ID (TLV Encoding) MBS_Service(TLV Encoding)
2. Mac_dot16_bs.h Mac_dot16_bs.cp	MacDot16BSHandleDsaReq MacDot16BSHandleDsaRsp MacDot16BSHandleDsaAck MacDot16BSBuildMacFrme MacDot16BSchedMacFrme MacDot16BSBuildMBSMap Pdu	MBS_Contents_ID(TLV Encode) MBS_zone_ID (TLV Encoding) MBS_Service(TLV Encoding) New Mac Frame
3. Mac_dot16_ss.h Mac_dot16_ss.cp	MacDot16HandIDsaReqPdu MacDot16HandIDsaReqPdu MacDot16HandIMBSMapP du	MBS_Contents_ID(TLV Encode) MBS_zone_ID (TLV Encoding) MBS_Service(TLV Encoding) MBS_MAP_Message (Type62)
4. Mac_dot16_sch.h Mac_dot16_sch.c	MacDot16schedDLSubframe	New DL Subframe
5. Mac_dot16_phy.h Mac_dot16_phy.c	MacDot16AddMBSDataTIE MacDot16GetMBSDataTIE MacDot16AddMBSMAPIE MacDot16GetMBSMAPIE	MBS_MAP_IE MBS_DATA_IE
6. Mac_dot16.h Mac_dot16.cpp	MacDot16BuildMobNbrAdv	Neighbor MBS Zone ID
7. Mac_dot16_ss.h Mac_dot16_ss.cp	MacDot16HandIMobNbrAdv	Neighbor MBS Zone ID
8. Mac_dot16.h Mac_dot16.cpp	MacDot16BuildMbsCfg	MBS Zone ID
9. Mac_dot16_ss.h Mac_dot16_ss.cp	MacDot16HandleMbsCfg	MBS Zone ID

The MS can also perform network entry to trigger MBS update, which may result in temporary interruption of the data across zones. In other to avoid this problem we use the MOB_NBR_ADV including neighbor MBS Zone ID and MBS Zone ID. For the MBS zone handover, while moving, the MS can detect if it has entered a new MBS zone by detecting the target BS's broadcast control messages such as MOB_NBR_ADV and MBS_CFG. IEEE 802.16 defines broadcast mechanisms for a BS on the border of MBS zones to inform its MSs about the MBS configuration of neighboring MBS zones. Having received this information, the MS entering the target MBS zone does not need to request an MBS update and may continue receiving the MBS data with no interaction with the BS. In the multiple MBS Zones Transmitting the same MBS content are required to Support Multi MBS Zone.

D. Simulation parameters for Dynamic MBS zone handover

Simulation study in this paper was performed using Qualnet C++. Scenario consists of 3 cell MBS zone and 2 cell MBS zone for MBS service. Here the three of multicast and unicast

channels are used for MBS Service transmission. The speed of the mobile stations in the simulations changes into three speeds such as 3km/h, 30km/h and 120km/h. The various initial simulation values are established and shown in table 1.

TABLE 1. SIMULATION PARAMETER VALUES

	Parameters	Values
1.	Carrier frequency	2.5GHz
2.	Frequency bandwidth	10MHz
3.	Simulation time	500sec
4.	Simulation Area	1500x1500
5.	Number of MBS zone	2
6.	Number of BSs	5
7.	Number of MSs	40
8.	Number of cell in one MBS zone	2,3
9.	Node Placement	Uniform
10.	Number of Multicast channel	5
11.	Number of Unicast channel	5
12.	Traffic Type	Multicast and unicast
13.	User mobility Speed	3,30,120km/h
14.	Duplexing Mode	TDD
15.	Frame Duration	5ms
16.	Cell radius	1000m
17.	Modulation scheme	BPSK, QPSK, 16QAM, 64QAM
18.	FFT size	2048
19.	Packet size	512
20.	Antenna type	Omni-Antenna
21.	Radio Propagation Method	Two ray ground
22.	BS TX power	43dB
23.	Noise power	-104dBm
24.	Cyclic Prefix Factor	8.0
25.	Multicast Protocol	DVMRP(IGMP)
26.	Multicast Group Address	255.0.0.1, 255.0.0.5

IV. Simulation result

To evaluate the performance of MBS zone handover in Mobile WiMAX, we simulated the handover procedure. To evaluate the performance of proposed scheme, we use the parameter shown in Table 1. Figure 5 and figure 6 show simulation results of MBS zone handover in the Mobile WiMAX (IEEE802.16e/m).

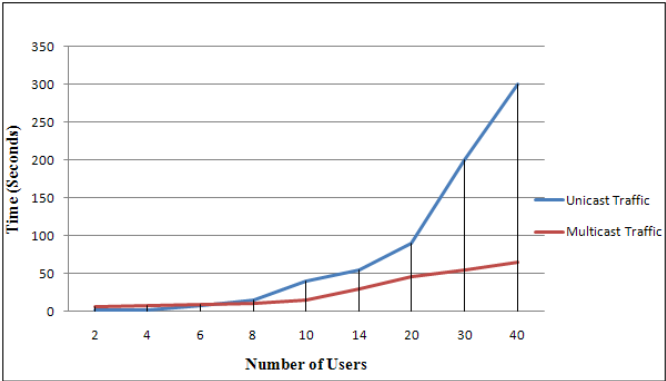


Figure 5. Simulation time versus Number of Nodes

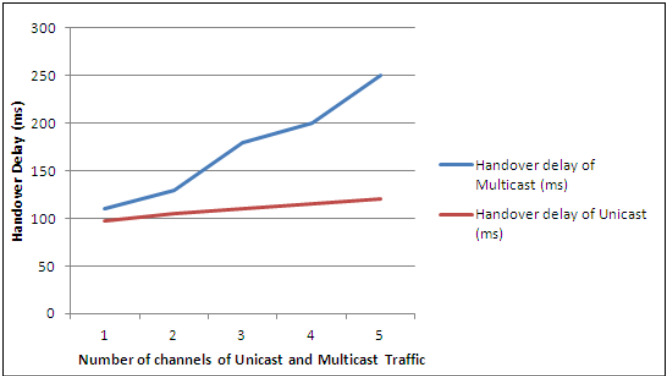


Figure 5. Handover Delay for Unicast and Multicast Traffic

V. CONCLUSION

An extensive Qualnet C++ code for MBS zone handover has been presented in this paper. In this paper we evaluated the performance metrics of MBS zone handover of WiMAX using our modified MBS simulation model in Qualnet. Firstly, we get the preliminary results for MBS handover such as handover latency and simulation time. For the future work, we will continue to focus on the MBS Handover in the Mobile WiMAX for developing Mobile IPTV service.

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