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Enhanced QoS support in OFDMA-Based WiMAX Systems

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Abstract: Worldwide Interoperability of Microwave Access (WiMAX) network offer promising opportunities for unwiring the last mile connectivity to the internet with its comprehensive support of Quality of Service(QoS). Everything has a disadvantage or a problem to be fixed, WiMAX also has a problem that is to provide QoS when providing data, audio and video services. Actually it's not a problem though as it supports orthogonal frequency division multiple access (OFDMA) technology. However the combination of several technologies like OFDM, OFDMA assures the QoS of WiMAX. One of the main features in a WiMAX MAC layer is that it can provide differentiated services among different traffic categories with individual QoS requirements. In this research paper the research team first give an overview of the key aspects of WiMAX and describe Multimedia broadcast multicast service (MBMS) architecture and then propose a broadcast architecture for WiMAX that is based on MBMS to increase the QoS of Multimedia Streaming in WiMAX.

Keywords: WiMAX , QoS , OFDMA , MBMS

I. INTRODUCTION

In the Last few Years, Due to the need of reaching more and more user communities and areas by overcoming the cost barriers of the wired technology. The rapid increase on need of a wireless wide area network with the level of high bandwidth, quality of services, low cost and uninterrupted service, The Institute of Electrical and Electronics Engineers (IEEE)was devoting continuous effort to develop the Wireless Metropolitan area network IEEE 802.16 Standard, Streamlined as the Worldwide Interoperability of Microwave Access (WiMAX) which incorporates the latest advancements in data ink and physical layer. WiMAX has a major realistic significance and strategic value as a standard facing to "The Last Mile" access. IEEE 802.16e based WiMAX network promises the best available quality of experience for mobile data service users. Unlike wireless LANs, WiMAX networks incorporate several qualities of service (QoS) mechanisms at the Media Access Control (MAC) level for guaranteed services for data, voice and video streaming. Table 1 reflects the physical and mac layer architecture. Imax supports multimedia broadcast multicast service (MBMS) a proper technology must be used to certify the best quality of service for the users, as users desires an uninterrupted and a high quality connection when it comes to a wireless communication.

WiMAX air interface utilizes The Orthogonal frequency division multiple access (OFDMA) as radio access scheme to improve system performance and to ensure an uninterrupted service between users. Table 2 and 3 describe the OFDMA functionality and scalability. What actually OFDMA does is it divides the transmission bandwidth into a series of orthogonal sub-carrier sets without overlap, and allocates this sub-carrier and sets to different users to realize the multiple-access without any interruptions. The WiMAX Forum has defined mechanisms for the initial MBSservice content of mobile WiMAX delivery over the mobile WiMAX air interface. In this article the research team briefly reviews the WiMAX system based on OFDMA and introduces the MBMS architecture. Finally the research team proposes and introduces an enhanced MBS architecture according to increase theQoS of multimedia stream services in WiMAX.

II. BACKROUND AND RELATED WORKS

This research systematically examines the design issues and the state of the art of multimedia downlink scheduling in the multicast/broadcast-based WiMAX system. The research group proposes a viable end-to-end framework, connection-oriented multistate adaptation, by considering cross-layer adaptations in source coding, queue prioritization, flow queuing, and scheduling. Its

performance is confirmed by simulations on important metrics, showing that the framework can effectively accommodate heterogeneity in link variations, queue fluctuations, and reception diversities. The framework performs simultaneous adaptations across protocol stacks. This research does not discuss about jitter [1]. The research consider the concepts of dynamic session and network control, driven by context, but introduce the concept of abstract trees in the network to increase the stability of the network to any context change. The research group proposes an efficient architecture for context-aware multiparty session and network control which dynamically adapts to contexts' and networks' dynamics and maintains the connectivity with the expected requirements over session lifetime. The research does not discuss about an internal algorithm of Network Use Management (NUM) and Session Management (SM) for the optimization of session and network control, support of distributed approaches for network decisions [3].

Mobile-WiMAX provides an adaptive modulation and coding (AMC) in OFDM. This will effects exclusive data rates and error detected transmission.AMC technology will use channel state information (CSI) to build up the result with better efficiency.LSE, MMSE, LMMSE, Low rank (Lr)-LMMSE channel estimators are buildup with the physical layer. BER, SNR, MSE and throughput will analyze the activity of estimation algorithms. With using BER value can show increment in modulation scheme size circumstance to improvement in throughput. There is an exchange between modulation size, BER value and throughput [4]. This wireless Metropolitan Area Network is based on IEEE 802.16e standard. Mobility, security, Quality of Service (QoS), centralized scheduling and radio resources utilization are buildup with the MAC layer. Spare Capacity Procedure technique and WiMAX QoS are watchful for load balancing. Those technologies load balance among cells. Cells are in the same Access Service Network (ASN).Extensive simulation will support to this technology. Simulation will prove that this technology can balance load capability between Neighbor Base Stations (NBS) [5]. Fixed and Mobile WiMAX Networks based on LTE (Long Term Evolution) .Build up with UDP protocol. Software MATLAB evaluates the performance. Simulation performance accomplishes UDP protocol traffic over for fixed, mobile WiMAX and LTE. Performance metrics are Throughput, average delay and average jitter [6].

In this research, the research group gives an overview of the key aspects of WiMAX and describes multimedia broadcast multicast service (MBMS) architecture of the 3GPP.Then; the research group proposes multicast and broadcast service (MBS) architecture for WiMAX that is based on MBMS. This architecture can support mobile services and offer more efficient power than that of the MBMS architecture adopted in 3GPP systems. This research is only for mobile services [2]. When using wired technology it can use limit users, but in wireless technology can use unlimited users. Scalable Video Coding for Adaptive modulation and coding with Mobile Media Based Multicast over WiMAX[7]. More television programs can be transmitted because signals are compressed by compression technology in digital television as compared to analog television. The Background of Adaptive Modulation and Coding, WiMAX is expected to provide higher transmission rate and wider transmission range and mobile WiMAX has support for mobility. The value of signal to noise ratio varies according to the distance between mobile station and BS. Scalable Video Coding. A video sequence is composed of a stream of individual frames. The joint video team develops the extension of H.264/Advanced Video Coding, Scalable Video Coding which encodes a picture into one base layer and several enhancement layers in general. Scalable Video Coding has three dimensions in spatial scalable, temporal scalable, and quality scalable. Spatial scalable means the bit-stream can provide different spatial resolutions. Temporal scalable means various frame rates are available [8]. Using Opportunistic Layard Multicasting (OLM).OLM use joint user scheduling and resource allocation algorithm. Using scalable video coding technology video streams are coded into base and enhancement layers. Research team hope to design fast and effective algorithms to link the gap between theoretical throughput capacity and implementation concerns, as a result or consequence of this basic video quality can be guaranteed to all subscribers. In multicast sessions there's a problem called as inevitable packet loss as a solution for this problem FEC rate adaptation scheme can be used. [10]

Allocating and managing radio resources to multicast transmissions in orthogonal frequency-division multiple access (OFDMA) systems is a challenging issue. By the help of sub grouping technique. Sub grouping technique divides the subscribers into subgroups by experienced channel quality. Using sub grouping technique can overcome the throughput limitations of conventional multicast data delivery schemes. To reduce the computational complexity of the subgroup formation problem system uses a low complexity algorithm [11]. Channel-width adaptation can optimize multiple performance metrics of a wireless communication link, including transmission rate, communication range and resilience to delay spread and power consumption. Research issue is how to exploit variable channel width to enhance throughput of a multichip wireless network remains an unresolved research issue. FEC rate adaptation scheme is use to approach theoretical performance [12].

III. OUR APPROACH

A. OFDMA-Based WiMAX SYSTEM

As specified in the introduction, WiMAX employs OFDMA technology in physical layer to orthogonally multiplex data streams onto downlink (DL) and uplink (UL) sub channel and subcarriers.

B.

OFDMA based WiMAX air interface supports both time division duplex (TDD) and frequency division duplex (FDD) modes in its physical layer to transmit the data mechanically. According to the references which is done by the research team, the TDD mode is considered as the best mode as it transmit the data frame by frame and each frame consist of a DL frame and an UL frame to prevent collision and interruption between UL and DL transmission.

According to the IEEE 802.16e standard, a Multimedia multicast broadcast service (MBS / MBMS) zone is identified as a specific region allocated by a Base Station (BS) or a group of BS in the DL frame along with MBS service. BS can send multicast or broadcast data synchronously through the same connection identifier (CID) and security association (SA) carrying MBS data in the same MBS zone and users can obtain the information for an MBS zone from the received data transmitted from a BS and one BS may belong to several MBS zones.

To explain the logical architecture of the WiMAX network, the research team introduces the Network reference model of the WiMAX shown in figure 1.

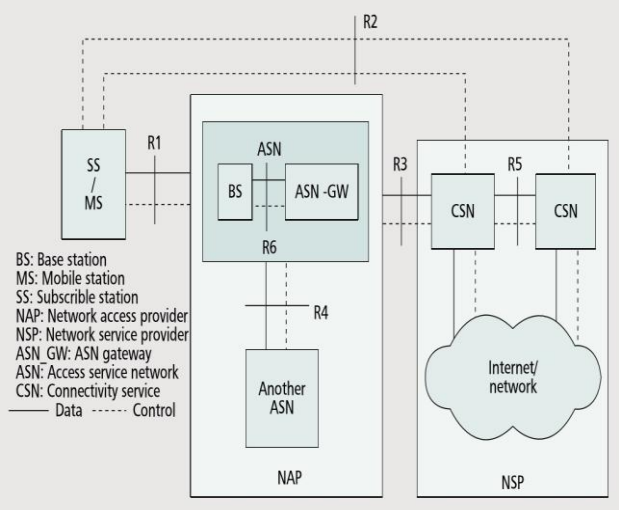

Fig.1 – WiMAX Network Reference Model (NRM)
(source : http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=4290318)

Figure 1 illustrate the NRM with the reference points for interconnection between the logical entities (R1, R2..) and the rest of the entities are as follows:

- MS/SS: Generalized collection of functions to provide connectivity between mobile or subscriber device and the BS. Contains two application functions named service discovery delivery and service subscription. The first one is responsible to provide information regarding BS contents for users.
- ASN: Access Service Network which is defined as a logical boundary that represent an aggregation of nodes in a mobile WiMAX radio access network. Typically an ASN consist of multiple BS that performs radio-related functions and a gateway node (ASN-GW) that interfaces with a Connectivity Service (CSN) with a single ASN-GW.

B. Proposed Solution.

Figure 1 show the current default NRM and the Figure 2 illustrate the proposed NRM for the WiMAX network by the research team.

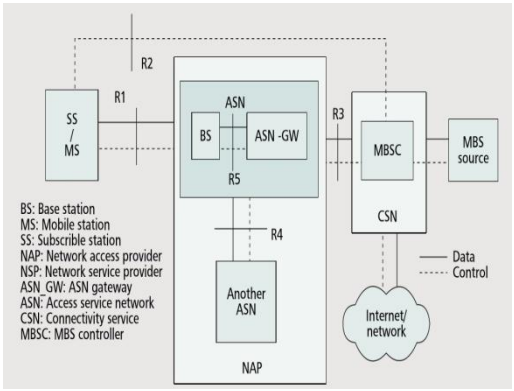

Fig.2 – Proposed WiMAX Network Reference Model (NRM)
(source : http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=4290318)

As some of the referred related research papers have implemented the same solution to enhance the security and the authentication of users, The research team has implemented and modified this solution by adding an additional function to the
added one additional functional entity in the NRM of WiMAX named multimedia broadcast service controller (MBS controller) to enhance the QoS of multimedia streaming and provide an uninterrupted service services between users, which is located in the Connectivity service network (CSN) named Bandwidth allocator. where MBSC is responsible of performing several functionalities which are explained detailed in the following phase,

- Service Announcement : this function is responsible to provide potential MBS users with description of the MBS channel and programs available.
- Membership Management : This function authorizes the user who requests to activate an MBS service and lookup the subscription data of the MBS users.

- MBS Zone Management : The MBSC delivers an MBS program to one or more MBS zones, each of which consists of multiple BS of a WiMAX network. MS/SS that access the same MBS channel in the same zone share a single multicast connection. To avoid the handoff delay between BS in the same MBS zone all BS in the same MBS zone use the same encrypting key to encrypt the same MBS program.

- MCID and IP Address Management : This function performs mapping between an 802.16 MCID and an IP multicast address as each BS requires the mapping information of the multicast connection identifier (MCID) and the IP multicast address when the MBSC creates a new MBS connection.

- Security : This function provides a key management as MS that access the same program in the same zone uses the same cryptographic key for data decryption regardless of BS.

- Session Management : Refers to a logical connection established between an MS or an SS and the MBSC. It also schedules and transmit the packets of MBS sessions.

Bandwidth Allocator (BA) : what actually this function does is when a user request for a multimedia streaming the BA calculate the actual distance between the user and the BS and it allocates the bandwidth according to the distance resulted in the calculation.

C. Reason for considering Distance.

The research team has found that the WiMAX bandwidth varies with the variation of the Down link (DL) data rate with the distance to the BS with the proof of the references which has been done. Figure 3 illustrate a scenario at 7MHz bandwidth in total number of 4 different areas which prove that the bandwidth varies with the distance between user and the BS.

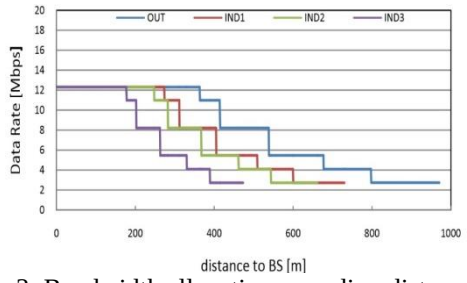

Fig.3: Bandwidth allocation regarding distance.

Figure 3 represent 4 areas which are sequentially named as Outdoor, Indoor 1, Indoor 2 and Indoor 3.

IV. Conclusion

In this research paper, an effort was made by the research team to enhance the Quality of service (QoS) of video streaming for mobile WiMAX by introducing a new logical entity named MBS controller to the network reference model (NRM) of WiMAX with an additional function named as Bandwidth allocator. The default NRM architecture do provide and assure the QoS to users only when streaming data between the users without any authentication and any standard proofs. The proposed NRM by the research team assure the QoS of multimedia streaming by an entity named MBS controller which provides several functionalities such as Membership Management which utilizes and authenticate users, Security which ensure the privacy of a data and the special function named Bandwidth allocator (BA) which allocates the bandwidth according the distance between the user and the BS.What actually BA does is it allocates the bandwidth from the maximum rate to the minimum regarding the distance between the user and the BS. The maximum bandwidth will be allocated when the user is closer to the BS and when the distance increases the bandwidth will be reduced accordingly. The proposed solution for the mentioned problem is capable of assuring and enhancing the QoS of multimedia streaming in OFDMA based WiMAX Technology.

V. Future Work

The proposed solution to enhance the quality of service (QoS) of multimedia streaming by the research team is dependent on the distance between the user and the base station (BS). The projected function named MBS controller ensure several functionalities like authentication of users , security of data , Managing the users, managing the MBS zone and allocating the bandwidth according to the distance. The proposed solution is capable of providing the maximum level of QoS for multimedia streaming when the user is close to the BS. The research team is trying to discover a new solution which will allow users to experience the maximum QoS regardless of the distance.

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VI. APPENDIX

Table1 - WiMAX physical and mac layer

(Source :http://cwi.unik.no/images/9/90/WIMAX_overview.pdf)

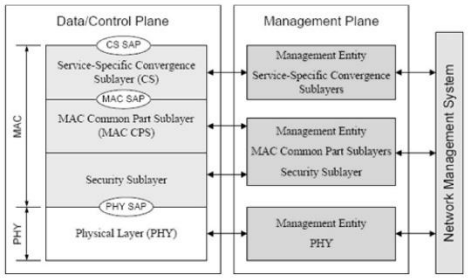

Table2 – OFDM vs FDM

(Source :http://cwi.unik.no/images/9/90/WIMAX_overview.pdf)

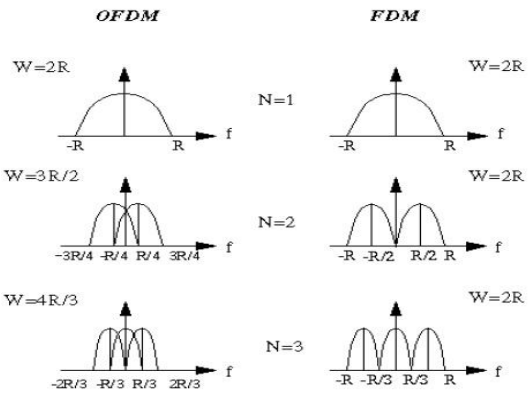

Table3 – OFDMA Scalability

(Source :http://cwi.unik.no/images/9/90/WIMAX_overview.pdf)

Parameters	Values				
System bandwidth (MHz)	1.25	2.5	5	10	20
Sampling frequency (F_s,MHz)	1.429	2.857	5.714	11.429	22.857
Sample time ($1/F_s$ $nsec$)	700	350	175	88	44
FFT size (N_{FFT})	128	256	512	1024	2048
Subcarrier frequency spacing	11.16071429 kHz				
Useful symbol time (T_b=1/ f)	89.6 µs				
Guard time (T_g=T_b/8)	11.2 µs				
OFDMA symbol time (T_s=T_b+T_g)	100.8 µs				