Australian Journal of Basic and Applied Sciences, 9(10) Special 2015, Pages: 195-202

ISSN:1991-8178

Australian Journal of Basic and Applied Sciences

Journal home page: www.ajbasweb.com

Application – Aware Dynamic Modulation Selection for WiMAX System

[1]Saira Banu and [2]K.M. Mehata

[1]Assistant Professor, Senior Grade, Department of Computer Science & Engineering B.S.Abdur Rahman University, Vandalur, India
[2]Dean, SCIMS, School of Computer, Information & Mathematical Science, B.S.Abdur Rahman University, Vandalur, India

ARTICLE INFO

Article history:
Received 28 January 2015
Accepted 25 February 2015
Available online 6 March 2015

Keywords:
WiMAX, Dynamic MCS, Adaptive MCS, SBN, BER

ABSTRACT

To meet the requirement of high speed application, OFDM based WiMAX(Worldwide Interoperability for Micro Wave Access Technology) is employed which promises high speed and high quality. WiMAX is the technology based on IEEE 802.16 standard. Modulation and coding is one of the features of PHY layer which is used to load the data in the uplink and downlink during transmission. The existing method comprises of adaptive modulation scheme based on the communication channel conditions i.e Bit Error Rate , Signal By Noise ratio, Power spectral density and Probability Error . The proposed method, DMCS (Dynamic Modulation and Coding Selection) dynamically selects the modulation scheme based on the application of the input traffic. As a result our study shows that by selecting the modulation type based on type of application can maximize the throughput while minimize the transmission delay and jitter. It has been observed that the performance of DMCS is better than adaptive MCS for the real time applications.

To Cite This Article: Saira Banu and K.M. Mehata, Application – Aware Dynamic Modulation Selection for WiMAX System. ***Aust. J. Basic & Appl. Sci.,*** *9(10): 195-202, 2015*

INTRODUCTION

The Digital Subscriber Line or the cable modem based connections are the ways to access the broadband internet services before the evolution of IEEE 802.16. This wired infrastructure is costlier for deploying in the rural areas. WiMAX is the recent alternate technology to establish broadband wireless communication.

There are two types of WiMAX standards, Fixed and Mobile WiMAX. IEEE 802.16d-2004 (also known as Fixed WiMAX) and IEEE 802.16e-2005 (also known as Mobile WiMAX) Fixed WiMAX provides support to fixed and nomadic applications while mobile WiMAX supports to mobile, portable, fixed and nomadic applications. Fixed WiMAX uses 2 to 11GHZ frequencies and provides transmission to stationary devices. Mobile WiMAX use 2 to 6 GHZ frequency band and allows people to communicate while walking or riding in cars.

The Orthogonal Frequency Division Multiple Access technique is used for transferring large amount of digital data over the radio wave. The orthogonal frequency division multiplexing divides the high bit rate data stream into several low bit rate streams and allocates a separate carrier for each stream. VOIP is used to transfer the voice packets in the existing internet infrastructure.

Modulation is mapping the data bits to the (I,Q) values, where I represents In-phase and Q represents the quadrature. Phase shift keying encodes information only in phase where as Quadrature amplitude modulation encodes information in both amplitude and phase.

Quadrature Phase Shift Keying (QPSK) allows the signal to carry twice the information as ordinary PSK using the same bandwidth.

Quadrature Amplitude Modulation or QAM used for modulating data signals onto a carrier used for radio communications. The number before QAM (for example 16 QAM) refers directly to the number of decision points in the constellation. These numbers will always a power of two. (EG. 2^6=64QAM) .The coding rate indicates the amount of data stream actually used to transmit usable data. The different convolution coding rates that can be used are expressed in fraction as rate 1/2 , rate 3/4 , rate 2/3 and rate 5/6.Modulation and coding technique provides the primary link between the user and the wireless channel. The performance of the system and the use of resources changes in accordance with the selected modulation and coding technique.

In the existing system the MCS is selected based on theChannel quality as shown in Figure 1. The proposed work investigates the performance of WiMAX by selecting the MCS based on the application type of incoming data. The real time

Corresponding Author: Saira Banu, Assistant Professor, Senior Grade, Department of Computer Science & Engineering, B.S. Abdur Rahman University, Vandalur, India
E-mail: saira.atham@gmail.com

application like voice conversation and video conferencing must have the jitter and end to end delay in the tolerable limit; otherwise the quality of the service of the played out data will be bad. So real time application considers throughput, jitter and delay as the main parameters for evaluating the performance.

Fig. 1: Adaptive MCS.

This paper is broadly divided into eight sections. A brief introduction about the WiMAX (IEEE 802.16) and the use of OFDMA is discussed in the first section. Published research papers related to this field are discussed in the second section. The parameters used for analyzing the QoS of Voice and Video are introduced in the third section. The fourth section deals with the network architecture of WiMAX. The different modulation and coding schemes available in the PHY layer and its uses are explained in the fifth section. The simulator and the simulation models are discussed in the sixth section. The seventh section analyzes the result and the graph. The eighth Section concludes the paper with the conclusion.

Literature review:

Author in (Hardeep Kaur, 2014), analyzed the performance of coded OFDM based WiMAX system with different fading conditions . Performance study of Mobile TV over mobile WiMAX is conducted with different types of Adaptive Modulation and Coding is done in (Jamil hamodi, 2014). Mr.SivaKumar Reddy and Ms.Lakshmi in (Sivakumar Reddy, 2014) proposes the method for modulation and coding selection based on the threshold given.The aim of the paper (Sivakumar Reddy, 2014) is to analyze the performance of the system in different channel conditions with adaptive modulation anfd coding features. B. Sivakumar and Lakshmi in (Siva Kumar Reddy, 2013), evaluated the performance of WiMAX by feeding the channel state information back to the transmitter by the channel estimator. The Performance of the WiMAX system is investigated and compared between the model with cyclic prefix and without cyclic prefix in (Salleh, 2013). This paper (Waran, 2011) investigates the application of link adaptation techniques to the downlink to achieve spectral efficiency gain.

Voip over wimax:

One of the killer applications for the 802.16 is Voice Over Internet Protocol. VOIP supports real time application like bidirectional voice conversation, video conferencing along with other application such as FTP, web etc.

Voice over Internet Protocol technology has a major impact on the telecommunications industry. VoIP technology provides advantages for both the user and client, by allowing calls to be made more cheaply, as well as enabling data, voice and video to be carried over the same network efficiently. The most widely used VoIP Codec is G711, although there are a variety of others are available with varying data rates and providing different levels of voice quality.

The standards of VOIP are as follows:

- H.323: ITU-T standard for packet based multimedia communication.
- H.255.0 : Standard for registration, admission, call signalling and control
- H.245: Standard for terminal capability exchange and control of logical channel.
- H.323: Offers specifications for call control, channel setup, codecs for the transmission of Real Time video and voice over the networks where the QoS and the guaranteed services are not available.

The various parameters used for measuring the quality of voice and video in WiMAX are jitter, end to end delay and throughput. The definitions of the parameters are given below.

- Jitter: Jitter is the variation in time between packets arriving, caused by network congestion, timing drift or route changes.
- End to End delay: End to end delay is the time taken for a packet to be transmitted across a network from source to destination.
- Throughput: The total number of packets/bits delivered to the end user in a network is called throughput. It is measured in terms of packets per second or bits per second.

Wimax network architecture:

WiMAX is an IEEE standard for high layer protocols like TCP/IP, Voice Over Internet Protocol and Session Initiation Protocol. WiMAX offers air link interoperability. WiMAX technology is a telecommunications technology that offers transmission of wireless data via a number of transmission methods; such as portable or fully mobile Internet access via point to multipoint links. Wimax supports packet switched and urban, rural radio propagation. The Wimax architecture consists of three logical entities: BS, ASN and CSN.

- *Base Station (BS):* The functionality of base station is supervision, handoff prompting, and classification of traffic, DHCP, Keys session and multicast group management.
- *Access Service Network (ASN):* used to describe and expedient way to explain combination of

functional Entities and equivalent significance flows connected with the access service. The ASN gateway supports Connection and mobility management across cell cities and manages traffic flows.

- *Connectivity Service Networks (CSN):* This entity offers IP services for connectivity to the WiMAX Clients. The CSN takes care of IP address, roaming, management of locations etc.

Wimax operates in infrastructure mode. It consists of base station which sends data to clients, receivers' requests and forwards to the network provider. It can provide various levels of QoS in teams of queuing, scheduling, control signaling mechanisms, classification and routing**.** Figure 2 shows the WiMAX network architecture.

The connection classifier in the subscriber station map the incoming packet to the appropriate connection based on the set of criteria. The admission control mechanism in the base station is used to admit or reject the service based on the available bandwidth. The scheduler is used to allocate the resource for the effective utilization.

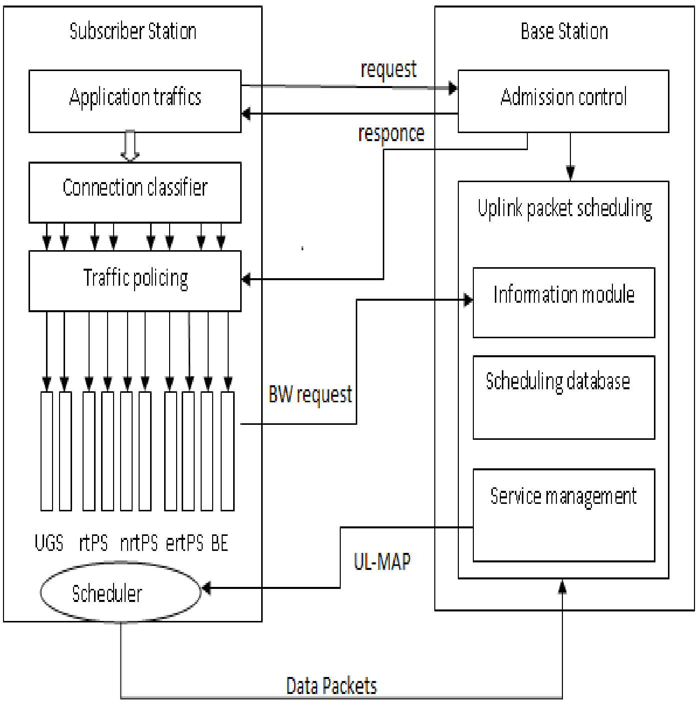


Fig. 2: WiMAX network architecture

Modulation and coding:

WiMAX uses the OFDMA system to support Voice traffic. Whenever the Voice and video traffic arrives at the base station (BS) it needs to be scheduled on the uplink and downlink. The frequency, transmit power; time of transmission, mode of transmission, the identification of mobile station are need to be specified during each allocation. This control information is compressed and coded using the Modulation and Coding Scheme (MCS).Thus the resources are allocated when the user is in active mode and reallocated when the user is in silent mode. This allocation and reallocation is done for every 1.25 second. The MCS used for data transmission and reception varies according to the channel variation. The amount of allocated resources depends on adaptive MCS.

WiMAX supports a variety of modulation and coding schemes and allows for the scheme to change on a burst-by-burst basis per link, depending on channel conditions. The channel quality feedback indicator helps the mobile to provide the feedback to the base station about the downlink channel quality base station. For the uplink, the base station can estimate the channel quality, based on the received signal quality. The list of the various modulation and encoding schemes supported by WiMAX are discussed in the table 1.

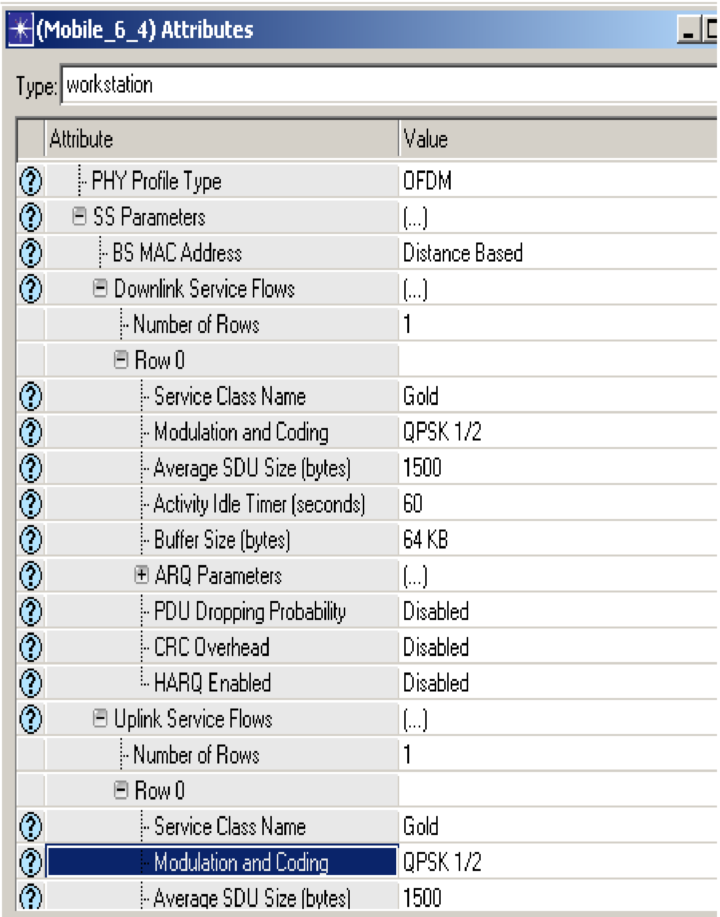


Fig. 3: Subscriber station Parameter.

Table. 1: Various Modulation and coding schemes.

	Downlink	Uplink
Modulation	BPSK, QPSK, 16 QAM, 64 QAM; BPSK optional for OFDMA-PHY	BPSK, QPSK, 16 QAM; 64 QAM optional
Encoding	Mandatory: convolutional codes at rate 1/2, 2/3, 3/4, 5/6 Optional: convolutional turbo codes at rate 1/2, 2/3, 3/4, 5/6; repetition codes at rate 1/2, 1/3, 1/6, LDPC, RS-Codes for OFDM-PHY	Mandatory: convolutional codes at rate 1/2, 2/3, 3/4, 5/6 Optional: convolutional turbo codes at rate 1/2, 2/3, 3/4, 5/6; repetition codes at rate 1/2, 1/3, 1/6, LDPC

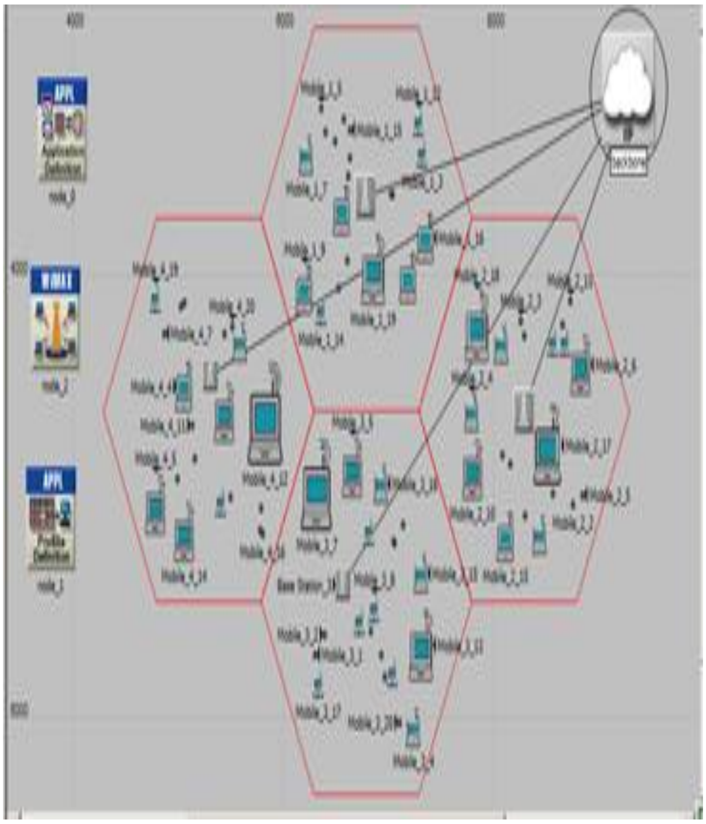
In the existing system the MCS is selected based on the Bit Error Rate, Signal By Noise Ratio and the probability rate of the communicating channel. The proposed System selects the MCS dynamically based on the application type of the input data. The modulation and coding scheme is set at the subscriber station i.e. the mobile station for both uplink and downlink channel as shown in the figure 3.

Simulation scenario:

This research work is done on a wireless network with four base stations and twenty subscriber stations (fixed node).The topology, which is shown in the scenario 1, consist of geographical overlay of four cells, each with radius 3km and 2 subscriber stations. The nodes are placed in a random manner. Main considerations made in our simulation while deploying wireless network are technology and topology.

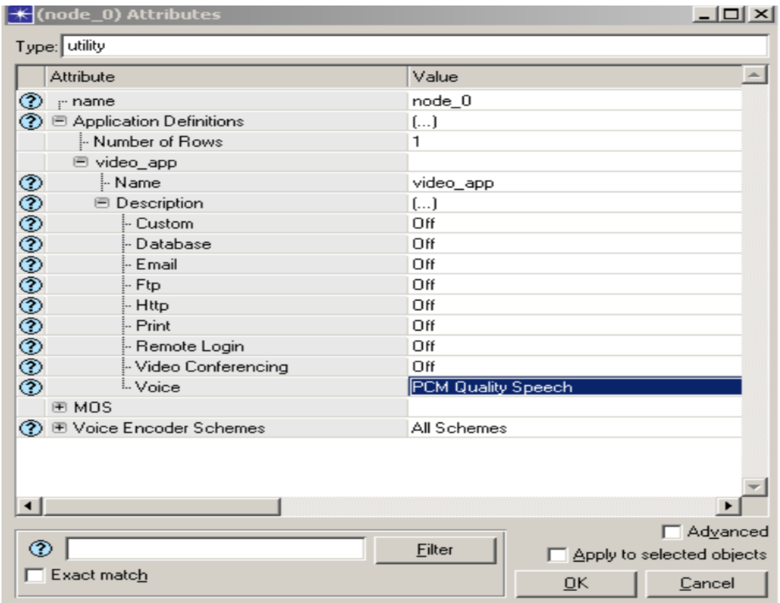
Technology: WiMAX technology with subscriber node transmission power 0.5 w and base station transmission power 0.5w.

Topology: The simulated topology consists of 4 hexagonal cells with cell radius of 3km.Number of subscriber stations per cell is 20.Base stations are modeled with wimax_3section_bs_atm2_ethernet2_slip4_wlan_router. The subscriber stations are modeled with wimax_ss_wkstn.



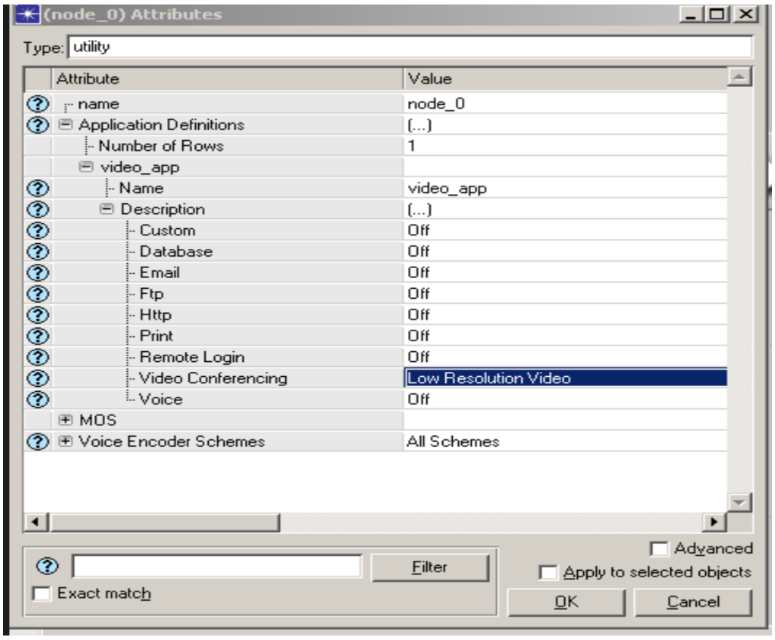
Scenario 1: Wimax Network with 4 cells and 20 subscriber stations

This topology is designed for VOIP application that is both voice and video application. This is shown in the scenario 2 and 3. The simulated parameters are discussed in the table 2.



Scenario 2: Voice Application

Australian Journal of Basic and Applied Sciences, 9(10) Special 2015, Pages: 195-202



Scenario 3: Video Application

The configuration used in the above simulated scenario is profile config, application config and wimax config.

Application Configuration:

This specifies the various application used in the project. The various application names nare web browsing, FTP, databases, HTTP, remote login, voice and video conferencing. In the above simulation we have k\taken the voice and video conferencing.

Profile Configuration:

It is used to create the traffic pattern for the application defined in the application config.

Wimax Configuration:

It is used to store profiles of physical and service classes which can be referenced by all wimax nodes in the network.

Table 2: Simulation Parameter.

Parameter	Value
Network interface type	Phy/Wireless Phy/OFDMA
Propagation model type	Propagation and OFDMA
Medium Access Control type	Mac/802_16/Base Station
Routing protocol	NOAH
Antenna model	Omni Antenna
Link layer type	Logical Link layer
Frame size (msec)	5 (msec)
Duplex scheme	TDD
Packet Rate	4 packet/second
Modulation and Coding Scheme Technique	QPSK 1/2
Simulation time	30 minutes

Simulation result:

In this section, the throughput of WiMax is computed using various modulations and encoding scheme for the voice and video application. Unsolicited grant service is set as the service class for the VOIP application. The performance of the network is considered high if the throughput is high. The throughput for the real time applications like Voice and Video is not the number of packets that reaches the receiver but the number of packets that has got played out. The throughput achieved for the VOIP (both voice and video) application when simulated with various Modulation scheme is discussed in the following section. OPNET 14.5 Modeler academic version, Which is a freeware for research purpose is used for the simulation.

A. Voice Application:

The graph in figure 4 shows the throughput of the WiMax network for the different Modulation and Coding scheme like QPSK ½, QPSK ¾, 16 QAM 1/2, 16 QAM2 3/4, 64 QAM1/2, 64 QAM2/3,64 QAM ¾, QPSK ½ repetition 2, QPSK ¾ repetition 2 , QPSK ½ repetition 4, QPSK3/4 repetition 4, QPSK ½ repetition 6, QPSK ¾ repetition 6, along with adaptive MCS. The comparison graph simulated using Opnet 14.5 Modeler is shown in the figure 4. The deployed WiMax network produces comparatively maximum throughput with the modulation scheme QPSK ½ and QPK ¾ for the voice application. So the throughput obtained in these two MCS are analyzed in the figure 5.

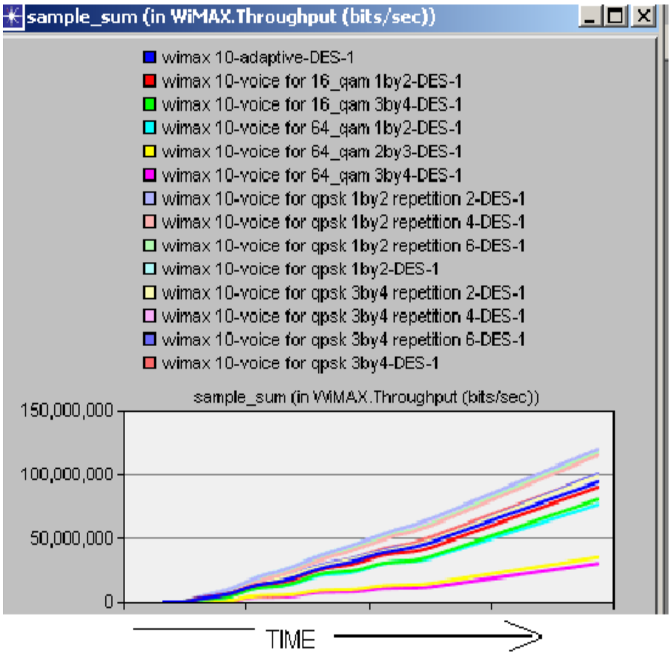


Fig. 4: Throughput

The graph in figure 5 observes the throughput obtained using QPSK ½ , QPSK ¾ , QPSK ¾ repetition 6 and compared the performance with adaptive modulation technique using channel condition. The results may show that QPSK ½ delivers more number of packets than the adaptive MCS.

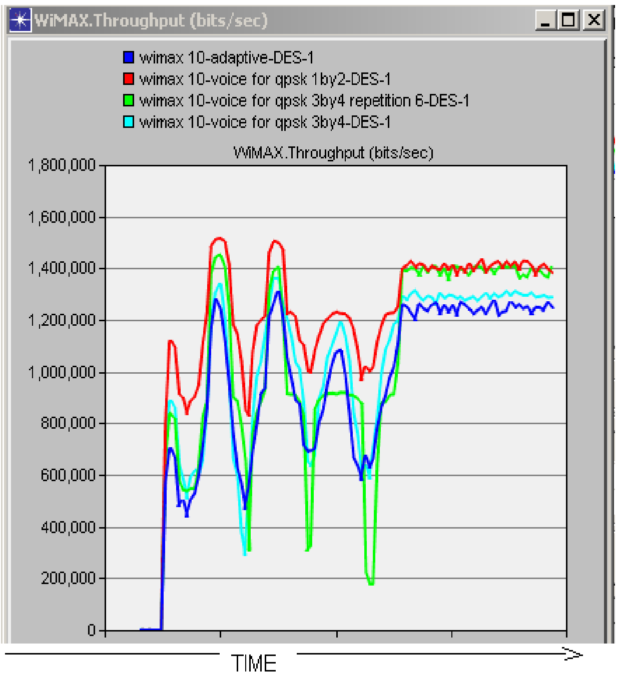


Fig. 5: Throughput in bits/second with respect to adaptive technique.

The important parameters considered for investigating the performance of voice are throughout, packet jitter and packet end to end to delay. Throughput is discussed using Figure 4 and 5.Jitter is based on the inter arrival time of the successive packets. The more variation in jitter results in more loss of packets which in turns degrades the QoS of Voice. The graph in figure 6 shows that MCS QPSK ½ produces less jitter compared to adaptive MCS.

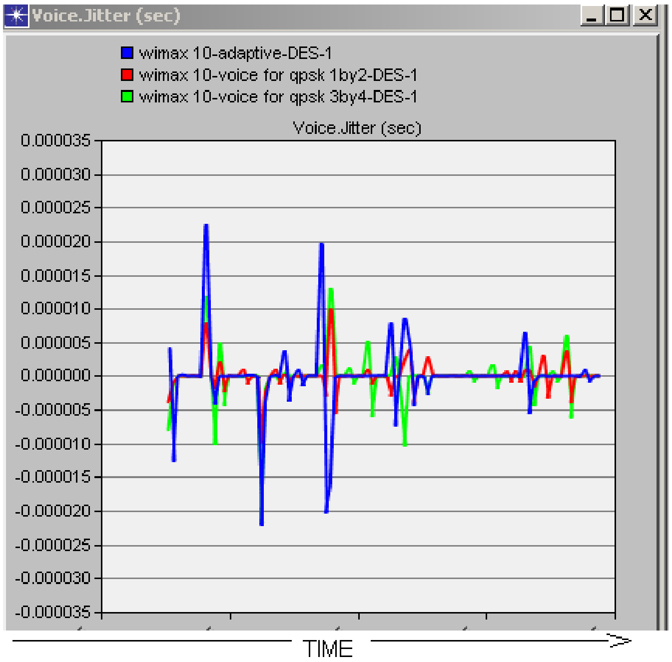


Fig. 6: Jitter in bits per second with respect to adaptive technique.

The lower the value of the end to end delay, the better the performance of the voice quality. The lower the value of end to end delay the better the performance of the voice. The results in fig 7 ensures that the QoS of voice will be better when MCS QPSK ½ is selected for voice.

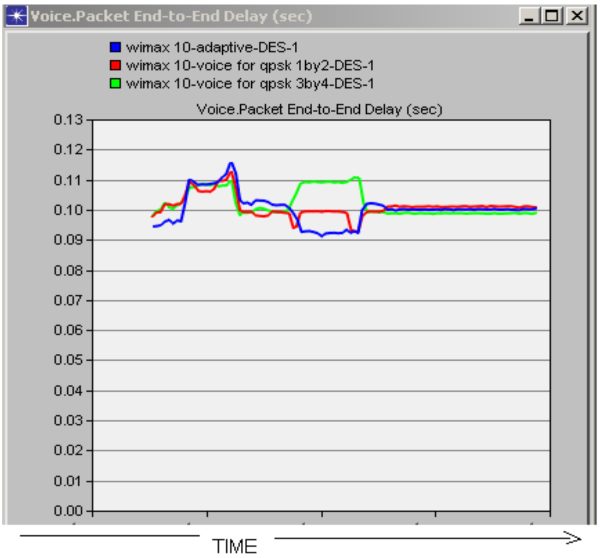


Fig. 7: Packet end to end delay.

B. Video Application:

The results of the simulation using OPNET 14.5 for the video application in the WiMAX network using different MCS are discussed in this section. The graph in figure 8 shows the throughput of the WiMAX network for the different Modulation and Coding scheme like QPSK ½, QPSK ¾, 16 QAM 1/2, 16 QAM2 3/4, 64 QAM1/2, 64 QAM2/3,64 QAM ¾, QPSK ½ repetition 2, QPSK ¾ repetition 2 , QPSK ½ repetition 4, QPSK3/4 repetition 4, QPSK ½ repetition 6, QPSK ¾ repetition 6 and adaptive MCS. The maximum bits delivered for each MCS is analyzed and found that the MCS QPSK 1/2 delivers more bits than all the other MCS. This is shown clearly in the graph in the figure 8.

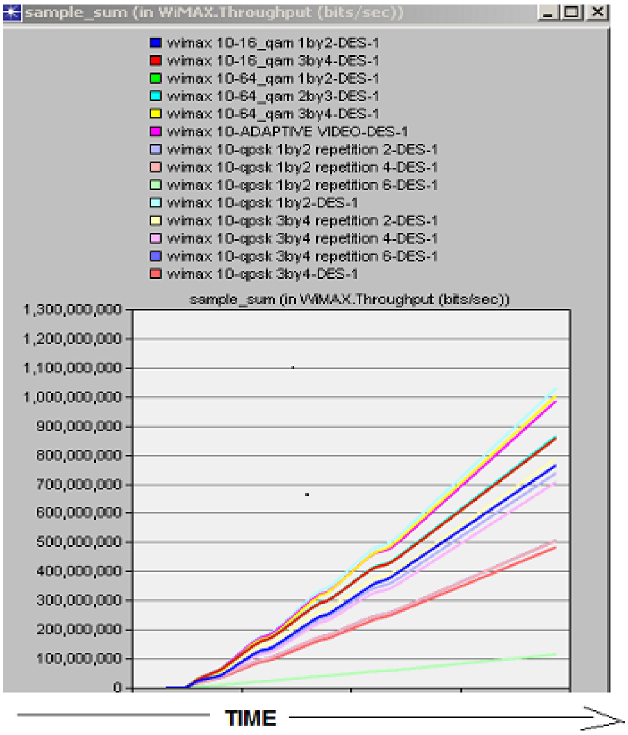


Fig. 8: Throughput comparison for Video application.

The top three throughputs obtained and their corresponding MCS compared with adaptive MCS is shown in the graph 9.This graph clearly shows that MCS QPSK ½ yields the maximum throughput when compared with all the other Modulation and coding scheme.

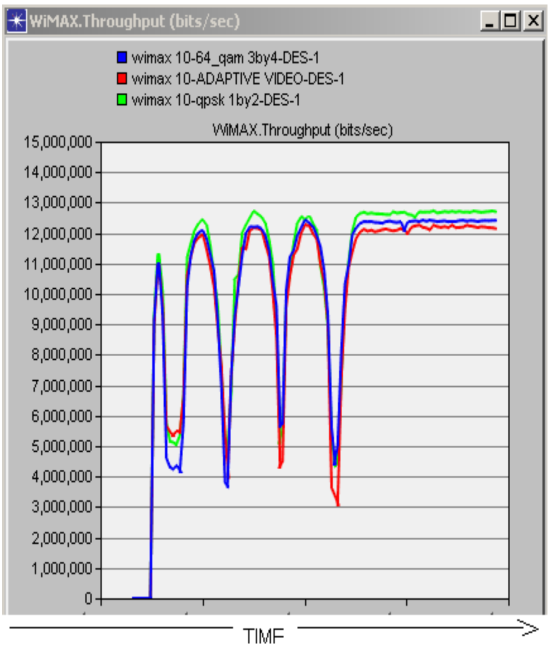


Fig. 9: Throughput with respect to adaptive MCS.

The graph 10 shows the average delay calculated for the modulation schemes QPSK ½ , QPSK ¾ ,the MCS that produces the top two throughputs and the adaptive MCS. The average delay is minimum for the QPSK ½ than the adaptive MCS. So QPSK 1/2 can be considered as the best modulation scheme for voice.

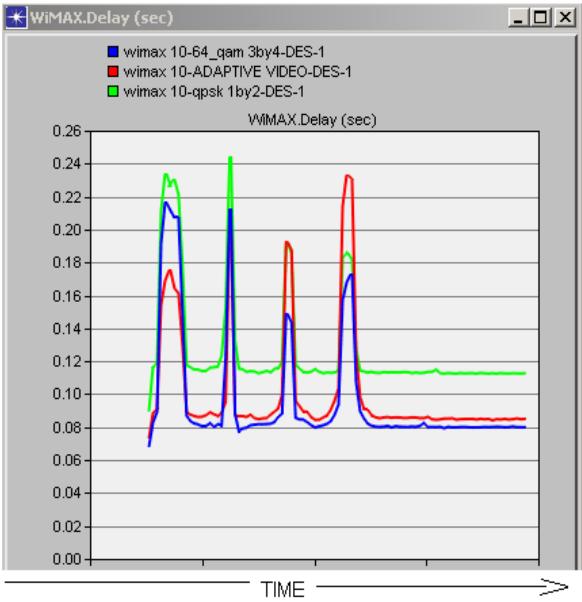


Fig. 10: Average delay with respect to adaptive MCS.

The performance of video in the network in terms of throughput and average delay is high by dynamically selecting the Modulation and Coding Scheme Qpsk ½ based on the application. The performance of the network for the video application is high for the dynamic selection of modulation and coding scheme than adaptive MCS.

The throughput is high for QPSK ½ and the delay is also comparately low for this modulation. so the QPSK ½ is considered as the best scheme for video application in WiMAX environment.

Conclusion:

The simulation was done to evaluate the performance of VOIP over the WiMAX networks. The parameters used to evaluate the performance of the network are throughput, jitter and end to end delay. Modulation and coding scheme are used to load the data into the uplink and downlink during transmission. Thirteen modulation and coding scheme namely Qpsk ½, Qpsk ¾, 16 QAM ½, 16 QAM ¾, 64 QAM ½ ,64 QAM 2/3, 64 QAM ¾, Qpsk ½ repetition 2, Qpsk ¾ repetition 2, Qpsk ½ repetition 4 , Qpsk ½ repetition 6 are simulated in the Wimax network and their throughputs and delay are taken for comparison. The research findings show that the real time applications like Voice and video application can perform better under the modulation QPSK with the encoding rate ½. In this paper same MCS has been selected for the uplink and downlink. This paper work can be extended by using different combination of MCS in the uplink and downlink channel. In this paper the simulation is done for the UGS service class. The work can be extended by taking the other service classes. The simulations results indicate that the choice of Modulation and coding scheme dynamically based on the network traffic have significant impact on the QoS of the network.

ACKNOWLEDGEMENT

I thank Riverbed for the academic version OPNET 14.5 Modeler, freeware for the academic research purpose.

REFERENCES

Hardeep Kaur, M.l. Singh, 2014. “Analyzing the performance of coded OFDM based WiMAX system with different fading conditions”, International Journal of Advanced Science and Technology, Vol. 68.

Jamil hamodi, Ravindra Thool, Khaled Salah, Anwar Alsagar, yousef Holba, 2014. “Performance Study of Mobile TV Over Mobile WiMAX Considering different Modulation and Coding Techniques”, International Journal Of Communications,Network and System Sciences.

Jaspinder Singh, Er. Ravinder Kumar, Mukesh Kumar, 2012. “Performance Analysis of WiMAX with Different Modulation Techniques”, International journal of Engineering Research and Technology,Vol.1 Issue 4.

Salleh, A., N.R. Mohamad, M.Z.A. Abd Aziz, M.H. Othman, N.M.Z. Hashim, 2013. “ Simulation Of WiMAX System based on OFDM Model with different adaptive Modulation Technique,Vol. 2.

Siva Kumar Reddy, B., B. Lakshmi, 2013. “Adaptive Modulation and Coding in COFDM for WiMAX using LMS Channel Estimator”.

Sivakumar Reddy, B., B. Lakshmi, 2014. “Channel Estimation/Equalization with Adaptive Modulation and Coding Over Multipath Faded Channels for WiMAX”, International Journal of

Electrical, Computer, Electronics ,and Communication Engineering, 8(11).

Sivakumar Reddy, B., B. Lakshmi, 2014. "Internation Conference on Circuits,Systems,Communication and Information Technology Applications (CSCITA).

Waran, K. Saad, Mohamod, rosdiadee. N. Ibraheem shayar, 2011. "Throughput performance Of Adaptive modulation and Coding Scheme with link Adaptation for Memo WiMAX Downlink Transmission, "Journal of Asian Scientific Research".

www.freewimax.com.

www.radio-electronics.com.