International Journal of
Emerging Research in Management &Technology
ISSN: 2278-9359 (Volume-4, Issue-2)

Research Article | **February 2015**

Performance Based Comparsion of Different Routing Protocol under Different Modulation over WiMAX

Naveed Abdullah, Hardeep Singh
CGC, College of Engineering, Landran Road,
Mohali, Punjab, India

Abstract-

Worldwide Interoperability for Microwave Access (WiMAX) is essentially a next-generation wireless technology that enhances broadband wireless access. (WiMAX) is a standards-based wireless technology for providing high-speed, last-mile broadband connectivity to homes and businesses and for mobile wireless networks. WiMAX is similar to Wi-Fi but offers larger bandwidth, stronger encryption, and improved performance over longer distances by connecting between receiving stations that are not in the line of sight. WiMAX uses Orthogonal Frequency Division Modulation (OFDM) technology, which has a lower power consumption rate. WiMAX can be used for a number of applications, including last-mile broadband connections, hotspots and cellular backhaul, and high-speed enterprise connectivity for business. It supports broadband services such as VoIP or video. WiMAX is also a possibility for backhaul technology in municipal Wi-Fi networks. WiMAX or 802.16 is definitely a hot topic and has a fair list of industry supporters. The wireless medium has limited bandwidth, higher packet error rate, and higher packet overheads that altogether limit the capacity of the network to offer guaranteed QoS.in this paper, we provide an overview of the cyclic prefixes (Conventional/ Turbo) and service classes that are the key functions in the MAC common part sub layer. In this paper, we evaluate the performance of different routing protocols namely AODV, DSDV and OLSR under varying digital modulation schemes namely BPSK, QPSK and QAM under different coging rates [1/2, 2/3, 3/4].

Index Terms- WiMAX, IEEE 802.16, AODV, DSDV, OLSR, SNR, BPSK, QPSK, QAM

I. INTRODUCTION

Since the final decades of the twentieth century, data networks have known steadily growing success. After the installation of fixed Internet networks in many places all over the planet and their now large expansion, the need is now becoming more important for wireless access.

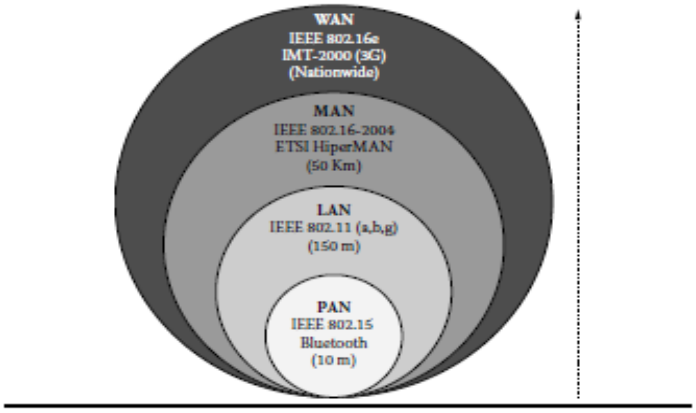

Figure1 :Illustration of network types

There is no doubt that by the end of the first decade of the twentieth century, high-speed wireless data access will be largely deployed worldwide. A large number of wireless transmission technologies exist, other systems still being under design. These technologies can be distributed over different network families, based on a network scale. In figure 1, a now-classical representation is shown of wireless network categories, with the most famous technologies for each type of network.

- **PAN :** A *Personal Area Network* (PAN) is a (generally wireless) data network used for communication among data devices close to one person. The scope of a PAN is then of the order of a few metres, generally assumed to be less than 10m, although some WPAN technologies may have a greater reach. Examples of WPAN technologies are Bluetooth, UWB and Zigbee.
- **LAN :** A *Local Area Network* (LAN) is a data network used for communication among data devices: computer, telephones, printer and personal digital assistants (PDAs). This network covers a relatively small area, like a home, an office or a small campus (or part of a campus). The scope of a LAN is of the order of 100 metres. The most presently used LANs are Ethernet (fixed LAN) and WiFi (Wireless LAN, or WLAN).

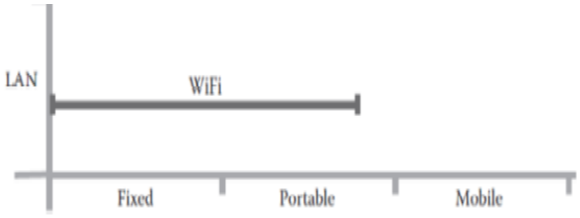

Figure 2 :Local Area Network (mapped against usage models and access modes).

- **MAN :** A *Metropolitan Area Network* (MAN) is a data network that may cover up to several kilometres, typically a large campus or a city. For instance, a university may have a MAN that joins together many of its LANs situated around the site, each LAN being of the order of half a square kilometre. Then from this MAN the university could have several links to other MANs that make up a WAN. Examples of MAN technologies are FDDI (Fibre-Distributed Data Interface), DQDB (Distributed Queue Dual Bus) and Ethernet-based MAN. Fixed WiMAX can be considered as a Wireless MAN (WMAN).

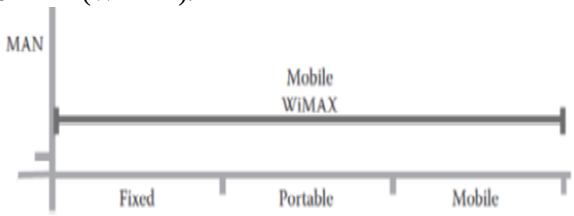

Figure 3 :Metropolitan Area Network (mapped against usage models and access modes).

- **WAN :** A *Wide Area Network* (WAN) is a data network covering a wide geographical area, as big as the Planet. WANs are based on the connection of LANs, allowing users in one location to communicate with users in other locations. Typically, a WAN consists of a number of interconnected switching nodes. These connections are made using leased lines and circuit-switched and packet-switched methods. The most (by far) presently used WAN is the Internet network. Other examples are 3G and mobile WiMAX networks, which are Wireless WANs. The WANs often have much smaller data rates than LANs (consider, for example, the Internet and Ethernet).

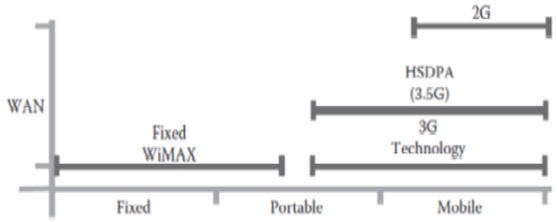

Figure 4 :Wide Area Network (mapped against usage models and access modes).

Obviously, the traditional mechanisms such as wifi, Bluetooth etc., to access network are no longer suitable and cannot meet the newly upcoming requirement. Fortunately, the Broadband Wireless Access (BWA) technology such as WiMAX, which can meet people's need to access the Internet conveniently, becomes more popular in recent years.
The 802.16 standard is designed to offer the ATM like QoS and a key aspect of the design is the polling-based MAC layer that is more deterministic than contention-based MAC used in other similar standards. TheMAC layer employs a single scheduling data service for each connection and each data service is associated with a set of QoS parameters that quantify its behavior. Like ATM, the 802.16MACalso defines different service classes and specifies up to five separate service classes to provide QoS for various types of applications. The service classes include:
Unsolicited grant service (UGS): It is designed to support real-time service flows generated at CBR. The UGS will be granted periodically without a polling-request procedure and thereby reducing the latency.
Real-time polling service (rtPS): It is designed to support real-time service flows where packets are generate at VBR. This service requires more request overheads and latency compared to UGS, but supports variable grant sizes. The rtPS is suitable for connections carrying services like VoIP or video streaming services.
Extended real-time polling service (ertPS): It is designed to support real-time service flows where packets are generated at variable-size rate on a periodic basis, like VoIP services. ertPS is intended to utilize the efficiency of both UGS and rtPS.
Nonreal-time polling service (nrtPS): It is designed to accommodate delay-tolerant data streams that consist of variable-size data packets. These services are capable of tolerating longer delays and are relatively insensitive to delay jitter. The nrtPS is appropriate for Internet services with a minimum guaranteed rate like File Transfer Protocol (FTP) and Hypertext Transfer Protocol (HTTP).
Best Effort (BE) service: The BE service is designed to facilitate data streams that have no minimum service requirement and therefore may be supported on a resource availability basis such as e-mail. For BE, throughput and delay guarantees are not required.

1. Digital Modulations

As for all recent communication systems, WiMAX /802.16 uses digital modulation. The now well-known principle of a digital modulation is to modulate an analogue signal with a digital sequence in order to transport this digital sequence over a given medium: fibre, radio link, etc.. This has great advantages with regard to classical analogue modulation: better resistance to noise, use of high-performance digital communication and coding algorithms, etc.

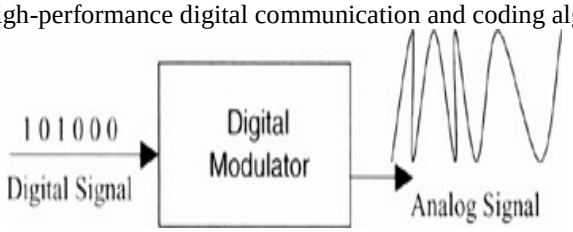

Figure 3: Digital modulation principle

Four modulations are supported by the IEEE 802.16 standard BPSK, QPSK, 16-QAM and 64-QAM. In this section the modulations used in the OFDM and OFDMA PHYsical layers are introduced with a short explanation for each of these modulations.

Binary Phase Shift Keying (BPSK) :

The BPSK is a binary digital modulation; i.e. one modulation symbol is one bit. This gives high immunity against noise and interference and a very robust modulation. A digital phase modulation, which is the case for BPSK modulation, uses phase variation to encode bits: each modulation symbol is equivalent to one phase. The phase of the BPSK modulated signal is π or $-\bar{}\pi$ according to the value of the data bit.

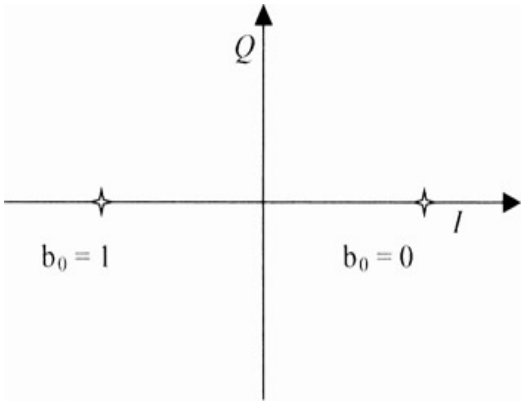

Figure 4: The BPSK constellation

Quadrature Phase Shift Keying (QPSK) :

When a higher spectral efficiency modulation is needed, i.e. more b/s/Hz, greater modulation symbols can be used. For example, QPSK considers two-bit modulation symbols.Many variants of QPSK can be used but QPSK always has a four-point constellation.

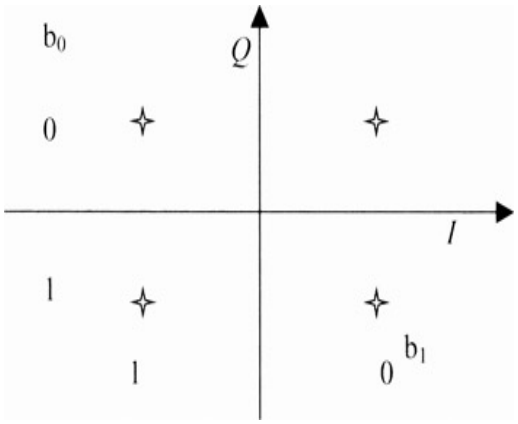

Figure 5: Example of a QPSK constellation

Quadrature Amplitude Modulation (QAM): 16-QAM and 64-QAM :

The QAM changes the amplitudes of two sinusoidal carriers depending on the digital sequence that must be transmitted; the two carriers being out of phase of $+\pi/2$, this amplitude modulation is called quadrature. It should be mentioned that according to digital communication theory, QAM-4 and QPSK are the same modulation (considering complex data symbols). Both 16-QAM (4 bits/modulation symbol) and 64-QAM (6 bits/modulation symbol) modulations are included in the IEEE 802.16 standard.

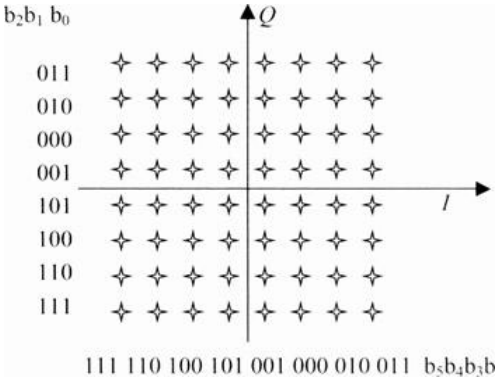

Figure 6: A 64-QAM constellation

II. RELATED WORK

In [1], L.D.Malviya et.al present an Adaptive modulation enables a WiMAX system to optimize the throughput based on propagation conditions. IEEE802.16 (WiMAX) system support BPSK, QPSK, 16-QAM and 64-QAM and the access scheme is OFDM. This paper presents the performance of different variants of transmission control protocols with different modulation schemes when density of mobile nodes changes.

In [2], J. B. Othman et.al. present a new admission control (AC) for IEEE 802.16. The AC aims to accept new connections according to the negotiated service class (UGS, rtPS, nrTPS, and BE).

The authors propose to use the token bucket concept that provide QoS for real time traffics without degrading the QoS of non real time traffic. With the diversity of service and in order to avoid any degradation of the active connection, and Admission Control (AC) is defined to limit the number of connections in the network. This mechanism is not specified in the standard and it is let to the operators. The major AC defined in the literature are based on merging real time traffics in one service class and the others in another class or on the strict priority. The advantage of this method is that we reduce lightly the number of high priority but we increase considerably the number of low priority traffic. To show the benefit of the proposed AC, authors have developed an analytical model based on Markov Chains that compare strict priority with our AC and numerical results show that the proposed solution decrease the overall QoS of UGS traffic of 05% while we increase it of more than 75% for the other traffics.

In [3] Vikram Mehta et.al focuses on analyzing essential QoS parameters for WiMAX Network. Essential QoS parameters like delay, Jitter, Packet delivery Ratio (PLR), Packet Loss Ratio (PLR) and throughput have been calculated for 500 mobile nodes in a WiMAX network. Ad Hoc on Demand Distance Vector Routing (AODV) protocol has been chosen as a routing protocol because of its ability to perform well under highly mobile and random conditions. MATLAB software version R2011 was used for creating WiMAX network architecture and Regression analysis is done for each of the QoS parameter.The results help in critically analyzing QoS parameters for WiMAX Network and it has been found that an optimum value of QoS parameters is obtained with increasing number of mobile nodes for WiMAX Network.

In [4], Z.M. Elkwash et.al. designed a simulator of WiMAX communication system using Simulink of MATLAB. The authors examine the effect of the cyclic prefix on the bit error rate (BER) with different types of modulation techniques such binary phase shift key,*Quadrature amplitude modulation* that are based on variation in gain vector, delay vector, and signal to noise ratio. In this paper, Performance evaluation is done based on various factors and for different modulation techniques with several code rates. The BER is plotted versus the cyclic prefix, for three cases with different values of delay vector [0 le-6], [0 3e-6], [0 5e-6], and [0 8e-6], gain vector [0-1], [0-3], [0-5], and [0-8], SNR 15, 30, 45, and 60. Different delay vectors, gain vectors, different SNR values were checked against different modulation techniques with several code rates. It was found that WiMax system gave good performance at delay vector of [0 le-6], gain vector of [0-4], cyclic prefix of (1/4), and modulation techniques are 4-QAM, and 16-QAM with coding rate of (2/3).Under BPSK modulation, the best result comes for gain vector [0-5] and CP of (1/\6) with delay gain [0\e-6] and SNR of 60. SNR has a small influence on the BER performance, and the lower BER is presented at SNR of 60.

In [5] Tarik Anouari et al. investigate the performances of the most common VoIP codecs, which are G.711, G.723.1 and G.729 over a WiMAX network using various service classes and NOAH as a transport protocol. Voice Over Internet Protocol is a promising new technology which provides access to voice communication over internet protocol based network, it becomes an alternative to public switched telephone networks due to its capability of transmission of voice as packets over IP networks. Therefore VoIP is largely intolerant of delay and hence it needs a high priority transmission. protocol . To analyze the QoS parameters, the popular network simulator ns-2 was used. Various parameters that determine QoS of real life usage scenarios and traffic flows of applications is analyzed. The objective is to compare different types of service classes with respect to the QoS parameters, such as, throughput, average jitter and average delay.

In [6], Rakesh Kumar Jha et al. present a concept of our WiMAX (Worldwide Interoperability for Microwave Access) network per-formance for QoS monitoring and optimization solution for BS (Base Station) with multimedia application. In the com-munication sector, the optimal objective is to equate quality and cost. Due to its large coverage area, low cost of de-ployment and high speed data rates. WiMAX is a promising technology for providing wireless last-mile connectivity. Physical and MAC layer of this technology refer to the IEEE 802.16e standard, which defines 5 different

data delivery service classes that can be used in order to satisfy Quality of Service (QoS) requirements of different applications, such as VoIP, videoconference, FTP, Web, etc. In this paper we have made six scenarios. Here two types of MAC layer QoS are used and they are UGS and rtPS having application of Voice over IP (VoIP) and MPEG respectively. Also the traf-fic priority for UGS is high as compared to rtPS. In each scenario the number of fixed nodes (Fixed Subscriber Stations) and Mobile nodes (Mobile Subscriber Stations) are different. To cover more nodes or if nodes are outside the coverage area more than one BS are required.

In [7], L.D.Malviya et.al present an Adaptive modulation enables a WiMAX system to optimize the throughput based on propagation conditions. IEEE802.16 (WiMAX) system support BPSK, QPSK, 16-QAM and 64-QAM and the access scheme is OFDM. This paper presents the performance of different variants of transmission control protocols with different modulation schemes when density of mobile nodes changes.

Shraddha Bansal et al. [8], investigate the performance of mobile Wi-Max, its physical layer is simulated using Matlab and bit error rate (BER) performance is observed. Further performance improvement is achieved using forward error correction codes (FEC). Two codes, convolution code (CC) and low density parity check code (LDPC) are considered for this purpose. BER performance is evaluated for these codes under different conditions.

Laxmi Shrivastava et. al. [9], a new algorithm named as load balancedcongestion adaptive routing (LBCAR) algorithm hasbeen proposed for randomly distributed networks in which two metrics - traffic load density and life timeassociated with a routing path, have been used todetermine the congestion status and weakest node of theroute and the route with low traffic load density andmaximum life time is selected for packet transmission.This algorithm combines the idea of load balancing and congestion adaptiveness effectively in AODV and limits the idealized maximum number of packets transmittable through the route having weakest node with minimum life time. It can adaptively adjust the forwarding probability of RREQ messages according to the distribution and load status of nodes and link cost in route discovery phase. Simulation results indicate that, compared with original AODV and DSR, LBCAR can significantly reduce the packet loss balancing the load in the network and increasing the network life time with varying pause time.

In [10], J. B. Othman et.al. present a new admission control (AC) for IEEE 802.16. The AC aims to accept new connections according to the negotiated service class (UGS, rtPS, nrTPS, and BE).

In [11] M. Rehan Rasheed et.al. investigates different routing protocols and their performances on 802.16 WiMAX networks. Using simulation, different routing protocols have been tested with various network parameters. Results show that DSDV in general outperforms other routing protocols.

III. PROPOSED METHODOLOGY

These are specific implementations, selections of options within the 802.16e standard, to suit particular ensembles of service offerings and subscriber populations. Although the routing and resource allocation for OFDM-based networks has been well studied in the literature, different routing and modulation schemes have been specifically designed for WiMAX. These schemes should be modified or new schemes should be defined for OFDM-based WiMAX to effectively utilize the network resources and improve the network performance for integrated voice, video, and data services over fixed, nomadic, portable, and fully mobile users. An appropriate resource allocation scheme for OFDM based WiMAX should consider diverse QoS requirement of heterogeneous traffic and mobility issues simultaneously, because a scheme that guarantees QoS for one type of traffic in a fixed network may not perform well for a different type of traffic in a fully mobile network. Moreover, the routing schemes should balance between users requirements and service providers revenue.

3.1 Simulation And Results

In this paper, we evaluate the performance of AODV, DSDV and OLSR routing protocols under various available modulation techniques. UDP has been considered as transport protocol and CBR as traffic generator. Performance evaluations are based on the simulation using ns2

3.1.1 Research Methodology

Ns-2 is an open source discrete event simulator used by the research community for research in networking. It has support for both wired and wireless networks and can simulate several network protocols such as TCP, UDP, multicast routing, etc. More recently, support has been added for simulation of large satellite and ad hoc wireless networks. The ns-2 simulation software was developed at the University of Berkeley. It is constantly under development by an active community of researchers.

The standard ns-2 distribution runs on Linux. However, a package for running ns-2 on Cygwin (Linux Emulation for Windows) is available. In this mode, ns-2 runs in the Windows environment on top of Cygwin as shown in the figure 7.

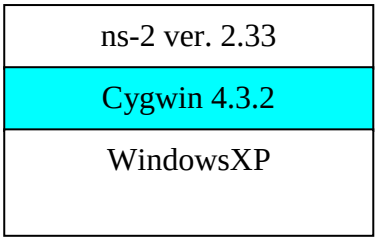

Figure.7: ns-2 over Cygwin

NS-2 provides a split-programming model; the simulation kernel is implemented using C++, while the Tcl scripting language is used to express the definition, configuration and the control of the simulation. This split-programming approach has proven benefits over conventional programming methods. Also, NS-2 can produce a detailed trace file and an animation file for each ad hoc network simulation that is very convenient for analyzing the routing behavior.

Parameter	**Value**
Simulation time	200 Sec
Simulation area	1500m x 1500m
Parameter	**Value**
Antenna	Omni antenna
No. of subscriber	50
Traffic	CBR
Routing protocol	AODV, DSDV and OLSR
Mobilty Model	Random Waypoint Model
Modulation technique	BPSK , QPSK , 16 QAM, 64 QAM

There are many parameters which can be used to evaluate the performance of routing protocols. Performance metrics are considered as follows**:**

Throughput

Number of bits delivered successfully per second to the destination. It is the measure of effectiveness. Figure 6,7 and 8 shows simulation results for different routing protocols under various modulation techniques.

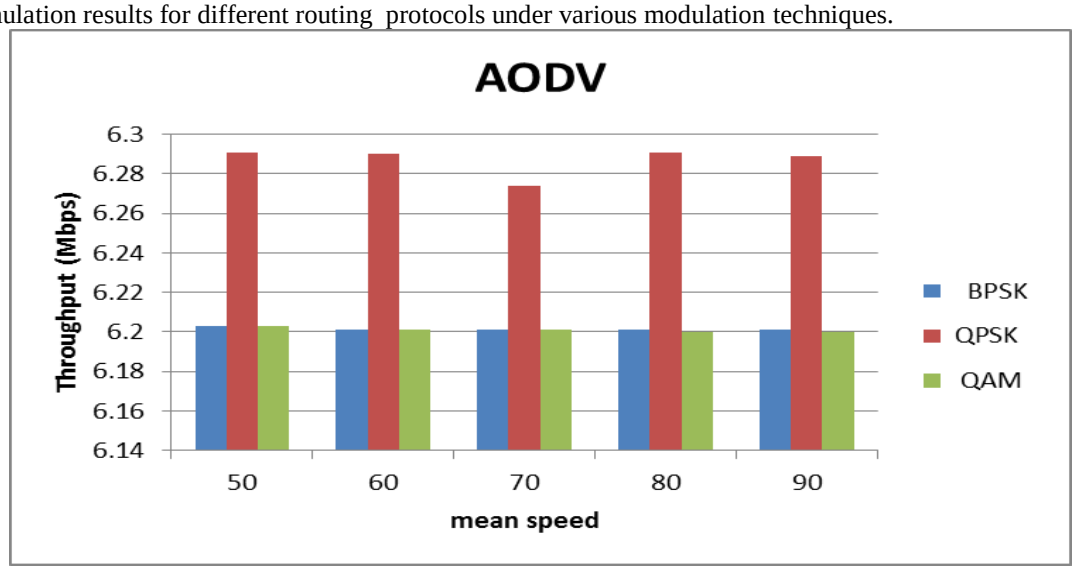

Figure 6: Throghput verus mean speed(AODV).

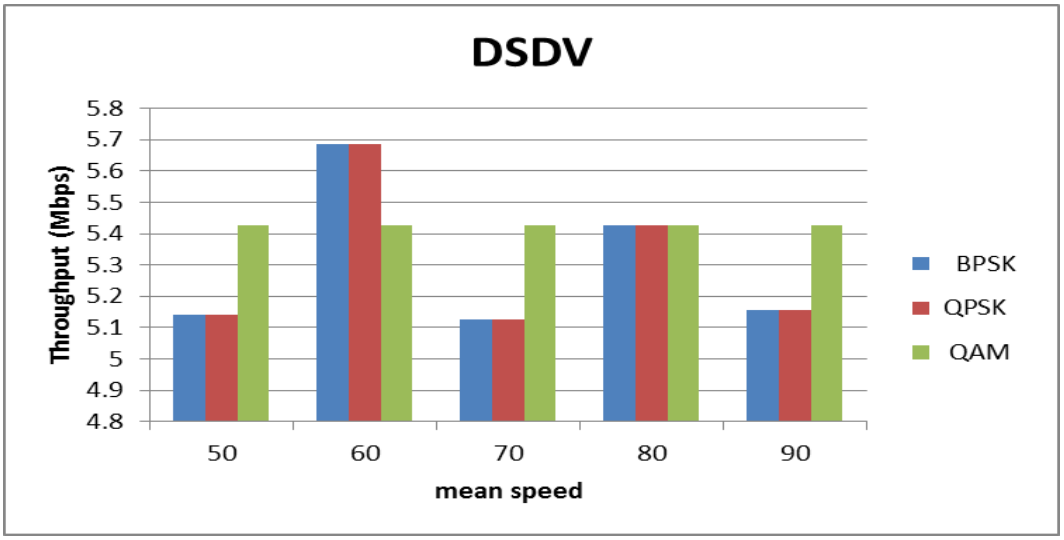

Figure 7: Throghput verus mean speed(DSDV).

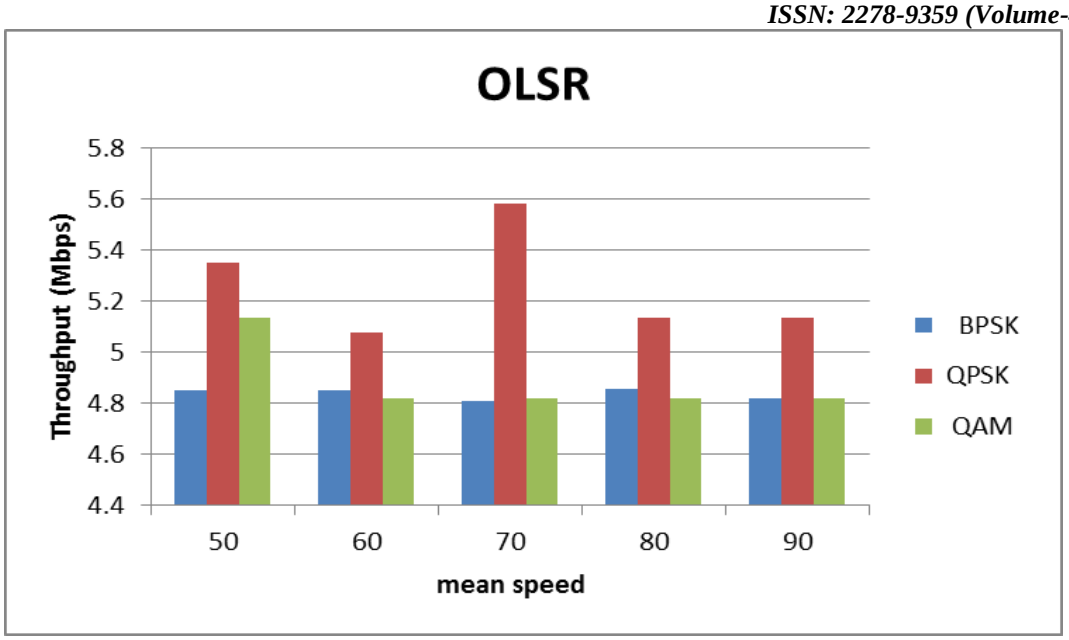

Figure 8: Throghput verus mean speed(OLSR).

IV. CONCLUSION AND FUTURE WORK

In this paper, the performance of three QoS service classes namely BPSK, QPSK and QAM under different coging rates. WiMAX networks promise to offer an easy deployable and relatively low cost solution for the wireless broadband access. In usual operating conditions, WiMAX will likely support traffic belonging to a wide range of broadband applications, and it is claimed to provide differentiation among heterogeneous demanding flows. Channel encoding and QoS services classes are the key components to provide QoS capability and proportional fairness in the bandwidth sharing over a changing radio environment. The simulation results were presented for varying mean speed for different modulation techniques with several routing protocols. From the simulation results it is observed that QPSK has best all-round performance under all routing protocols considered.

REFERENCES

[1] L.D.Malviya A. Gaiwak Dr. P.D.Vyavhare," Simulation based comparison of different Modulation schemes for Mobile WiMAX using TCP and its Variants", IEEE, First International Conference on Emerging Trends in Engineering and Technology.

[2] Jalel Ben Othman and Lynda Mokdad, " Improving QoS for UGS, rtPS, nrtPS, BE in WIMAX networks", International Conference on Communications and Information Technology (ICCIT), IEEE, 2011.

[3] Vikram Mehta ,"Performance Analysis of QoS Parameters for Wimax Networks", International Journal of Engineering and Innovative Technology, vol.1, issue-5, May 2012.

[4] Z. M. Elkwash, N. M. Shebani, A. Mjahed ,"Effect of Cyclic Prefix on Data Rates in WiMAX System with Variation in Delay Vector, Gain Vector, Signal to Noise Ratio and Coding Rates for Different Modulation", International Conference on Technological Advances in Electrical, Electronics and Computer Engineering (TAEECE), IEEE, 2013, pp. 538 – 545. , 2008.

[5] Tarik Anouari ,"Performance Analysis of VoIP Traffic in WiMAX using various Service Classes", International Journal of Computer Applications ,Volume 52– No.20, August 2012.

[6] Rakesh Kumar Jha, Idris Z. Bholebawa, Upena D. Dalal," Location Based Performance of WiMAX Network for QoS with Optimal Base Stations (BS)", Wireless Engineering and Technology, Volume 2, No.3, July 2011.

[7] L.D.Malviya A. Gaiwak Dr. P.D.Vyavhare," Simulation based comparison of different Modulation schemes for Mobile WiMAX using TCP and its Variants", First International Conference on Emerging Trends in Engineering and Technology, IEEE, 2008.

[8] Shraddha Bansal, Raksha Upadhyay, "Performance Improvement of Wi-Max IEEE 802.16e in Presence of Different FEC Codes", CICSYN, IEEE, 2009.

[9] Laxmi Shrivastava, Sarita Singh Bhadoria, G. S. Tomar and Brijesh Kumar Chaurasia," Effect of number of CBR Connections on the performance of a LoadBalanced Congestion Adaptive Routing for MANET" Fourth International Conference on Computational Intelligence and Communication Networks, IEEE, 2012.

[10] Jalel Ben Othman and Lynda Mokdad, " Improving QoS for UGS, rtPS, nrtPS, BE in WIMAX networks", International Conference on Communications and Information Technology (ICCIT), IEEE, 2011.

[11] M. Rehan Rasheed ," Performance of Routing Protocols in WiMAX Networks", International Journal of Engineering and Technology, Vol.2, No.5, October 2010.

