Compare and Evaluate and Performance of Fixed and Mobile WiMax using Applications

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ABSTRACT

WiMAX is a technology comes up with multiple solutions. It's defined as Worldwide Interoperability for Microwave Access, based on IEEE 802.16, which is a standard with similar principles. The main advantage of WiMAX is that: it supports higher throughput rates, covers larger areas and has higher data rates. There are two standard variants of WiMAX, the first one is a Fixed WiMAX and the second is Mobile-WiMAX. Mobile WiMAX 802.16e gives fully mobile internet access at higher broadband speeds than other broadband networks like Wi-Fi. Whereas Fixed-WiMAX 802.16 delivers point to multipoint broadband wireless access to our homes and offices. WiMAX supports multiple applications because it has a high capacity. In this paper, we will study, compare and evaluate the performance of Fixed and Mobile-WiMAX networks in term of throughput and load, using different applications. We will use OPNET Modeler14.5 to simulate several scenarios. For simulation scenarios, we will use real-time and Non-real time applications for Fixed and Mobile-WiMAX like (FTP, HTTP, E-mail, Voice and Videoconference). WiMAX Simulation results indicate that a Fixed WiMAX may carry the larger load and has better throughput than Mobile WiMAX.

Keywords— Fixed WiMAX; Mobile Wimax; FTP; E-mai;, HTTP; Voice; Video.

I.   INTRODUCTION

 WiMAX can provide broadband wireless access up to 30 miles (50 km) for fixed stations, and 3 - 10 miles (5 - 15 km) for mobile stations. WiMax coverage range is expected to provide fixed and nomadic wireless broadband connectivity without necessarily having a line-of-sight (LOS) with a base station. WiMax will also enable greater mobility, high speed data applications, range and throughput. The standards are designed for the Internet protocol applications. It is intended for a high-speed Wireless Wide Area Network (WAN). It operates in the range of up to 40 miles with speeds of 70 Mbps and beyond and covers an entire city. WiMAX is capable of supporting very high peak data rates. In fact, a peak data rate of 74Mbps can be achieved when operating with a 20MHz wide spectrum. Under very good signal conditions, even higher peak rates may be achieved by using multiple antennas and spatial multiplexing[1].The WiMAX MAC layer has a connection-oriented architecture that is designed to support a variety of applications, including real and non-real application like (FTP, HTTP, E-mail, VOIP, Multimedia services).

A real-time application (RTA) is an application program that functions within a time frame that the user senses as immediate or current. The latency must be less than a defined value, usually measured in seconds, like Voice and video. Non-real time, or NRT, is a term used to describe a process or event that does not occur immediately. For example, FTP, HTTP, and E-mail.

 WiMAX supports a number of modulations and Forward Error Correction (FEC) coding schemes. These schemes can be changed on a per-user and per-frame basis depending on the channel conditions[2]. WiMAX supports fixed and mobile Internet access. It can be connected with an Internet Protocol (IP) based core network, which is chosen by operators that serve as Internet Service Providers (ISPs). 802.16e uses Scalable Orthogonal Frequency-Division Multiple Access (SOFDMA) rather than Orthogonal Frequency-Division Multiplexing (OFDM)[3]. The arrival of WiMAX technology has met the user's demand for broadband wireless access since its ability to provide higher speed connection, with a large area coverage alongside with the quality of service assurance[4].   WiMAX is a second-generation protocol that allows for more efficient bandwidth use, interference avoidance, and is intended to allow higher data rates over longer distances[5]. Most common

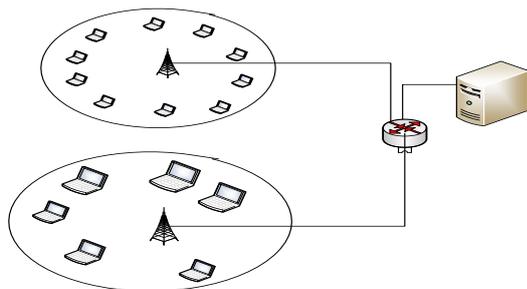applications are selected in this paper as illustrated in Figure 1.

Figure 1 Application over Wimax

OPNET Modeler : OPNET is a research-oriented network simulation tool. It provides a comprehensive development environment for modelling and simulation of deployed wired and wireless networks. OPNET Modeler enables users to create customized models and to simulate various network scenarios. The wireless module is used to create models for wireless scenarios such as Wi-Fi and WiMAX. The Modeler is object-oriented and employs a hierarchical approach to model communication networks. It provides graphical user interfaces known as editors to capture the specifications of deployed networks, equipment, and protocols. The three main editors are Project, Node, and Process Editors. OPNET provides high-fidelity modelling, simulation, and analysis of wireless networks such as interference, transmitter/receiver characteristics, and full protocol stack, including MAC, routing, higher layer protocols, and applications. It also has the ability to incorporate node mobility and interconnect wire line transport networks[4].

WiMAX : WiMAX supports fixed and mobile Internet access[3]. It can be connected with an Internet Protocol (IP) based core network, which is chosen by operators that serve as Internet Service Providers (ISPs). 802.16e uses Scalable Orthogonal Frequency-Division Multiple Access (SOFDMA) rather than Orthogonal Frequency-Division Multiplexing (OFDM). It employs two multiple duplexing schemes: Time Division Duplexing (TDD) and Frequency Division Duplexing (FDD). WiMAX base station uses T1 (1.544 Mbps), which may provide bandwidth to hundreds of Internet subscribers with frequency band from 10 GHz to 66 GHz[6].

Medium Access Control (MAC) layer of WiMAX employs a scheduling algorithm for the initial entry of the subscriber station (SS) into the network. The base station (BS) then allocates an access slot to SS and other subscribers may not use the same slot. The scheduling algorithm is used for controlling the bandwidth efficiency and Quality of Service (QoS) parameters by changing the time slot duration.

WiMAX is an all-IP infrastructure that uses the point to multipoint topology to communicate with the subscribers whereas base stations communicate to each other using point-to-point topology.

The throughput of WiMAX lies between the WiFi and 4G mobility. Cell radius of the base stations is 6 miles with service data rate of 40 Mbps. WiMAX can reach more subscribers and can deliver non line of sight services. WiMAX connections may be fixed or mobile. WiMAX provides a wide range of applications such as voice over Internet Protocol (VoIP), Internet Protocol Television (IPTV), mobile data TV, mobile emergency response services, browsing web, FTP, E-mail, and wireless backhaul as a substitute for fiber optic cable[4].The privacy and key management protocol version 2 (PKM v.2) is used in WiMAX for securely transferring keying material between the BS and Mobile Station (MS).[7]

II. Applications over Wimax

Non-real applications E-mail : Simple Mail Transfer Protocol (SMTP) is a protocol that supports the electronic mail for sending messages to mail server. E-mail stand for electronic mail, e-mail, is information stored on a computer that is exchanged between two users over telecommunications. E-mail applications are thought to be applications that are asynchronous, i.e. non real-time. Post Office Protocol (POP) is a protocol that can also support e-mail application for receiving mail from mail server [8]. +

FTP server : FTP stands for File Transfer Protocol is a standard network protocol. FTP is designed for transferring files and offers faster overall throughput and better error checking. FTP is the simplest and most secure way to exchange files over the Internet. FTP is built on client-server model architecture and uses separate control and data connections between the client and the server. The most common way to transfer files over the internet is through the FTP. It is a client-server connection and an application layer protocol [8].

HTTP and Web browser: The HTTP stands for Hypertext Transfer Protocol. It has a set of rules for transferring files (text, graphic images, sound, video, and other multimedia files) on the World Wide Web. It is a TCP/IP based communication protocol, which is used to deliver virtually all files and other data for World Wide Web and is designed to retrieve web pages. A web browser is a World Wide Web (WWW) application, working as an HTTP client because it sends requests to an HTTP server which is called a Web server. Users can easily do a search on their browsers to relevant resources through hyperlinks.

Real-time applications Video Conferencing: A video conference is a live, visual connection between two or

more people residing in separate locations for the purpose of communication. To make a video conference, users need a camera, screen, speakers, software, and microphone to process the video and audio and a connection between the computers. At its simplest, video conferencing provides transmission of static images and text between two locations.

Video conferencing contains the transfer of audio and video among two users or multiple users. It is always preferred to have higher resolutions, but they need high data rates so they can keep the video with good quality[8].

Voice over Internet Protocol (VoIP): VoIP is a methodology and group of technologies for the delivery of voice communications and multimedia sessions over Internet Protocol networks, such as the Internet. VoIP is so efficient because it uses an existing infrastructure in the form of internet connection aside from the low cost of using this type of communication. VoIP application uses different varieties of signalling protocols such as H.323, Session Initiation Protocol (SIP), Real-time Transport Protocol (RTP) and Real-time Transport Control Protocol (RTCP). Among these protocols, H.323 and SIP are generally used for call signalling and call management purposes[9].

III. METHODOLOGY

In this paper, used OPNET modeller 14.5 simulator, which has a support of applications over WiMAX to analyze, evaluate and compare the performance of Fixed and Mobile WiMAX in terms of throughput, a load of data and delay under given scenarios. In our scenarios this paper was carried out in several steps:

- First, designing and configuring Fixed and Mobile WiMAX networks Simulation.
- Implementing real and non-real applications like (E-mail, FTP, HTTP Web browsing, VoIP, and video conference) on the Simulation model.
- Analyzing application throughput, quality over Fixed and mobile WiMAX networks by comparing the simulation results of loads and delay for the network against each other.
- Finally, discussing the Result.

NETWORK DESIGN FOR SIMULATION

OPNET modeller 14.5 simulators were used to analyze real and non-real applications to determine the performance of fixed and Mobile WiMAX, by using E-mail, FTP, HTTP web browsing, VoIP, and video conference applications over WiMAX technology compared with each other. The diagram below

Figure.2 and Figure.3 shows the structure and topology of the network of Fixed and mobile WiMAX.

For a simulation model in this experimentation case, we designed five scenarios for applications using the following network components ; Server to implement applications over the Internet. Router to connect WiMAX base stations. Two WiMAX base stations distributed from the two cells. 2-Hexagonal cell networks. Various groups of users to apply applications via WiMAX technology. Total of Fixed WiMAX network subscriber stations (users) is sixteen, distributed between two cells in the range of base stations. Total of Mobile WiMAX network subscriber stations (users) is sixteen, distributed between the two cells in the range of base stations.
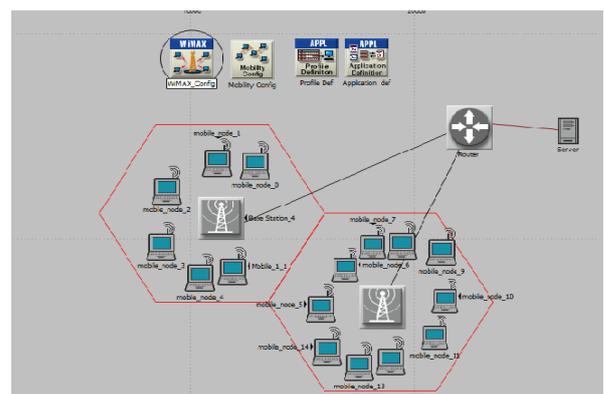

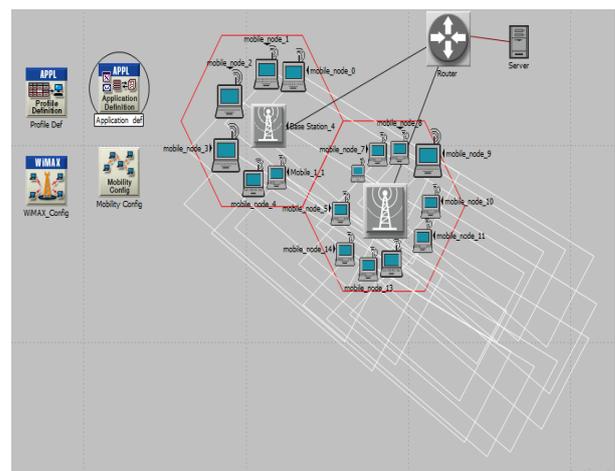Figure 2 Network structure and topology using Fixed Wimax

Figure 3   Network structure and topology using Mobile WiMAX

IV. SIMULATION: RESULT AND DISCUSSIONS

In this session we describe five different traffic types (FTP, HTTP, E-mail, VoIP and Video conference) typically used in wireless networks, three different traffic types for non-real applications and two different traffic types for real applications are used in the simulation experiments to examine the impact of traffic types on the performance of Fixed and mobile

WiMAX. This section reports the combined results of the experiment scenarios.

A. Non-real Applications

The result of non-real applications from figures (3-1, 3-1a, 3-2, 3-2a, 3-3 and 3-3a) below, shows delay, load, and throughput respectively: -
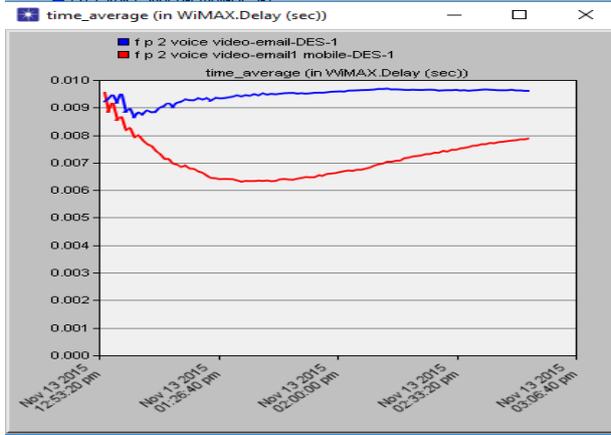

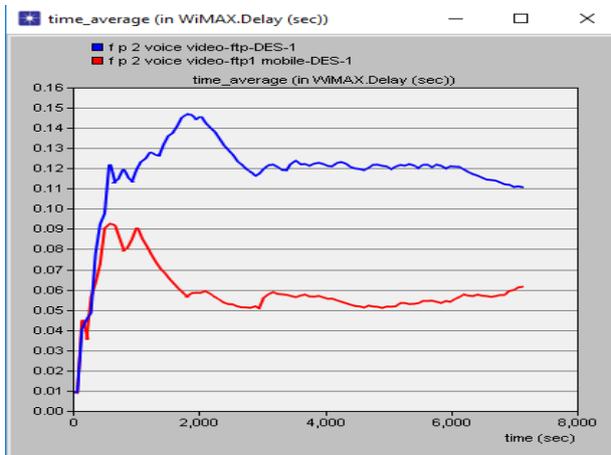Figure 3-1. Delay of E-mail over WiMAX networks

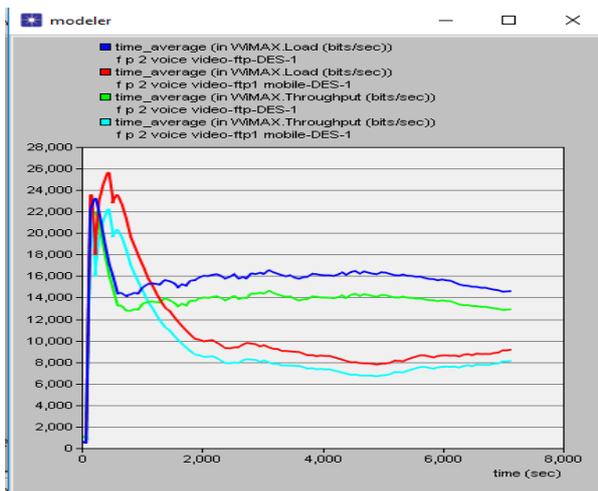Figure 3-2. Delay of FTP over WiMAX networks

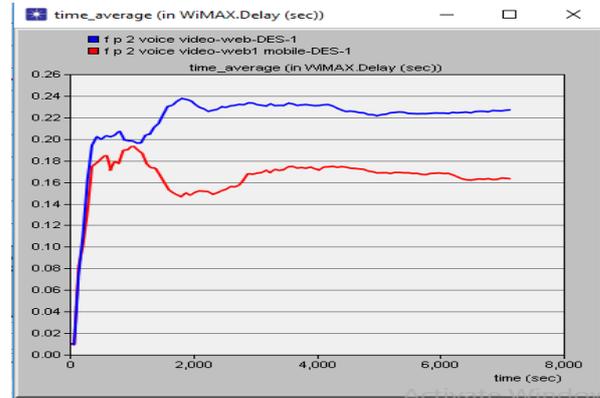Figure 3-2a. Load and Throughput of FTP over WiMAX networks

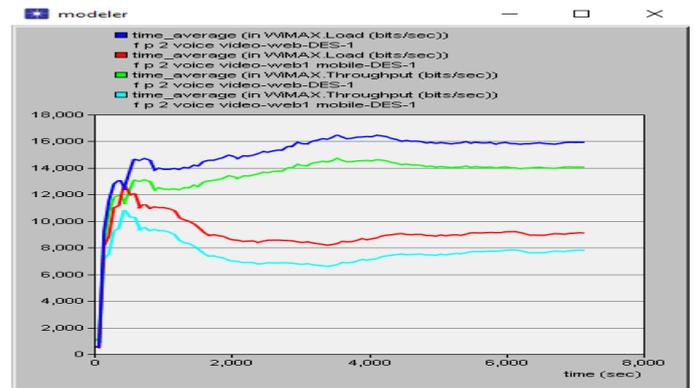Figure 3-3. Delay of HTTP web browsing over WiMAX networks

Figure 3-3a. Load and Throughput of HTTP web browsing over WiMAX networks

Key for non-real applications by Color	Application of Fixed WiMAX▬▬	Application of Mobile WiMAX▬▬

The result after analyzing non-real time applications (E-mail, FTP, HTTP web browsing) over fixed and Mobile WiMAX appears from the above figures (3-1, 3-1a, 3-2, 3-2a, 3-3 and 3-3a), which compares results of delay, load, and throughput of WiMAX networks. It can be seen that Fixed Wimax has a high throughput with high load and High delay. That means Fixed WiMAX has a much better performance than Mobile WiMAX when using Non-real time applications, despite it has a high delay because fixed WiMAX has a wide coverage area than mobile WiMAX.

B. Real Applications

The result of real applications from figures (4-1, 4-1a, 4-2 and 4-2a) below, shows delay, load, and throughput respectively: -

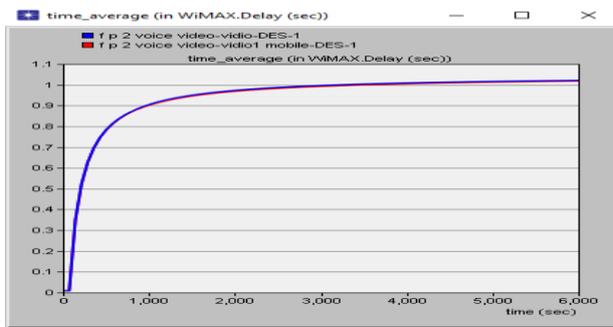| Key for real applications by Color	Application of Fixed WiMAX▬▬	Application of Mobile WiMAX▬▬

Figure 4-1Delay of video conference over WiMAX networks
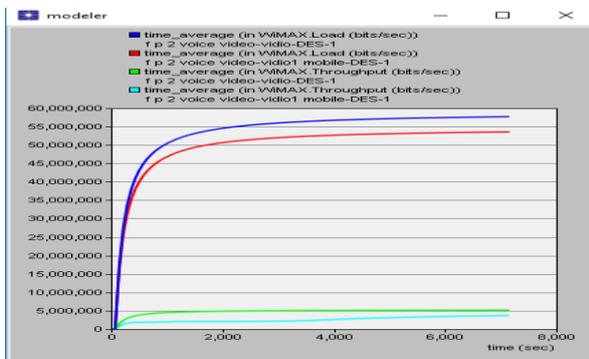

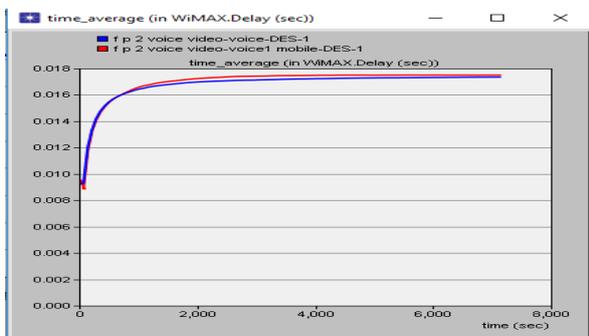Figure 4-1a. Load and Throughput of video conference over WiMAX networks

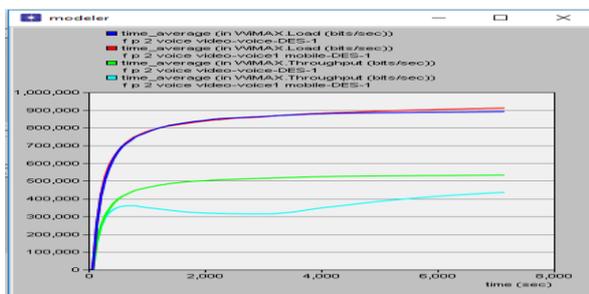Figure 4-2. Delay of VoIP over WiMAX networks

Figure 4-2a. Load and Throughput of VoIP over WiMAX networks

The result after analyzing real time applications (Video conference and VoIP) over Fixed and Mobile WiMAX networks, appears from the above Figures (4-1, 4-1a, 4-2 and 4-2a), Which compares results of delay, load, and throughput of fixed and mobile WiMax. It can be seen that fixed WiMAX has a High

throughput with high load and high delay than Mobile WiMax. That means Fixed WiMax has a much better performance than Mobile WiMax when using real applications, despite it has a high delay because fixed WiMAX has a wide coverage area than mobile WiMax.

C. Throughput

In general terms, throughput is the maximum rate of production or the maximum rate at which something can be processed. In a communications network throughput is the rate of successful message delivery over a communication channel. The unit that throughput will be measured in bits/Sec or packet/Sec. Figures 5-1 and 5-2 shows Throughput of Fixed and Mobile WiMAX at using real time and non-real time applications.
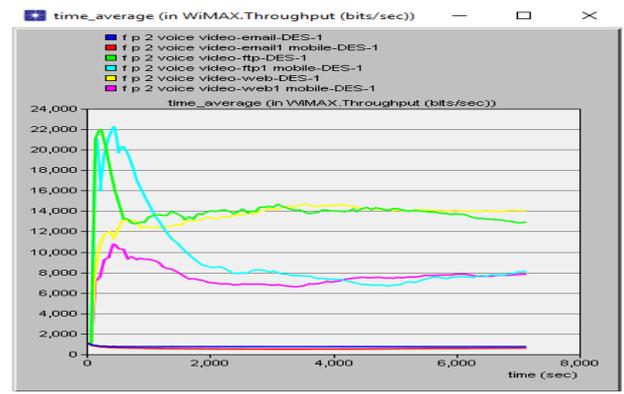

Figure 5-1. Throughput of WiMAX networks - Non-real time applications

Key for Throughput (Non-real applications) by Colors	Application of Fixed WiMAX▬▬	Application of Mobile WiMAX▬▬
	Application of Fixed WiMAX▬▬	Application of Mobile WiMAX▬▬
	Application of Fixed WiMAX▬▬	Application of Mobile WiMAX▬▬

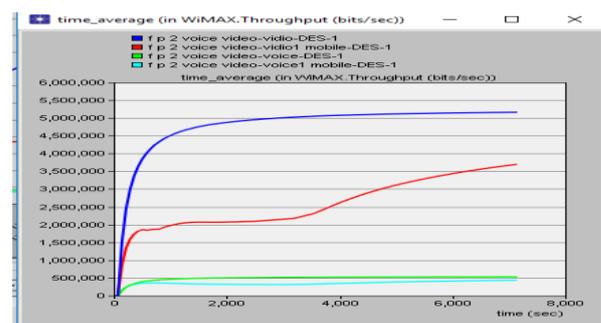Figure 5-2 Throughput of WiMAX networks - for Real time applications

Key for Throughput (Real applications) by Colors	Application of Fixed WiMAX━━	Application of Mobile WiMAX━━
	Application of Fixed WiMAX━━	Application of Mobile WiMAX━━

THROUGHPUT COMPARISON: ALL APPLICATIONS

The result from Figures 5-1 and 5-2 it can be seen the throughput of fixed WiMAX in all applications in this experiment (video, audio, HTTP, FTP, and email) is higher than Mobile WiMAX.

V. CONCLUSION

This paper analyses the Fixed WiMAX and Mobile WiMAX, and it compare its performance in terms of Throughput and load using real time and non-real applications. We found a Fixed WiMAX has a much better performance, higher efficiency and higher throughput than Mobile WiMAX. WiMAX networks provide high service for applications and data rates and it satisfies the performance factors. WiMAX Allows service providers to deliver high throughput broadband based services like VoIP, high-speed Internet, Video, data transfer, web browsing and E-mail. WiMAX enables greater mobility, high speed data applications, range and throughput.

REFERENCES

[1] J. G. Andrews, A. Ghosh, and R. Muhamed, *Fundamentals of WiMAX: understanding broadband wireless networking*: Pearson Education, 2007.

[2] Q. Liu, S. Zhou, and G. B. Giannakis, "Queuing with adaptive modulation and coding over wireless links: cross-layer analysis and design," *IEEE transactions on wireless communications,* vol. 4, pp. 1142-1153, 2005.

[3] B. G. Lee and S. Choi, *Broadband wireless access and local networks: mobile WiMAX and WiFi*: Artech House, 2008.

[4] G. Malik and A. Singh, "Performance evaluation of WiFi and WiMax using Opnet," *International Journal of Advanced Research in Computer Science and Software Engineering,* vol. 3, 2013.

[5] S. Omerovic, "WiMAX overview," *Faculty of Electrical Engineering, University of Ljubljana, Slovenia,* pp. 1-35, 2006.

[6] W. Hrudey and L. Trajković, "Mobile WiMAX MAC and PHY layer optimization for IPTV," *Mathematical and Computer Modelling,* vol. 53, pp. 2119-2135, 2011.

[7] R. Gill, T. Farah, and L. Trajkovic, "Comparison of WiMAX and ADSL performance when streaming audio and video content," 2011.

[8] C. So-In, R. Jain, and A.-K. Al Tamimi, "OCSA: An algorithm for burst mapping in IEEE 802.16 e mobile WiMAX networks," in *Communications, 2009. APCC 2009. 15th Asia-Pacific Conference on*, 2009, pp. 52-58.

[9] A. M. Devi and S. Kadanakuppe, "Internet: A Networked Computing For Information Exchange in Oral Health Care," *International Journal of Clinical Dental Science,* vol. 2, 2011.