QoS WiMAX and Wi-Fi Performances Analysis based OPNET Modeler

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***Abstract*—**The fast increasing and wide spreading usage of smart phones and many other wireless devices producing a great growth demand for the network technologies, and leads to the improvements of such technologies. Multimedia applications are earning a user attention with these broadband technologies. VoIP is the most well-known services of WiMAX and is a growing rapidly in telecommunication systems. In this paper, we compare the performance of WiMAX and Wi-Fi networks for voice and (light and heavy) video using OPNET Modeller in terms of throughput and voice packet end to end delay. Quality of service (QoS) support for both technologies provide smooth and steady voice and video transfer. Wi-Fi operates with base line and fiber line subnets and Wi-Fi fiber base can be considered the ideal design for these network. While WiMAX provides a faster and longer distance network to users than Wi-Fi.

***Keywords*—**WiMAX, Wi-Fi, QoS, VoIP, Performance Analysis, OPNET, light and heavy video.

I. Introduction

The technology of mobile communications advanced quickly as a result of increasing requests for higher data rates as well as with high quality services of mobile communications. Achieving these requests were done by determining a new air interfacing for cellular communications that enhances the performances of global systems and increases the ability of the system[1]. At the present time, the applications of interacting multimedia provide very advanced communication environments which may be used more than a homelike and amusing contexts, but further for professional cooperative business[2].

The significance of mobility produces the utilization of wireless networks become prominent, each day, the utilizing of these networks, such as WLAN, WiMAX, UMTS as well as LTE, are increasing and permits easy and quick infrastructure deployment of networks that might be executed on geographical locations unavailable to wired technologies like xDSL [3]. Indeed, those systems may be classified in two groups, the first presents mobility which has low data rates such as cellular systems and second presents a high data rates with a small as well as large covering area like Broadband WAN [4].

WiMAX is Worldwide Interoperability for Microwave Access specified by standard IEEE 802.16, which is a wireless communication framework provides an access of long-scale coverage broadband in diversity ways from point-to-point connections to mobile cellular access . It makes an IEEE 802.11 WLAN enhancements by expanding a wireless access to Broad Area Networks in addition to Metropolitan Area Networks(MANs). The early form of WiMAX, IEEEs802.16-2004, had been designed for providing connectivity of broadband wireless to fixed users and nomad for the last mile [5]. The limited coverage area to 50 km, with speed up to 40 Mbps letting utilizers to acquire broadband connectivity in non-line of sight (NLOS) conditions[6]. Another form is IEEEs802.16-2005 which considered Mobile WiMAX originates with QoS enhancement by submitting different service modules for both application of real-time and non-real-time traffic and mobility reaching to 120s km/h.

Mobile WiMAX is intended for realizing the gap between WLANs and high mobility WANs[7]. WiMAX Networks considered evolution appearing which proposed supporting services of multiple multimedia like internet browsing, email, voice telephony, video messaging, and so on. Such network services require different QoS (Quality of Service) demands, which involves establishments and managements of a collection of parameters like throughput, transmission delay, average packet delay, Packet Drop Rates, bandwidth, jitter, and minimum throughput requirements [8].

QoS is considered as the network capacity to present an acceptable services comprising high data rates, signal strengths and low distortions. The QoS purposing to be able for treating such parameters agreeing to the applications demands [9].

The technology of WiMAX is known as the last-mile solution for wireless broadband access. WiMAX structures of Media Access Control (MAC) layer is designed to characterize services during traffic groups with various multimedia requirements [10]. WiMAX provides several flexible features which can possibly be exploited to deliver real-time services. Although the WiMAX MAC layer can be standardized with certain features for exact applications and channels. The transmission of voice over wireless networks is commonly obvious through a huge implementation of mobile system around the world. VoIP can be considered as an example of a

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quickly developing voice application and be verified from high achievement rates of applications such as Skype [11]. Therefore WiMAX is a very attractive technology for providing integrated voice, video services for VoIP.

VoIP principle is facilitated by digitizing voice data first and then transferring as packets over IP network. On the other hand such packets are decoding and converting back to original analog voice signal, it utilizes Internet Protocol for voice transmitting as packets over IP networks so that it significantly increasing bandwidth efficiency and enables design of new facilities [12].

In this paper, we propose three scenarios for WiMAX, Wi-Fi base line and Wi-Fi fiber line to conduct a comparative performance analysis of WLAN and WiMAX technologies for a small network. We utilize wireless servers for voice and video applications and operate the networks with QoS support.

II. Overview & Comparison between Wi-Fi and WiMAX

A. IEEE 802.11 (Wi-Fi)

Wi-Fi is “wireless fidelity” used commonly as a WLAN synonym . Wi-Fi is a widespread technology that permits many electronic devices to interchange and transmit data by wireless through the network providing increase to high speed internet connections. A device that has Wi-Fi enabled can be connected to internet resources such as personal computers, Smartphones, video game supports, and tablets [13] as shown in fig. 1.

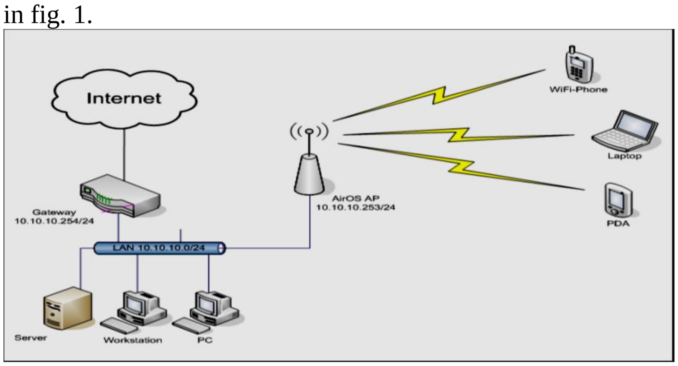

Fig. 1: Wi-Fi network structure

B. IEEE 802.16 (WiMAX)

WiMAX is a standard normally centered on universal interoperability comprising IEEEs802.16d-2004 for fixed, plus 802.16e for mobile high-speed data. It is earning acceptance as a technology that provides carrier-class, and wireless broadband of high speed at low cost whereas large distance covering area than Wi-Fi. It is proposed to process voice, video, and services with high-quality while posing a high QoS [14].

Many applications use these two technologies (WiMAX besides Wi-Fi) and have been increasing while they were originally concentrated on mobiles and PCs and then advanced for many devices and they are increasing continuously with easy for installing and Environmentally friendly.

C. Comparison between Wi-Fi and WiMAX

Wi-Fi offers a connection of Internet/LAN in the range of an access point AP. The purpose of Wi-Fi is to produce a mesh network as well as to offer peer to peer P2P connections among users. On the other hand, WiMAX networks provide higher bandwidth in addition to greater coverage range for providing services to high-speed mobile data and telecommunication like 4G networks. Another WiMAX employment to connect Wi-Fi hotspots.

D. Quality of Service QoS

QoS is the capability to transfer a specific traffic form, in perfect conditions, through many terms. In a mixed networks framework (WiMAX and Wi-Fi), QoS mechanisms employment are very essential, specifically these networks are open access, therefore a management of network access may be dominant.

E. Voice over IP (VoIP)

VoIP can be considered a most collective and low-cost technology for communicating of small and big area distances [15]. Numerous VoIP providers present a free services of charge in spite of distances. A VoIP application principally facilitated as follows. Firstly, the analog signal's voice is sampled, then digitized, and encoded to be as frames. These encoded data will be packetized and then transmitted over IP network by RTP/UDP/IP. At receiver, on the other side, data are de-packetized and progressed to a buffer that smooth out the delay sustained in the network. Then, the data is decoded and reconstructed voice signal is done.

III. WiMAX and Wi-Fi Simulation

A. WiMAX scenario1

The analyzation of the QoS in WiMAX networks need various real time procedure cases to be considered. The WiMAX offers basic IP connection, so that a requirement for mobile devices that are capable of employing WiMAX network to support voice calling over IP.

The WiMAX architecture contains four sections essentially: access services network (ASN), connectivity service network (CSN), mobile stations, and IP backbone as shown in fig. 2. ASN is a transition section with the purpose of connecting mobile stations (or any wireless devices) via a Base Station BS to internet services provider. While CSN Provides controlling and management services for WiMAX subscribers. Finally, the IP network (backbone) is Interconnecting networks and core routers with internet.

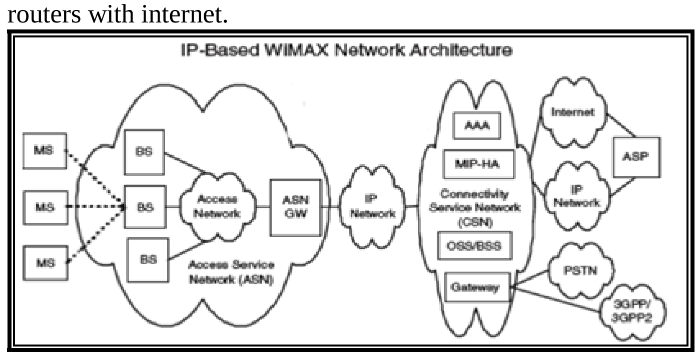

Fig. 2: WiMAX network Architecture

The selected components for implementing WiMAX using OPNET are:

* WiMAX Base Station: represented by WiMAX_BS_ethernet
* Gateway: represented by Ethernet4_Slip8_gtwy for Fixed node.
* Server: represented by Ethernet_server for Fixed node
* IP backbone: represented by Router_slip64_dc
* Workstation: represented by Wlan_skstn_adv for mobile node
* Link Model: represented by 100BaseT

In WiMAX scenario (shown in fig. 3), all configuration links have the same setting to create simple performance analysis comprehensively. In this scenario, the behavior of QoS classes is observed with the traffic is managed on Best Effort basis.

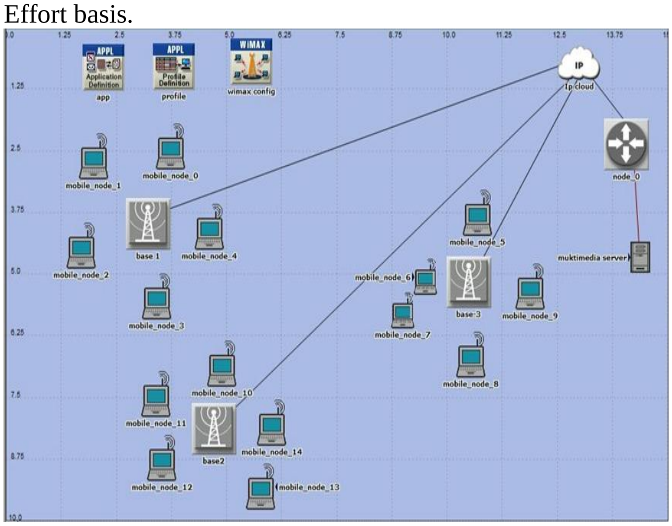

Fig. 3: WiMAX scenario1

WiMAX scenario has many WiMAX–BS-Ethernet that connected to router and WiMAX workstation SS Ethernet. A WiMAX BS is connected with IP cloud by (PPP-link). With this Scenario, the components used for network statistics measurements for both video conferencing and voice with GSM quality.

B. Wi-Fi simulation setup

The Wi-Fi scenarios use parameters shown in Table 1

TABLE I:
WI-FI PARAMETERS

WiFi 802.11g		
	AP (Access Point)	**Mobile Node**
Tx Power	0.1W	0.1W
Data Rate	11Mbps	11Mbps
Receiver Power Threshold	-95dBm	-95dBm
Buffer Size	1024000 bits	256000 bits
Short Retry Limit	7	7
Long Retry Limit	4	9
Large Packet Processing	Fragment	Fragment
Access Point Functionality	Enabled	Disabled

In Wi-Fi test two scenarios are performed, the first for baseline Wi-Fi and the second for base Fiber Wi-Fi. Also some components are required to simulate Wi-Fi network on OPNET.

A subnet in reign one, BC that has a server, for streaming video and voice, connected to the Internet cloud. There is another subnet in reign two, ON, which receives the video and voice data and distributes the data content from a WiMAX Base Station to various subscriber station (SS) subnets around it. The SS subnets are all WiFi enabled and receive the WiMAX data through their WiMAX and WiFi routers and distribute the data content over WiFi link to different computers.

C. Baseline Wi-Fi Scenario

The Baseline Scenario of WLAN model(802.11g) is produced using different models of the OPNET standard. The behavior of a single infrastructure 802.11g WLAN has been tested within the framework of a deployed WAN to perfect emulate the configuration of an actual network. The backbone Internet is represented by Internet Protocol IP cloud and connected with a Point-to-Point T1 (1.544Mbps) serial link. The group of subnets are located on the various sides of this IP cloud via a IP gateway connected by Point-to-Point Protocol PPP T1 link and two servers connected through a central switch using 100 BaseT, as shown in Fig. 4.

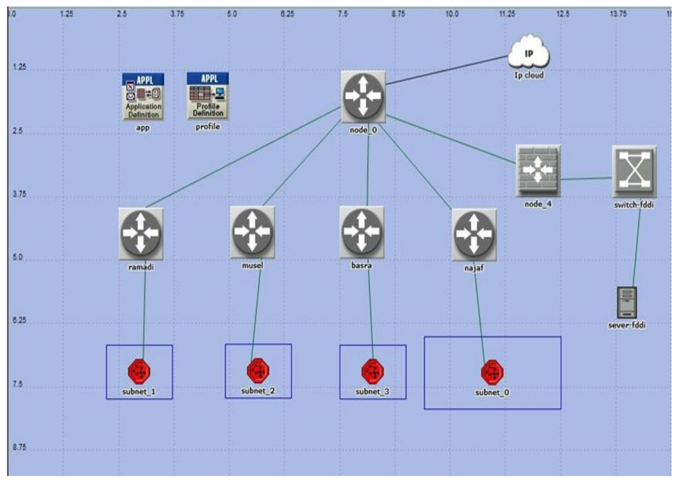

Fig. 4: Simulated Wire Server with four subnets.

The network's traffic server on the one side of this Internet Protocol (IP) cloud is are connected by 100BaseT Ethernet, the server connect to the firewall using 100BaseT Ethernet wiring and are used as the source and destination of all services: video conferencing, voice applications in the 802.11g WLAN during the simulation. The base line Wi-Fi application configuration was shown Figure 5 where the light, and heavy video, and PCM voice were used in the scenario.

The subnet 1 represents a remote office including an office-LAN having workstations that are connected by a link of 100BaseT. Office-LAN connected through a central switch using 100BaseT Ethernet wiring emulating a real time office environment with a standard Fast Ethernet LAN. An IP gateway connects the LAN to an IP cloud. The gateway connects to the office LAN using 100BaseT Ethernet wiring while the connection between the gateway and the IP cloud is done with a Point-to-Point T1 (1.544Mbps) serial link, as shown in Fig. 5.

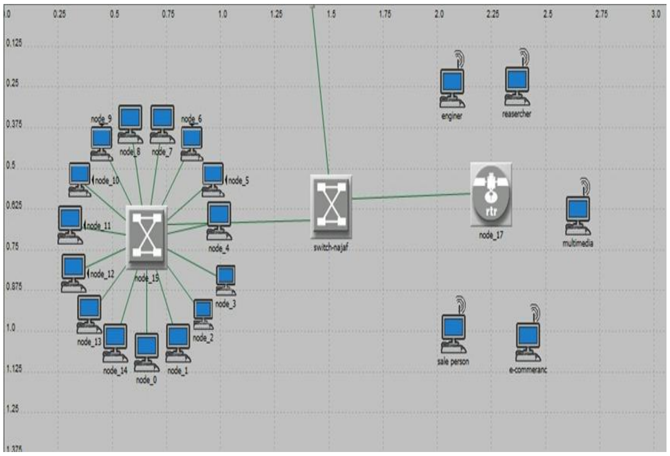

Fig.5: Subnet 1 802.11g LAN

1. Base Fiber Optic Wi-Fi Scenario

In this scenario we replaced all the Ethernet component with fddi, and all the 100baseT link are changed with FDDI link: The FDDI identified for Fiber Distributed Data Interface which requires a 100-Mbps token-passing.

- Ethernet gateway replaced by fddi gateway
- Ethernet firewall replaced by fddi2 firewall
- Ethernet _switch16 replaced by fddi16_switch
- 100baset link replaced by fddi link
- Ethernet server replaced by fddi server

Here, figures 4 & 5 can be shown in figures 6 & 7 for fiber base scenario.

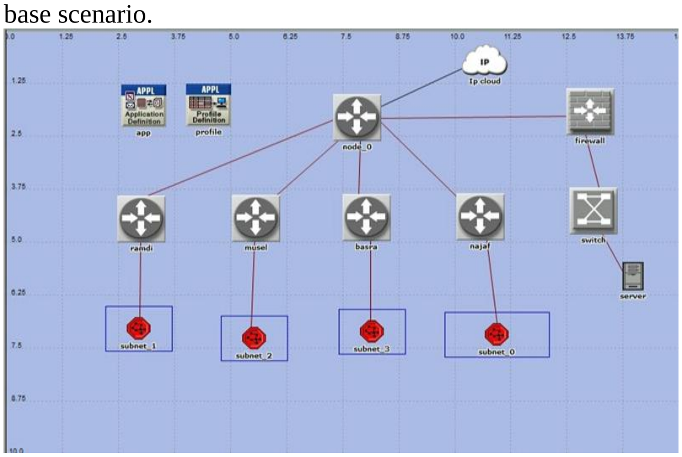

Fig. 6: Simulated fiber Server with four subnets

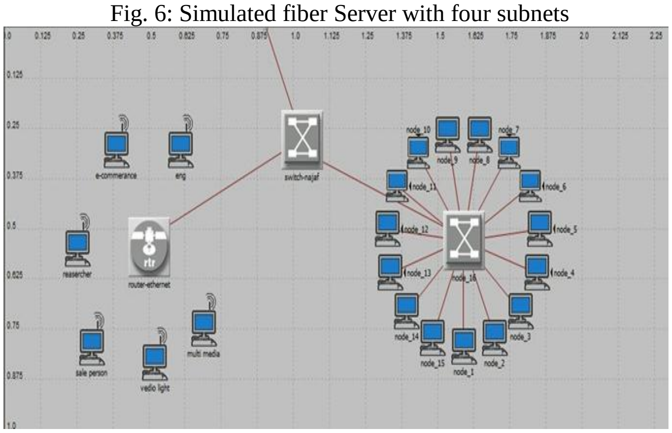

Fig. 7: WiFi base fiber Subnet 2

IV. SIMULATION RESULTS

The results and discussion of the WiMAX , Wi-Fi base line and Wi-Fi base fiber for the voice and video parameters data transmission (voice , light video and heavy video) will be described for time delay and voice-packet end to end delay measurement for both Wi-Fi base line and Wi-Fi base fiber, measurement of voice-packet end to end delay and video packets delay base WiMAX networks with Light and Heavy video, in addition to throughput measurement for WiMAX, Wi-Fi base line and Wi-Fi base fiber.

A. WiMAX QoS

1. **WiMAX voice-packet end to end delay**

The simulation results of the WiMAX voice-packet end to end delay for the PCM voice and light video and heavy video data transmission can be shown in fig 8. It's clear that no connection happened until second 110 where the connection network established, and the communication system reach the steady state at the second 250 and 240 for both types of videos with maximum delay 115 ms and 110 ms, so that the voice with heavy video has a delay less than the delay of voice with light video.

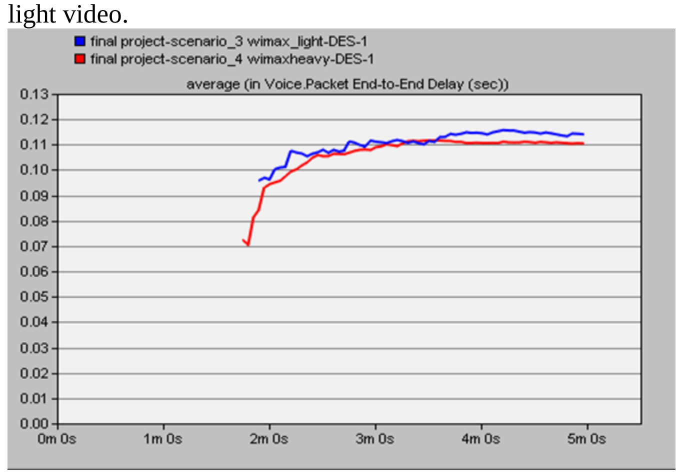

Fig.8: WIMAX scenarios delay of voice light and heavy video.

2. **WiMAX Light and Heavy video packets delay**

The simulation results for packets delay data transmission of both light and heavy video in WiMAX network is shown in fig. 9, the connection network happened at second 110, and the communication system reach the steady state at the second 300. From the second 300 in simulation , the light video traffic sent has 6.4 packet/sec and heavy video traffic sent has 37 packet/sec, so the traffic sent of heavy video was larger than light video .

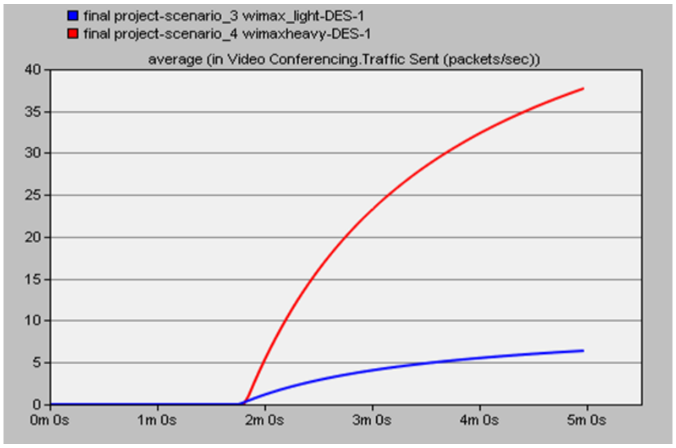

Fig.9 :WiMAX comparing of light and heavy video traffic

3.Throughput

The simulation results of the throughput of WiMAX network can be shown in fig. 10, when comparing between throughput of WiMAX with heavy video data transmission and that with light video data transmission, at the second 300 the light video has 275 packet/sec and the heavy video has 1180 packet/sec so the heavy video has larger throughput than light video as shown in Fig. 10.

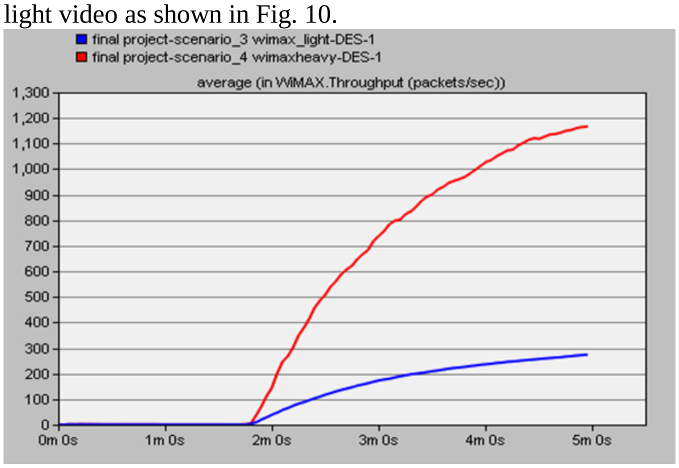

Fig. 10: Throughput of WiMAX light and heavy video

B. Wi-Fi QoS

1. Wi-Fi Delay

An important parameter to determine the successful process of the transmission data and the Required To send/ receive mechanism are overall packet transmission delay and the medium access delay statistics. The end-to-end delay measured in the simulation of the Wi-Fi base line and the Wi-Fi based fiber optic connections shown in Fig.11. From the simulation, no network connection until second 100 and the communication system reach the steady state with maximum delay 0.048 second at the second 200 for base line and delay 0.035 second at the second 200 for Wi-Fi based fiber optic connection. It can be concluded that the base line had delay larger than Wi-Fi base fiber delay.

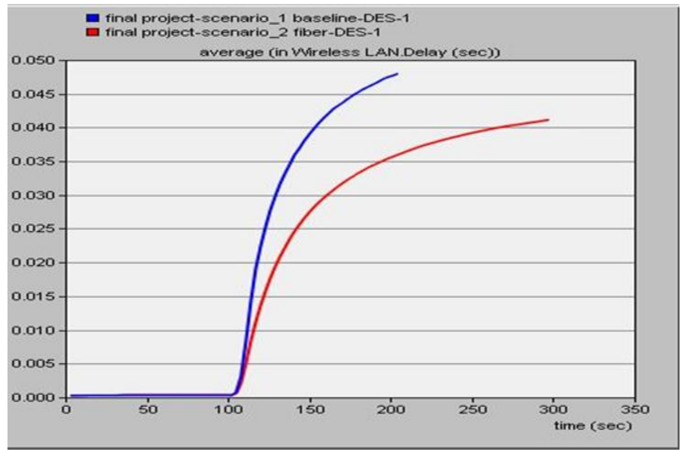

Fig. 11: Delay for Wi-Fi base fiber and Wi-Fi base line

2. Wi-Fi voice-packet end to end delay

The analog signal from the telephone is digitized into pulse code modulation (PCM) signals by the voice coder-decoder (codec). The samples of PCM are then passed to the compression algorithm that compresses the voice into a packet format for transmission across the WAN. From the simulation results of the voice-packet end to end delay Wi-Fi base line and base fiber, a connection network occurred at second 110, and the steady state communication system reach the with maximum delay 1 packet at the second 200 and 10 packet at the second 310 for base line and fiber line Wi-Fi respectively so that the base line Wi-Fi has delay larger than delay Wi-Fi base fiber as shown in Fig.12.

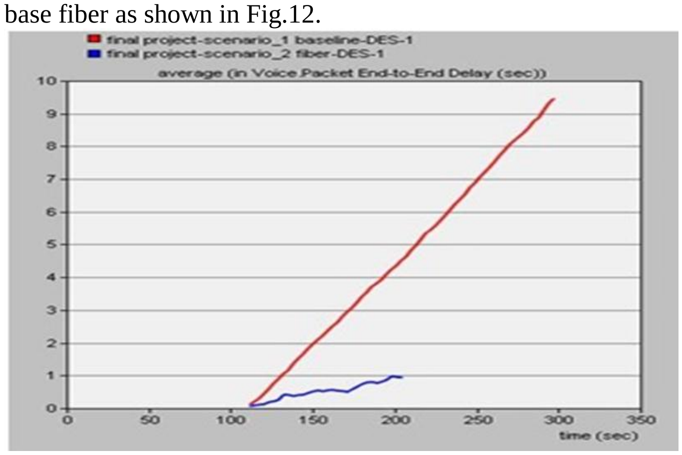

Fig. 12: voice delay for Wi-Fi base fiber and Wi-Fi base line

3. Throughput

In communication networks, the network throughput can be considered as the average rate of successful data message delivery over a communication channel. This data may be delivered over a physical or logical link, or pass through a certain network node. The throughput is typically measured in (bit/s or bps), or in data packets per second or data packets per time slot.

The simulation results of the throughput of Wi-Fi base line scenario at the second 200 the connection was established and arrived a maximum throughput is 7,750,000 bit/sec and the base fiber has 8,750,000 bit/sec so the base fiber has larger throughput than base line shown in Fig.13.

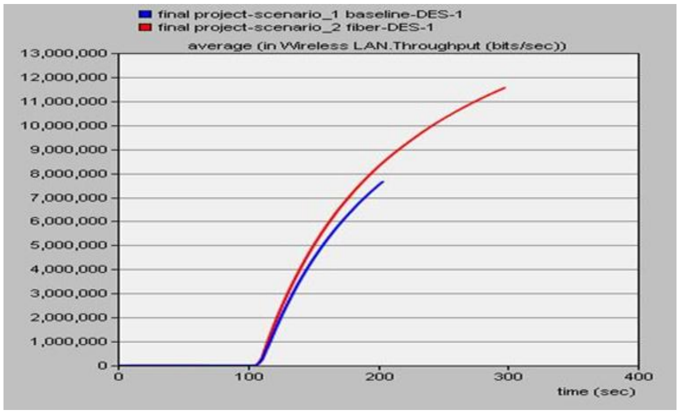

Fig.13: throughput for Wi-Fi based line and fiber optic

V. CONCLUSION

The OPNET Modeller is used to design and characterize the performance parameters of WiMAX. In this paper, a simulation of WiMAX and Wi-Fi scenarios and compared their delay and throughput. It can be concluded from simulation results that WiMAX has an overall better performances compared with Wi-Fi essentially due to the Quality of Service. The QoS purposes are to ensure high data transmission performances like voice-packet end to end delay and throughput can be achieved.

In WiMAX, the voice with heavy video has a delay less than the delay of voice with light video by 5ms and throughput is larger in case of the heavy video than light video. In Wi-Fi scenarios, the base line had voice-packet end to end delay larger than Wi-Fi base fiber delay and base fiber has larger throughput than base line. Wi-Fi fiber base is the perfect design because it provided a flexible, reliable and cost effective approach.

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