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WI-MAX NETWORK SIMULATION FOR SALAHADDIN UNIVERSITY NEW CAMPUS

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ABSTRACT

Wireless Networks became very important in this latest decade and especially Wi-Max system because of high bit rate, handover flexibility and longer distance of mobility. Signal strength and coverage is one of the challenges for this systems which leads to affect directly on Quality of Service (QoS), this paper is an attempt to design and study of Wi-Max network for a certain coverage area, testing the coverage of the signal for the area that can hold the sufficient amount of data with less latency has been studied depending upon the Wi-Max advanced specification and data stream behavior benefit's, some Wi-Max parameters like coverage, quality of service, data rate are optimized, the study and design has been done using OPNET modeler used in the a simulation of the certain coverage area, in this paper the new campus of university of Salahaddin has been used on supposed area of about 4 X4 km. The results show a perfect bit rate as a bit stream for the global characteristics in which is sufficient to the students and teachers of the university in addition of providing the mobility by high performance. It is needed to design a wireless computer network to Salahaddin University to improve mobility and to let the teachers and students to stay connected at any time in any university location Especially with the nowadays learning techniques and requirements which needs both teacher and students to be online with each other especially like E-learning and online remount learning especially with the COVID-19 university campus blocking. Therefore, it is needed to cover overall area of the university campus and with additional coverage that exceed the university boundaries to improve the reliability of the hall network and to insure the required coverage area. To do that is very efficient to design an advanced computer network like Wi-Max with the most powerful and advanced hardware capabilities to full-fit the teachers and students requirement of fast net browsing and download in addition in e-learning bases it is very regular to use video

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conferencing or video streaming which normally needs a very fast network data transfer especially with practical on-line lectures like surgery on operation room in learning hospitals for example. After the design of the university campus computer network we simulate it by OPNET 14 Modular to determine the design parameters. And to check if the design is efficient then what is the performance of the network designed.

KEYWORDS: Wi-MAX Network, Delay, Data Traffic< Server HTTP.

1. INTRODUCTION

IEEE 802.16 standard is based on Worldwide Interoperability for Microwave Access (WiMAX) wireless broadband. According to this standard, the physical (PHY) and medium access control (MAC) can support efficiently the Broadband Wireless Access (BWA). Fixed and mobile broadband connectivity devices like laptops, tablet's and smartphones can be supported online connection services by the Base Station (BS) through many versions of WiMAX. A major factor that plays an important role is to limit the ability of the system from the capacity perspective to the number of users through the network at the same time (Awan Nahel Mahmood, 2014). WiMAX offers an alternative to wired networks, such as coaxial systems using cable modems, fiber optics and DSL (Digital Subscriber Line). The IEEE 802.16 standard is a real revolution in wireless metropolitan area networks (Wireless MANs) that enables high-speed access to data, video, and voice services (Joseph Kweku Arthur, 2016). WiMAX or the IEEE802.16 standard was designed for a wider range of wireless network connections with the speed of 15 Mbps in a 3 km cell coverage area, though WiMAX is an emerging and extremely competitive wireless broadband access technology, the development prospects of its market is still unknown, now WiMAX can provide 54Mbps data transfer speed. Hybrid networks as a supplement to cell based or IP packet based services, can fully reflect the characteristics of wide network coverage. It means making a wireless coexistence of Wireless Local Area Network (WLAN or WiFi - a trademarked phrase that means IEEE 802.11x) and WiMAX for devices on different technology segments to communicate with each other (Shuang Song, et al, 2014). There are two main types of WiMAX: (a)802.16-2004(Fixed WiMAX) - 802.16-2004 transmission to stationary devices and replaces earlier specifications i.e. 802.16 and 802.16a. (b)802.16e or 802.16-2005 (mobile WiMAX) - 802.16e is an extension of 802.16 -2004 for mobile use in the 2 to 6 GHZ band. It allows people to communicate while walking or riding in cars and provides a mobile voice over IP and higher speed data alternative to the cellular networks (GSM, TDMA, CDMA) (Divya Garg et al, 2017).

Key characteristics of WiMAX

The key characteristics of the next generation wireless technology (WiMAX and Wi-Fi) are the following as needed and evaluated in this work (Divya Garg, et al. 2017):

a. **Efficiency** is a major issue to determine what type of applications can be run on a network Efficiency of wireless technology is measured in terms of bandwidth and latency. In Efficiency, bandwidth is defined two terms: A short bandwidth and a large bandwidth which can provide a high data bit rate. A short bandwidth network is only feasible for small applications and a large bandwidth network is used for more powerful applications. Short bandwidth support simple data application, for example, surfing on internet or file transfer and a higher bandwidth network is used for voice propagation and video navigation such as gaming devices. Another major issue in the case of real-time applications like voice is latency which is a very crucial issue.

b. **Maximum range** is calculated from the distance between the two base stations, like a cell phone. maximum coverage range of wireless technology is very much crucial according to cost since operators can reduce their initial capital investments if they can give the coverage in the same area with a smaller number of base stations. Another major issue that must be considered here is that the technology must have the capability to support hand-off between base stations without losing connection from the global world.

c. **Dependability** is measured by some metrics like average number of packet loss, average number of disconnects of calls. Dependability is defined as how much a wireless technology is dependable to the end user. Dependability is very crucial because some applications may require a reliable connection. If a connection is not dependable, in that case, packets may loss and that affect the network for that reason the speed of the network will decrease. This would have certainly impact on the performance of any applications, hence decreasing the applications that will use on the wireless network.

d. **Security** User exchange many personal data on the internet that why end user wants security. Security is obtained from the level of encryption of the data and the authentication of the device is provided by each technology. For many applications such as exchanging bank information require a secure connection to transmit confidential information. Security is the main characteristics of the wireless technology. We use many types of techniques to secure data.

e. **Mobility** It is the speed of the mobile access point at which the technology can remain connected to the global world without losing packets or service interruption. A wireless infrastructure environment needs to be mobile to provide connection to the end user at any place they visit.

f. **Market Comparison** The popularity of any technology is determined by the market. Mainly markets certify a technology whether it is accepted by the end user or not. So based upon the market we can decide which technology is most attractive to the wireless world. Devices in the market have demonstrated up to 11dB of variance across these performance parameters.

g. **In practical view** the whole network design is implemented using simulator, in this simulator there are many many network devices representing large amount of controlling or distributing devices like routers and switches, connecting devices like hubs or end devices like personal computers or mobile (Smartphones) either wired or wireless. In this research it was needed to use advanced hi-speed wireless devices for distributing and end devices. The network consist from two main Wi-Max towers to distribute the net service to the desired coverage area of the university with hi-signal rate which is noticed in the Fig. 1, these two towers connected to one net source explained like IP in mentioned figure, a number of mobile node is distributed around the towers in the area of the university, these nodes is located to check the reliability of the hall network if the signals distributed reaches the randomly distributed mobile devices or not. From the curves, the researchers discovered that the signals reaches all connected devices efficiently which maintain an efficient amount of data with less delay. The cost of this network is very competitive if compared with traditional wired network or wireless Wi-fi network because of the huge number of distributing devices fixed in the hall network with less data speed and large latency, delay and deadlocks. In addition to the difficulties of maintenance of all these devices in practical view. At last in view of network flexibility and footer expansion, this network will be very easy to be expanded or discarded devices.

2. RESEARCH METHOD

In this paper, a certain coverage area of the Salahaddin university new campus has been used to the design and simulate the WiMAX coverage and quality of service (QoS) parameters like delay, throughput, load.

This figure shows the WiMax prorogated signals covering the whole area of the university campus by using two WiMax towers connected by fiber optic cable (wired network) 1000Base X to the internet main source. These two towers distributing the internet service came by cable wirelessly to the mobile end users (nodes) or hosts by WiMax technology the coverage area is shown by white color.

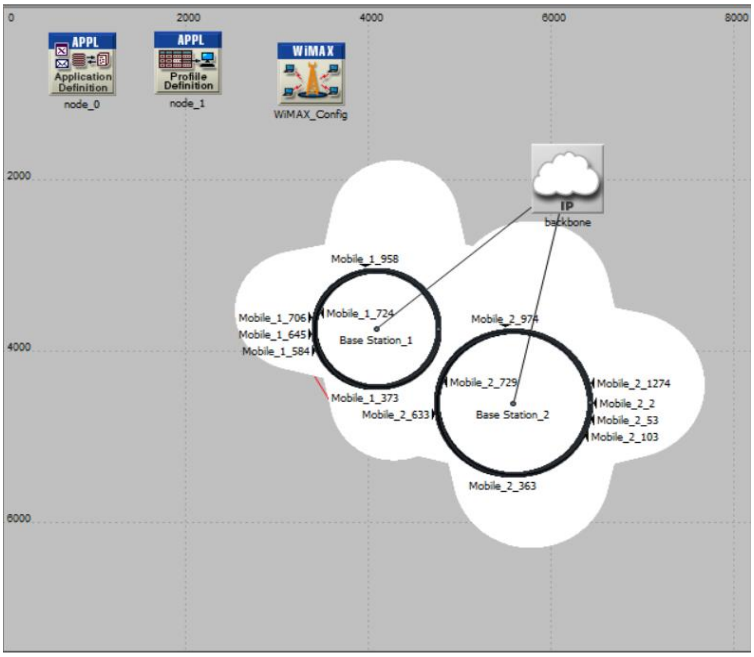

Fig. 1. The proposed design model.

3. RESULTS AND DISCUSSION

After the design of the Network for the sample area, using the OPNET software and run the software, the results has been obtained according to the following figures. A text box is shown in all of the Figs. 2-12, this yellow text box appears by the simulating software itself, the researches liked to show this text box in all results to support the results even it is not recommended to show it by others researches.

Global statistics means that this result determined for the whole network containing all devices and branches. Overall packet transferred in the network is about 2600 packet pes second, this value is growing up in a time period from the starting time of the network of about 15 minutes, this is because of many reasons like IP addressing and the time required to the signals to be reached to the mobile devices in addition to many operations like listening signal's propagation, acknowledgment replay's, and addressing … ext.

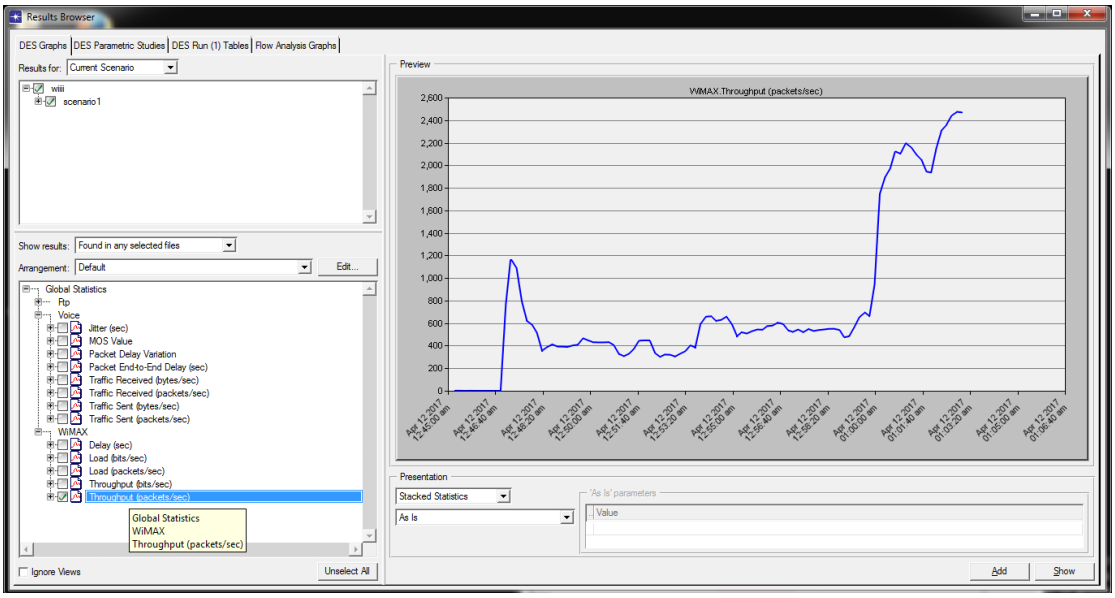

Fig. 2. Global Statistics WiMax throughput packet/second for overall network, reaches 2600 (2.6kbps) packet per second approximately.

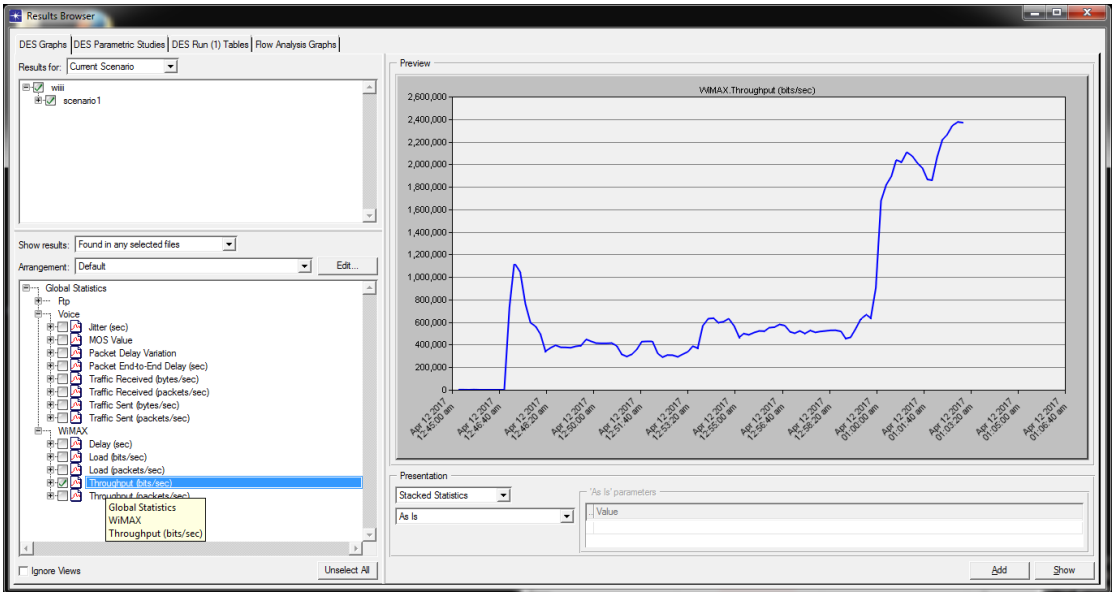

Fig. 3. Global Statistics WiMax throughput bits/second for overall network, reaches 2400000 (2.4Gbps) bit per second approximately.

This obtained result shows a good network performance for transferred data stream because of WiMax network and it's hi bit rate picked out devices and media types in addition to the topology designed.

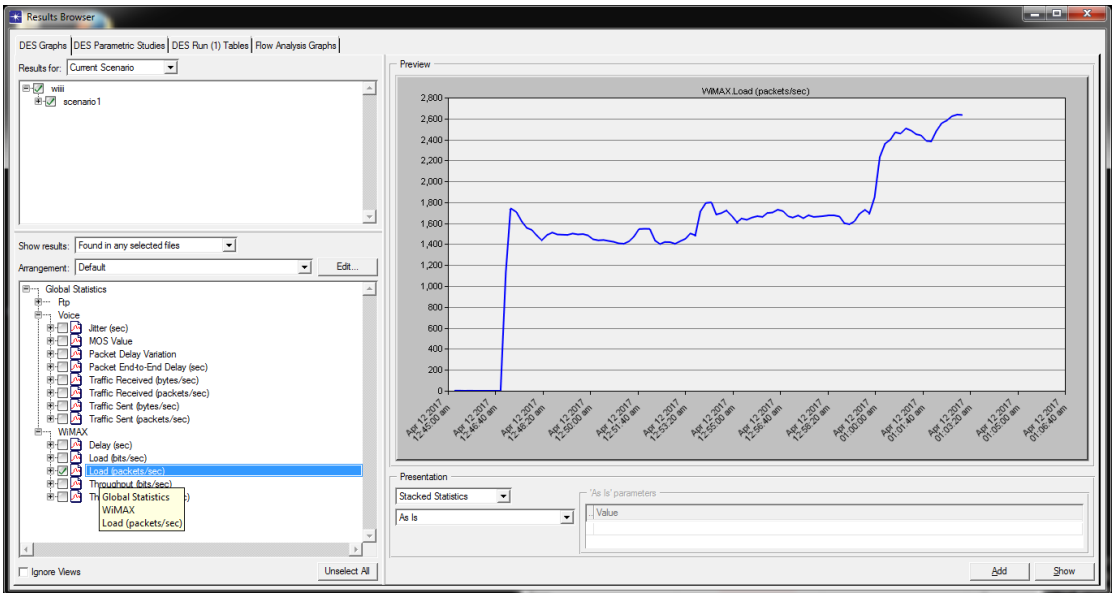

Fig. 4. Global Statistics WiMax Load Packet/second for overall network, reaches 2450 (2.450kbps) bit per second approximately.

This obtained result shows a good network values. That is sufficient to the university users of Techers and Students.

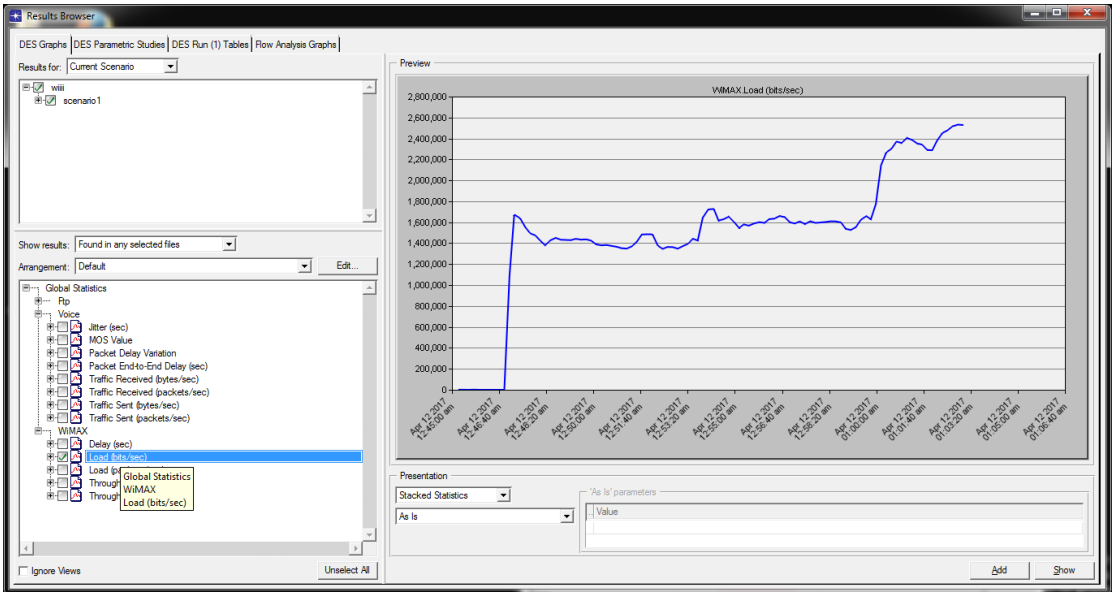

Fig. 5. Global Statistics WiMax Load bits/second for overall network, reaches 2580000 (2.58Gbps) bit per second approximately.

In this figure a curve shows the whole network speed of data transfer by bit pes second which is very familiar standard used for determining the efficiency of any nod and network or network branch.

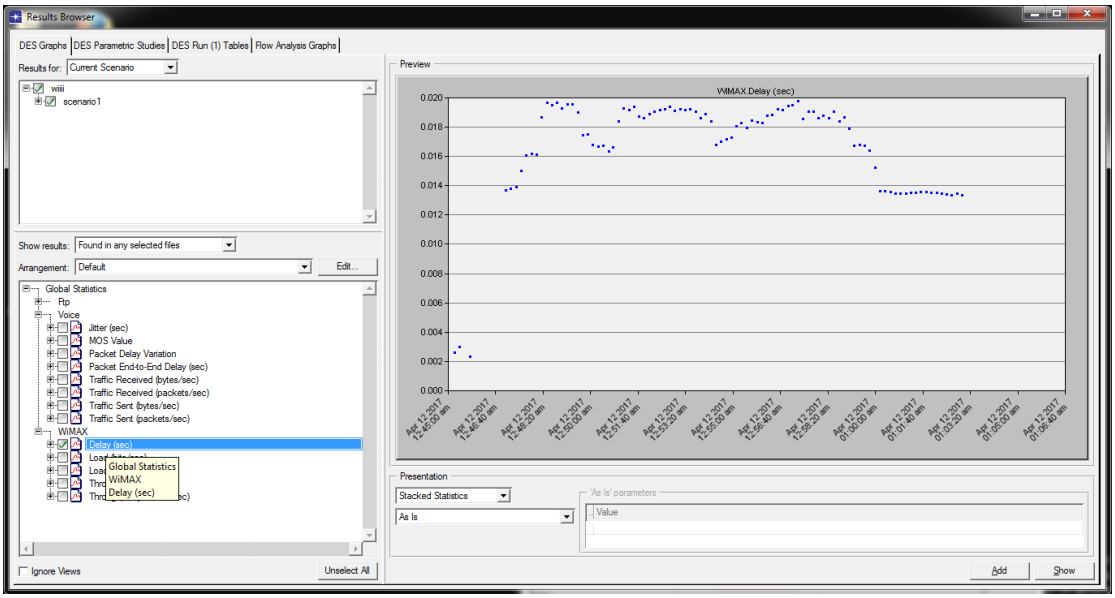

Fig. 6. Global Statistics WiMax delay second for overall network.

Global Statistics WiMax delay second for overall network,reaches 0.02 second for maximum and 0.002 second for minimum starts from the firs second of network operation for all the simulation period. Net latency or delay is one of the very important factors or deterministic of any computer network because it affects strongly the efficiency of the network by damping the data rate and speed

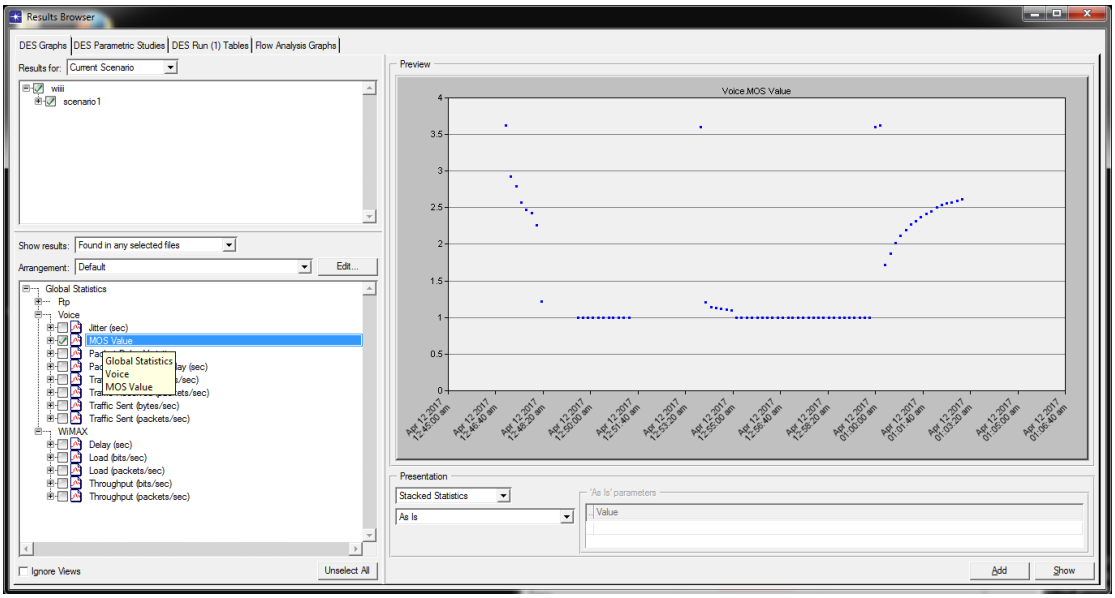

Fig. 7. Global Statistics WiMax VoIP MOS value for overall network, reaches 2.5 for maximum and 1 for minimum starts from the firs second of network operation.

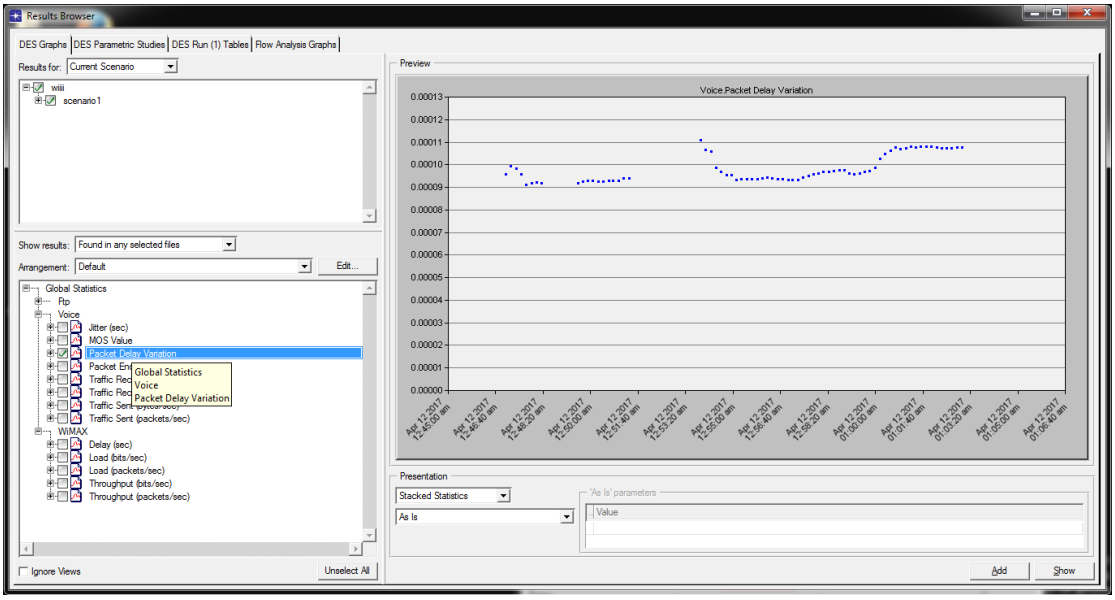

Fig. 8. Global Statistics WiMax packet delay variation for overall network, reaches 0.00011 second for maximum and 0.00902 second for minimum.

This curve shows the variation of packet delay reaching the destination, it is very good known that any computer network is suffering from a delay when packets transfer between source and destination passing all the nodes like WiMax towers cables ….. ext.

In this network the latency or delay of the packet reaching destination is very good because of its little value even when it is reaches the maximum value. This delay is happens because of hardware devices mostly or sometimes software or operating systems used in this devices.

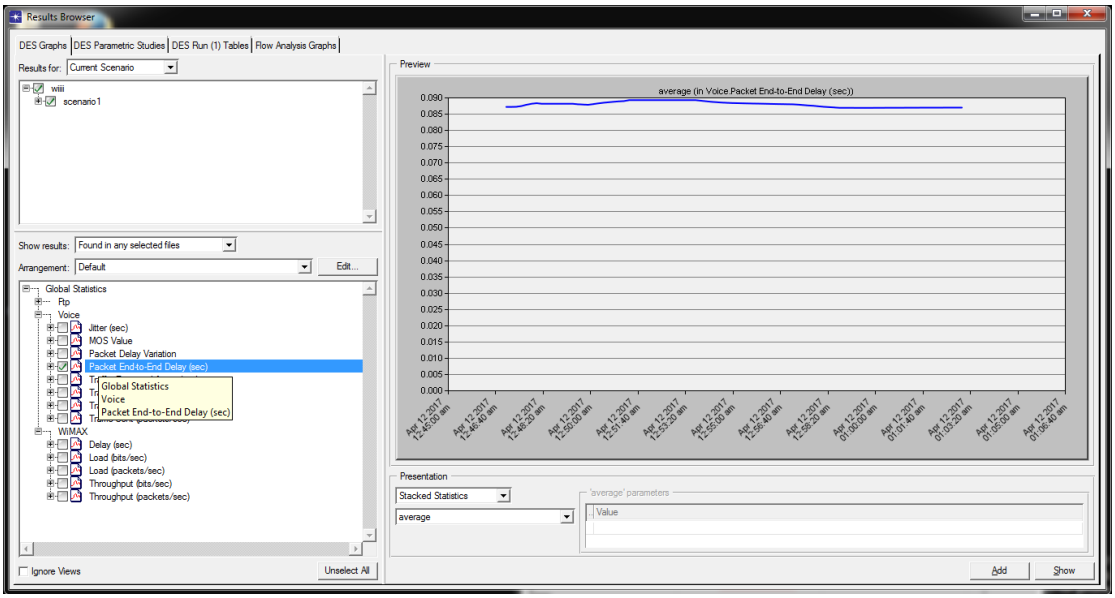

Fig. 9. This record of delay doesn't slowdown the network.

This delay is of the total time delay starting from source to the end point (destination) which is a good deterministic to check the efficiency of any computer network. Global Statistics WiMax VoIP Packet End-to-End delay in second for overall network, reaches 0.09 second for maximum.

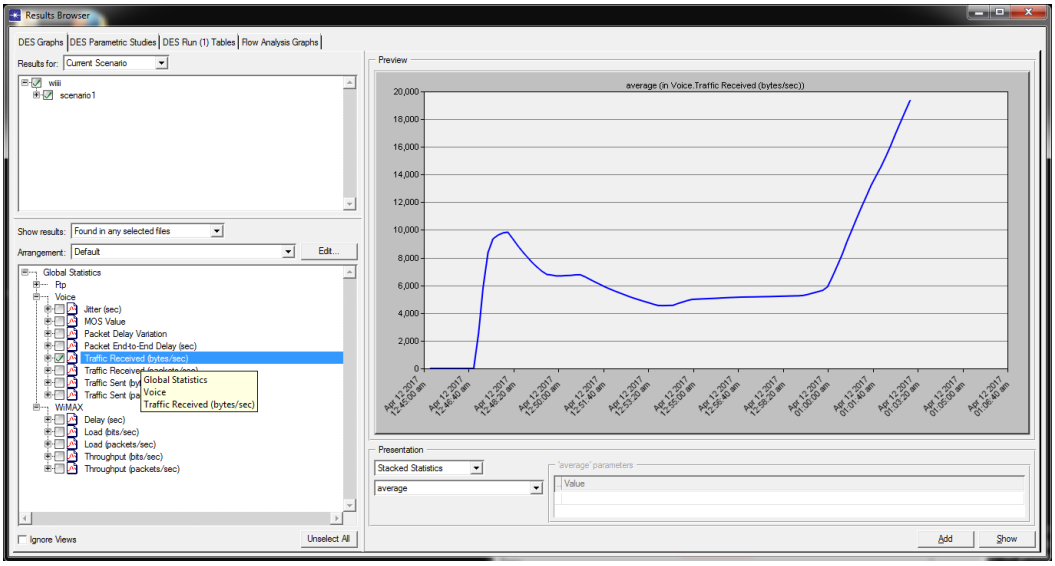

Fig. 10. Global Statistics WiMax VoIP Traffic received Byte/second for overall network, reaches 18000 byte per second for maximum. And it is a sufficient value for the network.

Byte per second for maximum. And it is a sufficient value for the network also. Byte pes second is a factor also used for measuring transferred data speed for any particular computer network even wired or wireless computer network, therefore the researchers used it in this paper. But not for all networks nowadays bit per second is more familiar and more efficient and accurate because of that is it is more accurate.

The same measurement but in opposite view in Fig. 11 the curve is about the data sent for VoIP application in this campus network measured by bytes per second,

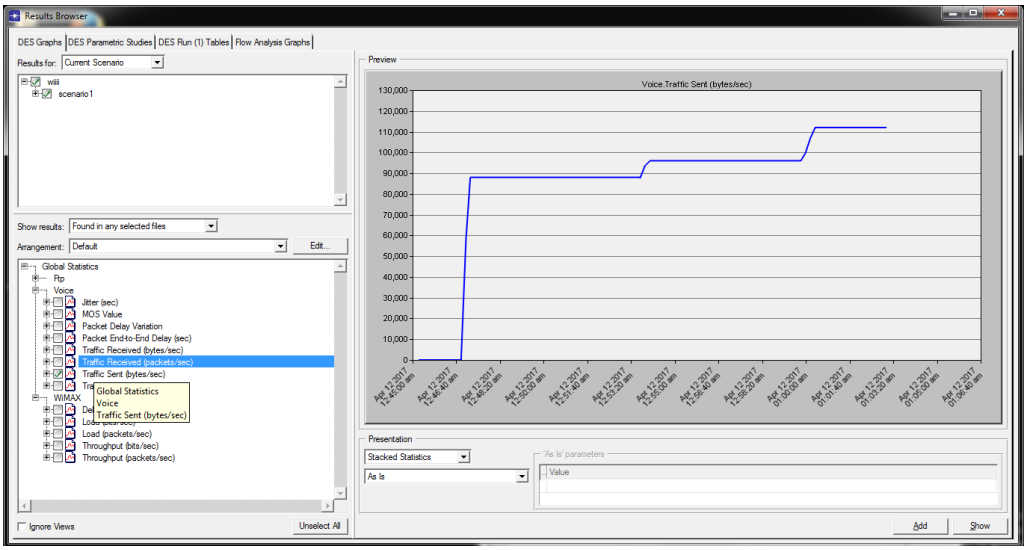

Fig. 11. Global Statistics WiMax VoIP Traffic sent Byte/second for overall network, reaches 18000. It's a high value competitive with another network connecting this large number of users on a large covering area using only two towers.

4. CONCLUSIONS

This paper is an attempt to contribute in WiMAX design for coverage area in University of Salahaddin new campus, using the OPNET riverbed software, some of the WiMAX parameters related to the services has been optimized for the area for better design and higher efficiency for the system, as shown in the results that throughput packet/second for overall network, reaches 2600 (2.6kbps) packet per second approximately which is an improvement, delay decreased, then better quality of service, the obtained result shows a good network performance for transferred data stream because of WiMax network and it's hi bit rate picked out devices and media types in addition to the topology designed

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