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Investigate Comparative Performance for Wireless IEEE 802.11a\b\g

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Abstract:

Wi-Fi is a worldwide used wireless technology which is a rapidly growing communication industry. The wireless network is excessively used all over the world. Wireless networks are subject to the Wi-Fi standard based on the IEEE 802.11 specification. IEEE 802.11a provides transmission of data rates from 11 Mb/s to 54 Mb/s at the 5GHz, IEEE 802.11b provides transmission data rates up to 11 Mb/s at 2.4GHz and IEEE 802.11g provides transmission data rate of 54Mb/s within a bandwidth of 2.5GHz. This paper presents some comparison between IEEE 802.11a\b\g in term of throughput, delay, wireless LAN delay, traffic send and traffic received using OPNET 14.5 simulator in order to know which technology is better. This paper describes study of the performance of voice, HTTP and E-mail applications over wireless networks. This study will help the researchers to choose the best technology depending on their deploying case and we will see that the best technologies are IEEE 802.11g**.**

***Keywords*:** IEEE 802.11a, IEEE 802.11b, OPNET, Wi-Fi, wireless networks**.**

1. Introdaction

Wi-Fi (Wireless Fidelity) is a technology that allows for many electronic devices laptops or a Personal Digital Assistant (PDAs) to send and receive data wirelessly from any location equipped with Wi-Fi access. Today, wireless services have become the most widespread information technology. With the high development of the use of these services, the claim to reliability, security and mutual compatibility between information systems. Wireless technology is almost ubiquitous and thanks to its cost is also relatively easy to use and most used. Wireless transmission allows users, mobility, comfort and high-quality transmission data, audio, or video. The main representative of the network that allows data transfer shared wireless media is a wireless local area network WLAN. Local wireless networks are subject to the Wi-Fi standard based on the IEEE 802.11 specification [1][2][3]. The proposed Wi-Fi network will be modeled with software development environment OPNET Modeler. The model will be used here optimizing design and analyzing communications networks and services. There will be work simulation of the properties of data sensitive to delay [4]. The result will be processed statistics and graphs.

The main contribution of this paper is to provide a comprehensive analysis for wireless network performances in IEEE 802.11a, IEEE 802.11b and IEEE 802.11g networks for different applications.

The paper is organized as follow: In Section 2, we provide an overview of IEEE 802.11 standards. Section 3 explains the simulation setup. Obtained test results Simulation are given in Section 4 with discussions. Finally, Section 5 concludes the paper.

2. IEEE 802.11 Standards

This is the first approved standard in 1997. It operates in the 2.4 GHz ISM band. His maximum speed is 2 Mbit/s. On the physical layer, he supports spread spectrum techniques, the Direct Sequence Spread Spectrum (DSSS) method, and the Skip method Frequency Hopping Spread Spectrum (FHSS) frequencies [4][5]. IEEE network specifications work on the physical and liner layer of the ISO/OSI reference model.

A. IEEE 802.11a

The first revision of the 802.11 standard approved in 1999. This is a new specification that operates on a 5 GHz license-free band and has a transfer rate of up to 54 Mbit/s. Achieve this the increase in speed was caused by the use of OFDM frequency division modulation (Orthogonal Frequency Division Multiplexing) [8].

B. IEEE 802.11b

The 802.11b standard came out in 1999, operating in the 2.4 GHz band. The maximum theoretical speed is 11 Mbit/s. However, the actual real-time transmission speeds achieved are lower because the WLAN is in semi-duplex mode and the network connection is quite large. Effective speed transmission may be up to 40% lower. To achieve the 11 Mbit/s speed on the physical layer, a new CCK (Complementary Code Keying) technique is used. Physical layer is supported by DSSS. The speeds are based on the environment can change dynamically [8]. There are 4 speeds 11 Mbit/s, 5.5 Mbit/s, 2 Mbit/s and 1 Mbit/s. The reach of the network is in a good order and with the use of directional antennas in the order of several kilometers.

C. IEEE 802.11g

The 802.11g add-in is the 802.11b standard. It was approved in 2003[6]. Currently it is most represented in normal traffic. The standard achieves a speed of 54 on the physical layer Mbit/s as well as 802.11b

operates in the 2.4 GHz band [7]. It works by using modulation multiple carrier frequencies OFDM and backward compatible with 802.11b used DSSS. QPSK (Quadrature Phase Shift Keying), BPSK, is used as the specific modulation (Binary Phase Shift Keying), 16-QAM, and 64-QAM (Quadrature Amplitude Modulation). The use of specific modulation depends on the quality of the transport environment and is supported standard on the device side of the network. Supported speeds on the physical layer are as follows: for OFDM 54, 48, 36, 24, 18, 12, 9 and 6 Mbit/s. For DSSS, it's 11, 5.5, 2 and 1 Mbit/s. In one Network can work both 802.11g clients and older version clients 802.11b.

3. Simulation Opnet

The simulation OPNET Modeler is a discrete network simulator used for the design and analysis of communication networks. OPNET Modeler has extensive libraries that can be used to simulate networks of different standards a wide range of nodes and lines that can be assigned many implemented attributes. After the simulation, the resulting data can be displayed in the form of graphs, tables [10]. OPNET Modeler contains a wide set of protocols and technologies for practically all types of networks, including IEEE 802.11a, IEEE 802.11b and IEEE 802.11g.

3.1 Network Model

In this paper the OPNET simulation tool is used to compare between the performance of the Voice, HTTP and E-mail over IEEE wireless LAN 802.11 a/b/g. The model networks for technologies consist of an E-mail server, voice server, HTTP server, access point and 24 wireless fixed nodes distributed in 100m×100m area as shown in figure 1. We use voice, HTTP and E-mail applications. The simulation run is lasted for 10 minutes period.

Application Definitions: were the applications when created for traffic generation on the network. There are three applications used in the scenario. We have selected some applications which are popular among the users today such as E-mail, voice and HTTP applications.

Profile Configuration: describes the applications activity used by users through a period of time. The Profile was using E-mail (high load), voice (PCM quality) and HTTP with (image browser) usage parameters. All the Profiles configured to run simultaneously to allow more than one application to operate at the same time.

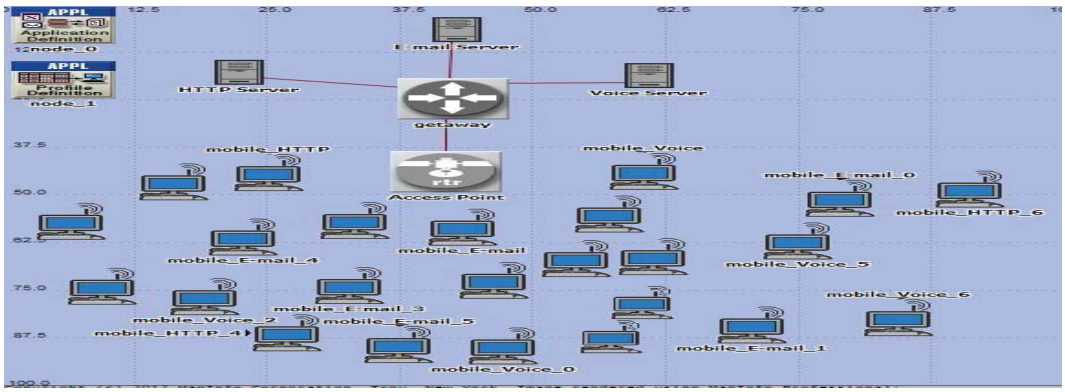

Figure (1): Network topology

Here is a summary of different 802.11 simulation parameters:
802.11b direct sequence 11Mbps
802.11a (OFDM) 54Mbps
802.11g 54 Mbps

4. Test Results Simulation

A. Voice Application

Figure 2 and 3 illustrate the average traffic sent and received by the voice application. As seen in the figure, the amounts of traffic sent in IEEE 802.11a/b/g for all scenarios are equal. However, the amounts of received traffic change depending on the protocols used. When we compare IEEE 802.11a and IEEE 802.11g both have the highest traffic received is around 90,781 (bytes/sec). While, IEEE 802.11b has the least traffic received is around 20,731 (bytes/sec) in the voice application.

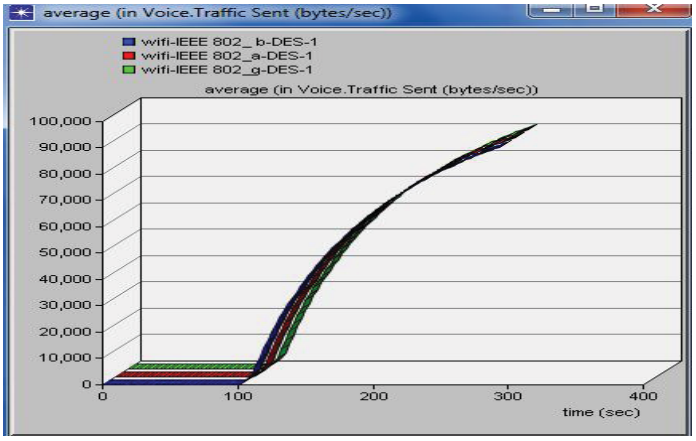

Figure (2): Traffic sent for voice

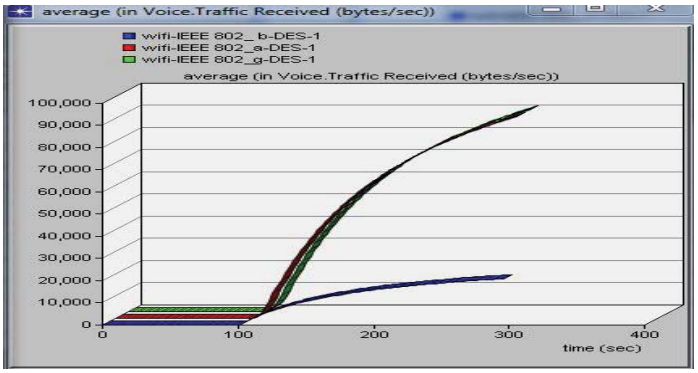

Figure (3): Traffic received for voice

Figure 4 shows the average end-to-end delay in the voice application. We observe that the average end-to-end delays of IEEE 802.11b are larger than 1.068sec which gives a lower performance with respect to the others. On the other hand, when we compare IEEE 802.11a and IEEE 802.11g. It can be seen that the average end-to-end delay of IEEE 802.11a larger than 0.0605sec, while, IEEE 802.11g has delay with only 0.0603sec.

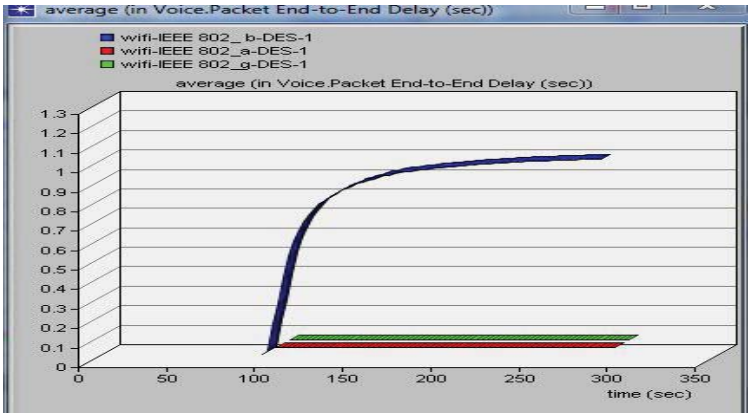

Figure (4): Average end-to-end delay in voice

Figure 5 shows the average jitter in the voice application which is known as the variation in the end-to-end delay of packets. IEEE 802.11b generally creates a higher jitter value than the others. On the other hand, when we compare IEEE 802.11a and IEEE 802.11g. It can be seen that the IEEE 802.11a and IEEE 802.11g at same level closer to zero. IEEE 802.11a and IEEE 802g are better than IEEE 802.11b since these protocols distinguished voice packets and behave them such a way to minimize jitter.

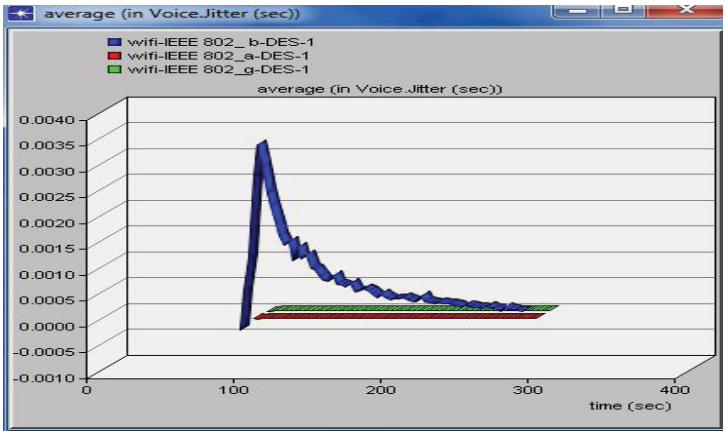

Figure (5): Average voice jitter

B. HTTP Application

Figure 6 and 7 show the average traffic sent and received in HTTP application. We observe that the average traffic sent and received of IEEE 802.11b is around 792.5 (bytes/sec) which gives a lower performance with respect to the others. On the other hand, the average traffic sent and received for IEEE 802.11g is around 25,115 (bytes/sec) is better than IEEE 802.11a is around 24,680 (bytes/sec).

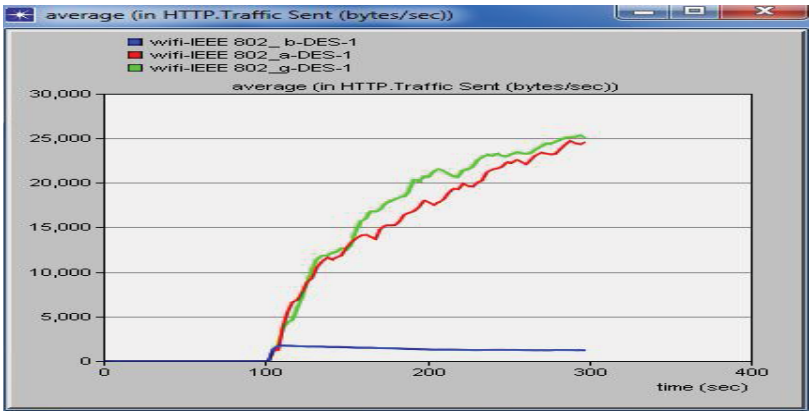

Figure (6): Traffic sent for HTTP

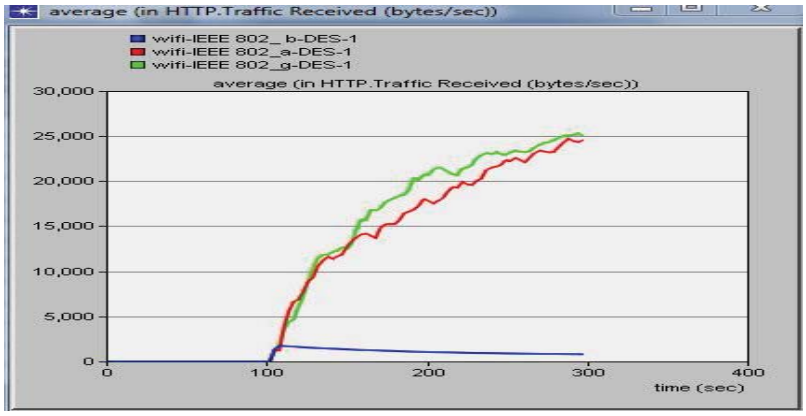

Figure (7): Traffic received for HTTP

Figure 8 shows the obtained results between the averages of download response time delay for HTTP application. We observe that the average of download response time delays of IEEE 802.11b are larger than 0.233sec which gives a lower performance for HTTP application with respect to the others. On the other hand, the average response time for IEEE 802.11g is around 0.037sec is better than IEEE 802a which is around 0.038sec. The result proved that IEEE 802.11a/g performs better than IEEE 802.11b based on HTTP application.

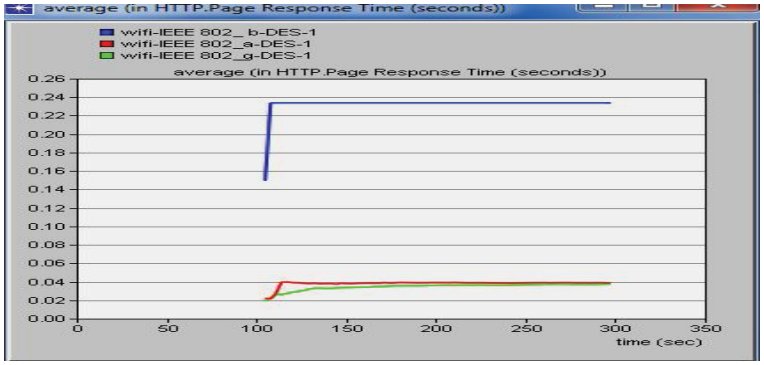

Figure (8): Page response time for HTTP

C. E-mail Application

Figure 9 and 10 show that the average traffic which sent and received to the E-mail application. IEEE 802.11b appears has the highest traffic sent. On the other hand, when we compare traffic received appear to has the lowest traffic received. IEEE 802.11b starts to drop packets almost about 120th second and reaches up to 490 (bytes/sec) of data. However, when we compare IEEE 802.11a and IEEE 802.11g have almost same send and received traffic for the E-mail application. Therefore, when we compare IEEE 802.11a/b/g the traffic with IEEE 802.11a give the best result over IEEE 802.11b for E-mail application. While, IEEE 802.11b has the worst amount of traffic in E-mail application because of dropped packets on the network.

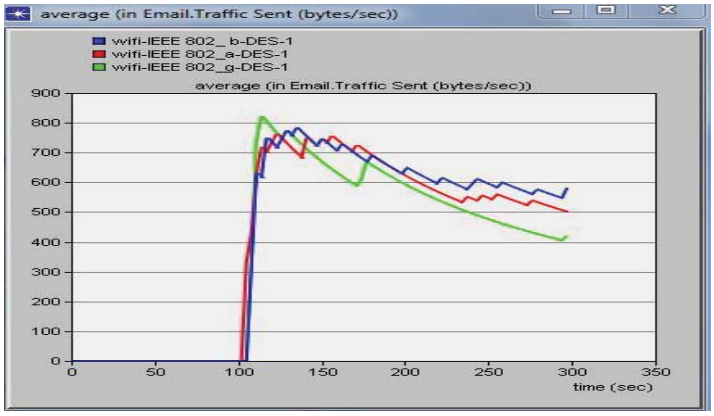

Figure (9): Traffic Send for E-mail

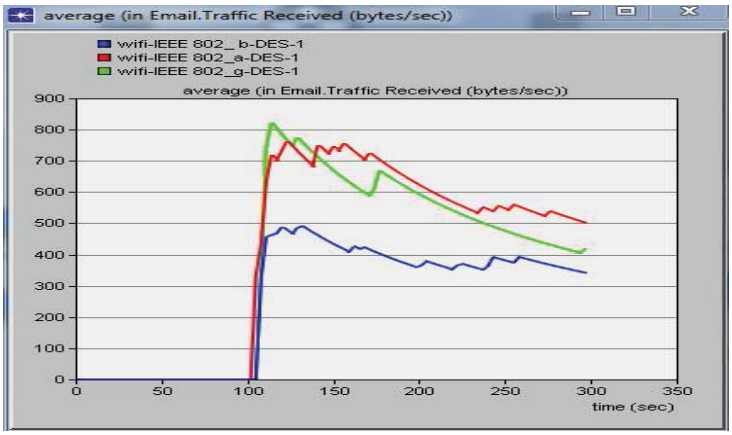

Figure (10): Traffic received for E-mail

Figure 11 shows the results of response time of E-mail Application for the IEEE 802.11a\b\g scenarios. We observe that the average download response time delays of IEEE 802.11b are larger than 0.106sec which gives a lower performance for E-mail application with respect to the others. On the other hand, the average response time for IEEE 802.11a and IEEE 802.11g is the same level around 0.0120 sec. The result proved that IEEE 802.11a/g performs better than IEEE 802.11b based on E-mail Application

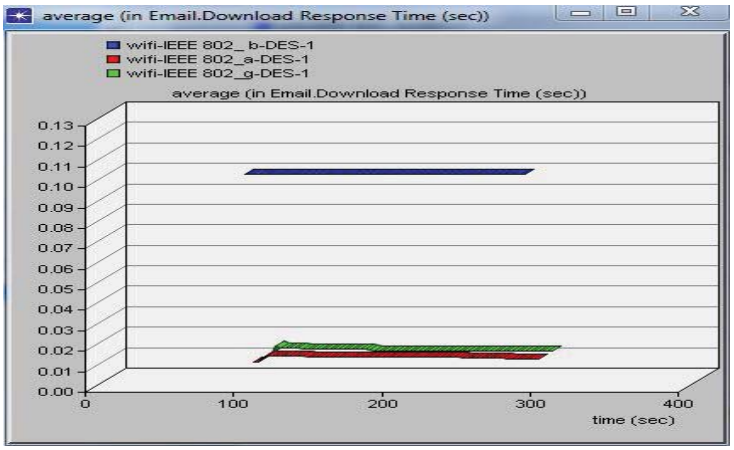

Figure (11): Download response time for E-mail application

Figure 12 shows the results of Wireless LAN load (bits/sec) for the IEEE 802.11a/b/g scenarios. As seen in the figure, we observe that IEEE 802.11b has the lowest load value which is around 1,111(bits/sec) in Wireless LAN. On the other hand, when we compare IEEE 802.11a and IEEE 802.11g has almost same higher load value are 1,300(bits/sec).

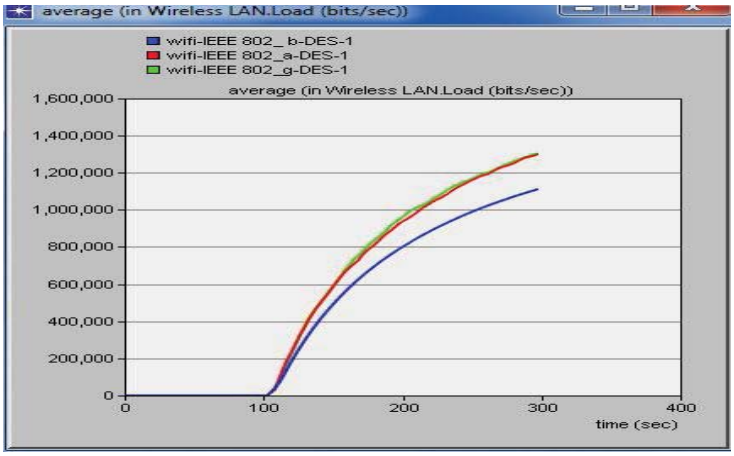

Figure (12): Wireless LAN load (bite/Sec)

Figure 13 shows the results of access wireless LAN delay; we can observe that IEEE 802.11b suffers huge performance degradation when we increase the number of clients, the results of access wireless LAN delay for IEEE 802.11b are larger than 0.952 which gives a lower performance with respect to the others. On the other hand, when we compare IEEE 802.11a and IEEE 802.11g. It can be seen that the average access wireless LAN delay for IEEE 802.11a is larger than 0.0006sec. While, IEEE 802.11g has a small delay with only 0.0004sec.

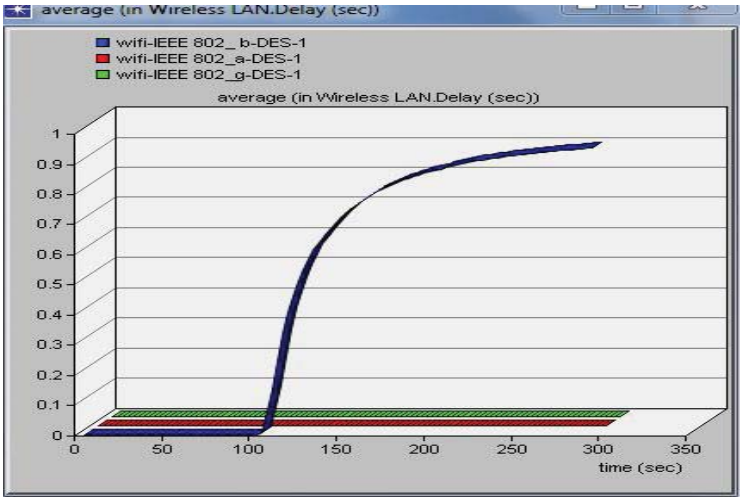

Figure (13): Wireless LAN delay

D. Discussions

Table I shows relative percentage increases in delay and download response time of applications during 10 Minutes. Using the table, the behavior of between IEEE 802.11a\b\g wireless networks can be compared easily.

As seen in the GIVES THE AVERAGE END-TO-END DELAY AND RESPONSE TIME

Application	Parameters	IEEE802.11a	IEEE802.11b	IEEE802.11g
Voice (PCM quality)	End to End Delay(MS)	60.5	1068	60.3
E-mail (high Load)	End to End Delay (MS)	12	106.4	12
HTTP (image browser)	Download Response Time (MS)	38.7	233.7	37.3

We observe the results shows that IEEE 802.11b which gives a lower performance with respect to the others for all applications (Voice, HTTP and E-mail). On the other hand, when we compare to IEEE 802.11a and IEEE 802.11g. As seen in the table is very small and they are approximately at the same results for all applications.

5. CONCLUSION

In this paper, an experiment comparison between Wi-Fi wireless network the performance of three different applications (Voice, HTTP and E-mail) over IEEE 802.11a, IEEE 802.11b and IEEE 802.11g standards scenarios using OPNET simulations. We observe the results shows that IEEE 802.11b which gives a lower performance with respect to the others on the network for all applications. On the other hand, when we compare to IEEE 802.11a and IEEE 802.11g are very small and they are approximately at the

same results for all applications. We observe the results show that the standard IEEE 802.11b is not suitable for all applications that used on the network in this work.

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