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Voice Over Wifi Performance Evaluation and Comparisons of IEEE.802.11 B, A, G, N Releases

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Abstract*: Cellular networks are not always available indoors, either at home or work. 802.11 WiFi networks can solve part of this problem by providing Voice over WiFi (VoFi) phones or computer with communication devices which make calls through the WiFi network over the internet. Data and calls are improved significantly because IEEE 802.11 standard is typically introduced to cover indoor spaces. Another reason to use 802.11 WiFi networks is to reduce the cost of per unit time usage of cellular networks. In this paper, different WLAN standards was concerned and the IEEE 802.11 standards b/a/g/n have been studied and compared regarding their VoFi performance based on Throughput, Delay and packet Drop Key Performance Indicators (KPI), which will help VoFi users , organizations and researchers in selection of better type of VoFi standard.*
Key terms*: IEEE 802.11a,b,g,n, throughput ,delay, packet drop and opent.*

I. Introduction

Background

The organization responsible for setting the WiFi standards called IEEE (Institute of Electrical and Electronic Engineering) set the first WLAN standard in 1997 and it has been called 802.11 WiFi standard but it has comparatively low data speed which can reach maximum of 2Mbps. Then in July 1999 new standard was emerged called 802.11b which can reach up to 11 Mbps and its signaling frequency can reach 2.4 GHz.

But the IEEE did not wait until the completion of the development of the 802.11b, the organization came up with the standard 802.11a which can reach up to 54Mbps and signal frequency 5GHz. Also it created the standard 802.11g in 2002-2003, its idea is to put together the best of the standards 802.11a and 802.11b in one standard. 802.11g specifications can reach up to 54 Mbps bandwidth, and it uses the 2.4 Ghz frequency for better range.

The IEEE did not stop developing new standards, 802.11n was introduced in 2009 which the most standard in use. It has two modes regarding the frequency, 5GHz and 2.4 GHz. A very high throughput standard called 802.11ac was created in 2013 with speed up to 1Gbps and support bands below 6GHz which mean that it is compatible with 802.11n standard.

802.11b

As it has been mentioned above, the 802.11b has bandwidth up to 11 Mbps and support 2.4GHz frequency which considered unregulated that mean it can interfere with other home appliances like microwave ovens, cordless phones and any other device with the same frequency so it must be installed with a suitable distance from other home devices.

802.11a

The high regulated frequency of 802.11a standard, 5GHz, reduce its coverage area and it is frequently used in companies and organization networks. The high frequencies also mean that it is difficult to penetrate through walls and other obstacles. 802.11a and 802.11b cannot be used in the same networks because they have different frequencies. It can be said that the power of 802.11a came from its high speed, 54Mbps and the regulated frequency which prevents signal interference with other devices but it also has disadvantages like short rage signal and high cost.

802.11g

New modulation technique has been used in 802.11g called OFDM (orthogonal frequency-division multiplexing) which also used in mobile networks. It has a maximum of 54Mbps, same as 802.11a and 2.4GHz same as 802.11b. Both 802.11b and 802.11g can work in the same 802.11g router but 802.11b clients will higher data than 802.11g clients.

802.11n

The largest leap in 802.11 standards world was made by the creation of 8022.11n, which has many advance features that we will talk about. Usually in the previous standards 802.11a/g/b it has access points (AP) with tow antennas and one data stream, the data or bit stream is sent and receive by both of the antennas at the same time, in 802.11n each antenna can send and receive its own data stream by a feature called MIMO (Multiple Input - Multiple Output), and up to four data streams can be sent concurrently, which increase the throughput of your data fourfold.

Another feature called channel bonding which merge active channels in either the 2.4 or 5GHz. This feature can be used to increase RF bandwidth used by WiFi clients from 20MHz to 40MHz, which result in increasing the data rates. The third feature is called Aggregation which combines data streams together, it is efficient only when both the AP and WiFi client are compatible. 802.11n has a feature called SGI (Short Guard Interval) which reduces the amount of "dead" between RF communications. This feature enhances the performace by 11% compared to other 802.11a/b/g standards. The last feature enlarges the signal strength toward the client direction by a feature called Beam Forming which allows the Aps to define and estimate the location of WiFi client.

IEEE802.11ac

There is no fear that channels in 802.11ac will be overlapped because they work in 5GHz frequency which is different from the previous 802.11n standard. 802.11ac considered to be more fast and scalable than 802.11n, it has a Gigabit Ethernet data rates.

IEEE802.11ad

A group called TGad has finished the work of creating the 802.11ad standard which can reach up to 6.75 Gbps at 2GHz channel of the spectrum of 60 GHz. The 60 GHz spectrum is considered to be unlicensed but a very large bandwidth is available compare to 2.4 or 5 GHz. It is a huge improvement in data rates over both 802.11n and 802.11ac and it allows WiFi devices to interact over four, 2.16GHz wide channels.

Wireless LAN Throughput by IEEE Standard		
IEEE WLAN Standard	**Over-the-Air (OTA) Estimates**	**Media Access Control Layer, Service Access Point (MAC SAP) Estimates**
IEEE802.11b	11 Mbps	5 Mbps
IEEE802.11g	54 Mbps	25 Mbps (when 11.b is not present)
IEEE802.11a	54 Mbps	25 Mbps
IEEE802.11n	Up to 600 Mbps	Up to 400 Mbps
IEEE802.11ac	Up to 867 Mbps with 2 antennas and 80 MHz ; up to 1.3 Gbps with 3 antennas and 80 MHz	Up to 600 Mbps with 2 antennas and 80 MHz ; up to 900 Mbps with 3 antennas and 80 MHz
IEEE802.11ad	At least 1.1 Gbps (up to 4.6 Gbps in some first generation products)	Up to 700 Mbps for 1.1 Gbps OTA (up to 3 Gbps for 4.6 Gbps OTA)

II. Methodology

OPNET 17.5 has been used to simulate four different methods from IEEE 802.11a,b,g&n. for analysis of the voice over wifi traffic between source(ip phone 1) and destination(ip phone 2), three parameters (throughput, delay and retransmission) have been considered to evaluate the network performance for each transition releases.

Network Components

This section discusses the network components used in our simulation which is shown in figure 1. The components used in the suggested network modelis running on OPNET 17.5, the devicesare 40 WLAN stations ,SIP server, HTTP server, 2 ip phones, switch Ethernet 16,Firewall,router,IP backbone**.** We use web browser HTTP and FTP heavy traffic applications in the Application_ Config .

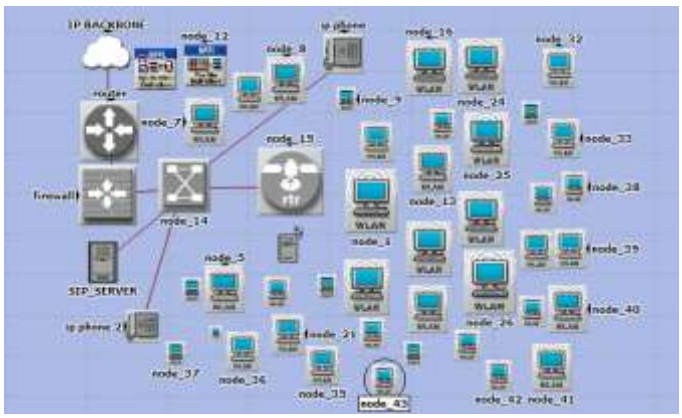

Figure 1

III. Results and Analysis

Throughput

The comparison between voice over Wi-Fi releases will be based on figure 2 which represents the throughput of voice over Wi-Fi with the releases a, b, g and n.

The graph shows that voice over Wi-Fi release n has the greatest throughput (close to 2000kbps) compare to other releases, which means that it has better performance in case of high traffic voice volume, on the other hand, the graph shows thatvoice over Wi-Fi release g has the lowest throughput (close to 200kbps) compare to other releases, and it indicates that the performance of voice in heavy traffic conditions will be degraded more and more when the traffic volume increased. While the releases b and a Wi-Fi products have medium voice throughputs, which indicate that they can work well in middle traffic conditions loads with acceptedperformance.

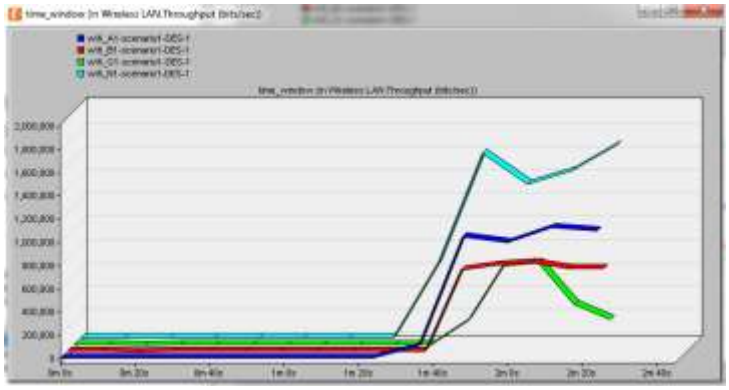

Figure 2

Delay

Figure3 shows that Wi-Fi nrelease haslittle delaytime in the packets than the rest of the other releasesb,a, g. So we can say that release n has the best amount of packet throughput and the little delay time compare to other releases , so, it's better to use product n in real time applications that require more bandwidth than other applications like Voice over IP, gamming and video conference .

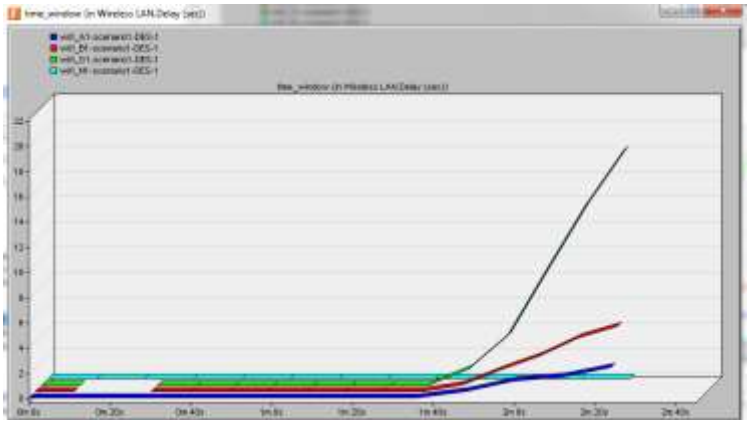

Figure3

Packet Drop and Retransmission Attempts

As we can see from figure 4 and 5, wifi release n starts with the highest packet drop rates and retransmission attempts but it stops at time 3min and 15 sec, the other releases resume its packet drop rates and retransmission attempts.

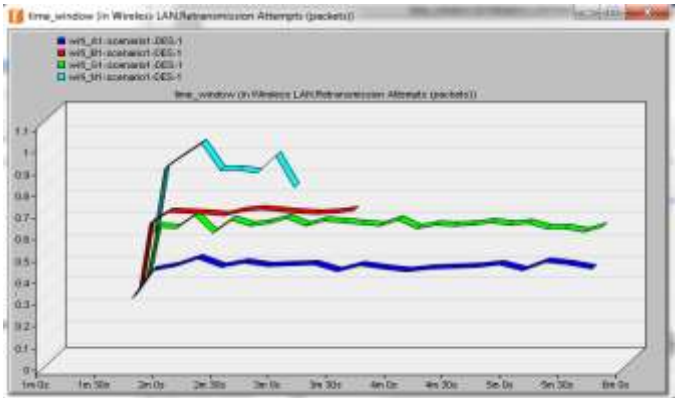

Figure 4

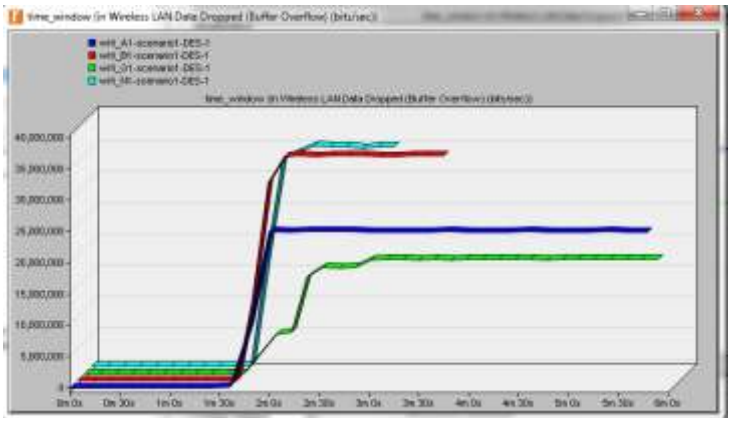

Figure 5

IV. Conclusion

In this simulation we used OPNET17.5 tool, and four types of key performance indicators (Throughput, Delay, Packet drop and retransmission attempts). We found that release n has the best throughput packets amounts, little delay time and lowest period of time for packet drop and retransmission attempts so it is suitable for critical and real time applications .

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