Simulation Comparison between LTE and Wi-Fi in Networks

ENSC 427 Communication Networks Project SP14

Group #1
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Abstract

LTE is known as long term evolution, and it is fourth generation (4G) wireless network for mobile communication networks. LTE provides higher data rate, lower latency, and a simplified architecture. LTE system uses OFDMA-based multicarrier modulation, MIMO techniques, and other advanced features to greatly improve wireless services. WIFI stands for Wireless Fidelity, and refers to any type of Wireless Local Area Network (WLAN). Using OPNET software, we test the simulations and compare the throughput, traffic received, and delay between LTE and WIFI on OPNET 16.0. Based on our experimental results, we were able to observe the differences for both technologies, and make positive conclusions.

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1. Introduction

In today's technology, various wireless communication services have entered the market. One of the latest technologies is LTE (Long Term Evolution) which is known as currently one of the fastest ways of mobile data transfer communication. Also WIFI (wireless fidelity) is one of the oldest wireless technologies that has been improved in the past decade and is still one of the major wireless technologies used day to day by people. In this project, we built simple network models for LTE and WIFI using OPNET 16.0 software. We plan to run simulations for File Transfer Protocol (FTP), Hypertext Transfer Protocol (HTTP), and Video Conferencing. We were able to compare throughputs, traffic received, and delays for both technologies in a variety of tests.

1.1 Technology Background

WIFI stands for wireless fidelity, it defined as the wireless local area network (WLAN) products that are based on the IEEE 802.11 standards. And the IEEE802.11 has 2 basic modes of operation, the ad hoc mode and infrastructure mode. The ad hoc mod, the mobile transmit the data peer-to-peer. In infrastructure mode, the mobile communicate other networks through access point, which we call it Internet or LAN. And for the signal range for the WIFI is around 35 m. LTE stands for long term evolution., and it is currently a leading fourth generation standard for wireless mobile commutation technology and data transfer that evolves from Global system for Mobile Communications (GSM) and Enhanced Data rates for GSM Evolution. And it use the Orthogonal Frequency- Division Multiple Access (OFDM) for the downlink and single-carrier frequency-division multiple access (SC-FDMA) for uplink in order to conserve the power.

1.2 WIFI Performance against LTE

There have been many studies that show the performance of WIFI against LTE. These experiments have been conducted such that user experience is examined for some everyday use services such as ping latency, FTP downloading, Video streaming, etc. They test the performance by sending the data packets to the server and record the ping time in millisecond for both WIFI and LTE. The result is that that the ping latency on LTE is the same when number of users increase. However, the latency on WIFI increases dramatically since number of users increase which shown on figure 1.

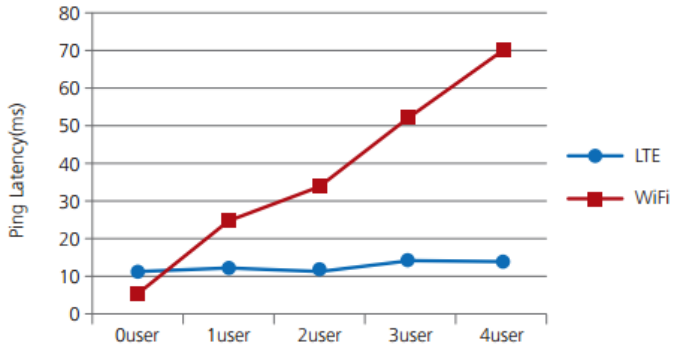


Figure 1.2.1: Ping Latency vs. Number of users

The other comparison of LTE and WIFI can be conducted for FTP downloading. We realize that as number of users increase, the download time is roughly the same for on LTE network; however, for WIFI network, download time increases dramatically.

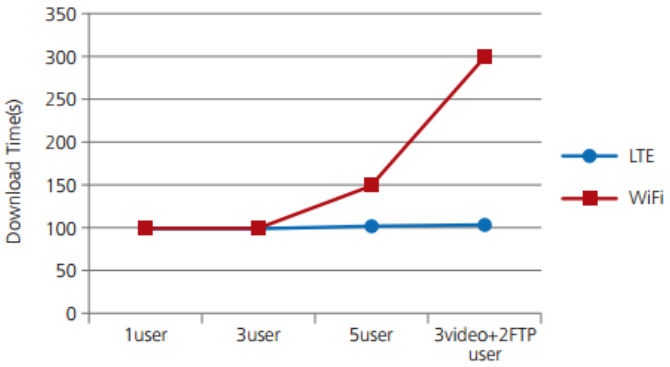


Figure 1.2.2: FTP Downloading vs. number of users

Another conducted test to show the performance of WIFI vs. LTE was conducted for video streaming or media streaming. In this case it is also seen that as number of users increase the quality of the video is lower on users who are on WIFI network vs. users who are on the LTE network.

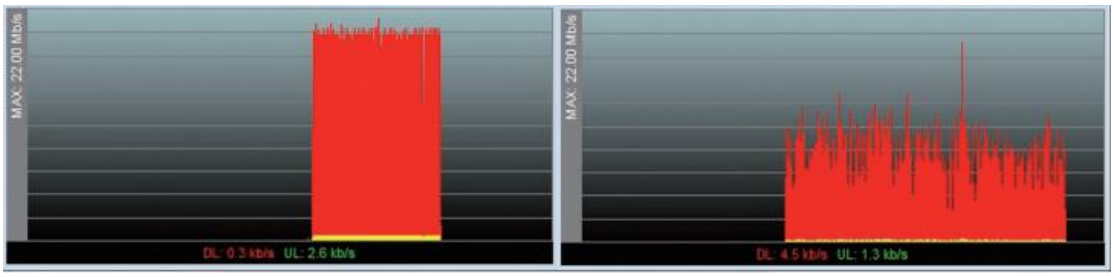


Figure 2: Video Streaming LTE vs. WIFI

2. Model Setup

2.1 WIFI topology

Our goal is to compare the simulation between LTE and WIFI in order to understand that which network technology has better performance. So we create two separate OPNET 16.0 projects, one is for WIFI and another one is for WIFI. We start the WIFI network model first because it is simple and easy to implement. For our WIFI topology setup, we set it to office with area 100x100 meters. The object we need were one server, one switch, one access point, one application configuration, one profile continuation and two workstations:

Name	Model Name
Server	ethernet_server
Switch	Nay Network Accelar1050
Access Point	wlan_ethernet_slip4_adv
Application	Application Configuration
Profile	Profile Configuration
node_0, node_1	wlan_station_adv

Table 2.1.1: Summarization of Nodes

After we pull out those objects from object palette, we need to link the server to switch and switch connected to access point by 100BaseT. The workstations would place close to access point.

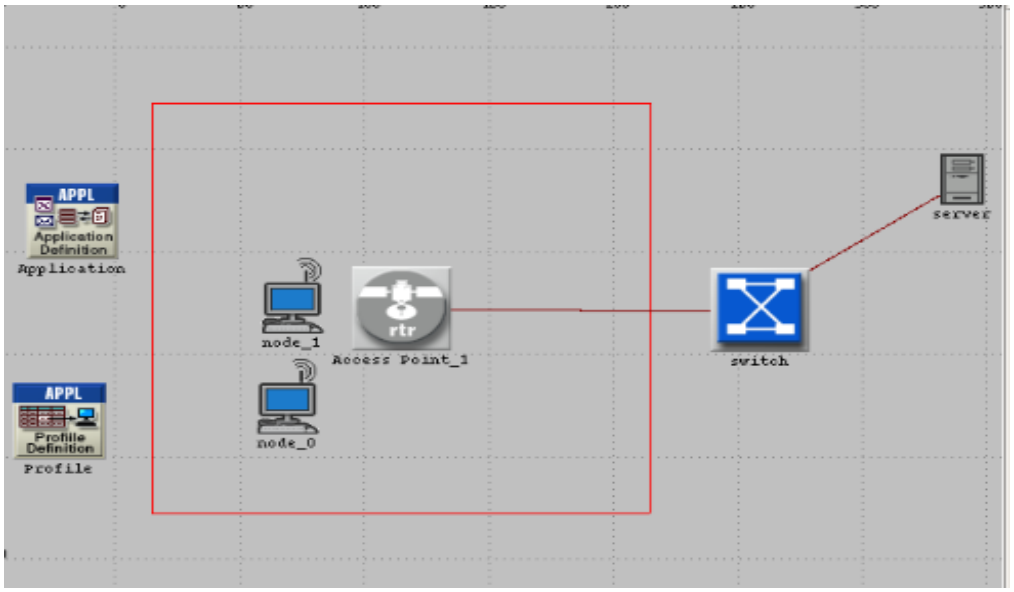


Figure 2.1.1: WIFI topology

2.2 WIFI traffic setup

In this section, we are going to set up the traffic for our model. First, we set the start time offset (seconds) to constant (10) and Duration (seconds) to constant (30) in Profile Configuration.

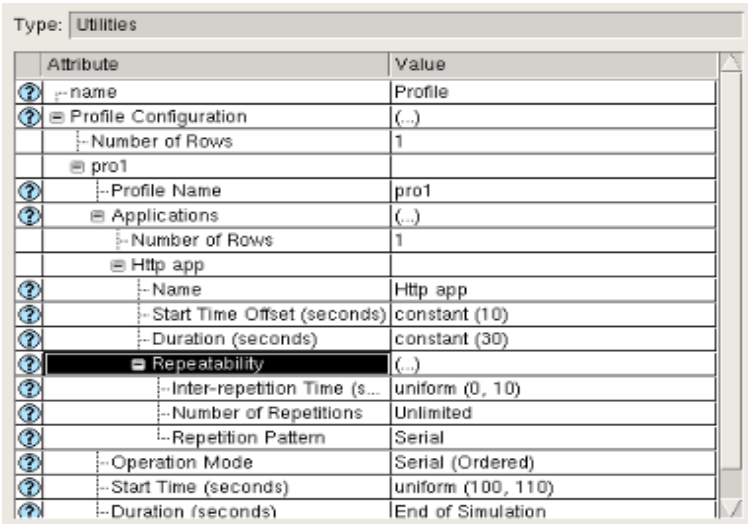


Figure 2.2.1: Profile setup in WIFI

In addition, we need to set the Access Point Functionality to enable for access point, and disable for all workstation. Also, the BSS identifier needs to be the same for access point and workstations; therefore, we set it to 1.

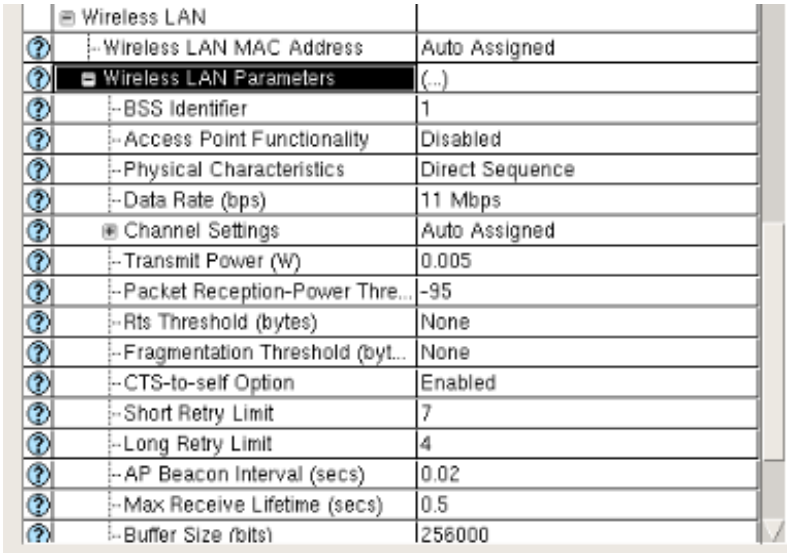


Figure 2.2.2 Workstation setup in WIFI

And we need to set up different application in Application Configuration in order to compare the simulation result in different condition:

Description	Value
HTTP	Heavy Browsing
FTP	High Load
Video Conferencing	High resolution video

Table 2.2.1: Application types

2.3 LTE Topology

For LTE topology, we download it from the standard library. Since we need to compare WIFI and LTE under the same condition, we need to set it like WIFI; so we need to set the start time offset to constant (10) and duration to constant (30). Also, the application configuration in LTE topology has to edit the value same as table 2.1.

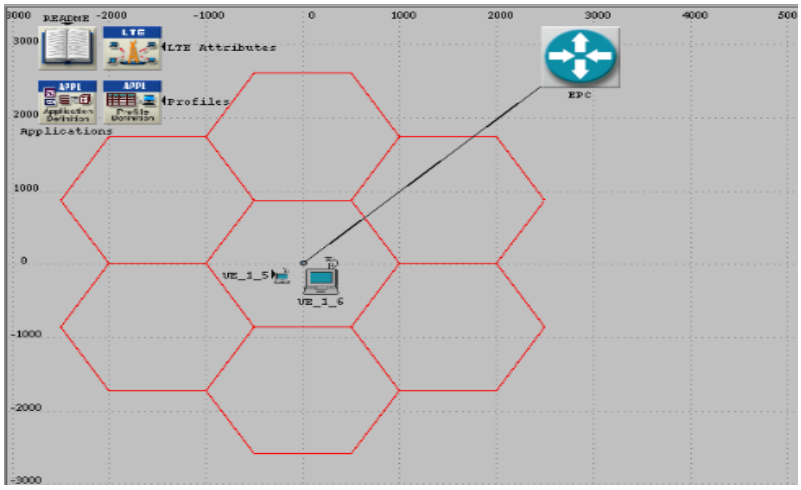
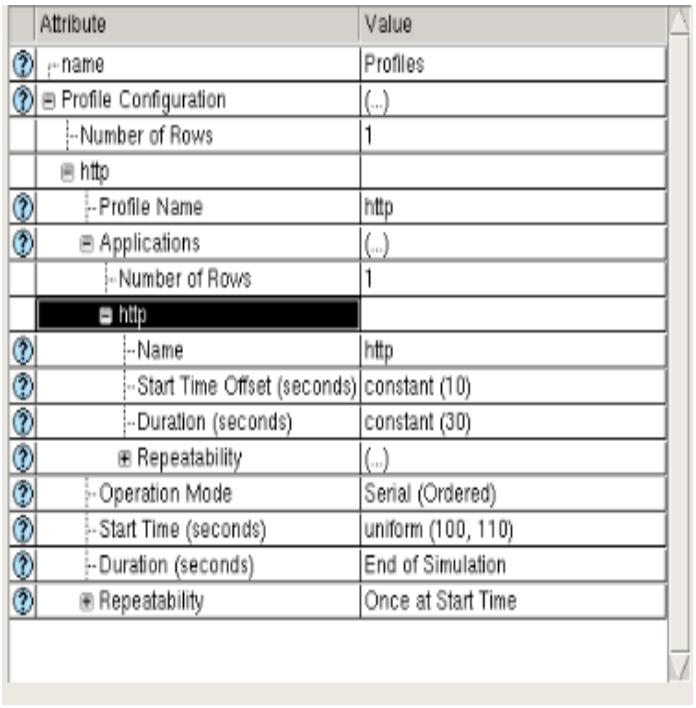


Figure 2.3.1: LTE Topology

2.4 LTE traffic setup

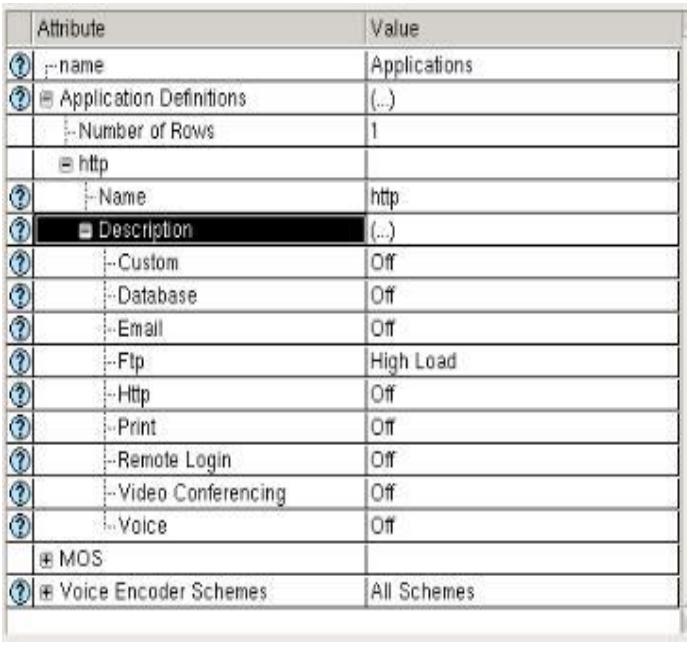
In this part, we need to set up for the LTE traffic. Since we are comparing the simulation between WIFI and LTE, we need to set the LTE traffic same as the WIFI traffic. We set the start time offset to constant 10 and Duration to constant 30 in profile.



Attribute	Value
name	Profiles
Profile Configuration	(...)
Number of Rows	1
http	
Profile Name	http
Applications	(...)
Number of Rows	1
http	
Name	http
Start Time Offset (seconds)	constant (10)
Duration (seconds)	constant (30)
Repeatability	(...)
Operation Mode	Serial (Ordered)
Start Time (seconds)	uniform (100, 110)
Duration (seconds)	End of Simulation
Repeatability	Once at Start Time

Figure 2.4.1: Profile setup in LTE

Also, set the application profile same as the table 2.1.



Attribute	Value
name	Applications
Application Definitions	(...)
Number of Rows	1
http	
Name	http
Description	(...)
Custom	Off
Database	Off
Email	Off
Ftp	High Load
Http	Off
Print	Off
Remote Login	Off
Video Conferencing	Off
Voice	Off
MOS	
Voice Encoder Schemes	All Schemes

Figure 2.4.1: Application setup in LTE

3. Experimental Results and Discussions

As we mentioned in the model setup section, we set application of FTP to high load, HTTP to heavy browsing, and Video Conferencing to high resolution video. The first part of the experimental results are relate to the throughputs in File Transfer Protocl (FTP), Hypertext Transfer Protocol (HTTP) and Video Conferencing for WIFI and LTE. In the graph, X-axis is in time domain, and Y-axis is in bits or bytes; also blue line represents WIFI and red line is LTE.

3.1 Throughput (bits/sec) in FTP

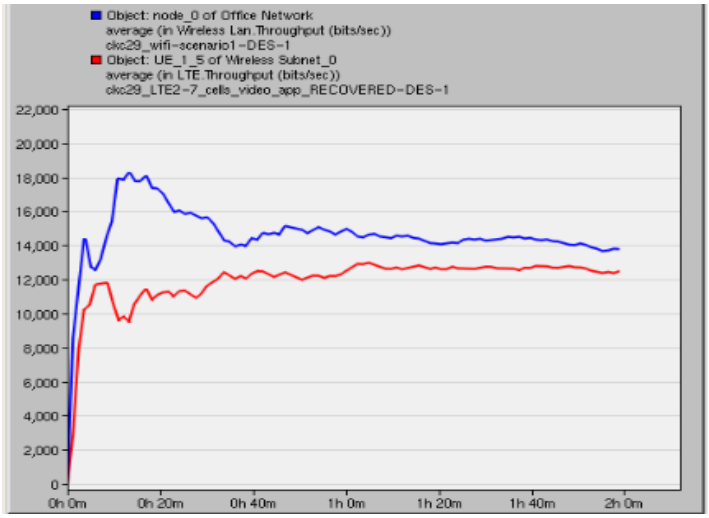


Figure 3.1.1: Throughput (bits/sec) in FTP

From figure 6.1, we can observe that WIFI has higher throughputs. We collected the data from the figure 6.1 to support this observation in table 3.1.

Time(s)	LTE(bits)	WIFI(bits)
0.0	0	16.0
72.0	2947.11	8578
144.0	7882.52	11529.77
216.0	10267	14426.22

Table 3.1.1: WIFI vs LTE throughput in FTP

The data in table 3.1 supports our obersvation which is reasonable. For instance, we compared the throughputs for LTE and WIFI at 72, 144, 216 seconds. The numbers in WIFI are much larger than LTE. We can see that WIFI has more throughputs than LTE in FTP.

3.2 Throughput (bits/sec) in HTTP

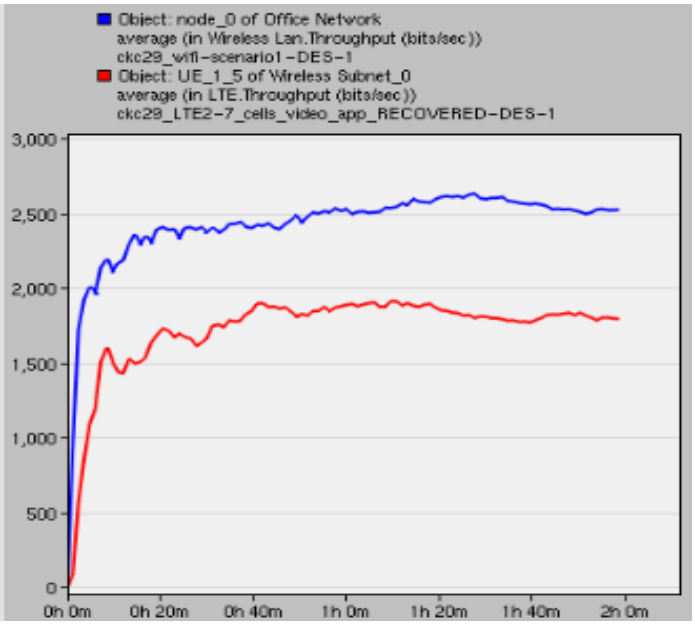


Figure 3.2.1: Throughput (bits/sec) in HTTP

The figure 6.2 shows that WIFI has greater throughputs. We compare the data that collected from the graph to support this observation.

Time(s)	LTE(bits)	WIFI(bits)
0.0	0	16.0
72.0	91	962.5
144.0	572	1728.07
216.0	860.56	1926.03

Table 3.2.1: WIFI vs LTE throughput in HTTP

The data in table 3.2 supports our obersvation becuase we compared the throughputs for LTE and WIFI at 72, 144, 216 seconds. The numbers in WIFI are much higher than LTE. Therefore, WIFI has more throughputs in HTTP.

3.3 Throughput (bits/sec) in Video Conferecing

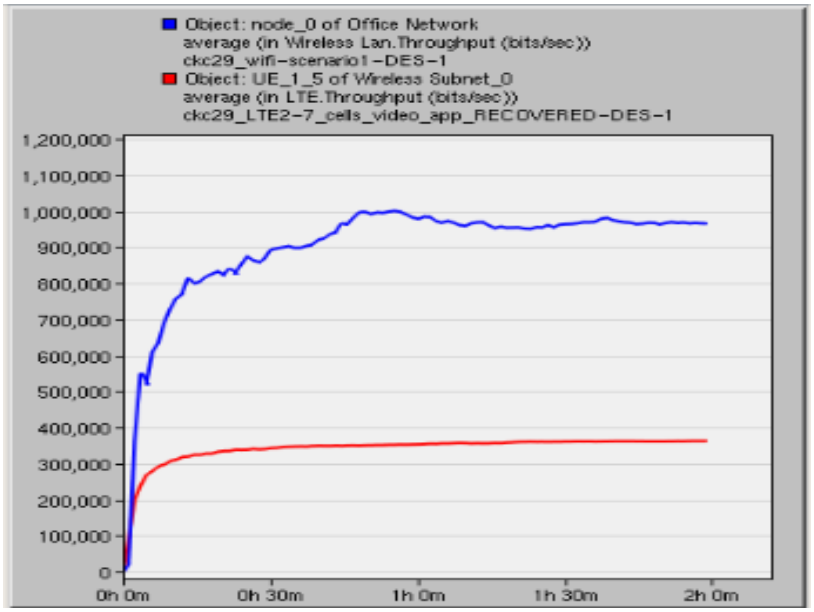


Figure 3.3.1: Throughput (bits/sec) in Video Conferencing

Figure 6.3 show that WIFI has more throughputs. We recorded data from the graph to support this observation.

Time(s)	LTE(bits)	WIFI(bits)
0.0	0	16.0
72.0	95689.78	21426.72
144.0	200664.59	365038.96
216.0	239722.22	551431.81

Table 3.3.1: WIFI vs LTE throughput in Video Conferencing

We compared the throughput from the table 3.3 for LTE and WIFI at 0, 144, 216 seconds. The throughput in WIFI are higher than LTE. Therefore, WIFI has more throughputs in Video Conferencing. Based on the different test results in FTP, HTTP, and video conferecing, our first conclution is that WIFI has higher throughputs than LTE.

The second part of the result we is delay for Protocl (FTP), Hypertext Transfer Protocol (HTTP) and Video Conferencing for WIFI and LTE.

3.4 Delays (sec) in FTP

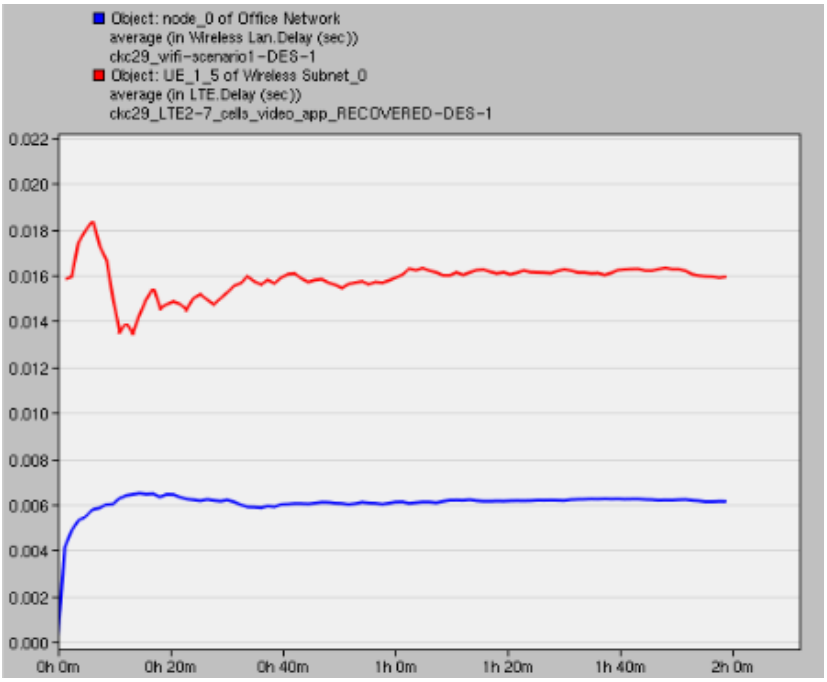


Figure 3.4.1: Delays in FTP

Figure 7.1 show that LTE has more delay than WIFI. We recorded data from the graph to support this observation.

Time(s)	LTE(bits)	WIFI(bits)
0.0	NA	0
72.0	0.0158	0.00416
144.0	0.0159	0.00489
216.0	0.0174	0.00533

Table 3.4.1: WIFI vs LTE delays in FTP

We compared the delays for LTE and WIFI at 72, 144, 216 seconds The numbers in LTE are higher than WIFI, so LTE has more delays in FTP. Since both delay are less the 1 second, we can say that both network has excellent performace on FTP

3.5 Delays (sec) in HTTP

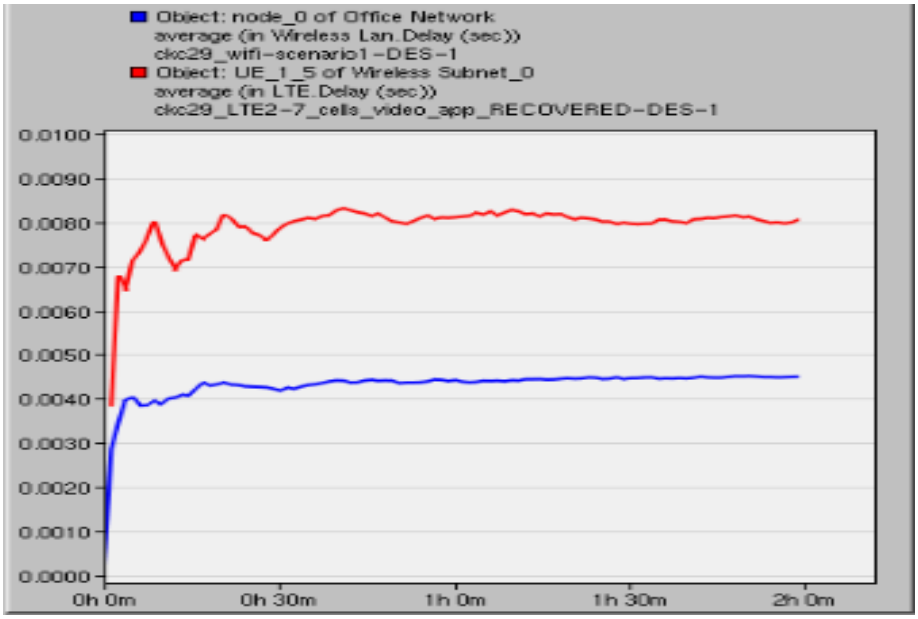


Figure 3.5.1: Delays in HTTP

Figure 7.2 show that that LTE has more delay than WIFI. We recorded data from the graph to support this observation.

Time(s)	LTE(bits)	WIFI(bits)
0.0	NA	0
72.0	0.0038	0.0028
144.0	0.0067	0.0034
216.0	0.0064	0.0039

Table 3.5.1: WIFI vs LTE delays in HTTP

We compared the throughputs for LTE and WIFI at 72, 144, 216 seconds. From the table 4.2, we can see that the delay in WIFI is lower than LTE. Since both delay are less the 1 second, we can say that both network has excellent performace on delay, but WIFI is slightly better in HTTP

3.6 Delays (sec) in Video Conferecing

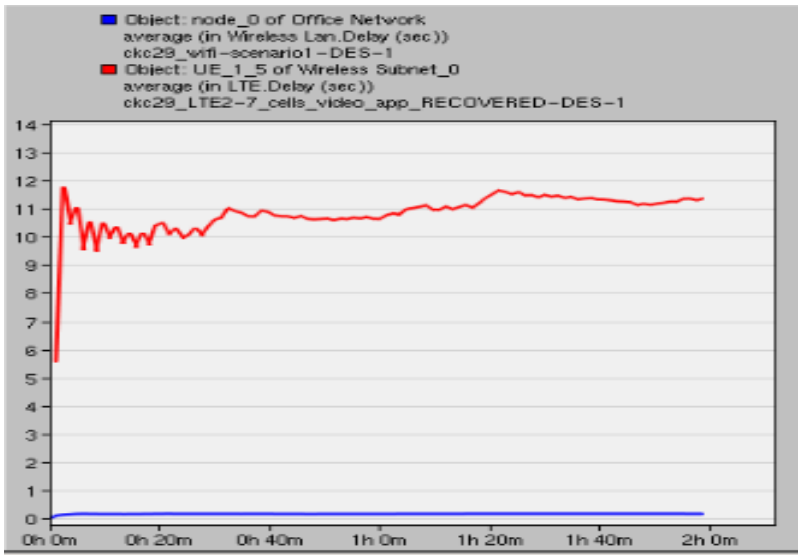


Figure 3.6.1: Delay in Video Conferencing

Figure 7.3 shows that LTE has more delay than WIFI. We recorded data from the graph to support this observation.

Time(s)	LTE(bits)	WIFI(bits)
0.0	NA	0
72.0	5.57	0.0998
144.0	11.79	0.128
216.0	10.45	0.143

Table 3.6.1: WIFI vs LTE throughput in Video Conferencing

The data is shown in table 4.3 which support our obersvation. We compared the delays for LTE and WIFI at 72, 144, 216 seconds. The numbers in LTE are higher than WIFI. LTE has more delays in Video Conferencing. In figure 7.3, we can clearly see that WIFI has delay which is less than 1 seoncds but LTE has delay which is higher than 10 seconds. Therefore, WIFI outperfom than LTE in video conferencing. Based on the results, WIFI and LTE has excellent performance in FTP and HTTP; however LTE has poor delay in video conferenceing. Therefore, our second conclution is that LTE has higher delays than WIFI.

The third part of the results is related to traffic received in File Transfer Protocl (FTP), and Hypertext Transfer Protocol (HTTP) for WIFI and LTE.

3.7 Traffic Received (bytes/sec) in FTP

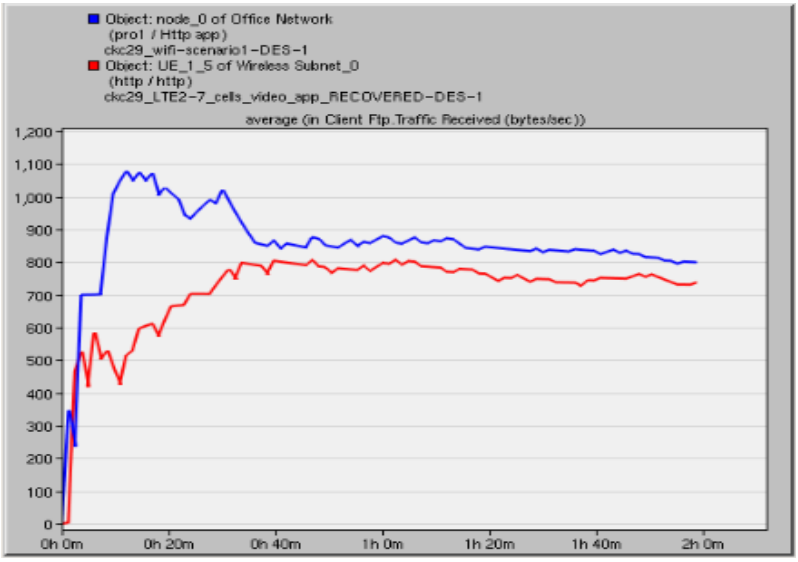


Figure 3.7.1: Traffic received in FTP

From the graph, we can observe that WIFI has more received bytes than LTE. We recorded data from the graph to support this observation.

Time(s)	LTE(bytes)	WIFI(bytes)
0.0	0	0
72.0	3.55	347.22
144.0	467.70	236.22
216.0	526.17	699.78

Table 3.7.1: WIFI vs LTE traffic received in FTP

We compared the bytes for LTE and WIFI at 72, 144, 216 seconds. The WIFI recevies more bytes than LTE. Therefore, WIFI has better performance in FTP,

3.8 Traffic Received (bytes/sec) in HTTP

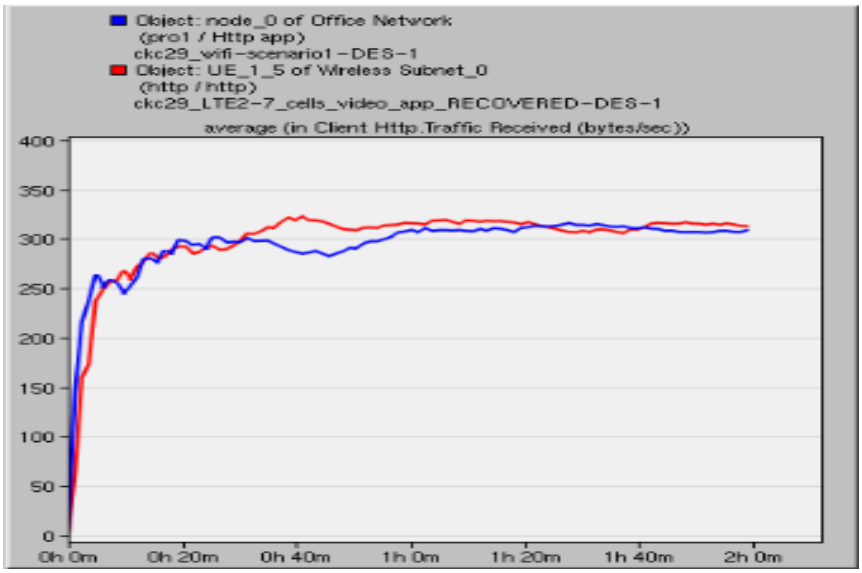


Figure 3.8.1: Traffic received in HTTP

From the graph, WIFI has more received bytes than LTE. We recorded data from the graph to support this observation.

	LTE	WIFI
0.0	0	0
72.0	63.27	144.85
144.0	159.97	216.19
216.0	173.72	238.05

Table 3.8.1: WIFI vs LTE traffic received in FTP

We compare the receving bytes for LTE and WIFI at 72, 144, 216 seconds. LTE and WIFI only have slightly different numbers of receiving bytes in HTTP.
Based on the results, our third conclution is that WIFI has more received bytes in FTP. However, WIFI and LTE both has similar performance in HTTP. We conclude that WIFI has better performnace in FTP

The final part of the results we collected were related to data lost between traffic received and traffic sent in File Transfer Protocl (FTP), and Hypertext Transfer Protocol (HTTP) for WIFI and LTE. In this part, blue line stands for traffic received, and red line stands for traffic send.

3.9 Data lost (bytes/sec) in HTTP

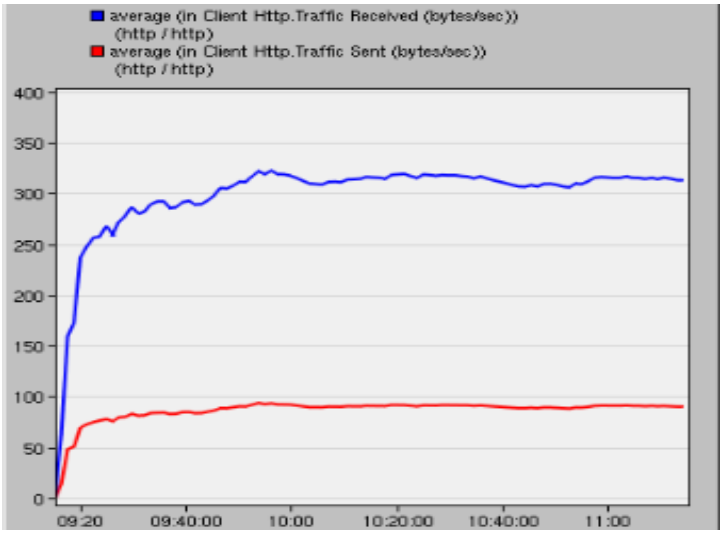


Figure 3.9.1: LTE data lost in HTTP

In the LTE, there is an average of 200 bytes difference between traffic received and traffic sent for data lost.

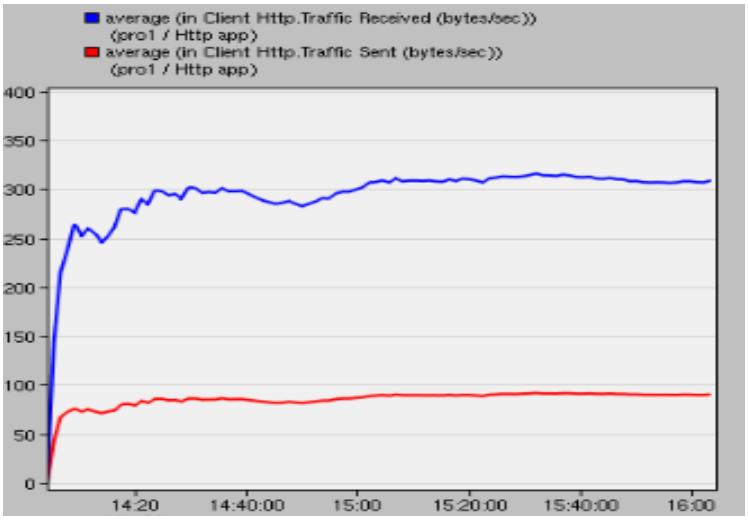


Figure 3.9.2: WIFI data lost in HTTP

There is an average of 200 bytes difference between traffic received and traffic sent for data lost in WIFI. Based on the observation, we conclude that WIFI and LTE have same data lost in HTTP.

3.10 Data lost (bytes/sec) in FTP

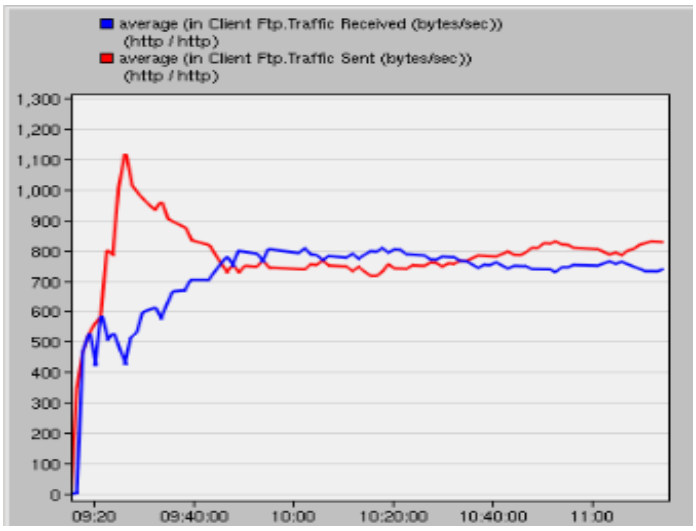


Figure 3.10.1: LTE data lost in FTP

In the LTE, there is an average of 100 bytes of data lost difference after 9:40:00.

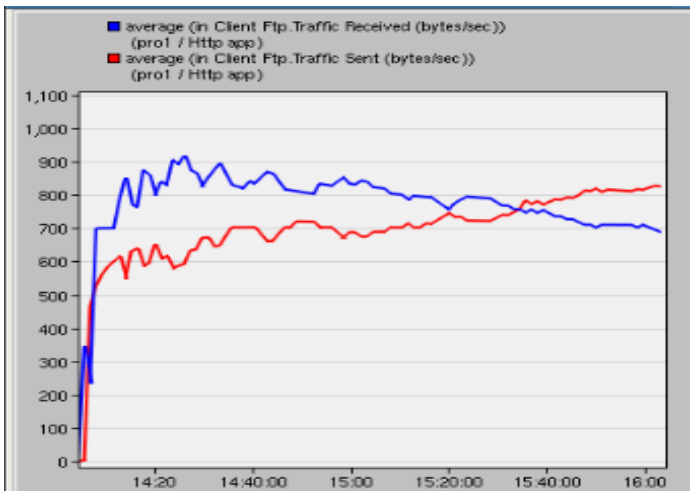


Figure 3.10.2: WIFI data lost in FTP

There is an average of 100-200 bytes difference between traffic sent and traffic received at 15:40:00 for data lost in WIFI. Based on the observation, LTE has similar rate of data lost than WIFI in FTP.

We concluded LTE and WIFI have similar data lost in HTTP and FTP, so they both have and excellent performance.

4. Conclusion

We have demonstrated that LTE and WIFI simulation performance in the following characteristics:

- Throughputs in FTP, HTTP, and Video Conferencing: the simulation graph and data are shown WIFI has higher rates of throughputs than LTE. LTE has lower throughputs than WIFI.
- Delays performance in FTP, HTTP, and Video Conferencing: The numbers of delays in WIFI are Smaller than LTE from simultaion result and data. LTE has more delays than WIFI.
- Traffic Received and Data Lost in FTP and HTTP: WIFI has more received bytes than LTE. LTE has more data lost than WIFI in FTP. WIFI and LTE have same data lost in HTTP.

Based on the above, we confirm our claim that WIFI is better than LTE in areas such as throughputs (data rate), delays, and traffic received. WIFI provides a high performance in our testing model networks, and WIFI is the clear winner in the comparison of technologies to succeed as the communication networks standard for our experimental models and simulation claims.

In the reality, The LTE is superior to the 3G generation (WIFI) in areas such as throughputs (data rate), delays, traffic received and data lost. LTE provides a new simpler architecture for mobile devices as phones and tablets in the mobile communication standard for the world.

Our future work will be fixed the possible setting errors in our network model cases. The observations from our simulation are not matching the general ideas in the reality for LTE and WIFI. Being respect to the real world, we will re-plot experimental simulation results for the fixed models, and state correct conclusions that support LTE is more advanced technology than WIFI in reality.

5. References

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