Design and Analysis of 60 GHz Wireless Gigabits Throughput on LTE Networks with Full HD VideoStreaming

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Abstract. LTE network signal strength can be affected by obstacles from a room wall, thequality of the internet network is difficult to reach. This study observes and analyzes the quality of the LTE network traversed by the 60 GHz Wireless Gigabits network with a Point to Point topology.Simulation measurements are based on the distance of the beamwidth source from the destination and collect data in real time with bandwidth, throughput, jitter and RSSI parameters.In this study,data collection used Wireshark,and OpenSpeedTest applications.The results of obtaining the quality of the existing bandwidthare carried over from the same LTE network that is passed by the 60 GHz network with Full HD resolution video streaming. For local network testing using the openspeed test, the highest DL and UL bandwidth are the same,with the highest being 981 Mbps and the lowest being 920 Mbps.The RSSI value is affected by distance,weather conditions (wind),wall thickness.

Keywords: Beamwidth, 4G, WiGig 60 GHz, video streaaming, throughput

1 Introduction

The need for technology has had such a big impact that the need for remote technology to reduce face-to-face contact. This development concerns the adaptation of the use of information and communication services that are effective in terms of real-time needs, and efficiency in terms of time and costs as well as the risks that arise. One of the facilities in the cellular system is to ensure continuity of communication if the signal transmission power passes through the beamwidth size.

Wireless Gigabits (WiGig) 60 GHz is one of the developments in EHF (extremely high frequency) technology between 30 – 300 GHz unlicensed IEEE 802.11.ad band as broadband communication on channels between 57 GHz to 66 GHz [1]. WiGig technology has low attenuation. high because the bandwidth carried is very large so it is only used at low distances[2]. An inevitable obstacle is the attenuation of oxygen in the air.

Video Streaming is a technology that can transmit video files continuously, allowing the

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video to be played without waiting for the video file to be delivered in its entirety. In video streaming services, the type of service traffic used is asymmetric technology. Because most home routers are set up to handle the difference between the amount of data downloaded and the data uploaded. This asymmetric technology is a technology that allows more bandwidth in one direction than the other [3]. Video streaming provides services on the downlink or uplink only. Video streaming only uses one direction [4]. So the main 4G network was chosen as the network that will get the Full HD video streaming service for the coverage area between buildings.

Things that affect network performance in an area decrease due to obstacles and interference. The effect of poor network performance both caused by obstacles and interferencealso affects the SINR value, if the SINR value is bad it will cause the value of the Throughput parameter to be bad [5]. Throughput is the average number of bits received by User Equipment in a network. Changing the height of the antenna installation must be calculated based on the height of the obstacle that blocks the antenna beam in an area so that there is no loss in signal reception [5]. In research [6] determining the optimal beamwidth selection criterion by using a thinner beam allows high user data rates to risk no coverage in the event of an error in estimating the user's position. In contrast, a larger beamwidth will increase this coverage probability, although reducing throughput at the user. Therefore, it is important to find the right balance of priorities between localization accuracy and communication and based on that, the optimal beamwidth [6].

The aim of carrying out this research is to design and analyze the process of sending data throughput on the 4G LTE network to the MGWS FLANE (Multiple Gigabit Wireless System Fixed Local Area Network Extended) network point to point consistently. Based on the device specifications, the beamwidth beam can influence the throughput parameters of Full HD videostreaming services by simulating the conditions of obstacles and angular shifts. This research will analyze the beamwidth of 4G network services using throughput parameters as the main reference for broadband communications on lossless bandwidth.

2 Research Methods

In solving a problem, a research method is needed to achieve research results. In this research there are six stages to analyze Wigig throughput with Line of Sight (Los). The following is the research block diagram in Figure 1.

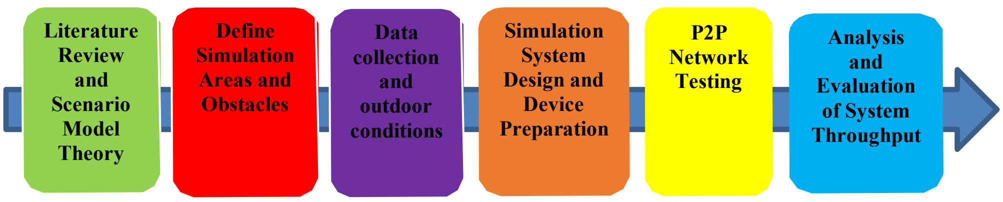


Fig. 1. Design and Analysis of Beamwidth for Optimizing 60 GHz WiGig Throughput on4G LTE Networks

2.1 Literature Review and Scenario Models

The stages of literature review are taken from journals about bandwidth and beamwidth, throughput, and 60 GHz frequency. In Figure 1 the scenario model consists of a network without obstacles and simulated obstacles on the WiGig network in the form of movement noise, between WiFi nodes using a point to point network topology. There is a possibility of an obstacle scenario between the correlation distance of less than 200 and oxygen attenuation.

2.2 Defining the Simulation Area and Obstacles

Determine the Simulation area for network planning and analyzing the best 4G LTE network quality. The determination of this area aims to create a WiGig backhaul to find out the throughput value. Throughput is the rate of data sent over the network (bps units). Throughput refers to the amount of data carried by network traffic.

2.3 Data Collection and Outdoor Conditions

One of the data collection processes is weather prediction so that research data reception is maximized and carried out in outdoor and indoor conditions, oxygen attenuation really determines the quality of WiGig throughput.

2.4 Simulation System Design and Device Preparation

System design is divided into 2:

a. Mobile Network Design For Throughput Optimization
   Equipment to be used: Laptop, USB Power Cable, Power Over Ethernet (PoE), HP Tems pocket (for cellular signal measurement), Modem, Antenna Indoor Data Cable, CAT8 LAN Cable and Accessories (Tripod, Powerbank as a power source).

b. Pointing Design for Throughput Optimization for WiGig Networks
   System design simulation and device preparation for the WiGig 6 network. This stage will use 2 (two) WiGig Router units, 1 (one) Laptop unit, 1 (one) 4G LTE modem unit. The application used is the Full HD YouTube web application. Device Configuration has also been set in this stage indoors. Each router is connected via WiGig with a point to point topology. For model completeness, see Figure 2 below;

Figure 2. Design and Build of Point to Point WiGig Topology

2.5 Point to point Network System Testing using a Wigig Router

This stage begins with a drivetest / walktest of the 4G LTE laptop dongle connected to the router with the video streaming application active, checking the ping test, data packets using the Wireshark application. Data retrieval on the WiGig PTP backhaul is also taken during this process both outdoors and indoors based on disturbance scenarios including weather conditions and temperature and humidity. Testing the Wigig network for throughput optimization is divided into 2, namely the Line of Sight (Los) and Non Line of Sight (NLOS) methods. The Non Line of Sight (NLOS) scenario can be seen in Figure 3.

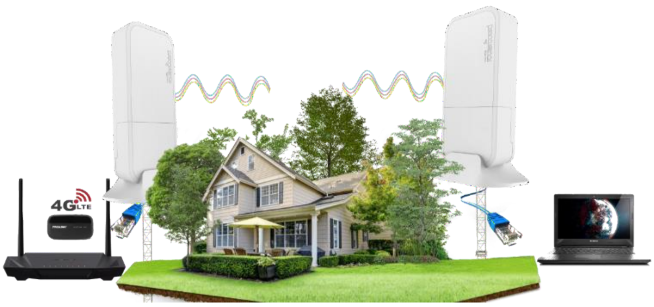


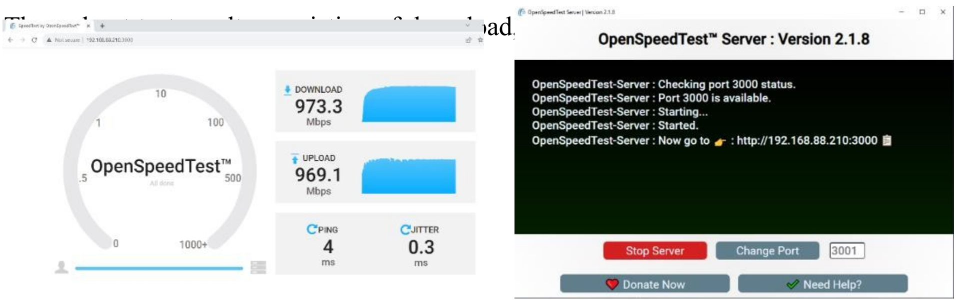
Fig. 3. WiGig Illustration with Non Line of Sight (NLOS) Scenario

2.6 Analysis and Evaluation of System Throughput

The final stage based on Figure 1 is to carry out data analysis using a data processing application with Matlab R2022. WiGig 60 GHz device with Beamwidth value of the device specifications. The analysis results will be further evaluated for WiGig devices with higher bandwidth. So that the local network is very supportive as a replacement network signal amplifier between base stations that are difficult to reach using cables because of building (outdoor) and room (indoor) barriers. During the throughput process it will be viewed using the Wireshark application. 60 GHz beam analysis results and adjusted to the optimization values obtained for throughput on the 4G network.

3. Result and Discussion

3.1 Throughput Test Results



(a) (b)

Fig. 4. Bandwidth testing (a) client, (b) server

Throughput testing was carried out using the local bandwidth throughput of two 60 GHz wireless devices, one as master and one as slave using a local server. Tests were carried out with distance conditions of 2 meters (m), 4 m, 8m and 15 m. During the testing process, the values obtained did not decrease in terms of both downloads and uploads, and were close to 1 Gbps.

For jitter values obtained without obstacle conditions, such as rain, wind and storms, the values obtained are 0.3-0.4 ms. The test results over the LTE 60 GHz network can be seen in Figure 5.

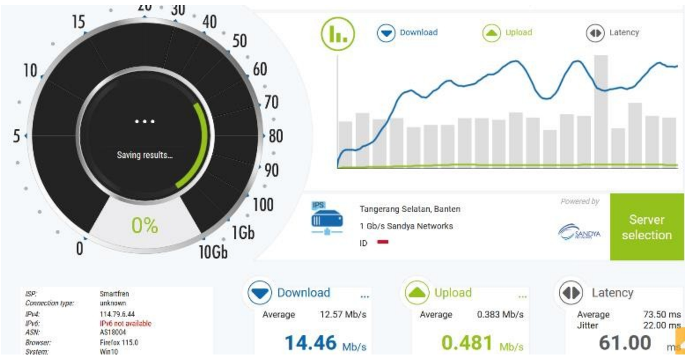


Figure 5. Throughput Testing over the 60 GHz LTE Network

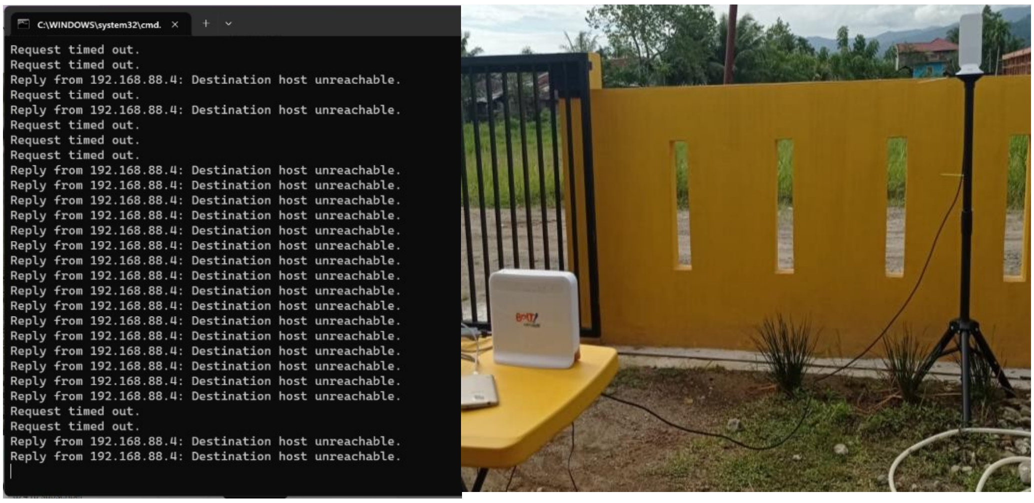
Figure 5 above shows the bandwidth obtained by the computer through the nperf.com website. The ping obtained is less than 100 ms, the lower the value obtained, the better the quality of the internet network used. The download and upload obtained from the highest internet speed for LTE TDD 2300 MHz operators is 40 Mbps and 30 Mbps, bandwidth comparison results can be seen in table 1 below:

Table 1. Results of Bandwidth Measurements

Distance (metre)	Speed (Mbps)			
	Lokal		Internet	
	DL	UL	DL	UL
1	981	971	39.1	28.7
2	967	968	40.5	30.1
4	955	959	38.5	29.3
8	960	966	37.8	33.4
15	960	966	36.5	28.8

Furthermore, the internet uses video streaming via the YouTube site with a resolution of 1920x1080 (Full HD) with a framerate of 60 fps. The download results obtained were around 30 Mbps and upload 1 Mbps. The results obtained were no buffering or decrease in resolution /framerate up to a distance of 15 meters.

In the next scenario, communication causes obstacles between sides of objects such as polesand roofs, the result obtained is that the resulting ping has exceeded 100 ms. And local and internet bandwidth speeds have decreased significantly. Ping test results are missing or experiencing RTO (Request Time Out), there is no network. Wigig testing using the Line of Sight method can be seen in Figure 6.



(a) (b)

Fig. 6. Line of Sight Method Test Results (a) NLOS Ping Test Results (b) Outdoor Wigig Test withObstacles

Based on Figure 6, determining the location and determining the height of the radio is important when building a point to point wireless network in order to create an optimal network. One of the requirements for a point to point wireless network is Line of Sight (LOS), which is a condition in which a radio transmitter can see clearly without obstruction by a receiver. Meanwhile, the condition of Non Line of Sight (NLOS) is used to describe radio transmission through partially blocked paths, usually in the form of physical objects within the Fresnel zone. Obstacles that can cause NLOS are buildings, roofs, walls, trees, hills and mountains. These obstacles affect the quality of the signal received by the user.

3.2 Wireless Signal Quality Test Results

One way to determine the quality of the received wireless signal is to use the Received Signal Strength Indicator (RSSI) method. RSSI is a measurement of the power received by wireless devices. Measurements are made based on the received Signal Strength. RSSI is used as an index that shows the signal strength received by the receiver from Wigi Point to point. Theunit of wireless signal strength is shown in dBm units with a signal strength range of -10 dBm to approximately -100 dBm.

The results of the signal strength of the 60 GHz point to point transmitter and receiver at a distance of 6.6 m obtained an RSSI value of -52 dB with a beamwidth of 3.8^{0}, while a distance of 8.8 m obtained -54 dBm with a beamwidth of 3.8^{0}. Testing the distance to the RSSI with point to point LOS conditions. Whereas if the condition is not LOS or there is an obstacle, a distance of 6.6 m obtains an RSSI value of -52 dB with a beamwidth of 3.8^0 and a distance of 6.6 m obtains an RSSI value of -58 dB with a beamwidth of 11.4^0. The value of wireless signal strength (RSSI) is greatly influenced by distance, weather conditions (presence/strength wind), wall thickness both indoor and outdoor. The form of testing the throughput and strength of the Wigig 60 Ghz wireless signal by LOS can be seen in Figure 7.

Fig. 7. Throughput and RSSI WiGig 60 GHz Testing by LOS

4. Conclusion

Point to point 60 GHz wireless devices that have been tested less than 20 meters produce the same throughput, and data from the 2300 MHz TDD network does not experience a decrease in the quality of the data sent, the results obtained with video streaming of 1920x1080p resolution with a 60fps framerate on the YouTube website. com does not experience buffering / lag. The resulting ping and jitter did not experience significant changes. Because the local ping latency that is obtained is a maximum of 2 ms and a jitter of 3 ms. Rain conditions do not decrease speed. But the influence of the quality of the 2300 MHz LTE network is affected by rain. LoS between bandwidth locally and the internet does not affect latency values. The beamwidth shift is < 8 degrees so you don't have to point straight, so the signal strength is still below the -70 dbm threshold (the wireless threshold for good signal quality) resulting in good QoS.

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