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# Modeling of Heterogeneous WLAN Based on Traffic Application

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***Abstract***— Inherently, the negative effect of parameters of interest like: low bit rate, speed loss, packet drop, bandwidth congestion, and decrease in signal strength are latent in nature. These obviously affect the behavioral attitude of a network system and those affected areas are to be monitored and therefore be reduced even though, these factors may not be completely eliminated. No doubt that the performance of the wireless local area network (WLAN) technology has been greatly affect by these retarded factors. Options of total elimination of these factors are almost impossible, but then, this study will greatly reveal the negative effects, posed by these undesirable factors. In the light of these, three different WLAN technology scenarios were modeled and simulated and parameters of concern include: delay (sec), load (bits/sec), and throughput (bits/sec). The file transfer protocol (FTP) as the traffic application was used to administer the effect of the stated factors on the each WLAN of different scenarios. Also, the results obtained showed: more delay, minimum throughput, and minimum load occurred in a scenario with the highest number of nodes. Besides, if factors like: distance, interference, signal sharing, and other physical obstructions between the devices were considered, better results would be obtained.

***Keywords***— *Load; Protocol; Signal Sharing; Throughput; WLAN*

## I. INTRODUCTION

Wireless local area network is a technology that communicates based on radio waves and this is done over a network [1]. The technology depends on the IEEE802.11 standards [2], [3]. And it has some advantages over traditional wired systems which cannot be overlooked. These include; low-cost wireless internet access, flexibility, and provides mobility while connected to the wireless network [4], [5]. Nevertheless, the performance of the WLAN technology is affected by some well, and lesser-known factors such as high error rates, low bit rate, speed loss, packet drop, bandwidth congestion, and a decrease in signal strength as the distance between an access point and workstation increases. WLAN can be set-up as either infrastructure-less (i.e. computer-to-computer connection) or as infrastructure (access point-to- other computers) [6]. The important components that are required in a wireless environment are routers, servers, access points, wireless workstations, antenna, and wireless bridges [7]. Different network modeling has been carried out by several researchers using different network simulators such as Network simulator -2 (NS-2) [8], OMNet, NetSim, NS-3, OPNET, and GomoSim to implement and investigates different factors affecting the WLAN network in order to cut down the cost of prediction and estimation [9]. This research was, therefore, conducted to investigate the: delay (sec), load (bits/sec), and throughput (bits/sec) in three WLAN scenarios with different number of nodes (15, 20, and 30). This is to enable us to determine the behavior of the WLAN when the number of nodes is lesser, average, and higher. The research was conducted in a simulation environment using the OPNET simulator. This is because OPNET presents an object-orientation modeling approach and with graphical editors that indicate the actual structure of the network and its components [10]. The components used for the implementation of this works include a wireless router (access point), application definition, profile definition, Ethernet server, Ethernet switch, wireless workstations (clients/stations), and 100base-T for connecting Ethernet server through the Ethernet switch to the router. File transfer protocol (FTP) was used as a traffic application in the simulation environment.

The body of this paper is structured as follows: Section I covers the introduction of WLAN technology, Section II discussed the related research works of WLAN network, Section III discussed the methodology of the WLAN implementation, Section IV presented and discussed simulated results obtained in OPNET environment, in Section V, the conclusion was drawn based on the results obtained and also, recommendations are presented for future work on the WLAN network.

## II. RELATED WORK

Researchers have worked and dwelt so much on the wireless local area network technology (WLAN) and this system involved communication between or among two or more nodes using radio frequency over a distance. A lot of works have been carried out on the WLAN using simulation methods, and besides, the simulation

 

environment makes lives much easier in terms of the time to generate the needed results. [11], presented in their paper, performance optimization methods using OPNET as network simulator on WLAN to examined effects of various wireless LAN parameters such as data rate, fragmentation threshold, and RTS/CTS threshold on network parameters like media access delay, delay, load, data dropped and throughput based on selected traffic applications such as Telnet, HTTP, Email, and FTP services. They concluded the work based on the results obtained on the effects of chosen WLAN parameters on each traffic application. [10], emphasized the effects of buffer size on quality of service (QoS). They, therefore, varied the buffer size to different values based on network parameters such as throughput, media access delay, and delay using OPNET simulator. They, however, concluded that a buffer size of 64kbps presents an excellent reduction in media access delay, delay with insignificance difference noticed in throughput. But [12], tactically presented the performance optimization methods using OPNET as a network simulator to model a WLAN subnetwork set-up within an enterprise. It was considered in there research, wireless LAN parameters such as physical characteristics and data rate based on network parameters like Delay, throughput, load, and Medium Access Delay. He then compiled the results obtained to advanced WLAN performance. The infrastructure-based WLAN system comprises mobile access point (AP) and workstations that were connected to the internet using the OPNET for its design and simulation. The work was addressed based on network parameters such as packet drop, throughput, and delay for best service delivery. It was therefore deduced that WLAN performance depends on network parameters chosen and also the traffic value on the network has a remarkable effect on the network parameters when considered on it as the Access Point [2]. Invariably, [13], modeled and carried out performance analysis on a WLAN based on OPNET simulator where they compared different parameters such as traffic sent (bytes/sec), traffic received (bytes/sec), data sent (bits/sec) and data received (bits/sec) on statistics overall and also, between two or more nodes. They concluded that the use of the OPNET software simulator provides an easy and efficient means of WLAN network modeling. Also, [7], modeled a Wireless- based Campus Local Area Network to determine the network performance of a particular college, using OPNET Modeler. Traffic applications such as HTTP and FTP were considered based on network parameters like Ethernet delay and page response time. They concluded that minimal network delay was achieved in FTP while minimal page response was achieved in HTTP. In addition to this, more clients' computers could be added to the set-up for expansion without performance degradation.

## III. METHODOLOGY

The research work was implemented using Optimized Network Engineering Tools (OPNET) 17.5 academic edition. Three WLAN scenarios were modeled with 15, 20, and 30 workstations respectively. The scenarios were examined based on the three network parameters as global statistics and these include delay (sec), load (bits/sec), and throughput (bits/sec). File transfer protocol (FTP) was configured as a traffic application on each node to examine the effects of metrics used. In these three scenarios, application definition (Application_Config) was deployed and configured with a file transfer protocol (that is, traffic application used). The profile definition (Profile_Config) was also deployed and configured to create user profiles, which was further specified on each node in the scenarios to set up application-layer traffic. Ethernet server node with server applications (FTP_Server) was also deployed and configured running over TCP/IP and UDP/IP. The FTP-Server was connected through 100BaseT duplex link operation at 100Mbps to Ethernet16_ switch (switch). Another 100BaseT duplex link operation at 100Mbps linked switch with the wireless LAN based router (Wlan_Router), which has one Ethernet interface. The router then connected wirelessly with workstations (WKS) with client-server applications running over TCP/IP and UDP/IP. The workstations were configured to support 11 Mbps. Figure 1-3 below show the modeling of wireless local area network (WLAN) with 15, 20, and 30 workstations.

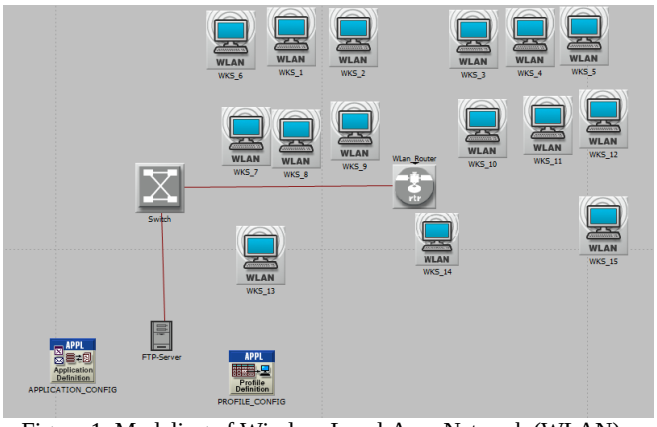


Figure 1: Modeling of Wireless Local Area Network (WLAN) with 15 Workstations

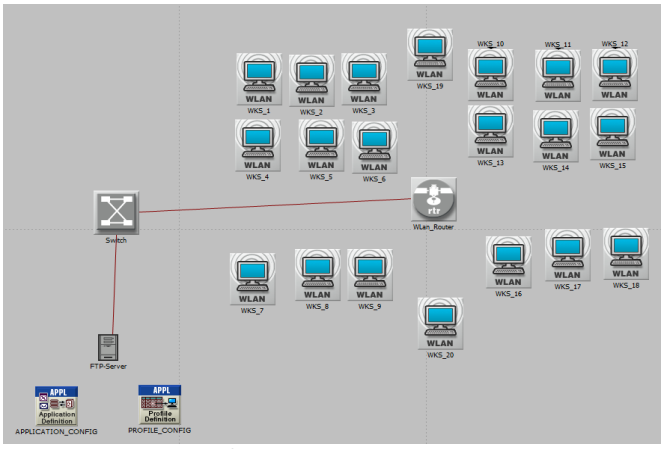


Figure 2: Modeling of Wireless Local Area Network (WLAN) with 20 Workstation

 

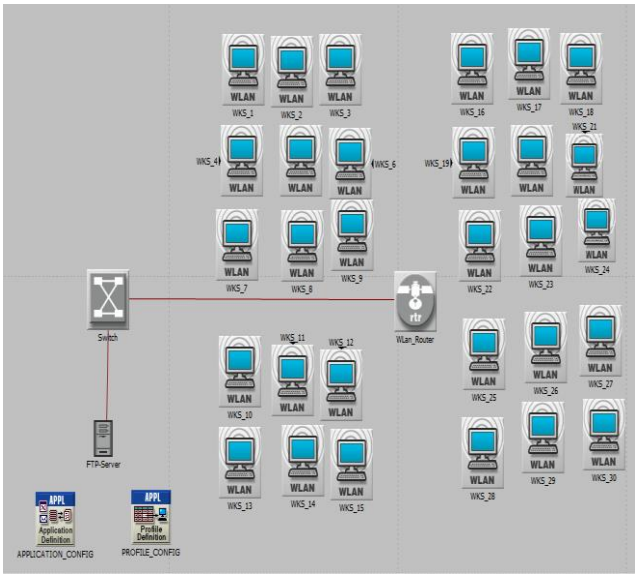


Figure 3: Modeling of Wireless Local Area Network (WLAN) with 30 Workstation

## IV. RESULTS AND DISCUSSION

According to figure 4-6, the three scenarios were simulated for 10 minutes based on the selected global statistics for 15, 20, and 30 workstations. The results obtained were further discussed and presented in both stacked and overlaid statistics

In figure 4 (a) & (b), delay (sec) was examined for the three scenarios in each case and more delay was observed in WLAN with 30 workstations, which has a delay of 0.008ms, then followed by WLAN with 20 workstations, which has a delay of 0.006ms and lowest in WLAN with 15 workstations, which has a delay of 0.004ms as clearly indicated on the graph.

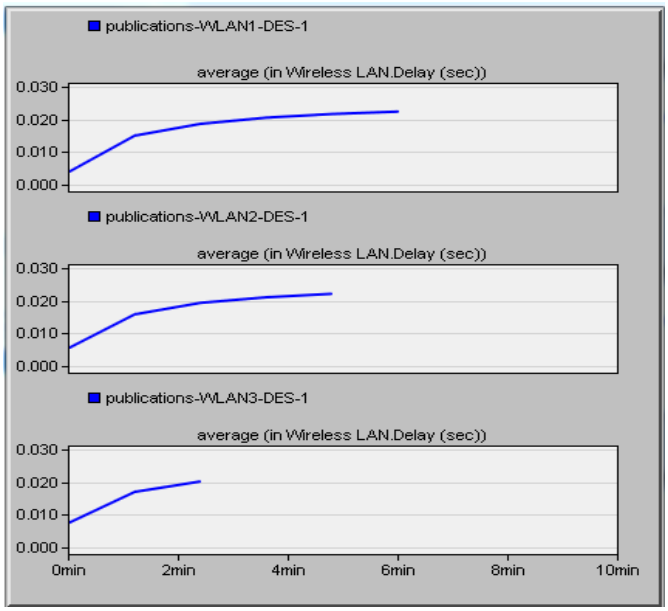


Figure 4 (a): Comparison of Delay (Sec) in WLAN Scenarios in Stacked Statistics

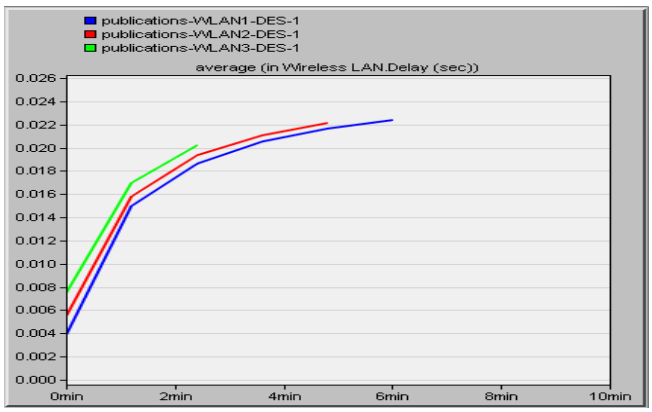


Figure 4 (b): Comparison of Delay (Sec) in WLAN Scenarios in Overlaid Statistics

In figure 5 (a) and 5 (b) shown below, load (bits/sec) was examined for the three scenarios, the lowest load was observed in WLAN with 30 workstations, which has a load of 3.4Gbps, then followed by WLAN with 20 workstations, which has a load of 4.1Gbps and highest in WLAN with 15 workstations, which has a load of 4.2Gbps and all these are clearly indicated on the graphs.

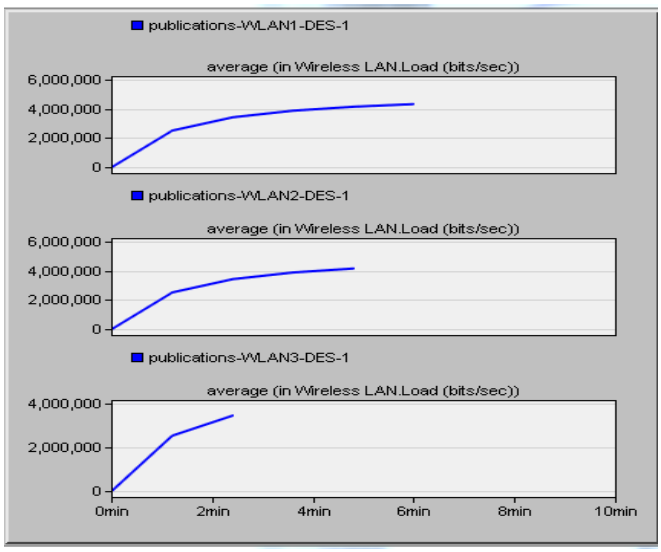


Figure 5 (a): Comparison of Load (bits/sec) in WLAN Scenarios in Stacked Statistics

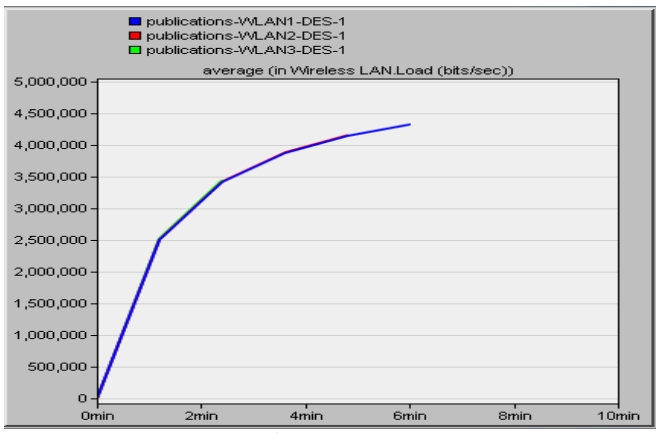


Figure 5(b): Comparison of Load (bits/sec) in WLAN Scenarios in Overlaid Statistics

 

In figure 6 (a) and 6 (b) shown below, throughput (bits/sec) was examined for the three scenarios, the lowest throughput was observed in WLAN with 30 workstations, which has a load of 3.4Gbps, then followed by WLAN with 20 workstations, which has a load of 4.1Gbps and highest in WLAN with 15 workstations, which has a load of 4.2Gbps and all these are equally and clearly indicated on the graphs.

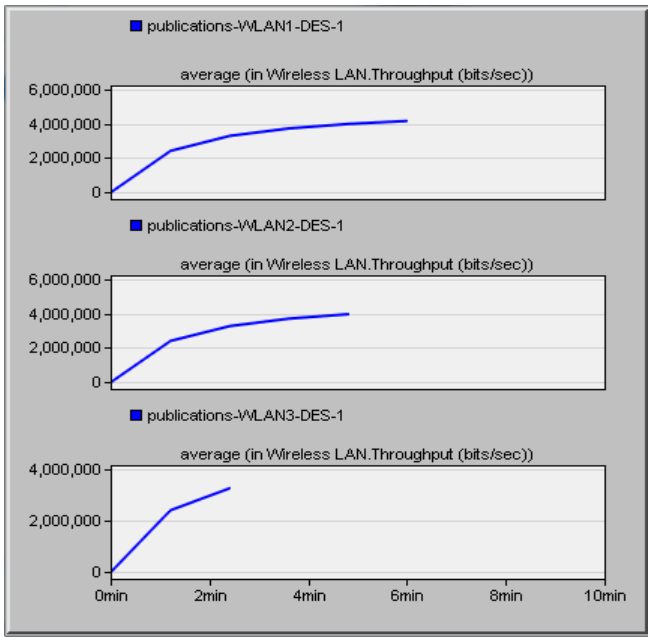


Figure 6 (a): Comparison of Throughput (bits/sec) in WLAN Scenarios in Stacked Statistics

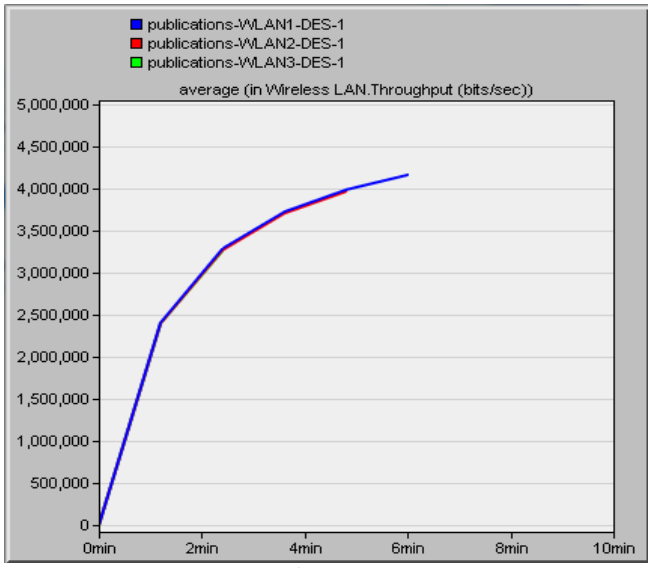


Figure 6 (b): Comparison of Throughput (bits/sec) in WLAN Scenarios in Overlaid Statistics

## V. CONCLUSION AND FUTURE SCOPE

The adoption of wireless technology in data communication has greatly assisted to facilitate networking thereby given access to multiple users to concurrently share resources both at home and in offices without the additional cost of cabling system. Based on this known fact, a wireless local area network was investigated for an office where three scenarios with a different number of workstations were modeled. The three scenarios were compared based on Delays (sec), load (bits/sec), and throughput (bits/sec). The results obtained showed that as the number of workstations increases; there would be more delay (sec) with decreased load (bits/sec) and decreased throughput (bits/sec). Although, there was no significant difference between loads (bits/sec) and throughput (bits/sec) and nevertheless, the number of workstations could still be further increased to observe the behavior in the WLAN environment as a recommendation for future direction on WLAN technology

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Adaramola Ojo Jayeola**,** Has an MSc degree in computer systems and network engineering at The University of Greenwich, London, United Kingdom 2016, and MSc in Electronics and Computer Engineering from Lagos State University, Nigeria, 2017. He is currently working as Asst. Chief Technologist in the Department of Computer Engineering, The Federal Polytechnic Ilaro, Ogun State, Nigeria. Adaramola is a member of the Engineering professional body in Nigeria (Council for the Regulation of Engineering in Nigeria) and many societies and associations which include: The Nigerian Society of Engineering Technicians (NISET), The Society of Digital Information and Wireless Communication (SDIWC), International Association of Engineers (IAENG), and International Computer Science and Engineering Society: (ICSES). He has published in reputable Journals and attended conferences both Local and International. His area of interest is computer hardware and networking, wireless communication, routing protocols, Vehicular Ad-hoc Network, and ZigBee technology.

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