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RESEARCH ARTICLE

PERFORMANCE EVALUATION FOR WIRELESS NETWORK

Okafor Doris.N *and Okereke George .E

[1]Department of Computer Science, Faculty of Physical Sciences,
University of Nigeria, Nsukka-South East, Nigeria

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ABSTRACT

Wireless Network technologies in recent times are faced with several challenges. This has made it impracticable not just to have networks but to obtain its optimal performance at any given time. Recent researches have focused much on network technologies especially data communication networks at various times. This paper examines the behaviors of network data packets in order to evaluate its performance for wireless network. Cisco packet tracer 7.0 simulator is used to determine the UDP/TCP throughput, delay and packet loss in the wireless network. Top down decomposition design, trace and event driven techniques which are standard network simulation methods are used in this paper. The result obtained was compared with wired LAN to examine performance and efficiency of the two networks and it showed that wired networks have better quality of service, high speed of delivery than the wireless networks

INTRODUCTION

Network technologies in this 21st century demand competence, firmness and data security which are very important issues in IT world today that constantly generates very big data. Such big data require a competent and reliable network technology to provide efficient and reliable data communication for optimal operations and services to network users. This paper examines wireless network performance evaluation using standard network simulation methods in order to obtain optimal network performance at any given time. Network parameters and attributes were carefully examined so as to expose relevant network features. The paper monitors network data packets in communication networks using standard network metrics to ensure network optimal performance. A comparative analysis of performance evaluation between wired LAN and wireless LAN networks was carried out to determine better network technology for optimal operations. Performance evaluation of wireless network is a measure of quality of services, the speed of the network and total behavior of data/packet at a given time in the network. This paper determines the quality of service, speed of data delivery in the network and general behavior of packet/data in wireless network. It designed WLAN with three different departments using packet tracer 7.0 simulators to demonstrate how packets work in the network. Network measurement metrics such as transmission control protocol and user datagram protocol (TCP/UDP) throughput, latency and packet loss were used to analyze the result.

Corresponding author: Okafor Doris.N.
Department of Computer Science, Faculty of Physical Sciences, University of Nigeria, Nsukka-South East, Nigeria

Overview of wireless local area network technology

Wireless local area network (WLAN): this is network communication of two or more computer system or devices without the use of cables, but with wireless distribution such as radio frequency. Examples of wireless devices include: Global positioning systems (GPS), walkie-talkies, wireless phones, garage door opener, radio car keys, broadcast television, satellite television, and video-games. In WLAN, the following devices help in establishing the communication between different component and the operating system in communication network: access points, clients (computer), bridges and servers.

Current trend in wireless technology

Table 1.1 shows the timeline of historical development of the WLAN technology.

Table 1 Timeline of Wireless local area network technology

Year	Discovery
I880	Hertz discovered electromagnetic waves.
1898	First commercial radio data service.
1900	First mobile radio wireless dispatch system for Detroit police.
1921	
1946	First mobile telephone service in St. Louis by AT & T half-duplex.
1970	First cell phone service in Chicago by AT&T W.
1971	First wireless data network developed by Aloha at University of Hawaii.
1980-1990	First commercial wireless LAN was produced by AT & T wave LAN.
1997	First wireless LAN standard was developed by Institution ofElectrical and Electronics Engineers (IEEE) 802.11.
1997- till date.	A serial of 802.11 were produced. e.g. 802.11a, b, d, e, g, h, I,n, ac, ad, af, ah, ai, aj, aq.

Adapted from Raj Jain, 2006

Wireless local area network standards

It is very important to understand what we mean by "standard" in WLAN. WLAN standards developed by IEEE are set of media access control and physical specifications for implementation of wireless local area network in computer communication system (Wikipedia, 2017). The aim of serials WLAN standard is to have a particular standard for media access control and for improvement in quality of services of wireless local area network. The following are brief explanations of standards of WLAN produced by IEEE and other group.

***802.11 WLAN standards*:** This was developed in 1997 as stated on the table above by IEEE (Institution of Electrical and Electronics Engineers). This standard operated with 2.4 frequency range and has maximum throughput of 1 to 2 M/bits per second.

802.11b WLAN standard: The successor of 802.11 has maximum speed throughput of 11 M/bits per second with 2.4 GHz frequency range. It was introduced in 1999 by IEEE. This standard was called Wi-Fi meaning wireless fidelity. This Wi-Fi was taken to mean any type of 802.11 WLAN standards, including 802.11a and 802.11b etc.

Hiper LAN: This standard was developed in late 1999 and was amended in 2000 as a supplement to 802.11. It operates in the 5GHz band but was subjected to less interference problem. Hiper LAN simply means high performance radio location area network.

Wired equivalent privacy, WEP: This also was developed by IEEE to avoid eavesdropping of packets on the wireless network.WEP provides more security compared with previous standard. It sends or receives packet using secrete key to encrypt or decrypt the packet (source:www.cse. tkk.fi/fi/opinnot).

Other specifications developed by other companies include

Bluetooth technology*:* This was developed in 1999 by Bluetooth specification interest group. It operates using 2.45GHz and makes use of a technique called spread-spectrum frequency hopping. It is used for short RF connectivity for wireless devices.

Home Radio Frequency: Home RF is an open industry specification developed by home radio frequency working group. The aim of this standard was to attain higher QoS than the developed standards. This connects wireless devices and also communicates voice, data and streaming media in and around the home. Home RF compliant products operate in the license -free 2.4 GHz frequency band and utilize frequency - hopping spread spectrum RF technology for secure and robust wireless communication with data rate of up to mbps. This may become the worldwide standard for cordless phones, (www.uta.edu.oit/policy)

Factors affecting wireless networking performance

There are some many inevitable factors that affect the performance of wireless networking

Physical obstructions: Obstruction such as hills, iron, building, stones etc. can really lower the performance of wireless network and the obstruction that are unavoidable in real world.

The set-up range and distance between device: The range of network is another factor that affect the performance of the wireless network. When the distance between the sender is far from the receiver the throughputs at the end point will be low.

Other Signal interference: There are different interference that can actually affect the wireless network performance example: radio frequency interference, electrical interference, environmental factors etc.

***Low performance due to compatibility with older standards*:** When the networker combines the new standards devices with the old standard device it may result to problem of compatibility and this will reduce the signal strength of the network.

Transmitter power limitation: When the network is stretched be young its limits the weaker the signal strength. While building your network this and many more are to bear in mind for a better performance of wireless network. (Sources: www.support.microsoft.com.)

Application of wireless technology

The wireless technology can be applied in many areas of life**.**

Security system*:* wireless technology has been used to build many security gadgets like GMS control and monitoring system which is used to control the electronic devices at home and offices;

Communication*:* Smart phone, modems and many other devices were constructed based on the wireless technology;

Home /office recreation systems*:* computer games, TV remotes etc which are designed using are based on the wireless technology system;

Wireless antenna network*:* Wireless antenna network, which is used for monitoring and recording the physical conditions of the environment and organizing the collected data at central locations in based on wireless technology;

Location-Based Services*:* Global positioning system which is used in tracing of cars, ships etc. are based on wireless technology.

Advantages of wireless networks

The advantages of wireless local area network (WLAN) include

Mobility: This is outstanding in the wireless network technology because connectivity is possible beyond the area of physical network cables;

Ease of Access: The internet can be easily accessed from anywhere any time;

Low Cost of Installation: The cost and time of installing wireless is relatively small compared with the wired network;
Wireless network offers help to people living in remote areas where wired network cannot be accessed;

Maintainability: It is very easy to maintain.
The transmission and access of wireless network is higher and quicker.

Disadvantage of WLAN Technology

There are disadvantages associated with wireless network technology. Notable are: it can be easily accessed by unauthorized client and this may result to loss of important

document/ information. Others include: radio signal interference and system interoperability.

MATERIAL

There the researchers reviewed related materials, which help not only shaping but sharpening the track of the work. Cali, (2002) "in this paper the researcher, analyzed the performance of the IEEE 802.11 protocol with a dynamically turned back-off based on the network status. The results obtained indicate that under stationary traffic and network configurations the capacity of the enhanced protocol approaches the theoretical limits in all the configurations analyzed. Performance evaluation study reveals some of the key throughput-energy delay tradeoffs inherent in this MAC protocol." Heinzelmon and Chandrakasan, (2002) " the researchers developed and analyzed low-energy, adaptive clustering hierarchy (LEACH), a protocol architecture for micro sensor network that combines the ideas of energy-efficient cluster-based routing and media access tighter with application-specific data aggregation to achieve good performance in terms of system life time, latency and application-perceived quality. Cicconetti, (2006) "this research work focused on mechanisms that are in an 802.16 system to support quality of services (QoS) and whose effectiveness is evaluated through simulation."

Ganglu, (2004) "Provided an analysis comparing the energy costs of beacon tracking and non-tracking modes for synchronization, showing that the optimum choice depends on the combination of duty cycles and data rates". Perkins, (2001) there the researcher compared the performance of two prominent on-demand routing protocols for mobile and ad hoc network: dynamic source routing (DSR) and ad hoc on-demand distance vector routing (AODV). A detailed simulation model with MAC and physical layer model is used to study interlayer interaction and their performance implications." Velasquez and Eric, (2014) the authors proposed an enhancement to the classical performance evaluation by using three processes-client, server and a middle process - that reports additional gauges which allow user to more accurately and rapidly detect network anomalies. Wiley et.al, (2005) the researchers presented a survey on a new analytical approach they have developed in the last few years to evaluate the performance of wireless cellular networks under more realistic assumptions. Campillo *et.al.,* (2013) the authors compared the efficiency of most significant opportunistic routing protocols through simulation in realistic disaster scenarios in order to show how different characteristics of an emergency scenario impact in the behavior of each one of them.

According to Deer and Jianping, (2010) "it is possible for multi-hop wireless networks to increase coverage and improve video streaming performance at the same time." Fulvio, (2007) "investigated the performance of a distributed wireless network in which the nodes were equipped with fully adaptive smart antenna." Dmitri Moltchanov, (2010) reviewed performance evaluation models proposed for wireless channels highlighting their basic ideas, shortcomings and advantages.
Causha, *et al.,* (2014) evaluated two of the most important performance metrics: throughput and delay. They considered the cellular network as an integrate infrastructure that includes mobile and field nodes and calculated and analyzed throughput and delay base on the model. The results showed that the throughput increased while the delay decreased in 4G data network compared to the previous 3G architecture. Bansal, (2010) reviewed the current research literature, in the field of wired and wireless network, in conclusion said that network simulators provided an ease in predicting and estimating the performance of networks and among the various network simulators available, OPNET had an edge in analyzing the performance of the network through simulations. In conclusion wireless network and mobile computing systems have been evaluated with thousand of devices and will continue to evaluating as long as there is emerging of technology to maintain optimizations in network.

METHODS

Methodology and wireless network performance analysis

In the implementation of the design of the wireless area network, the researchers used top down decomposition design technique, to achieve the goal of the research which is to evaluate the performance of wireless network. In addition trace and event driven techniques were also applied, when packet are sent from one network group to the other / from one department to another, careful observation and trace of packet/data were made to determine a concluding result of the actions of wireless network. It is important to note that the technique is well-suited when the problem and environment is defined.

Understanding how wireless network technology works

Wireless network requires connection of internet modem to draw signals or what is called "Access point" (AP), the access point serves as radio frequency which generates signals. To air any communication, wireless devices within the range can draw signal from the air and access the internet.

Wireless local area network Architecture

Wireless LAN architecture is a technique used for designing and arranging different components of wireless local area network. A typical architecture of WLAN is shown in figure 1.

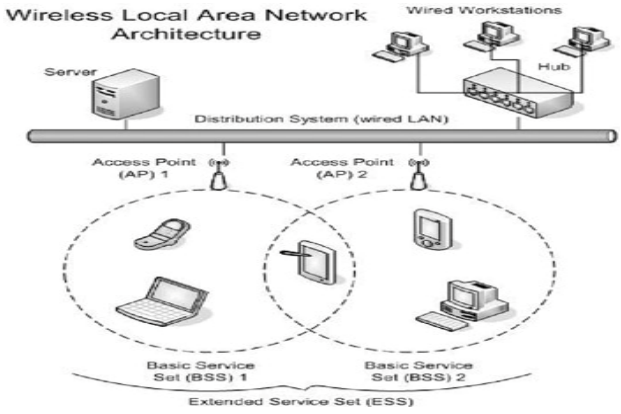

Fig 1 Wireless local area network architecture
Source: www.google.com.ng

System requirement

Download and install the Cisco packet tracer 7.0application.

The packet tracer 7.0 was chosen because of the following reasons

- It operates on windows platform and works with 32bit version;

- It allows creating network topologies and imitating modern computer networks;
- This software allows user to simulate the configuration of Cisco router and switch using a simulated command interface;
- Other reasons include improved HTTP server and physical workspace.

The system should have up 400MB free space
The Implementation of the network systems

In this section the Wireless area network were implemented, and were evaluated using network metrics, UDP and TCP through, packet delay, packet lost using the simulation command prompt environment and lastly the wired network also were configured, the obtained result of the networks were than compared.

Implementation of Wireless local area network: To design the topology of the wireless network, select Cisco Packet Tracer Application from the Desktop environment. The network was designed by picking devices in packet trace environment. The wireless devices in the packet trace were used to design three different departments which were

Administration, works and financial departments: which represent the network working groups. At the virtual center of the design is the router (the access point) that sends signals to wireless devices. Each of the devices in the different departments was assigned an IP address which is a unique address number which wireless devices like computers, tablets devices, and smart phones use to identify them and communicate with other devices in the network.
Example: The device was assigned PC 1: 192.168.0.100/24, for administrative department.

PC 2: 192.168.0.106/24, for works department and
PC3: 192.168.0.110/24, for accounting department. Packets will be sent from one department to other bearing the mind the following the time taken for the packet to move from one department to another, the number of packet sent and number received. The two types of IP addresses are DHCP (Dynamic host configuration protocol) and static IP address.

Static IP address was used in this study for the following reasons

(a). To eliminate the network traffic associated with DHCP, DNS.
(b). To make it easy for other clients or administrator to look up server anywhere or time.
(c). Stability and simplicity: It is much stable, easy to assign IP addresses and maintain the administrator when compared with DHCP.

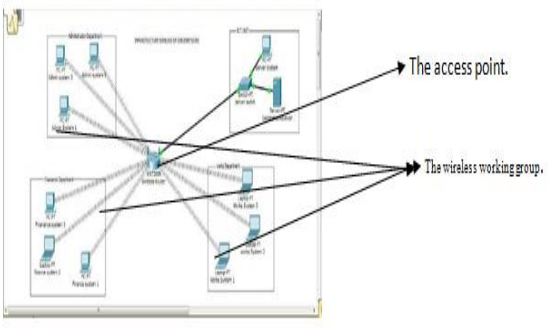

Figure 2 Setup of the three departments or the working group.

In the above set up the following: GUI of the wireless router, the gate way address, MAC address and IP were configured to enable the systems broadcast within its network footprint. Under the wireless router, the SSID and WED keys were configured to ensure security for the network.

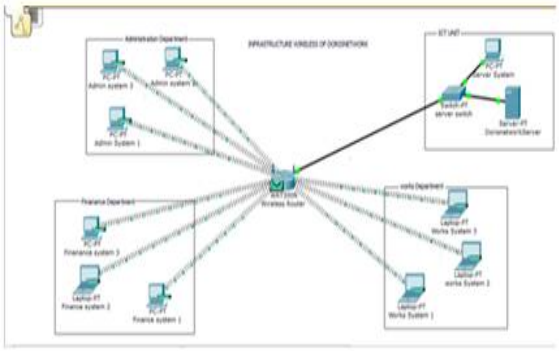

Figure 3 Broadcasting of the network

The PDU component which is like an envelope was added and dragged to a system within each department or from one department to another to measure PDU within the network layers linking the systems. We simulated (clicking on the simulation panel tool buttes) and observed the system broadcasted in the network that is sending of the packet.

Ping command: Ping command is a command used in router configuration to measure the performance of the network and it is done from the command prompt of a simulator 7.0 in this case. This command produces protocol called internet control message protocol (ICMP) which makes packet to be sent directly to a target system. When this is done, the sender starts timing the process (Trace driven event). The targeted system simply reverses the ICMP header and sends it back to the sender as an ICMP echo reply and then the time taken for the process will be reported. (Event driven) The ping command sent from a PC at the Finance department to Works department was: ping 192.162.0.4 and the result are shown in figure. 4.

RESULTS

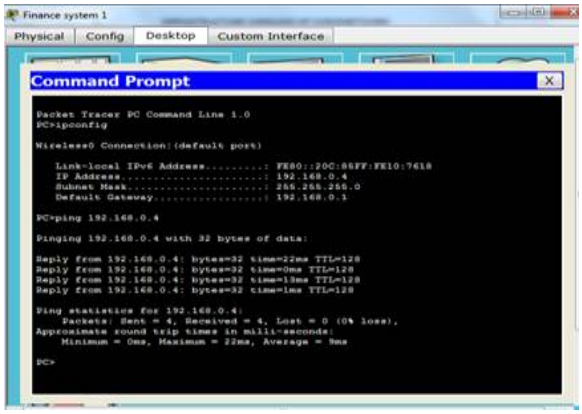

Figure 4 Result interface of the Wireless Local Area Network. (WLAN).

To measure throughput, delay and loss of packet within the network, wireless PC in the Finance department (with the IP 192.168.0.4) was chosen as a reference point for the measurement. Through the command prompt of the PC and you can ping IP address of any other system within the working group of the network to obtain throughput, delay and lost value in the packet sent from reference point and received at the destination end the following information were obtained.
PC>ping 192.168.0.4. [The main command]

Result ping statistics for 192.168.0.4 packet: sent= 4, Received =, lost =(0% loss) approximate round trip times in mili-seconds. [The simply means that 4 packet where sent and 4 was also received and none were missing at the end destination.]
Minimum =0ms, maximum =22ms, average = 9ms. [This means Total time taken to send a packet from the source to destination.]

Observation

From the above interface, 32 bytes of data were sent across the network. The throughput which is measured from the arrival of the first bit of data at the receiver endpoint was observed and is measured in bytes per second (Bps), bits per second (bps) and packets per second (pps). There was no packet loss because the network was not congested and signal strength was high. The average delay due to packet process and packet queuing was also observed.

The implementation of wired local area network

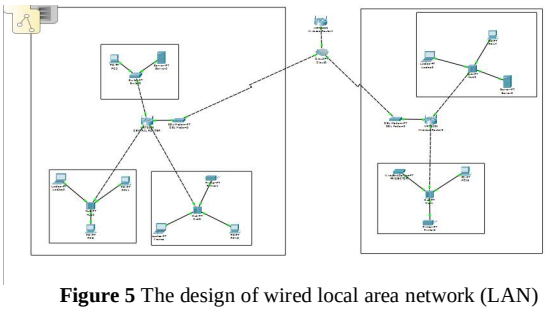

Figure 5 The design of wired local area network (LAN)

The code used for the configuring the switches of the above switch interface.

Cisco Internetwork Operating System Software
IOS (tm) PT3000 Software (PT3000-I6Q4L2-M), Version 12.1(22)EA4, RELEASE SOFTWARE (fc1)
Copyright (c) 1986-2006 by cisco Systems, Inc.
Compiled Fri 12-May-06 17:19 by pt_team

Press RETURN to get started!

%LINK-5-CHANGED: Interface FastEthernet1/1, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/1, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan1, changed state to up

%LINK-5-CHANGED: Interface FastEthernet2/1, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet2/1, changed state to up

%LINK-5-CHANGED: Interface FastEthernet0/1, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up

MYSWITCH>enable
MYSWITCH#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
MYSWITCH(config)#interface FastEthernet0/1
MYSWITCH(config-if)#
MYSWITCH(config-if)#exit
MYSWITCH(config)#interface FastEthernet1/1
MYSWITCH(config-if)#
MYSWITCH(config-if)#exit
MYSWITCH(config)#interface FastEthernet1/1
MYSWITCH(config-if)#

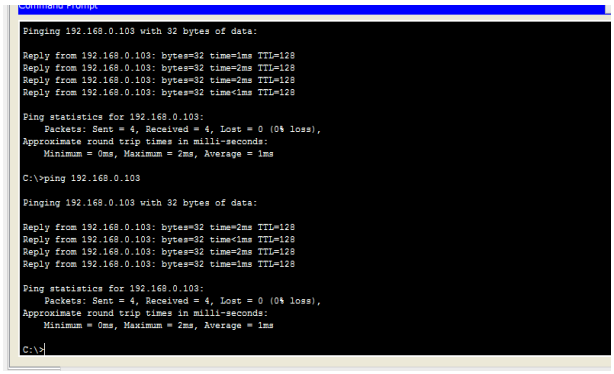

Figure 6 Result interface of wired local area network (WLAN)

PC>ping 192.168.0.103. [The main command]
Result ping statistics for 192.168.0.103 packet: sent= 4, Received =, lost =(0% loss) approximate round trip times in mili-seconds. [The simply means that 4 packet where sent and 4 was also received and none were missing at the end destination.]
Minimum =0ms, maximum =2ms, average = 1ms. [This means Total time taken to send a packet from the source to destination.]

Comparison

The average round trip time of wireless network is 9ms while the wired is 1ms. Therefore, wired network have better quality of service, high speed of delivery than the wireless network. In real world this may be as a result of the following physical obstructions, networks exceeding limits, environmental factors, electrical interference, signal reflection etc.

DISCUSSION

In this section the network protocol and network metrics that were used in the evaluation of wireless and wired network is discussed.

Network protocol

The network protocols used in the simulator for evaluation of the wireless network is the protocol data unit (PDU), transmission control protocol (TCP), user datagram protocol (UDP) and routing information protocol (RIP).

Protocol Data Unit (PDU): A protocol data unit is information delivered as a unit to the networks containing control information, address information or data. PDU represents a unit of data specified in the protocol of a given layer which consists of protocol control information and user data.

Transmission Control Protocol (TCP): This is a set of rules controlling communication devices on the network. It is a connection oriented protocol. Once a connection is established, data can be sent bidirectional. The TCP provides reliable, ordered and error checked delivery of stream service in the network. Its transmissions are sent in a sequence and they are

received in the same sequence. It is the protocol that detects the congestion problem in the network. The applications used by TCP are e-mail, FTP, www etc.

User Datagram Protocol: is connectionless internet protocol. The protocol supports error detection via checksum but when an error is detected, the packet is discarded. Retransmission of the packet for recovery from that error is not attempted. This is because UDP is usually for time-sensitive applications like gaming or voice transmission.

Routing Information Protocol (RIP): It is responsible for broadcasting User Datagram Protocol (UDP) and data packet to exchange routing information. If a router does not obtain an update from another router for 180 seconds or more, it is said that the router is unusable.

The wireless network metrics

The network metrics are descriptors used to represent some feature of computer networks performance. The following network metrics were used to evaluate the network in this experiment: throughput, latency and packet loss.

Throughput: The rate at which data or packet is sent from one source to another in the network is called network throughput. It is the actual data/ packet that successfully reach the destination per unit of performance. The throughput of network is measured in bytes per second (Bps), bits per second (bps).

Packet loss: When packets of data sent through the network fails to reach its destination in the network packet loss is said to have occurred. It is measured as a percentage of packets with respect to packets sent. The TCP is the protocol that detects packet loss and performs retransmissions to ensure reliable messaging. In the network, there are several reasons that make packets not to reach its destinations and they include:

Network delay: the total time sent for a packet to reach its destination is called Network delay or latency.

It is measured in multiples or fractions of seconds. According to (Wikipedia 2007) the reasons why packets are delayed in the network include

(a). Processing delay: Processing delay is the time taken for the routers to process the packet header in the network;
(b). Queuing delay: Time the packet spends in routing queue;
(c). Propagation delay: Time for signal to reach its destination.

CONCLUSION

This paper discussed the general overview of wireless local area network technology, review related work done in the area of wireless network and finally compare wireless with wired network by designing the two networks and result obtained shows that wired network is more efficient and effective.

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