Network Design & Improvement, Using Riverbed Academic Edition, Version 17.5 in University of Technology, Jamaica.

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***Abstract*---Planning network, designs and improvements with different users, hosts, services and subnets with different topologies have been actively used and implemented in computer network vision over Two (2) decades. As a result, numerous approaches have been used with varying degrees of success to evaluate the performance of these computer network designs and improvements. A class of approach that has shown a substantial promise is the one that gives predictive results regarding the number of workstations, servers,hosts,services,subnets and categories of cables used in the network is by riverbed academic edition, version 17.5.**
A common theme in this green computing, to this approach is by creating different scenarios and duplicate scenarios. The researchers have investigated the extent to which this new approach, if implemented, will not only improve the Network bandwidth but will also improve the data rate and the overall performance of the network at University of Technology, Jamaica. In addition, the researchers considered the cost constraints and the required service to be offered to different types of users.

***Keywords*--riverbed technology, users, servers, simulation, network, subnet, bandwidth**

I INTRODUCTION

The goal of this paper is to show the basics of network design and improvement, taking into consideration the different users, services, hosts and subnet in a university campus network using riverbed academic edition version 17.5. For the sake of clarity, a user is anyone or anything that uses a computer system while a host is any device or computer that is connected and functions on to a network that has a unique IP address. A subnet is a small network that is a part of a larger network. It is a logical grouping of connected network devices that tend to be located in close physical proximity to each other on a local area network [1].

This paper will review the performance of a simple network scenario, a Utech busy network scenario and an improved Q4_faster network scenario by analyzing, and comparing the results using different statistical network variables, using riverbed. Simulations are usually used to analyze the conceptual design of the network.

The initial conceptual design is usually refined several times until a final decision is made to implement the design and its improvement. The aim is to have the final design that maximizes the network performance, taking into considerations the cost constraints and the required services to be offered to different users.

After the network has been implemented, network optimization and improvement should be performed periodically throughout the lifetime of the network to ensure maximum performance of the network and to monitor utilization of the network resources.

In this work, we designed a network for the University of the Technology, Jamaica, by taking Four (4) departments; Engineering, SCIT, Business and Administration as a case study.
We utilized a LAN model that allows us to simulate multiple users, and servers in one simulation object palate. This model dramatically reduces both the amount of the configuration work we needed to perform and the amount of memory needed to execute the simulation. We also added profile definitions server that specifies the pattern of applications employed by the users of each department in the network. The results of these simulations show how different design decisions can affect and improve the performance of the network [2].This approach by using riverbed academic edition almost yielded 100% results.

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II BACKGROUND

At the University Technology Jamaica WiFi connectivity and speed have been a concern for quite a while now. As Networking students, we are knowledgeable of the fact that connectivity and speed inconsistencies are not only attributed to the ISP (internet service provider), but also to the overall design of a network. It is unknown as to the true nature of the problem, but through proper research, analysis and simulations, we could arrive at a rational reason and then fix the problem through simulating an improved network design.

A computer network is defined as a collection of computers and other devices interconnected for the sake of communication [3]. In today's technologically driven world a computer network is used in almost every organization. Information sharing has become imperative, as it is essential for many business functions and processes. With that being said, it is very important for a network to remain fully functional and efficient. Unfortunately, they don't always do, due varying factors that may render them obsolete over time.

Computer networks are ever changing and complex systems and because of this configuration and management continue to be challenging [9].

Network design and improvement introduce [4] a broad spectrum of problems, and these problems can range from physical arrangement , for example, cabling and topologies to logical variables like; routing, noise, bandwidth and network traffic and can include resource constraints and behavioral and systems assumption. Network cabling is a common problem in a network design. Not only does cables carry data but also signals of different nature [5]. Varying network cable can introduce different capabilities. For example, the University of Technology Jamaica uses Ethernet for LAN (Local Area Network) connection. Both 10BaseT and 100BaseT are IEEE standards for LAN Ethernet connection and in a 10BaseT Ethernet connection; data transfer speeds [10] can reach 10 Mbps (megabits per second) through a copper cable. In a 100BaseT Ethernet connection, transfer speeds can get up to 100 Mbps". Both can work well depending on the organization. But an organization like a University can get busy at times and when network traffic is factored in, the recommendations for improvement for a faster connection such as 1000BaseT (1Gbps) and or fiber optics become a priority.

Given that knowledge, it imperative that a network design is simulated prior to its implementation. Simulations are usually used to analyze the conceptual design of a network where the initial design is refined several times until an optimal system is decided and implemented.

There are various tools available for network simulation but for the sake of our research and better results, we used the riverbed academic edition, version 17.5, for design and simulating the improved network at the University of Technology, Jamaica for a better performance. Given that performance (P) is reciprocal of time (T). $P = 1/T$

III WHY RIVERBD ACADEMIC EDITION 17.5

Riverbed is a good tool for computer network designs, simulations and analysis. It runs on the backbone of Opnet IT guru. Riverbed software equips researchers, teachers, students and industries with most complete infrastructure visibilities to optimize application [6].Riverbed offers instructor-led class training courses that feature in-depth lectures and hands-on installation [8], configuration and optimization experience within the riverbed lab environment. Riverbed is the leader in application performance infrastructure, providing solutions for end to end application visibility, optimization, and control in hybrid IT environment [6].

Riverbed Technology [7], Inc. (Riverbed) is a provider of application performance infrastructure which offers a platform to deliver, control and optimize IT resources across the hybrid enterprise. The technology delivers application performance infrastructure solutions with a focus on two areas, which include application acceleration and performance management.

There are other technologies that are quite similar to that of the Riverbed Technology, Inc. (riverbed) such as Clearfield, Inc. and Plantronics .Clearfield, Inc. manufactures [7], markets and sells fiber management and enclosure platform that consolidates, distributes and protects fiber as it moves from the inside plant to the outside plant and all the way to the home, business and cell site.

IV SIMILAR STUDIES

Riverbed has been used in comparative analysis of performance of hub with switch local area network (LAN) in University of Technology (UTech), Jamaica. The results proved that hub will send data packets to all other output lines, which means that when one node receives a packet on an input line, the hub will forward the packet to all other nodes, while switch will send the received packet to the dedicated line from all other nodes [11]. This functionality of switch helps in increasing its performance, throughput and latency. More so, hub is more exposed to collisions leading to packet loss.

V THE PROPOSED NETWORK DESIGN AND THE GOALS

The goal is to use this tool (riverbed) again as it was used in section 4, to design and improve computer network in the University of Technology. This shows the basics of network design and improvement by taking into consideration the different users, services, hosts and subnet in a university campus network. To minimize the cost constraints, CPU utilization for three (3) servers where checked for the 4 departments of the University and it was better to use one server instead of 3 servers based on the CPU underutilization for 3 servers. Our proposal is to design and illustrate the performance of a simple network scenario, a Utech busy network scenario and an improved Q4_faster network scenario by analyzing and comparing the results using different statistical network variables, using riverbed.

VI SIMULATION

In the process of design, we added to the project workspace from the object palette, the application definitions, profile definitions server and a subnet (node 0).The sample profiles provide patterns of applications employed by users such as Engineering, SCIT, Business and Administration departments.

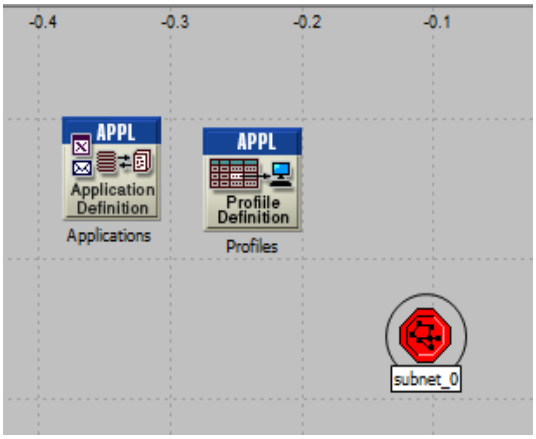

Figure 1: The campus network design

The application definition is used to specify applications that will be used to configure users profile, while the profile definitions describes the activity patterns of a user or group of users in terms of applications, used over a period of time.

1. Subnet

We right click on the subnet node_0, with edit attributes we changed the name to Engineering node and by double clicking on the Engineering node, we created an empty space as a subnet.

Inside the subnet, we added 10Base T LAN, Ethernet 16 Switch and 10 Base T link to connect the LAN with the Switch. The subject which we have created is equivalent to 10-Workstation star topology LAN. The traffic generated from the users of this LAN resembles that generated by 'Engineers".

The subnet is configured as shown in figure 2.

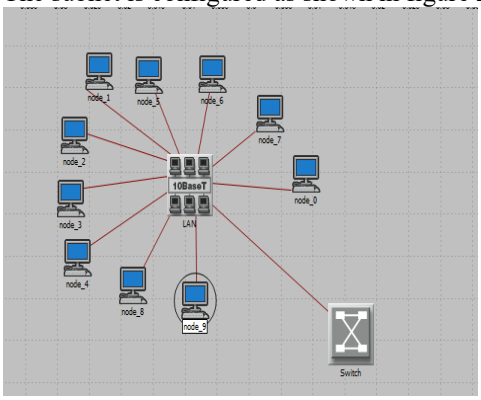

Figure 2, The engineering subnet, which shows the configuration of each subnet with a LAN containing 10 workstations star topology and an Ethernet 16 switch.

2. Configuring other Subnets (Departments)

Now we have completed configuring Engineering department subnet, the subnets of other departments in the University, should be similar to the engineering subnet except for the supported profile. We made three (3) copies of the engineering subnet and place it three (3) times on the workspace area and we renamed the other new subnets, SCIT, Business and Administration, as shown in figure 3.

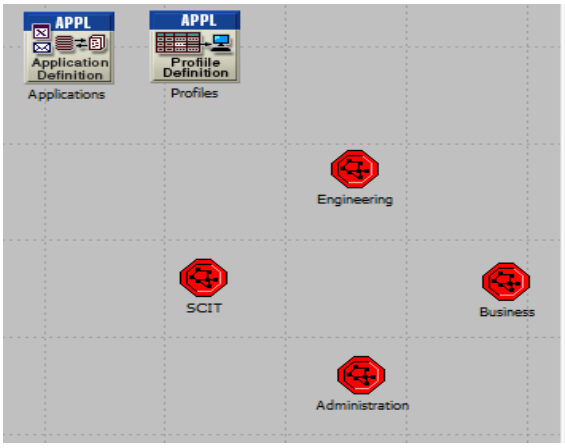

Figure 3: The network of 4 departments of the University.

3. Configuring the 3 Servers

We configured the subnet that contains the 3 servers. The servers have to support the applications defined in the profile we deployed. These 3 servers support the following applications; web browsing, Email, telnet, file transfer, database, and file print. We drag 3 servers and one Ethernet 16 switch from the object palette to the new workspace subnet area and connect them with 10BaseT link as shown in figure 4A.

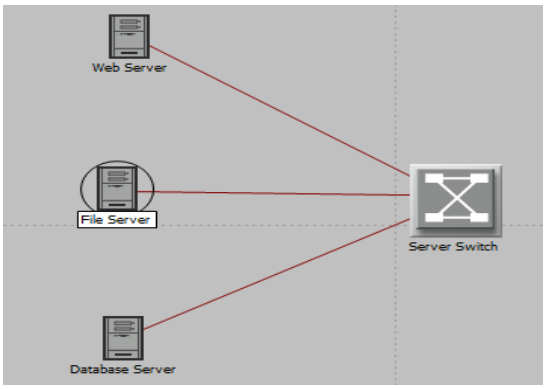

Figure 4A: The subnet with 3 servers and an Ethernet 16 Switch

To minimize costs, we reduced the 3 servers into one single server and checked the CPU utilization and performance.

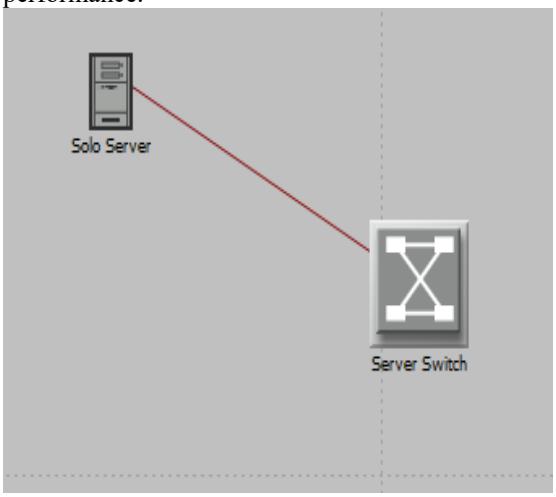

Figure 4B: The subnet with single server and Ethernet 16 Switch.

4. Connecting the Subnets

We configured and connect all the subnets of Engineering, SCIT, Administration and Business with 100BaseT link.

The configured 4 departments are connected to the server switch as shown figure 5.

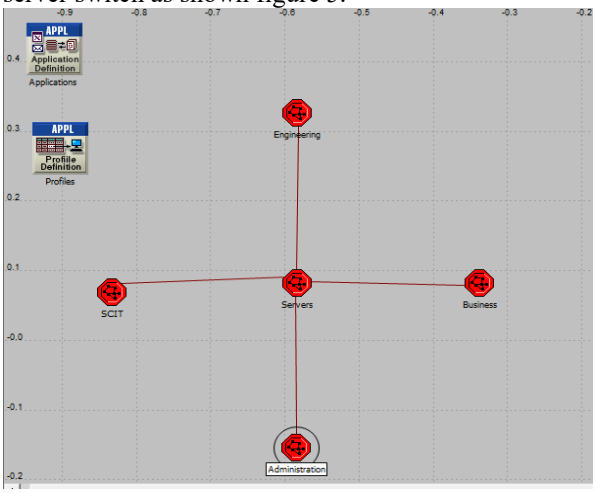

Figure 5: The configured network diagram of 4 departments of the University, connected to the server.

5. Duplicate Scenario

We created a duplicate scenario of simple network called Utech Network, with 99% expanded hierarchy with background utilization in 100Base T links and applied changes to the selected objects.

6. Choose the Statistics and configure the simulation run.

To test the performance of the network, we selected individual statistics. We chose “HTTP page response time” as the statistics that should be tested. After, we configured and set the simulation run duration to 30 minutes. To run the simulation for both scenarios, we went to scenario menu and selected manage scenarios and change the values under results column to ‘collect’ for both scenarios. When the simulation was run, it ran for approximately 25 minutes based on the speed of the processor.

VII ANALYSES OF THE RESULTS OF THE SIMULATION

To view the results, we selected compare results from results menu and then selected time average in HTTP Page Response time, which is under global statistics and the following results were obtained.

A) Page Response Time

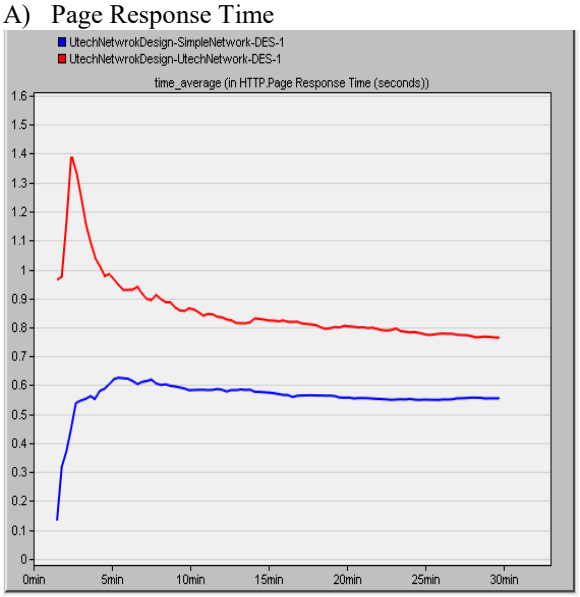

Figure 6: HTTP page response time.

Based on the graph of HTTP Page Response time, figure 6 above, it can be observed that the simple network has better performance and takes less time (0.15 seconds) to pick up and was stable after 0.6 seconds, while Utech Network (busy network), takes a longer time (1 second), with a spike and fluctuates to 0.9 seconds. This is showing that Utech Network is slow and always busy, due to much traffic.

We also accessed CPU utilization for the 3 servers and for a single server, to consider the cost constraints in network designs.

B) CPU Utilization of the 3 Servers

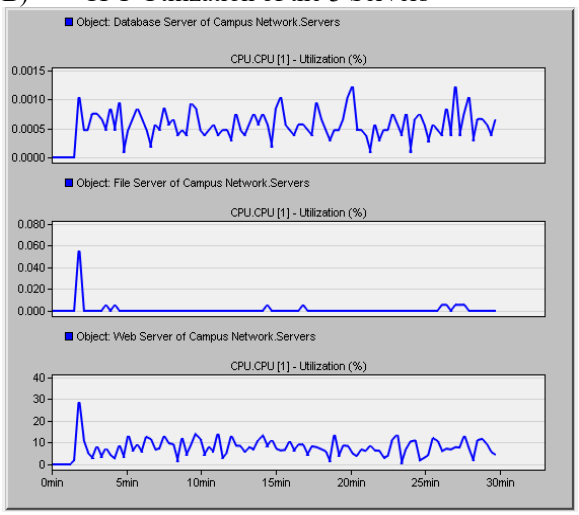

Figure 7A: The CPU utilization of the 3 Servers in the Utech Network.

C) CPU Utilization for a Single Server

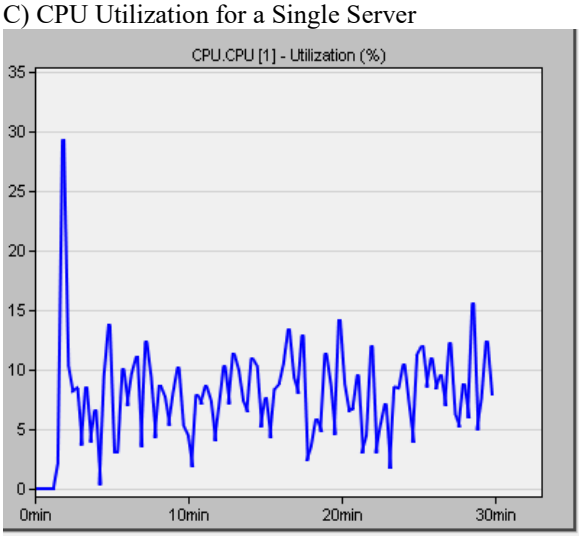

Figure 7B: The CPU utilization of a single Server in the Utech Network

Based on the graph of figure7A, it can be seen that the database and web server have more traffics and fluctuations, with high CPU utilization while file server is smooth, with less CPU utilization. Based on the figure 7B, it could also be observed that there was much better CPU utilization when the 3 servers were reduced to single server. This means that the use of a single server will not only minimize the operating costs, but, will also improve performance, with better CPU utilization and efficiency to avoid redundancy.

D) TCP Delay

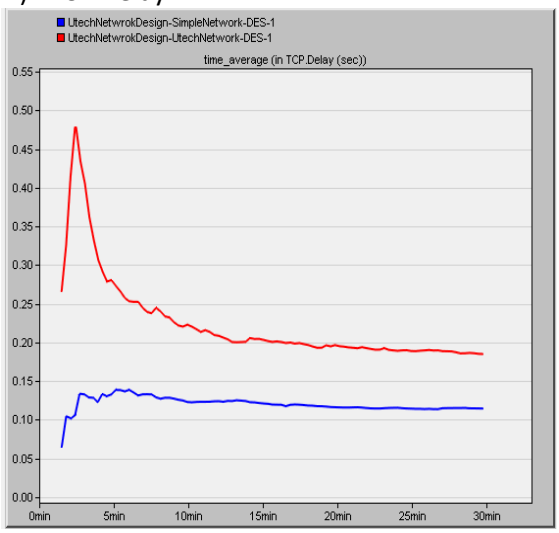

Figure 8: TCP delay

The figure 8, above shows the comparative results for the TCP delays for both network scenarios.
The simple network scenario (blue) has better performance with less time (0.05 seconds) in TCP

delay when compared to Utech network scenario (red), which has more time delay (0.25 seconds).

VIII IMPROVING NETWORK DESIGN OF UNIVERSITY OF TECHNOLGY, JAMAICA, USING REVERBED ACADEMIC EDITION VERSION 17.5

Based on the results of HTTP page response time (figure 6) and TCP delay (figure 8), it can be observed that the overall performance of Utech network is very poor and needs improvement due to the overall delays and many traffics.
To improve the network, we created a duplicate of Utech network and called it Utech Network Design Q4 _Faster Network. In the Q4 _Faster Network scenario, we replaced all 100BaseT links with 10Gbps Ethernet links and replace all 10BaseT links 100BaseT links. We investigated how increasing the bandwidth of the links affected the performance of the network as shown in figures 9 and 10 below.

E) Time Average of HTTP page response time of improved Q4_faster network and Utech busy network.

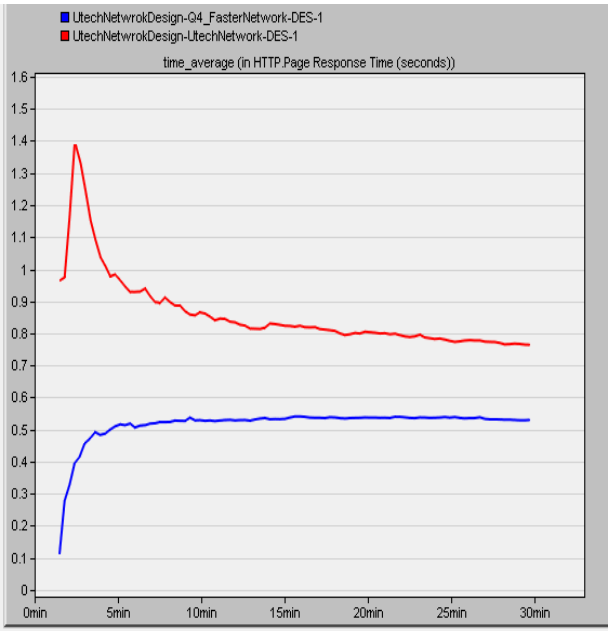

Figure 9: HTTP page response time for the Utech network (busy network) and the Utech network design Q4_faster network.

Based on the results from the graph (figure 9) above, it was observed that by increasing the bandwidth of the links, the performance Utech Network Design of Q4_Faster Network was improved. The Q4_Faster Network (blue) has 0.1 seconds of HTTP Page response time when compared to Utech Busy network (red line) which has 0.98 seconds, HTTP page response time in time average.

IX COMPARATIVE ANALYSIS OF SIMPLE, UTECH DESIGN (BUSY) AND Q4_FASTER NETWORK OF UNIVERSITY OF TECHNOLOGY (UTECH) JAMAICA.

We compared the results of simple, Utech design (busy) and Q4_faster network of the university as shown in figure 10.

F) Time Average of HTTP page response time for Simple Network, Utech Network (busy) and Q4_FasterNetwork

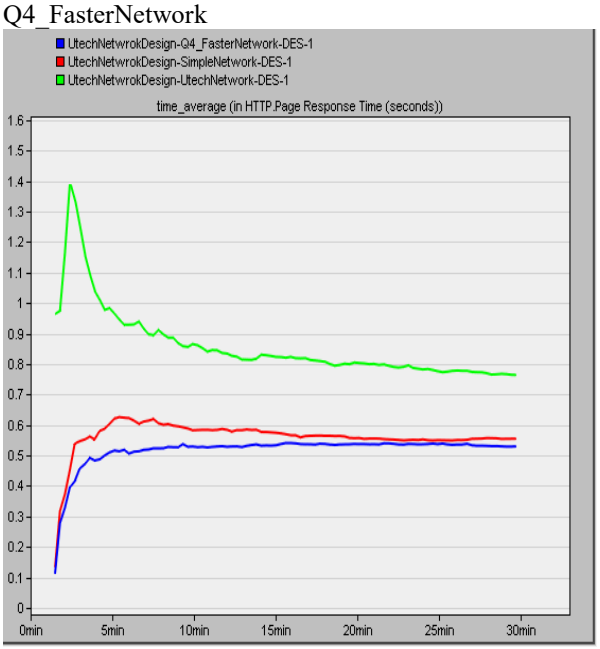

Figure 10: HTTP page response time for Simple Network, Utech Network (busy) and Q4_FasterNetwork.

Based on the results shown in figure 10 above, it was found that Utech network design (green) has time average, HTTP page response time of 0.98 seconds, and Utech simple network (red) has time average, HTTP page response time of 0.28 second, while, Utech Q4_Faster Network (blue), which is the improved network, has time average, HTTP page response time of 0.1 seconds. This shows big improvement on the performance of the Q4_Faster Network of the University, using reverbed.

X ANALYSIS BASED ON QUESTIONAIRES

In our Methodology we projected to garner responses from 50 participants within each department of the University of Technology, Jamaica of which we got 100% of the targeted outcome. The target audience

include: the IT technical staff, students and lecturers in engineering, business, SCIT and Administration departments of the University. The results obtained were analyzed as shown below.

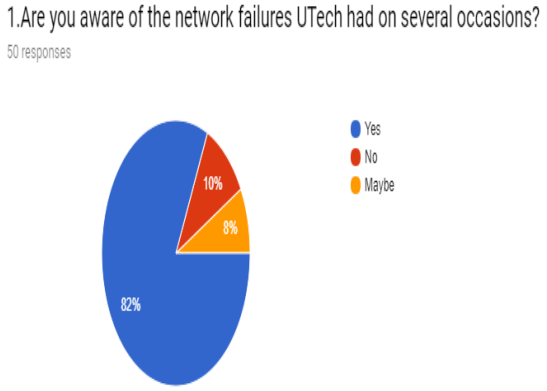

Figure 11: Network failures in the campus.
When ask about the awareness of network weaknesses and failures at the University of Technology, a significant number of 82% of the respondents, responded “Yes”. 10% percent of the respondents, responded “No” and 8% responded “May be”. With a vast majority of the population sample responding yes, to the above question, it implies that most people on campus have had some experience of the slow, weakness and unresponsive network at some point in time.

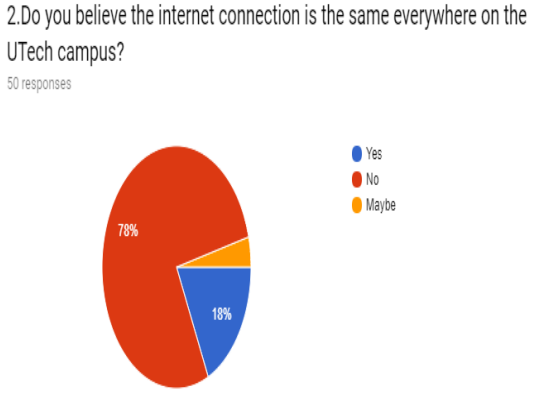

Figure 12: Instability of internet services in the campus.
The figure 12 above shows the summary of responses for internet connection not being the same all over the UTech campus. As illustrated by the pie chart above, 78% of the respondents believes that there is an inconsistency in internet connection throughout the entire Campus while 18% thinks the opposite and the remain 4%, not sure.

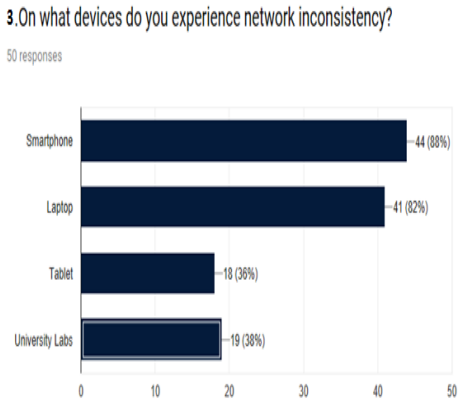

Figure13: Network devices used in the campus.
The bar graph of figure 13 above shows the different devices that are used within the University of Technology, Jamaica campus. As seen in the diagram, approximately eighty-eight percent (88%) of the respondents experiences inconsistencies on their smartphones, eighty-two percent (82%) of the respondents experiences inconsistencies on a laptops, thirty six percent (36%) of the respondents experiences inconsistencies on a tablets and thirty eight (38%) of the respondents experiences inconsistency on the university laboratories.

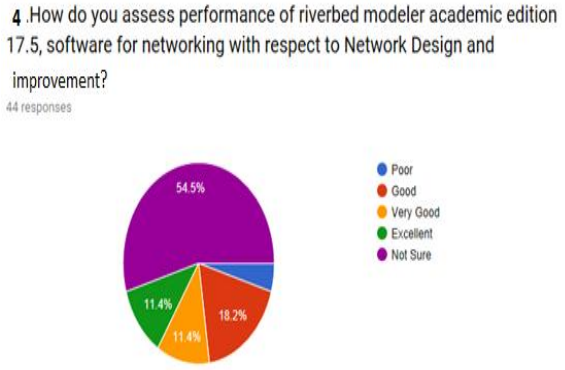

Figure 14: Riverbed modeler 17.5 academic edition performance.
Figure 14, illustrates the performance of the Riverbed Modeler Academic Edition 17.5 with respect to Network Design and improvement. Approximately, fifty four percent (54.5%) are not sure how to assess this software. On the other hand eighteen percent (18.2%) thinks this is good, eleven percent (11.4%) think this is very good and another eleven percent (11.4%) thinks this is excellent.However,many people do not know much about riverbed, because it is a new tool for network simulations and improvements.

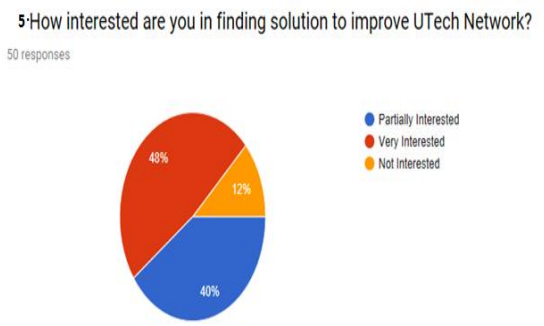

Figure 15: Solution to improve Utech network.

Figure 15 above, explains the interests that the respondents have to find solutions to improve the UTech Network. Forty eight percent (48%) of the respondents stated that they were very interested to find solution to improve the network, while forty percent (40%) of the respondents were partially interested and the other twelve percent (12%) were not interested

XI CONCLUSION

Planning network, designs and improvements with different users, hosts, services and subnets with different topologies have been actively used and implemented in computer network vision over Two (2) decades. But the use of riverbed modeler 17.5 has shown substantive improvements in the present computer network vision, which forms part of green technique in computing. Based on the graphs on figures 9 and 10, it could be observed that time average of HTTP page response time is reduced close to 0.1 seconds, which shows a big improvement in performance of Q4_faster network, which has increased bandwidth, when compared with Utech design busy network., which has more traffics and loads.

It could also been observed that there was more CPU utilization and costs minimization when the one server was used in comparison with 3 servers which have less CPU utilization and more cost constraints. In the Utech network (Busy), scenarios, there were more fluctuations and spikes, which show heavy traffics, network congestions and delays. Hence it takes a long time for students to download data, pictures and flies.

Based on the responses from the questionnaires, as shown in figures 11, 12 and 13, it can be said that Utech network needs improvements.

In general, and based on the results from the simulations, reverbed academic edition, version 17.5, can be concluded to be a very useful tool to design and improve the performance of computer network in the University of Technology, Jamaica.

In addition, with increase in bandwidth, the Q4_Faster network will have more data rate and signal rate as an improvement to its performance, with better transmission time, propagation time and throughput.

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