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Optimizing Local Area Network efficiency using Riverbed Academic Edition 17.5

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Abstract

Over the past two decades, computer networks have been rapidly evolved to accommodate diverse users, hosts, services, and subnets with varying topologies. To evaluate the performance of these networks and their improvements, various methods have been employed and definitely, the Riverbed academic edition version 17.5 can be a better choice for that which can measure network performance by assessing the number of workstations, servers, hosts, services, subnets, and cable categories. In this article, Riverbed Academic Edition, Version 17.5 has been considered as a useful tool for the design and performance optimization of local area computer networks after completing rigorous simulation. The emergence of green computing has become vital as it is playing a crucial aspect of network design, with a focus on reducing power consumption and improving energy efficiency. Creating and duplicating scenarios is a common theme in green computing. At the same time, implementing network measurements can enhance bandwidth and overall performance in the local area. In the simulation, three scenarios - subnet, servers, and LAN connection – have been considered, with categorizations based on their complexity: simple, busy, and fast networks. By analyzing two network models in the evaluation methodology of the local area, the 4-building network model is determined to have superior performance than other models. To summarize, computer networks have been advanced significantly, though continuous improvements and developments are necessary to create efficient and dependable networks.

Keywords: LAN, Riverbed, Building Network Model.

Highlights

- Utilization of Riverbed Academic Edition 17.5 for network performance evaluation.
- Emphasis on green computing for energy efficiency in network design.
- Comparative analysis of network scenarios (subnet, servers, LAN) for performance optimization.

Acknowledgements

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1 Introduction

OFTEN considered one of the most intricate cyber-physical systems ever considered, the smart grid is often regarded as one of the greatest multifaceted systems in antiquity. LAN devices that tend to be physically close to each other are called network nodes [1], [2]. The main aim of this paper is to demonstrate the fundamentals of network design. Basically, this is the data (smart meter data) transfer process through a particular network system. The network design process, among other things, has been done by riverbed academic software. The whole network system has been designed in consideration of the different departments, users, and subnets of an office using Riverbed Academic Edition Version 17.5. We designed two simple networks by varying some fundamental parts. This paper will observe the performances of simple network scenarios, busy network scenarios, and faster network scenarios by exploring and assimilating the outcomes using various types of network variables using riverbed. The primary design has been corrected many times until the final design has been made, which is more compact than the other ones. This has been the same process for both networks we have designed. The finalized goal is to design a network that gives more efficient network

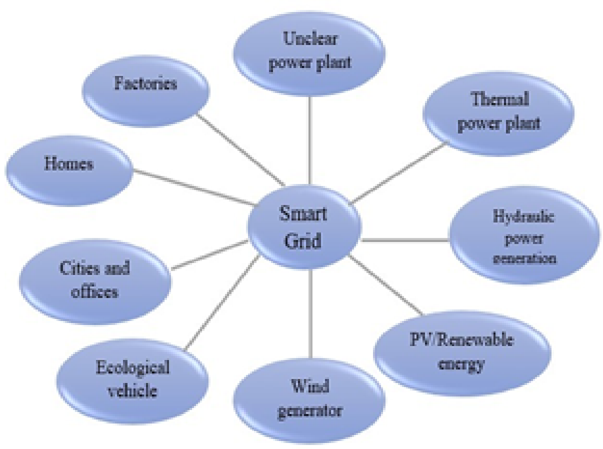


Fig 1. Concept of Smart Grid

performance along with improvements in order to ensure maximum performance of the network as an output. A user is connected to a computer system, though there are few devices or computers with a unique IP address on a network. As part of a larger network, a subnet makes up a smaller network. In this entire work, two networks have been designed, and the outcome shows the comparison between the two networks. As we mentioned earlier, each network has three scenarios. These are simple networks, busy networks, and Q4_fast networks. The first design has been done by taking 4 departments; on the other hand, the second design has been done by considering 5 departments. In both designs, we considered 10 parameters for each department. We set up a LAN model, which indicates that we should simulate several users' servers in one simulation object palette. The outcome will be shown based on three parameters. HTTP delay, page response time, and CPU utilization performance are those parameters, and the comparison will be held based on these parameters' performances. The specialization of this model is that it decreases the volume of configuration work that we have to perform, besides the volume of memory required to conduct the whole simulation process. The outcome of the simulation demonstrates the way various design steps can affect and improve the outcome of the network. This entire work goes through the Riverbed Academic Edition and gets almost 80% of the results. A LAN consists of logical groups of network devices that are situated close together on the network [3], [4]. With a LAN model, we are able to simulate multiple users and servers within a single object palette. Both the bandwidth and data rates are being improved with this model. Our network also includes a profile definition server that specifies the application patterns used by each building's users. These simulations provide insight into how different designs can affect the performance of the network. This paper analyzes and compares the results of a simple network scenario, a busy network scenario, and an improved Q4_faster network scenario using the various statistical network variables.
Variable network cables can introduce several types of capabilities. For example, in our simulation design, we have used Ethernet for a LAN connection. It can be effective with 10 BaseT and 100 BaseT, so we used both 10 BaseT and 100 BaseT, which are definitely IEEE standards for LAN Ethernet connections. In a 10BaseT Ethernet connection, data transfer speeds have been managed to reach 10 Mbps (through a copper cable). In 100BaseT, transfer speeds have been gotten up to 100 Mbps".

2 Literature Review

At the University of Technology Jamaica, WiFi connectivity and speed have been a concern for quite a while now. The goal of this paper is to show the basics of network design and improvement, taking into consideration the different users, services, hosts, and subnets in a university campus network using Riverbed Academic Edition version 17.5. The final design maximizes the network's performance, taking into consideration 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 and monitor utilization of the network resources [5]. This next-generation internet protocol brings new modified routing protocols that are enhanced versions of the existing ones. In this paper, the IS-ISv6 routing protocol is considered as it is scalable, more flexible towards IPv6 addresses, robust, supports larger areas, and can give better performance than other existing routing protocols. The IPv6 network is configured to measure the performance of real-time applications (voice and video) using the IS-ISv6 routing protocol, and the network is simulated on Riverbed Modeler Academic Edition 17.5. The main objective of this paper is to find out the performance of IS-ISv6 for routing traffic. For both applications, the traffic sent and received is used to calculate the maximum throughput of the network. The results are also present for end-to-end delay and packet delay variations for voice and video applications to determine how much traffic can be routed using the IS-ISv6 routing protocol with the highest possible data. Riverbed Modeler Academic Edition 17.5 is used to simulate the network. Sending and receiving traffic for both applications was used to estimate the network throughput. An advanced metering infrastructure (AMI) in the Smart Grid system measures the energy use of various utility resources, such as electricity, gas, and water [6]. AMI sensor networks are analyzed using the IEEE 802.15.4 MAC protocol. The evaluation was conducted with an OPNET simulator based on the analysis. A specific focus of this work is on the performance implications of protocol parameters. To maximize efficiency, simulation results are presented under various traffic loads based on these parameters.

2.1 Why Riverbed Academic Edition

Riverbed is a very compatible tool for simulations, network design, analysis, providing superior outcomes, and all that. Although presently it's been found to be difficult to install, it's easier to work on it, design the network, and get to the simulation part. In the riverbed lab environment, configuration and optimization are very smooth. Riverbed holds many key features that are tremendous throughout the entire experience. These features are application performance infrastructure, profile configuration, subnet, server, etc.

2.2 Proposed Work & The Aim

In that diagram, we take four buildings. And those buildings are attached with LAN in star connection. Our actual goal is to design and improve a computer network using riverbed academic software. Here we designed two networks where we compare the output between each of them. Actually, each network design shows the fundamental improvement in order to taking consideration by different users, services, host and subnet.

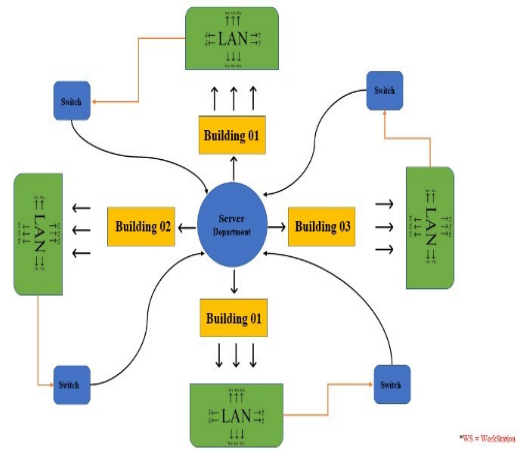


Fig 2. Block diagram for OPNET model

3 Simulation

In designing the workspace, we have added the object palette, application definitions, profile definition server, and a subnet (node 0) of the two network models. Sample profiles provided models of how users would use certain applications, such as Building 1, Building 2, Building 3, Building 4, and Building 5.

3.1 Fundamental of four building

At the very beginning, we chose application configuration and profile configuration from the object palette. The application configuration module contains the application definitions, while the profile configuration module contains the profiles of user behavior. Using the application definitions, users' profiles will be configured by applications. The profile definitions also describe the types of applications the user or group of users has accessed over time. Then we have selected four subnets, and each subnet has 10 workstations connected with a switch. We formed a star connection between those subnets through a 10-basset link LAN. Then we formed a server department where we considered three servers and connected them with a switch. Now we have connected the server departments switches with all subnet's switches, which is how we complete our network model.

3.2 Fundamental of Five Building

We have done the same design for the five buildings as we have for the four buildings, except for one change. In the five-building design, we have enhanced one building and made it a five-building network design; besides, the fundamental issues are similar in the four-building design.

4 Result

4.1 For 4 building networks in the local area

The graph of the HTTP page response time, Figure 5, indicates that simple network performance is fast and requires little time (0.13 seconds), stable after 0.3 seconds, and that a busy network takes a lot longer (0.25 seconds), up to 1 second with spikes and ups and downs. There is a lot of traffic on this network, making it slow and very busy. The CPU usage for three servers and one server was also accessed, taking into account the cost constraints in the design of the network.

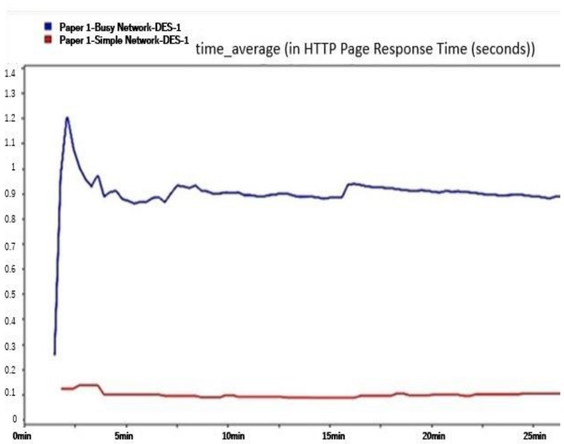


Fig 3. Response times for HTTP pages for Simple and Busy Networks

Considering Figure 4, one can see that the file server and database services have lower CPU utilization and more traffic, while the web server and database servers have more fluctuations. Based on Figure 5, it can also be seen that CPU usage was much better when it was 3. When the server was downgraded to a single server. Utilizing a single server will result in a reduction in operating costs as well as improved performance, including more effective use of resources and avoiding redundant components. Busy Network Design Q4 Faster Network was duplicated to improve the network.

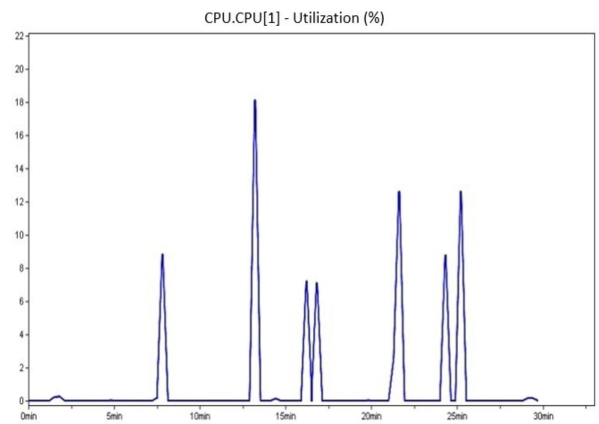


Fig 4. CPU utilization of three servers in the busy network

Figure 8 shows the comparative results of TCP delays in equal network situations. This compares TCP delays for equal network situations. This easy network scenario (blue) has good performance in TCP with a small-time delay (0.057 seconds). Similarly, the delay (red) corresponds to a busy network situation that has a longer delay (0.028 seconds).

Time Average of HTTP page response time & Q4_faster network

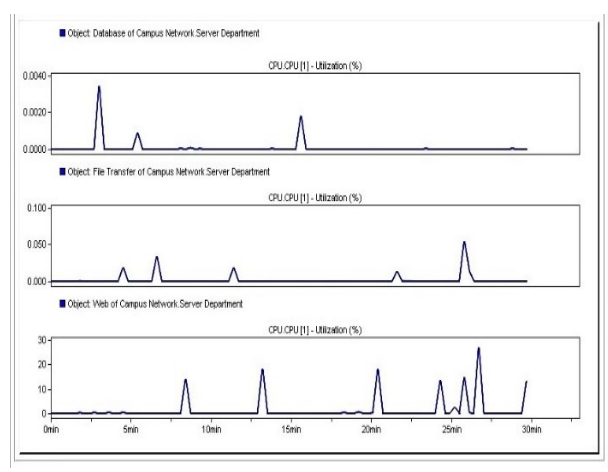


Fig 5. CPU utilization of a single server in the busy network

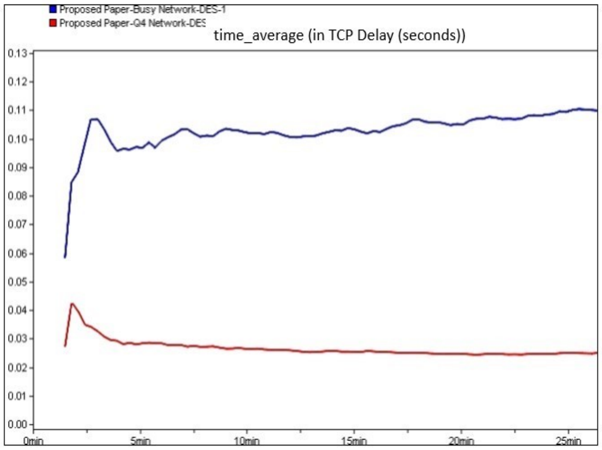


Fig 6. TCP delay

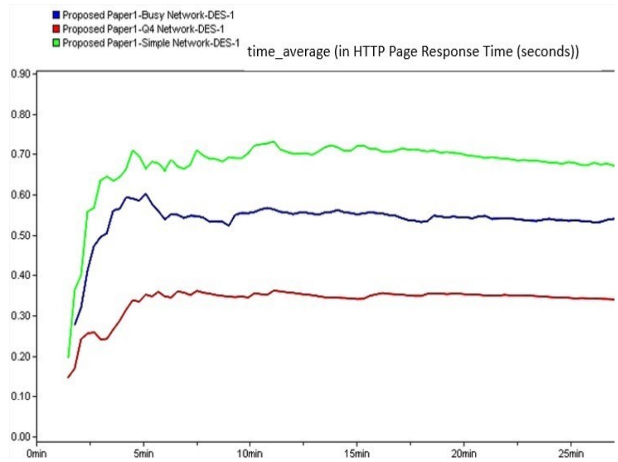


Fig 8. Response time for HTTP pages for a simple, busy, Q4 faster network

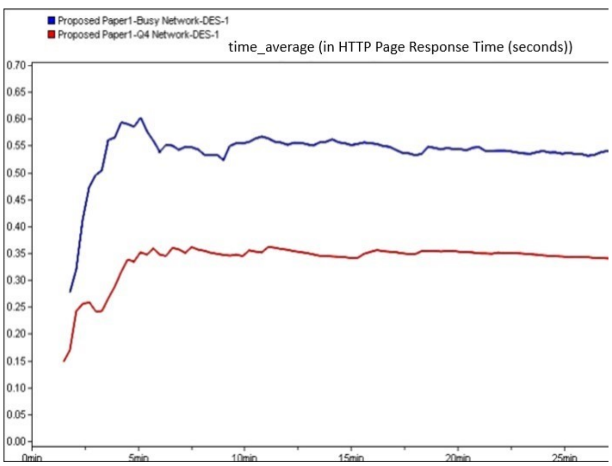


Fig 7. Response times for HTTP pages for the Q4 fast network and the busy network

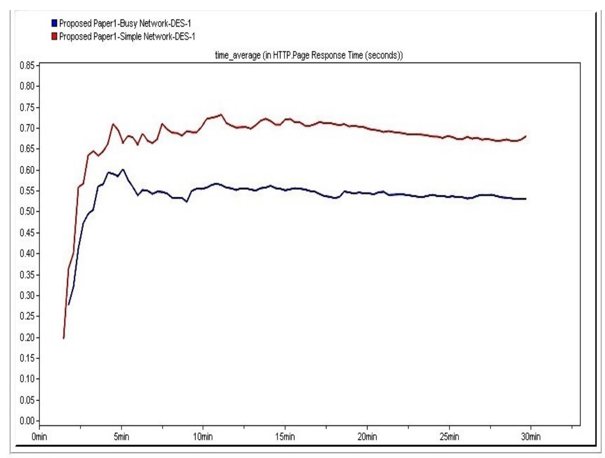


Fig 9. HTTP page response time.

According to HTTP PAGE RESPONSE TIME (Figure 5) and TCP DELAY (Figure 6), traffic and overall delay have badly affected the overall performance of the busy network.

Q4_faster network

In our scenario, we replaced all 100BaseT links with 10Gbps Ethernet links and all 10BaseT links with 100BaseT links. As shown in Figures 6 and 7, we have examined the impact of increasing the bandwidth of links on the network.
According to the results obtained from the graph above (Figure 7), the busy network scheme of the Q4_Faster network is enriched as bandwidth from links is accumulated. Compared to the Q4_Faster network (red), the Busy Network (blue) averages a response time of 0.28 seconds. According to an analysis of the results in Figure 10, busy network design (blue) time average, HTTP page response time 0.28 seconds, and simple network (green) time average, HTTP page response time 0.20 seconds The HTTP page response time forQ4_Faster Network (red), which is an advanced network, is 0.15 seconds on average.

4.2 For 5 Building network in the local area

Figure 11 shows the HTTP page response time graph, which shows that Simple Network takes less time (0.20 seconds) and 0.15 seconds is stable, while Busy Network takes longer (0.28 seconds), with spikes and fluctuations

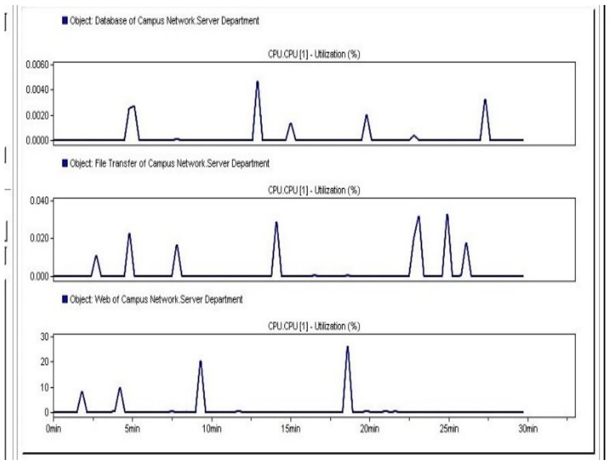


Fig 10. CPU utilization of three servers in the busy network.

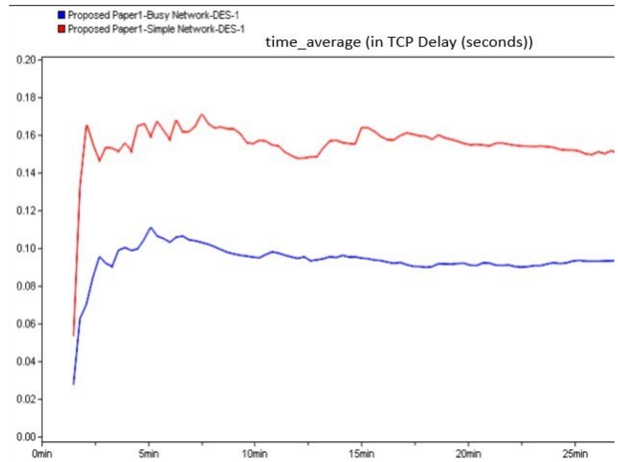


Fig 12. TCP delay

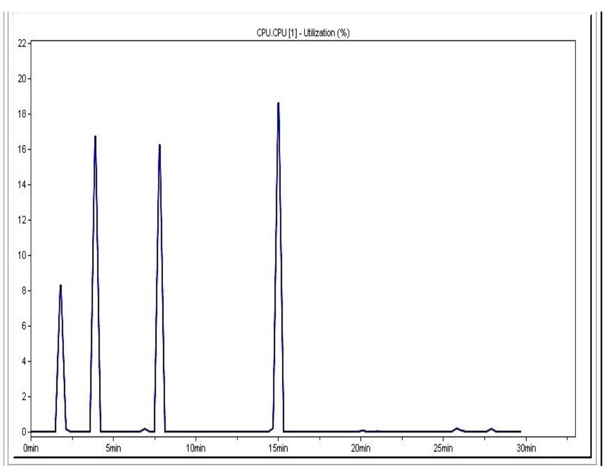


Fig 11. A single server's CPU utilization in a busy network.

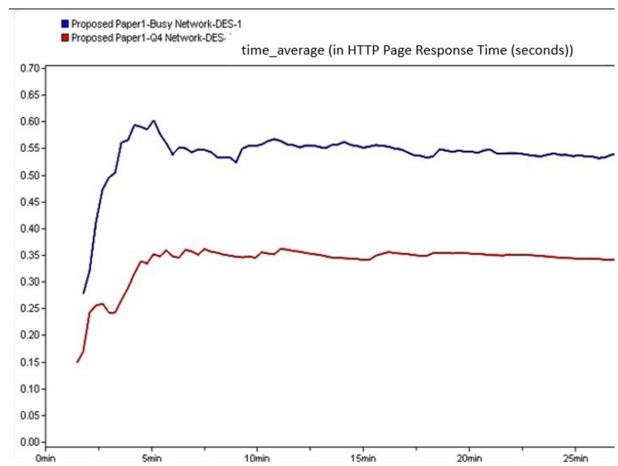


Fig 13. HTTP page response time for busy network and Q4 fast network

up to 0.20 seconds. Despite a lot of traffic, this is a slow and always-busy network. Aside from CPU usage, we also have access to cost constraints in network design based on three servers and a single server.

As shown in Figure 12, the TCP delay for both network situations. When compared with busy network situations (0.03 seconds) the delay (blue) is better. Simple Network Scenario (red) TCP takes longer (0.05 seconds).

Time Average of HTTP page response times for Q4_faster and Utech busy networks

Based on the HTTP PAGE RESPONSE TIME (Figure 11) and TCP DELAY (Figure 12) results, it can be perceived that the whole performance of the busy network is very deficient in essential enhancement due to overall delay and a lot of traffic. To expedite, the network was replicated and given the name Busy Network Design Q4_Faster Network.

Q4_Faster network

We replaced 100BaseT links with 10Gbps Ethernet links and 10BaseT links with 100BaseT links. As shown in Figures 15 and 16, we have examined the impact of increasing the bandwidth of links on network performance.

On the basis of the graph in Figure 15, it appears that increasing the bandwidth of the links will enhance the performance of the busy network design of the Q4_Faster

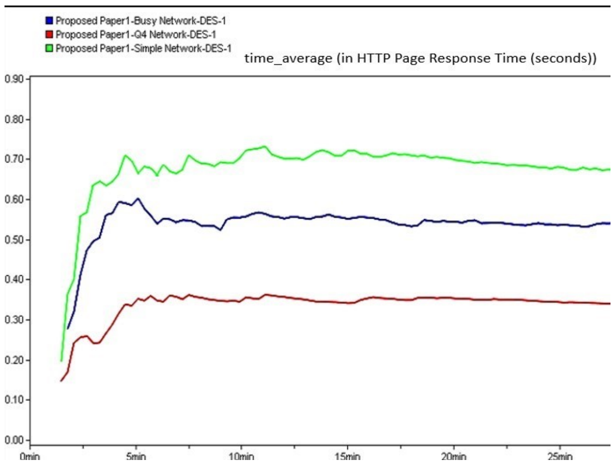
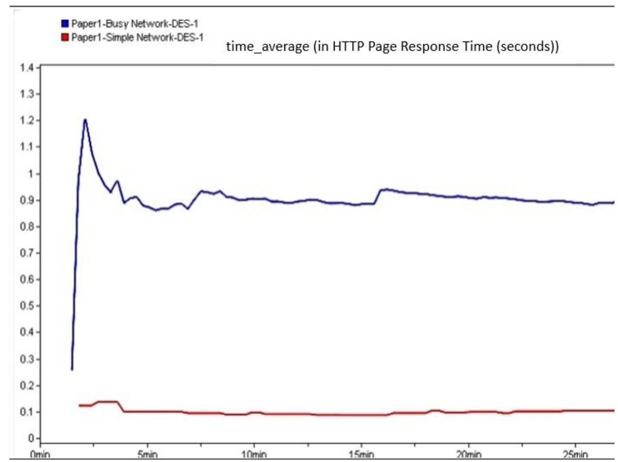
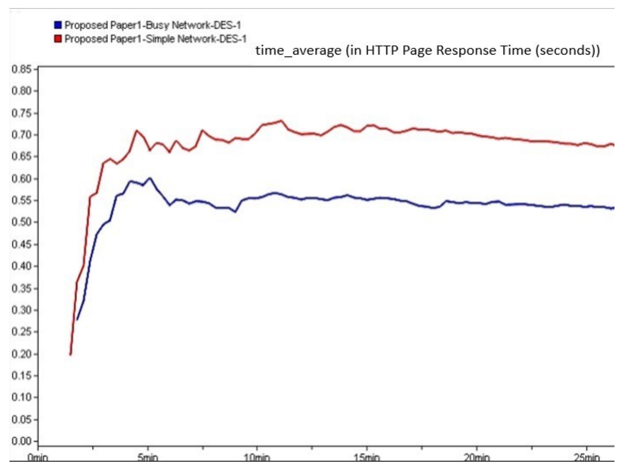


Fig 14. HTTP page response for simple, busy, Q4 faster network



(a)



(b)

Fig 15. HTTP page response time for Simple and Busy Network for (a) 4 building (b) 5 building

network. Q4_Faster Network (red) has an HTTP page response time of 0.15 seconds, while Busy Network (blue) has an HTTP page response time of 0.28 seconds.

According to Figure 14 above, the typical HTTP page response time for a busy network (blue) and a simple network (green) averages out to 0.28 seconds and 0.20 seconds, respectively. The HTTP page response time for Q4_Faster Network (red), which is an advanced network, is 0.15 seconds.

5 Comparison of Both Netwo rk

5.1 Response times for HTTP pages for Simple and Busy Networks

For the HTTP page response time for simple and busy networks for 4 buildings, the simple network needs time to start up (0.13 secs) and becomes stable after 0.3 secs, while the busy network requires longer (25 secs), with a spike and fluctuating to 0.9 secs. This took a long time (28 seconds), with a spike, and then stabilized after 0.20 seconds. In the simple network of 5 buildings, it takes about 0.20 seconds to spontaneously occur and was steady at 0.15 seconds.

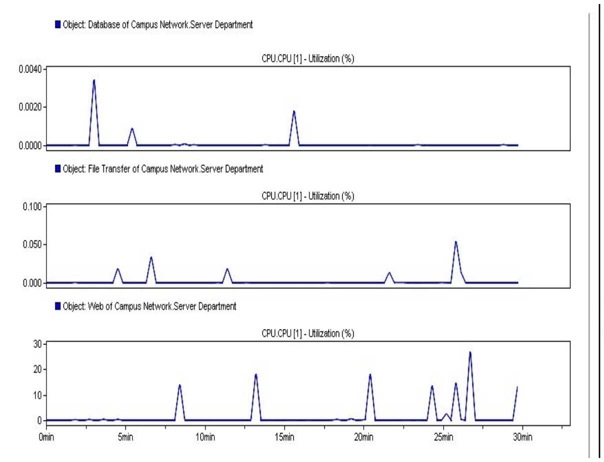
When we compare both scenarios, it can be observed that the HTTP page response time for the Simple and Busy Network for 4 buildings has better performance and takes less time to pick up than the HTTP page response time for the Simple and Busy Network for 5 buildings.

5.2 CPU utilization of three servers in the busy network

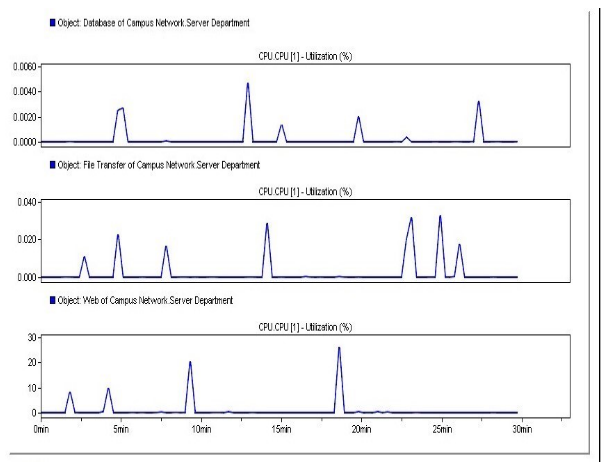
When we compare both it can be observed that in Figure 16a there are fewer movements and instabilities, with great CPU utilization than in Figure 16b.

5.3 TCP Delay

Figures 17a and 17b show the comparative outcomes for the TCP delays for both network consequences. The Simple and Busy Network for 4 building networks has good performance with a small TCP delay compared to the Simple and Busy Network for 5 building networks.

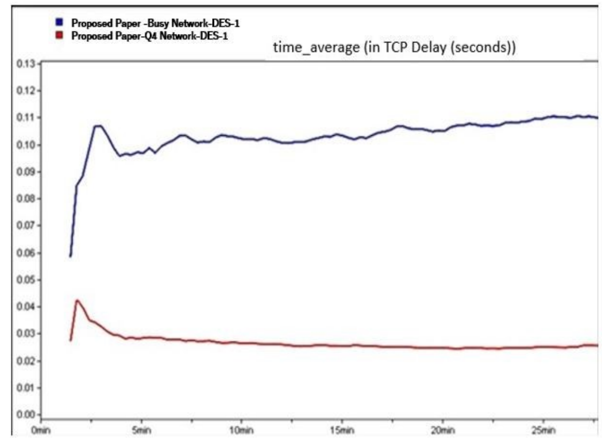


(a)

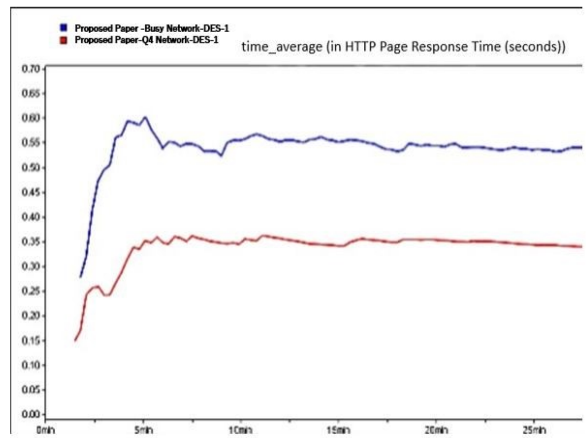


(b)

Fig 16. CPU utilization of three servers in the busy network for (a) 4 building connected server (b) 5 building connected server



(a)



(b)

Fig 17. TCP delay for Simple and Busy Network for (a) 4 building networks (b) 5 building networks

5.4 Time Average of HTTP page response time of improved Q4_faster network and Utech busy network

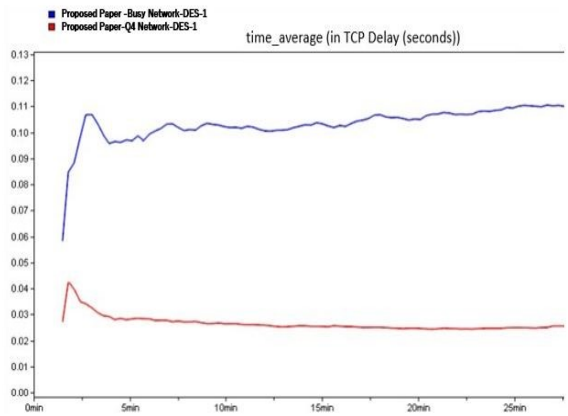
During Q4 Fast Network and Busy Network, the HTTP page response time ranges from (0.06 seconds) for Building 4 Fast Network to (25 seconds) for Building 4 Busy Network, with a spike and fluctuation of 0.9 seconds. As a result, HTTP page response time for 5 simple networks takes time (0.15 seconds) to start, but busy networks take longer (28 seconds).

When we compare both scenarios, it can be observed that the HTTP page response time for the Fast and Busy Network for 4 buildings has better performance. It also takes less time to pick than the HTTP page response time for the Fast and Busy Network for five buildings.

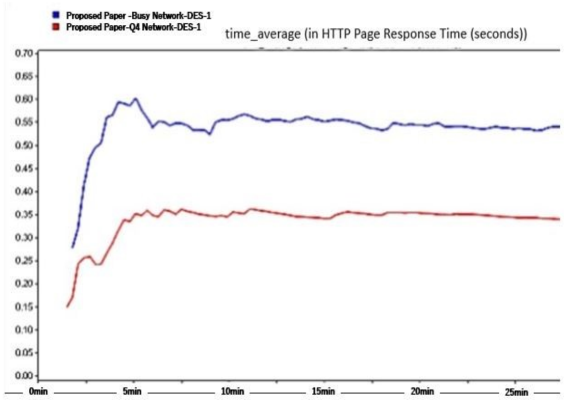
5.5 Time Average of HTTP page response time for Simple Network, Busy Network (busy), and Q4_FasterNetwork.

When we compare both scenarios, it can be observed that the HTTP page response time for Simple, Fast, and Busy Network for 4 buildings has better performance and takes less time to pick up than the HTTP page response time for Simple, Fast, and Busy Network for 5 buildings. So, after all the comparisons, the 4-building network model has better performance than the others.

Why four buildings are better than five buildings
As we have designed a model, we have made many in-

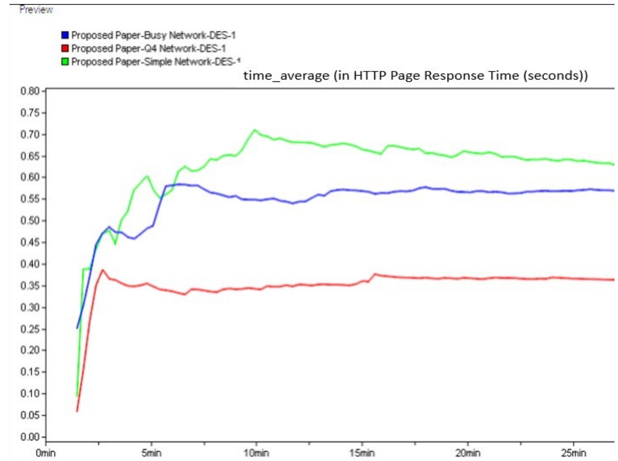


(a)

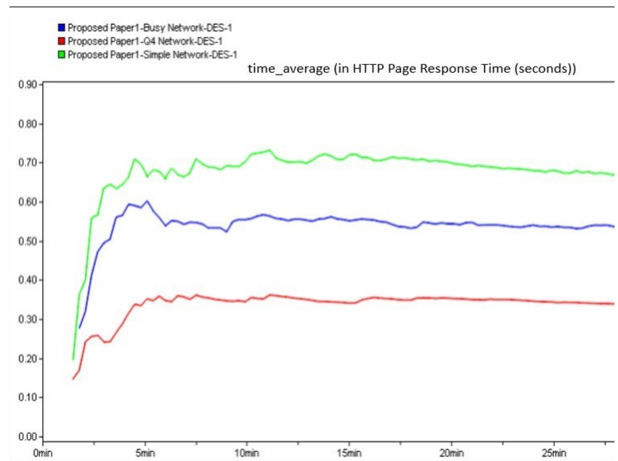


(b)

Fig 18. HTTP page response time for busy network and q4 fast network for (a) 4 building networks (b) 5 building networks.



(a)



(b)

Fig 19. HTTP page response time for Simple Network, Busy Network (busy), and Q4_FasterNetwork for (a) 4 building networks (b) 5 building networks

Table 1. Reference Model (Four Department) [7]

	HTTP (Page Response Time) Sec	TCP Delay (Second)	CPU Utilization (Second)
First Scenario (Simple Network)	0.15	0.07	90%
Second Scenario (Busy Network)	0.9	0.26	70%
Third Scenario (Q4 Fast Network)	0.1	0.17	94%

ternal changes. In our design, every building has nodes, and using those nodes, we made some changes in the application part. In every building, we have 10 workstations that are connected in a 10 BaseT. We have made some changes in that part as well. We have made some changes in the server department as well. In our design, we have three scenarios: simple network, busy network, and Q4 fat network. In our connection, we used two types of wire. These are 10 BaseT and 100 BaseT wires. Both are IEEE standards for LAN Ethernet connections. On 10 BaseT Ethernet connections, data speed can reach 10 MBPS (megabits per second); on the other hand, on a 100 BaseT Ethernet connection, data speed can reach up to 100 MBPS. So, we use two different wires in our design, which makes several other changes as well. The fundamental difference between the 4 and 5 building models is the enhancement of traffic, and due to this extra traffic, there is

Table 2. Comparison of both networks through the data table

	PROPOSED MODEL (FOUR BUILDING)			COMPARING MODEL (FIVE BUILDING MODEL)		
	HTTP(Page Response Time)Sec	TCP Delay(Second)	CPU Utilization(Second)	HTTP(Page Response Time)Sec	TCP Delay(Second)	CPU Utilization(Second)
First Scenario(Simple Network)	0.09	0.0255	92%	0.20	0.0287	89%
Second scenario(busy network)	0.25	0.0575	76%	0.28	0.0585	72%
Third scenario(q4 fast network)	0.06	0.0152	96%	0.15	0.0186	91%

more delay in the 5-building design.

6 Discussion

Throughout the last two (2) decades, computer network vision has actively used and implemented the planning, designing, and improvement of networks with dissimilar users, hosts, services, and subnets. The riverbed modeler 17.5 has been shown to improve the vision of the current computer network and is a fragment of green computing. Experiment results show that the average HTTP page response time has been condensed to close to 0.28 seconds for four buildings in the local area. This indicates that the Q4_faster network has enlarged bandwidth and has better performance than the Utech-designed busy network, which has more traffic and loads. Similarly, for five buildings in the local area, the average HTTP page response time has been condensed to nearly 0.25 seconds. So, the four-building network model has better performance than the others.

7 Conclusion

From the obtained graphs, it is clear that, in both the four-building model and the five-building model, Q4's fast network has given us better performances compared to a simple and busy network. A busy network has always given us poor performance compared to the other two parameters. In the four-building model for simple network HTTP, the value of page response time, TCP delay, and CPU utilization are 0.09, 0.0255, and 92% respectively, whereas in the five-building model we get 0.20, 0.0287, and 89% for the same parameters. On the other hand, Q4 fast network has also provided data for four buildings which are 0.06, 0.0152, and 96%, and for five buildings, these are 0.15, 0.0186, and 91% consequently. Finally, it can be decided that Q4's fast network has given us better performances. Comparing two network model of the local area, the performance of the 4-building network outperforms the 5-building network model. According to the consequences of the simulations, the Riverbed Academic Edition, Version 17.5, is considered as a useful tool for the design and performance optimization of local area computer networks.

8 Future Scope

While analyzing the smart meter network, several different cases and scenarios were considered. A cloud environment included smart meters with wireless connections to other network elements, such as nodes, routers, switches, and servers. Connect utility servers in a cloud environment with a wireless AMI network similar to the wired one. Smart Meter can evaluate the results of FTP, database, and HTTP requests through Riverbed OPNET Simulation. This complex smart grid system is believed to be fundamentally reliant on advanced metering infrastructure.

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