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Proposing Minimum Performance of Proposed Topology in Plateau State University

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ABSTRACT

This paper is restricted to the computer network of Plateau State University Bokkos, which is located in Plateau State, Nigeria, in the western part of Africa. The existing network topology of Plateau State University Bokkos (PSU) was investigated via interview method of survey and topology simulated (from simulation panel) and discussed, of which a topology requirement was proposed, which has been published in International Journal of Computer networks and Communications Security (IJNCS). But, this paper presents the simulation outputs carried out by 'ping' utility (from command prompt). The confirmed topology or layout designed is simulated for performance outputs based on parameters like Throughput, Delay and Packets Loss, which will further be analyzed statistically. We use the results of the statistical analysis to present the possible performance of the topology to be proposed for PSU. CISCO Packets Tracer simulator was used for all necessary designs and simulation. In the end, a set of topology performance values will be obtained based on the specified parameters and used to predict the minimum performance values for the subsequent topology, indicating improvement over the simulated one. This is useful for newly established University like Plateau State University Bokkos.

Keywords: *Campus Area Network, Network Simulation, Statistical Analysis, Performance evaluation, Performance Parameters.*

1 INTRODUCTION

The performance of any computer network is certainly influenced by the technology, which we adopt in making network interconnections. Network topologies (Banerjee, S. et al, 1999; Cem Erosy and Shivendra PanWar, 1992; C. M. Harris, 2008; D. Bertsekas and R. Gallager, 1992) are the technology for arrangement of various computer elements like links, nodes etc. Basically network topology is the topological structure (Geon Yoon and Dae Hyun Kwan, 2006) of a computer network. In mathematics topology is concerned with the connectedness of objects which is the most basic properties of space. In simple term, network topology refers to the way in which the network of computers (Nicholas F. Maxemchuk and Ram Krishnan, 1993; Bannister, J.A. et al, 1990) is connected. Each topology is suited to specific tasks and has its own advantages and disadvantages. A most simple and good example of network topology is a Local Area Network (LAN) (F. Backes, 1988; Li Chiou Chen, 2004). A situation where a node has two or more physical links to other devices in the network, a star topology is described. Which is the most commonly adopted topology in most campuses. In recent days there are basically two categories of network topologies: Physical topologies and Logical topologies. Physical Network Topology emphasizes the hardware associated with the system including workstations, remote terminals, servers, and the associated wiring between assets. The existing network topology of Plateau State University Bokkos (PSU) is being investigated via interview method of survey (Datukun et al, 2016c). With the help of the Technical Staff the University, information about the topology was collected and/or confirmed via observation. The confirmed topology or layout will be design and simulated for behavioural outputs.

2 LITERATURE REVIEW

Local Area Networks (LAN) and Campus Area Networks (CAN) are synonymous. However, CAN could interconnect LANs with geographically dispersed users to create connectivity (Zubbair S. et al, 2012). Network Topology shows the way in which a set nodes are connected to each other by links (Qatawneh Mohammed et al, 2015), which basically is synonymous to CAN. The links and nodes constitutes basic requirement for network installation (Datukun et al 2016a). T1 (William, 1998), T3 (Regis, 1992), ATM (Koichi et al., 1997), ISDN (Jonathan, 2004), ADSL (Michel, 2003), frame relay (Jim, 1997), radio links (Trevor, 1999), amongst others, constitutes few of these technologies. Technologies are accompanied with various topologies and model of deployment that best suit the technology.

A network for optimal performance and meeting users' need is key in every campus, which always needs attention. Properly selecting of equipments to be deployed after considering the requirements of the users is necessary (Sood, 2007). The impact of TCP window size on application performance as against the choice of an increased bandwidth can help boost network (Panko, 2008b). The use of redundant links may also increase performance, implement load balancing and utilise links from say 92% to 55% and response time reduced by 59% (Panko, 2008; Seung-Jae, 2008). From a risk and performance point of view, it is desirable to break a larger campus networks into several smaller collapsed modules and connect them with a core layer (Robert, 1998). Distribution modules are interconnected using layer 2 or 3 core (Tony, 2002). In effect, the layer 3 switches at the server side become a collapsed backbone for any client to client traffic (Graham, 2010).

A Gigabit Ethernet channel can be used to scale bandwidth between backbone switches without introducing loop (Rich and James, 2008). A truncking capacity is necessarily provided into the backbone of any network design (Jerry and Alan, 2009). Hierarchical design is common in practice, when designing campus or enterprise networks (Saha and Mukherjee, 1999; Sami et al, 2002). There is no need to redesign a whole network each time a module is added or removed, provided a proper layout has being in place. But, a better topology for improving performance (Datukun et al, 2016b) in view, due to improper designed is called for. This capability facilitates troubleshooting, problem isolation and network management (Damianos et al., 2002) is necessary in an ideal CAN. In a hierarchical design (Saha et al., 1993), the capacity, features, and functionality of a specific device are optimized for its position in the network and the role that it plays. The number of flows and their associated bandwidth requirements increase as they traverse points of aggregation and move up the hierarchy from access to distribution and to core layer (Awerbuch et al., 2000).

In network analysis, problems related to network mapping, characterization, sampling, inference and process can be adopted (Eric D. Kolazyk, 2009). This has to do with identifying the network components; nodes and routing system, which has to do with the analysis of the path. It could also be mathematical analysis of the network that yields explicit performance expressions (Leonard Kleinrock, 2002). This study is concerned with simulating the existing topology for proposing a better topology requirement for improving network performance.

3 METHODS

The methods used for survey were interview and observation, which was presented in my previous paper titled "Towards proposing network topology for Plateau State University Bokkos", with IJCN, of which this paper is a continuation.

The paper presented the analyzed results of the survey, graph model, the physical topology, simulation outputs via simulation panel and further present a topology requirement for subsequent design.

In this work, we will simulate the same physical topology from command prompt via 'ping' utility and analyze the outputs based on Throughput, Delay and Packets loss for performance evaluation. We will then propose the minimum performance of the intending topology for subsequent design.

4 RESULTS

The results of this work constitute the topology presented in the previous paper and the prints of simulation outputs from command prompt, which will subsequently be analyzed statistically.

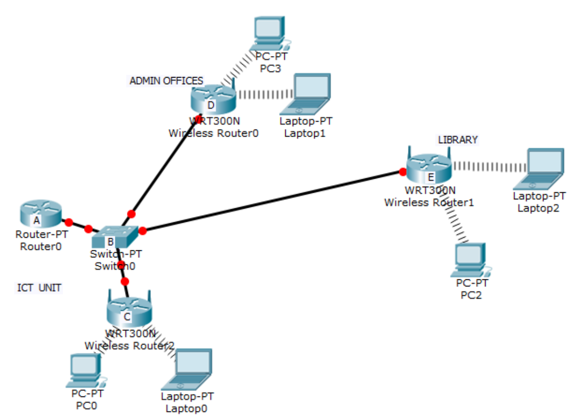

Fig. 1. PSU Physical Topology

Figure 1 is PSU network which carries one IP block ("192.168.0.0"), within block C, which was used to configure the topology before simulation. After the configuration of the physical topology, it was simulated through 'ping' utility and the outputs are thus presented below:

```
Packet Tracer PC Command Line 1.0
PC>ping 192.168.0.1

Pinging 192.168.0.1 with 32 bytes of data:

Reply from 192.168.0.1: bytes=32 time=25ms TTL=255
Reply from 192.168.0.1: bytes=32 time=81ms TTL=255
Reply from 192.168.0.1: bytes=32 time=12ms TTL=255
Reply from 192.168.0.1: bytes=32 time=14ms TTL=255

Ping statistics for 192.168.0.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 12ms, Maximum = 81ms, Average = 33ms

PC>ping 192.168.0.102

Pinging 192.168.0.102 with 32 bytes of data:

Reply from 192.168.0.102: bytes=32 time=22ms TTL=128
Reply from 192.168.0.102: bytes=32 time=19ms TTL=128
Reply from 192.168.0.102: bytes=32 time=38ms TTL=128
Reply from 192.168.0.102: bytes=32 time=37ms TTL=128

Ping statistics for 192.168.0.102:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 19ms, Maximum = 38ms, Average = 29ms
```

Fig. 2. PSU- PC0 pings gateway and laptop 2

From figure 2 above, we will observe that PC0 was used to ping the gateway (192.168.0.1), which is the gateway to the Internet. It was also used to ping a neighbour (Laptop 2-192.168.0.102). the reply showing connectivity success with the packets rate sent as 4, received as 4 and loss as 0 and average delays (RTT) of 33ms and 29 ms respectively. The TTLs are 255 and 128 accordingly.

```
Command Prompt

Packet Tracer PC Command Line 1.0
PC>ping 192.168.0.1

Pinging 192.168.0.1 with 32 bytes of data:

Reply from 192.168.0.1: bytes=32 time=27ms TTL=255
Reply from 192.168.0.1: bytes=32 time=22ms TTL=255
Reply from 192.168.0.1: bytes=32 time=21ms TTL=255
Reply from 192.168.0.1: bytes=32 time=21ms TTL=255

Ping statistics for 192.168.0.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 21ms, Maximum = 27ms, Average = 22ms

PC>ping 192.168.0.101

Pinging 192.168.0.101 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 192.168.0.101:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

Fig. 3. PSU-Laptop0 pings gateway and PC3

Table 3 shows that Laptop 0 pings the gateway and PC3 with their IP addresses indicated accordingly. We will observe that this 'ping' result shows that the gateway was properly connected while the other neighbour was timing out because the set TTL runs out without finding the destination hub.

```
Command Prompt

Packet Tracer PC Command Line 1.0
PC>ping 192.168.0.1

Pinging 192.168.0.1 with 32 bytes of data:

Request timed out.
Reply from 192.168.0.1: bytes=32 time=17ms TTL=255
Reply from 192.168.0.1: bytes=32 time=16ms TTL=255
Reply from 192.168.0.1: bytes=32 time=27ms TTL=255

Ping statistics for 192.168.0.1:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
    Minimum = 16ms, Maximum = 27ms, Average = 20ms

PC>ping 192.168.0.102

Pinging 192.168.0.102 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 192.168.0.102:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

Fig. 4. PSU-PC 2 pings gateway and PC0

Figure 4 show that PC2 pings the gateway and a neighbour, PC0. A packet was loss while pinging gateway but lost all pinging her neighbour. This shows a kind of looping situation that makes the TTL value set by the source PC to count off without finding her destination neighbour, PC0.

```
Command Prompt

PC>ping 192.168.0.1

Pinging 192.168.0.1 with 32 bytes of data:

Reply from 192.168.0.1: bytes=32 time=22ms TTL=255
Reply from 192.168.0.1: bytes=32 time=19ms TTL=255
Reply from 192.168.0.1: bytes=32 time=7ms TTL=255
Reply from 192.168.0.1: bytes=32 time=14ms TTL=255

Ping statistics for 192.168.0.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 7ms, Maximum = 22ms, Average = 15ms

PC>ping 192.168.0.101

Pinging 192.168.0.101 with 32 bytes of data:

Reply from 192.168.0.101: bytes=32 time=46ms TTL=128
Reply from 192.168.0.101: bytes=32 time=7ms TTL=128
Reply from 192.168.0.101: bytes=32 time=23ms TTL=128
Reply from 192.168.0.101: bytes=32 time=17ms TTL=128

Ping statistics for 192.168.0.101:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 7ms, Maximum = 46ms, Average = 23ms
```

Fig. 5. PSU-Laptop1 pings gateway and Laptop2

Figure 5 describes that Laptop 1 pings the gateway and Laptop 2. The pinging in this scene was successful. We will observe that the packets were all successfully delivered with no packets lost. Also, the RTT was 15 ms and 23ms with TTL of 255 and 128 respectively.

Next, we present the statistical analysis for performance evaluation based on specified parameters:

Table 1: PSU- network hop count

TTL	Hop Count(255-TTL) (h)	Frequency (f)	Cumulative Frequency	hf
255	0	15	15	0
128	127	8	23	1016
0	255	9	32	2295
$\sum_{h,f=0}^{n}(hf)$				3311

Average Hop count=$\frac{3311}{32}$=103 (approx.), using table 1 data.

Table 2: PSU-Throughput (Packets Sent)

Packets Sent (s)	Frequency (f)	Cum. Freq.	Sf	Percentage (%)
4	8	8	32	100
$\sum_{s,f=0}^{n}(sf)$			32	

Average Packets Sent=$\frac{32}{8}$=4, %of Packets sent=$\frac{32}{32}(100) = 100\%$, from Table 2 data.

Table 3: PSU-Goodput (Packets Received)

Packets Received (r)	Frequency (f)	Cum. Freq.	Rf	Percentage (%)
4	5	5	20	100
3	1	6	3	75
0	2	8	0	0
$\sum_{r,f=0}^{n}(rf)$			23	

Average Packets Received=Average Goodput=Average actual-delivered-Throughput=$\frac{23}{8} = 2.8$ (approx.), %Goodput $=\frac{\text{Total packets received}}{\text{Total packets sent}} \times 100$=$\frac{23}{32}(100) =$ 71.8% (approx.), using values from Table 3.

Table 4: PSU-Packets Loss

Packets Loss (l)	Frequency (f)	Cum. Freq.	Lf	Percentage (%)
4	2	2	8	100
1	1	3	1	25
0	5	8	0	0
$\sum_{l,f=0}^{n}(lf)$			9	

Average Packets Loss=$\frac{9}{8} =$ 1.1 (approx.)=$\frac{\text{Total Packets Lost}}{\text{Total Packets Sent}}(100)$=$\frac{9}{32}(100) =$ 28.1%(approx.), using values from Table 4.

Table 5: PSU-Transmission delay

Delay (d)(ms)	Frequency (f)	Cum. Freq	df
25	1	1	25
81	1	2	81
12	1	3	12
14	2	5	28
22	3	8	66
19	2	10	38
38	1	11	38
37	1	12	37
27	2	14	54
21	2	16	42
17	2	18	34
16	1	19	16
7	2	21	14
46	1	22	46
23	1	23	23
$\sum_{D,F=0}^{n}(DF)$			554

Average delay=$\frac{554}{23} = 24$ ms (approx.), using values from Table 5.

Table6: Values of Performance parameters

University	Parameters	Hop Count	Delay (ms)	Throughput delivered (goodput) (%)	Packets Loss (%)
PSU		103	24.0	71.8	28.1

5 DISCUSSIONS

Figure 1 is PSU network which carries one IP block (“192.168.0.0”), within block C, which was used to configure the topology before simulation. After the configuration of the physical topology, it was simulated through ‘ping’ utility. From figure 2 above, we will observe that PC0 was used to ping the gateway (192.168.0.1), which is the gateway to the Internet. It was also used to ping a neighbour (Laptop 2-192.168.0.102). the reply showing connectivity success with the packets rate sent as 4, received as 4 and loss as 0 and average delays (RTT) of 33ms and 29 ms respectively. The TTLs are 255 and 128 accordingly.

Table 3 shows that Laptop 0 pings the gateway and PC3 with their IP addresses indicated accordingly. We will observe that this 'ping' result shows that the gateway was properly connected while the other neighbour was timing out because the set TTL runs out without finding the destination hub. Figure 4 show that PC2 pings the gateway and a neighbour, PC0. A packet was loss while pinging gateway but lost all pinging her neighbour. This shows a kind of looping situation that makes the TTL value set by the source PC to count off without finding her destination neighbour, PC0. Figure 5 describes that Laptop 1 pings the gateway and Laptop 2. The pinging in this scene was successful. We will observe that the packets were all successfully delivered with no packets lost. Also, the RTT was 15 ms and 23ms with TTL of 255 and 128 respectively.

Table 1 describes the average hopcount, which explains the average number of routers a packets passes as it gets to her destination. Tables 2-5 describes the average packets sent, received (goodput), lost and delay accordingly. This were based on the earlier specified parameters.

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7 CONCLUSION

Considering the values in Table 6, the topology that will be designed subsequently, would need to have upgraded values. Good puts may need to be 73 % or above, packets loss below 28% and delay below 24 ms if it has to perform better than this existing one. The hop count needs to be smaller without 'time out' as well.

8 REFERENCES

[1] Banerjee, S., Jain, V., Shah, S. (1999). Regular multihop logical topologies for lightwave networks. Communications Surveys & Tutorials, IEEE. 2 – 18. 2(1). First Quarter

[2] Cem Ersoy and Shivendra PanWar (1992). Topological Design of Interconnected LAN-MAN Networks. IEEE INFOCO. 2260- 2269.

[3] Backes F. (1988). Transparent Bridges for Interconnection of IEEE 802 LANs. IEEE Network. 5-9.

[4] Li Chiou Chen (2004). The Impact of Countermeasure Propagation on the Prevalence of Computer Viruses. IEEE Transactions on Systems, MAN, and Cybernetics PartB; Cybernetics. 823-833. 34 (2).

[5] Geon Yoon, Dae Hyun Kwan, Soon Chang Kwon, Yong Oon Park and Young Joon Lee (2006). Ring Topology-based Redundency Ethernet for Industrial Network. SICE-ICASE International Joint Conference. 1404 – 1407. 18-21.

[6] Nicholas F. Maxemchuk, Ram Krishnan (1993). A Comparison of Linear and Mesh Technologies---DQDB and Manhattan Street Network. IEEE Journal on Selected Areas in Communications. 11 (8).

[7] Bannister, J.A., Fratta, L. and Gerla, M. (1990) Topological design of the wavelength-division optical network, INFOCOM, Ninth Annual Joint Conference of the IEEE Computer and Communication Societies. The Multiple Facets of Integration. Proceedings, IEEE. 1005 – 1013. 3.

[8] Harris C. M. (2008). Fundamentals of Queueing Theory, Wiley Series in Probability and Statistics. John Wiley & Sons, Hoboken, NJ, USA, 4th edition.

[9] Bertsekas D. and Gallager R. (1992). Data Networks, 2nd ed. Englewood Cliffs,.NJ: Prentice-Hall.

[10] Qatawneh Mohammad , Ahmad Alamoush, Sawsan Basem , Maen M. Al Assaf and Mohammad Sh. Daoud (2015). Embedding bus and ring into hex -cell interconnection network . International Journal of Computer Networks & Communications (IJCNC). 7(3).

[11] Awerbuch B, Du Y and Shavitt Y (2000). The effect of network hierarchy structure on performance of ATM PNNI hierarchical routing Comput. Commun., 23(10): 980-986

[12] Damianos G, Dominic G, Mohammed G, Mike O (2002). Hierarchical network management: a scalable and dynamic mobile agent-based approach Comput. Networks. 693-711. 38(6).

[13] Graham C (2010). Algorithms for Next Generation Networks (Computer Communications and Networks) Springer; 1st Edition. Edition p. 462.

[14] Jerry F, Alan D (2009) Business Data Communications and Networking.

[15] Jonathan C (2004). Cisco Frame Relay Solutions Guide. Cisco Press; 2nd edition. 696.

[16] Koichi A, Tadanobu O, Masatoshi K, Yoichi M, Katsuyuki Y, Hiroyuki I, Shin-Ichi K and Takumi O (1997). Introduction to ATM

Networks and B- ISDN. John Wiley & Sons; 1st edition.

[17] Michel B (2003). ADSL - Edition 2003 Campus Press. 360.

[18] Panko R (2008b). Predicting the Impact of TCP Window Size on Application Performance. OPNET University Program. 8.

[19] Panko R Inc (2008). Evaluating Application Performance across a WAN. OPNET University Program. Regis J. 16.

[20] Robert C (1998). Wide Area Network Design: Concepts and Tools for Optimization (The Morgan Kaufmann Series in Networking) Morgan Kaufmann 1st edition. 441.

[21] Saha D, Mukherjee A (1995). Design of hierarchical communication networks under node/link failure constraints Computer Communications, 378-383. 18(5).

[22] Saha, D, Mukherjee, A, Dutta SK (1993). Hierarchical design of large computer communication networks, Technical Re- port JU/CSE/AM/93/DS-2, Department of CSE, Jadavpur University, India

[23] Sami JH, Alice CP, Daniel CL (2002). Automated design of hierarchical intranets Computer Communications. 1066-107525(11-12).

[24] Sood A (2007). Network Design By Using Opnet™ It Guru Academic Edition Software. Rivier Acad. J., 3(1). 8.

[25] Tony K (2002). High Performance Data Network Design: Design Techniques and Tools (IDC Technology) Digital Press; 1st edition. 480.

[26] Leonard Kleinrock (2002). Creating a Mathematical Theory of Computer Networks.

[27] Eric D. Kolaczyk (2009). Tutorial: Statistical Analysis of Network Data. SAMSI Program on complex Networks. Opening workshop Department of Mathematics and Statistics. Boston University.

[28] Datukun Kalamba Aristarkus, Sellappan Palaniappan, Tatchanaamoorti Purnshatman (2016c). Towards proposing network topology for improving performance in Plateau State University Bokkos. International Journal of Computer Networks and Communications Security (IJCNCS). 4(9). 259-264. http://www.ijcncs.org/published/volume4/issue9/index.php

[29] Datukun Kalamba Aristarkus, Sellappan Palaniappan, Tatchanaamoorti Purnshatman (2016b). Towards proposing network topology upgrade in Salem University Lokoja. Journal of Conputer Science and Information Technology (JCSIT). Research Publish Journals. 4(3). http://www.researchpublish.com/journal/IJCSITR/Issue-3-July-2016-September-2016/0

[30] Datukun Kalamba Aristarkus, Sellappan Palaniappan, Tatchanaamoorti Purnshatman (2016a). Towards improving network installation in Plateau State University Bokkos. Pyrex Journals of Computer and Information Systems (PJCIS). Pyrex Journals. 1(1). 1-8. http://www.pyrexjournals.org/articles.php