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Hybrid Topology design in the lime light of graph model generating

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Abstract This paper is about 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 a concern, resulting to poor internet service delivery. It was investigated via interview and observation, designed and simulated for performance outputs, towards proposing a topology for improving network performance. The interview questions used for existing network is also used for the intending topology and is presented in the appendix. This is being used to collect the network data of the proposed topology and was confirmed with the observed data. The topography of the University was observed for specific characterization of the proposed topology and subjected to technical critism for customer satisfaction. Hence, this paper presents the matrix formulation for binary matrix representation of the graph model of the proposed topology. The graph model is being generated from the obtained binary matrix, manually derived by applying the formulated matrix that was formulated from the tabulated network data that characterized the intending topology.
The graph model is further generated by keying the binary matrix into online software (graphonline.ur) and presented for physical design, configuration and simulation for performance outputs.

Keywords Matrix Formulation, binary matrix, graph model

Introduction

Any computer network performance is certainly influenced by the technology, which we adopt in making network interconnections. Network topologies [1-4] are the technology for arrangement of various computer elements like links, nodes etc. 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) [5-6]. 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. A graph model can be seen as a logical representation of a network. The existing network topology of Plateau State University Bokkos (PSU) is being investigated via interview method of survey [7], collecting necessary data about the network. This was possible with the help of the technical staff in the University.

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 (. Network Topology shows the way in which a set nodes are connected to each other by links [8], which basically is synonymous to CAN. The links and nodes constitutes basic requirement for network installation [9]. T1, T3, ATM [10], ISDN [11], ADSL

[12], frame relay, radio links, amongst others, constitutes few of these technologies. Technologies are accompanied with various topologies and model of deployment that best suit the technology.

The provision of internet access is a basic need in any University environment due to the fact that teaching, research, administration and community services are more effectively carried out when there is a link to the internet [13]. An optimal performance of a network, meeting users' need requires the network facilities' consideration against improving installation [14]. Properly selecting of equipments to be deployed after considering the requirements of the users is necessary [15]. The impact of TCP window size on application performance as against the choice of an increased bandwidth can help boost network [16]. 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% [17]. 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 [18]. Distribution modules are interconnected using layer 2 or 3 core [19]. In effect, the layer 3 switches at the server side become a collapsed backbone for any client to client traffic [20].

A Gigabit Ethernet channel can be used to scale bandwidth between backbone switches without introducing loop. A truncking capacity is necessarily provided into the backbone of any network design [21]. Hierarchical design is common in practice, when designing campus or enterprise networks [22-23]. 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 [24] in view, due to improper designed is called for. This capability facilitates troubleshooting, problem isolation and network management [25] is necessary in an ideal CAN. In a hierarchical design [26], 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 [27].

In network analysis, problems related to network design, we can adopt network mapping, characterization, sampling, inference and process [28]. This is to further design a graph model before physical design. Diagnosing the physical design can help in predicting the performance of the real network system after installation. But, this paper gives us a pre-design process of the physical design. We shall be using the adjacency matrix of the following form.

$$A_{ij} = \begin{cases} 1 & \text{if there is an edge between vertices } i \text{ and } j, \\ 0 & \text{otherwise.} \end{cases} \qquad \text{…………(eqn 1)}$$

Methods

Interview and observation was used for the existing network. The questions used to collect network data is presented in the Appendix, which is also being used for the proposed topology.

Results

Table 1: Links and Weights of proposed Topology

Path Descriptions	Weight (meters)
R1-S1	70
R1-S3	85
R2-S2	96
R2-S4	75
S1-S5	50
S1-S2	60
S5-S6	50
S2-S7	50
S3-S8	50
S3-S4	60
S8-S9	50

S9-S10	50
S4-S11	50
S11-S12	50
S12-S13	50

In Table 1 above, the various links are presented with their respective weights

Table 2: Number of nodes and links for the proposed Topology

Number of Nodes	Plateau State University (PSU)
Number of nodes	15
Number of links	15

Table 2 above indicates the number of nodes and links accordingly. The similarity in the number of nodes and links shows that the topology is not strictly "star" as it was in the existing topology.

Following the topology characterization in Tables1 and 2, we present the matrix formulation by using Table 1, containing the weights of each link.

$$U_{Hij} = \begin{pmatrix} R1R2, R1S1, \ldots, R1S13 \\ \ldots\ldots\ldots\ldots\ldots\ldots. \\ \ldots\ldots\ldots\ldots\ldots.. \\ \ldots\ldots\ldots\ldots\ldots\ldots \\ S13R1, S13R2, \ldots S13S13 \end{pmatrix} \text{............(eqn 2)}$$

Next, we apply (eqn1) and (eqn 2), denoting all connections by 1 otherwise 0 . Using H as the Hybrid topology, we have;

$$H_{ij} = \begin{matrix} 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \end{matrix}$$

Making reference to the binary matrix, we present the graph model generated from the matrix using an online software (graphonline.ru). This is seen as follows:

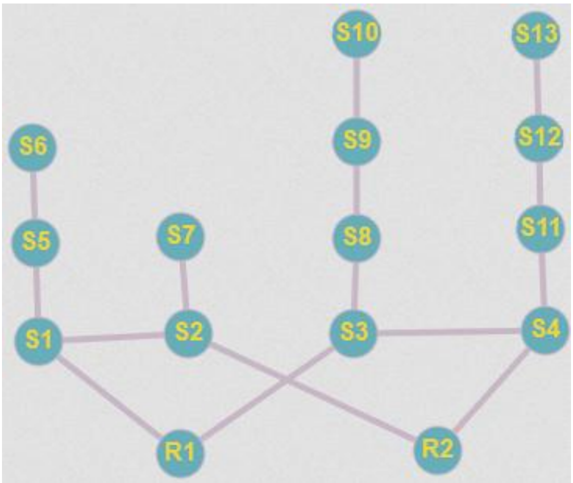

Figure 1: *Hybrid graph model*

Discussions

Tables 1 and 2 shows the basic characterization of the graph model presented. It shows the noted nodes and links (connections) that was used to formulate the matrix based on (eqn 1) as given in this work. The matrix formulation is presented in (eqn 2) while Figure 1 presents the actual graph model that will be used to design the intending physical design. The binary matrix is obtained by manually comparing the weighted links in Table 1 with (eqn 1) and (eqn 2), assigning 1 to weighted links and 0 to non connections accordingly. The graph model in Figure 1 is then generated by keying the binary matrix into an online software (graphonline.ur).

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Conclusion

In conclusion, the graph model in figure 1 is presented for further design and simulation of the physical hybrid topology for subsequent installation.

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Appendix

Computer Network Technical Questions

This interview seeks to collect technical Information on the Computer Networks in the various campuses. These shall be Information on LAN Topology, Network Devices Internet Subscription Information, for the selected University Campus in Nigeria, being administered by Mr. Datukun Kalamba Aristarkus in 2016 to respective technical staff. Your participation in this study is voluntary and will form part of this study and will not identify you as an individual.

Part A- Basic Questions; tick as may apply

1. Staff: Technical ☐ Administrative ☐ IT ☐

Part B-Survey Interview Questions; tick all that applies

1. Topology of the LAN: Star ☐ Bus ☐ Others [Write here]
2. Network Devices: Enterprise ☐ Home Basic ☐ Both ☐
3. Network Media: Category ☐ Fiberoptic ☐ State others [ ]
4. Bandwidth Subscription: Dedicated ☐ Shared ☐
5. Number of Nodes on Network:50 ☐ 100 ☐ Others, Pls write Figure [ ]

Kindly provide the following Information if available on your campus Network: A Network Model or layout, History of Internet Subscription to date.