IASET: Journal of Computer Science
and Engineering (IASET: JCSE)
ISSN(P): Applied; ISSN(E): Applied
Vol. 1, Issue 2, Jul - Dec 2016; 9-18

International Academy of Science, Engineering and Technology
Connecting Researchers; Nurturing Innovations

GRAPH MODEL FOR PHYSICAL TOPOLOGY DESIGN

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ABSTRACT

This paper is limited 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 and analyzed, of which a topology requirement was proposed. Another work used the information provided in that work to design the existing topology in order to guide the proposed topology design. But, this paper presents the graph model of the proposed topology, towards the physical design. The graph model is being generated from the formulated binary matrix, obtained from a survey data that characterized the intending topology.

The graph model is further simulated for shortest path using disktrar algorithm. At the end, a graph model will be proposed towards guiding the physical network design, following the specifications of the graph model. An online software (graphonline.ur) is used to generate and simulate the graph model.

KEYWORDS: Campus Area Network, Graph Model, Binary Matrix, Disktra Algorithm

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. 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. 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 (Datukun et al, 2016c), 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 (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.

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 (Dele et al, 2011). An optimal performance of a network, meeting users' need requires the network facilities' consideration against improving installation (Datukun et al, 2016d). 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 design, we can adopt network mapping, characterization, sampling, inference and process (Eric D. Kolazyk, 2009). This is to further design a graph model before physical design. Diagnosing the physical design (Onwudebelu et al, 2014) can help in predicting the performance of the real network system after installation.

METHODS

Interview and observation was used for the existing network, presented in my previous paper titled “Towards proposing network topology for Plateau State University Bokkos”, of which this paper is a continuation. The previous paper presented the analyzed results of the survey, graph model, the physical topology, simulation outputs via simulation panel and further presents a topology requirement of the existing topology towords subsequent design, of which this paper addresses.

In this paper, we will present the graph model for the intending physical topology, whose information was collected by characterizing the campus and tabulating the nodes/links requirements as will be seen in the results section. The characterization was done by moving round the campus, observing the necessary nodes locations and connections (links) before subjecting the data to objective critism by some technical staff in the campus.

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	University	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 binary matrix denoting all connections by 1 otherwise 0. Using H as the Hybrid topology, we have;

$H_{ij} =$

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

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

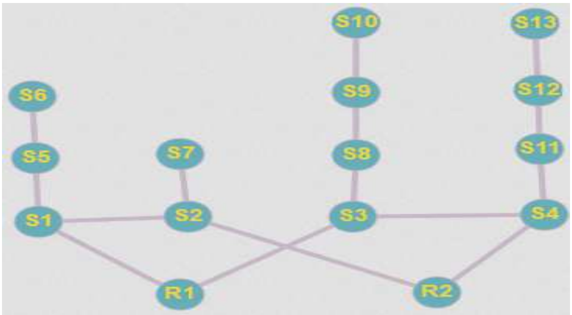

Figure 1: Hybrid Graph Model

The hybrid graph model was simulated for shortest path and the results of the simulation for shortest paths, which was based on disktra algorithms are shown in the figures below:

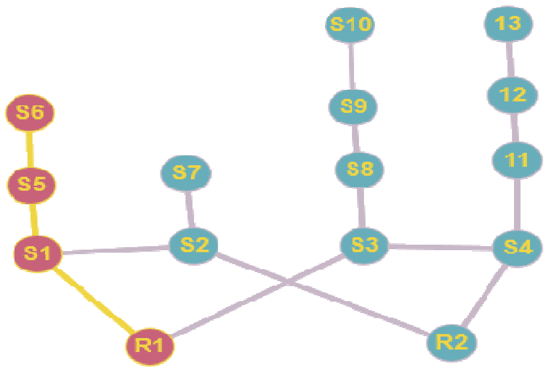

Figure 1: Path 1

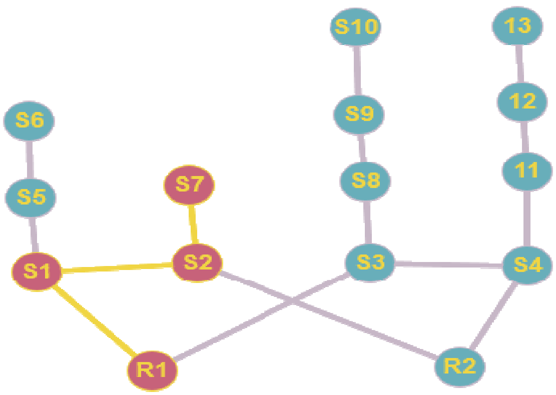

Figure 2: Path 2

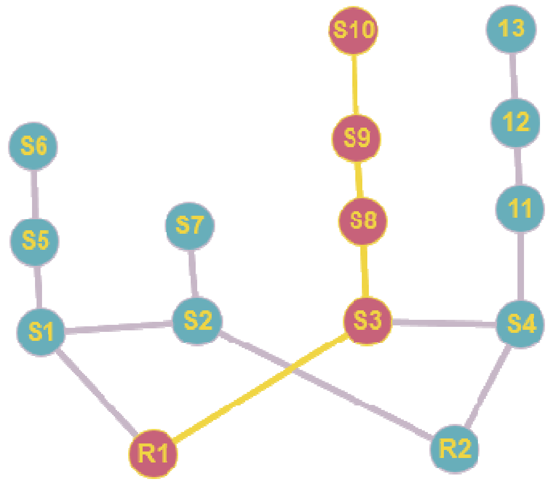

Figure 3: Path 3

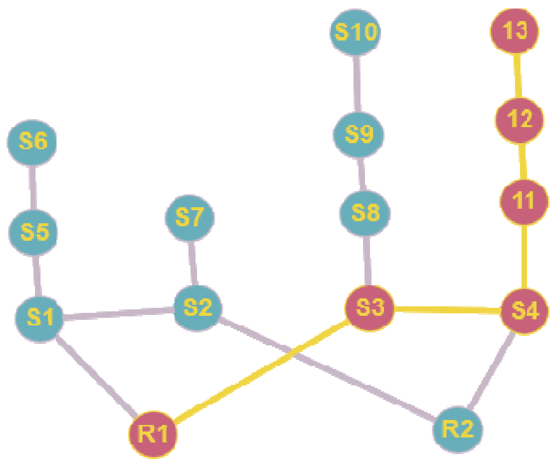

Figure 4: Path 4

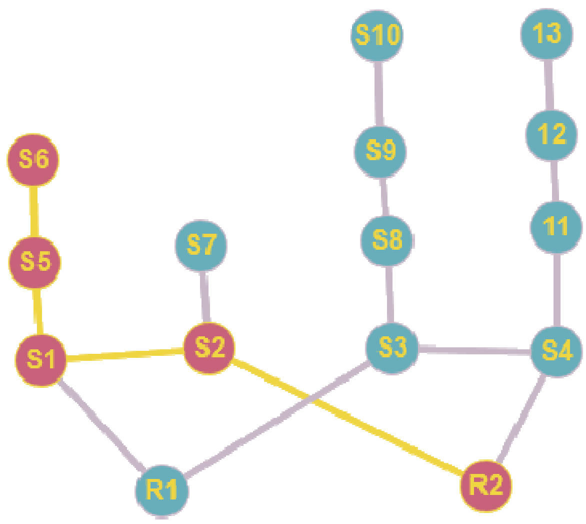

Figure 5: Path 5

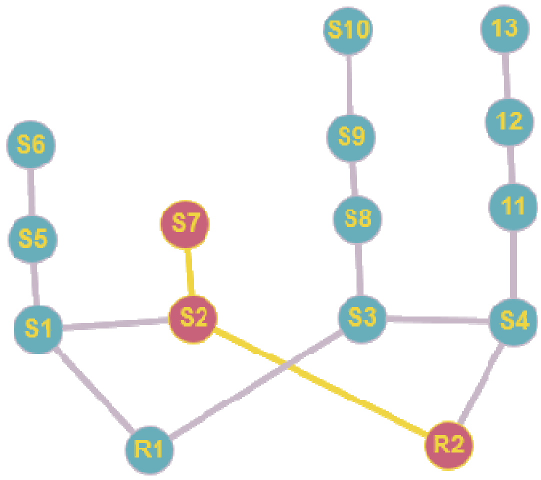

Figure 6: Path 6

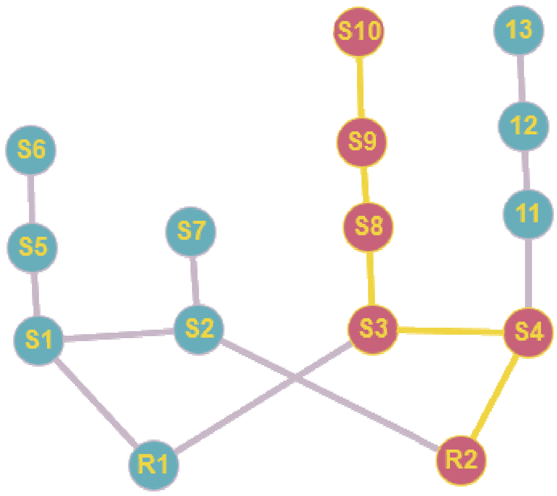

Figure 7: Path 7

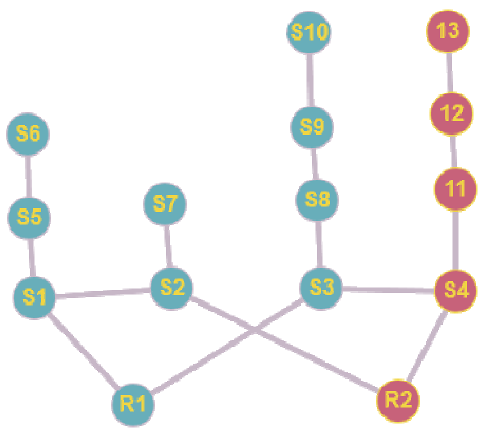

Figure 8: Path 8

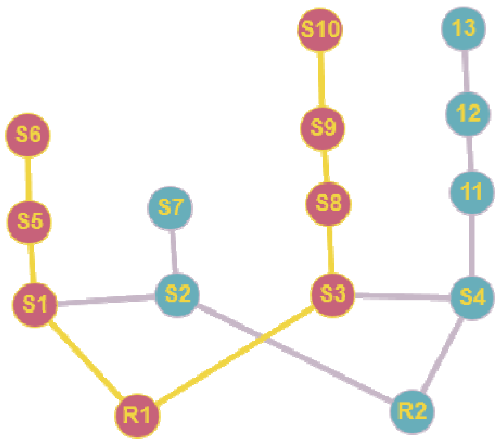

Figure 9: Path 9

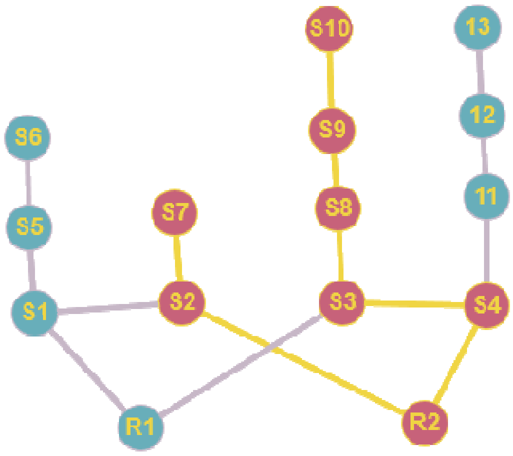

Figure 10: Path 10

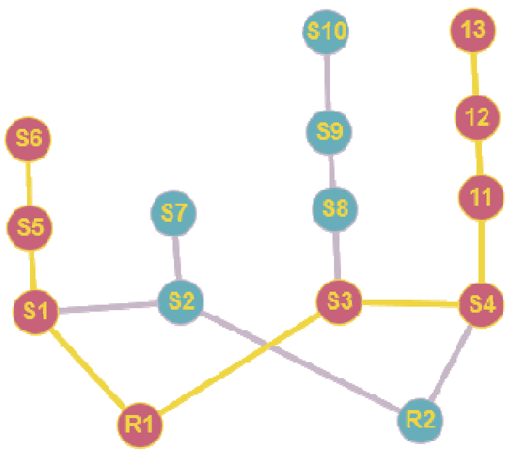

Figure 11: Path 11

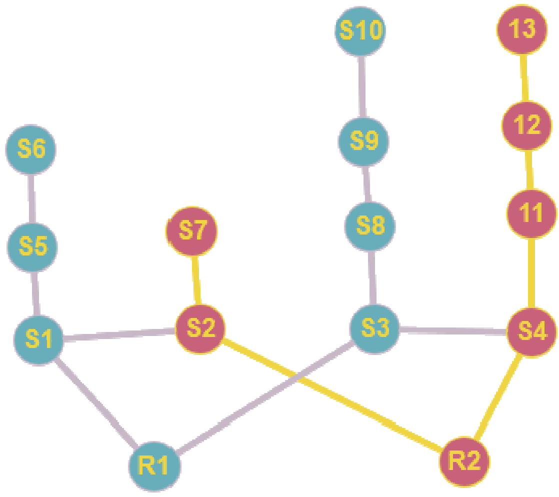

Figure 12: Path 12

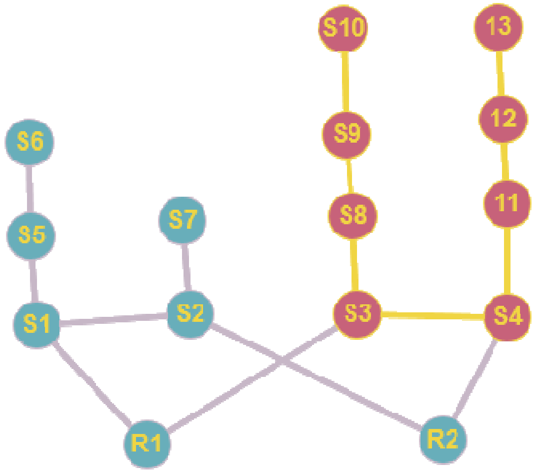

Figure 13: Path 13

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 binary matrix as given in the work. Figure 1 presented the actual graph model that will be used to design the intending physical design. Figures 2-13 presents the simulation trail of the paths traced via the signal transition from one node to the other. The paths shows the shortest paths signals would follow as it moves from one terminal node to the other.

ACKNOWLEDGEMENTS

I thank all the Technical staff in each University under study for being patient so far, providing me with relevant information for this research. I also thank my co-authors for all their contributions in gathering and analyzing the data of this work.

CONCLUSIONS

Following the trail of signal flow of the graph model, we have an idea of how the network will work in terms of signal transmission. Hence, 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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