

Network Configuration by Utilizing Cisco Technologies with Proper Segmentation of Broadcast Domain in FNAS-UMYUK Nigeria

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ABSTRACT

This research work will provide the needs for the Faculty of Natural & Applied Sciences of Umaru Musa Yar'adua University Katsina Nigeria (FNAS-UMYUK) departments to communicate among themselves, in order to share and search on vital and useful information's which will enhance and promote research and learning. This work is strictly based on the movement of data in the seven layers of the Open System Interconnection (OSI) Model and IPv4 is the protocol used in this work. The design variation are based on primarily layer 2 and layer 3 to the access switches with different variations of design which Spanning Tree Protocol (STP) design used for loop avoidance, Virtual Trunking Protocol (VTP) design used for trunking protocol, RIP for routing protocol and server farm design for resource services. The configuration processes of the various design models are based on the packet tracer simulator, and the simulation is conducted and we obtained the result that we are expected for the all proposed design models. Finally, FNAS-UMYUK proposed network designed results to a Scalable, redundant, fast convergence, resilient and easy troubleshooting as the objectives of the research work defined.

Keywords:-Networking, CISCO technology, segmentation, domain, protocol

INTRODUCTION

Networks conceptually means linking group of computer components joints together to share computer resources within a precise location. The improvements of networks includes given the easy access to computer resource i.e. resulted to growing in the efficiency of the users. Resources that are commonly shared in a network include data and applications, printers, network storage components (shared disk space), and backup storage components [10].

A networking organization known as cisco established in 1984 by Sandy Lerner, cisco leads in developing, manufacturing of networking components i.e. hardware's and technological standards. Cisco defined several protocols and produce different hardwares that are currently leading the

networking, telecommunication era in world wide. The achievement that cisco has brought to the world today resulted to efficient, reliable and scalable networks (Mohammad Y. et. al, 2020),[3].

This research work focuses on Campus network Design and Configuration, that connect offices and laboratories in the faculty of natural and applied sciences (FNAS), Umaru Musa Yar'adua University Katsina (UMYUK) that allowed the departments to interact among themselves, in order to share and search on vital and useful information's which will enhance and promote research and learning by adopting cisco technologies.

LITERATURE REVIEW

According to Forouzan B. A. [2], Networks initially means connecting

computers in two commonly classifications, known as Local Area Network (LAN) which is a network based on size that covered a single building or single organization network. Metropolitan Area Network (MAN) which refers to a network that span a city or a state. Another category is Wide Area Network (WAN) that is usually covers a large geographic area like a country. Wireless LANs and WANs (WLAN & WWAN) are the wireless equivalent of the LAN and WAN.

Virtual Local Area Networks (VLANs) are a new type of LAN architecture using intelligent, high-speed switches. Unlike other LAN types, which physically connect computers to LAN segments, VLANs assign computers to LAN segments by software. VLANs have been standardized as institute of electrical and electronic engineers (IEEE) IEEE802.1q and IEEE802.1p. There are two basic designs of VLANs. They are: Single-switch VLANs and Multi-switch VLANs [5].

Network segmentation is the idea of creating sub-networks within a corporate or enterprise network or some other type of overall computer network. Network segmentation allows for the containment of malware and other threats, and can add efficiency in terms of network performance, and with a broadcast domain which is a collection of network devices within one or more segments that receive broadcast traffic from each other [3].

RELATED WORKS

Recently, many works have been carried out on configuration of networks and various campus networks have been configured to meet a set of explicit necessities counting the topology availability, network modes and its reliability.

Nathaniel S. T.[8], this work Designed and

Simulated the Local Area Network Using Cisco Packet trace at department of electrical and electronics engineering, University of Agriculture, Makurdi. The work describes how the tools can be used to develop a simulation model of the LAN for the College of Engineering of the University of Agriculture, Makurdi, Nigeria. The study also provides an insight into various technologies such as topology design, IP address configuration and how to send information in form of packets in a single network and the use of VLANs to separate the traffic generated by different departments which also provides reliability of network designed. In the work a dynamic address configuration was done on the network, i.e. when a client device connects to the network; it is offered an IP address that is available in that network address pool, that the client is connected to.

The next reviewed work is carried by Edward E and Ibiba S[1], in the year 2014, the work focus on modeling network router, switches and security using cisco and OPNET simulation software. The paper exhibit the modeling network routing and security using Cisco network simulation software (packet tracer), which ordinarily will not work without some set of configurations. In the view of researchers, packet tracer has all the tools that can be used to design a Cisco network and accept configurations by a network administrator if they are correct and acceptable by the Cisco equipment. The model is validated through extensive simulation results. The results shown on paper ensured that the routing, switching, and security were fully implemented in the model.

Another work which was carried by Mu'azu M and Yahya F [7], focused on the design of an enterprise network by effectively deploying technologies and protocols as Voice over IP, Access Control

Lists, EIGRP routing, Fiber Optics, VLSM for addressing, Inter VLAN routing, Network Address Translation, use of DHCP and wireless routing. This research also investigated the major requirement that necessitates an enterprise network for the benefit of Network Communication Engineers.

Another research was carried out by Joseph D. E. *et.al* (2019), this research goal is to achieve a much secured network with the availability of redundancy and resiliency for the Faculty of Engineering, Rivers State University, Port Harcourt, Nigeria. Cisco based model for network designed is defined in the paper i.e. Hierarchical Network Model. In result achieve after simulating the designed network it shows that any operator can connect to the network and initiated using http traffic for authentication of user details.

Based on the above literature review on existing works which are related to the research in this paper, it can indicate that none of the research is able to utilize the Cisco technologies for the entire configuration process. Also only one of the researches developed an adapted different server farm of the proposed case study. Finally, based on the researches case study and achievement of the works, it was observed that two of the papers are carried out at the same campus with the same goal but with different strategies, also other two of the papers are from same state, different campus with different goals and strategies, accordingly there is no such related research work in the FNAS-UMYUK.

This research work will design and configure network by utilizing Cisco technologies for the FNAS-UMYUK. Furthermore, this research work would be focus towards achievement of the branded knowledge gap as indicated above. At the completion of this research work, we will developed a solution that would enable a reliable communication with better performance, high speed and simple manageable network for the FNAS-UMYUK and it will also serve as a prototype for other faculties/institutions.

THE PROPOSED SYSTEM

The proposed systems will employ hierarchical model with intended to solve the limitations of FNAS-UMYUK network system which will result to reliable network with high performance, greater speed and simple manageable network. The design will divide into core layer, distribution layer and access layer. The core layer will help to achieve redundancy, reliability and high-speed transmission. Considering the distribution layer will help to provide large bandwidth. The access layer device is the most straightforward device of the end user, and it should have plug-and-play features and easy-to-maintain features. And also the system will use various technological tools for the achievement of the research.

For the configuration of network in this research work, it is necessary some basic requirement are needed to accomplish the work successfully which includes the software's (see Table 1) and technological tools (see Table 2).

Table 1:-Software tools used in this research work

CATEGORY	SOFTWARE NAME	FUNCTIONALITY
Configuration of network	Cisco packet Tracer	Emulate the network design and performance
Network design	Smart draw	Designing the network physical structure
Documentation	Microsoft word 2013	Report documentation
	Microsoft PowerPoint 2013	Presentation preparation
	Microsoft Visio 2013	Gantt chart generation

Without both either one of the requirement, this research goal cannot achieved. Software is basically required to support the simulation work or documentation of project and

technological tools is required to support the configuration of network of FNAS-UMYUK during the simulation processes of this project research.

Table 2:-Technological Tools used in this research work

CATEGORY	TOOL NAME/MODEL	FUNCTIONALITY
Design model	Cisco hierarchical model	Building topology of FNAS
Addressing and routing protocols	IPv4	The standard routed protocol for designed network implementation
	VTP	Trunking protocol
	RIP	Core switches routing protocol
Devices	Layer-1 switch (cisco access P-T)	Interconnected switches for the designed network
	Layer-2 switch (cisco 3650G)	
	Layer-3 switch (cisco 3650G)	
Connectors	Straight through	Connection for end-user to access switch
	Cross over	Connecting the multi-layer switches
	Trunk cable	Connecting switches within a single VLAN

OBJECTIVES OF THE DESIGN

The construction of the FNAS-UMYUK network will be design based from the actual situation and characteristics of the existing network. In the design process, we will concentrate to the practicality of the FNAS-UMUKY network, and the use of CISCO technologies and solutions to ensure the realism of the FNAS-UMYUK network. Hence, at the design process of FNAS-UMYUK follows the following objectives.

- Reliability and high performance networks must be considered; this includes the network-level reliability such as routing, switching aggregation, link redundancy, and load balancing. The network must be of satisfactory performance to gather the requirements of the FNAS-UMYUK network activities.
- Scalability of the system, with the FNAS-UMYUK network growth and level of applications and the need for good network scalability, this is to allow the continuation to upgrade the network of FNAS-UMYUK with the development of technology.
- Simple manageable network, as the FNAS-UMYUK network system is

large and complex application, the need for network management system has to be good manageability. At the same time, the components that we will use must be common product for simple management and maintenance. Here we use the components is Cisco technology.

- Resiliency is also considered; the network must remain available for use under both normal and abnormal conditions. Normal conditions include normal or expected traffic flows and traffic patterns. Abnormal conditions include hardware or software failures, extreme traffic loads, unusual traffic patterns, and other unplanned events.

Design Guidelines

- Each Department has a dedicated VLAN for the Users, Either a wireless access point, an IP Phone or a Workstation Computer that will be connected to the access switch port.
- Each department has a dedicated IPv4 Subnet to cater for the separation of the Layer 2 VLANS and hence separation of broadcast domains.
- Inter-VLAN Routing is done with the VTP in case of Layer 3 to the access

- or layer 2 to the access.
- Layer 2 Trunk links will be used from the Distribution Block to the access Layer Switches Depending on the Design; this is for the layer 2 to the access.
- The Data Centre will be configured in a separate VLAN and Access/Distribution Block; this will house the DNS Servers, such As mail Servers, Web Servers and File/Print Servers.
- The connection Speeds will all be Gigabit Ethernet from the user to the Access Switches and from the Access switches to the Distribution Switches.

- The Connection between the Core-link, i.e. between the distribution Switches to the Core Switches will be Ten Gigabit Ethernet, this is the same as the back to back link between the Core Switches. This is the recommended design for the sake of cost, we will use Gigabit Ethernet all through.

Physical Design of FNAS-UMYUK Network

The Figure 1 depicts the general Physical Connectivity design of the FNAS Network.

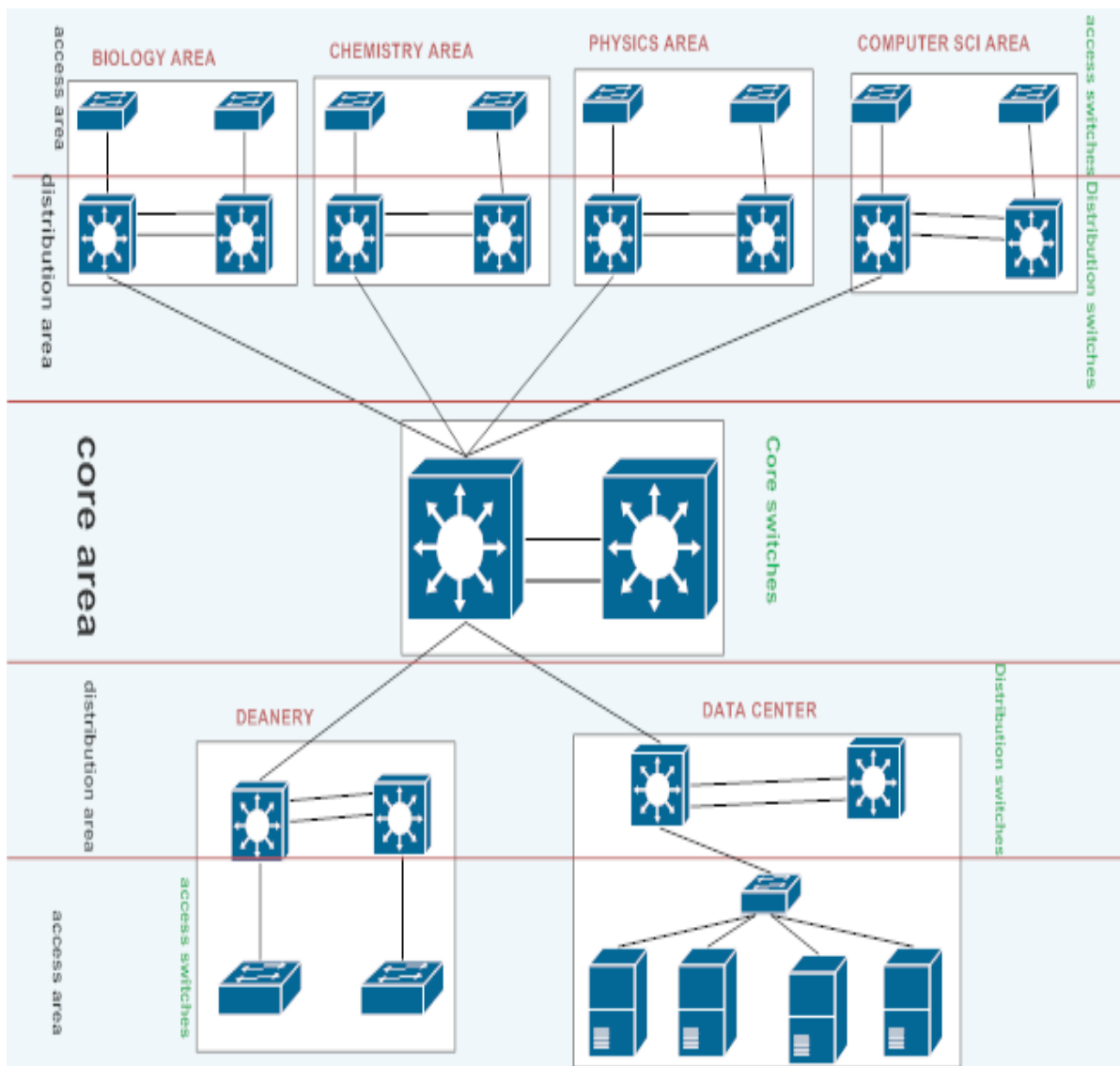


Fig.1:-The FNAS network physical design.

Figure 2 is the Spanning Tree Protocol (STP) designing distribution and access layer

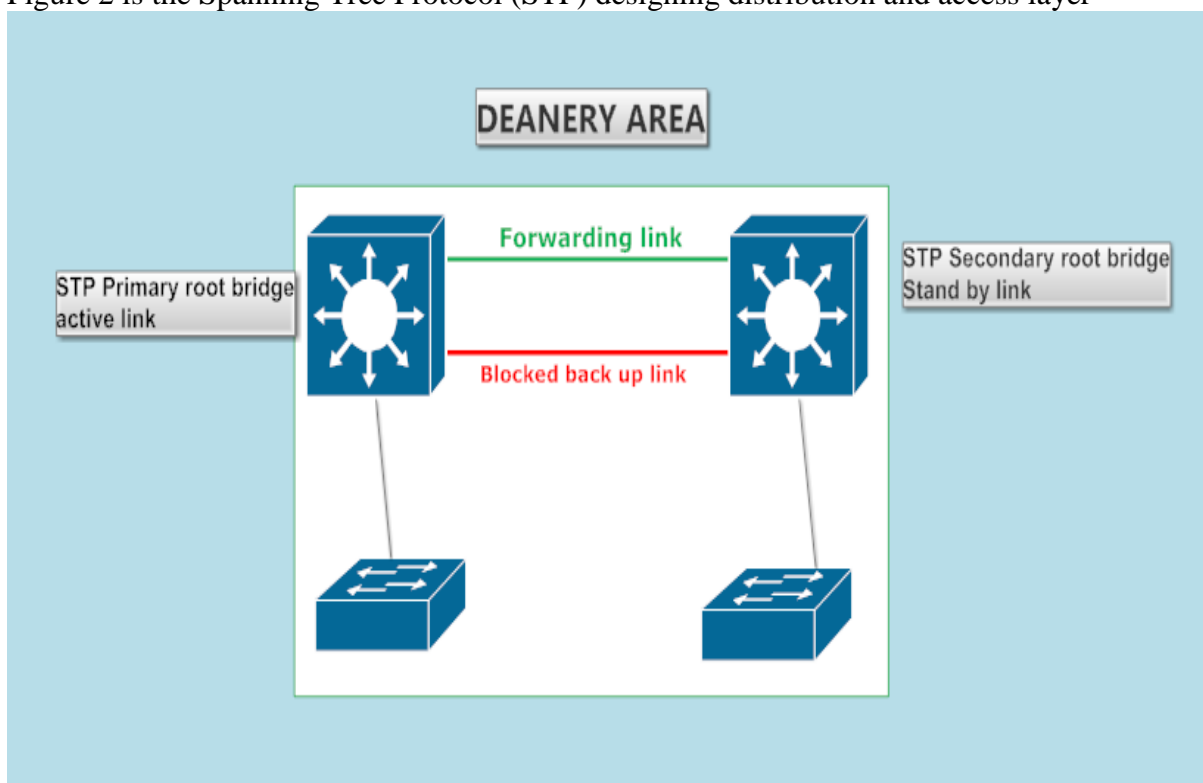


Fig.2:-The STP design

Figure 3 shows the use of VLAN Trunking Protocol (VTP) in distribution and access layer

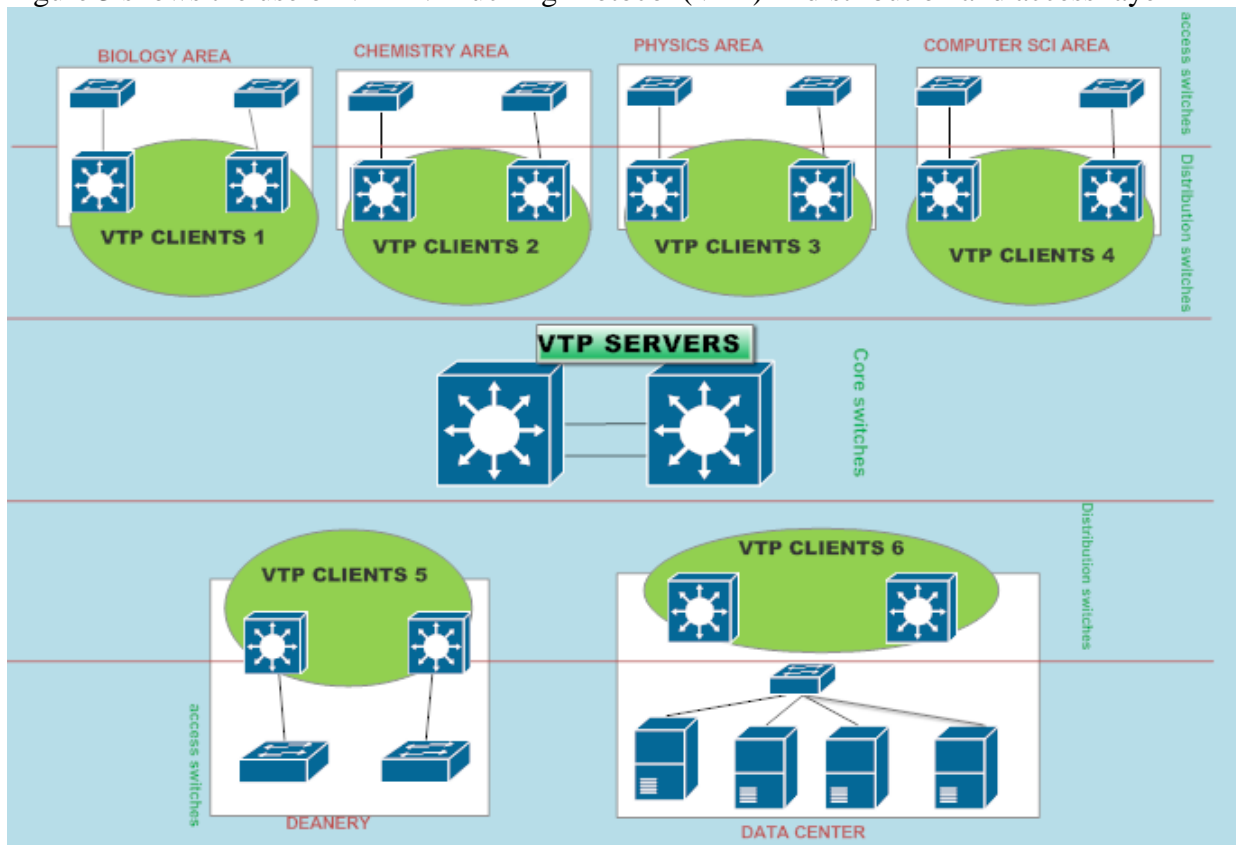


Fig.3:-The VTP Design

Figure 4 shows the use of Routing Information Protocol (RIP) in core area

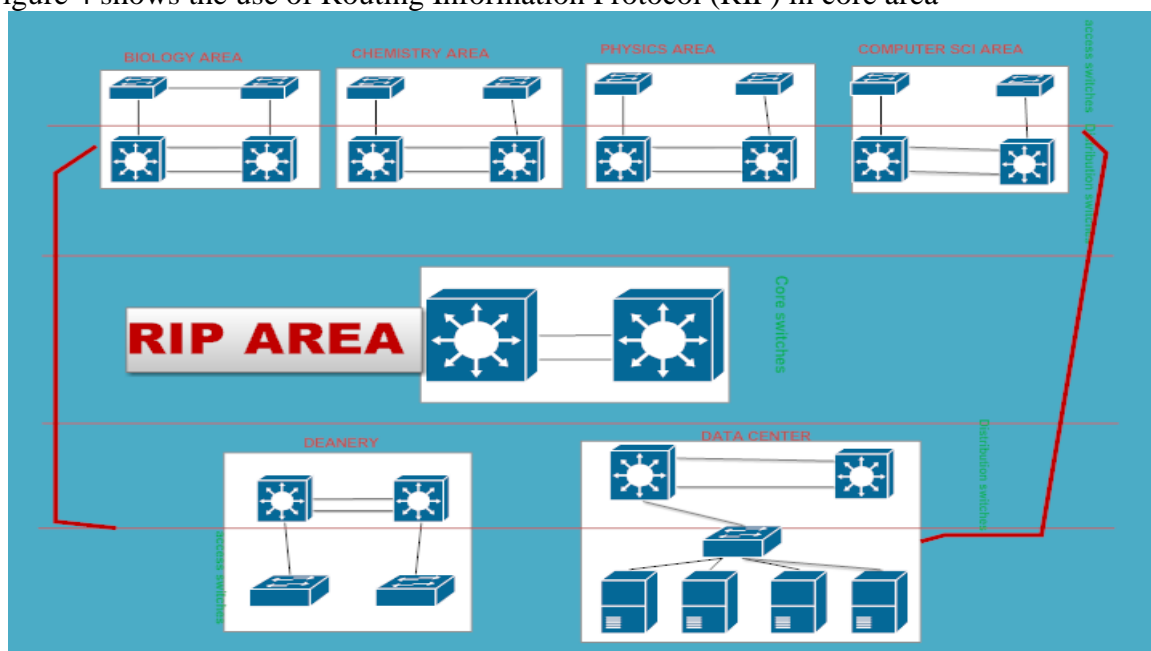


Fig.4:-The RIP Design

The Figure 5 displays the Data Center Design

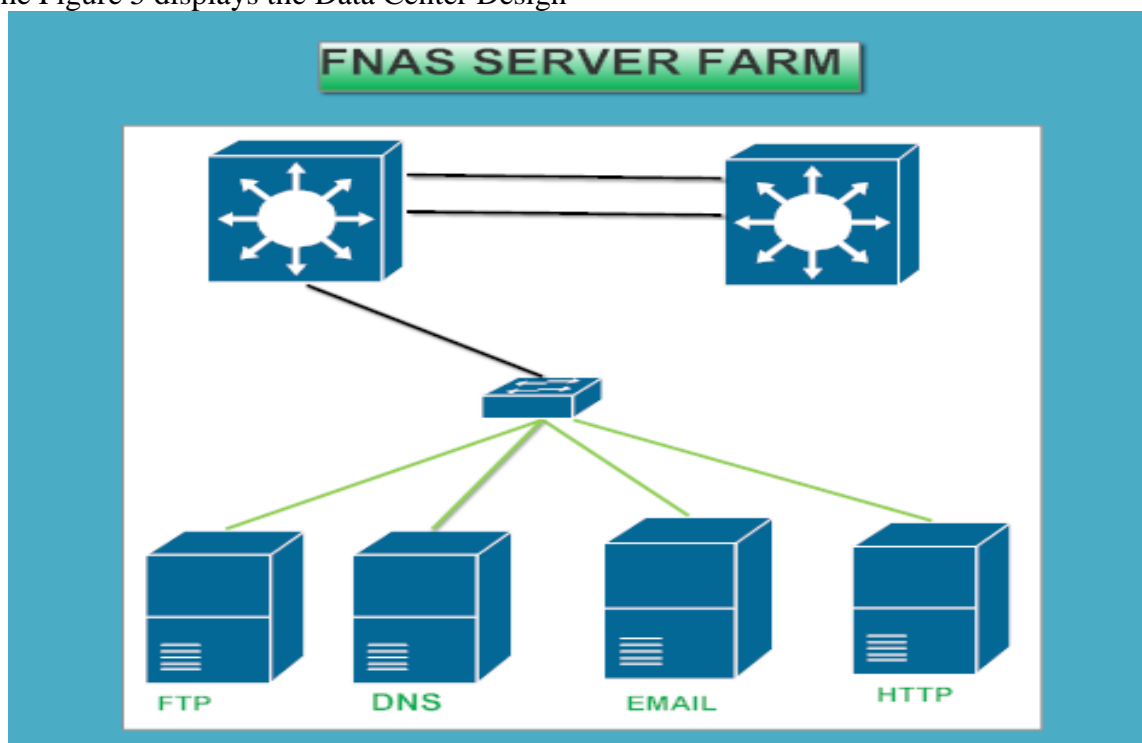


Fig.5:-The Data Center Design

System Implementation

The implementation phase of configuration of FNAS-UMYUK network is the stage where we simulate the network to achieve its definitive goals. In this phase, the actual

configuration of each of the design variations is carried out using a simulator i.e. packet tracer in terms of some set metrics. For the each of the variations, we will configure the designed protocol at

each of the access, distribution and core layers as previously described above in the system design section.

Development process of FNAS-UMYUK network

The configurations to be made on the each of the above designs are: configuring RIP as routing protocol at core switches, configuring VTP in the core switches, making some ports access ports and some ports as the trunk port to the core switch, creating VLANs and assigning switch ports to the VLANs, making the distribution and access switches as VTP clients, configuring a default-gateway, and lastly configuring the FTP, EMAIL, DNS

and HTTP servers. Some configurations will be made using command line interface of the packet tracer and some will be made using graphical user interface (GUI).

RESULT PRESENTATION AND DISCUSSION

Verifying the Virtual Local Area Network (VLAN)

The result of the “show VLAN brief” command is captured in Figure 6 which indicates that the VLANs are active, the ID and ports corresponding to all VLANs assigned to each building in the FNAS-UMYUK are active and working properly as expected.

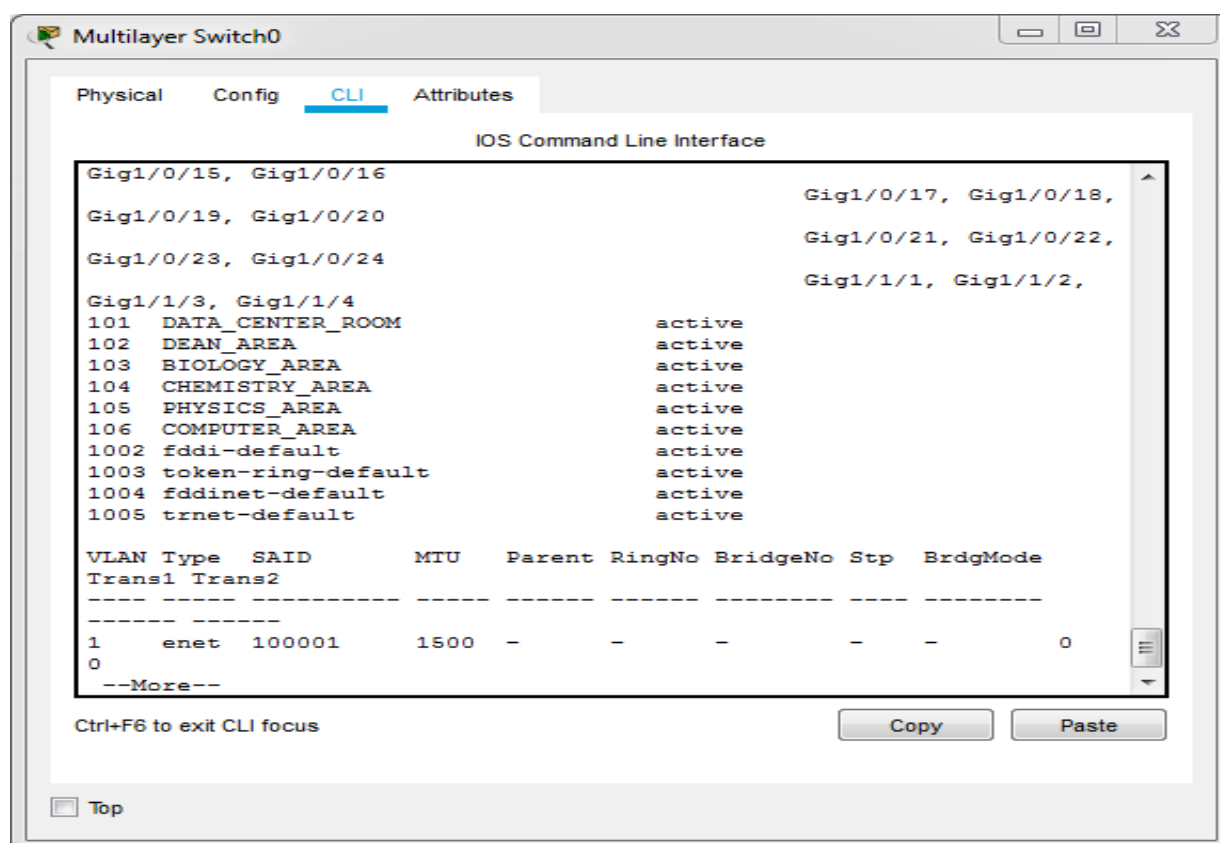


Fig.6:-Verifying the VLANs

End-User Connectivity Test

As the ping command was used for testing the communication and connectivity of the enterprise network, with the IP address of the user or the domain name. About six VLANs were configured on the FNAS-

UMYUK network and four server computers. A ping command was executed to ascertain the connectivity of devices on the VLANs. Figure 7 shows the results obtained from the test.

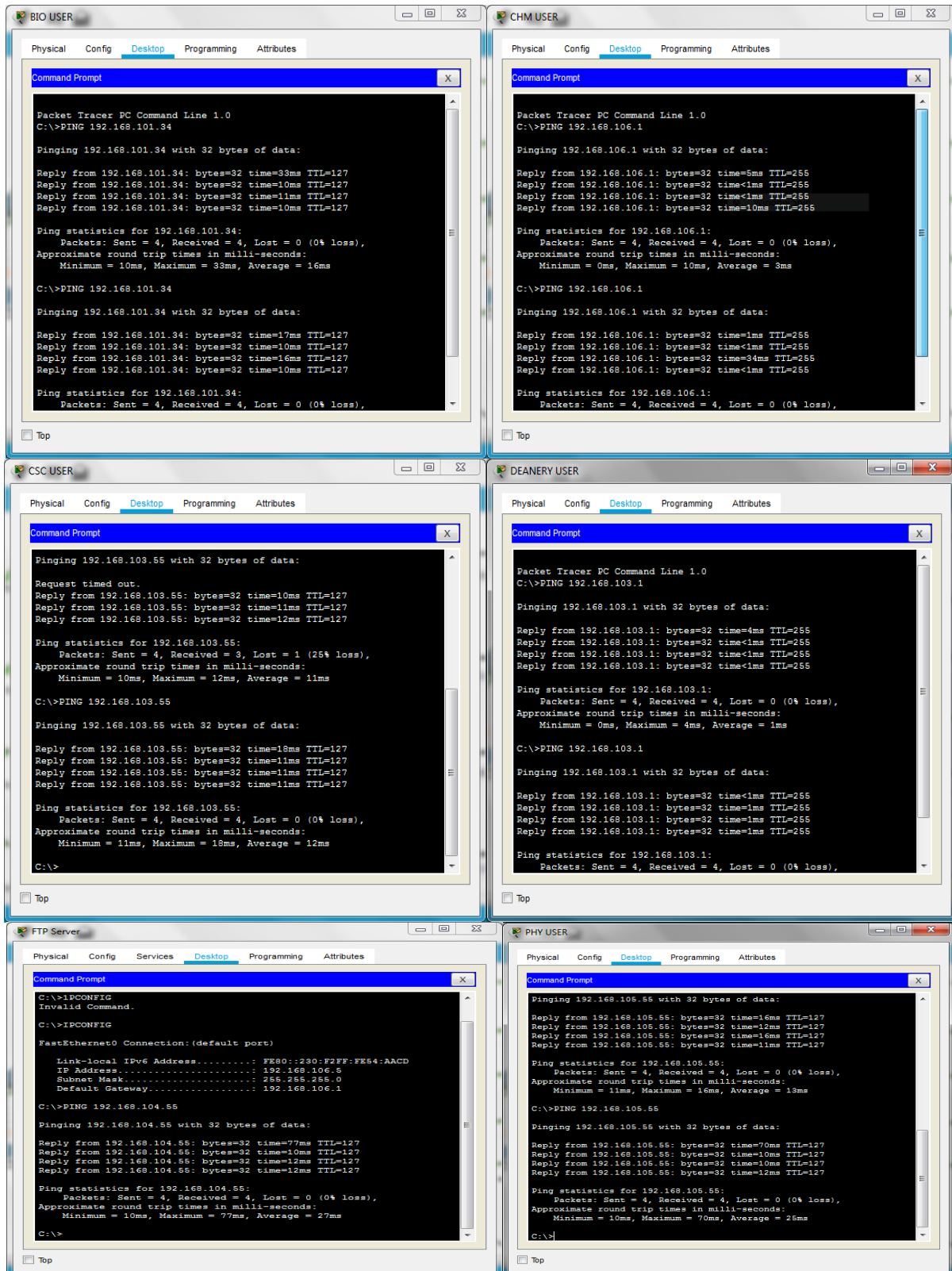


Fig.7:-The user connectivity tests

Verifying VTP Setup

The Figure 8 shows the result from the configuration of the VTP setup in the core

switch. The result indicates that VTP configuration is active and working properly as expected.

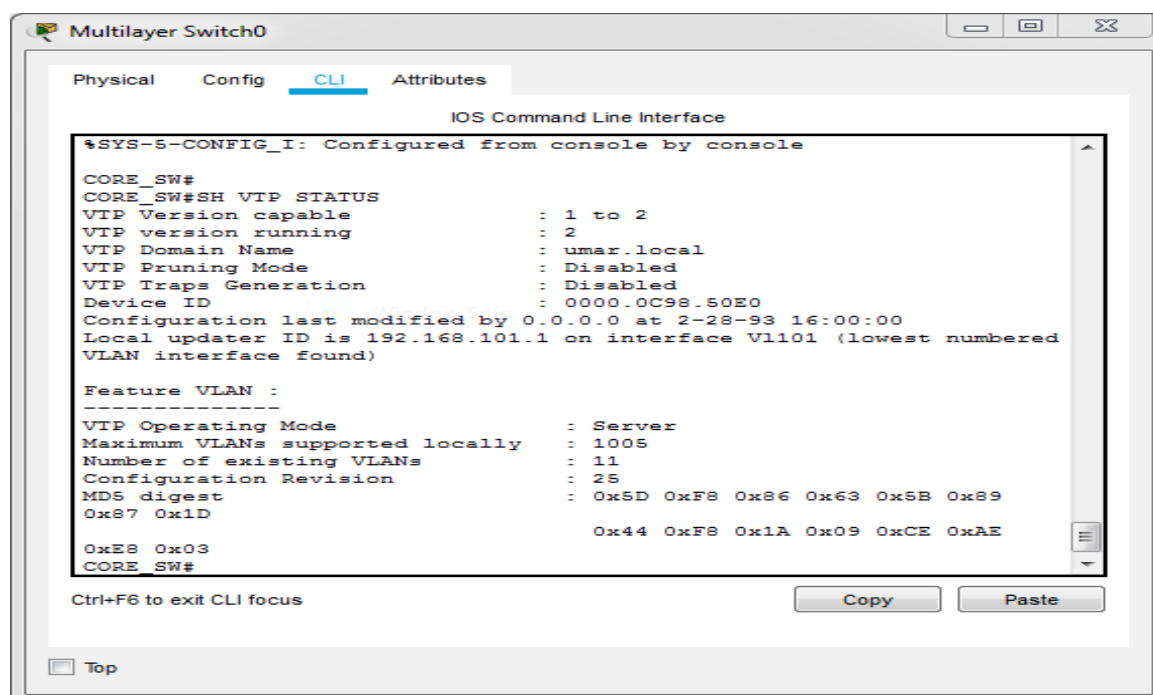


Fig.8:-The VTP setup

Access to FTP server

The users can access the resources available in the FNAS-UMYUK network using username and password provided by

FNAS-UMYUK network managers. The Figure 9 shows that the FTP server is working properly as expected.

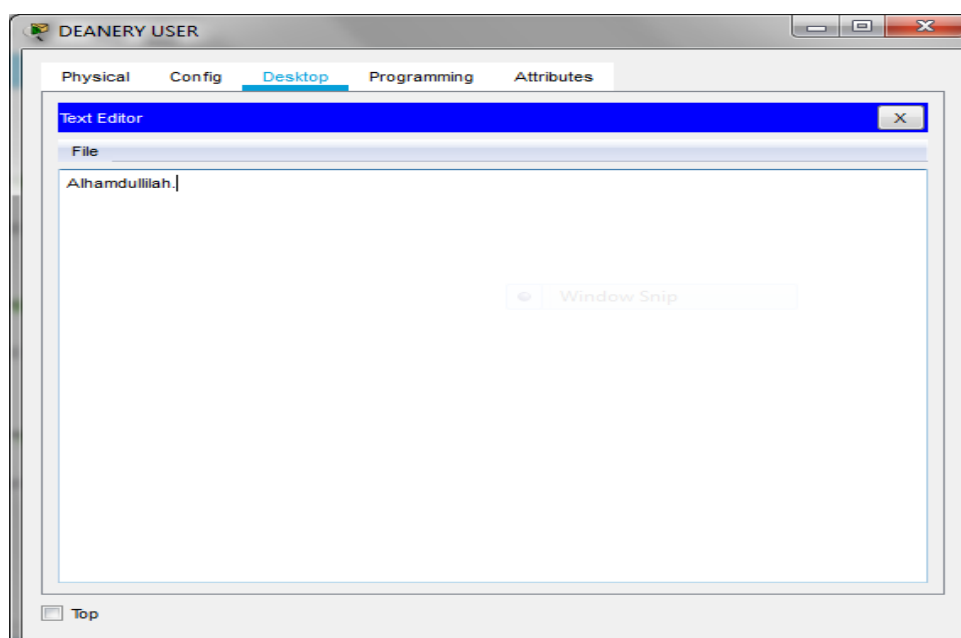


Fig.9:-The FTP server test

Access to HTTP server

The users in the FNAS network can surf the FNAS-UMYUK website with the

domain name or IP address as shown in figure 610. This shows that the HTTP server was working properly as expected.

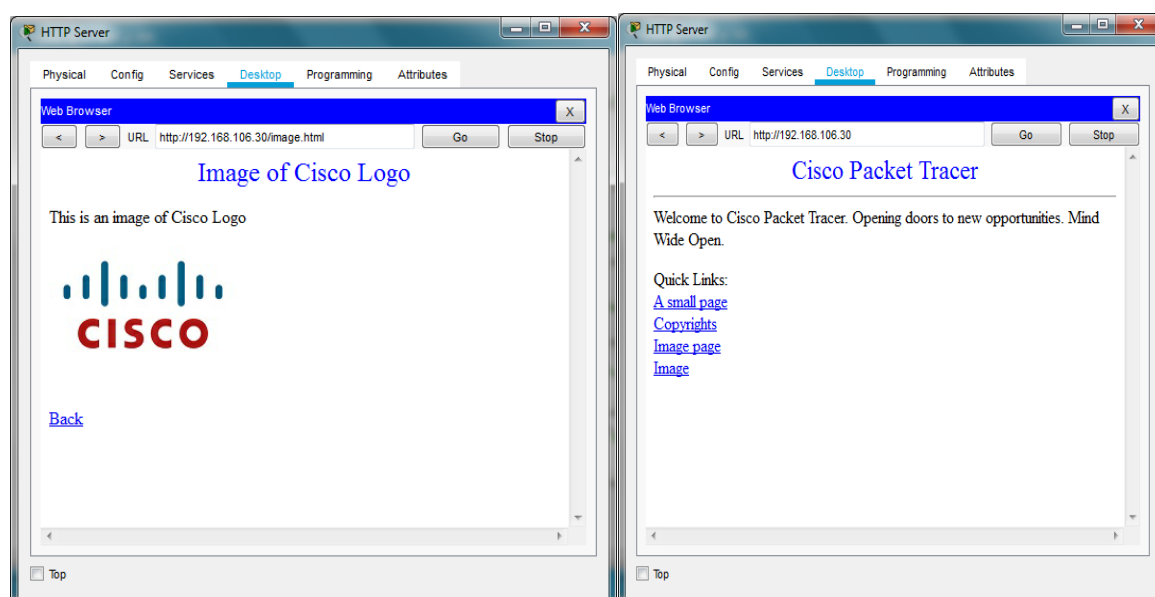


Fig.10:-The HTTP Server test

Access E-mail Service

The email service was tested by sending a message after registering an email client

on the server. The results of the email service are shown in Figure 11.

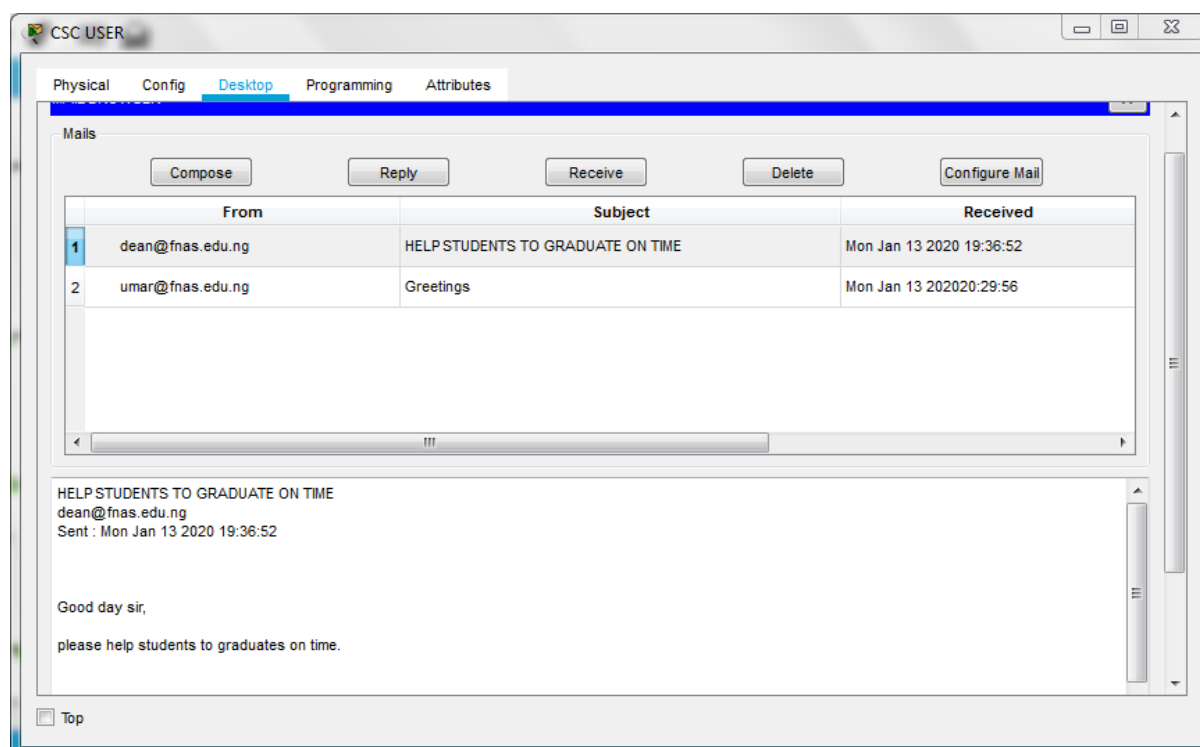


Fig.11:-The Email server test

Redundancy Status across the Four Design Models

Redundancy in Network is the availability of an alternate path that traffic can take in

the case the primary path or device fails. While the design is highly redundant from layer 3's perspective, its significantly more redundant from the layer 3 perspective as

the secondary link is already active due to equal cost load balancing that the routing protocols affords, i.e. RIP.

Resiliency Across the Four Design Models

Resiliency in Networking is a concept of having to contain a certain disturbance of a network to as close as possible to the failure point, link or device. The first Layer 2 Designs may not have resiliency as a broadcast domain or a Spanning tree Disturbance may affect the whole layer 2 domain. RIP (Routing Information Protocol) as it does not have the capability of Segregating the Campus Network into Domains which will have a rippling effect on the whole convergence, this will directly affect the resiliency of the network.

Scalability across the Four Design Models

Scalability in networking is a distinct ability of a network design to grow larger than its current size without a major redesign of the network. The first two Design variations are based on Layer 2, and over the time period, Layer 2 has proven to be less scalable as the broadcast domain cannot grow relatively large.

RIP Based layer 3 Design will not grow larger than 15 hop counts and since there is no any segregation of the departments routing table to the other, the network can only grow as large as the memory and processor of the switches can handle, store and process the routing computations.

VTP design also makes the network to be at higher scalable due to its available features.

CONCLUSION

In this paper, we have shown that CISCO technologies can be used in the configuration of FNAS-UMYU network with availabilities of CISCO solutions, and

it shows that the proper segmentation of the broadcast domain of FNAS-UMYU network design into several VLANs can be achieved with several objectives of good network design.

The methods of configurations not only stress the significance of using institutional prerequisites and goals in developing the FNAS-UMYUK network design objectives yet in addition provide built-in mechanisms to capture troubleshooting needs and use them seamlessly throughout the steps of designing and configuring the FNAS-UMYUK network architecture.

Finally, also from the simulation work shows that this proposed FNAS-UMYUK network is result to high speed, performance, reliable, resilient and well scalable network compared to the existing FNAS-UMYUK network.

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