

DESIGN OF CAMPUS LAN WITH FUTO AS A CASE STUDY

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ABSTRACT

Education, in the highly digitized environment of our present day, requires continual access to large amounts of data and strong collaboration between students and lecturers, in universities and all over the world. The need for this necessitates a fast connection or network between all the collaborators in some way. E-draw Network Diagram version 6.1.8 which runs on Windows 7 was used to design the logical topology of the network, and Cisco Packet Tracer which also runs on Windows 7 was used to test network connectivity. The results revealed that the network design is viable and implementable. The design test results show that for speedy connections, 10Gbps speed should be used at the core layer; 2Gbps speed should be used at the distribution layer; 1Gbps speeds should be used at the access layer and wireless access points should be used for wireless devices for wireless connections to the network.

Keywords: E-Draw Network, Campus LAN, Connectivity, Distribution layer, Logical Topology, packet Tracer

INTRODUCTION

The development of the personal computer brought about tremendous changes for business, industry, science, and education. A similar revolution is occurring in data communications and networking. Technological advances are making it possible for communications links to carry more and faster signals. As a result, services are evolving to allow use of this expanded capacity. For example, established telephone services such as conference calling, call waiting, voice mail, and caller ID have been extended. Research in data communications and networking has resulted in new technologies. One goal is to be able to exchange data such as text, audio, and video from all points in the world. We need to access the Internet to download and upload information quickly and accurately and at any time. [Forouzan, 2007]

The project aims to develop a workable network model for the Federal University of Technology Owerri (FUTO) community as a case study. The benefits of an implemented Campus Network for FUTO are numerous. There shall be availability of the infrastructure necessary for the full implementation of the digitization of FUTO's academic records. A complete network resource for exchange of ideas required research and hence a platform for quick and effective dissemination of information to students. This makes servers accessible for host ing different FUTO websites and email facilities for lecturers and students.

DESIGN OBJECTIVES

The purpose of the network is to create a high speed data connection to serve staff and students departmental information access and dissemination, internet access, voice services, e-mail services, research support and database access. The network should offer secure, reliable and highly available data connections. The network should also be scalable for agility to adapt to future requirements without requiring a complete network overhaul, resilient, service differentiating, adaptable and cost effective. [Kachalia, 2010]

Design Specifications

Cisco 3945 Integrated Routers (10GE fiber ports), Cisco Catalyst 4500 Switches (10GE fiber ports), Cisco Catalyst 4900 Switches (10GE fiber ports), Multiple Cisco Catalyst Express 500G-24PC

Switches (1GE port), Multiple Cisco WAP4410N Wireless Access Points, Multiple Dell Vostro 260 Mini Tower desktop computers, Cisco 7960 IP phones for offices. [Cisco Inc, 2010].

Description of Network Block Diagram

Figure 1 shows the block diagram of the network showing the data flow paths and the speeds, whereas Figure 2 shows the logical diagram of the full network. The functions of each of the components involved are briefly highlighted as follows:

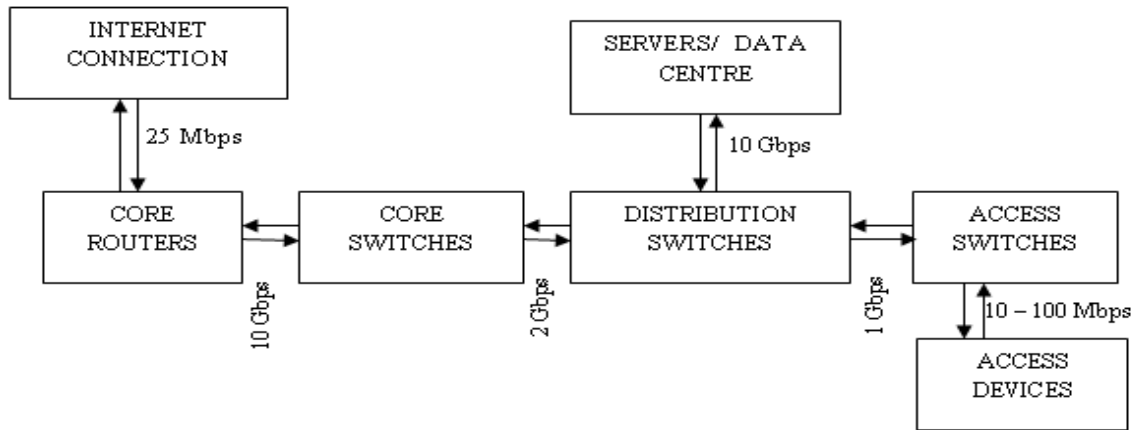


Figure 1: Network Block Diagram, Showing Data Flow Paths

Cisco 3945 Routers

These routers connect the network to the internet. They offer embedded hardware encryption acceleration, voice- and video-capable digital signal processor (DSP) slots, optional firewall, intrusion prevention, call processing, voicemail, and application services. **Cisco Catalyst 4500**

Switches

These switches aggregate data from the Cisco Catalyst 4900 distribution switches. They are modular switches which have up to 848 Gbps in switching capacity and are optimized for unified communication with high density PoE and PoE+.

Cisco Catalyst 4900 Switches

These switches aggregate data from the access layer devices. They also have layer 3 capabilities. They have standalone fixed-configuration for low-latency and wire-speed switching, wire-rate performance with 96-320 Gbps non-blocking switching fabric, Layer 2-4 switching and intelligent services with dynamic IP routing and IPv6.

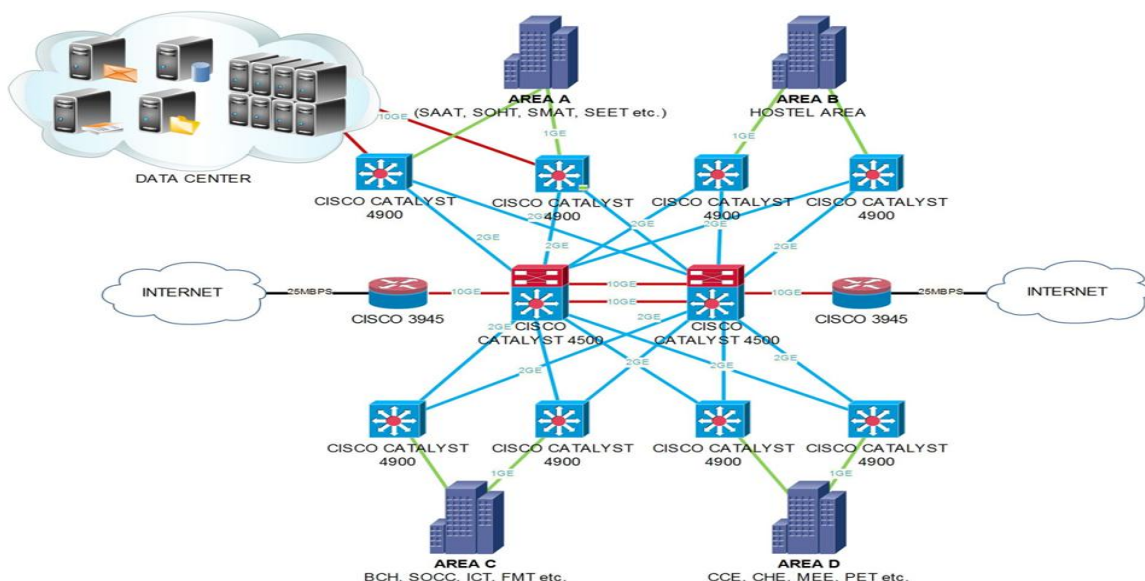


Figure 2: Network Design Diagram

Cisco WAP4410N Wireless Access Points

These provide wireless network access to computer users.

Cisco IP phones

This provides voice services for office locations on the network and has the ability to be powered over Ethernet [Cisco Inc, 2009].

Cisco catalysts express 500 switches

These provide network access to computers on the network. They also provide data access and power for wireless access points and IP phones due to their Power over Ethernet capability.

Dell Vostro 260 Mini Tower desktop

These are the computer assigned to network users for network access. All desktop computers deployed for use by the academic staff shall run on Windows 7 operating system. They shall also have Microsoft Office Enterprise Suite (Word, Excel, Power Point, Outlook etc.) and software relevant for academic work according to departmental requirements.

Fiber cable

These are used to make the connections for the network backbone. 24-core fiber is used for core layer connections (10GE - laser optimised 50 micron fiber [OM3]); 12-core fiber is used for core to distribution layer connections (2GE); 6-core fiber is used for distribution to access layer connections (1GE) [Sivakumar, 2005] and [Njeru, 2006].

Server Farm/Data Centre

All network servers shall run on Linux Red Hat. The data center shall be deployed using full server virtualisation. Server applications shall include LDAP Server, DNS Server, DHCP Server, Database Server, File Server (Samba), VPN Server, SSH for all relevant servers, Mail Server, Print server, Web server (Apache) etc.

Cat 6 cable

This shall provide data access to wireless access points because it has a higher speed.

Cat 5 cable

This provides data access to computers on the network [University of California, 2008].

IP ADDRESSING SCHEME

There are approximately 20,000 students and lecturers at FUTO. Making an allowance for population growth, the school requires an IP addressing scheme which can cater for 30,000 people easily. To achieve this, the school was divided into four areas – Area A, Area B, Area C and Area D. This division was based on the estimated population of the areas. Each area was assumed to have 7,500 people. Table 1 and 2 show the IP addressing method used to accommodate this population.

This population of users calls for a Class B addressing scheme. Here are the IP addressing details.

Table 1: IP Addressing

IP Address Block	172.30.0.0
Address Class	B
Network Address	172.30.0.0
Subnet Mask	255.255.192.0
Subnet Bits	18
Host Bits	14
Number of Subnets	4
Hosts per Subnet	16382

Table 2: IP Addressing Details for Areas

AREA	SUBNET	SUBNET MASK	SUBNET SIZE	HOST RANGE	BROADCAST
A	172.30.0.0	255.255.192.0	16382	172.30.64.1 to 172.30.63.254	172.30.63.255
B	172.30.64.0	255.255.192.0	16382	172.30.64.1 to 172.30.127.254	172.30.127.255
C	172.30.128.0	255.255.192.0	16382	172.30.128.1 to 172.30.191.254	172.30.191.255
D	172.30.192.0	255.255.192.0	16382	172.30.192.1 to 172.30.255.254	172.30.255.255

Table 3: IP Addresses for Connectivity Test

DEVICE	IP ADDRESS	SUBNET MASK	GATEWAY
Host1	172.30.64.3	255.255.192.0	172.30.64.1
Router1 Fa0/0	172.30.64.1	255.255.192.0	172.30.64.1
Host2	172.30.64.4	255.255.192.0	172.30.64.2
Router1 Gig4/0	172.30.64.2	255.255.192.0	172.30.64.2

ROUTER CONFIGURATION

The IP addresses in Table 3 are used for the router configuration and the Ping and Tracer connectivity tests.

```
Router>enable
```

```
Router#config term
```

Enter configuration commands, one per line. End with CNTL/Z.

```
Router(config)#hostname router1
```

```
router1(config)#line console 0
```

```
router1(config-line)#password cisco
```

```
router1(config-line)#login
```

```
router1(config-line)#line vty 0 4
```

```
router1(config-line)#password cisco
```

```
router1(config-line)#login
```

```
router1(config-line)#interface fa0/0
```

```
router1(config-if)#ip address 172.30.64.1 255.255.192.0
```

```
router1(config-if)#no shutdown
```

```
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
```

```
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
```

```
router1(config-if)#description connection to host1
```

```
router1(config-if)#interface gig4/0
```

```
router1(config-if)#description connection to switch1
```

```
router1(config-if)#ip address 172.30.64.4 255.255.192.0
```

```
router1(config-if)#ip address 172.30.64.2 255.255.192.0
```

```
router1(config-if)#no shutdown
```

```
%LINK-5-CHANGED: Interface GigabitEthernet4/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet4/0, changed state to up
router1(config-if)#end
router1#
%SYS-5-CONFIG_I: Configured from console by console

Ping and Tracert results
Packet Tracer PC Command Line 1.0
PC>ping 172.30.64.1
Pinging 172.30.64.1 with 32 bytes of data:
Reply from 172.30.64.1: bytes=32 time=10ms TTL=255
Reply from 172.30.64.1: bytes=32 time=1ms TTL=255
Reply from 172.30.64.1: bytes=32 time=6ms TTL=255
Reply from 172.30.64.1: bytes=32 time=1ms TTL=255
Ping statistics for 172.30.64.1:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
Minimum = 1ms, Maximum = 10ms, Average = 4ms
PC>ping 172.30.64.3
Pinging 172.30.64.3 with 32 bytes of data:
Reply from 172.30.64.3: bytes=32 time=2ms TTL=128
Reply from 172.30.64.3: bytes=32 time=1ms TTL=128
Reply from 172.30.64.3: bytes=32 time=4ms TTL=128
Reply from 172.30.64.3: bytes=32 time=2ms TTL=128
Ping statistics for 172.30.64.3:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
Minimum = 1ms, Maximum = 4ms, Average = 2ms
PC>ping 172.30.64.4
Pinging 172.30.64.4 with 32 bytes of data:
Request timed out.
Reply from 172.30.64.4: bytes=32 time=10ms TTL=127
Reply from 172.30.64.4: bytes=32 time=21ms TTL=127
Reply from 172.30.64.4: bytes=32 time=18ms TTL=127
Ping statistics for 172.30.64.4:
Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
Minimum = 10ms, Maximum = 21ms, Average = 16ms
```

```
PC>ping 172.30.64.2
Pinging 172.30.64.2 with 32 bytes of data:
Reply from 172.30.64.2: bytes=32 time=29ms TTL=255
Reply from 172.30.64.2: bytes=32 time=4ms TTL=255
Reply from 172.30.64.2: bytes=32 time=2ms TTL=255
Reply from 172.30.64.2: bytes=32 time=3ms TTL=255
Ping statistics for 172.30.64.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 2ms, Maximum = 29ms, Average = 9ms
PC>tracert 172.30.64.4
```

Tracing route to 172.30.64.4 over a maximum of 30 hops:

```
 1  3 ms   1 ms   3 ms   172.30.64.1
 2 21 ms  21 ms  22 ms  172.30.64.4
```

Trace complete.

```
PC>tracert 172.30.64.2
```

Tracing route to 172.30.64.2 over a maximum of 30 hops:

```
 1  6 ms   6 ms   5 ms   172.30.64.2
```

Trace complete

The results indicate that the network devices can “see” each other and have adequately high transmission speeds.

CONCLUSION

Over the past decade, communication has grown to become an indispensable constituent of human life, especially in the areas of education and business. Indeed considerable number of Universities in the developing world does not currently have stable campus LAN. The benefits of an implemented Campus Network for FUTO are numerous. There shall be availability of the infrastructure necessary for the full implementation of the digitization of academic records. A complete network resource for exchange of ideas required for research and hence a platform for quick and effective dissemination of information to students. This makes servers accessible for hosting different institutions websites and email facilities for lecturers and students.

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