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IMPLEMENTATION OF OPEN SHORTEST PATH FIRST USING INTERNET PROTOCOL VERSION 6

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Abstract

Open Shortest Path First (OSPF) is one of the routing protocols used by a router to dynamically determine the route of a packet (user information) through an internet work. This paper looked at an Inter-Campus network system which was Configuration using IP Version 6 to Implement Open Shortest Path First. The methodology adopted for this research was the Object Oriented Analysis and Design Model (OOADM) and the Inter-Campus network system was designed using Cisco technology. In this paper, OSPF was used to test-run its features and performance in IPversion6.

Keywords: Wide Area Network (WAN), OSPF, Protocol, IP Address.

INTRODUCTION

The exponential growth of internetwork has led to number of difficulties as it relates to the administration of IP addresses. The regulative aerial in assigning a continuous expanding numbers of Internet Protocol Addresses for worldwide end-users has pressured institutions which carryout perform this activity. The volumes of Internet Protocol Addresses accessible over the network have accessed the ability of numerous routers to manage their routing tables. The eventual exhaustion of assigned 32 bit version 4 addresses has become a threat the classes of IP address space. As the Internet grew larger, it became obvious that the existing system which was established on classful assigning scheme of Internet Protocol addresses and routing of Internet Protocol packets did not have the ability to handle the growing amount of work.

In order to ease these drawbacks, new set of standards were published in 1993 by the ‘‘Internet Engineering Task Force’’, to describe new ideas in assigning blocks of IP address as well as better ways in routing Internet protocol version 4 packets. These standards were RCF 1518 and

RCF 1519, recent standard of these descriptions were made available in [5] as ''RFC 4632''. The Internet Protocol address comprises two major segments, these include: the network part, and the host part. In the Internet protocol version 4, classful network scheme apportioned IP addresses in partitions of four aggregates. This addressing is the addition of a 24-bit prefix alongside an 8-bit node address. Hence a least routing block would have an address of 256 which is considered very little to serve medium size firms whilst succeeding group of 65536 addresses is seen as too large to efficiently serve larger organizations. This results in poor distribution of IPv4 address space. This paper designs a Wide Area Network which covers the following Campuses.

1. University of Port Harcourt
2. Rivers State University of Science and Technology
3. College of Arts and Sience

Related Literature

According to [6], *Packet switching* is a Wide Area Network technology where end-users share essential carrier resources. It permits a network conveyor to efficiently use its infrastructure, which cost is better compared to point-to-point lines. In the setup of packet switching, systems possess connections in the carrier's network are also shared by several customers. These carriers in turn create indirect circuits among the customers' sites through which data packets would be sent between each other through the network. The portion of the carrier network shared is called a cloud. Few types of packet-switching networks are; 'Asynchronous Transfer Mode' (ATM), 'Frame Relay', 'Switched Multimegabit Data Services' (SMDS), and X.25. Virtual links between customer sites are usually known as virtual circuit.

[3], stated that the Routing Information Protocol been a Distance vector protocol, uses the hop count technique as a routing measurement. It averts routing loops by imposing hop count limit to be allowed in path from source to a destination. The permitted number of hop counts accepted for Routing Information Protocol is 15. Ordinarily the RIP router sends updates every 30 seconds. As network size increased, it became apparent that there could be a massive time. In certain networking situations, RIP is never a preferred routing choice due to its convergence time and poor scalability as compared to EIRGP and OSPF, hence, the OSPF protocol was used in CISCO 2800 series Router to overcome the above mentioned problem.

Internet Protocol (IP) Version 4

IP version 4 Address is 32 bits in length, divided into four parts of 8 bits each, 8bits. 8bits.8bits.8bits. It is written in decimal dotted notation. It can be expressed in binary, decimal and hexadecimal function. It is divided into Network part (N) and Host part (H). Each part contains 8 bits. The parts vary; depending on the class the IP address belong *[1]*.

Number of Bits → 8 .8 .8 .8

1. ‘‘Class A → N.H.H.H’’
2. ‘‘Class B → N.N.H.H’’
3. ‘‘Class C → N.N.N.H’’

In Class A, 8 bits are on and 24 bits are off. In Class B, 16 bits are on and 16 bits are off. In Class C, 24 bits are on and 8 bits are off.

Network Address

This address is for identifying the network itself. In a network address, the Network (N) part is not totally on (contains 0s and 1s) and the Host (H) part is totally off (0s). The following are examples of a network address:

1. Class A → 10. 0. 0. 0
2. Class B → 172. 16. 0. 0
3. Class C → 192.168.100. 0

Broadcast Address

This address is assigned to every host in a network. In the Broadcast address, the Network (N) part is not totally on, that is, it is mixed 0s and 1s, but the Host part is totally on (1s). The following are examples of a broadcast address:

1. Class A → 10.255.255.255
2. Class B → 172. 16.255.255
3. Class C → 192.168.100.255

Subnet Masks

A subnet is a 32-bit number which permits the receiver of Internet packets to differentiate the network section of the IP address from the host section of the IP address [1]. The Internet service provider forms a subnet mask of 32-bit consisting of 0s and 1s. The 1s shows the areas which point to the subnet or network addresses. Not every internetwork require the use of subnets, this means that they can make use of a default subnet mask, which implies that the network does not bear a subnet address.

Default Subnet Mask

Default Subnet Mask is for calculating the network quantity of an Internet Protocol address. In addition, it helps to define the quantity of a host bits an address has. In Default Subnet Mask, the Network (N) is totally on (1s) and the Host (H) part is totally off (0s). The Default Subnet Mask is as follows:

1. Class A → 255. 0. 0. 0

2. Class B → 255.255. 0. 0

3. Class C → 255.255,255. 0

Variable Length Subnet Mask

'Variable Length Subnet Mask' is derived and generated from the Default Subnet Mask. If one part of a Default Subnet Mask of say Class A is to be considered each, we will have 8 bits on (1s) in the Network part, which produces 255 in the decimal form and 24 bits off (0s) in the Host part, which produces 0 on the decimal form. Class A, Default Subnet Mask in binary form is:

Class A → 11111111.00000000.00000000.00000000

When generating a Variable Length Subnet Mask (VLSM), we add one bit on (1s) to the binary form to give:

Class A →11111111.10000000.00000000.00000000

The VLSM for Class A in the decimal form is:

Class A → 255.128. 0. 0

The same method can be applied for Class B and Class C. keep on adding one bit to previous number of bits on, until it produces thirty-two bits on. The VLSM for the thirty-two bits on (1s) in the binary form is:

11111111.11111111.11111111.11111111

It does not belong to any class and its decimal form will be:

255.255.255.255

IP Routing

Internet Protocol routing is a procedure for sending Internet-packets from a network to another network with the use of routers. The essence of Internet Protocol Routing is to create communication between devices and network. It is also used to find updates of routes in the network. There are two terminologies used in IP routing. The two terminologies are:

1. Routed Protocol
2. Routing Protocol

Routed Protocol is used to send packet from source to destination or from one network to another. Routed protocols are assigned to interfaces to choose specific ways in the delivery of packets. Types of Routed Protocol are 'Internet Protocol' (IP) and 'Internet Protocol Exchange' (IPX).

Routing Protocol is used to maintain as well as update the routing table of a router. The routing table of a router is like the memory of the router. It stores IP addresses of its neighbour router that is connected to it. The routing protocol selects the path through which packets are sent in an internetwork. Examples of Routing Protocol are 'Routing Information Protocol' (RIP), 'Interior Gateway Routing Protocol' .

Types of IP Routing

There are three types of IP Routing.

1. **Static Routing: -**occurs when the network administrator manually adds IP routes or network address in the routing table of each router. It has a default administrative distance of one.
2. **Default Routing:** - is used when the destination address is not known. It is used in a stub network. A Stub Network is a network with a single exit path out of the network. Default Routing uses Wild Card Mask.
3. **Dynamic Routing:** - is the process of finding networks and updating the routing table of a router using a Routing Protocols e.g. RIP, IGRP, EIGRP and OSPF. A routing protocol defines the set of rules used by a router when it communicates routing information between neighbour routers.

Open Shortest Path First (OSPF)

A shortest path tree is created first, and then the routing table is supplied with the resulting best paths. Open Shortest Path First converges fast, and it supports several, corresponding-cost routes to the same destination. It supports Internet Protocol routing [1]. OSPF is a type of routing protocol, which manages the routing tables of routers. The following are features of OSPF:

1. It Consists of autonomous systems and areas
2. It reduces update of routing flow
3. It permits scalability
4. It supports CIDR/VLSM
5. It has limitless count
6. Its open standard

OSPF is configured in an order of ranks; this means that the larger internetwork can be separated into smaller internetworks, known as areas. This is said to be an excellent model for OSPF. Purposes for designing OSPF in this order are:

1. To reduce routing overhead
2. To increase convergence rate
3. To limit network fluctuation to solitary sections of the network

These reasons do not make OSPF configuration easier, but more detailed as well as demanding.

Inter- Campus Network System (ICNS)

Inter-Campus Network System (ICNS) is the connection of systems between two or more campuses. ICNS is a WAN communication that occurs between geographically segregated regions. In internetworks, WANs links campuses together. If a remote end station needs to interface with another local stations situated at a different location, the data has to be conveyed across one or more WAN links using routing protocols. Routers within the Inter-Campus Network represent the LAN/WAN junction points of the internetwork. These routers determine the most appropriate path through the internetwork for the required data streams. Figure 1 shows an example of an Inter-Campus Network System.

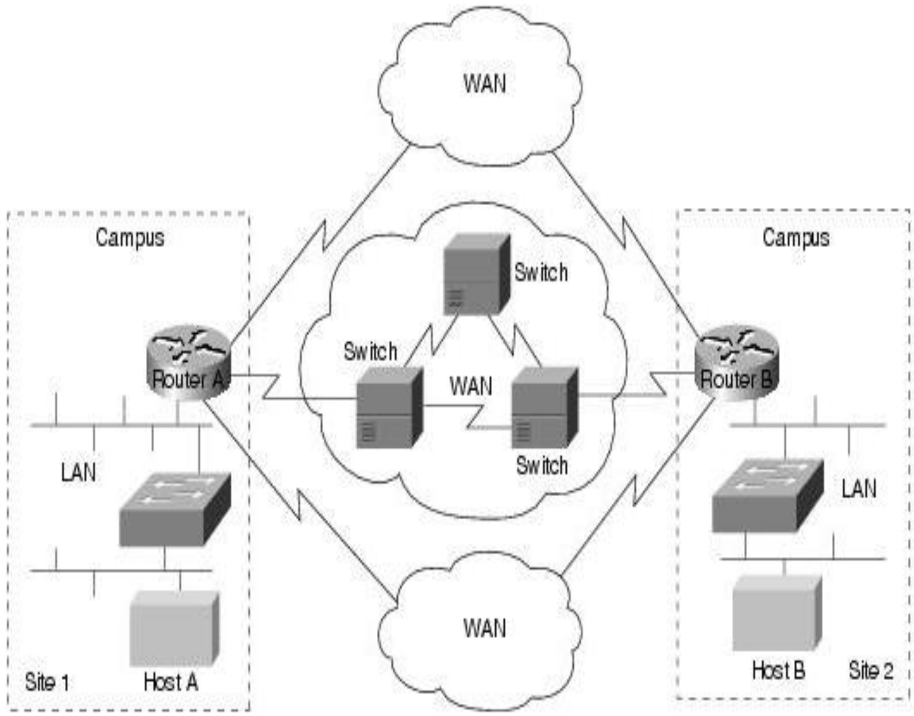

Fig. 1: An Inter-Campus Network System *(Source: [4])*

Network Configuration Requirement

The following software and hardware are required for the configuration of the Inter-Campus Network System (ICNS):

1. At least 512 MB of RAM for each computer.
2. A minimum of 500 MHz processor
3. Windows Vista or any Operating System
4. RJ45 (Registered Jack) connector
5. UTP (Unshielded Twisted Pair Cable) Categories 5 or above (for LAN)
6. Switch (for LAN)
7. Router (for WAN Configuration)
8. Modem
9. Radio or VSAT (for Serial Connection)

Network Topology

The Network topology used in this system design is the Ring Topology for ICNS and Star Topology for each CNS. The reasons for choosing Ring and Star Topology are:

Ring Topology widely supports serial link configuration while in Star Topology:

1. It is easy to install and configure.
2. It is widely used for serial link configuration.
3. Faults can easily be detected in the network.
4. Adding or removing end devices does not in any way affect the network.
5. A break in cable does not affect the network.

Methodology

The methodology deployed for this work, is the Structured System Analysis and Design Methodology (SSADM) and the Object Oriented Analysis and Design Methodology (OOADM). Structured System Analysis and Design Methodology would be adopted for data collected while Object Oriented Analysis and Design Methodology would be used for the design phase. This approach will provide a more thorough understanding of the design of an Inter-Campus Network System, which will in turn lead to systems that are more complete and correct.

Packet Delay Value (PDV) Calculation

The Calculation for the Packet Delay Value for each Network Operating Centre (NOC) network design is shown in Table 1, Table 2, and Table 3, respectively.

Table 1: UNIPORT Campus NOC

Device	**Quantity**	**Round Trip Delay**	**Maximum Round Trip Delay**
TX and FX DTE	54	Not Available	100
Switch	3		92
Router	1		
UTP Cat 5 Cable		1.112 x 217.5m	241.86
Safety Margin			**433.86**

Table 2: RSUST Campus NOC

Device	Quantity	Round Trip Delay	Maximum Round Trip Delay
TX and FX DTE	56	Not Available	100
Switch	3		92
Router	1		
UTP Cat 5 Cable		1.112 x 213.07m	236.93
Safety Margin			**428.93**

Table 3: CAS Campus NOC

Device	Quantity	Round Trip Delay	Maximum Round Trip Delay
TX and FX DTE	11	Not Available	100
Switch	2		92
Router	1		
UTP Cat 5 Cable		1.112 x 67m	75.10
Safety Margin			**267.10**

Distances between NOCs in each Campus

Figure 2 and Table 4 shows the architecture of the Inter-Campus Network and distances between the Network Operating Centre (NOCs) of each Campus respectively.

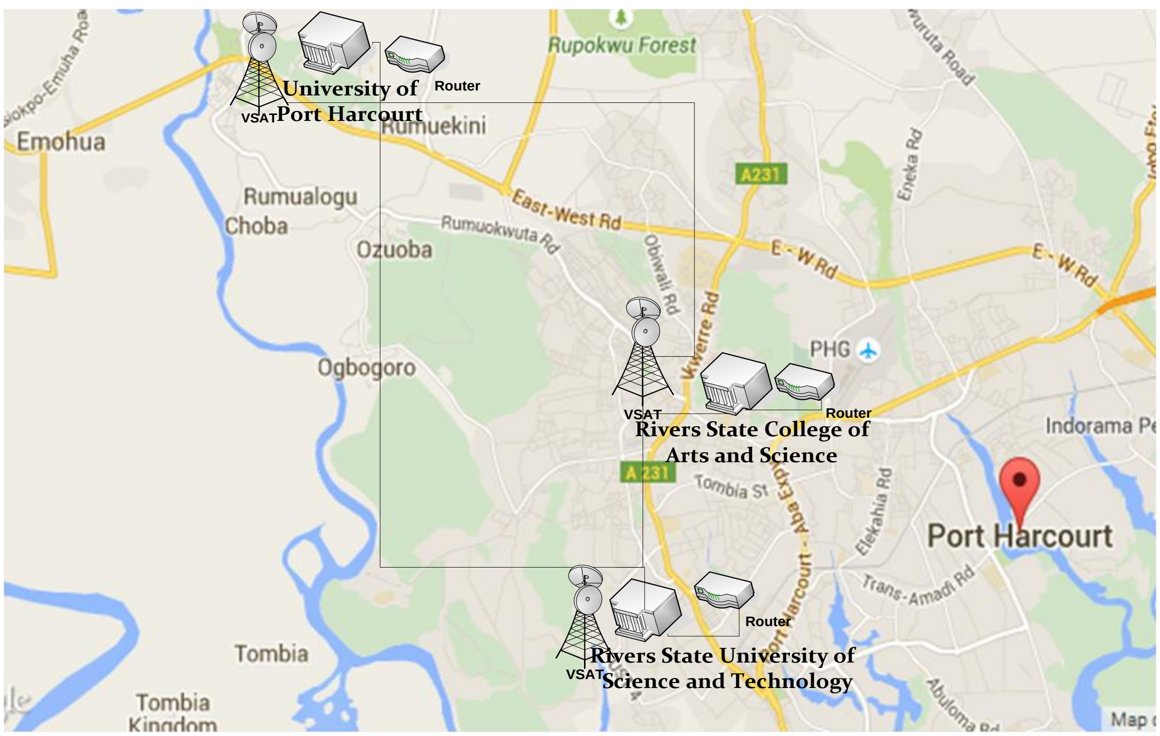

Fig. 2 Architecture of the Inter-Campus Network

Table 4: Campus NOCs and their Administrative Distance

Campus Network Operating Centre	Distance (in Kilometers)
UNIPORT and RUSUT	21
UNIPORT and CAS	31
RUSUT and CAS	10

IP Routing Configuration

The routing protocol used in updating the routing table of each Campus router is the OSPF, which has link state capabilities. OSPF uses 110 as its default administrative distance. Figure 3 shows the Network Configuration of the Campuses.

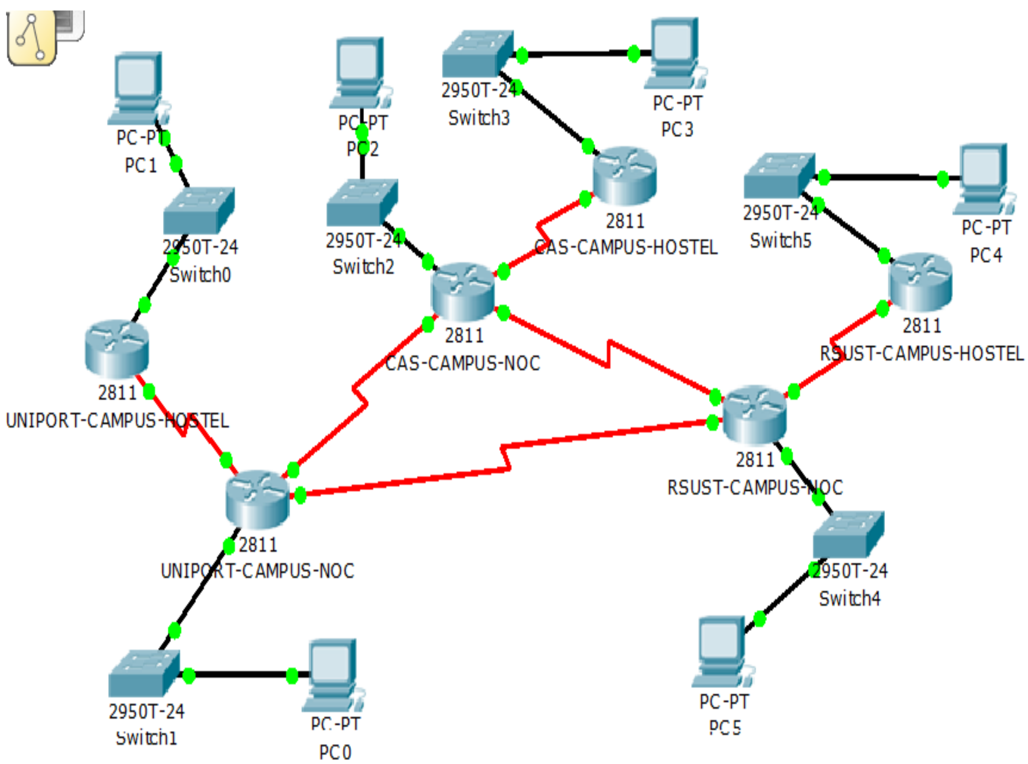

Fig. 3 Network Configuration of the Campuses

The routing protocol used during the design and configuration of the Wide Area Network (WAN) System have been tested based on its convergence, which determines optimality of the Classless Inter – Domain Routing (CIDR) in TABLE 5 and TABLE 6 respectively.

Table 5: OSPF Convergence testing by pinging RUSUT and CAS Campus NOC IPv4 addresses respectively from UNIPORT Campus NOC.

Routing Protocol	Source NOC	Destination NOC	Distance between Source and Destination NOC	Average Round Trip Time (in millisecond)
OSPF	UNIPORT Campus NOC 192.168.107.2	RSUST Campus NOC 192.168.101.2	21km	182ms
OSPF	UNPORT Campus NOC 192.168.107.2	CAS Campus NOC 192.168.103.2	31km	148ms
OSPF	RSUST Campus NOC 192.168.107.2	CAS Campus NOC 192.168.109.2	10km	126ms

Table 6: OSPF Convergence testing by pinging RSUST and CAS Campus NOC IPv6 addresses respectively from UNIPORT Campus NOC.

Routing Protocol	Source NOC	Destination NOC	Distance between Source and Destination NOC	Average Round Trip Time (in millisecond)
OSPF	UNIPORT Campus NOC 2001:DB8:4:1::2	RSUST Campus NOC 2001:DB8:8:1::2	21km	161ms
OSPF	UNIPORT Campus NOC 2001:DB8:4:1::2	CAS Campus NOC 2001:DB8:6:1::2	31km	128ms
OSPF	RSUST Campus NOC 2001:DB8:8:1::2	CAS Campus NOC 2001:DB8:6:1::2	10km	124ms

Optimal CIDR Convergence Testing

Table 7 shows the convergence testing of the Optimal Classless Inter-Domain Routing.

Table 7: Optimal CIDR Convergence Testing

IP Addressing Scheme	Distance	Average Round Trip Time (in millisecond)	Convergence Speed
IPv4	21km	135ms	Fast
IPv6	21km	126ms	Faster

Conclusion

The tables show the Routing Protocol, Average Round Trip Time (in millisecond) and Convergence Speed of testing both IP version 4 and 6 respectively. It also includes the competence of Wide Area Network (WAN) System design and configuration. As various concepts and principles have been employed in the design and configuration of Inter-Campus Network System, it can be seen clearly that Routing Optimality can be enhanced by deploying Open Shortest Path First (OSPF) which has more better and outstanding features for routing.

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