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Comparative Analysis of Distance Vector and Link-State Routing Protocols for Organisational Development

[1]Iliyasu Adamu[2]Suleiman Sa'ad [3]Abubakar Mohammed &
[4]Abdussalam Abba Tukur
[1,2&3]Department of Information Technology Modibbo Adama University of Technology, P.M.B 2076 Yola Adamawa State Nigeria
[4] MIS Unit Federal University Dutse Dutse Jigawa StateNigeria

Abstract

Dynamic routing protocols are classified in to two major categories which are Distance Vector and Link-state routing protocols. The early routing protocols were based on distance vectors, where network information is shared with the directly connected neighbouring devices. Link-state routing protocol create a complete network topology by gathering information from all of the other connected network devices. Link-state routing protocol determine the best route based on different criteria such as speed, bandwidth and the distance between devices connected to the network. As a result of the challenge of choosing the best routing protocol brought about this work. In this paper, three different dynamic routing protocols domain are designed, configured and simulated using packet tracer version 6.2 network simulator. Comparative analyses are carried out on three basic types of dynamic routing protocols in order to ascertain which one is the best amongst the three. In conclusion the research was able find out that EIGRP is the best dynamic routing protocol and recommended its usage by Nigerian organisation so as to optimise their network as such subsequent boost in productivity.

Keywords: *Routing, Protocol, Network, RIP, OSPF, EIGRP*

Background to the Study

In the past, the term routing protocol simple means a network protocol for forwarding network traffic/packet. However later with the ever growing demand for multimedia services, high mobility and global connectivity has resulted in more exploration of new technology for wired and wireless communication. Network protocol or routing protocols play a significant role in the modern internetworking era. Routing is the technology or method by which network devices (Routers) directs message/packet across networks to arrive at the correct destination despite it being wired or wireless. A routing protocol determines how routers communicate with each other by sending routing table update about the routes connected to neighbour device. An efficient active network device (Routers) forward routing table update packets from source node to a destination node through an optimal path and maintaining the convergence of the network. Routing is used to find as well as maintain routes information between network device in a rapidly changing topology, with a possibility of different directional links and minimum resources (Ghaisas and Sedamkar, 2014). Routing is used for moving a packet from one device to another device in a different network. Network device do not really care about the network device connected to it but only care about the network and the best path to reach out the network (Todd, 2007).

Statement of the Problem

The major issue that lead to this paper work has to do with most organisation's network in Nigeria are not working optimally due to the fact that wrong or inappropriate usage of the Dynamic Routing Protocols. Most organisations do go for simple to configure protocol which may not give them optimum use if their network infrastructure.

Fundamentals

Routing Information Protocol (RIP) was the first version of distance vector routing protocol. Routing Information Protocol version 1 (RIP-v1) was defined by the RFC1053. RIP-v1 was the first version of distance vector routing protocol and only IP routing protocol available in the early days of internetworking. RIP-v1 broadcast routing information update to the entire network and uses a maximum hop count of 15 to determine the network distance. RIP version 2 was defined by the RFC2453. Unlike RIP-v1, RIP-v2 support for classless routing protocol and VLSM (Variable-Length subnet marks). Instead of broadcasting routing information update to all network device, RIP-V2 multicast routing information update to some selected network device on the network. (Hedrick, 1988). Enhance Interior Gateway Routing Protocol (EIGRP) is an advanced distance-vector routing protocol (hybrid) that is Cisco proprietary protocol which is later converted to open standard in 2013. EIGRP uses distance metric to determine the best path based on Diffusion Update Algorithm (DUAL) (Todd, 2007) Networking device running distance vector protocol does not know the entire path to a destination; it only knows the distance to the remote network and the direction or vector. Its routing update comes through information from directly connected neighbours. Distance vector routing protocol usually not the best choice for a complex network like Enterprise network and ISP. Open Shortest Path First (OSPF) is an open

standard routing protocol developed by Internet Engineering task force (IETF). Unlike EIGRP, OSPF is a link-state routing protocols based on Dijkstra algorithm of link-state interior gateway protocol popularly known as Shortest Path First (SPF) Algorithm. OSPF is the best routing protocol for Enterprise networks and ISPS because of their hierarchical design and ability to scale for feature expansion (Hucaby, McQuerry and Whitaker, 2010).

Related Work

With the rapid growth and modernization of telecommunication network devices, the task of network performance management became increasingly challenging. The network topology and network equipment becomes more and more sophisticated. The network performance management and end-user response time management, become more difficult. . Early routing protocols were based on distance vector routing protocol by sharing network protocol with the directly connected neighbouring device or Router.(Rakesh, Suresh, and Upena, 2010) Review the performance of wireless routing protocol for security issue. DSR and TORA routing protocol are compared concurrently in the same network. The networks are divided in to DSR and TORA in different proxy environment. TORA maintain the same behaviour even after proxy is enabled on the network environment. The Routing Information Protocol (RIP) is one of the first widely used internet protocol. RIP employs the hop count of 15 to determine the network distance of a packet and anything above that will be considered as infinite or unreachable network (Jeevan, 2013).

Overview of Dynamic Routing Protocol

Due to the network size and topology, manual configuration of a static route is hectic or not possible. Routes are manually configured by the network administrator, usually pointing to one direction, route, hop or exit interface. The network address and subnet mask of the destination network, along with the exit interface or the IP address of the next hop. Static route has the lowest administrative distance (AD) of one (1) due to its highest connection reliability and denoted by later (*S*) in routing table as shown in RIP, EIGRP and OSPF routing table. Unlike static route, in dynamic routing protocol the network devices or routers is responsible for the creation, designing, updating and maintenance of network connection. Dynamic Routing enables network device to share network topology information about the distance, cost, status and how to reach the remote network. Each router send and receive data packets while locating other network device and use to construct, update and maintain routing table. Routing table develop through a dynamic routing protocol are identified by the protocol in used as shown in Figure1 below. These are the major types of dynamic routing protocol used.

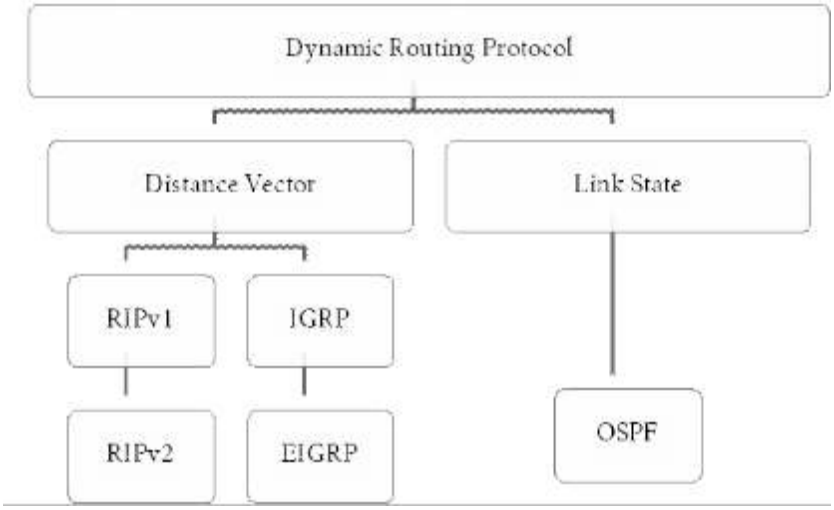

Figure 1: Classification of Dynamic Routing Protocol (Survey 2015)

Methodology

The paper makes use of Cisco Packet tracer version 6.2 for simulation and configuration of the three different routing protocols which consists of two Distance vector routing protocol domain (configured to used RIP routing protocol), EIGRP_Network (Configured to used EIGRP routing protocol) and the Green background network domain represent a link-state routing protocol (Configured to used OSPF routing protocol). Simple percentage was used for data analysis and the results were presented using tables.

Results and Discussions

This section covers the actual network simulation and configuration as well as the comparison between the three routing protocols. It discusses the results obtained from the analysis of the protocols.

Network Simulation and Configuration

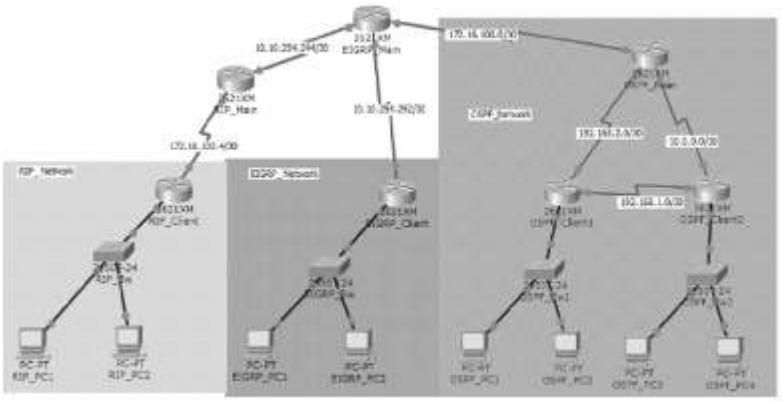

Figure 2: The Network Domains

Network Configuration

In Figure 2 above, three different routing protocols were implemented on each of the three network segments, namely; RIP, EIGRP and OSPF protocols. The RIP_Network segment was configured with three routers, one switch and two hosts for interfacing. The RIP_Main router which is connected directly to ISP router was configured with RIP version 2 on 172.16.0.0 and 10.0.0.0 networks for advertisement to neibouring router(s) as well auto summary was enabled. Show ip route command was issued in order to show the routing table. The major indexes for comparison were network size, nodes mobility and throughput (network traffic load).

RIP network configuration and routing table of RIP Main from the command line interface of packet tracer is shown below:

Router2>Enable
Router2#Configure Terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router2(config)#Hostname RIP_Main
RIP_Main(config)#Router RIP
RIP_Main(config-router)#Version 2
RIP_Main(config-router)#Network 172.16.0.0
RIP_Main(config-router)#Network 10.0.0.0
RIP_Main(config-router)#auto-summary
RIP_Main(config-router)#Do Show IP Route

Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
- *- candidate default, U - per-user static route, o - ODR*

P - periodic downloaded static route

Gateway of last Resort is 172.16.100.6 to Network 0.0.0.0

10.0.0.0/30 is subnetted, 1 subnets
C 10.10.254.244 is directly connected, Serial1/2
172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
R 172.16.20.0/24 [120/1] via 172.16.100.6, 00:00:12, Serial0/0
C 172.16.100.4/30 is directly connected, Serial0/0
S 0.0.0.0/0 [1/0] via 172.16.100.6*

The other network segment (EIGRP_Network) as shown in Figure 2 was configured with three routers, a switch and two hosts for interface also. The EIGRP_Main router which is connected directly to ISP router was configured with EIGRP 10 (autonomous 10). Networks 10.10.254.244 with wild card bits 0.0.0.3, 10.10.254.248 0.0.0.3 and 172.16.0.0 0.0.0.3 were configured as well auto summary was enabled so as to advertise those. Show ip route command was issued in order to show the routing table. Likewise same protocol was configured on the other router with the autonomous number 10. The network configuration of the EIGRP_Main router and routing table from the command line interface of packet tracer is shown below:

Router4(config)#Hostname EIGRP_Main
EIGRP_Main(config)#Router EIGRP 10
EIGRP_Main(config-router)#Network 10.10.254.244 0.0.0.3
EIGRP_Main(config-router)#Network 10.10.254.248 0.0.0.3
EIGRP_Main(config-router)#Network 172.16.100.1 0.0.0.3
EIGRP_Main(config-router)#auto-summary
EIGRP_Main(config-router)#Do show IP Route

Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area

- *- candidate default, U - per-user static route, o - ODR*

2. *P - periodic downloaded static route*

Gateway of last Resort is not Set

10.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
D 10.0.0.0/8 is a summary, 00:17:27, Null0
C 10.10.254.244/30 is directly connected, Serial1/2
C 10.10.254.248/30 is directly connected, Serial1/0
172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
S 172.16.0.0/16 [1/0] via 172.16.100.2
C 172.16.100.0/30 is directly connected, Serial1/1

In the last network segment as in Figure 2 above; four routers, two switches and four hosts of course interfacing were configured. The OSPF_Main router which is connected directly to ISP router was configured with OSPF 1 (process ID 1) for networks 10.0.0.0, 172.16.100.0 and 192.168.2.0 with 0.0.0.3 wild card bits and “Area 0” was used for all the routers; as such we adopted a single area OSPF routing protocol. The same process ID 1 and area 0 were configured on the other two routers in order to establish full convergence of the network. Show ip route command was issued in order to show the routing table. The OSPF network configuration and routing table of the OSPF_Main router from the command line interface of packet tracer is shown below:

Router7>Enable
Router7#Configure Terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router7(config)#Hostname OSPF_Main
OSPF_Main(config)#Router OSPF 1
OSPF_Main(config-router)#Network 10.0.0.0 0.0.0.3 Area 0
OSPF_Main(config-router)#Network 172.16.100.0 0.0.0.3 Area 0
OSPF_Main(config-router)#Network 192.168.2.0 0.0.0.3 Area 0
OSPF_Main(config-router)#Do Show IP Route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
a. - candidate default, U - per-user static route, o - ODR
P - periodic downloaded static route

Gateway of last Resort is not Set

10.0.0.0/30 is subnetted, 1 subnets
C 10.0.0.0 is directly connected, Serial1/0
172.16.0.0/30 is subnetted, 1 subnets
C 172.16.100.0 is directly connected, Serial1/1
192.168.1.0/30 is subnetted, 1 subnets
O 192.168.1.0 [110/128] via 192.168.2.1, 01:06:06, Serial0/0
192.168.2.0/30 is subnetted, 1 subnets
C 192.168.2.0 is directly connected, Serial0/0
OSPF_Main_Router(config-router)#Do Show IP Route OSPF

Comparative Analysis

The Table 1 below Shows a Comparative analysis and the performance Evaluation of Distance Vector (RIP, EIGRP) and link State (OSPF) Routing Protocol under Different Features.

Features	RIP	EIGRP	OSPF
Routing Protocol Type	Distance Vector	Enhance Distance vector (Hybrid)	Link State
Route computation Algorithm used	Bellman Ford (BF)	Diffusing Update Algorithm (DUAL)	Shortest Path First (SPF)
Proprietary	Open Standard	Cisco	Open Standard
Protocol Used	UDP	Cisco (RTP)	IP Datagram
Distance Limitation	15 hop Count	255 Hop Count	No limit
Routing Metric	Hop Count	Hybrid	Bandwidth
Routing Update	Periodically	Only changes	Only changes
Update Intervals	30 Seconds	No	No
Update address	224.0.0.9	224.0.0.10	224.0.0.5
CPU and Memory Utilization	Small	Medium-High	Very High
Support for IPv6	Yes for Ripng	Yes	Yes for V3
Route Administrative Distance	120	90 Int. & 170 Out.	110
Network Convergence	Very Fast	Medium	Slow
Configuration	Very Simple	Medium	Complicated

Conclusion/Recommendations

Routing Information Protocol (RIP) is one of the oldest, simple to configure and widely used routing protocol in the early days of internetworking era. RIPv2 introduces the support for classless inter domain routing (CIDR) protocol, by sending subnet mask address in routing update. RIPng (RIP New Generation) enable the support for IPv6 in RIP network domain, due to the RIP lapses and difficulties in supporting larger network, Open Shortest Path First (OSPF) is a preferences to the RIP protocol. OSPF is an older routing protocol introduced to support larger Autonomous System (AS) network using link state routing protocol. Enhance Interior Gateway Routing Protocol (EIGRP) is an enhance distance vector routing protocol (Hybrid) that combine the feature of RIP and little techniques of OSPF for design and maintenance of network topology and uses bandwidth to determine best route. This paper analysed and compared the performance of two distance vector and link state routing protocols based on different network criteria. Based on the research carried out EIGRP is the best routing protocol since it has most of the features of both distance vector and link state routing protocol as such is recommended for Nigerian organizational network to ensure Quality of Service (QoS) and better network security. We also recommend that organizations should endeavour to make use of Cisco routers or Cisco layer 3 switches

for better security and network scalability that support other applications such FTP, Video conferencing and QoS. We also recommend EIGRP routing protocol usage by Nigerian organisation's network so as to optimise their network as such subsequent boost in productivity.

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