CONFIGURATION AND PERFORMANCE ANALYSIS OF CISCO ROUTING PROTOCOLS USING PACKET TRACER

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Abstract:

In this paper Performance analysis of different routing protocols like Routing Information Protocol (RIP), Open Shortest Path First (OSPF) and Enhanced Interior Gateway Routing Protocol (EIGRP) are to be discussed.

At every individual type of topologies with the help of packet tracer to get the best performance of dynamic routing protocols, we get various results which are concluded on the basis of the type of topology we have used. We configured various routing protocols and collect statistics such as network convergence time, Ethernet delay, security and bandwidth requirement, and number of hop counts in the physical and logical structure of a network and to analyze the routing tables. We are showing the Study of metrics of each routing protocol with the best performance for a large, realistic network. The comparison between RIP, OSPF and EIGRP are done on the basis of matrix parameters of routing technique through Cisco network simulator packet tracer.

Keywords: RIP OSPF, EIGRP, and PING, Packet Tracer, matrix, bandwidth, and delay.

I. INTRODUCTION

Routing is the process of transferring the packet from source to destination host. Each Router maintains the routing table, so each router can easily make the decision of the best route selection for foreign networks through routing table. In Static routing protocol, we manually assign the IP route of directly or indirectly connected networks. The default static route's have administrative distance of 1. So we prefer Static routing for small and simple network configuration, where the routes are user-defined and do not change frequently. Whereas in the case of Dynamic routing or adaptive routing the routing table updated automatically. A dynamic routing protocol such as RIP, IGRP, BGP, OSPF, EIGRP, IS-IS having high hop count, a Routing table is updated automatically to re-route the traffic for routing protocols running on the router to load balance between multiple links.

Distance vector protocols (RIP and IGRP) finds the best path to a remote network by judging the distance between source to destination is based on a number of hop counts, each time a packet goes through a router is called a hop. The route having the least number of hops will be the best route.

Link State protocols (OSPF - Open Shortest Path First and IS-IS - Intermediate System to Intermediate System) or shortest path first protocols. Separate tables are created for each link state routing protocols, where the best path information is stored in a routing table, and alternate or back-up path information is stored in a topological table, and directly connected information is stored in neighbors table.

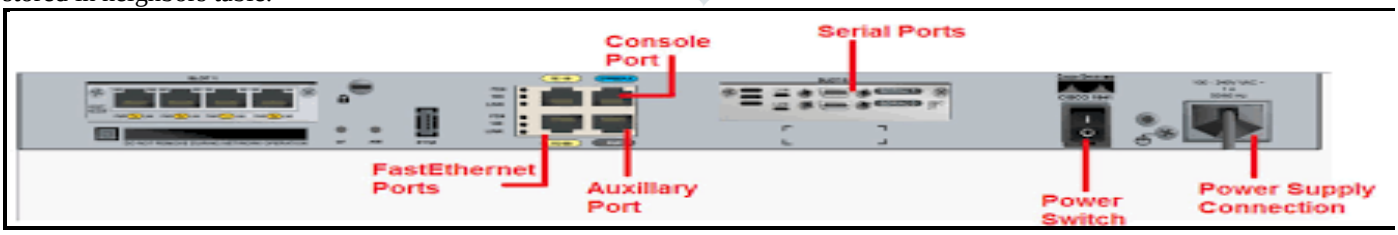

Figure 1 Router Port

II. Static Default Routing Configuration

Static Default Routing with Variable-length subnet masking is shown in figure 2; a static route is created to a specific interface that sends all traffic to the destination.

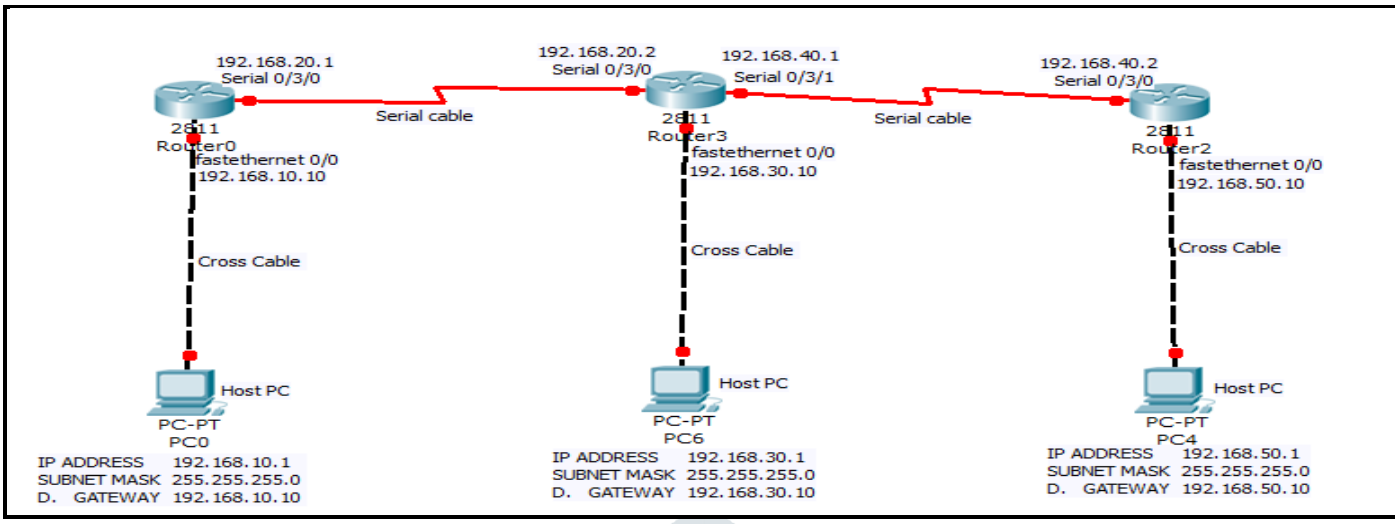

Figure 2 Static routing VLSM using Packet Tracer Simulator

2.1 Router Configuration Commands:

Pick the router Higher than 2800 series…..
Router>
Router>enable
Router#configure terminal
Router (config)#interface FastEthernet 0/0
Router (config-if)#ip address 192.168.10.10 255.255.255.0
Router (config-if)#no shutdown.
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UP-DOWN: Line protocol on Interface FastEthernet0/0,
Then Press Cnt+Z to exit mode.
Router#configure terminal
Router (config)#int serial 0/3/0
Router (config-if)#ip address 192.168.20.1 255.255.255.0
Router (config-if)#no shutdown
%LINK-5-CHANGED: Interface Serial0/3/0, changed state to down
For serial Cables we have to first check its DCE or DTE ports:
If it is DCE ports than assign a clock rate to those ports with 64000
Router#show ip interface brief

Interface	IP-Address	OK?	Method	Status	Protocol
FastEthernet0/0	192.168.30.1	YES	manual	up	
FastEthernet0/1	unassigned	YES	manual	administratively down	
Serial0/3/0	192.168.20.2	YES	manual	up	

Then check status: for a router
Router#show ip interface brief

Interface	IP-Address	OK?	Method	Status	Protocol
FastEthernet0/0	192.168.30.1	YES	manual	up	
Serial0/3/0	192.168.20.2	YES	manual	up	
Serial0/3/1	192.168.40.1	YES	manual	up	

Router with Foreign Network Configuration Command:

Router (config)#ip route 192.168.30.0 255.255.255.0 192.168.20.2
Router (config)#ip route 192.168.40.0 255.255.255.0 192.168.20.2
Router (config)#ip route 192.168.50.0 255.255.255.0 192.168.20.2

ICMP Response Round-trip time (RTT):

E.g.: Ping through router 2 to pc1
Router#ping 192.168.10.1
Type escapes sequence to abort.
Sending 5, packet of 100-byte ICMP Echos to 192.168.10.1, timeout is 2 seconds:
Success rate is 100 percent (5/5), All Packet sent, round-trip min/avg/max = 5/7/11 ms
RTT: time is taken to send a packet plus the length of time taken for acknowledgment of that received packet

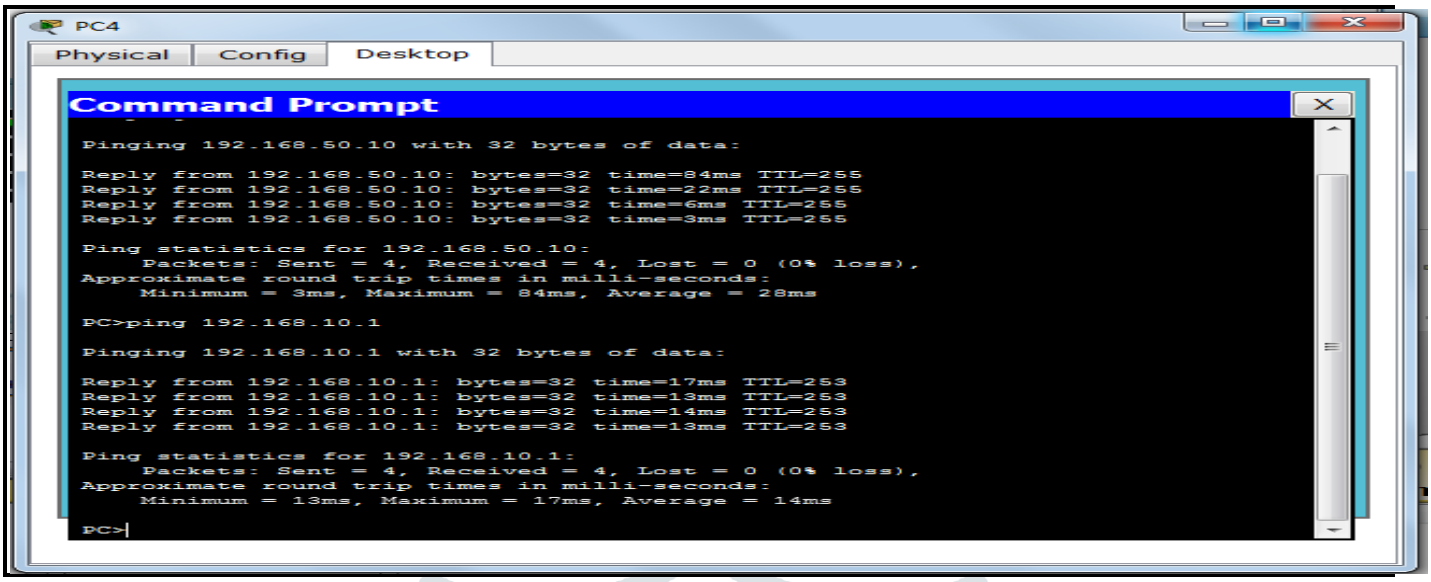

Figure 3 Ping from source pc with the IP 192.168.50.1 to destination host pc ip 192.168.10.1

For Security: Plain Text Authentication,
MD5 ("message digest") Authentication concepts is used. Access list Deny and permit for neighbor information.
Router (config)#access list 10 deny host 192.168.10.1
Router (config)#access list 20 permit host 1992.168.30.1
Router (config)#ip access group 110 in /out

III. Routing Information Protocol (RIP)

RIP is a distance vector routing protocol.RIP support maximum hop count of 15 to measure the distance between source and destination, The IP address of the sender is used as the next hop count, RIP having an administrative distance of 120. RIP root update timer is 30 second. There are two versions of RIP

Table 1 RIP Version1 V/s RIP Version2

RIP v1	RIP v2
Classful Routing	Classless Routing
Broadcast base	Multicast address use 224.0.0.9
Not support for VLSM	Support for VLSM
Not support for CIDR	Support for CIDR
No authentication	MD5 and key-chain authentication

As shown in Figure 4 RIP (Routing Information Protocol) selects the best path from source IP 192.168.10.1 to destination IP 192.168.70.1 based on a number of hop count.

3.1 RIP Network Configuration:

Here a minimum number of hop counts via a different route from Router0 to Router3.
Best Path from Source to Destination
Router0-> 3560 L3 Switch Catalyst->Router3.
Alternate hop count path is
Router0->Router1->Router2->Router3.

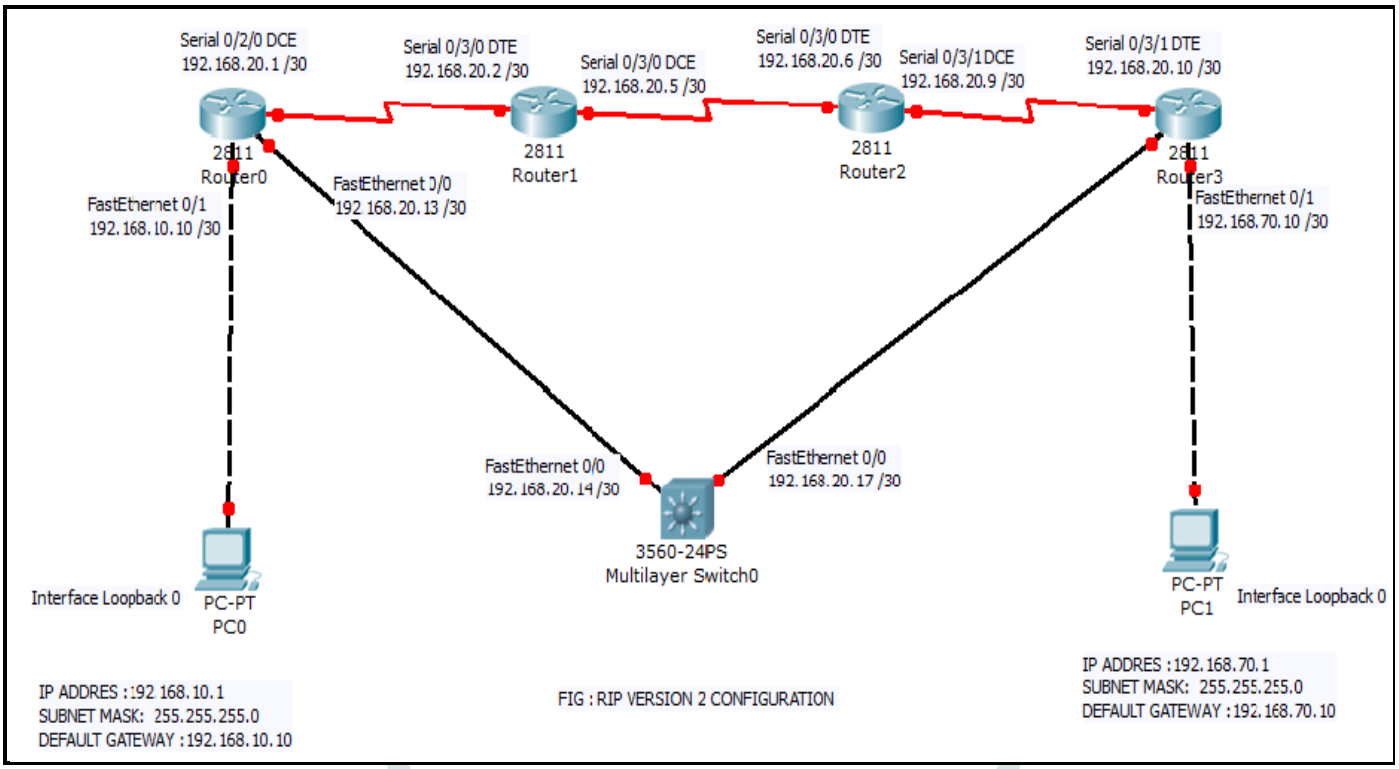

Figure 4 RIP Configuration Network using Packet Tracer Simulator

3.2 Routing Information Protocol (RIP) Configuration:

Router (config)# router rip
Router(config-router)# version 2
Router (config-router)# network 192.168.20.0
Router (config-router)# network 192.168.10.0
Router (config-router)# network 192.168.20.4
Router (config-router)# network 192.168.20.8
Router (config-router)# network 192.168.20.12
Router (config-router)# network 192.168.20.16
Router (config-if)#ip rip authentication key-chain prithvi (any Password)
Router (config-if)#Exit
Router (config-if)#Key1
Router (key-chain-key)#key String prithvi
Router (config-if)#ip rip authentication mode md5
Router (config-if)#timer basic 30 180 180 240
Here RIP TIMER update 30sec, invalid 180sec, hold-down 180 sec, flush 240 sec.

3.3 RIP Routing Table: RIP uses hop count as a metric to determine the best path.

Table 2 RIP (Routing Hop Count)

Destination IP ADDRESS	Destination Node	Matrix	Next Hop Address	Next Hop Node	Outgoing Interface
network 192.168.20.0 /30	Router0	0	Router0	192.168.20.2 /30	Fast Ethernet 0/0
network 192.168.10.0 /30	Router1	2	Switch L3-3560	192.168.20.6 /30	Serial 0/3/0
network 192.168.20.4 /30	Router2	3	Router0	192.168.20.10 /30	Serial 0/3/1
network 192.168.20.8 /30	Router3	16	Switch L3-3560	192.168.20.17 /30	Serial 0/2/0
network 192.168.20.12 /30	Multi-layer Catalyst	1	Router0	192.168.70.1 /30	Fast Ethernet 0/0

3.4 Performance of RIP

Router calculates metric to select the best path of the network. Metric is a measuring parameter, which is used to select the best path among multiple routes learned by a routing table, protocol.

Table 3 RIP (RTT & Matrix)

The speed of channel Capacity	Round Trip Time (m sec)	Hop Count	Matrix
64 kbps	28	5	0
128 kbps	22	3	2
256 kbps	18	2	3
512 kbps	14	6	16
1 Mbps	12	3	1

RIP has the worst performance in the case of large networks actually RIP is suitable for small and simple network configuration with minimum hop counts.

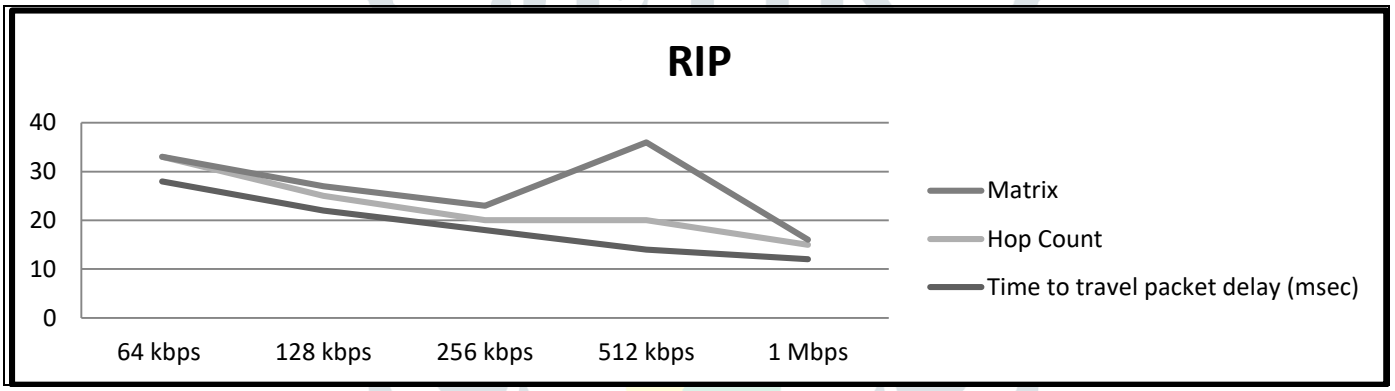

Figure 5 Routing Information Protocol HOP Count Performance

IV. OSPF (Open Shortest Path First): OSPF is a link state interior gateway routing protocol. OSPF uses the concepts of Dijkstra's algorithm to find the shortest path to the destination, and exchange LSA (Link State Advertisement). In case of OSPF while sending a packet across an interface, two parameters will affect the cost and bandwidth, if bandwidth is higher than the cost is lower, so Cost = (10^8/bandwidth (bps)). OSPF has Administrative Distance value is 110. OSPF uses HELLO PACKET (packet are sent after every 10 seconds) to establish & maintain a neighbor relationship to elect DR and BDR. OSPF area 0 is always the backbone area. OSPF uses multicast address 224.0.0.5 for all OSPF router, IP address 224.0.0.6 for all OSPF DR (designated router- that are connected to same multi-access networks), BDR (Backup Designated Router- router with second highest priority). OSPF having a maximum hop metric of 65,535. OSPF is more efficient routing than RIP protocols in terms of throughput and traffic load.

4.1 OSPF with Multi Area Networks:

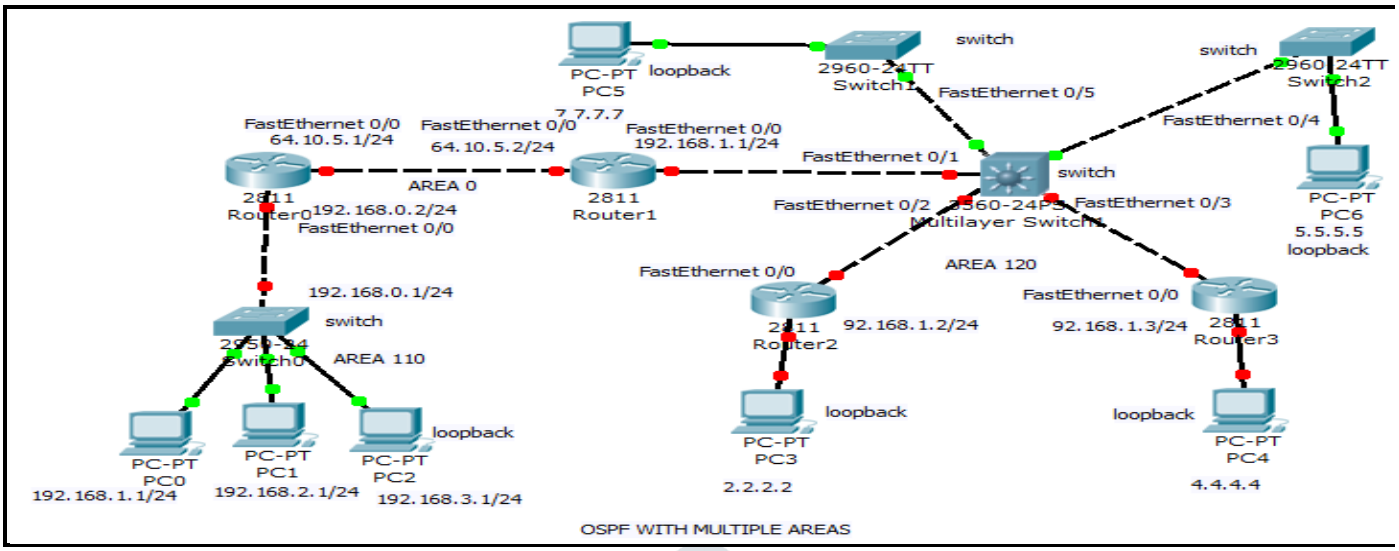

Figure 6 OSPF with Multiple Areas Using Packet Tracer Simulator

Open Shortest Path first select the best path from source to destination with different autonomous system number (area 110 & area 120) with area 0 as a backbone area.

4.2 Router Configuration with OSPF

Router>
Router>enable
Router#configure terminal
Router (config)#interface loopback 0
Router (config-if)#ip address 192.168.1.1 255.255.255.0
Router (config-if)#no shutdown
Router (config-if)#ip ospf network point to point
Router (config-if)#Exit
To be configured the various area network
Area 110 point to point – Hello 2 ways
Area 0 Always backbone area
Area 120 Broadcast (DR and BDR)
router ospf process-id
network ip-address wildcard-mask area area-id
Router(config)#Router ospf 10
Router (config)#Network 192.168.0.0 0.0.0.255 area 110
Router (config)#Network 64.10.5.0 0.0.0.255 area 0
Router (config)#Network 2.2.2.2 0.0.0.255 area 120

Table 4 OSPF Routing Table (Multi-Area Network & Bandwidth)

Destination IP ADDRESS	Destination Node	Matrix	Next Hop Address	Next Hop Node	Outgoing Interface
network 192.168.0.1 /24	L3 Switch	4	Router0	1.1.1.1 /24 loopback	Ethernet 0/0 area 110
network 192.168.0.2 /24	Router0	21	Switch L3-3560	2.2.2.2 /24 loopback	Ethernet 0/0 area 0 backbone
network 64.10.5.1 /24	Router1	8	Router1	4.4.4.4 /24 loopback	Ethernet 0/0 area 0 backbone
network 64.10.5.2 /24	Router2	16	Switch L3-3560	5.5.5.5 /24 loopback	Ethernet 0/0 area 120
network 192.168.1.1 /24	Multi-layer Catalyst	12	Router2	7.7.7.7 /24 loopback	Ethernet 0/0 area 120

4.3 OSPF Summarization

In the configuration of OSPF, there are two ABR (Area Border Router).

Summarized Router Info: 192.168.0.0 /256
192.18.1.0 /256
192.168.2.0 /256
12.168.3.0 / 256
Total = 1024 so in binary total ON bits = 2^7
So range 192.168.0.0 /22 255.255.252.0
Router (config) #Router ospf 10
Router (config) #area 110 range 12.168.0.0 255.255.252.0

4.4 Performance of OSPF

Performance of OSPF, on the basis of the delay, cost of packet delivery, and amount of overhead on each router.

Table 5 OSPF (RTT & Matrix)

A speed of channel Capacity	Average RTT in (milliseconds)	ABR (Area)	Matrix
64 kbps	18	110	4
128 kbps	20	110	21
256 kbps	24	0	8
512 kbps	16	120	16
1 Mbps	22	120	12

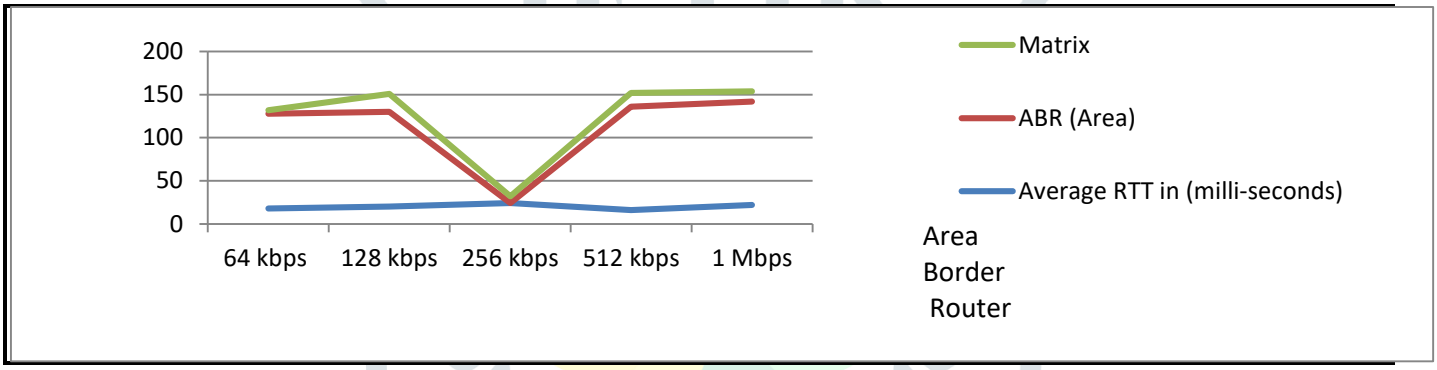

Figure 7 OSPF with area 110, 120 and area 0 as Backbone area

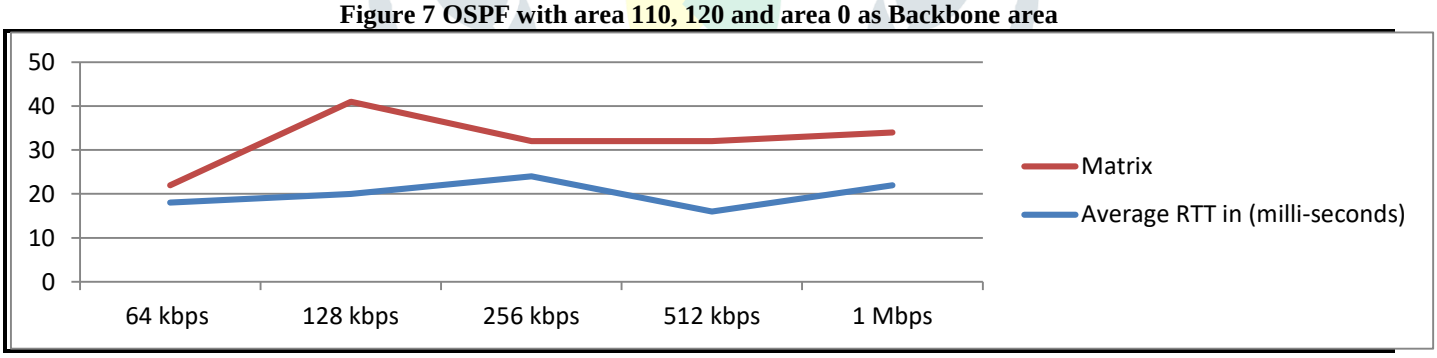

Figure 8 OSPF Matrix DUAL Performance

V. EIGRP (Enhanced Interior Gateway Routing Protocol)

EIGRP combining the features of both distance vector and link state routing protocols. EIGRP Support for both CIDR and VLSM, also support for summarization and discontinuous network. The Diffusing Update Algorithm (DUAL) is used for the best path selection. EIGRP Administrative Distance is 90. AD measures the reliability of a given routing protocol. AD is less so its higher reliable network. EIGRP uses 224.0.0.10 as a multicast address. Calculation of route selection in EIGRP depends on components like Bandwidth (K_1-1), Load (K_2-0), Delay (K_3-1), Reliability (k_4-0), and maximum transmission unit (MTU) (K_5-0).

EIGRP Matrix:

$256*([K_1*BW+K_2*BW\ (256-Load) +K_3*\ Delay]*[K_5/\ (Reliability + K_4)])$

Feasible Distance (FD) = the metric of the best route from source to a neighbor + neighbor to a destination. Reported Distance (RD) = the metric on a neighboring router which is reported to destination route in an EIGRP Update. SUCCESSOR is the best path that is stored in a routing table, Back-up or alternate path stored in the topological table whereas neighbor information stored in neighbor's table. In terms of certain parameters, EIGRP routing protocol the source router R0 start transmitting data to the

destination on the feasible path to destination router R1. From source node to destination node, each router calculates EIGRP matrix based on performance of cable only, which is used to connect different routers. Higher the bandwidth (Kbps) of cable gives lower delay (m sec) in transmission of packet. With serial 0/3/0 speed of transmission is 1 Mbps having minimum delay, and FastEthernet0/0 speed of transmission is 128 Kbps having maximum delay.

5.1 EIGRP Network Configuration

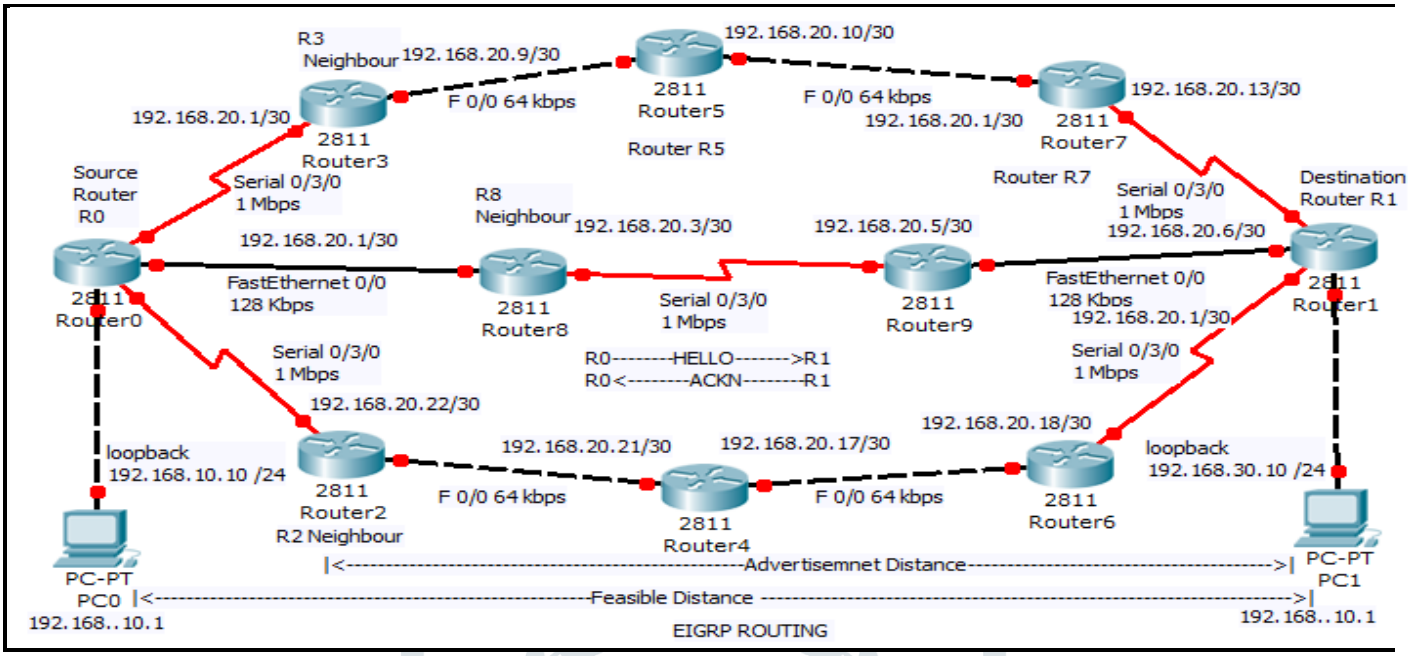

Figure 9 EIGRP Network using Packet Tracer Simulator

EIGRP metric in simulated results, the selection of the best path depends on bandwidth (K1) and delay (K3).
From source to destination HOST with a minimum hop count (number of routers DR and BDR) and maximum channel speed in Kbps, the best route selection is given below
Router0→Router8→Router9→Route1

5.2 Configuring the Enhanced Interior Gateway Routing Protocol (EIGRP)

Router (config) #router eigrp 10
Router (config) #network 192.168.30.0
Router (config) #network 192.168.20.0
Router (config) #network 192.168.20.4
Router (config) #network 192.168.20.8
Router (config) #network 192.168.20.12
Router (config) #network 192.168.20.16
Router (config) #network 192.168.20.20
Router (config) #no auto summary
Router (config) #eigrp log neighbor change

EIGRP Routing Table

Table 6 EIGRP (Bandwidth & Delay)

Destination IP ADDRESS	Destination Node	Metric	Delay (m sec)	Next Hop Node	Outgoing Interface
network 192.168.30.10 /24	Router1	2145873/ 0	80	192.168.20.1 /30	Fast Ethernet 0/0
network 192.168.10.0 /30	Router6	2681239/ 2168532	20	192.168.20.9/30	Serial 0/3/0
network 192.168.20.6 /30	Router7	3706438/ 3056812	40	192.168.20.3 /30	Serial 0/3/1
network 192.168.20.18 /30	Router4	3126439/ 2652872	60	192.168.20.2 /30	Serial 0/2/0
network 192.168.20.14 /30	Router5	3167429/ 2136835	70.	192.168.30.1 /30	Fast Ethernet 0/0

5.3 Performance of EIGRP

Table 7 EIGRP (RTT & Matrix)

A speed of channel Capacity	Average RTT in (milliseconds)	Best Path	Matrix
64 kbps	28	R0-R2-R4-R6-R1	2136835
128 kbps	16	R0-R8-R9-R1	2681239
256 kbps	18	R0-R3-R5-R7-R1	3167429
512 kbps/ 1 Mbps	14	R0-R8-R9-R1	2168532
1 Mbps	12	R0-R2-R4-R6-R1	3706438
1 Mbps	14	R0-R3-R5-R7-R1	3126439

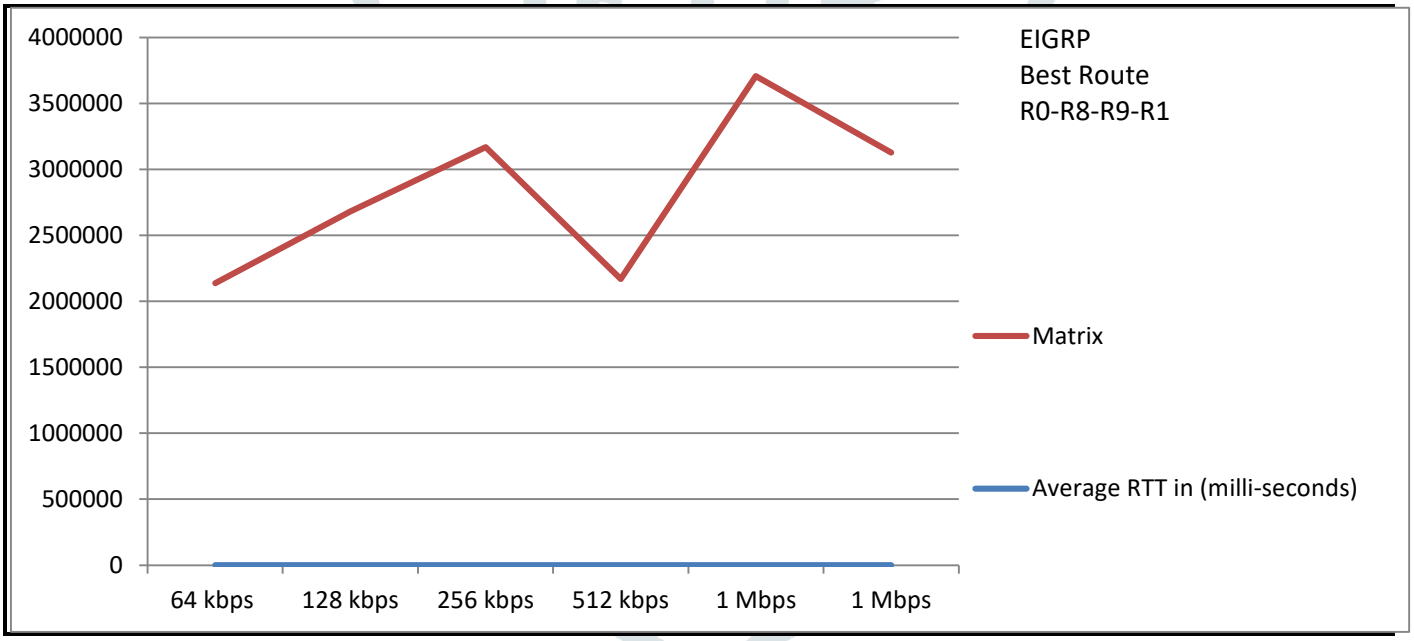

Figure 10 EIGRP Performance Matrixes

VI. Result Analysis

Convergence of network performance is high for EIGRP as shown in the following chart

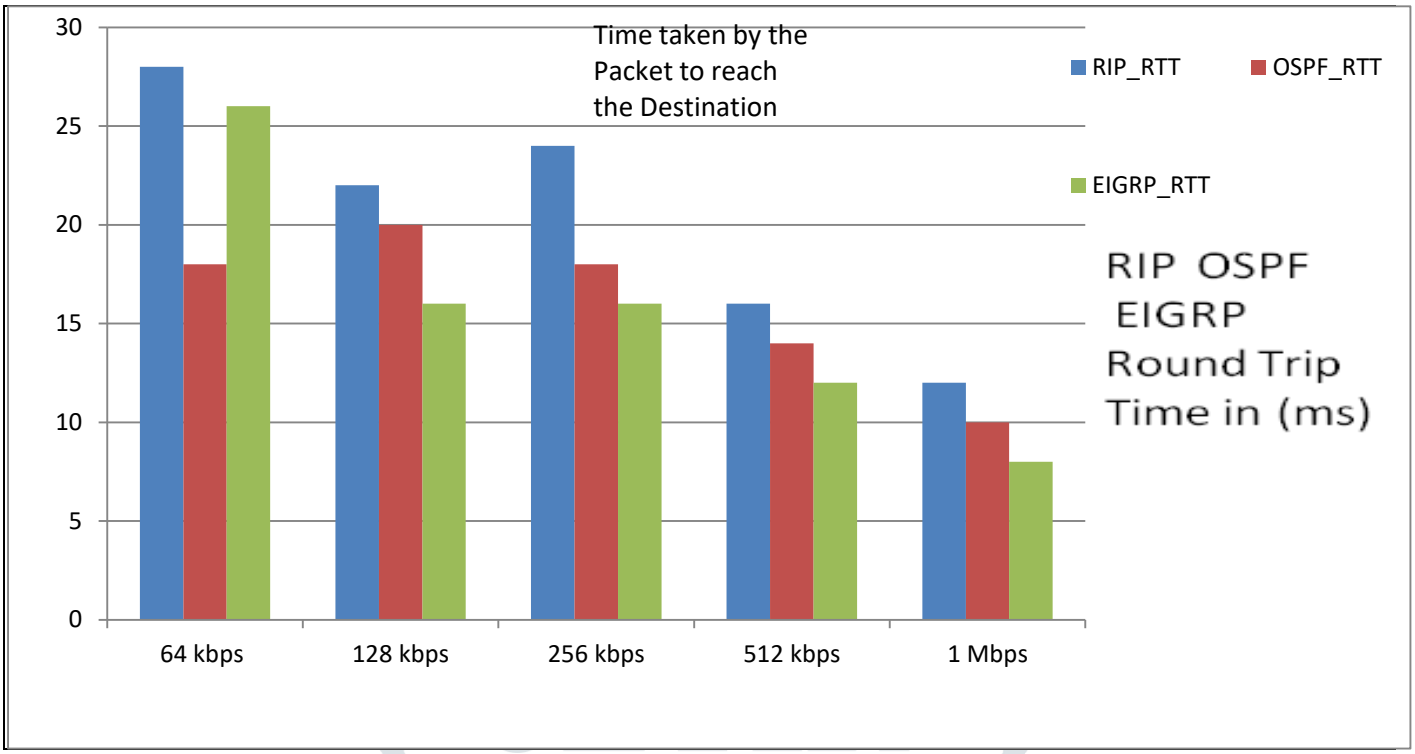

Figure 11 Comparison Chart of RIP, OSPF, EIGRP Routing Protocol

VII. Conclusion and Future Work

Packet Tracer analyze the simulated results, that EIGRP routing protocol is the best choice for fastest convergence for all Network topologies, Through simulated results observed that EIGRP and OSPF both efficiently utilize the Bandwidth, accordance with the traffic send (bytes/sec). While RIP configured router sends complete information to next hop or flood the network which wasted bandwidth. So in terms of network congestion RIP provides the highest delay from this result, we have analyzed that the delay is improved by increasing the transmission rate. So EIGRP is the best protocol that provides better performance than RIP and OSPF. The security analysis for all these protocols can be considered in future work.

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