AN IMPLEMENTATION OF ROUTE DISTRIBUTION BETWEEN OSPF, EIGRP, AND BGP

[1]Rahul Sharma, [2]Nishi Yadav
[1]Bachlor of Technology, [2]Assistant Professor
[1]School of Studies in Engineering and Technology, Guru Ghasidas Vishwavidalaya Bilaspur, (C.G), India
[2] School of Studies in Engineering and Technology, Guru Ghasidas Vishwavidalaya, Bilaspur, (C.G), India

Abstract: Redistribution of one or more routing protocols is a requirement for many real-life problems. Due to their wide applicability in the organization, engineering, and other areas, various types of routing protocols have been proposed in real application based networking. The packets from the source router to destination router routed in a reliable manner and routing protocol plays an important role to provide a most suitable route. A real network with real network traffic is forward by different routing protocols having different Autonomous System having the different-different network topologies.

***Index Terms* - BGP, EIGRP, OSPF, GNS3, Wire Shark, Routers and Routing Protocols.**

I. INTRODUCTION

Routing Protocol is a technique to advertise their own routes, but the redistribution of routing protocols is that, learn the route basically that are advertised by another means, they may be from a static routing protocol, default routing protocol, or dynamic routing protocol. Only running one routing protocol over your entire IP internetwork is desirable. Multi-routing protocol is common for many reasons like as, emerging organization, multiple departments handled by multiple network administrator and various service provider environments. Implementing various routing protocol is a part of impressive network design. If any network running multiple routing protocols then redistribution is very necessary.

Every routing protocol has some of their own characteristics, some of the factors are administrative distance, metrics, classful, classless, and convergence which can affect redistribution. For efficient and successful redistribution of routing protocol, we should consider all characteristics very carefully.

II. BACKGROUND DETAILS AND WORKS

2.1EIGRP

Enhanced Interior Gateway Routing Protocol is advanced distance-vector routing protocol it is a Cisco proprietary protocol which only works on Cisco routers, not on other vendor routers. EIGRP was converted to an open standard in 2013 and it replaces IGRP (Interior Gateway Routing Protocol) [6]. EIGRP has the feature of both Distance Vector as well as Link State routing protocol. It works on DUAL (Diffusing Update Algorithm) to select the best path among all routing path & by using DUAL it creates a loopfree environment [14]. It will establish neighbourship with contiguous routers, which has an equal autonomous system [9]. All the traffic of EIGRP routing protocol whether it is unicast or multicast on an address 224.0.0.10. For ensuring an end to end packet delivery it uses Reliable Transport Protocol (RTP) [15]. It has administrative value for the external network which is 170 and 90 for the internal network. Bandwidth and delay of the line are used for calculating distance metric, reliability load and MTU (Maximum Transfer Unit) that can be also used for calculating metric. It doesn't send a periodically full table of routing when any change occurs the only changes are sent to another router [16]. There are several packets in EIGRP and they are defined [9] in Table 2.1.

Table 2.1: EIGRP Packets

Serial Number	Message Name	Used for
1.	Hello Packet	Multicasting
2.	Update Packet	Multicasting &
3.	Query Packet	Multicasting
4.	Reply Packet	Unicasting
5.	Acknowledgement Packet	Unicasting

There are some metric parameters in EIGRP and they are defined in [9] Table 2.2

Table 2.2: EIGRP Parameter

Serial Number	Parameter Name	Value
1.	K1	Bandwidth
2.	K2	Load
3.	K3	Delay of line
4.	K4	Reliability
5.	K5	MTU

2.2 OSPF

Open Shortest Path First used Dijkstra Shortest Path First algorithm is used for determining the shortest path among a large network. OSPF is pure Link State Routing Protocol to get more efficiency over a large network [7]. OSPF establish neighbourship with the routers having the same area. OSPF revels the status of directly connected Link State Advertisement(LSA). OSPF also sent only the changes that occur in the routing table [16]. LSAs are refresh additionally in every 30 minutes. The traffic of all routers of OSPF multi-casted on the address 224.0.0.5 and for only designated the address will 224.0.0.6. OSPF is a classless routing protocol means it supports VLSM (Variable Length Subnet Mask) [14]. The administrative value is 110 for OSPF [16]. It uses cost parameter for calculating metric. Cost = 1/bandwidth

There are five neighboring states in OSPF down, Init, 2-way, Ex-start, exchange loading and full and they are defined [10] Table 2.3.

Table 2.3: OSPF States

Serial Number	State	Information
1.	Down	No OSPF connection between linked routers Get router-id from each other
2.	Init	Get router-id from each other
3.	2-way	Bi-directional communication established and designated and backup designated routers elected
4.	Ex-start	Routers are ready to share their information
5.	Exchange	Database description are exchanged by linked routers
6.	Loading	Link State Advertisements are finally, exchange by linked routers
7.	Full	fully synchronization is done by routers

Some type of LSAs in OSPF and they are defined [10] in Table 2.4.

Table 2.4: OSPF's LSA

Serial Number	LSA Name	Work
Type 1	Router LSA	Contains a list of all links local to the router
Type 2	Network LSA	Number of network on multi-access segment means contains a list of all routers, attached to the Designated Router contains
Type 3	Network Summary LSA	a list of all destination networks within an area
Type 4	ASBR Summary LSA	contains a route to any ASBRs in the OSPF system contain routes to the destination
Type 5	External LSA	networks outside the local Autonomous System

2.3 BGP

Border Gateway Routing Protocol uses path vector routing protocol. Its current standard version is BGPv4 [8]. BGP was not recalled route with an autonomous system, but rather to route between different AS. A separate routing table is maintained by the BGP which is based on AS path and various another attribute, as opposed to IGP like distance cost. On the internet, the most demanded routing protocol is BGP because the internet is a collection of the interconnected autonomous system. BGP AS number range is 1 to 65535 means a 16-bit number. On port number 179 it uses TCP. There are two types of BGP peer connection [11].

Ibgp: BGP neighbor in same AS.

Ebgp: BGP neighbor in different AS.

There are several types of BGP and they are defined [11] in Table 2.5

Table 2.5: BGP Message

Serial Number	Message Name	Information
1.	Open Message	to initiate the communication sent to between two peers
2.	Keepalive Message	It is sent in every 60 seconds to check that remote router is still present if not available then its hold-down time will 180 seconds
3.	Update Message	Send to exchange route between routers
4.	Notification Message	If any error encounter then it is sent to inform

The states of BGP are defined [11] in Table 2.6.

Table 2.6: BGP's State

Serial Number	State Name	Information
1.	Idle	Beginning state of BGP
2.	Connect	BGP waits for a TCP connection with the remote peer
3.	Active	BGP attempts to initiate a TCP connection with the remote peer
4.	OpenSent	BGP and TCP connection both performed and sent an open message and waits for reply Sent keepalive message to reply the open message
5.	OpenConfirm	BGP listens for a reply KEEPALIVE message.
6.	Established	A session of BGP established and an update message send which containing all the information

2.4 Description of the network topology

The sample design of the network topology is drawn in Figure 2.4 In the network topology, there are six Cisco routers of series C7200. The routers have the 4 Ethernet interfaces, 3 FastEthernet interfaces, 4 Serial interfaces, 509K bytes of NVRAM (NonVolatile Random Access Memory) and it requires 512 MB(megabyte) RAM of the hardware device. C7200 cisco routers support multiprotocol, multimedia routing and bridging with a wide variety of protocols and media types. Network interfaces lie on the port of the routers, establish a relational connection between the routers Peripheral Component Interconnect (PCI) buses and external networks. All the routers are connected to each other by Cross-over Ethernet cable. Cross-over Ethernet cable is used to connect the same devices such as router to router, switch to switch and all the same devices. If the devices are different then the straight-through cable is used such as a router to switch. The routers R1, R2 & R3 are using OSPF routing protocol with 100 Autonomous System and Area no is 10. The basic configuration is done in the network topology using IP's belonging to IP range of Class A. the range of Class A is 1-127, but we don't use 127 because it used for loopback or testing purpose.

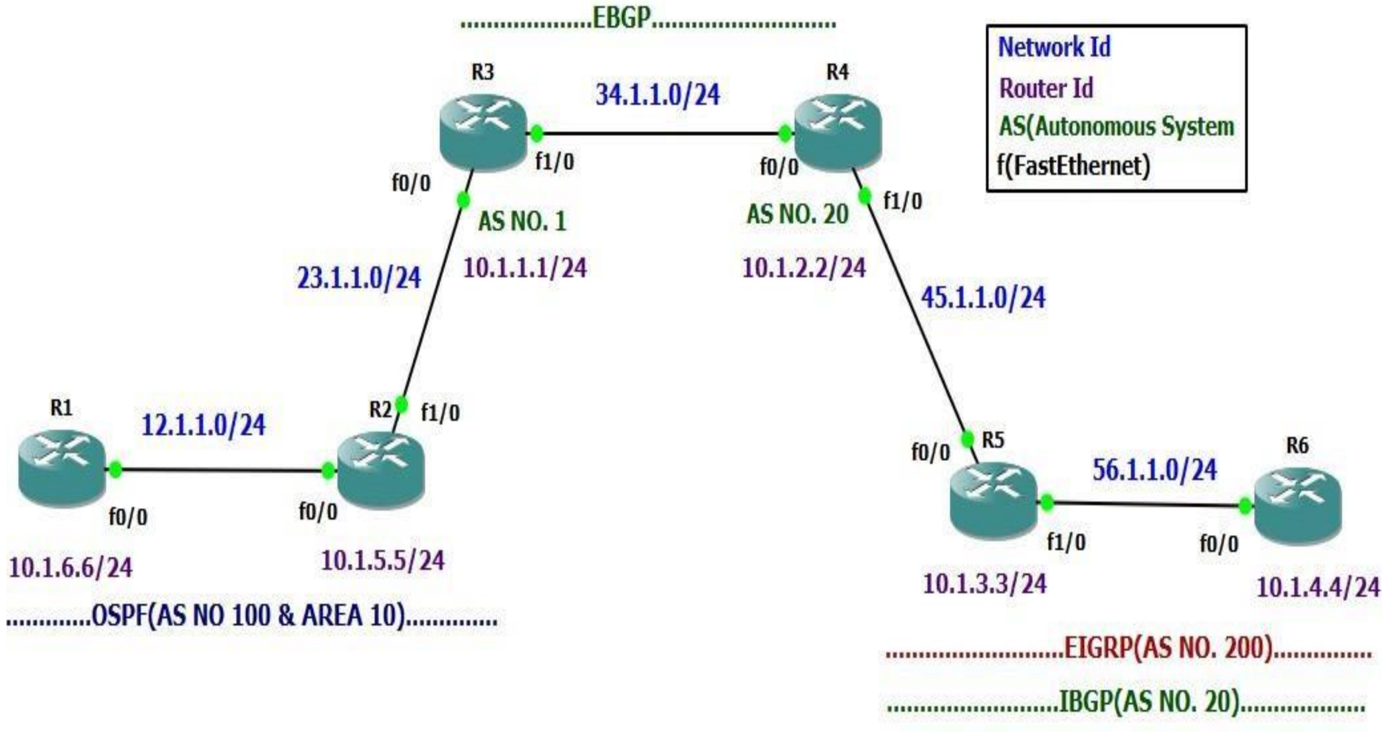


Figure 2.4: Network Topology

But the subnets mask of Class C is used means 255.255.255.0 but Class A have 255.0.0.0. Class A has 2^{24} -2 = 16,277,214 and Class C has 2^8 -2 = 254 means if a small network having less host can use the subnets mask of Class C to prevent the wastage of valid IP addresses. In any network topology, any range of IP classes can be used with the appropriate subnets mask according to the requirement. In the Fig. 2.3.1.1 every router has their own router-id that's is provided by the router automatically, but here provided manually. Router 3 have OSPF, as well as BGP with Autonomous System 1 and router R4, have BGP with Autonomous System 20 and also EIGRP with Autonomous System 200. The router R5 and router R6 have EIGRP with Autonomous System 200. The network of EIGRP with Autonomous System 200 and OSPF with Autonomous System 100, with area 10 is considered as internal BGP. In all the routers. there is loopback interface, it is not a physical interface. Loopback is a logical interface, it is very helpful for router-id, if router-id is not provided manually then the loopback IP address will become the router-id of that router on that loopback which is configured and loopback will be always in the upstate. By-default any router has no loopback interface, it is created and deleted very easily. If there is one physical interface (FastEthernet, serial or another one) connected to the router and it is in down state even then in the condition it helps to perform BGP neighbourship between two routers. To configure real routers, it can be done by Hyperterminal and putty application.

2.4.1 Configuration of router R1

The snapshot of the Basic configuration of the router, R1 is shown in Figure 2.4.1(a) & 2.4.1(b). In the configuration, a valid IP address from the IP pool of 12.1.1.0/24 provided to the FastEthernet port with level0/0 and a loopback0 with a valid IP address of 10.1.6.0/24 IP pool which is a logical interface to the network. And OSPF routing protocol is applied with 100 AS and 10 area number and IBGP with 1 AS and taking remote as Autonomous system 1, BGP router-id 10.1.6.6 is given manually.

R1

```
!
!
!
interface Loopback0
 ip address 10.1.6.6 255.255.255.0
!
interface FastEthernet0/0
 ip address 12.1.1.1 255.255.255.0
 duplex full
!
```

Figure 2.4.1(a): Configuration of router R1

R1

```
!
router ospf 100
 network 10.1.6.0 0.0.0.255 area 10
 network 12.1.1.0 0.0.0.255 area 10
!
router bgp 1
 bgp log-neighbor-changes
 network 10.1.6.0 mask 255.255.255.0
 neighbor 10.1.1.1 remote-as 1
 neighbor 10.1.1.1 update-source Loopback0
 neighbor 10.1.5.5 remote-as 1
 neighbor 10.1.5.5 update-source Loopback0
!
```

Figure 2.4.1(b): Configuration of router R1

2.4.2 Configuration of router R2

The snapshot of the Basic configuration of the router, R2 is shown in Figure 2.4.2(a) & 2.4.2(b). In the configuration, the valid IP address from the IP pool of 12.1.1.0/24 provided to the FastEthernet port0/0, for FastEthernet port1/0 from IP pool of 23.1.1.0/24 and a loopback0 with a valid IP address of 10.1.5.0/24 IP pool which is a logical interface to the network. And OSPF routing protocol is applied with 100 AS and 10 area number and IBGP with 1 AS and taking remote as Autonomous system 1, BGP router-id is 10.1.5.5 which is given manually.

R2

```
!
interface Loopback0
 ip address 10.1.5.5 255.255.255.0
!
interface FastEthernet0/0
 ip address 12.1.1.2 255.255.255.0
 duplex full
!
interface FastEthernet1/0
 ip address 23.1.1.1 255.255.255.0
 speed auto
 duplex auto
!
```

Figure 2.4.2(a): Configuration of router R2

R2

```
!
router ospf 100
 network 10.1.5.0 0.0.0.255 area 10
 network 12.1.1.0 0.0.0.255 area 10
 network 23.1.1.0 0.0.0.255 area 10
!
router bgp 1
 bgp router-id 10.1.5.5
 bgp log-neighbor-changes
 network 10.1.5.0 mask 255.255.255.0
 neighbor 10.1.1.1 remote-as 1
 neighbor 10.1.1.1 update-source Loopback0
 neighbor 10.1.6.6 remote-as 1
 neighbor 10.1.6.6 update-source Loopback0
!
```

Figure 2.4.2(b): Configuration of router R2

2.4.3 Configuration of router R3

The snapshot of the Basic configuration of the router, R3 is shown in Figure 2.4.3(a)& 2.4.3(b). In the configuration a valid IP address from the IP pool of 23.1.1.0/24 provided to the FastEthernet port0/0, for FastEthernet port1/0 from IP pool of 34.1.1.0/24 and a loopback0 with a valid IP address of 10.1.1.0/24 IP pool which is a logical interface to the network. And OSPF routing protocol is applied with 100 AS and 10 area number and IBGP with 1 AS and taking remote as Autonomous system 1, EBGP with AS 1and remote as 20 AS, BGP router-id 10.1.1.1/24 is given manually. Redistribution process of OSPF and BGP routing protocols is applied to the router R3.

R3

```
!
interface Loopback0
 ip address 10.1.1.1 255.255.255.0
!
interface FastEthernet0/0
 ip address 23.1.1.2 255.255.255.0
 duplex full
!
interface FastEthernet1/0
 ip address 34.1.1.1 255.255.255.0
 speed auto
 duplex auto
!
```

Figure 2.4.3(a): Configuration of router R3

R3

```
!
router ospf 100
 redistribute connected metric 5000 subnets
 network 10.1.1.0 0.0.0.255 area 10
 network 23.1.1.0 0.0.0.255 area 10
!
router bgp 1
 bgp router-id 10.1.1.1
 bgp log-neighbor-changes
 network 10.1.1.0 mask 255.255.255.0
 redistribute connected
 redistribute static
 redistribute ospf 100
 neighbor 10.1.5.5 remote-as 1
 neighbor 10.1.5.5 update-source Loopback0
 neighbor 10.1.6.6 remote-as 1
 neighbor 10.1.6.6 update-source Loopback0
 neighbor 34.1.1.2 remote-as 20
!
```

Figure 2.4.3(b): Configuration of router R3

2.4.4 Configuration of router R4

The snapshot of the Basic configuration of the router, R4 is shown in Figure 2.4.4(a) & 2.4.4(b). In the configuration a valid IP address from the IP pool of 34.1.1.0/24 provided to the FastEthernet port0/0 and for FastEthernet port1/0 from IP pool of 45.1.1.0/24 and a loopback0 with a valid IP address of 10.1.2.0/24 IP pool which is a logical interface to the network and EIGRP routing protocol is applied with 200 AS, IBGP with 1 AS and taking remote as Autonomous system 1 and EBGP with 20 AS and taking remote as Autonomous system 1, BGP router-id 10.1.2.2/24 is given manually.

R4

```
!
!
interface Loopback0
 ip address 10.1.2.2 255.255.255.0
!
interface FastEthernet0/0
 ip address 34.1.1.2 255.255.255.0
 duplex full
!
interface FastEthernet1/0
 ip address 45.1.1.1 255.255.255.0
```

Figure 2.4.4(a): Configuration of router R4

R4

```
!
router eigrp 200
 network 10.1.2.0 0.0.0.255
 network 45.1.1.0 0.0.0.255
 redistribute bgp 20 metric 1500 2000 255 1 1500
!
router bgp 20
 bgp router-id 10.1.2.2
 bgp log-neighbor-changes
 network 10.1.2.0 mask 255.255.255.0
 redistribute connected
 redistribute static
 redistribute eigrp 200
 neighbor 10.1.3.3 remote-as 20
 neighbor 10.1.3.3 update-source Loopback0
 neighbor 10.1.4.4 remote-as 20
 neighbor 10.1.4.4 update-source Loopback0
 neighbor 34.1.1.1 remote-as 1
!
```

Figure 2.4.4(b): Configuration of router R4

2.4.5 Configuration of router R5

The snapshot of the Basic configuration of the router, R5 is shown in Figure 2.4.5(a) & 2.4.5(b). In the configuration a valid IP address from the IP pool of 45.1.1.0/24 provided to the FastEthernet port0/0 and for FastEthernet port1/0 from in pool of 56.1.1.0/24 and a loopback0 with a valid IP address of 10.1.3.0/24 IP pool which is a logical interface to the network and EIGRP routing protocol is applied with 200 AS, IBGP with 20 AS and taking remote as Autonomous system 20, BGP router-id 10.1.2.2/24 is given manually.

R5

```
!
!
interface Loopback0
 ip address 10.1.3.3 255.255.255.0
!
interface FastEthernet0/0
 ip address 45.1.1.2 255.255.255.0
 duplex full
!
interface FastEthernet1/0
 ip address 56.1.1.1 255.255.255.0
 speed auto
 duplex auto
!
```

Figure 2.4.5(a): Configuration of router R5

R5

```
!
!
router eigrp 200
 network 10.1.3.0 0.0.0.255
 network 45.1.1.0 0.0.0.255
 network 56.1.1.0 0.0.0.255
!
router bgp 20
 bgp log-neighbor-changes
 network 10.1.3.0 mask 255.255.255.0
 neighbor 10.1.2.2 remote-as 20
 neighbor 10.1.2.2 update-source Loopback0
 neighbor 10.1.4.4 remote-as 20
 neighbor 10.1.4.4 update-source Loopback0
!
```

Figure 2.4.5(b): Configuration of router R5

2.4.6 Configuration of router R6

The snapshot of the Basic configuration of the router, R6 is shown in Figure 2.4.6(a) & 2.4.6(b). In the configuration a valid IP address from the IP pool of 56.1.1.0/24 provided to the FastEthernet port0/0 and a loopback0 with a valid IP address of 10.1.4.0/24 IP pool which is a logical interface to the network and EIGRP routing protocol is applied with 200 AS, and EBGP with 20 AS and taking remote as Autonomous system 1, BGP router-id 10.1.2.2/24 is given manually.

R6

```
interface Loopback0
 ip address 10.1.4.4 255.255.255.0
!
interface FastEthernet0/0
 ip address 56.1.1.2 255.255.255.0
 duplex full
```

Figure 2.4.6(a): Configuration of router R6

R6

```
!
!
router eigrp 200
 network 10.1.4.0 0.0.0.255
 network 56.1.1.0 0.0.0.255
!
router bgp 20
 bgp log-neighbor-changes
 network 10.1.4.0 mask 255.255.255.0
 neighbor 10.1.2.2 remote-as 20
 neighbor 10.1.2.2 update-source Loopback0
 neighbor 10.1.3.3 remote-as 20
 neighbor 10.1.3.3 update-source Loopback0
!
```

Figure 2.4.6(b): Configuration of router R6

III. EXPERIMENTAL RESULTS

After completing configuration of all the routers, basic configuration means to provide a valid IP address to all the active port of a router, the port may be serial, FastEthernet, Giga Ethernet, and many types. After that applied routing protocols to the appropriate router. After doing this, the following command applied to the routers terminal to check whether the right configuration is done or not. Some of them are following:

Ping: it applied to the Privileged mode of the router and uses for an end to end full connection and reliability between routers.

Show up route: it is also applied in the Privileged mode of the router and provide the information of route for that particular router.

Traceroute: it also applied to the Privileged mode of the router and shows that which route chosen by the packet.

And many more command on the Privileged mode of the router that is used for debugging the information or getting the information.

The result from the configuration of the router, R1 is shown in Figure 3.1 to obtain the result a command Show IP Route in the privilege mode of the router, and all the possible routes for the router R1 will be displayed on the console of the router. In Figure 3.2 after that Ping command applied in the privilege mode of the router, ICMP (Internet Message Control Protocol) request send and wait for the reply of ICMP request. It is shown in a fraction of means (successful packet / unsuccessful packets) total 5 packets are sent and in Figure 3.3 Traceroute command is also in privileged mode, it gives the information of route that is followed by the ICMP request packets. In the Figure 3.4 packet delivery per seconds is shown in the graph which is obtained by an application named Wireshark.

R1

```
R1#sh ip route
Codes: L - local, C - connected, S - static, 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
       i - IS-IS, su - IS-IS summary, 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, H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 9 subnets, 2 masks
B        10.1.1.0/24 [200/0] via 10.1.1.1, 00:58:43
O        10.1.1.1/32 [110/3] via 12.1.1.2, 01:23:11, FastEthernet0/0
B        10.1.2.0/24 [200/0] via 34.1.1.2, 01:08:47
B        10.1.3.0/24 [200/156160] via 34.1.1.2, 00:51:37
B        10.1.4.0/24 [200/158720] via 34.1.1.2, 00:51:37
B        10.1.5.0/24 [200/0] via 10.1.5.5, 00:57:14
O        10.1.5.5/32 [110/2] via 12.1.1.2, 01:23:46, FastEthernet0/0
C        10.1.6.0/24 is directly connected, Loopback0
L        10.1.6.6/32 is directly connected, Loopback0
      12.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        12.1.1.0/24 is directly connected, FastEthernet0/0
L        12.1.1.1/32 is directly connected, FastEthernet0/0
      23.0.0.0/24 is subnetted, 1 subnets
O        23.1.1.0 [110/2] via 12.1.1.2, 01:24:16, FastEthernet0/0
      34.0.0.0/24 is subnetted, 1 subnets
O E2     34.1.1.0 [110/5000] via 12.1.1.2, 01:21:47, FastEthernet0/0
      45.0.0.0/24 is subnetted, 1 subnets
B        45.1.1.0 [200/0] via 34.1.1.2, 00:52:07
      56.0.0.0/24 is subnetted, 1 subnets
B        56.1.1.0 [200/30720] via 34.1.1.2, 00:51:37
R1#
```

Figure 3.1: Result of Show IP Route for Router R1

R1

```
R1#ping 56.1.1.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 56.1.1.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 80/88/100 ms
R1#
```

Figure 3.2: Result of Ping for Router R1

R1

```
R1#tra
R1#traceroute 56.1.1.2
Type escape sequence to abort.
Tracing the route to 56.1.1.2
VRF info: (vrf in name/id, vrf out name/id)
  1 12.1.1.2 16 msec 16 msec 16 msec
  2 23.1.1.2 36 msec 36 msec 32 msec
  3 34.1.1.2 56 msec 48 msec 52 msec
  4 45.1.1.2 [AS 20] 76 msec 56 msec 72 msec
  5 56.1.1.2 [AS 20] 88 msec 100 msec 84 msec
R1#
```

Figure 3.3: Result of Traceroute for Router R1

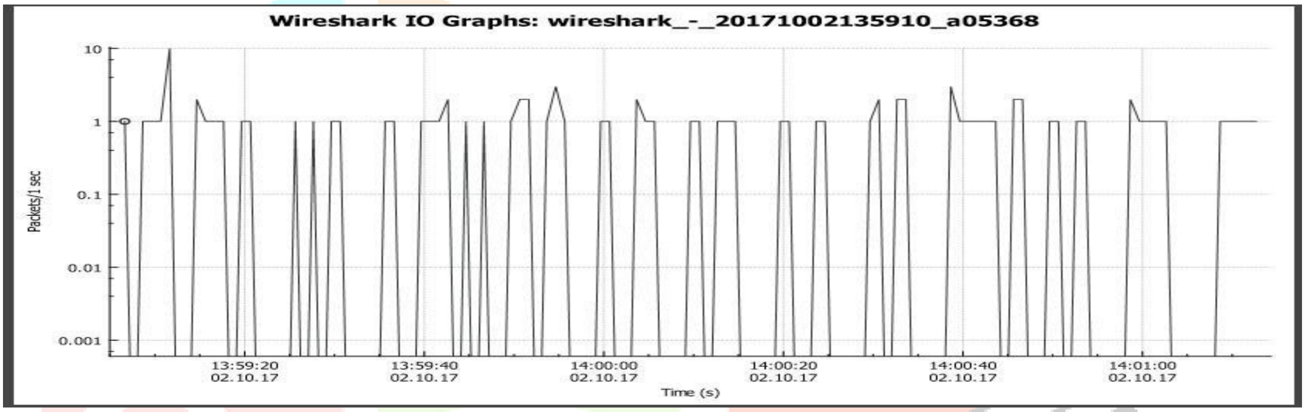


Figure 3.4: Result of Packet Delivery for Router R1

The routes for the router, R2 are obtained by a command Show IP Route in the privilege mode of the router in Figure 3.5.

R2

```
      10.0.0.0/8 is variably subnetted, 9 subnets, 2 masks
B        10.1.1.0/24 [200/0] via 10.1.1.1, 00:08:47
O        10.1.1.1/32 [110/2] via 23.1.1.2, 00:09:46, FastEthernet1/0
B        10.1.2.0/24 [200/0] via 34.1.1.2, 00:08:47
B        10.1.3.0/24 [200/156160] via 34.1.1.2, 00:08:47
B        10.1.4.0/24 [200/158720] via 34.1.1.2, 00:08:47
C        10.1.5.0/24 is directly connected, Loopback0
L        10.1.5.5/32 is directly connected, Loopback0
B        10.1.6.0/24 [200/0] via 10.1.6.6, 00:08:47
O        10.1.6.6/32 [110/2] via 12.1.1.1, 00:09:41, FastEthernet0/0
      12.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        12.1.1.0/24 is directly connected, FastEthernet0/0
L        12.1.1.2/32 is directly connected, FastEthernet0/0
      23.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        23.1.1.0/24 is directly connected, FastEthernet1/0
L        23.1.1.1/32 is directly connected, FastEthernet1/0
      34.0.0.0/24 is subnetted, 1 subnets
O E2     34.1.1.0 [110/5000] via 23.1.1.2, 00:09:46, FastEthernet1/0
      45.0.0.0/24 is subnetted, 1 subnets
B        45.1.1.0 [200/0] via 34.1.1.2, 00:08:47
      56.0.0.0/24 is subnetted, 1 subnets
B        56.1.1.0 [200/30720] via 34.1.1.2, 00:08:47
R2#
```

Figure 3.5: Result of Show IP Route for Router R2

R3

```
      10.0.0.0/8 is variably subnetted, 9 subnets, 2 masks
C        10.1.1.0/24 is directly connected, Loopback0
L        10.1.1.1/32 is directly connected, Loopback0
B        10.1.2.0/24 [20/0] via 34.1.1.2, 00:11:09
B        10.1.3.0/24 [20/156160] via 34.1.1.2, 00:11:09
B        10.1.4.0/24 [20/158720] via 34.1.1.2, 00:11:09
B        10.1.5.0/24 [200/0] via 10.1.5.5, 00:10:44
O        10.1.5.5/32 [110/2] via 23.1.1.1, 00:11:43, FastEthernet0/0
B        10.1.6.0/24 [200/0] via 10.1.6.6, 00:10:43
O        10.1.6.6/32 [110/3] via 23.1.1.1, 00:11:33, FastEthernet0/0
      12.0.0.0/24 is subnetted, 1 subnets
O        12.1.1.0 [110/2] via 23.1.1.1, 00:11:33, FastEthernet0/0
      23.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        23.1.1.0/24 is directly connected, FastEthernet0/0
L        23.1.1.2/32 is directly connected, FastEthernet0/0
      34.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        34.1.1.0/24 is directly connected, FastEthernet1/0
L        34.1.1.1/32 is directly connected, FastEthernet1/0
      45.0.0.0/24 is subnetted, 1 subnets
B        45.1.1.0 [20/0] via 34.1.1.2, 00:11:09
      56.0.0.0/24 is subnetted, 1 subnets
B        56.1.1.0 [20/30720] via 34.1.1.2, 00:11:09
R3#
```

Figure 3.6: Result of Show IP Route for Router R3

The routes for the router, R3 are obtained by a command Show IP Route in the privilege mode of the router in Figure 3.6. The routes for the router, R4 are obtained by a command Show IP Route in the privilege mode of the router in Figure 3.7.

R4

```
      10.0.0.0/8 is variably subnetted, 9 subnets, 2 masks
B        10.1.1.0/24 [20/0] via 34.1.1.1, 00:14:01
C        10.1.2.0/24 is directly connected, Loopback0
L        10.1.2.2/32 is directly connected, Loopback0
D        10.1.3.0/24 [90/156160] via 45.1.1.2, 00:15:18, FastEthernet1/0
D        10.1.4.0/24 [90/158720] via 45.1.1.2, 00:15:18, FastEthernet1/0
B        10.1.5.0/24 [20/0] via 34.1.1.1, 00:13:31
B        10.1.5.5/32 [20/2] via 34.1.1.1, 00:14:01
B        10.1.6.0/24 [20/0] via 34.1.1.1, 00:13:31
B        10.1.6.6/32 [20/3] via 34.1.1.1, 00:14:01
      12.0.0.0/24 is subnetted, 1 subnets
B        12.1.1.0 [20/2] via 34.1.1.1, 00:14:01
      23.0.0.0/24 is subnetted, 1 subnets
B        23.1.1.0 [20/0] via 34.1.1.1, 00:14:01
      34.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        34.1.1.0/24 is directly connected, FastEthernet0/0
L        34.1.1.2/32 is directly connected, FastEthernet0/0
      45.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        45.1.1.0/24 is directly connected, FastEthernet1/0
L        45.1.1.1/32 is directly connected, FastEthernet1/0
      56.0.0.0/24 is subnetted, 1 subnets
D        56.1.1.0 [90/30720] via 45.1.1.2, 00:15:18, FastEthernet1/0
R4#
```

Figure 3.7: Result of Show IP Route for Router R4

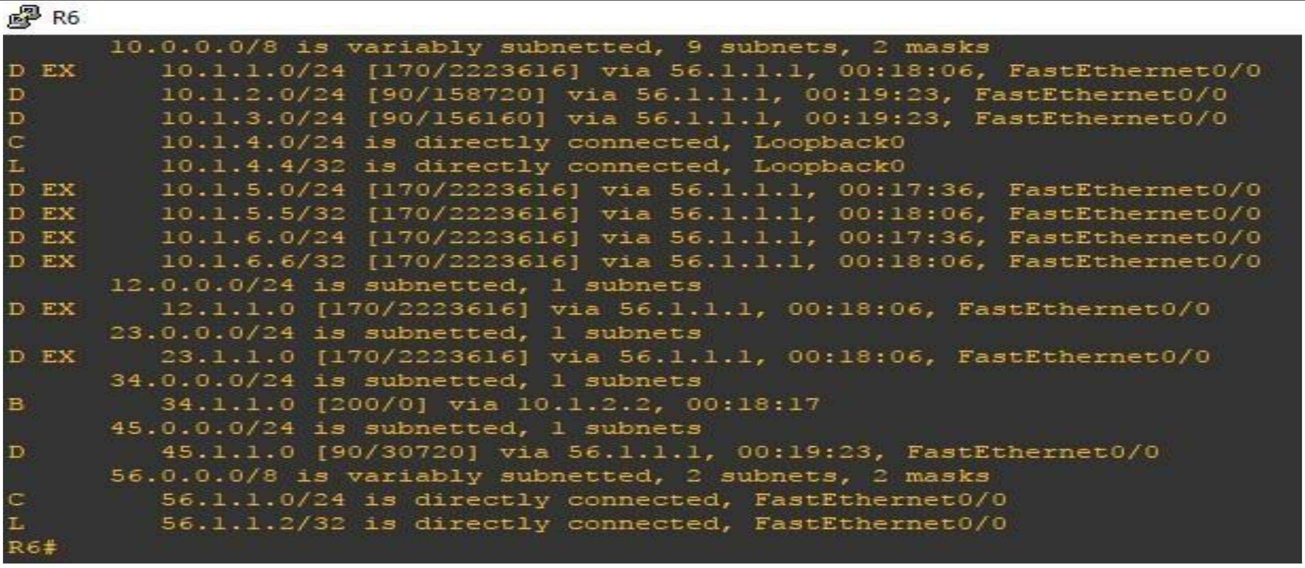
The routes for the router, R5 are obtained by a command Show IP Route in the privilege mode of the router in Figure 3.8.

R5

```
      10.0.0.0/8 is variably subnetted, 9 subnets, 2 masks
D EX     10.1.1.0/24 [170/2221056] via 45.1.1.1, 00:15:59, FastEthernet0/0
D        10.1.2.0/24 [90/156160] via 45.1.1.1, 00:17:16, FastEthernet0/0
C        10.1.3.0/24 is directly connected, Loopback0
L        10.1.3.3/32 is directly connected, Loopback0
D        10.1.4.0/24 [90/156160] via 56.1.1.2, 00:17:16, FastEthernet1/0
D EX     10.1.5.0/24 [170/2221056] via 45.1.1.1, 00:15:29, FastEthernet0/0
D EX     10.1.5.5/32 [170/2221056] via 45.1.1.1, 00:15:59, FastEthernet0/0
D EX     10.1.6.0/24 [170/2221056] via 45.1.1.1, 00:15:29, FastEthernet0/0
D EX     10.1.6.6/32 [170/2221056] via 45.1.1.1, 00:15:59, FastEthernet0/0
      12.0.0.0/24 is subnetted, 1 subnets
D EX     12.1.1.0 [170/2221056] via 45.1.1.1, 00:15:59, FastEthernet0/0
      23.0.0.0/24 is subnetted, 1 subnets
D EX     23.1.1.0 [170/2221056] via 45.1.1.1, 00:15:59, FastEthernet0/0
      34.0.0.0/24 is subnetted, 1 subnets
B        34.1.1.0 [200/0] via 10.1.2.2, 00:16:10
      45.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        45.1.1.0/24 is directly connected, FastEthernet0/0
L        45.1.1.2/32 is directly connected, FastEthernet0/0
      56.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        56.1.1.0/24 is directly connected, FastEthernet1/0
L        56.1.1.1/32 is directly connected, FastEthernet1/0
R5#
```

Figure 3.8: Result of Show IP Route for Router R5

The routes for the router, R6 are obtained by a command Show IP Route in the privilege mode of the router in Figure 3.9.



```
R6
      10.0.0.0/8 is variably subnetted, 9 subnets, 2 masks
D EX     10.1.1.0/24 [170/2223616] via 56.1.1.1, 00:18:06, FastEthernet0/0
D        10.1.2.0/24 [90/158720] via 56.1.1.1, 00:19:23, FastEthernet0/0
D        10.1.3.0/24 [90/156160] via 56.1.1.1, 00:19:23, FastEthernet0/0
C        10.1.4.0/24 is directly connected, Loopback0
L        10.1.4.4/32 is directly connected, Loopback0
D EX     10.1.5.0/24 [170/2223616] via 56.1.1.1, 00:17:36, FastEthernet0/0
D EX     10.1.5.5/32 [170/2223616] via 56.1.1.1, 00:18:06, FastEthernet0/0
D EX     10.1.6.0/24 [170/2223616] via 56.1.1.1, 00:17:36, FastEthernet0/0
D EX     10.1.6.6/32 [170/2223616] via 56.1.1.1, 00:18:06, FastEthernet0/0
      12.0.0.0/24 is subnetted, 1 subnets
D EX     12.1.1.0 [170/2223616] via 56.1.1.1, 00:18:06, FastEthernet0/0
      23.0.0.0/24 is subnetted, 1 subnets
D EX     23.1.1.0 [170/2223616] via 56.1.1.1, 00:18:06, FastEthernet0/0
      34.0.0.0/24 is subnetted, 1 subnets
B        34.1.1.0 [200/0] via 10.1.2.2, 00:18:17
      45.0.0.0/24 is subnetted, 1 subnets
D        45.1.1.0 [90/30720] via 56.1.1.1, 00:19:23, FastEthernet0/0
      56.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        56.1.1.0/24 is directly connected, FastEthernet0/0
L        56.1.1.2/32 is directly connected, FastEthernet0/0
R6#
```

Figure 3.9: Result of Show IP Route for Router R6

IV. CONCLUSION

The use of multiple routing protocols is very necessary to develop an effective working network. For connecting to external network here BGP is used because its administrative value is 20 which is more efficient than the other routing protocols but in the case of the internal network only RIP/RIPv2, EIGRP, OSPF can be used because they all have less administrative value then the internal BGP routing protocol, it means for external network IBGP will be more efficient and for internal network RIP, EIGRP, OSPF or all dynamic and static routing protocols.

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