Attaining more Efficiency from Enhanced Interior Gateway Routing Protocol

Aditi Chadha
Department of Computer Science
RIMT-IET, Mandi Gobindgarh

Anuj K. Gupta
Department of Computer Science
RIMT-IET, Mandi Gobindgarh

ABSTRACT
Routing protocols are categorized as link state, distance vector and hybrid routing protocol. EIGRP is one of the hybrid routing protocols which has good characteristics of link state as well as distance vector routing protocol. Thus EIGRP is considered as the best routing protocol, but when EIGRP is configured, it is difficult to achieve the maximum efficiency due to some features of EIGRP**.** Thus in this paper the configuration of EIGRP is analyzed, its metric calculation are computed and more efficiency from EIGRP is attained.

Keywords
EIGRP, STUB, OSPF, IGRP, DUAL

1. INTRODUCTION
As there were limitations in Routing Information protocol (RIP) so to overcome that Interior Gateway Routing Protocol was introduced. Interior Gateway Routing Protocol is a distance vector routing protocol whereas Enhanced Interior Gateway Routing Protocol is an advanced distance vector routing protocol which are commonly related with link state protocols [11]. IGRP is not used now-a-days. Open Shortest Path First protocol is the link state routing protocol. The above mentioned are the different routing protocols, out of which the implementation and results of EIGRP are discussed in the paper.

Enhanced Interior Gateway Routing Protocol is the Cisco Proprietary protocol which runs on the Cisco routers. EIGRP is the protocol which provides support for multiple network layer protocols like Apple Talk, IP, IPX and IPv6. EIGRP is classless as it gives a real edge over another Cisco proprietary protocol like IGRP. Like IGRP, EIGRP also uses the concept of autonomous system to describe the set of contiguous routers which runs the same routing protocol and the share the same routing information[4]. But unlike IGRP, EIGRP includes its subnet mask in its routes updates. EIGRP advertise the subnet information which allows the use of variable length subnet mask (VLSM) and summarization while designing a network. Administrative Distance (AD) value of EIGRP is 90 which lesser as compare to other routing protocols. So least the AD value better will be the routing protocol. **Features that make EIGRP a better routing protocol as compare to other routing protocols are:**

- Supports VLSM/CIDR
- Classless
- Supports IP and IPv6 through Protocol Dependent Modules (PDM).
- Best path is selected through Diffusing Update Algorithm (DUAL).
- Lesser Administrative Value that is 90.
- Communication is done through Reliable Transport Protocol (RTP).
- Efficient neighbor discovery.

Table 1: Comparison between IGRP and EIGRP as in [15]

IGRP	EIGRP
Classful Routing Protocol	Classless Routing protocol
24 bit metric for bandwidth and delay	32 bit metric for bandwidth and delay
Maximum Hop Count=255	Maximum Hop Count =224
No differentiation between internal and external routes	Outside routes are tagged as external routes

1.1 EIGRP Metrics
Unlike other protocols which use the single factor to select the best possible path and compare routes, EIGRP use the combination of four:

- Bandwidth
- Delay
- Load
- Reliability

MTU (Maximum Transmission Unit) is the fifth element which is not used in the calculation but is used in EIGRP related commands. In EIGRP, bandwidth and delay are set by default to find the best path to a remote network. Default Metric is:

$$\textbf{Metric=256*[(10}^{7}\textbf{/BW) + Delay]}$$

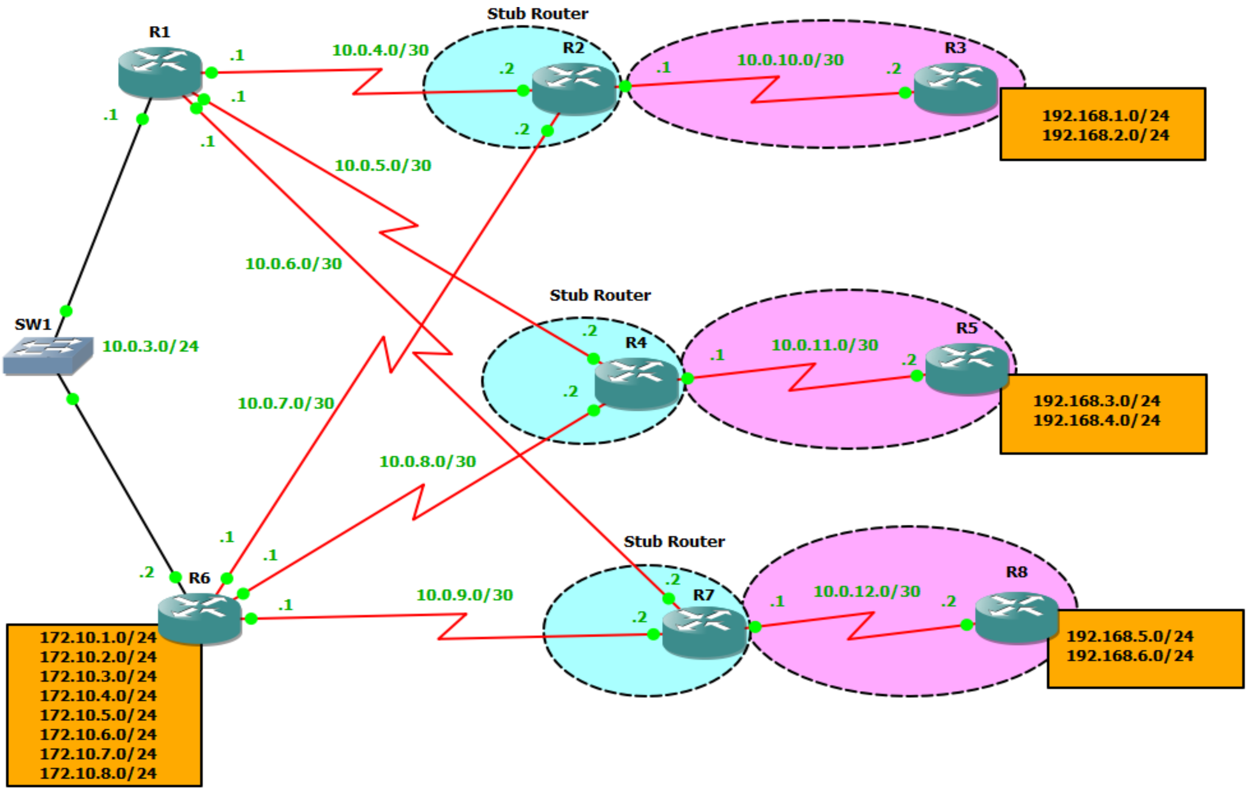


Fig1. Network Design

2. Network design

Consider a network in which there are eight routers out which five are in an organization network and the three routers in the outer world. These routers are connected to each other using the Serial cable. One switch is used to connect two routers that are R1 and R6 using Fast Ethernet cable.

3. Proposed algorithm

The proposed method is implemented to attain more efficiency from Enhanced interior gateway routing protocol by using the methods known as manual summarization, unequal cost load balancing and stubbing. Manual summarization minimizes the routing table; unequal cost load balancing balances the convergence; stubbing reduces the unbounded queries. Thus the mentioned three techniques are used to attain more efficiency from Enhanced interior gateway routing protocol.

3.1 Proposed steps

- Consider a network design as in Fig.1
- Next assign the IP addresses to the routers and the loopbacks.
- After IP addressing, check that all routers can send packets to each other.
- Then make all the routers as the EIGRP router.
- Next it is seen that when packet is being sent from one router to another, the detailed convergence of the routes to neighbours occurs which gives rise to extra consumption of processor of the router. Thus to formulate method called manual summarization is used.
- When there is unequal cost for reaching the destination networks, the ideal routes occur, thus to utilise the routes unequal cost load balancing method is implemented.
- Finally, when unbounded query packets are about to damage the whole network the technique called stubbing is implemented to protect the network from damage.

4. SIMULATION

Graphical Network Simulator is an open source simulation tool that simulates complex networks. It performs close to possible as real networks perform even without having the desired network hardware like switches and routers. GNS3 provides about 1,000 packets per second throughput in a virtual environment. Thus a router provides a hundred to a thousand times greater throughput [7].

5. RESULTS

5.1 Manual Summarization

When packets is being sent from Router6 (consider Fig 1) to any other router in the network the size of routing table increases and thus gives rise to detailed convergence. So to decrease this manual summarization is implemented. Here showing the result of one of the router of the network in Fig 2 and Fig.3.

```
R3
Connected to Dynamips VM "R3" (ID 4, type c3600) - Console port
Press ENTER to get the prompt.

R3#sh ip route
Codes: 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

Gateway of last resort is not set

     172.10.0.0/24 is subnetted, 8 subnets
D       172.10.6.0 [90/2809856] via 10.0.10.1, 00:05:34, Serial0/0
D       172.10.7.0 [90/2809856] via 10.0.10.1, 00:05:34, Serial0/0
D       172.10.4.0 [90/2809856] via 10.0.10.1, 00:05:34, Serial0/0
D       172.10.5.0 [90/2809856] via 10.0.10.1, 00:05:34, Serial0/0
D       172.10.2.0 [90/2809856] via 10.0.10.1, 00:05:34, Serial0/0
D       172.10.3.0 [90/2809856] via 10.0.10.1, 00:05:34, Serial0/0
D       172.10.1.0 [90/2809856] via 10.0.10.1, 00:05:34, Serial0/0
D       172.10.8.0 [90/2809856] via 10.0.10.1, 00:05:37, Serial0/0
D    192.168.4.0/24 [90/3833856] via 10.0.10.1, 00:05:35, Serial0/0
D    192.168.5.0/24 [90/3833856] via 10.0.10.1, 00:05:37, Serial0/0
     10.0.0.0/8 is variably subnetted, 10 subnets, 2 masks
C       10.0.10.0/30 is directly connected, Serial0/0
D       10.0.11.0/30 [90/3705856] via 10.0.10.1, 00:05:40, Serial0/0
D       10.0.8.0/30 [90/3193856] via 10.0.10.1, 00:05:41, Serial0/0
D       10.0.9.0/30 [90/3193856] via 10.0.10.1, 00:05:41, Serial0/0
D       10.0.12.0/30 [90/3705856] via 10.0.10.1, 00:05:41, Serial0/0
D       10.0.3.0/24 [90/2707456] via 10.0.10.1, 00:05:41, Serial0/0
D       10.0.6.0/30 [90/3193856] via 10.0.10.1, 00:05:37, Serial0/0
D       10.0.7.0/30 [90/2681856] via 10.0.10.1, 00:05:41, Serial0/0
D       10.0.4.0/30 [90/2681856] via 10.0.10.1, 00:05:41, Serial0/0
D       10.0.5.0/30 [90/3193856] via 10.0.10.1, 00:05:37, Serial0/0
D    192.168.6.0/24 [90/3833856] via 10.0.10.1, 00:05:41, Serial0/0
C    192.168.1.0/24 is directly connected, Loopback1
C    192.168.2.0/24 is directly connected, Loopback2
D    192.168.3.0/24 [90/3833856] via 10.0.10.1, 00:05:39, Serial0/0
R3#
```

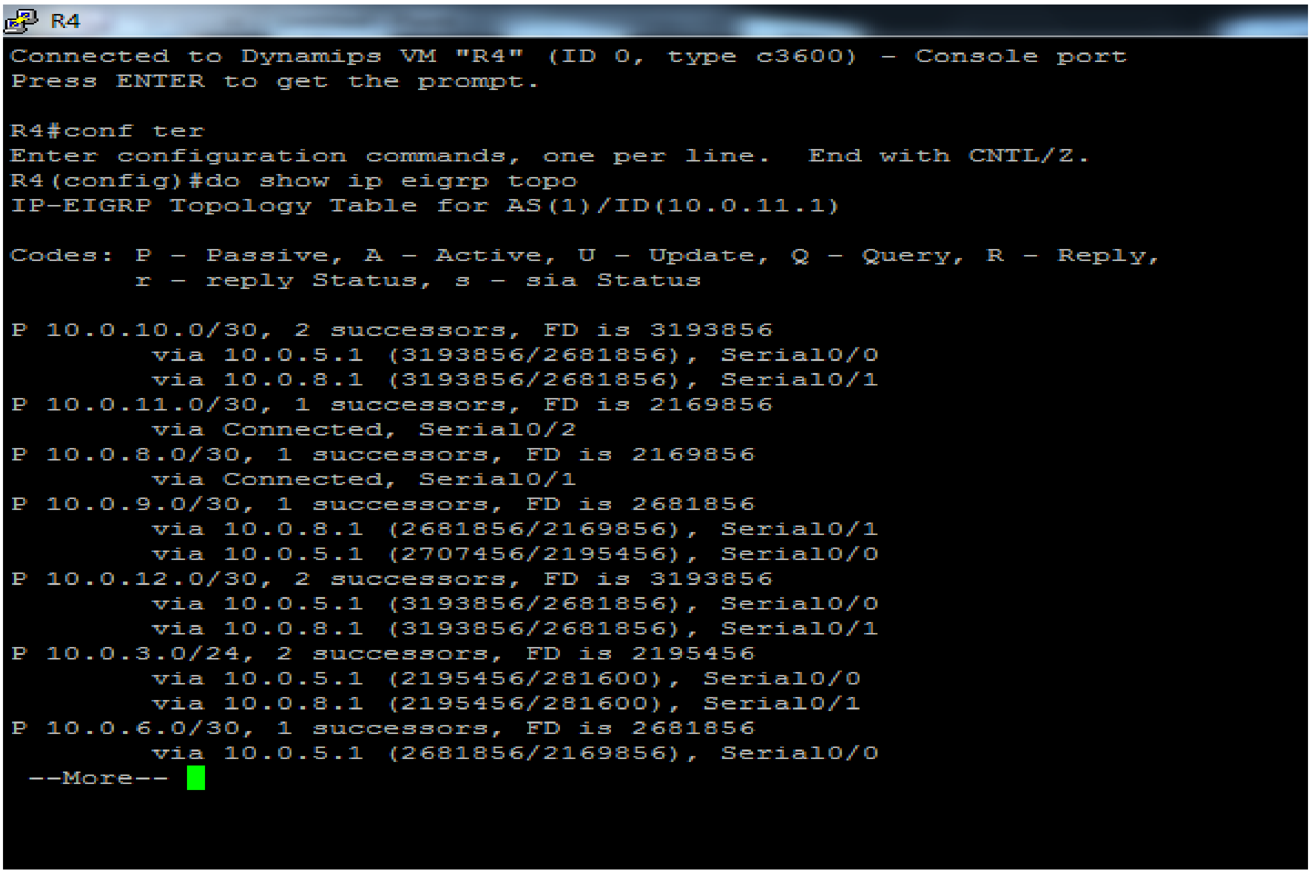
Fig2. Before Manual Summarization

```
R3
Connected to Dynamips VM "R3" (ID 16, type c3600) - Console port
Press ENTER to get the prompt.

R3#sh ip route
Codes: 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

Gateway of last resort is not set

     172.10.0.0/16 is variably subnetted, 2 subnets, 2 masks
D       172.10.0.0/21 [90/2809856] via 10.0.10.1, 00:08:24, Serial0/0
D       172.10.8.0/24 [90/2809856] via 10.0.10.1, 00:08:24, Serial0/0
D    192.168.4.0/24 [90/3833856] via 10.0.10.1, 00:08:21, Serial0/0
D    192.168.5.0/24 [90/3833856] via 10.0.10.1, 00:08:24, Serial0/0
     10.0.0.0/8 is variably subnetted, 10 subnets, 2 masks
C       10.0.10.0/30 is directly connected, Serial0/0
D       10.0.11.0/30 [90/3705856] via 10.0.10.1, 00:08:21, Serial0/0
D       10.0.8.0/30 [90/3193856] via 10.0.10.1, 00:08:32, Serial0/0
D       10.0.9.0/30 [90/3193856] via 10.0.10.1, 00:08:32, Serial0/0
D       10.0.12.0/30 [90/3705856] via 10.0.10.1, 00:08:32, Serial0/0
D       10.0.3.0/24 [90/2707456] via 10.0.10.1, 00:08:32, Serial0/0
D       10.0.6.0/30 [90/3193856] via 10.0.10.1, 00:08:32, Serial0/0
D       10.0.7.0/30 [90/2681856] via 10.0.10.1, 00:08:38, Serial0/0
D       10.0.4.0/30 [90/2681856] via 10.0.10.1, 00:08:38, Serial0/0
D       10.0.5.0/30 [90/3193856] via 10.0.10.1, 00:08:36, Serial0/0
D    192.168.6.0/24 [90/3833856] via 10.0.10.1, 00:08:36, Serial0/0
C    192.168.1.0/24 is directly connected, Loopback1
C    192.168.2.0/24 is directly connected, Loopback2
R3#
```

Fig3. After Manual Summarization

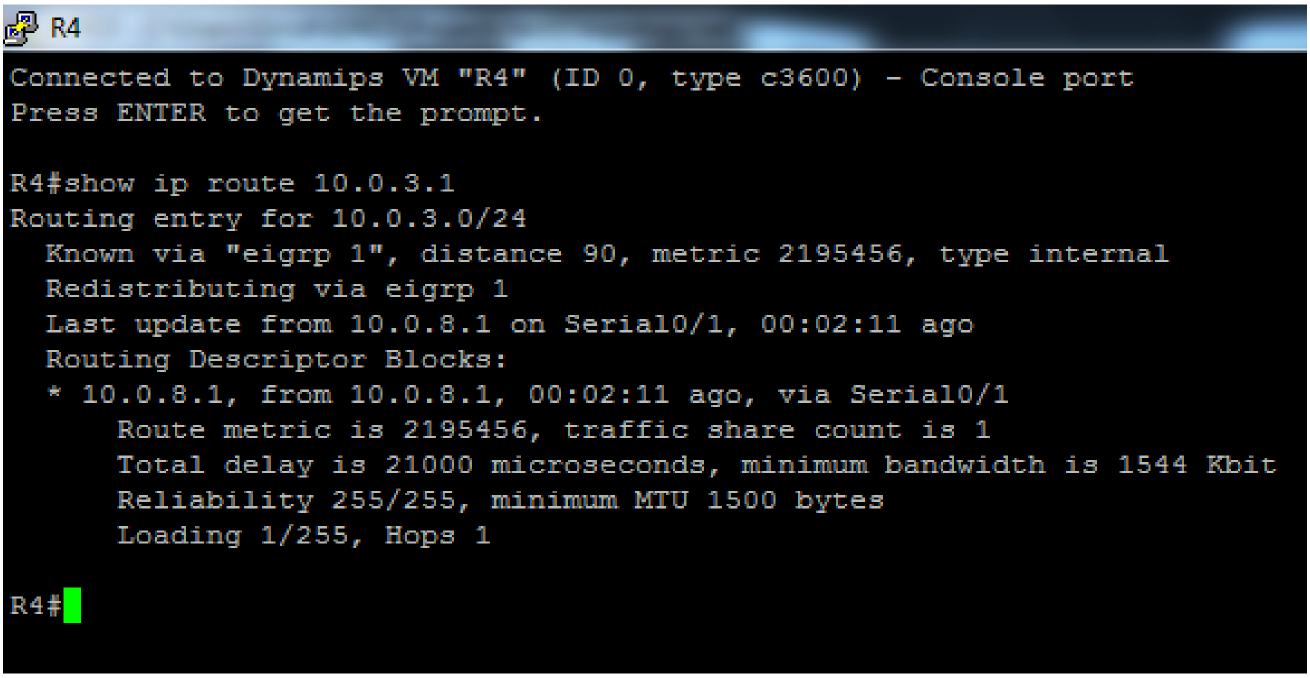
5.2 Unequal Cost Load Balancing

Considering a network it is been seen that when packet is sent from the Router4 to the network 10.0.3.0/30 before delay occurs the packet is sent equally through the network 10.0.5.0/30 and 10.0.8.0/30. But when delay occurred on the network 10.0.5.0/30 the packets are sent from the network 10.0.8.0/30 only which lefts the network 10.0.5.0/30 ideal. So to utilize the ideal route the method called unequal cost load balancing is implemented. Consider the results as shown in Fig 4 for equal cost load balancing, Fig. 5 for delay occurred and Fig 6 for Unequal Cost load Balancing.



```
R4
Connected to Dynamips VM "R4" (ID 0, type c3600) - Console port
Press ENTER to get the prompt.

R4#conf ter
Enter configuration commands, one per line.  End with CNTL/Z.
R4(config)#do show ip eigrp topo
IP-EIGRP Topology Table for AS(1)/ID(10.0.11.1)

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 10.0.10.0/30, 2 successors, FD is 3193856
        via 10.0.5.1 (3193856/2681856), Serial0/0
        via 10.0.8.1 (3193856/2681856), Serial0/1
P 10.0.11.0/30, 1 successors, FD is 2169856
        via Connected, Serial0/2
P 10.0.8.0/30, 1 successors, FD is 2169856
        via Connected, Serial0/1
P 10.0.9.0/30, 1 successors, FD is 2681856
        via 10.0.8.1 (2681856/2169856), Serial0/1
        via 10.0.5.1 (2707456/2195456), Serial0/0
P 10.0.12.0/30, 2 successors, FD is 3193856
        via 10.0.5.1 (3193856/2681856), Serial0/0
        via 10.0.8.1 (3193856/2681856), Serial0/1
P 10.0.3.0/24, 2 successors, FD is 2195456
        via 10.0.5.1 (2195456/281600), Serial0/0
        via 10.0.8.1 (2195456/281600), Serial0/1
P 10.0.6.0/30, 1 successors, FD is 2681856
        via 10.0.5.1 (2681856/2169856), Serial0/0
 --More--
```

Fig4. Equal Cost Load balancing



```
R4
Connected to Dynamips VM "R4" (ID 0, type c3600) - Console port
Press ENTER to get the prompt.

R4#show ip route 10.0.3.1
Routing entry for 10.0.3.0/24
  Known via "eigrp 1", distance 90, metric 2195456, type internal
  Redistributing via eigrp 1
  Last update from 10.0.8.1 on Serial0/1, 00:02:11 ago
  Routing Descriptor Blocks:
  * 10.0.8.1, from 10.0.8.1, 00:02:11 ago, via Serial0/1
      Route metric is 2195456, traffic share count is 1
      Total delay is 21000 microseconds, minimum bandwidth is 1544 Kbit
      Reliability 255/255, minimum MTU 1500 bytes
      Loading 1/255, Hops 1

R4#
```

Fig5. Delay Occurs

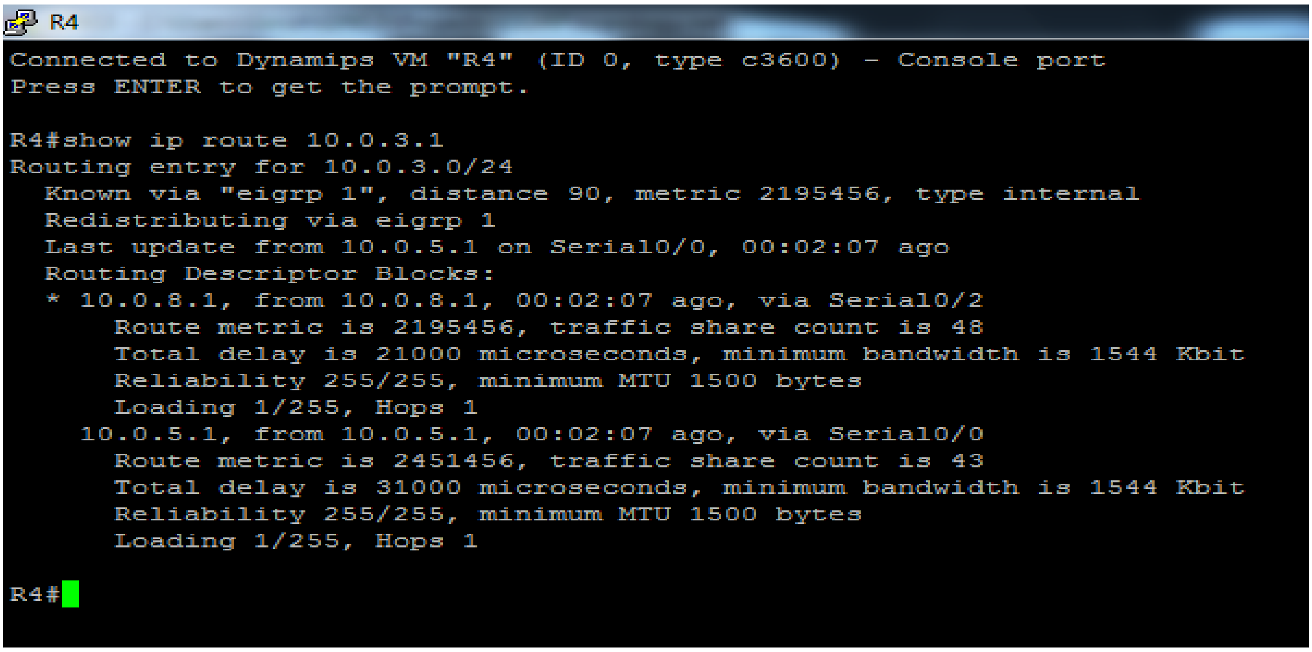


Fig6. Unequal Cost load Balancing

5.3 Stubbing

When in a network the interface or loopback is shut down then unbounded query packets occur which damages the whole network, thus to protect the network from damage the stub router is used. Here in the network design Fig1. R2, R4 and R7 are the stub routers. The interface of the R6 is down thus giving rise to number of unbounded query packets. But after stubbing the unbounded query packets are reduced as shown in Fig 7 and Fig 8.

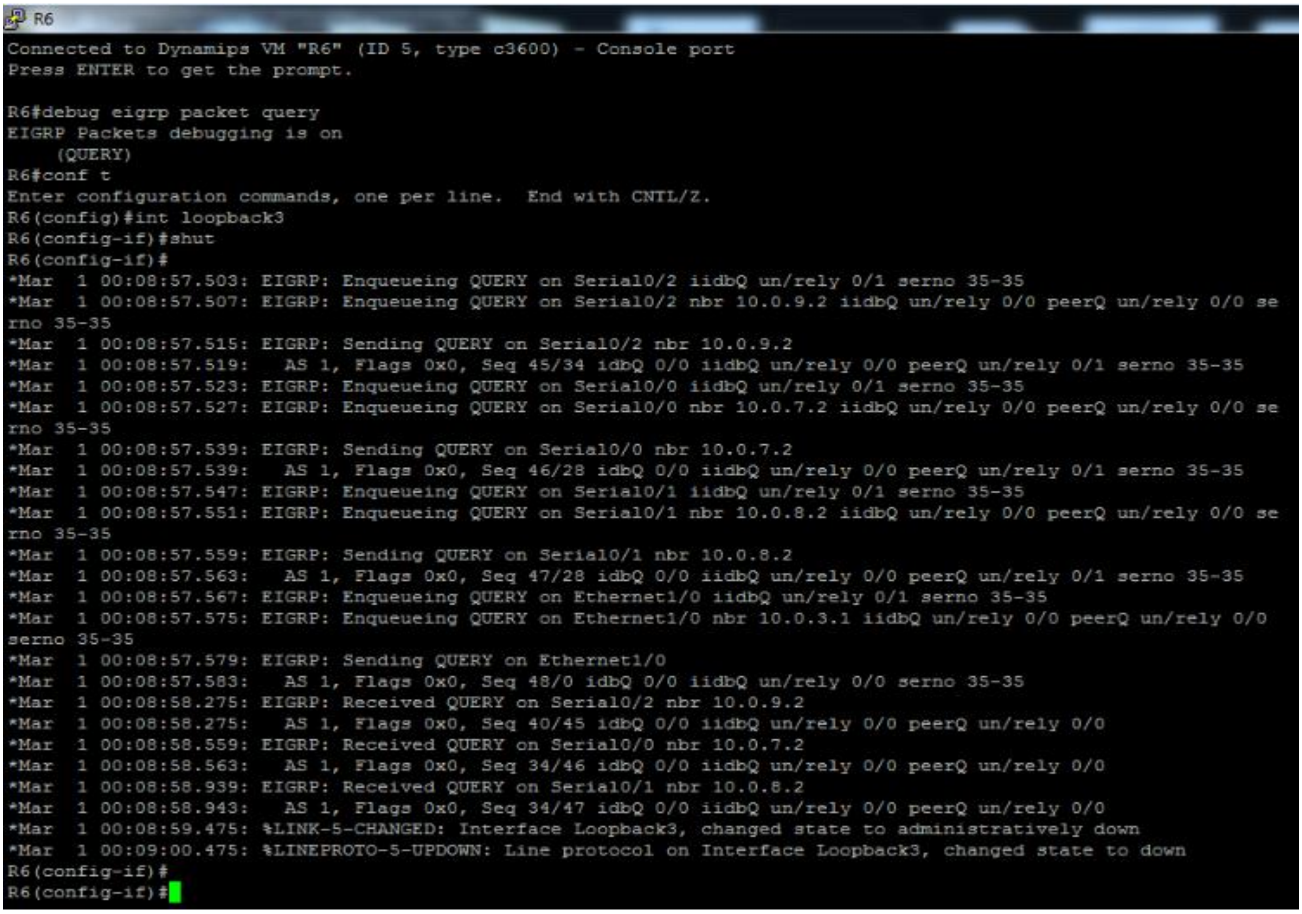


Fig7. Before Stubbing

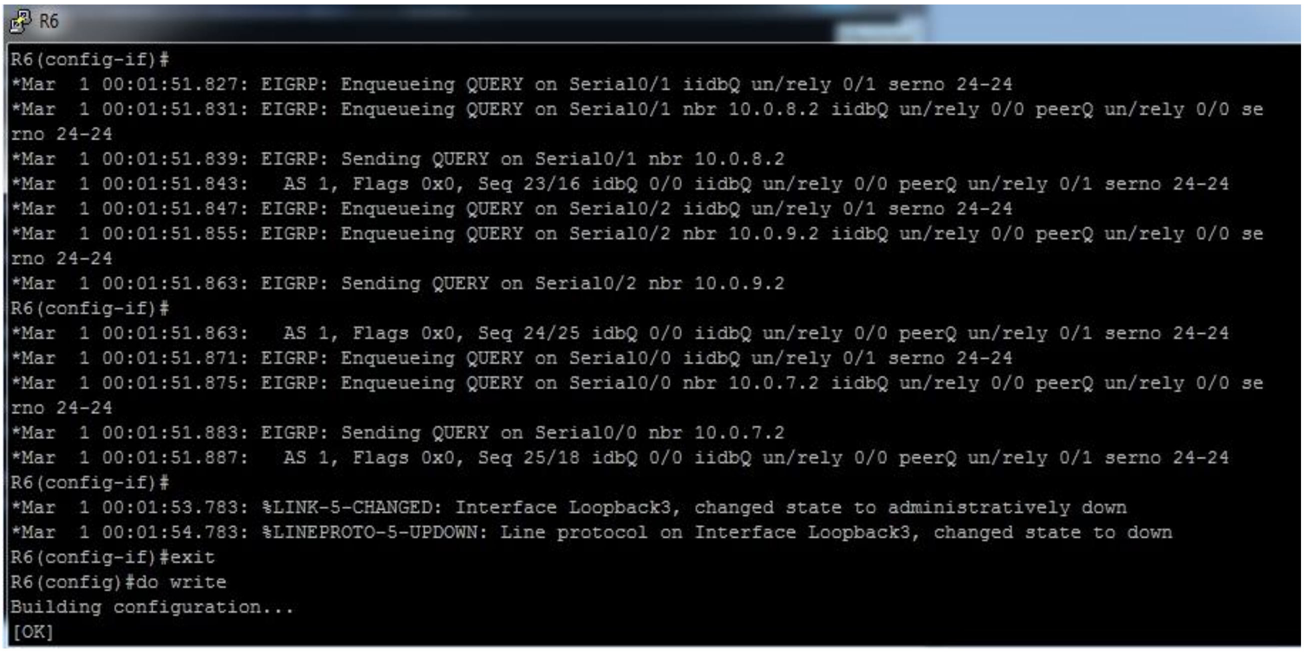


Fig8. After Stubbing

6. CONCLUSION

EIGRP is considered as the best routing protocol. The main objective of the paper is to analyze the configuration of an EIGRP using routing model, to review its metric calculation to compute the best path and thus computing the more efficiency from EIGRP by using the methods known as manual summarization, unequal cost load balancing and stubbing. Thus our results conclude that efficiency of an EIGRP routing protocol is improved and works faster as compare to earlier.

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