Performance Analysis of OSPF and EIGRP Routing Protocols for Greener Internetworking

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***Abstract*— Routing protocol is taking a vital role in the modern internet era. A routing protocol determines how the routers communicate with each other to forward the packets by taking the optimal path to travel from a source node to a destination node. In this paper we have explored two eminent protocols namely, Enhanced Interior Gateway Routing Protocol (EIGRP) and Open Shortest Path First (OSPF) protocols. Evaluation of these routing protocols is performed based on the quantitative metrics such as Convergence Time, Jitter, End-to-End delay, Throughput and Packet Loss through the simulated network models. The evaluation results show that EIGRP routing protocol provides a better performance than OSPF routing protocol for real time applications. Through network simulations we have proved that EIGRP is more CPU intensive than OSPF and hence uses a lot of system power. Therefore EIGRP is a greener routing protocol and provides for greener internetworking.**

***Keywords*—OSPF, EIGRP, CPU, routing protocol**

I. A BRIEF LOOK ON THE EIGRP AND OSPF ROUTING PROTOCOLS

EIGRP is a Cisco proprietary distance-vector protocol based on Diffusing Update Algorithm (DUAL). It is basically a hybrid protocol, that is it is a cross breed of distance vector protocols and link state advertisements[1].However at heart EIGRP is a distance vector protocol because it learns about other routing routes by rumors from the neighboring routers[2]. On the other hand, OSPF is a link-state interior gateway protocol based on Dijkstra algorithm (Shortest Path First Algorithm). In the context of routing protocol performance, each of them has different architecture, adaptability, route processing delays and convergence capabilities. In order to evaluate OSPF and EIGRP's performance, we have designed a network model in which both OSPF and EIGRP are configured one after the other and system parameters are noted down in each case.

II. EIGRP ROUTING PROTOCOL

EIGRP is a cisco proprietary protocol [4].It is a cross breed of distance vector protocols and link state advertisements. EIGRP uses the concept of autonomous systems to group routers which perform the same tasks. It learns about its routes from updates from other routers. But unlike other Distance vector protocols EIGRP maintains a partial topology of the network .It uses 3 tables to make routing decisions. The Routing table, the Neighbor table and the Topology table.EIGRP uses bandwidth and delay as the metrics to determine which route is the best. The protocol can also use bandwidth MTU, Reliability, load as metrics [5]. One of the major disadvantages of distance vector protocols is that they broadcast routing updates, since the updates are broadcasted they are received even by the hosts which is not required and hence bandwidth and system time is wasted in processing broadcast router updates that are received. EIGRP eliminates this by multicasting updates to 224.0.0.10[6].EIGRP also sends only triggered updates when a network is fully functional. However it uses 1byte hello packets to verify if the neighboring router is alive or not [7]. These hello packets are sent out every 5 seconds on LAN and multipoint connections with T1/E1 speeds (60 seconds in all other cases) and if the sending router doesn't receive a reply in 15 seconds (180 seconds in other cases) the router removes it from the routing table.

A. EIGRP operation

EIGRP operation consists of 2 parts

1-Building neighbor relationships

2-Choosing routes

1) Building neighbor relations abbreviations: For 2 routers running on EIGRP to become neighbors they must form an adjacency [8]. They can form an adjacency if and only if the autonomous system numbers and the K values on both the routers must be the same. Then the routers undergo the following steps.

1-The first router generates a hello with its configuration information

2-If the configuration information (Autonomous system numbers and K values) matches then the second router responds with an update message with its local topology table information (not its routing table as done by the distance vector protocols)

3-The first router responds with an ACK message acknowledging the receipt of the second's Update

4- The first router then sends its topology table to second router via an update message.

5- The second router responds with an ACK message

As for transferring of routing updates are concerned there are 3 types of messages involved [9]. They are

1-UPDATE- Contains a routing update

2-QUERY- Asks a neighboring router to validate routing information

3-REPLY- Responds to a query message.

2) Choosing Routes: EIGRP has the following metrics bandwidth, reliability, delay, load and MTU. However only fixed metrics such as bandwidth and delay are activated.

EIGRP maintains something such as successor route and a feasible successor route in the local topology table. Successor route is the route via which the packets are forwarded and has the best metric. Feasible successor route is the route with which the router will forward packets once the successor route goes down or has the second best metric. This is the advantage of EIGRP, once a route goes down it doesn't have to send hello packets to find out another alternative route. It just brings on the feasible successor route.

III. OSPF ROUTING PROTOCOL

OSPF is an open standard. OSPF stands for "Open Shortest Path First"[10]. OSPF is a LSA type routing protocol. OSPF is also a classless routing protocol and supports Variable Length Subnet Mask(VLSM).OSPF uses the concept of areas to group similar routers together. OSPF supports a 2 layer hierarchy, the backbone and the areas connected to the backbone .The backbone area is known as the default area, it is usually referred to as area0. Between area routing is carried out by the backbone router and it uses route summarization [11]. OSPF also supports load balancing up to 16 equal paths. Each router running on OSPF has a router ID.A router ID is the highest address on a loopback interface (if the loopback interface is not configured, then the router id is the highest address configured on the interface) OSPF undergoes 3 processes while it is being configured

1-Finding neighbors

2-Creating Adjacency

3-Sharing routing information

A. Finding Neighbors

A router finds its neighbors by sharing link state advertisements which exist in different types .OSPF generates LSA hello messages every 10 seconds, When a neighbor is discovered and an adjacency is formed with the neighbor then the router expects to see hello messages every 10 from the neighbor .If a neighbor's message is not seen within 40 seconds (dead interval time). The hello LSA packet contains information like the area number, hello and dead timer intervals, OSPF password if it is configured.

B. Creating adjacency

In OSPF, adjacency is created if the information from the hello packets of one router match with the information present in the configuration file of the proposed router. Once the information matches then adjacency is created [13].

An OSPF router will not form adjacency with any other router instead a client server design is implemented in OSPF on each broadcast segment. For each multi-access broadcast segment such as the Ethernet there is a Designated router (DR), a Backup designated router (BDR),as well as other OSPF routers called DROTHER.Only exception when these 3 kinds of routers are not elected is on a WAN point to point link.

The DR is chosen when the router s in the area boot up, the router with the highest router id is chosen as the Designated router, while the router with the second highest router id is chosen as the BDR. All other routers are considered as DROTHERs. The backdrop of this process is that this process is carried out only once, that is when the routers in the area are all switched on, supposing another router with a higher router ID than the DR is added to the area after a couple of days, the DR will not change.

C. Sharing Router Information

Any exchange of routing information is between DR and BDR routers and the other OSPF routers in the segment. No 2 DROTHERs can directly communicate with each other.

OSPF routers use link state advertisements to communicate with each other. One type of LSA is hello which is used to form neighbor relationships and as a keep alive function. Link state advertisements are sent to the DR at 224.0.0.6 and the DR disseminates this to everyone else at the multicast address 224.0.0.5

On point to point links since no DR or BDR is used , all OSPF packets are addressed to 224.0.0.5

IV. PERFORMANCE COMPARISON OF OSPF AND EIGRP

When OSPF and EIGRP routers are compared, it is the OSPF routing protocol which demands a lot of resources from the router, since OSPF has to undergo a lot of background processes such as electing a DR and a BDR. Also the router ID has to be computed on each router. This induces a lot of delay when compared to EIGRP routing protocol. Therefore total delay will be equal to average delay × no of routers. OSPF causes massive CPU utilization therefore more heat is produced, more amount of cooling is required. EIGRP being a hybrid protocol uses less amount of CPU resources.

Since OSPF uses server-client relationship the DR router should be a powerful router to process a lot of incoming traffic otherwise it will crash bringing the entire router area down .The use of a server client model jams the bandwidth since the routing updates from all the routers have to go to the path connected to the DR after which the DR will forward them to the other routers. In case of EIGRP there will be no election of DR or BDR and hence there is less time delay and less consumption of router resources. Since EIGRP doesn't use the client-server model, therefore there will be no jamming of bandwidth.

Supposing in a network, a path goes down then OSPF will have to use LSA hello packets again causing the finding neighbor process to start all over again therefore OSPF will fail to act fast in high speed networks and also a lot of energy is consumed due to high overhead of router. In case of EIGRP the router carries an alternative route known as the feasible successor router which will be used once the successor router goes down. Therefore EIGRP doesn't have to send hello packets once again or find its neighbors again.

OSPF uses a backbone router to route between different areas, which increases equipment cost, EIGRP uses BGP protocol to route between different autonomous systems, This saves the cost of the extra router required in OSPF.

V. EXPERIMENTAL ANALYSIS

We have tried to use 3 different networks having same topologies. One is configured with EIGRP, the second one with OSPF and the third with OSPF and EIGRP .The common network topology is shown in Fig 1

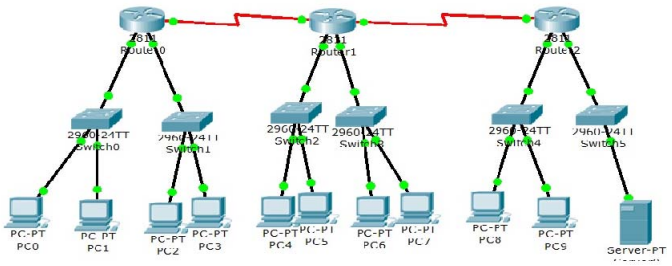

Fig 1 Network topology of the experimental network.

From the experiment we have observe the following

1-From Fig 2 and Fig 5 we can see that in the process 174 have 369 threads when EIGRP is running and when OSPF is running the number of free threads is 193.

2-From Fig 3 and Fig 6 we can see that the memory used in NVRAM when EIGRP is running is 191 Kbytes and when OSPF is running 291 Kbytes.

3- Fig 4 shows the CPU process history of the router during the last 60 seconds when EIGRP is running.

4- Table 1 shows the summary of the time taken for the various network parameters.

A. Screenshots of EIGRP

All 3 routers are configured with EIGRP protocol. The processes that occur and the overheads of the 2 routers are as shown in fig2, fig 3, fig 4.

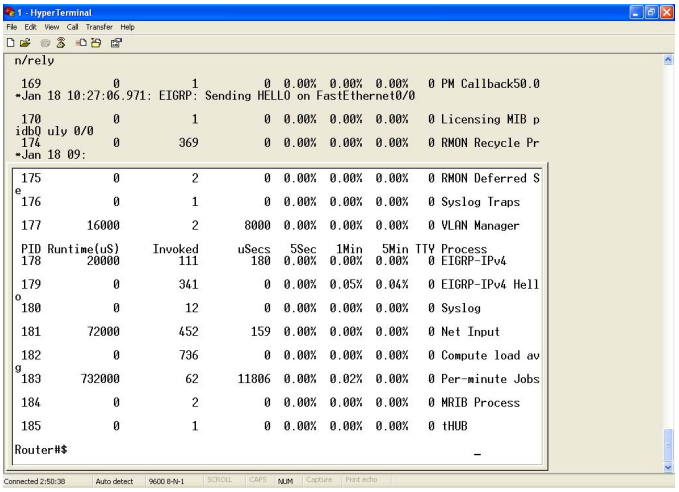

Fig 2 Shows the processes running on the first EIGRP router

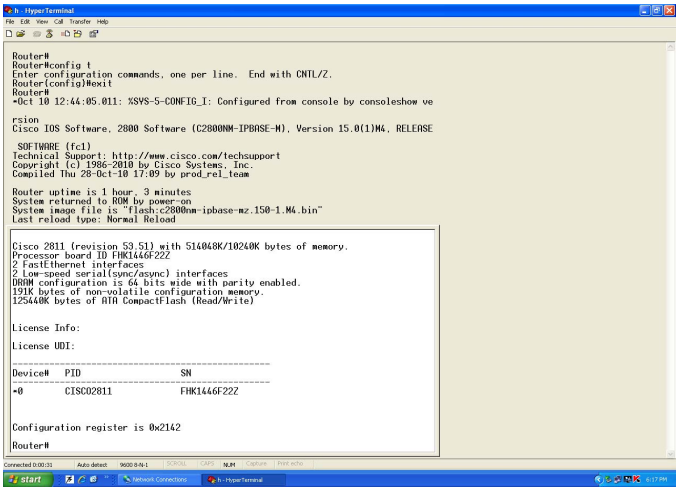

Fig 3 Shows the memory consumption of the first router running on EIGRP

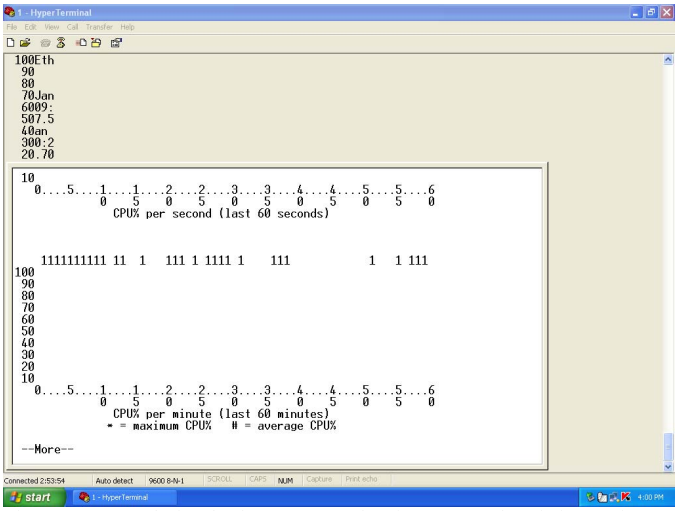

Fig 4- CPU graph for the last 60 seconds of router 1 when it is running on EIGRP

B. Screenshots of OSPF analysis

In this case all 3 routers are configured with OSPF[6].

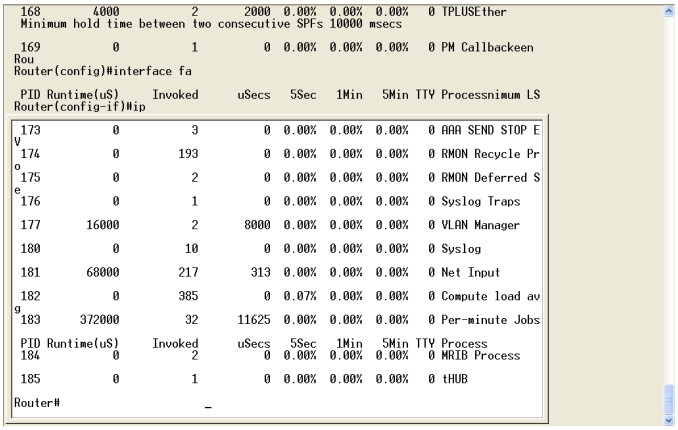

Fig 5 showing the processes running on the first OSPF router

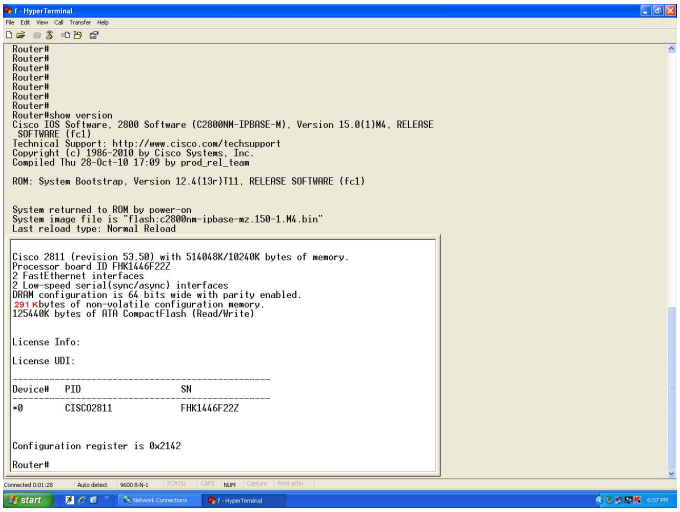

Fig 6- Showing the memory consumption of the first router running on OSPF

TABLE 1- OSPF AND EIGRP COMPARISON

Scenarios	OSPF	EIGRP
On Startup	1 min 22 seconds	47 seconds
When one of the network goes down	180 seconds	16*5 seconds
When a change occurs in the network	Convergence time of 3 seconds	Convergence time almost instantaneous

VI. CONCLUSION

From the results obtained from our experiments we can thoroughly conclude that EIGRP uses less system resources when compared to OSPF. However EIGRP is a Cisco proprietary protocol, but since Cisco routers make 85% of the internet backbone, it is necessary for us to implement a greener solution on Cisco routers itself.

By using lesser system resources, EIGRP is used as a routing protocol produces lesser heat and therefore the cooling cost is also saved .EIGRP also uses its own external routing protocol and therefore unlike OSPF doesn't need a separate router to do routing between areas. Therefore resources are also saved.

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