Performance Analysis of EIGRP and OSPF for Different Applications using OPNET

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ABSTRACT
Routing protocols are taking an important role in the modern communication networks. Enhanced Interior Gateway Routing Protocol (EIGRP) and the Open Shortest Path First (OSPF) protocol are used to propagate network topology information to the neighboring routers. Extensive experiments have been conducted to analyze and compare a set of characteristics of EIGRP and OSPF for Different Applications like video streaming and voice conferencing by using OPNET. The characteristics that will be studied include convergence time, jitter for video streaming and voice conferencing, end-to-end delay for video streaming and voice conferencing, traffic sent and received for video streaming and voice conferencing and throughput. The designated simulation, experiment scenarios compare the difference between EIGRP and OSPF routing protocols for the above mentioned parameters. In this study shows EIGRP is better than OSPF on the basis of above mentioned parameters.

Key words: EIGRP, OSPF, IGP, EGP, OPNET

INTRODUCTION
Computer communication networks exchange data with a set of devices connected via links, using routing protocols are mainly used for transmitting packets across the Internet. Routing protocols are based on routing algorithms which rely on various metrics to find the best path to transmit data across networks. Most common metrics are cost, bandwidth, Maximum Transmission Unit (MTU) and packet delay and hop count (Forouzan, 2007). Routing protocols utilize a routing table to store the results of these metrics. Based whether the routing is within an Autonomous System (AS) or between ASs, there are two types of routing protocols: Interior Gateway Protocol (IGP) and Exterior Gateway Protocol (EGP) (Bagad and Dhotre, 2007). Now-a-days, mostly used Interior Gateway Protocols are RIP, EIGRP and OSPF. The performance of each routing protocol is different from each other. This study is specification of the Enhanced Interior Gateway Routing Protocol (EIGRP) and Open Shortest Path First (OSPF) internet routing. The network based on TCP/IP protocol permits the efficient routing of data packets based on their IP address. First of all, designed various network scenarios where all network scenarios are configured respectively with EIGRP and OSPF and simulated these networks with real time traffic to observe how the performance varies between EIGRP and OSPF. Then measured the performance based on different parameters such as Convergence time, Jitter for Video Streaming, End-to-End Delay for Video
Routing protocols are set of rules or standard which used to continuously update the routing tables that are consulted for forwarding and routing. The network administrator must edit the routing table of the devices at all times. It is called the new routing protocol for dynamic routing network:

- Static route (default route) is a route as a way to smooth and easy to understand. It is mostly used on smaller networks
- Dynamic route is the route in accordance with requirements and facilitate the creation of the main functions of the two routing table as it is. It is also capable to find the best path to send data to the destination and the routing information to other machines on the network

**Enhanced interior gateway routing protocol (EIGRP):** EIGRP is a Cisco proprietary routing protocol. It incorporates a new route calculation algorithm called the Diffusing Update Algorithm (DUAL). It includes the features of both distance vector and link state protocols. Reliability, MTU, delay, load and bandwidth are EIGRP metrics. Delay and bandwidth are the basic parameters for calculating metrics (Feldmann et al., 2000). EIGRP uses three tables for collecting data. The first neighbors’ table stores data about neighboring routers that are directly accessible through interfaces. The second topology table contains the aggregation of the routing tables that are gathered from all neighbors. It maintains a list of destination networks in the EIGRP routed network and their respective metrics. The last routing table stores the actual routes to all destinations. EIGRP does not rely on periodic route dumps so it differs from most distance vector protocols. If EIGRP router cannot locate a router based on its routing database, it broadcasts to other neighbors.

**Open shortest path first (OSPF):** OSPF is a classless link state protocol that operates within a single AS (Gupta and Kaur, 2010). So, it works by using the Dijkstra algorithm (Lammle, 2007). OSPF is an efficient IGP. OSPF maintains the routing table for all connections in the network. Each OSPF router stores the local network connection state with Link State Advertisement (LSA) and advertises to the entire AS. Each router receives the LSA generated by all routers within the AS. Link State Database (LSDB) is formed by the LSA collection. Each LSA is the description of the surrounding network topology of a router. Hence, the AS network topology reflected by the LSDB (Fortz and Thorup, 2002). When a new router is added to the network, it will broadcast hello messages to every neighbor and will receive the feedback hello messages from its neighbors. Eventually, routers establish connections with newly added router and synchronize their routing databases. When network topology changes, every router broadcasts link state update messages. Consequently, all routers may keep same information of network topology. Every router indicates the closer router for each transmission and calculates the best paths to all destinations. OSPF is the most widely used IGP in large enterprise networks.

**NETWORK MODELS IN OPNET**

OPNET Modeler is using for network Simulations. OPNET is a comprehensive network simulation tool with a multitude of powerful functions. It enables simulation of heterogeneous
networks by employing a various protocols (Thorennoor, 2010). In this study, two scenarios are created that consists of six interconnected subnet where routers within each subnet are configured by using EIGRP and OSPF routing protocols. All subnet contain routers, switch and workstations. The network topology composed of the following network devices and configuration utilities: CS_7000 Cisco Routers, Server, Switch, PPP_DS3 Duplex Link, PPP_DS1 Duplex Link, Ethernet 10 BaseT Duplex Link, Workstation, Application Configuration, Profile Configuration, Failure Recovery Configuration, QoS Attribute Configuration. The network topology design is shown in Fig. 1.

Consider link utilization in each network by increasing order from normal 0 to 90% and analyze the variation of each defined parameters. For PPP-DS links data rate is 1.544 Mbps. Table 1 shows the corresponding link utilization.

**PERFORMANCE METRICS**

**Convergence time:** A convergence time is the time to construct the attack path (Kim et al., 2006). In dynamic routing, it is a potential factor for a group of routers. If a routing protocol is enabled, then routers attempt to exchange information from each other about the topology of the network. When any change occurs in the network that affects routing tables, routers split the convergence temporarily until this change has been effectively communicated to all other routers.

**Jitter:** Jitter is introduced in real-time data by the delay between packets (Forouzan, 2007). At the sending sides, packets are sent in a continuous stream with the packets spaced evenly apart.

![Fig. 1: Simulation of network topology using OPNET](image-url)
Table 1: Link value (bps) corresponding link utilization (%) with time (sec)

<table>
<thead>
<tr>
<th>Time (sec)</th>
<th>Link utilization (%)</th>
<th>Link value (bps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>100</td>
<td>10</td>
<td>154400 (154400*0.1)</td>
</tr>
<tr>
<td>200</td>
<td>20</td>
<td>308800 (154400*0.2)</td>
</tr>
<tr>
<td>300</td>
<td>30</td>
<td>463200 (154400*0.3)</td>
</tr>
<tr>
<td>400</td>
<td>40</td>
<td>617600 (154400*0.4)</td>
</tr>
<tr>
<td>500</td>
<td>50</td>
<td>772000 (154400*0.5)</td>
</tr>
<tr>
<td>600</td>
<td>60</td>
<td>926400 (154400*0.6)</td>
</tr>
<tr>
<td>700</td>
<td>70</td>
<td>1080800 (154400*0.7)</td>
</tr>
<tr>
<td>800</td>
<td>80</td>
<td>1235200 (154400*0.8)</td>
</tr>
<tr>
<td>900</td>
<td>90</td>
<td>1389600 (154400*0.9)</td>
</tr>
</tbody>
</table>

Improper queuing or configuration errors can be lumpy or the delay between each packet can vary instead of remaining constant due to network congestion.

**End-to-end delay:** The End-to-end delay is introduced due to processing, queuing delay in routers and processing in end systems (Bagad and Dhotre, 2007). When a packet arrives too late at the receiver as a consequence, the packet can be effectively lost which is the critical importance of end-to-end delay. Due to delay, lost packets have negative effects on the received quality for both video and voice traffic.

**Throughput:** The throughput is a key parameter to determine the rate at which total data packets are successfully delivered and received through the channel in the network. It is usually considered in bits per second (bits/sec or bps) and data packets per second or data packets are also considered (Pan and Jain, 2008).

**SIMULATION SCENARIOS**

**Convergence time:** The EIGRP and the OSPF protocol experience the shortest and the longest network convergence times, respectively, as shown in Fig. 2.

**Jitter for video streaming:** The EIGRP and the OSPF protocol experience the lowest and highest delays, respectively, as shown in Fig. 3.

**End-to-end delay for video streaming:** End-to-end delay of EIGRP network is lowest and OSPF network is highest, respectively, as shown in Fig. 4.

**Traffic sent and received for video streaming:** The packet loss of EIGRP network for each background load is less than the one of OSPF networks, respectively, as shown in Fig. 5.

**Jitter for voice conferencing:** The EIGRP protocol experiences the lowest and on the other hand OSPF experience highest delays, respectively, as shown in Fig. 6.

**End-to-end delay for voice conferencing:** The end-to-end delay of EIGRP is relatively lower than the one of OSPF networks, respectively, as shown in Fig. 7.
Traffic sent and received for voice conferencing: EIGRP and OSPF exhibit lowest and highest packet loss when there is high congestion in the network, respectively, as shown in Fig. 8.
Fig. 5(a-b): Video traffic (a) Sent and (b) Received (bytes sec$^{-1}$) of EIGRP and OSPF

Fig. 6: Jitter (sec) of EIGRP and OSPF for voice conferencing

Fig. 7: End-to-end delay (sec) of EIGRP and OSPF for voice conferencing

Fig. 8(a-b): Voice traffic (a) Sent (b) Received (bytes sec$^{-1}$) of EIGRP and OSPF
Fig. 9: Throughput (bits sec\(^{-1}\)) of EIGRP and OSPF

**Throughput:** EIGRP network has higher throughput as compared to OSPF network, respectively, as shown in Fig. 9.

**RESULTS ANALYSIS**

The network convergence time is faster than OSPF networks, because EIGRP network can learn the topology information and updates more rapidly. The performance of packet delay variation for EIGRP is better than for OSPF. The packet delay variation of OSPF network is high while the one of EIGRP network is low with available network load. The simulation results have shown that the end-to-end delay of EIGRP network is relatively less than OSPF network. Delay stays less than acceptable quality for EIGRP with available bandwidth in the link but OSPF delay stays high with same bandwidth in the link. As a result, data packets in EIGRP network reach faster to the destination compared to OSPF network. The packet loss in the EIGRP network is less than in OSPF network. In addition, the simulation results have shown that the throughput of EIGRP network is higher than for OSPF network due to high congestion in the link. EIGRP has very low usage of network resources during normal operation since only hello packets are transmitted. When a routing table changes, its convergence time is short and it reduces bandwidth utilization. OSPF has large protocol overhead when updating the routing table. OSPF is an open standard protocol and has the ability to handle large networks. Its drawback is that it relies on a more complex algorithm compared to EIGRP and requires more time to converge when building routing table. Hence, it generates Additional protocol traffic.

**CONCLUSION**

In this study shows EIGRP performs better over OSPF video streaming and Voice Conferencing applications. Besides, OPNET Modeler can be employed by network planners to select the most suitable routing protocol for various networks and to design an optimal routing topology.

**REFERENCES**


