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Performance Evaluation of Dynamic Routing Protocols on Video Streaming Applications

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Abstract — This paper introduces simulation results on comparative performance analysis of EIGRP and OSPF routing protocols on real time applications such as video streaming. OPNET is used for the simulation and it is performed on two network models configured with EIGRP and OSPF. Evaluation of these protocols has been done based on quantitative metrics such as convergence duration, packet delay variation, end-to-end delay and throughput. Results show that EIGRP performs better over OSPF on real time video streaming applications.

Keywords — EIGRP, OSPF, OPNET, Real-time Video Streaming, Convergence, Jitter, End-to-End Delay, Throughput.

1. Introduction

A number of publications discuss similar research [1],[2] [3],[4],[5],[6],[7],[8], however, a very few of them worked on comparison and analysis of protocols such as EIGRP and OSPF on real-time, bandwidth intensive network applications. Past studies on different routing protocols such as EIGRP, OSPF and RIP have been done based on simulation [3], in which, authors concentrated on comparative performance and detailed simulation study on IP networks. Numerous researches have been published on the behaviors of OSPF and EIGRP [1],[9] and how VoIP performance is affected by their routing characteristics [10]. These studies contributed potential insights of interior routing protocols. This paper has similar approach and works towards that direction. The comparison and evaluation of the routing protocols have been made here based parameters such as network convergence, convergence activity, CPU utilization, throughput, queuing delay, bandwidth utilization etc.

2. Network Topology

Two network scenarios have been proposed consisting of six interconnected subnets where routers within subnets are configured with EIGRP and OSPF. Each subnet consists of routers, switches, workstations etc. From the OPNET object palette, Application Config and Profile Config are added into the workspace. Application Config generates different types of application traffics. Application Definition Object is set to support video streaming. Profile Definition Object defines profiles within the application traffic of the Application Definition Objects. In the Profile Config, a profile has been created for supporting video streaming.

Failure links have been configured to introduce disturbances in the routing topology, leading to additional convergence activities. A video server is connected to the network that transmits video streaming. Quality of Service (QoS) plays an important role to provide better quality and guarantees a minimum amount of data availability during network congestions. In order to implement QoS, the QoS parameters are taken into the workspace where it is used to enable and deploy Weighted Fair Queuing (WFQ). WFQ is a scheduling technique that allows different scheduling priorities based on the Type of Service (ToS) and Differentiated Service Code Point (DSCP).

Routers are interconnected using PPP_DS1 duplex links. Switches are connected with routers using same quality links. Workstations are connected to switches using 10BaseT duplex links. First, we enable EIGRP in all routers on the network. Individual DES statistics is chosen to select performance metrics and to evaluate the behavior of EIGRP. Then the simulation run time is set to 900 seconds. After this, we configure OSPF and do the same as before.

3. Performance Metrics

Convergence Duration, Packet Delay Variation (also known as Jitter), End-to-end Delay and Throughput-metrics that are used here to measure protocol performances.

Convergence Duration measures how fast a set of routers reaches the state of convergence [11],[12],[13]. When routing protocol is enabled, routers attempt to exchange information from each other regarding the topology of the network. Upon a change in network topology, routers exchange information until the change has successfully propagates throughout the network.

Jitter is defined as the variation in delay on received packets. At the sending side, packets are sent in a continuous stream with packets spaced evenly apart. Due to network congestion, improper queuing and miss-configuration, the steady stream becomes lumpy or the delay between packets varies. This degrades the video speed and quality drastically [16].

End-to-end delay refers to the time a packet takes to travel across the network from source to the destination. End-to-end delay is critical in real time media performance. When a packet arrives too late at the destination, it gets lost eventually and generates a negative affect on the received video quality [15].

Throughput is a key parameter to determine the rate at which total data packets are successfully delivered and received through the network channels. Throughput is usually measured in bits per second (bits/s or bps), and sometimes in data packets per second or simply data packets [14].

4. RESULT ANALYSIS

In both network models, data rate for PPP_DS1 links are 1.544 Mbps. We consider background utilization on each network by varying the link utilization and analyze the variation of defined parameters. Link utilization is set to increasing order from normal 0% to high 80% as shown on Table 1.

Table (1) Link utilization values

Time in (sec)	Link utilization in (%)	Link value in (bps)
0	0	0
200	20	308800 (1544000*0.2)
400	40	617600 (1544000*0.4)
600	60	926400 (1544000*0.6)
800	80	1235200 (1544000*0.8)

OPNET is configured to acquire graphical information from various network devices and data sources including video traffic, routers, links and switches. In this section, several graph results are presented for the proposed metric parameters. Simulation duration of each scenario is 900 seconds. Video traffic starts at 70 seconds.

4.1 Convergence Duration

The convergence duration of EIGRP is faster than OSPF networks. Fig. 1 shows that EIGRP takes less time to converge than OSPF when a link fails at 400 seconds and recovers at 800 seconds. When change occurs in the network, an EIGRP router detects it and sends query only to the immediate neighbors in order to discover a successor and this way, the message propagates to all nodes on the network.

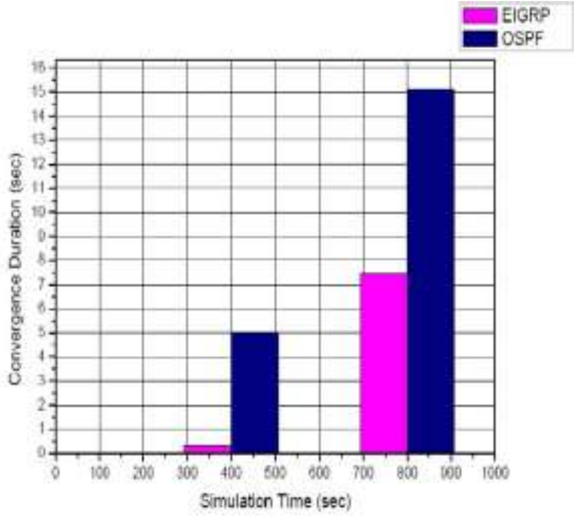

FIG. 1. Convergence duration

In case of OSPF, routers within an area update topology database by flooding LSAs to the neighbors and routing table is recalculated. As a consequence, OSPF takes more time to converge.

4.2 Packet Delay Variation (Jitter)

Delay Variation is measured by the difference in delay of packets. This metric has huge impact on video streaming. In Fig. 2, we observe that packet delay variation of OSPF at 400 seconds of simulation time starts rising and reach approximately to 1 second. Delay variation of EIGRP at 400 seconds increases slowly and reaches around 10ms, and then starts rising sharply. Network loads has been set at several steps, for instance 20%, 40%, 60% and 80% at 200, 400, 600 and 800 seconds respectively. At 400 seconds, delay on both networks stay close less than 30ms, which is an acceptable quality. In case of EIGRP, delay increases slowly after 400 seconds with network load 40% whereas delay of OSPF increases sharply after 400 seconds with a network load of 40%. It is noticed that there is an increase of delay variation for EIGRP and OSPF networks from 400 seconds to 900 seconds.

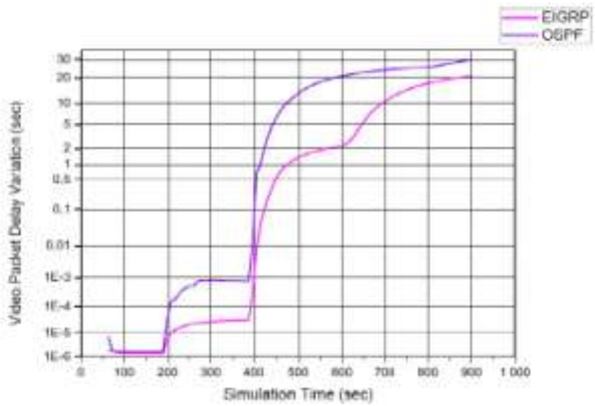

FIG. 2. Packet delay variation

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Network load with 80% at 800 seconds, delay variation reaches peak for both EIGRP and OSPF networks, which is not acceptable. For this reason, we measure these values until 400 seconds with 20% network load. It is apparent from the figure that packet delay variation of EIGRP network is less than OSPF network.

4.3 End-to-End Delay

Fig. 3 illustrates End-to-end delay of the networks. As shown in the figure, End-to-end delay of EIGRP and OSPF networks are around 70ms and 190ms at 395 seconds with 20% network load. It is also noticed that EIGRP increases to 200ms and OSPF increases to 1.5 seconds at 400 seconds of simulation time when the background load is set to 40%. However, with a higher background load, the delay for both EIGRP and OSPF networks start to increase sharply up to 600 seconds, followed by a gradual increase until the end of simulation.

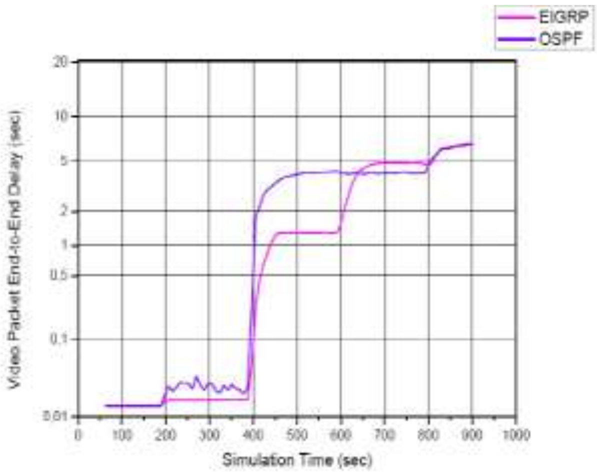

FIG. 3. End-to-end delay

We used multimedia streaming traffic class for low resolution in terms of video traffic across the network. All users in the network are simultaneously watching video from the video streaming server.

4.4 Throughput

Fig. 4 demonstrates the number of received traffic on both EIGRP and OSPF networks. Packets start to drop from 400 second in both EIGRP and OSPF networks. This figure shows the impact on the received traffic for different background loads at different simulation times. Packet loss on EIGRP network is 0.14% and 2.9% when the respective loads are 20% and 40%. OSPF packet loss is 0.35% and 6% under 20% and 40% loads respectively.

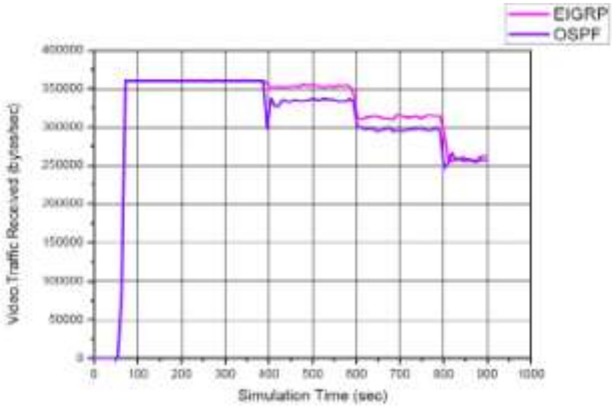

FIG. 4. Throughput

Background loads under 60% and 80% are not collected due to large number of packet drops. As we can see, overall packet loss on EIGRP network under various loads is less than that on OSPF network and therefore, EIGRP network gives more throughput than its counterpart OSPF.

5. CONCLUSION

In this paper, we have reported a comparative analysis of EIGRP and OSPF interior routing protocols. The analysis has been done on a single network with proposed protocols on real time applications. Protocol performance has been evaluated on the basis of proposed parameters. From the outcome of the simulations, we came across the conclusion that the performance of EIGRP is better compared to OSPF in terms of:

a. Convergence Duration
b. Packet Delay Variation
c. End-to-End Delay
d. Throughput

In this paper, we found that the implementation of EIGRP network converges faster than OSPF network, because EIGRP is able to learn the topology and updates rapidly.

We observed that packet delay variation of OSPF network is high while on EIGRP network it is low at a same network load. Therefore, performance on packet delay variation of EIGRP is better than that of OSPF.

Simulation results also show that End-to-end delay on EIGRP network is relatively less than that on OSPF. Delay stays less during acceptable quality for EIGRP at a certain bandwidth in the link, while for OSPF, delay stays more at same bandwidth in the link. As a result, data packets on EIGRP network reach faster to the destination than on OSPF.

We also found that the packet loss in the EIGRP network is less than in OSPF network and therefore, throughput of EIGRP network is much higher than that of OSPF network in high congestion link situations.

Due to the reason that EIGRP pose a hybrid nature of both Link State and Distance Vector characteristics, it provides better convergence, delay, throughput etc. A detailed simulation in future would reveal best results on our research objectives.

As a future extension to this work, a research will be performed on the explicit behaviors of both OSPFv3 and EIGRP protocols on IPv4/IPv6 environments. Security analysis for both protocols will be performed as well.

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