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RESEARCH ARTICLE

ANALYSIS OF THE IMPACT OF INTERIOR GATEWAY PROTOCOLS ON THE NETWORK PERFORMANCE

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ABSTRACT

In an Autonomous System (AS), network devices communicate through interior gateway protocols. Because they have characteristics such as high throughput, flexibility, low overhead, scalability, easy configuration, and high bandwidth and CPU utilization, interior gateway protocols are among the routing protocols with the fastest growing usage in networking technologies. Despite the fact that convergence time is a critical issue in any of these routing protocols, The network's updated, comprehensive, and correct information is summarized during convergence time. Numerous studies have examined interior gateway protocols; however, only a small number of these studies have taken link failure into account while employing various network scenarios. This study makes a contribution in this field. (Graphical Network Simulator) GNS3 software simulates a ten-router setup to mimic a complex real-time enterprise-level network. Every protocol is put into practice using the intended topology. Methods/Statistical Analysis: The interior gateway protocols Routing Information Protocol (RIP), Open Shortest Path First (OSPF), Enhanced Interior Gateway Routing Protocol (EIGRP), and Intermediate System to Intermediate System (IS-IS) are analyzed in a complex enterprise-level network using GNS3 version 2.2.34 software. Results: End-to-end delay, jitter, and convergence time for each protocol implemented in the planned topology are examined. Each node has authentication capabilities to guarantee secure data delivery. Finding the best practical interior gateway routing protocol for various traffic scenarios is the study's main goal. *In this paper, results are shown. The EIGRP protocol is superior in terms of end-to-end delay and convergence time after the results are tallied. While OSPF is supposed to have lower jitter than other Interior Gateway Protocols, in terms of convergence time, IS-IS outperforms OSPF. The results indicate that RIP protocols had the worst delays and convergence times.*

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INTRODUCTION

Technology is changing at an accelerating rate, which is causing a communications network to expand at an even faster rate. Dynamic routing protocol is used more frequently than static routing protocol in contemporary communication networks, such as the Internet network. We require a dynamic routing design that can adapt to these changes without the help of the network administrator as the network grows. Routing is the process of selecting a path for traffic in one or more networks. Protocols allow routers to vigorously share and pass information about remote networks and to update their routing tables with this data on a regular basis. Routing protocols are used to configure the superior route for each network. A routing protocol shows the relationship between all routers present in the network and communicates information first between immediate neighbors and then through the whole network (Masruroh, 2017). The two types of routing are static and dynamic. as illustrated in Fig. 1 The first one is the static routing; Static routing occurs when IP addresses are manually configured, and routes are entered using the keyboard. The entries are made into the routing table by the network administrator before the actual routing process begins. These entries can only be changed by the administrator; they cannot alter themselves. This requires additional configuration when the subnets are added to the network. Since, they can't adapt to any changes made in the network, they are usually not preferred when the network is huge, and the outcome is unpredictable. They also do not send or route any information that can be heard by the hackers. They do not consume CPU memory or link bandwidth (Karna, 2019; Anjana, Kummari, 2015). On the other hand, dynamic routing is done using the routing protocols, i.e., instead of giving each and every IP of the entry and exit of the router, the network administrator just has to write the protocol with the given syntax. In real time, these are very practical and beneficial since they can identify, if notified, the changes brought into the network and find the shortest path. By reading the routing update messages, they can adapt to changing network environments. If the messages indicate any change in the network, they calculate the shortest path and send the message (Karna, 2019; Anjana, Kummari, 2015).

Interior Gateway Protocols: In the following section, introduce dynamic routing protocols in local area network. They are further classified into three types-Distance vector routing protocol, Link state routing protocol and advanced distance vector routing protocol sometimes called Hybrid protocol. In a distance-vector protocol, A router periodically transmits to each of its neighbor's data regarding the destinations it knows how to reach. The router informs its neighbors two things: first, how far away the destination is, and second, the path (or vector) to take to get there. Routers that utilize the distance vector protocol are not have knowledge of the whole route to a destination. Router that uses distance-vector protocol that sends all or a portion of a router's routing table to every neighbor. Protocols for Distance vector routing include RIP (Version 1 – version 2), and IGRP . In link state routing protocols, routers Instead of only learning routes from nearby routers requires routers to gather link state data from each router and create a network topology from that data. Then, each router determines routes to each network using the topology. Protocols for link-state routing include OSPF and IS-IS. In Hybrid protocol is combines the Link-State and Distance-Vector routing protocols.

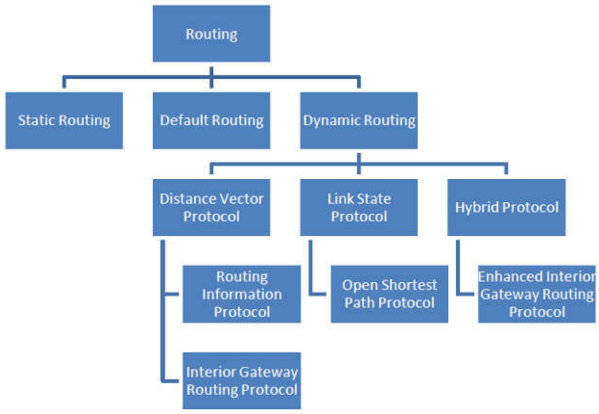

Fig. 1. Hierarchy of Routing Protocols (2)

RIP: Routing Information Protocol (RIP) is a distance-vector protocol that uses the hop count in its primary metric calculations to identify the best paths maximum Hop count in RIP is 15. It is also known as the Ford-Fulkerson or Bellman-Ford algorithm. RIP is available in three primary versions: RIP v1, RIP v2, and RIPng. RIP information is encapsulated in UDP. well-known port number for RIP V1 and V2 is 520 and RIPng use port 521. The administrative distance used by RIP protocol is 120. Every 30 sec router that use RIP send copy of its routing table to his neighbours. The updates are sent to the multicast address 224.0.0.9 for V1 and V2. The RIPng are sent to multicast address FF02: 9.

EIGRP: Enhanced Interior Gateway Routing Protocol (EIGRP) is combines the Link-State and Distance-Vector routing protocols. The metric depends on delay, Bandwidth, Reliability, and load. Diffusion Update Algorithm (DUAL) is used by EIGRP for route optimization and quick convergence. EIGRP delivers EIGRP packets via the Reliable Transport Protocol (RTP) protocol. There are two main versions of EIGRP, EIGRPV4 for IPV4 or EIGRPV6 for IPV6. The default administrative distance of EIGRP is 90 and hop count of 255. In EIGRP Protocol, there are two types of routes EIGRP has a concept of internal and external routes. Internal and external routes have a different AD. Internal route, have an AD of 90. External routes have an AD of 170. well-known port number for EIGRP is 88 .EIGRP routers use the multicast address of 224.0.0.10. The EIGRP metrics are shown in the calculation below, constants are K1 = 1, K2 = 0, K3 = 1, K4 = 0, and K5 = 0 (Dey, 2015).

$$metric = \left[K1 \times bandwidth + \frac{(K2 \times bandwidth)}{256 - load} + K3 \times delay\right] \times \left[\frac{K5}{reliability + K4}\right] \times 256$$

Fig. 2: EIGRP Composite Metric

Metric= 256*(BW + Delay)

Fig. 3: Default Metric Calculation

OSPF: Open Shortest Path First (OSPF) is a typical link state routing protocol that used Dijkstra's algorithm. The fundamental concept behind Dijkstra's algorithm is quite different from the Bellman–Ford algorithm or the distance vector algorithm. Dijkstra's algorithm has the interesting property of computing shortest paths to all destinations from a source, rather of only for one specific pair of source and destination nodes at a time (Improving Convergence Speed and Scalability in OSPF: A Survey). The metric depends on cost. OSPF protocol has no limit on the number of hop counts of the route. There are two main versions of OSPF for IPv4 (OSPFv2) or IPv6 (OSPFv3) have the same operating principle. Where every router generates "Link State Advertisements" (LSAs) to establish and maintain a local, consistent representation of the topology of the entire routing domain. OSPF routers gather the network's link state data and store it in the Link State Database (LSDB). Each OSPF router determines the shortest path to each network segment using the short path first (SPF) algorithm. well-known port number for OSPF is 89. The administrative distance used by OSPF is 110. OSPFv2 use multicast address 224.0.0.5, while OSPFv3 use multicast address FF02::5. The OSPF metrics are shown in the calculation below (Dey, 2015).

Cost = 10^8 /Bandwidth.

Fig. 4. OSPF metric

IS-IS: Intermediate System to Intermediate System (IS-IS) is a link-state protocol and behaves very similarly to OSPF. IS-IS was created by the ISO (11). IS-IS use a link state database and the SPF Dijkstra to choose shortest paths routes. There are four distinct metric values supported by IS-IS default metric, delay, expense, and error. IS-IS protocol has no limit on the number of hop counts of the route. IS-IS routes have an administrative distance is 115. IS-IS A router may be a level 1, level 2, or L1/L2 device. Level 1 routers have no direct connections to any other areas. Level 2 routers which connects several areas like OSPF area 0. Router can be an L1/L2 router, similar to an OSPF ABR that connects to both the backbone area and its own area.

RELATED WORKS: Biradar and Ambresh G (2020). The authors compared the performance of different routing protocols at the enterprise level to decide on the best protocol for routing packets. in terms of delay and convergence time. The author has utilized different types of routing protocols (RIP, OSPF, and EIGRP) for this purpose. The simulation was performed under the GNS3 simulator. The authors used nine Ethernet switches, nine Cisco 2691 routers, and nine Cisco c2691 routers and nine Virtual Personal computers (VPCs). The authors found that EIGRP and OSPF have a better delay time compared with RIP. EIGRP has the least convergence time compared with OSPF and RIP. The authors showed that EIGRP is the best routing protocol for an enterprise-level network. Okonkwo, Ifeanyi Joseph, and Ikiomoye Douglas Emmanuel (2020). From the perspective of convergence time in star and mesh topologies, the authors compared the performance of two various routing methods. For this, the authors have used a choice of routing protocols, such as EIGRP and OSPF. In this work, the authors employed star topology and mesh topology to mimic various network topologies under the network simulator GNS3 (1.5.4). The authors found that, when a link fails or a new link is introduced to the network, the EIGRP routing protocol performs better than the OSPF routing protocol in terms of convergence time. M Athira, Lekha Abrahami, and R. G. Sangeetha (Athira, 2017). In this paper, a complex real-time enterprise-level network is simulated in GNS3 software using routers, switches, and hosts. Each protocol is implemented in the designed topology. Interior gateway protocols RIP, OSPF, and EIGRP are analyzed in a complex enterprise-level network. Throughput, end-to-end delay, and convergence time were all considered when evaluating each protocol used in the intended topology. At each node, authentication is offered to ensure secure data transmission. The study aims to identify the most practical interior gateway routing protocols for various traffic situations. Moreover, the authors discovered that EIGRP's convergence time is better than RIP's and OSPF's. When compared to RIP, and OSPF have less significant delays. Compared to RIP, OSPF has a higher throughput. The end-to-end delay and throughput values of the three protocols do not vary significantly in a stable network condition. They said, "The best routing protocol for an enterprise-level network is EIGRP." Harsh Karna, Vidhu Baggan, Ashok Kumar Sahoo, and Pradeepta Kumar Sarangi (2019). In this paper, the authors conducted a performance analysis of Interior Gateway Routing Protocol (IGRP) about OSPF, RIPV2, and EIGRP using parameters such as throughput, jitter, convergence time, end-to-end delay, and packet depletion using Graphical Network Simulator (GNS-3). Based on the results, it is observed that the EIGRP routing protocol delivers superior performance as compared to OSPF, requires more computation than OSPF, and hence consumes immense system power. Manzoor, Atif, Muzammil Hussain, and Sobia Mehrban (9). The authors compared the performance of various routing protocols in medium- to large-scale IP networks. In terms of network convergence, debugging commands and Wireshark analyzer software were used to compare throughput and packet delay. The authors have utilized different types of routing protocols, including EIGRP, OSPF, and BGP, for this purpose. The simulation was performed under the GNS3 simulator. The authors have used five Cisco 7200 series routers and a switch in this simulated topology. The authors found that EIGRP is better at convergence and throughput, whereas OSPF is better at packet delay.

Problem Statement: A network administrator must create a high-performing network due to the complexity of the network environment. Applying the right routing protocol to a network can improve its performance. A few of the many factors that affect a network's performance are convergence, jitter, and delay. The effectiveness of a network is also influenced by how the routing protocol is implemented. Using the right routing protocol in combination should result in optimal network performance. This study's focus is on analyzing network performance based on convergence, jitter, and delay metrics while utilizing the Internal Gateway Protocol (RIPv2, OSPF, EIGRP, and IS-IS).

PROPOSED WORK

This research's objective is to assess and contrast the effectiveness of dynamic routing protocols that comprise is RIP, OSPF, IS-IS, and EIGRP. I implemented in the GNS3 software. In the same network, it implements RIP, OSPF, IS-IS, and EIGRP separately. An in-depth analysis of various network performances (convergence time, delay, and jitter) of each protocol to determine which protocol is optimal for the topology.

Models and measurement parameters: In this part, first go through the devices and media types that were used to set up the topology. and examine the software used. Also, describe the measurement parameters used to analyze the network topologies. The proposed network topologies consist of ten routers connected to each other using three serial connections to form a complex network at the enterprise level. As illustrated in Fig. 5 below.

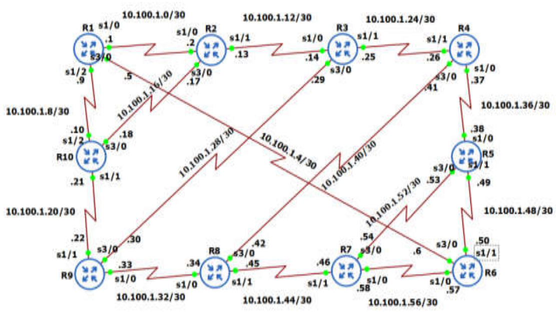

Fig. 5. Topology created for analysis

Hardware and software resources: The hardware and software resources utilized for the test are described in this subsection. Additionally, the IP addressing configuration and network topology used in these experiments are shown in Fig. 5 above. Ten Cisco routers make up the network topology. has multiple paths to go from one side of the topology to the other. The routers used in the test are the same models: Cisco 7200 router. The specifications of these devices are shown in table I. The software used to perform these experiments is GNS3 version 2.2.34. And the device that was used for these tests was the HP Pro Book 450 5G. The specification of this device is displayed in table II.

Table 1. devices specification for network topology

S.NO	Description
Device	Cisco 7200 router
Processor	NPE- 400
RAM Memory	512MB

TABLE 2 . Devices specification for PC

S.NO	Description
Device	HP ProBook 450 5G
Processor	Intel(R) Core (TM) i5-8250U
RAM Memory	8G
CPU	CPU @ 1.60GHz
Windows	Windows 11 Pro

From the standpoint of three initial parameters, network performance was examined using the same network topology and different protocols.

End to end delay: Is the entire amount of time, beginning when the first bit of the message is transmitted from the source and ending when the last bit of the message is delivered to the destination, needed for a full message to reach its destination.

Convergence time: Is a measurement of how quickly a group of routers brings a network back to its normal state.

Jitter: Is known as a "packet delay variance." It may simply imply that jitter is a concern when various data packets have disparate network delays. Milliseconds are used to measure jitter (ms).

RESULTS

In this section, each interior gateway protocol provided by this paper has been tested in accordance with the paper's objectives in order to determine the best protocol in this network topology. by calculating the end-to-end delay, convergence time, and jitter.

End To End Delay Tasting Results: Table III displays the average values of the end-to-end delay for RIP, EIGRP, OSPF and IS-IS which was computed by the ping performed throughout the analysis.

Table 3. End to end delay of RIP, EIGRP, OSPF, and IS-IS for each subnets

S. No.	IP	RIP	EIGRP	OSPF	IS-IS
1	10.100.1.1/30	170	40	48	43
2	10.100.1.5/30	196	42	24	50
3	10.100.1.9/30	152	42	40	48
4	10.100.1.13/30	83	24	26	32
5	10.100.1.17/30	26	20	22	20
6	10.100.1.21/30	21	20	22	25
7	10.100.1.25/30	40	39	32	30
8	10.100.1.29/30	48	42	57	27
9	10.100.1.33/30	35	31	28	42
1	10.100.1.37/30	57	56	66	64
1	10.100.1.41/30	77	68	86	52
1	10.100.1.45/30	46	58	65	60
1	10.100.1.49/30	40	40	38	42
1	10.100.1.53/30	44	38	36	37
1	10.100.1.57/30	26	21	24	19

Table III represents end to end delay for each protocol by taking the average of round-trip time (RTT) by using ping. Figs. 6, 7, 8, and 9 represent samples of results.

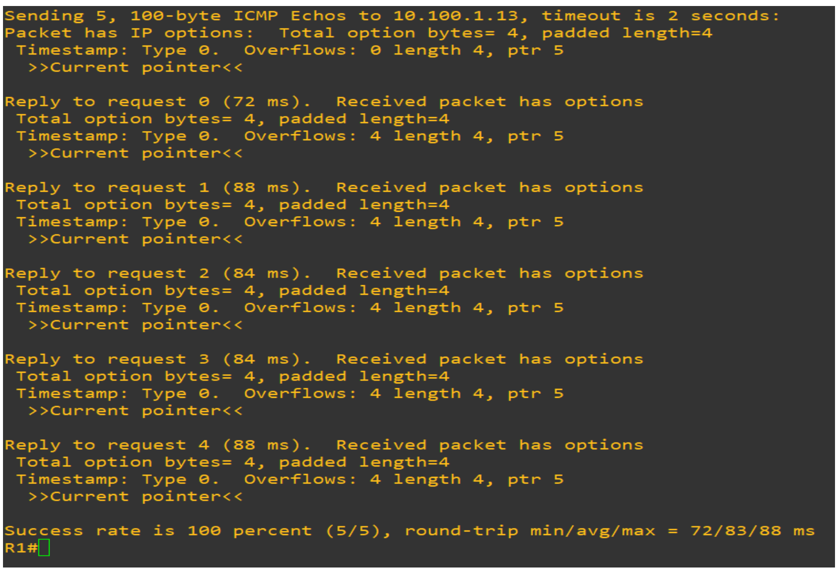

Fig. 6. Ping completed for 10 Routers for RIP protocol

```
Sending 5, 100-byte ICMP Echos to 10.100.1.45, timeout is 2 seconds:
Packet has IP options:  Total option bytes= 4, padded length=4
 Timestamp: Type 0.  Overflows: 0 length 4, ptr 5
  >>Current pointer<<

Reply to request 0 (68 ms).  Received packet has options
 Total option bytes= 4, padded length=4
 Timestamp: Type 0.  Overflows: 8 length 4, ptr 5
  >>Current pointer<<

Reply to request 1 (60 ms).  Received packet has options
 Total option bytes= 4, padded length=4
 Timestamp: Type 0.  Overflows: 8 length 4, ptr 5
  >>Current pointer<<

Reply to request 2 (64 ms).  Received packet has options
 Total option bytes= 4, padded length=4
 Timestamp: Type 0.  Overflows: 8 length 4, ptr 5
  >>Current pointer<<

Reply to request 3 (52 ms).  Received packet has options
 Total option bytes= 4, padded length=4
 Timestamp: Type 0.  Overflows: 8 length 4, ptr 5
  >>Current pointer<<

Reply to request 4 (48 ms).  Received packet has options
 Total option bytes= 4, padded length=4
 Timestamp: Type 0.  Overflows: 8 length 4, ptr 5
  >>Current pointer<<

Success rate is 100 percent (5/5), round-trip min/avg/max = 48/58/68 ms
R1#
```

Fig. 7. Ping completed for 10 Routers for EIGRP protocol

```
Sending 5, 100-byte ICMP Echos to 10.100.1.13, timeout is 2 seconds:
Packet has IP options:  Total option bytes= 4, padded length=4
 Timestamp: Type 0.  Overflows: 0 length 4, ptr 5
  >>Current pointer<<

Reply to request 0 (36 ms).  Received packet has options
 Total option bytes= 4, padded length=4
 Timestamp: Type 0.  Overflows: 4 length 4, ptr 5
  >>Current pointer<<

Reply to request 1 (28 ms).  Received packet has options
 Total option bytes= 4, padded length=4
 Timestamp: Type 0.  Overflows: 4 length 4, ptr 5
  >>Current pointer<<

Reply to request 2 (24 ms).  Received packet has options
 Total option bytes= 4, padded length=4
 Timestamp: Type 0.  Overflows: 4 length 4, ptr 5
  >>Current pointer<<

Reply to request 3 (20 ms).  Received packet has options
 Total option bytes= 4, padded length=4
 Timestamp: Type 0.  Overflows: 4 length 4, ptr 5
  >>Current pointer<<

Reply to request 4 (24 ms).  Received packet has options
 Total option bytes= 4, padded length=4
 Timestamp: Type 0.  Overflows: 4 length 4, ptr 5
  >>Current pointer<<

Success rate is 100 percent (5/5), round-trip min/avg/max = 20/26/36 ms
R1#
```

Fig. 8. Ping completed for 10 Routers for OSPF protocol

```
Sending 5, 100-byte ICMP Echos to 10.100.1.57, timeout is 2 seconds:
Packet has IP options:  Total option bytes= 4, padded length=4
 Timestamp: Type 0.  Overflows: 0 length 4, ptr 5
  >>Current pointer<<

Reply to request 0 (1 ms).  Received packet has options
 Total option bytes= 4, padded length=4
 Timestamp: Type 0.  Overflows: 4 length 4, ptr 5
  >>Current pointer<<

Reply to request 1 (40 ms).  Received packet has options
 Total option bytes= 4, padded length=4
 Timestamp: Type 0.  Overflows: 4 length 4, ptr 5
  >>Current pointer<<

Reply to request 2 (16 ms).  Received packet has options
 Total option bytes= 4, padded length=4
 Timestamp: Type 0.  Overflows: 4 length 4, ptr 5
  >>Current pointer<<

Reply to request 3 (8 ms).  Received packet has options
 Total option bytes= 4, padded length=4
 Timestamp: Type 0.  Overflows: 4 length 4, ptr 5
  >>Current pointer<<

Reply to request 4 (32 ms).  Received packet has options
 Total option bytes= 4, padded length=4
 Timestamp: Type 0.  Overflows: 4 length 4, ptr 5
  >>Current pointer<<

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/19/40 ms
R1#
```

Fig. 9. Ping completed for 10 Routers for IS-IS protocol.

Fig. 10 represent the delay variation, from the values in Table III, so we can see that ee that for the 1st case EIGRP has least delay, whereas 2nd and 3rd case OSPF has least delay. For 4th, 5th and 6th case EIGRP has least delay. For 7th and 8th case IS-IS has least delay.RIP always has worst delay except case 12th. For 13th and 14th OSPF has least value. So EIGRP has least delay among the RIP, OSPF and IS-IS. So EIGRP has least delay among the RIP, OSPF and IS-IS.

Fig. 10. End-to-End Delay variation graph for RIP, EIGRP, OSPF, and IS-IS

The table below displays the average values of the end-to-end delay for RIP, EIGRP, and OSPF, which were computed by taking the average of the table III averages for each protocol separately.

Table 4.Comparison of Average End to End Delay for RIP, OSPF, EIGRP and IS-IS

NO.	Type of Protocol	Average end to end Delay time (ms)
1	RIP	70.73
2	EIGRP	38.73
3	OSPF	40.93
4	IS-IS	39.4

The graph below represents the average end-to-end delay from the values in Table IV, and by analyzing Fig. 11, can see that EIGRP has the least average value of delay and does not differ much from IS-IS and OSPF. Figure 10 shows that RIP has the worst average value of delay.

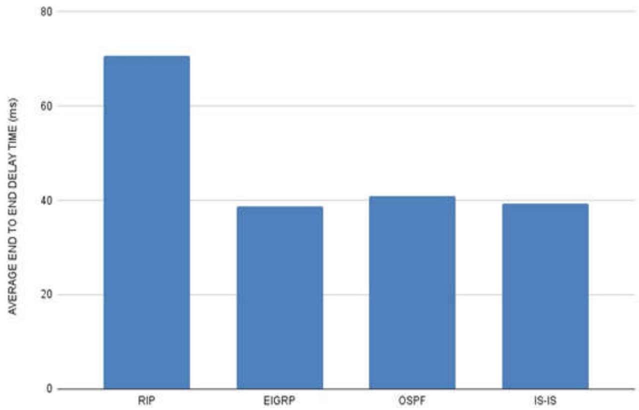

Fig. 11: Delay Variation Graph for RIP, EIGRP, OSPF and IS-IS

Jitter Tasting Results: Table V displays the values of the jitter for RIP, EIGRP, OSPF, and IS-IS, which were computed by the difference of the second packet's and the first packet's delay time. Figs. 6, 7, 8, and 9 represent samples of results.

Table 5.Jitter of RIP, EIGRP, OSPF, and IS-IS for each subnets.

S. No.	IP	RIP	EIGRP	OSPF	IS-IS
1	10.100.1.1/30	4	16	44	36
2	10.100.1.5/30	124	16	24	56
3	10.100.1.9/30	0	24	52	60
4	10.100.1.13/30	16	24	8	28
5	10.100.1.17/30	24	20	20	4
6	10.100.1.21/30	16	20	12	20
7	10.100.1.25/30	4	32	20	44
8	10.100.1.29/30	40	20	8	12
9	10.100.1.33/30	8	20	24	44
1	10.100.1.37/30	40	36	24	4
1	10.100.1.41/30	24	20	28	28
1	10.100.1.45/30	24	8	20	0
1	10.100.1.49/30	4	20	0	20
1	10.100.1.53/30	28	44	8	40
1	10.100.1.57/30	8	20	16	39

Fig. 12 represents the jitter variation, from the values in Table V. By analyzing Fig. 12, we can see that the 1st, 7th, 9th, 13th, and 5th cases RIP have the least amount of jitter. For 2nd, 3rd,11th, and 12th cases EIGRP has least value of jitter. For 4th,6th,8th, and 14th OSPF has least value. For 5th, and 10th IS-IS having least value.

Fig. 12. Jitter variation graph for RIP, EIGRP, OSPF, and IS-IS

The table below displays the average values of the jitter for RIP, EIGRP, and OSPF, which were computed by taking the average of the jitter values from Table V for each protocol separately.

Table 6. Comparison of Average jitter for RIP, OSPF, EIGRP and IS-IS

NO.	TYPE OF PROTOCOL	JITTER AVERAGE (ms)
1	RIP	24.26
2	EIGRP	22.66
3	OSPF	20.53
4	IS-IS	29

The graph below represents the average jitter from the values in Table VI. The lower the degree of jitter, the smoother the data transmission process. OSPF's routing protocol has the lowest average value of jitter and more disagreements than other protocols, especially IS-IS. The IS-IS protocol has the highest average value of jitter.

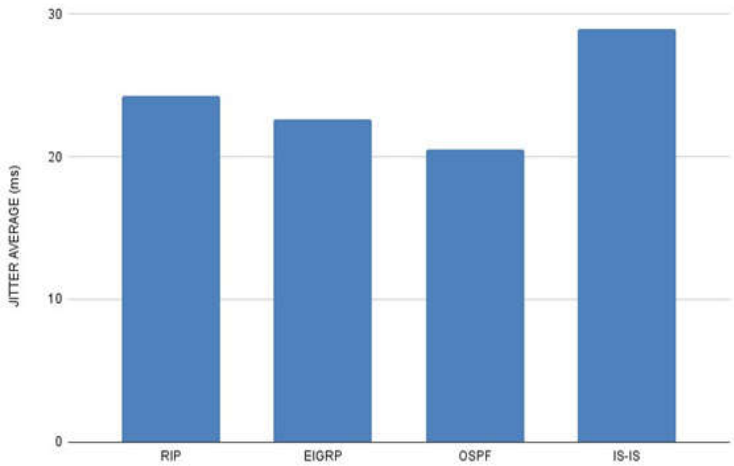

Fig. 13: Jitter Variation Graph for RIP, EIGRP, OSPF and IS-IS

Convergence Time Tasting Results: When a path fails, the router will take some time to update other routers about the failure. to calculate and find the next best path. Practically, this is known as convergence time. Packets with datagram size 100 and timeout 2s are sent from the source to the targeted destination with a repeat count of 500.

While sending a sequence of packets, we fail a path and the packets start to drop, this will continue till a new update is converged to all the routers. In order to find the convergence time, we find out the number of packets lost, and we know that each lost packet has a timeout of 2s. The convergence time is calculated by multiplying the number of lost packets by the time out, and this process is repeated five times before the average is taken.

Table 7. Convergence Time of RIP

NO.	Packets received	Packet lost	Convergence time (s)	Average convergence time (s)
1	468	32	64	63.6
2	464	36	72	
3	471	29	58	
4	474	26	52	
5	464	36	72	

Table 8.Convergence Time of EIGRP.

NO.	Packets received	Packet lost	Convergence time (s)	Average convergence time (s)
1	489	11	22	20.8
2	488	12	24	
3	490	10	20	
4	489	11	22	
5	492	8	16	

Table 9.Convergence Time of IS-IS

NO.	Packets received	Packet lost	Convergence time (s)	Average convergence time (s)
1	481	19	38	40.8
2	480	20	40	
3	479	21	42	
4	479	21	42	
5	479	21	42	

Table 10. Convergence Time of IS-IS.

NO.	Packets received	Packet lost	Convergence time (s)	Average convergence time (s)
1	486	14	28	30
2	484	16	32	
3	485	15	30	
4	485	15	30	
5	485	15	30	

Tables VII, VIII, IX, and X represent the convergence times and the average convergence times for each protocol. Figs. 14, 15, 16, and 17 represent samples of results.

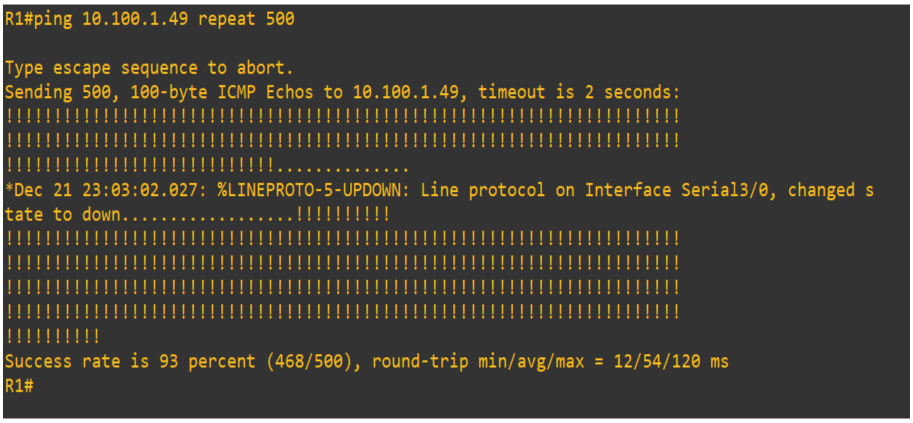

Fig. 14: RIP Configuration When Port s3/0 of R6 is Blocked

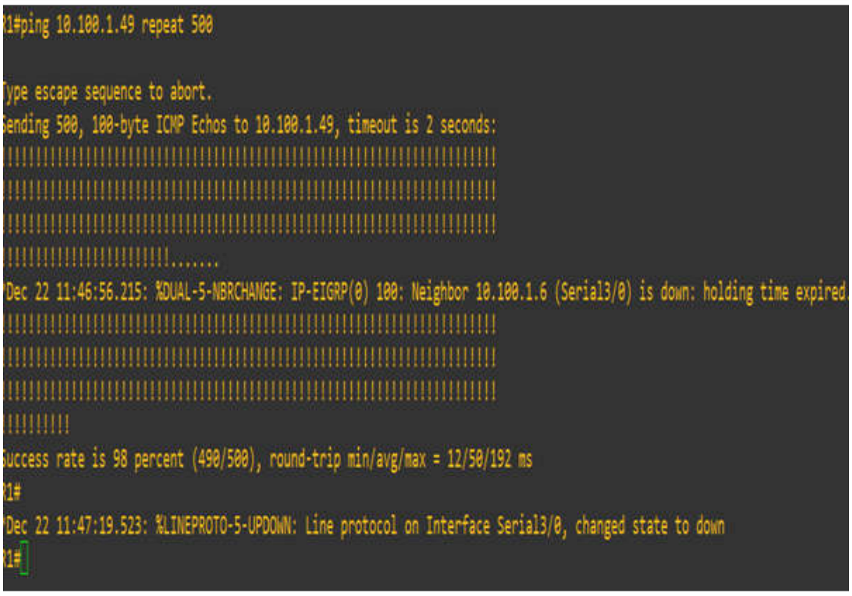

Fig. 15. EIGRP Configuration When Port s3/0 of R6 is Blocked.

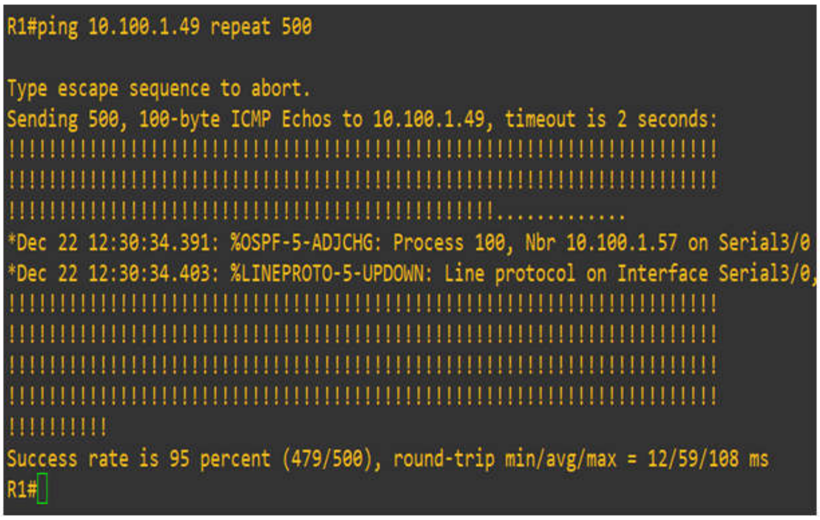

Fig. 16. OSPF Configuration When Port s3/0 of R6 is Blocked

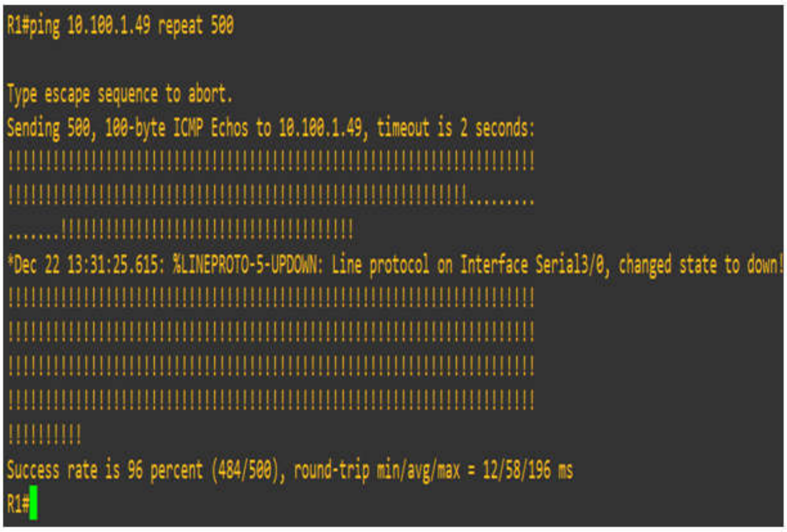

Fig. 17. IS-IS Configuration When Port s3/0 of R6 is Blocked.

The graph below represents the average of convergence time from the values in Tables VII, VIII, IX, and X, and by analyzing Fig. 18, so can see that EIGRP has the least average value of convergence time and the RIP has the worst average value of convergence time.

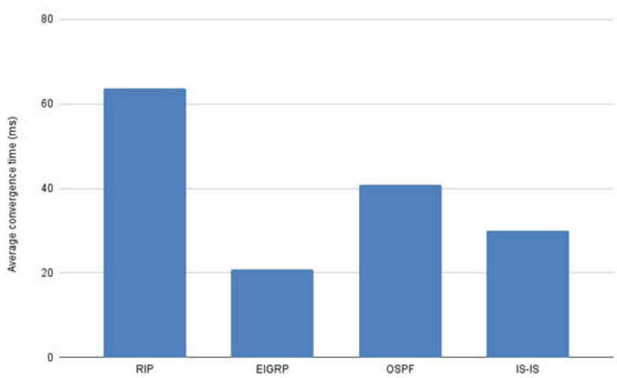

Fig. 18. Convergance Time Variation Graph for RIP, EIGRP, OSPF and IS-IS

CONCLUSION

A performance comparison between the interior gateway protocols RIP, EIGRP, OSPF, and IS-IS has been investigated to evaluate these protocols by using parameters such as convergence time, end-to-end delay, and jitter for every fifteen subnets in the proposed network topologies. After getting all the results, it's clear that the EIGRP protocol is better in terms of delay and convergence time. whereas OSPF is considered to be better in terms of jitter than other routing protocols. IS-IS is better in terms of convergence time than OSPF. RIP protocols, as shown in the results, had the worst delay and convergence time.

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