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Evaluation of EIGRP IPv6 and RIPng Effectiveness on IPv6 Networks with EVE-NG Emulator

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ABSTRACT

This study aims to evaluate the performance of two IPv6 routing protocols, namely EIGRP and RIPng, based on Quality of Service (QoS) parameters such as throughput, packet loss, and delay on a network with a configuration of two routers and five routers. The method used is Design Science Research Methodology (DSRM), which includes literature review, network simulation design, data collection, and analysis. Tests were conducted using the EVE-NG simulator and Wireshark to analyze network traffic. The results show that EIGRP has a higher throughput than RIPng, with an average throughput of 3910 bit/s on two routers and 4118 bit/s on five routers, while RIPng recorded a throughput of 3594 bit/s and 4090 bit/s on the same configuration. In addition, EIGRP also showed a lower delay of 999 ms in both configurations, compared to RIPng which recorded a delay of 1570 ms for two routers and 1530 ms for five routers. Both protocols had similar results on the packet loss parameter (0%). These findings indicate that EIGRP is more efficient in maintaining throughput stability and reducing delay, thus it is superior in providing responsive network performance, even with a larger number of routers.

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1. INTRODUCTION

In the evolution of network technology, the demand for allocating Internet Protocol (IP) addresses is increasing as the number of devices connected to the internet grows [1]. Internet Protocol version 4 (IPv4) has been the main foundation of internet infrastructure for more than 30 years [2]. However, the rapid growth of users and connected devices has caused the number of IPv4 addresses to become increasingly limited and insufficient for current needs [3]. This limitation encourages the shift towards IPv6 as a solution to support the future development of the internet [4]. IPv6 was developed by the Internet Engineering Task Force (IETF) with additional features, such as smaller header size, larger address space, new any-cast addressing types, integrated security, efficient routing, and better Quality of Service (QoS) [5]. In addition, the adoption of Internet of Things (IoT) devices and the growth of global networks accelerate this transition process [6]. However, this transition requires routing protocol adjustments to ensure network scalability and performance remain optimal, as IPv4 routing protocols are not compatible with IPv6 networks [7]. Compared to IPv4, IPv6 has a more efficient and longer header structure, allowing routing updates to convey more complete and detailed information [8]. Routing protocols are divided into two types: EGP (Exterior Gateway Protocols) such as BGP and IGP (Interior Gateway Protocols) such as RIP, EIGRP, ISIS, and OSPF [9]. In the context of IPv6, EIGRPv6 and RIPng (RIP Next Generation) are two important solutions for different environments. EIGRPv6 excels in fast convergence and bandwidth efficiency, while RIPng is easy to configure but limited in network scale. The choice of these protocols greatly affects network performance, given that each protocol has its own strengths and weaknesses [10].

Various studies have been conducted related to routing in IPv6. One study compared the performance of OSPF static and dynamic routing, showing that in busy scenarios, static routing has more optimal throughput, delay, packet loss, and jitter than OSPF [11]. Another study evaluated the performance of RIPng, OSPFv3, and EIGRP routing protocols in IPv6 networks through simulation. The findings showed that RIPng had the highest throughput and lowest packet loss, while the combination of OSPFv3 and EIGRP showed the lowest jitter, reflecting more stable performance [12]. In addition, there is research comparing the performance of OSPF, RIP, EIGRP, and IS-IS protocols in IPv4 and IPv6 networks using convergence and round-trip time metrics on topologies with 4, 6, and 8 routers. The results show that EIGRP excels thanks to the use of the DUAL algorithm with feasible successors [13]. Another study analyzed OSPF and EIGRP in a dynamic network scenario using BGP, which showed that EIGRP is better in terms of failover and packet loss than OSPF [14]. Finally, there was a study that focused on implementing and analyzing the OSPFv3 routing protocol in an IPv6 network, which involved testing using traceroute and ping commands to verify the results. The findings show that the use of OSPFv3 in IPv6 packet management allows for faster and safer decision-making, and improves network efficiency in an IPv6 environment [15].

Although there have been studies that address IPv6 routing protocols, there is still a significant gap in the literature that specifically compares the performance of EIGRP IPv6 and RIPng. Most of the previous research focuses on analyzing the OSPFv3 routing protocol or a combination of protocols in the context of large networks. This leads to a lack of understanding of the effective implementation of both protocols in the context of smaller networks. In addition, there is also a lack of studies that use realistic EVE-NG-based simulations to evaluate the performance of both protocols. To address this gap, this research will focus on a direct comparison between EIGRP IPv6 and RIPng in a simple scenario, using two routers and five routers. With this approach, a clearer insight into the characteristics and differences between EIGRP and RIPng in the context of IPv6 is expected. This research will also assess various performance metrics, such as throughput, packet loss, and delay.

2. RESEARCH METHODS

The method used in this research is Design Science Research Methodology (DSRM), which aims to develop and evaluate innovative solutions in the context of existing problems. It includes systematic steps in the research. These steps include literature study, setting research objectives, and analyzing the research data. Analysis of network measurements and routing protocol characteristics is carried out through parameters such as throughput, packet loss, and delay which includes the implementation of EIGRP IPv6 and RIPng.

The flow chart can be seen in Figure 1 below. Based on the flowchart, the research flow begins with a literature study stage to collect information and theories from various sources. The next stage is the preparation of hardware and software needed for simulation. After the device is ready, followed by the implementation stage which includes topology creation and configuration of RIPng and EIGRP protocols for IPv6. The testing process is carried out to collect data and monitor network traffic, which is then followed by an evaluation of the test results. If the test does not meet the specified criteria, the process will return to the testing stage until the test is successful. After successful testing, the collected data is analyzed based on parameters such as throughput, packet loss, and delay to compare the performance of EIGRP and RIPng protocols on IPv6. Finally, conclusions are drawn to determine the most optimal protocol to support IPv6 networks. This entire process is described in detail in the following subsections

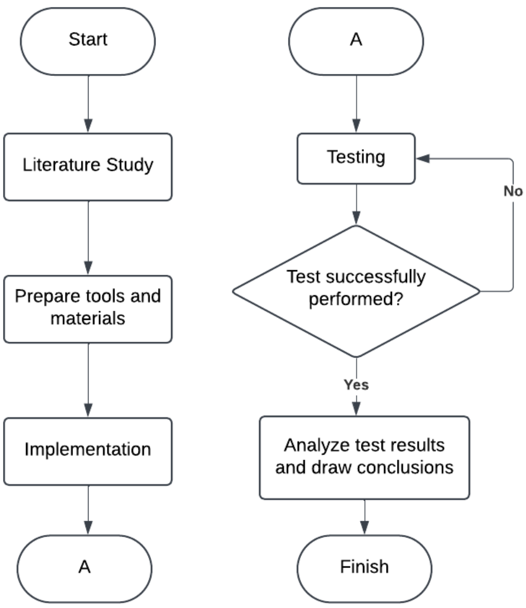


Figure 1. Flow of Implementation

2.1 Literature Study

This stage involves collecting information and theories from various sources, both electronic and print media. In this study, researchers sought and reviewed theories relevant to the EIGRP IPv6 and RIPng protocols. The main sources come from scientific articles and publications that can be accounted for to strengthen the basis of research.

2.2 Preparation of Tools and Materials

After installing EVE-NG in VirtualBox, configure the Network Adapter by setting Adapter 1 as NAT for internet access and Adapter 2 as Host-only Adapter so that the PC can connect to EVE-NG. Run the EVE-NG VM, record the IP obtained from DHCP, and login using the username root and default password eve. Make sure the internet connection is running properly using the ping 8.8.8.8 command. Then, access the EVE-NG GUI via a browser by entering the IP that has been recorded, then login using the username admin and password eve. To support testing the EIGRP and RIPng protocols, upload a compatible Cisco IOS file (e.g. c7200-adventerprisek9) to the /opt/unetlab/addons/dynamips/ directory using WinSCP or SCP. After that, unpack the file and set the permissions with the fixpermissions command.

To start, open the EVE-NG GUI and create a new lab via the menu “Add New Lab.” Next, add a node by clicking Add Object → Node, then select the router whose image has been uploaded previously. Arrange the topology according to the desired scenario, such as using 2 routers or 5 routers. Finally, connect each node using a virtual cable through the Add Link feature to connect the inter-router interfaces.

2.3 Implementation

This section describes the implementation process of the designed network topologies using two routing protocols, RIPng and EIGRP. Each topology was tested under predefined schemes, and detailed configurations were performed to ensure the correct functionality of the routing protocols. The implementation includes both the verification of configurations and the validation of network connectivity, which were carried out systematically for each scheme as outlined below.

2.3.1 Scheme 1 two Routers RIPng

In the first scheme, a network topology was designed using two routers with the RIPng routing protocol. Figure 2. shows the results of the topology that has been created and successfully connected.

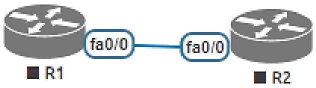
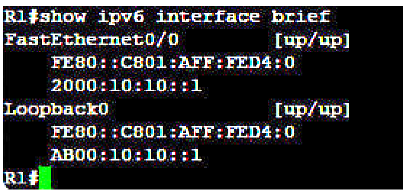


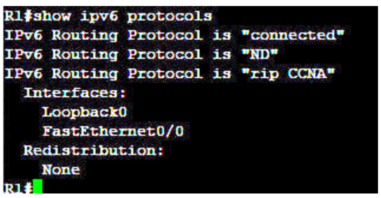
Figure 1. Topology Results of Two RIPng Routers

This configuration uses the RIPng protocol to support IPv6 inter-network communication. In the topology with two routers, each router has the IPv6 unicast-routing feature enabled, where the FastEthernet and Loopback interfaces are assigned unique IPv6 addresses to reflect different subnets. The RIPng protocol is enabled on all interfaces with the ipv6 rip CCNA enable command, allowing the dynamic exchange of routing information between routers. The no shutdown command ensures each interface is up, while the Loopback interface is provided a static IPv6 address for connectivity testing.

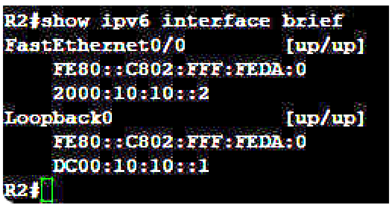
After that, a configuration check is performed on each router to ensure that the RIPng protocol has been implemented correctly. This check includes using the show ipv6 interface brief command to verify the status and IP address of the interface, as well as show ipv6 protocols to ensure that the RIPng protocol is active and functioning as configured. This step is important to ensure that there are no misconfigurations that could disrupt communication between networks and that all interfaces involved are properly connected.



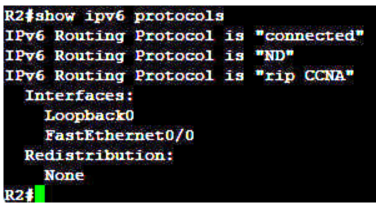
(a)



(b)



(c)



(d)

Figure 2. Configuration of Two RIPng Routers

Figure 3 (a-d) presents the configuration verification results using the 'show ipv6 interface brief' and 'show ipv6 protocols' commands on routers R1 and R2. The results confirm that the FastEthernet0/0 and Loopback0 interfaces are up/up with configured IPv6 addresses, and the RIPng routing protocol with the CCNA rip name is successfully running on both routers over the same interface without any route redistribution. This confirms that the RIPng configuration has been successfully implemented, and both routers are ready for IPv6 communication.

2.3.2 Scheme 2 (Testing two Routers) EIGRP

In the second scheme, a network topology was designed using two routers with the EIGRP routing protocol. Figure 4 shows the results of the topology that has been created and successfully connected.

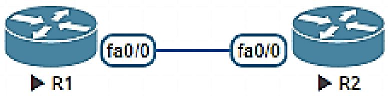


Figure 3. Topology Results of Two EIGRP IPv6 Routers

This configuration uses the EIGRP protocol for IPv6 (Enhanced Interior Gateway Routing Protocol) to support communication between IPv6 networks. In the topology with two routers, each router has the IPv6 unicast-routing feature enabled, with the FastEthernet and Loopback interfaces each assigned a unique IPv6 address to reflect a different subnet. The EIGRP protocol was enabled on all interfaces with the ipv6 eigrp 100 command, where "100" is the autonomous system (AS) used to group routing domains. The no shutdown command ensures EIGRP interfaces and processes are active, while Loopback is used to provide static IPv6 addresses to test connectivity between routers.

After that, a configuration check is performed on each router to ensure that the EIGRP protocol has been implemented correctly. This check involves using the show ipv6 eigrp neighbors command to verify that the router has formed neighbors with other routers. The successful establishment of neighbors indicates that the communication between routers via EIGRP has been functioning properly and is ready for the exchange of routing information.

```
R1#show ipv6 eigrp neighbors
EIGRP-IPv6 Neighbors for AS(100)
H   Address                Interface              Hold Uptime   SRTT   RTO  Q
Seq
                                                  (sec)         (ms)       Cnt
Num
0   Link-local address:    Fa0/0                    10 00:01:01   65   390  0
3
    FE80::C802:3EFF:FE3C:0
R1#
```

(a)

```
R2#show ipv6 eigrp neighbors
EIGRP-IPv6 Neighbors for AS(100)
H   Address                Interface              Hold Uptime   SRTT   RTO  Q
Seq
                                                  (sec)         (ms)       Cnt
Num
0   Link-local address:    Fa0/0                    12 00:00:45   51   306  0
3
    FE80::C801:24FF:FE7A:0
R2#
R2#
```

(b)

Figure 5. Configuration Results of Two EIGRP Routers

In Figure 5 (a-b) shows that routers R1 and R2 have formed neighbors using the EIGRP protocol for IPv6 in AS (Autonomous System) 100. Information such as link-local neighbors' addresses, the interface used (Fa0/0), and uptime indicate that the two routers recognize each other as neighbors and are ready to exchange routing information. The SRTT (Smooth Round Trip Time) and RTO (Retransmission Timeout) values show the average communication time and retransmission timeout between the two routers, which are relatively low, and the Count value of 0 indicates that no retransmission has occurred, indicating a stable and efficient connection.

2.3.3 Scheme 3 (Testing five Routers) RIPng

In scheme three, a network topology was designed using five routers with the RIPng routing protocol. Figure 6 shows the results of the topology that has been created and successfully connected. For the five router topology, the same approach was applied but with additional routers (R1-R5) to create a more extensive and complex network. Each router remained similarly configured, with unique IPv6 addresses on the FastEthernet and Loopback interfaces. The RIPng protocol remains enabled on all interfaces using the same routing domain, CCNA, to synchronize routing tables across the network. With this configuration, connectivity between routers in an IPv6 network can be tested and optimized, both on a small and large scale.

After that, a configuration check is performed on each router to ensure that the RIPng protocol has been implemented correctly. This check includes using the show ipv6 interface brief command to verify the status and IP address of the interface, as well as show ipv6 protocols to ensure that the RIPng protocol is active and functioning as configured. This step is important to ensure that there are no misconfigurations that could disrupt communication between networks and that all interfaces involved are properly connected.

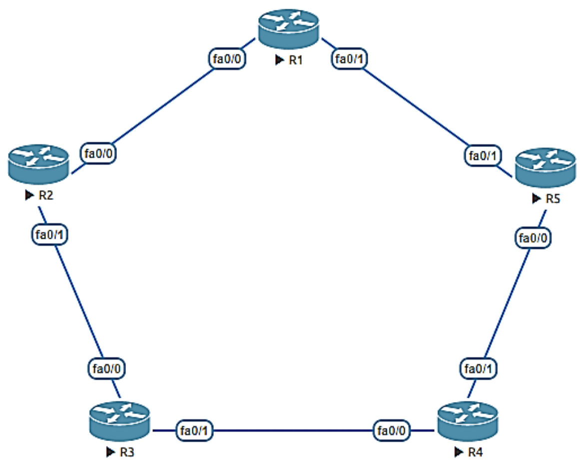
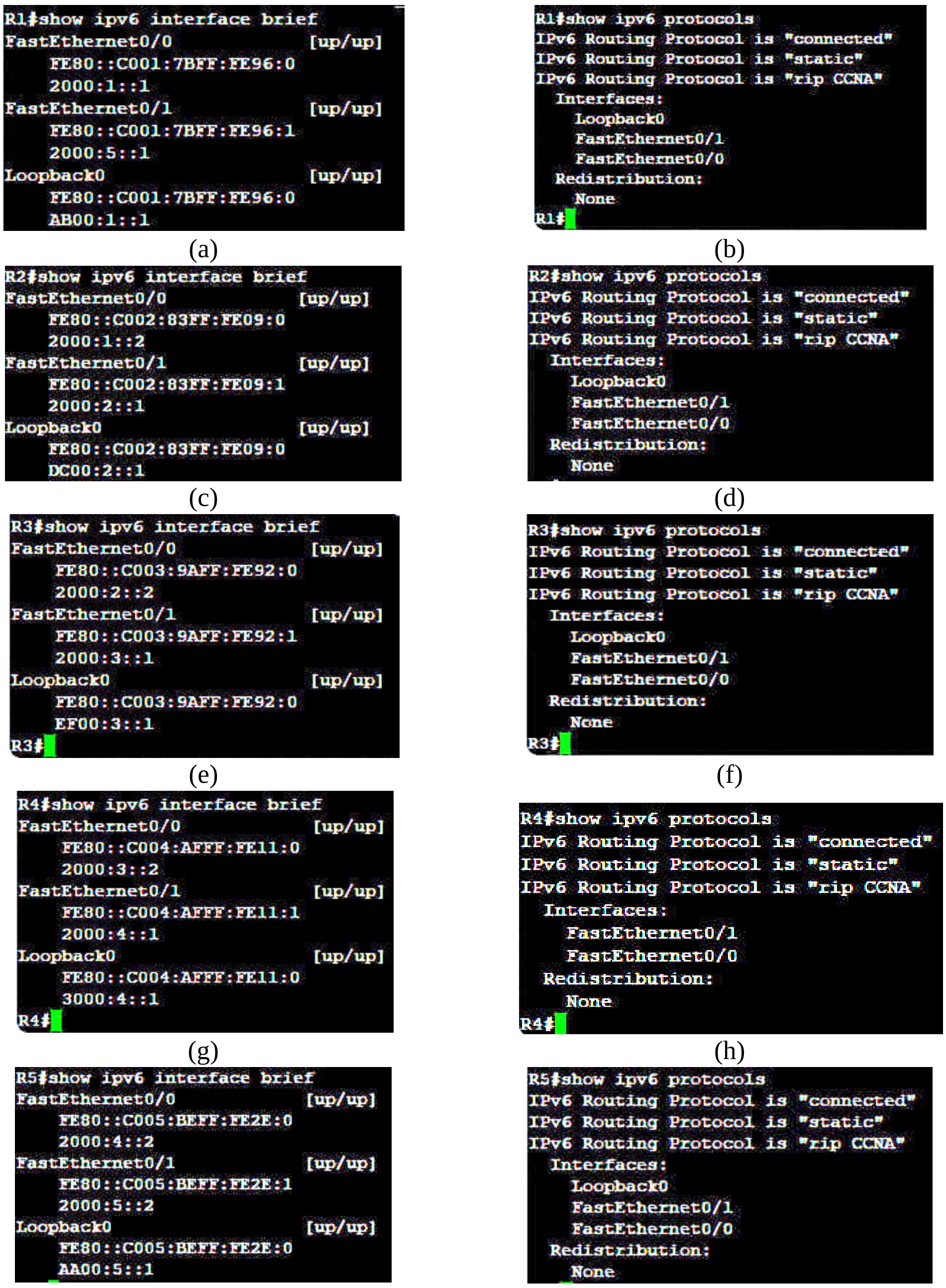


Figure 6. Topology Results of five RIPng Routers



```
R1#show ipv6 interface brief
FastEthernet0/0            [up/up]
    FE80::C001:7BFF:FE96:0
    2000:1::1
FastEthernet0/1            [up/up]
    FE80::C001:7BFF:FE96:1
    2000:5::1
Loopback0                  [up/up]
    FE80::C001:7BFF:FE96:0
    AB00:1::1
```

(a)

```
R1#show ipv6 protocols
IPv6 Routing Protocol is "connected"
IPv6 Routing Protocol is "static"
IPv6 Routing Protocol is "rip CCNA"
  Interfaces:
    Loopback0
    FastEthernet0/1
    FastEthernet0/0
  Redistribution:
    None
R1#
```

(b)

```
R2#show ipv6 interface brief
FastEthernet0/0            [up/up]
    FE80::C002:83FF:FE09:0
    2000:1::2
FastEthernet0/1            [up/up]
    FE80::C002:83FF:FE09:1
    2000:2::1
Loopback0                  [up/up]
    FE80::C002:83FF:FE09:0
    DC00:2::1
```

(c)

```
R2#show ipv6 protocols
IPv6 Routing Protocol is "connected"
IPv6 Routing Protocol is "static"
IPv6 Routing Protocol is "rip CCNA"
  Interfaces:
    Loopback0
    FastEthernet0/1
    FastEthernet0/0
  Redistribution:
    None
```

(d)

```
R3#show ipv6 interface brief
FastEthernet0/0            [up/up]
    FE80::C003:9AFF:FE92:0
    2000:2::2
FastEthernet0/1            [up/up]
    FE80::C003:9AFF:FE92:1
    2000:3::1
Loopback0                  [up/up]
    FE80::C003:9AFF:FE92:0
    EF00:3::1
R3#
```

(e)

```
R3#show ipv6 protocols
IPv6 Routing Protocol is "connected"
IPv6 Routing Protocol is "static"
IPv6 Routing Protocol is "rip CCNA"
  Interfaces:
    Loopback0
    FastEthernet0/1
    FastEthernet0/0
  Redistribution:
    None
R3#
```

(f)

```
R4#show ipv6 interface brief
FastEthernet0/0            [up/up]
    FE80::C004:AFFF:FE11:0
    2000:3::2
FastEthernet0/1            [up/up]
    FE80::C004:AFFF:FE11:1
    2000:4::1
Loopback0                  [up/up]
    FE80::C004:AFFF:FE11:0
    3000:4::1
R4#
```

(g)

```
R4#show ipv6 protocols
IPv6 Routing Protocol is "connected"
IPv6 Routing Protocol is "static"
IPv6 Routing Protocol is "rip CCNA"
  Interfaces:
    FastEthernet0/1
    FastEthernet0/0
  Redistribution:
    None
R4#
```

(h)

```
R5#show ipv6 interface brief
FastEthernet0/0            [up/up]
    FE80::C005:BEFF:FE2E:0
    2000:4::2
FastEthernet0/1            [up/up]
    FE80::C005:BEFF:FE2E:1
    2000:5::2
Loopback0                  [up/up]
    FE80::C005:BEFF:FE2E:0
    AA00:5::1
```

(i)

```
R5#show ipv6 protocols
IPv6 Routing Protocol is "connected"
IPv6 Routing Protocol is "static"
IPv6 Routing Protocol is "rip CCNA"
  Interfaces:
    Loopback0
    FastEthernet0/1
    FastEthernet0/0
  Redistribution:
    None
```

(j)

Figure 7. Configuration Results of Five RIPng Routers

Figure 7 shows the IPv6 configuration on five routers, R1 to R5, that use the RIPng protocol for IPv6. In figures (a), (c), (e), (g), and (i), the output of the show ipv6 interface brief command is shown, which shows the active interfaces with IPv6 addresses on each router from R1 to R5. Figures (b), (d), (f), (h), and (j) display the show ipv6 protocols output on each router, where the active IPv6 routing protocols are connected, static, and rip CCNA. The Loopback0, FastEthernet0/0, and FastEthernet0/1 interfaces on all five routers are involved in the RIP protocol, allowing them to exchange IPv6 routing information dynamically. This configuration allows the five routers to recognize each other and form a connected IPv6 network.

2.3.4 Scheme 4 (Testing five Routers) EIGRP

In scheme four, a network topology was designed using five routers with the EIGRP routing protocol. Figure 8 shows the results of the topology that has been created and successfully connected.

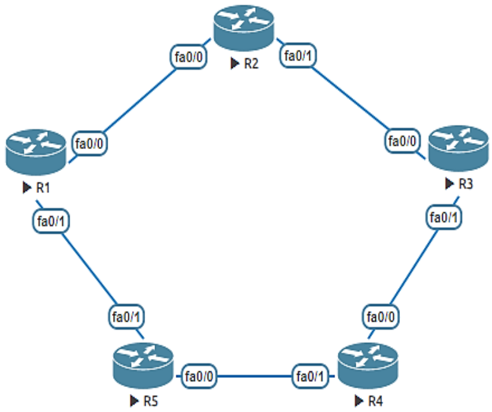


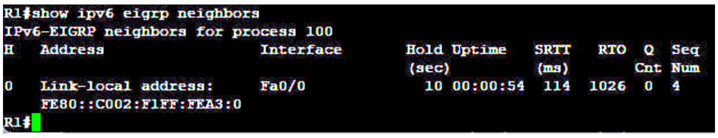
Figure 8. Topology Results of Five EIGRP Routers

For the five router topology, a similar approach was applied but with additional routers (R1-R5) to build a larger and more complex network. Each router uses the same configuration, including assigning unique IPv6 addresses to the FastEthernet and Loopback interfaces, and enabling the EIGRP protocol with the same autonomous system of 100. Router IDs can be manually specified to ensure unique identification of each router. With this configuration, each router in the network can exchange routing information efficiently, both on a small and large scale, to create optimal connectivity in IPv6 networks.

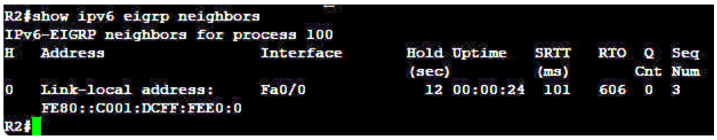
After that, a configuration check is performed on each router to ensure that the EIGRP protocol has been implemented correctly. This check involves using the show IPv6 EIGRP neighbors command to verify that the router has formed neighbors with other routers. The successful establishment of neighbors indicates that the communication between routers via EIGRP has been functioning properly and is ready for the exchange of routing information.

The figure above shows that five routers have established neighbor relationships using the EIGRP protocol for IPv6 within Autonomous System (AS) 100. Each sub-image (a, b, c, d, e) shows one router with link-local neighbors address information, Fa0/0 or Fa0/1 interface used for communication, and uptime, which indicates that all routers recognize each other as neighbors and are ready to exchange routing information. Low SRTT (Smooth Round Trip Time) and RTO (Retransmission Timeout) values on each router indicate fast communication times and small retransmission timeouts, indicating good communication performance. In addition, the Count value of 0 in each figure indicates that no retransmissions occur, so the connection between these routers is stable and efficient.

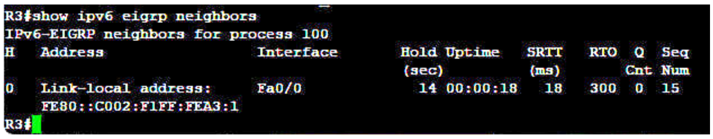
The selection of four scenarios in this study, namely two routers for RIPng, two routers for EIGRP, five routers for RIPng, and five routers for EIGRP, is based on the need to evaluate the performance of routing protocols in various scales of network topology using throughput, packet loss, and delay metrics. The scenario with two routers for RIPng and EIGRP represents a simple base configuration to see the initial performance and efficiency differences of the two protocols in a small network. On the other hand, the five-router scenario for each protocol aims to analyze the protocols' ability to handle more complex topologies and test their scalability and effectiveness in coping with an increasing number of hops. The use of throughput metrics measures the capacity of the network in transferring data, packet loss evaluates the reliability of transmission, while delay assesses the speed at which data is sent between devices. With this approach, the research seeks to provide a comprehensive overview of the advantages and limitations of RIPng and EIGRP in the IPv6 protocol.



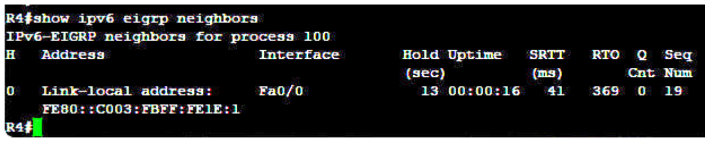
(a)



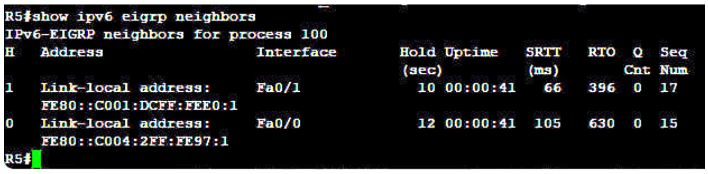
(b)



(c)



(d)



(e)

Figure 9. Configuration Results of Five EIGRP Routers

2.4 Testing and Evaluation

Once the network topology was set up, Ping tests were conducted between routers to measure the basic performance of the network. This test serves to generate light traffic while checking connectivity between devices. Traffic monitoring was performed using Wireshark, which was used to capture and analyze ICMP packets generated during the Ping test. Figure 10 shows an example of a capture file from Wireshark for RIPng on a two-router configuration.

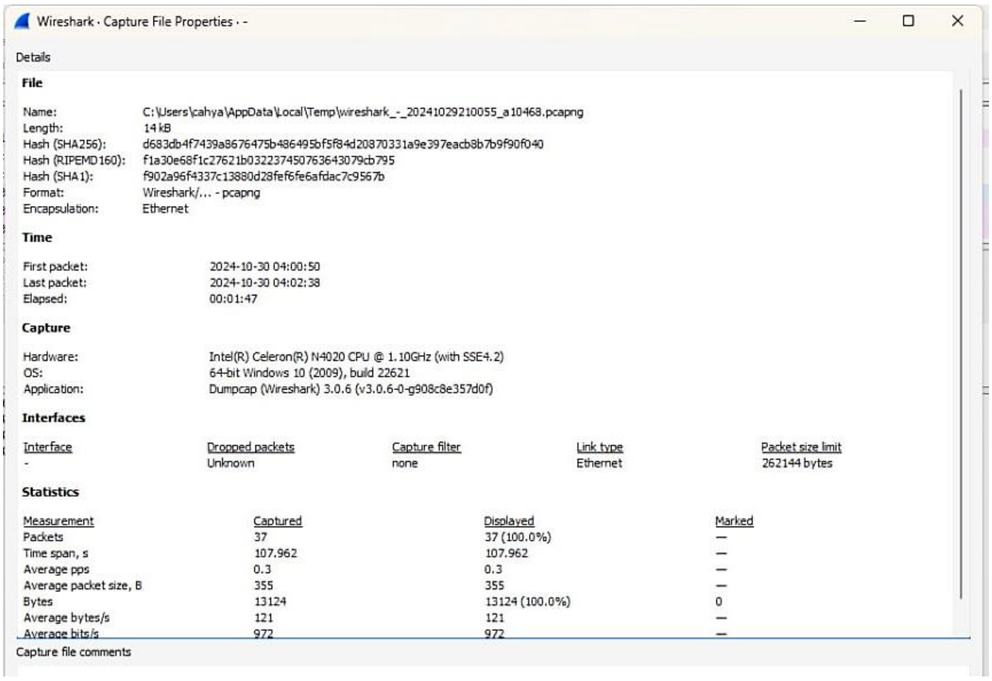


Figure 10. Wireshark capture

During the tests, several performance metrics were measured, such as throughput, which is calculated based on the amount of ICMP data successfully transferred in bits per second; packet loss, which is the percentage of ICMP packets lost during transmission; and delay, which is the round-trip time of ICMP packets, describing the speed of data delivery between the source and destination. For each test, data was collected for 10 iterations to ensure reliable results. Mathematically, the formula can be expressed as Equations (1) through (3).

$$Throughput = \frac{Amount\ of\ data\ sent\ (Bytes\ capture)}{Time\ span\ capture} \times 8 \quad (1)$$

$$Packet\ Loss = \frac{Packets\ sent\ (Packet\ capture) - Packets\ received\ (Packet\ display)}{Packets\ sent\ (Packet\ capture)} \times 100 \quad (2)$$

$$Delay = \frac{Time\ span\ display}{Packets\ received\ display} \times 1000\ (\text{ms}) \quad (3)$$

The data includes throughput, packet loss, and delay, which are then analyzed using statistical methods such as averages and standard deviations to compare the efficiency of the RIPng and EIGRP protocols across different scenarios. The average test results of each topology are presented in Tables 1, 2, 3, and 4.

Table 1. Router RIPng Test Results

Testing	Throughput (bits/s)	Packet Loss (%)	Delay (ms)
1	972	0	2917
2	2879	0	1581
3	1539	0	2316
4	6757	0	809
5	2405	0	1833
6	2854	0	1450
7	4790	0	1136
8	4448	0	1292
9	5858	0	1017
10	3441	0	1345
Average	3594	0	1570

Table 1 shows the test results for the RIPng protocol on two routers with several network metrics, namely throughput, packet loss, and delay. The test results show that the average throughput achieved was 3594 bits/s without packet loss, while the average delay was recorded at 1570 ms. The highest throughput value was achieved in the 4th test with 6757 bits/s and the lowest delay in the same test, which was 809 ms.

Table 2. EIGRP 2 Router Testing Results

Testing	Throughput (bits/s)	Packet Loss (%)	Delay (ms)
1	2886	0	1150
2	3882	0	974
3	4284	0	874
4	3874	0	935
5	4475	0	939
6	2660	0	1155
7	4301	0	932
8	5265	0	857
9	3902	0	1080
10	3572	0	1090
Average	3910	0	999

Table 2 shows that the average throughput achieved is 3910 bits/s without packet loss, with an average delay of 999 ms. The highest throughput was achieved in the 8th test with a value of 5265 bits/s, while the lowest delay occurred in the same test, which was 857 ms.

Table 3. RIPng Testing Results 5 Routers

Testing	Throughput (bits/s)	Packet Loss (%)	Delay (ms)
1	1760	0	2171
2	3971	0	1098
3	4430	0	1287
4	3737	0	1429
5	914	0	3011
6	4497	0	1252
7	6023	0	937
8	5935	0	954
9	8213	0	730
10	1422	0	2427
Average	4090	0	1530

The tests in Table 3 show that the average throughput achieved is 4090 bits/s without packet loss, with an average delay of 1530 ms. The highest throughput was achieved in the 9th test with a value of 8213 bits/s, while the lowest delay occurred in the same test, which was 730 ms.

Table 4. EIGRP 5 Router Testing Results

Testing	Throughput (bits/s)	Packet Loss (%)	Delay (ms)
1	1267	0	1673
2	3635	0	1028
3	3099	0	1070
4	4138	0	1019
5	4130	0	909
6	5285	0	799
7	3634	0	997
8	3782	0	988
9	5800	0	800
10	6415	0	703
Average	4118	0	999

The tests in Table 4 show that the average throughput for the EIGRP protocol on five routers is 4118 bits/s without packet loss, with an average delay of 999 ms. The highest throughput was achieved in the 10th test with a value of 6415 bits/s, while the lowest delay occurred in the same test, which was 703 ms.

2.5 Conclusion

The final stage in this research is to analyze and interpret the test data based on the measured performance metrics, such as throughput, packet loss, and delay. Results from various test scenarios, both with two routers and five routers, will be comprehensively compared to evaluate the performance of RIPng and EIGRP IPv6. Conclusions will be drawn with the aim of identifying the most optimal protocol in supporting IPv6 network communications, in both small and medium topologies. This analysis is expected to provide insight into the effectiveness of both protocols in different network scenarios as well as help network administrators choose the most suitable protocol for specific needs.

3. RESULTS AND DISCUSSION

After the testing phase was completed and data was collected, analysis was conducted to evaluate the performance of the RIPng and EIGRP routing protocols based on Quality of Service (QoS) parameters, namely throughput, packet loss, and delay. Tests were conducted on various network scenarios, both with two routers and five routers configurations, to provide a more comprehensive picture of the performance of each protocol. The test results were summarized and visualized in graphs to facilitate interpretation and comparison. The focus of the analysis is on the average throughput and delay of each protocol and topology, as shown in Figure 10, to assess the efficiency and effectiveness of RIPng and EIGRP in various network scenarios.

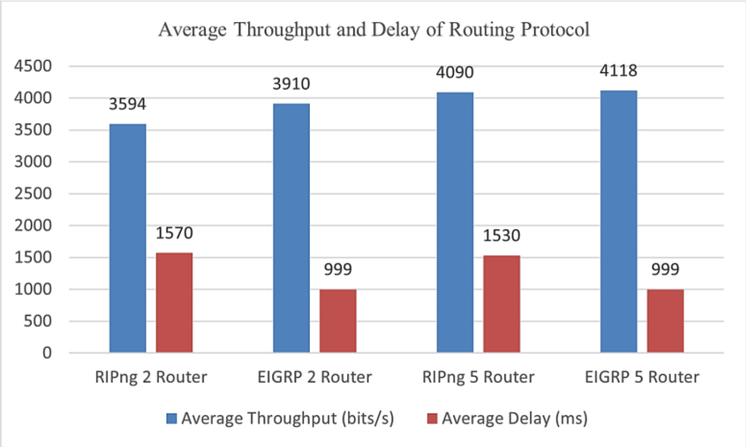


Figure 10. Average Throughput and Delay Results of Routing Protocols

This graph shows the average throughput and delay comparison between two routing protocols, RIPng and EIGRP, in two topology scenarios, namely two routers and five routers. It should be noted that the packet loss parameter is not shown as both protocols show the same result of 0% packet loss in all tests. In the two router configuration, EIGRP had a higher average throughput (3910 bit/s) than RIPng (3594 bit/s), indicating that EIGRP is more efficient in transferring data in networks with fewer routers. In the five router configuration, EIGRP throughput is also slightly higher (4118 bit/s) than RIPng (4090 bit/s). Despite the increase in the number of routers, EIGRP's throughput remained stable and even increased slightly, which shows the efficiency of this protocol in managing network traffic on larger topologies. The difference in throughput between EIGRP and RIPng in the five router configuration is very small, only 28 bit/s difference, compared to 316 bit/s difference in the two router configuration. This indicates that both protocols have almost equivalent performance on larger scale networks.

In addition to throughput, this graph also shows a comparison on the delay parameter. EIGRP shows a lower average delay compared to RIPng in both configurations. In the two router configuration, EIGRP recorded an average delay of 999 ms, while RIPng had a higher delay of 1570 ms. Similarly, in the five router configuration, EIGRP recorded an average delay of 999 ms, while RIPng had a delay of 1530 ms. These results indicate that EIGRP is more efficient in reducing data transmission delay, which contributes to the overall increase in network responsiveness. Thus, EIGRP is proven to be superior in maintaining stable network performance, both in terms of throughput and delay, compared to RIPng. This comparison supports the findings from previous research that EIGRP is superior in managing more complex networks and can adapt better to changes in network topology.

4. CONCLUSION

Based on the test results of IPv6 routing protocols, namely EIGRP and RIPng, it can be concluded that EIGRP shows more stable performance compared to RIPng, especially in terms of throughput and delay. EIGRP has a higher average throughput and lower delay in both topology configurations, both with two routers and five routers, which supports previous research results that show EIGRP's superiority in terms of data transmission efficiency and network responsiveness. In addition, packet loss testing showed 0% results for both protocols, reflecting their ability to maintain data integrity during transmission. This finding is in line with the expectation that EIGRP is superior in maintaining network stability compared to RIPng. This research contributes to the understanding of the selection of routing protocols that are more appropriate according to quality of service (QoS) requirements and network scale, and can be a reference for further research involving other routing protocols such as OSPF and IS-IS in more complex IPv6 networks.

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