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Implementation of IPv6 Protocol in EIGRP Routing to Improve Data Transfer Efficiency in Wide Area Networks

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ABSTRACT

The development of network technology has encouraged the adoption of Internet Protocol version 6 (IPv6) as a solution to the limitations of IPv4, especially in terms of address space and network efficiency. Consequently, a routing protocol capable of optimally supporting the complexity of IPv6 networks is required. Enhanced Interior Gateway Routing Protocol (EIGRP) is a dynamic routing protocol that natively supports IPv6 and is known for its efficiency and scalability. This study aims to examine the implementation of EIGRP on IPv6 networks, specifically in improving data transfer efficiency on Wide Area Networks (WANs). Testing was conducted using Cisco Packet Tracer, with evaluations of device connections, latency performance, and routing paths. The test results showed good connectivity between devices, with an average latency value of 0.5 ms, as well as an optimal routing path based on the Diffusing Update Algorithm (DUAL) algorithm. Configuration adjustments such as the Autonomous System (AS) value and K-value were proven to affect routing efficiency. This study concludes that EIGRP on IPv6 is able to improve data delivery efficiency and is a reliable solution in modern network development. These results can be a reference for network developers in optimizing IPv6 routing configurations.

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1. INTRODUCTION

Along with the adoption of IPv6, the need for routing protocols that are compatible and able to manage routing efficiently in IPv6 networks also increases. The routing protocol used must be able to handle greater network complexity and support new features in IPv6. Enhanced Interior Gateway Routing Protocol (EIGRP) is one of the dynamic routing protocols that is widely used in the Cisco network environment. EIGRP is known for its ability to perform fast, efficient, and scalable routing, as well as ease of configuration and management. This protocol uses the Diffusing Update Algorithm algorithm which allows for fast convergence and effective management of alternative paths.

The ability of the EIGRP routing protocol to determine which router to pass allows data to reach its destination faster, especially if there is network traffic congestion [1]**.** The advantages of EIGRP as a scalable and efficient routing protocol make it the right choice to be applied to IPv6 networks. With the ability to support IPv6 routing natively, EIGRP can optimize data delivery and improve network performance. However, implementing EIGRP on IPv6 also presents its own challenges, such as configuration adjustments, routing parameter optimization, and different performance evaluation compared to IPv4.

From the results of calculations and evaluations of the performance of the Dual Routing EIGRP protocol in the Bina Darma University research network center laboratory, it is found that the DUAL workings in the EIGRP routing protocol in determining the best path choice to the destination network address, by giving the smallest matric value by giving the bandwidth value twice the neighboring router [2]. Therefore, research on the implementation and optimization of EIGRP on IPv6 networks is very relevant and important to do to ensure the network can run optimally and reliably. EIGRP must have the same AS value and K-value in order to form a neighboring relationship so that it can exchange routing information, the default K-Value value used for metric calculation is the lowest bandwidth along the path and cumulative delay along the path [3].

This research aims to examine in depth the application of EIGRP in IPv6 networks, including how to optimize the configuration and routing parameters so that the efficiency of data transmission can be improved. In addition, this research will also compare the performance of EIGRP on IPv6 with IPv4 to provide a comprehensive overview of the advantages and disadvantages of each protocol in the context of modern networks. Thus, the results of this research are expected to make a significant contribution to the development of network technology and become a reference for practitioners and academics working in the field of computer networks.

Routing is the process of selecting the path on the network used to deliver data packets to the destination address. Routers make routing decisions based on the destination IP address of the packet. The term routing is used for selecting the path of a packet from a network to another network that is interconnected via a route. EIGRP is often called a hybrid-distancevector routing protocol, because it works using two types of routing protocols, namely Distance vector protocol and Link-State protocol, in the sense that EIGRP routing is actually a distance vector protocol but its working principle uses the links-states protocol. So that EIGRP is referred to as a distance-vector hybrid, why is it said that way because the principle works the same as the links-states protocol, namely sending a kind of hello packet. EIGRP uses bandwidth and delay-based formulas to calculate the metric corresponding to a route. EIGRP converges precisely when avoiding loops [4].

The metric used by EIGRP with the Diffussing Update Algorithm (DUAL) there are 5 variables which in Cisco routers are marked with K1, K2, K3, K4 and K5. Each of these Ks is [5].

K1 = Bandwidth defaults to 1
K2 = Load defaults to 0
K3 = Delay defaults to 1
K4 = Reliability defaults to 0
K5 = Reliability defaults to 0

EIGRP performs calculations using the K value parameter, here are some metric parameters in the EIGRP calculation [4].

1. Default Composite Formula:
   Metric = [K1**Bandwidth* + K3**Delay*] * 256 (1)
2. Complete Composite Formula (not used if "K" Values are "0"):
   Metric = [K1**Bandwidth* + (K2**Bandwidth)/(*256-*load)* + K3**Delay*] * [K5/(Reliability + K4)].
3. Syntax Router Configuration Command:
   Router (config-router)#metric weights *tos k1 k2 k3 k4 k5*

Bandwidth Calculation Example, EIGRP Router will choose among the slowest interfaces to be used as a barometer for metric calculation.

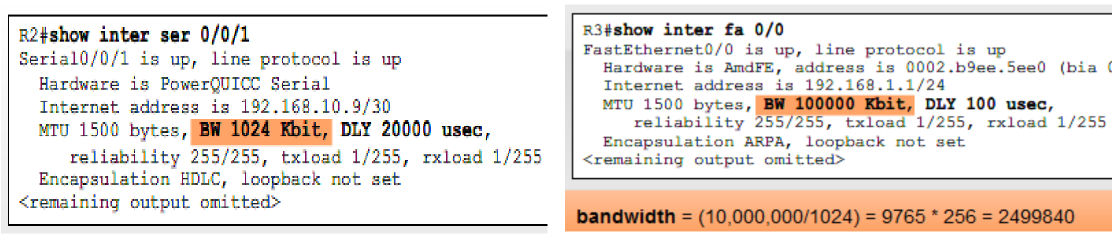

Figure 1. Bandwidth Calculation

Delay calculation example: Using the cumulative sum of interface delay metrics.

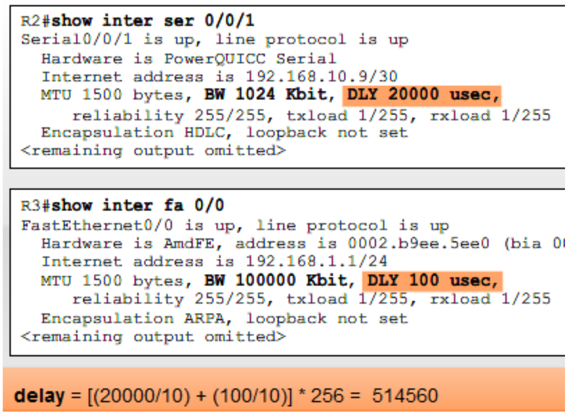

Figure 2. Delay Calculation

2. METHOD

This research uses a simulation method with the help of Cisco Packet Tracer. The network topology consists of five routers, 3 PCs for each router, and one server connected to each other in an IPv6 network. Each router is configured with EIGRP using the same Autonomous System (AS) number of 40 and a unique IPv6 router-id.

Configuration is done through the CLI (Command Line Interface), including setting the IPv6 address and link-local address on each interface. Connectivity testing was done by sending PING packets from the PC to the server and using the traceroute command to verify the packet path. In addition, observations were made of the routing table, topology, and EIGRP neighbors using the show ipv6 eigrp neighbors and show ipv6 eigrp topology commands. The research method can be seen in Figure 3 below.

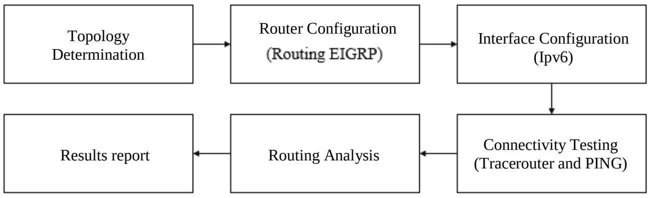

Figure 3. Research method

In this research the author uses a tree topology in building a network. The purpose of this tree topology is to see the extent of routing performance in overcoming networks that have branches on their connections. This topology can be seen in Figure 4 below.

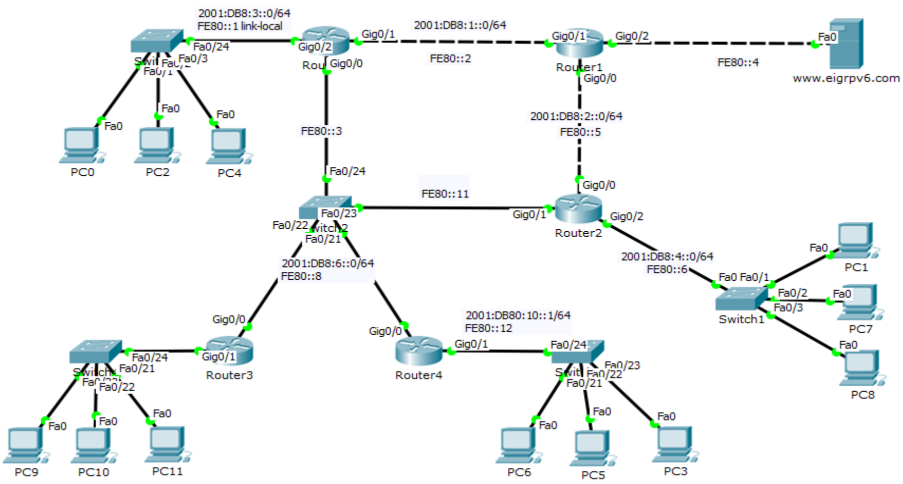

Figure 4. Network topology design

The devices on the network are all configured using IP version 6. The configuration can be seen in table 1 below.

Table 1. IP configuration of network devices

No	Device	Interface	Description	Link-local
1	Router 1	Gigabitethernet0/0 Gigabitethernet0/1 Gigabitethernet0/2	2001:DB80:0::0/64 2001:DB80:1::0/64 2001:DB80:2::0/64	FE80::2 FE80::4 FE80::5
2	Router 2	Gigabitethernet0/0 Gigabitethernet0/1 Gigabitethernet0/2	2001:DB80:0::0/64 2001:DB80:3::0/64 2001:DB80:4::0/64	FE80::5 FE80::11 FE80::6
3	Router 3	Gigabitethernet0/0 Gigabitethernet0/1 Gigabitethernet0/2	2001:DB80:5::0/64 2001:DB80:6::0/64 2001:DB80:7::0/64	FE80::8 FE80::13 FE80::12
4	Router 4	Gigabitethernet0/0 Gigabitethernet0/1 Gigabitethernet0/2	2001:DB80:5::0/64 2001:DB80:6::0/64 2001:DB80:7::0/64	FE80::12 FE80::8 FE80::14
5	Router 5	Gigabitethernet0/0 Gigabitethernet0/1 Gigabitethernet0/2	2001:DB80:6::0/64 2001:DB80:7::0/64 2001:DB80:8::0/64	FE80::1 FE80::2 FE80::3
6	Server	Fastethernet0/0	2001:DB80:3::0/64	FE80::7
7	PC0	Fastethernet0/0	2001:DB80:8::0/64	Null
8	PC3	Fastethernet0/0	2001:DB80:9::0/64	Null

3. RESULTS AND DISCUSSION

Testing on each device is carried out to determine the results of the configuration and the extent of the success of the configuration that has been carried out. This test is carried out by sending traceroute commands on the router and PING packets to each connected device before routing.

3.1 Testing with Traceroute

This EIGRP routing test is carried out for each router. This is done to see the extent of the results of the routing configuration performed. The first test was carried out on router 3 by sending a traceroute command to the destination IP address, namely the server IP address. The results of this test can be seen in Figure 5 below.

Figure 5. Testing with traceroute

The results of this traceroute can be seen that router 3 packets pass through router 0 with IP address 2001:DB8:1::2 with an average of 1 msec. Then the packet passes through router 1 with IP address 2001:DB8:5::2 with an average speed of 1 msec.

3.2 Testing with PING

This test is carried out to see the extent to which the routing configuration can work properly. This test uses the PING command on the router to the server. Testing is carried out on each router. This test can be seen in several figures 6 below.

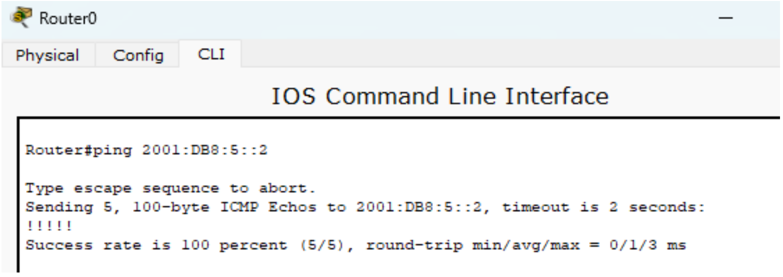

Figure 6. Testing the connection to the server

In the test above, it can be seen that the connection is successful with a success rate of 100 percent (5/5) which indicates there is no packet loss. Then the round-trip min/avg/max = 0/1/3 ms which means the smallest data traffic is 0 ms, the largest is 3 ms and the average is 1 ms.
After testing for each device on the network. The average test results are obtained as described in table 2 below.

Table 2. Test averages

No	Source	Destination	Sending	Byte	Min	Avg	Max	Loss
1	Router 0	2001:DB8:5::2	5	100	0	1	3	0
2	Router 1	2001:DB8:5::2	5	100	0	0	1	0
3	Router 2	2001:DB8:5::2	5	100	0	0	1	0
4	Router 3	2001:DB8:5::2	5	100	0	2	13	0
5	Router 4	2001:DB8:5::2	5	100	0	0	1	0
6	PC 0	2001:DB8:5::2	4	32	0	0	0	0
Average					0	0,5	3,16	0

The test results show that all devices are successfully connected and can communicate with each other well. PING testing from PC to server shows an average latency value of 0.5 ms, which is relatively fast and stable. Traceroute shows that data packets choose the optimal path between routers according to the DUAL algorithm.

In addition, the neighbor table and EIGRP topology show that all routers successfully establish adjacency and exchange routing information effectively. The configuration of important parameters such as router-id, AS number, and EIGRP IPv6 interface proved crucial in successful routing. This implementation shows that EIGRP can be an efficient solution in managing IPv6 networks, especially on a WAN scale. From the test results, it can be concluded that the application of EIGRP routing in this network scheme works well. Namely in the min/avg/max test results with a value of 0/0.5/3.16 ms.

4. CONCLUSION

After testing the network that has been designed, there are several results that the author found during the test. These results are presented in the following conclusions and suggestions. The connection for each computer device is well connected, this can be seen from testing using tracert and PING packages that have been carried out. Testing on server devices for each router and PC averages min/avg/max with a value of 0/0.5/3.16 ms. This indicates that EIGRP routing with IP version 6 is capable of sending well and is relatively fast. The connection on the router is tested using several commands, namely traceroute which functions to see which path the data packet sent by the router to the server is traveling.

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