

Enhanced interior gateway routing protocol (EIGRP) website based on cisco router 2811 using application programming interface (API) from cisco

Sudaryanto Sudaryanto¹, Anggraini Kusumaningrum^{2*}, Yuliani Indrianingsih³, Dadan Rachman Prabowo⁴

^{1,2,3} Informatic Study Program, Adisutjipto Institut of Aerospace Technology, Indonesia

⁴ Informatic Study Program, Adisutjipto College of Technology, Indonesia

Article Info

Article history:

Received May 27, 2021

Accepted October 19, 2021

Published November 30, 2021

Kata Kunci:

EIGRP

API Cisco

Telnet

Cisco Router 2811

ABSTRAK

Enhanced Interior Gateway Routing Protocol (EIGRP) is a routing protocol that can be used to determine the path of data to be sent. EIGRP can achieve goals and study interconnected networks to obtain useful information in order to determine the best path. EIGRP is only adopted by Cisco routers or can be called a Cisco Proprietary Protocol, which can only be used on Cisco router devices. Currently, the EIGRP routing configuration uses the command line. For this reason, a website-based EIGRP system was created and can be accessed remotely with the aim of providing freedom of access and not focusing on one device. Website-based EIGRP system was created by utilizing Cisco's API as a liaison between the programming language and Cisco Router 2811 software. Telnet utilization plays an important role in creating a website-based EIGRP system where Telnet can provide wider access in management. By visiting the host and port of the router, the EIGRP Website Based System can easily do the program. The results of the test in this study indicate that the Website-based EIGRP system is proven to be able to configure, so that administrators can use it for device management of Cisco Router 2811.

Corresponding Author:

Anggraini Kusumaningrum,
Informatics Study Program,
Adisutjipto Institut of Aerospace Technology,
block R Adisutjipto Airbase Yogyakarta 55198, Indonesia.
Email: *anggraini@itda.ac.id

1. INTRODUCTION

One part of the computer networks that is needed to exchange data is a routing protocol [1]. The routing protocol will determine the data path on the router that is sent to reach its destination and learn the interconnected networks in order to obtain information. Enhanced Interior Gateway Routing Protocol (EIGRP) is a routing protocol that can be used to overcome this problem. EIGRP uses the Diffusing Update Algorithm (DUAL) to determine the best path. DUAL has functions to perform calculations and build routing tables as well as to ascertain network paths and provide a loopless routing environment in order to assist in sending packets [2]. Damaged or corrupted packets can cause incorrect information on the router so that information route can be lost and the loopless routing will occur. In addition, sometimes the router will send the packet back so that the router will get the correct information and the route will return to normal.

In a study entitled [3] conducted an EIGRP routing performance analysis to determine the best path and ability to transmit data, EIGRP has a system of routing protocols that is used to calculate and construct a routing table and to ensure network paths that provides a loopless routing environment to help in delivering a packet across the network. Loopless routing can occur when updating information about the loss of a route; since it cannot be accepted by all routers on the network. Thus the router that receives the update will assume that there is a problem with the network. When the origin router (sender) does not receive a packet from a neighbor within a certain period of time, the origin router (sender) will send again the update

packet. The result of these parameters is the EIGRP protocol has the ability to transmit data of 1.14 Mbps with a delay (responsetime) of 1 s.

In a study entitled [4] dynamic routing is a process that has and creates routing tables automatically by listening to network traffic and also by connecting to other routers. In simulation research using the EIGRP protocol with IPv4 implementation in star and ring topologies, the parameters to be tested are throughput and delay. In addition, this research also provides network authentication with a radius server using zeroshell. From the test results, the throughput and delay values are in a good category that have met the ITU-T standard and zeroshell can run well with the EIGRP protocol.

In previous studies, no one has conducted research for EIGRP routing management and monitoring, so this research has a goal at administrators, and can be used for: creating a website-based user interface management and monitoring EIGRP routing protocol.

2. RESEARCH METHOD

EIGRP is a protocol that is included in the Interior Gateway Protocol, but it uses an Autonomous System. On a large internet network, the network will be divided into small networks called autonomous systems, each autonomous system manages its own area, then the router inside an autonomous system is called the Interior Gateway Protocol (IGP). Cisco introduced EIGRP in another term called the Balanced Hybrid Routing Protocol because the EIGRP protocol uses the features of the distance vector protocol and link-state protocol. EIGRP uses bandwidth and delay-based formulas that are useful for calculating metrics that match the routes traversed. This formula is almost the same as that is used by IGRP but the number is multiplied by 256 which is to accommodate calculations when the value of the bandwidth used is high. EIGRP converges rapidly to avoid loops. The convergence of EIGRP is faster than the distance vector protocol, it is because EIGRP does not require loop avoidance which causes the convergence of the distance vector protocol to be slow.

Cisco Router 2811 is one of the routers manufactured by Cisco. Currently the EIGRP routing protocol configuration is still based on the Command Line Interface (CLI), so it must require network administrators to fully understand the routing protocol configuration commands. Of course, it is not easy and less effective. Therefore, we need a software based on a Graphical User Interface (GUI) that can configure EIGRP.

2.1. DATA COLLECTION METHOD

The methodology used for data collection in the study is as follows:

- a. Observation
In this method, direct observations were made to the object of research in the laboratory of an agency regarding matters related to the EIGRP routing management protocol.
- b. Interview
The interview was conducted by collecting data through direct interview with laboratory administrators (network administrators) and interview with lecturers who are competent in their fields.
- c. Study of literature
In this method, it aims to collect relevant theories in the problem being researched by reading books and journals related to the problem.

2.2. SYSTEM DESIGN

The Web-based EIGRP on the Cisco Router 2811 that will be built requires design in advance through several stages of the Unified Modeling Language (UML) which consists of use case diagrams and activity diagrams.

- a. Use Case Diagram
Use Case Diagrams are used to briefly describe who can use the system and what can be done on the system.

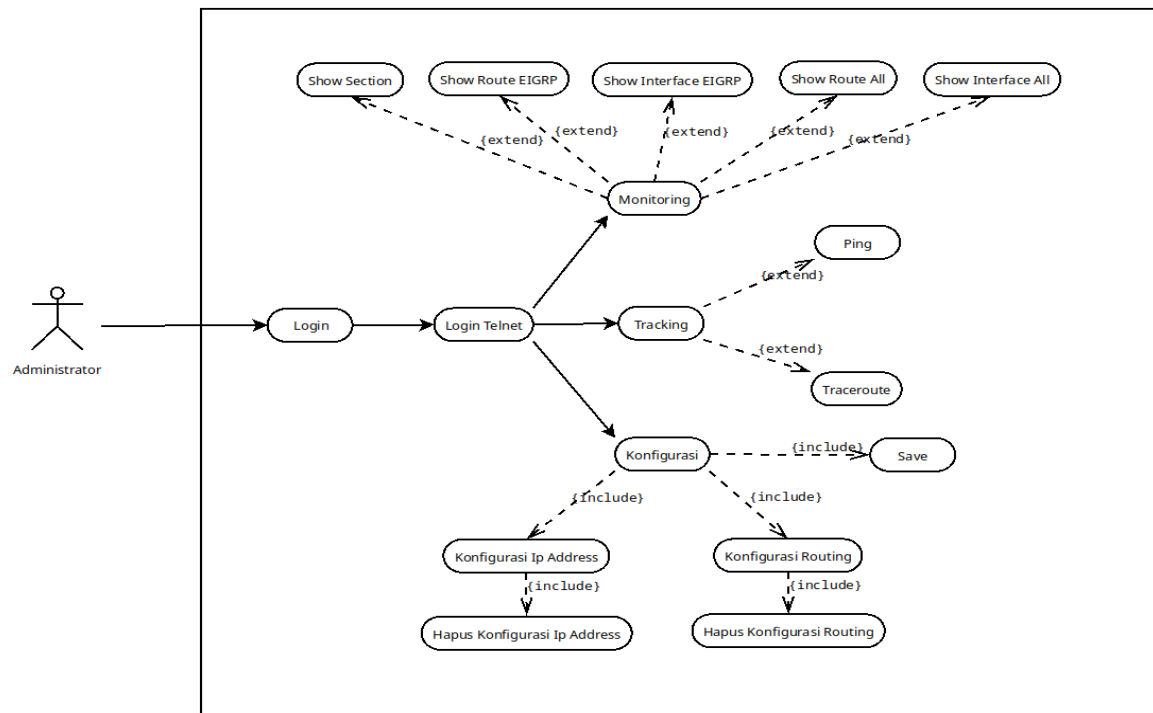


Figure 1 EIGRP Web-based Use Case Diagram

- b. Activity Diagram illustrates a series of flow in any activities that can be performed by system users or administrators.

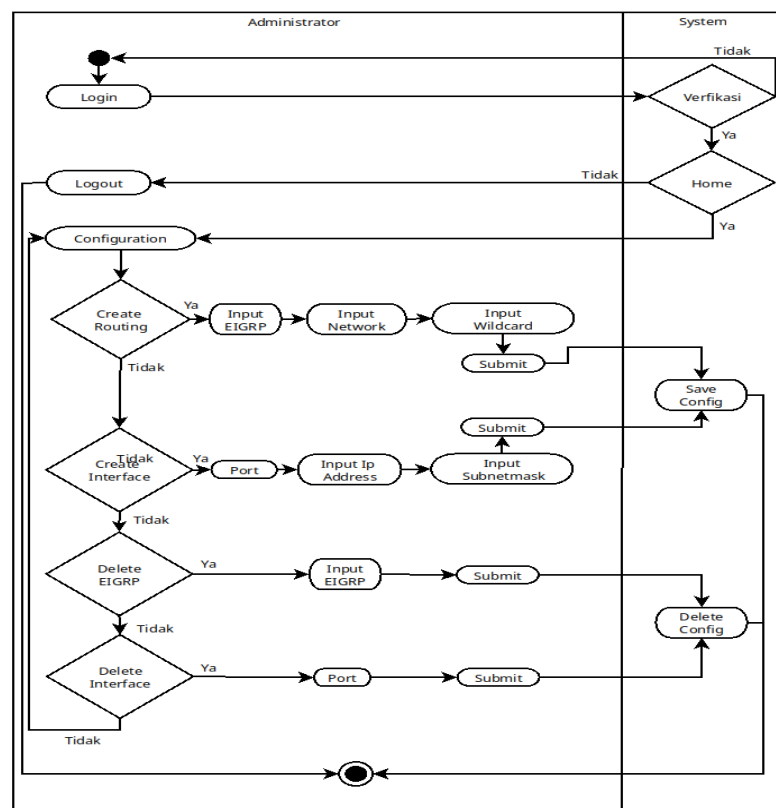


Figure 2 EIGRP Web-Based System Configuration Activity Diagram

3. RESULT AND DISCUSSION

Testing was done by means of a ping test on each computer to find out the reply of each condition. The test was carried out at the Adisutjipto Institute of Aerospace Technology Network Laboratory and used a Bus topology.

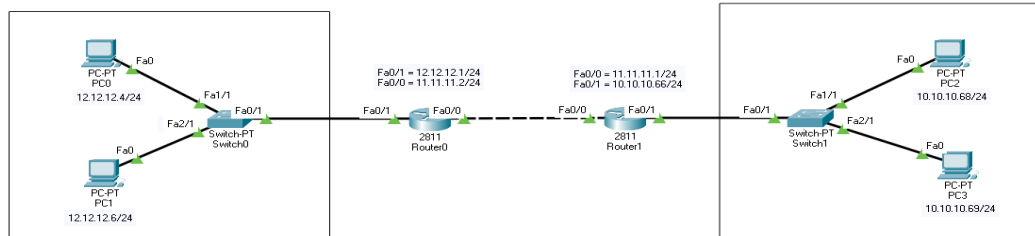


Figure 3 Network Testing Topology

3.1. COMPUTER RELATIONSHIP WITHOUT EIGRP ROUTING

In this test, all computers were not using EIGRP routing or before it was configured. The testing process was done by pinging the computer's IP address. Ping test was done using 4 computers and 2 routers.

```
C:\>ping 12.12.12.4

Pinging 12.12.12.4 with 32 bytes of data:

Reply from 10.10.10.66: Destination host unreachable.
Reply from 10.10.10.66: Destination host unreachable.
Reply from 10.10.10.66: Destination host unreachable.
Request timed out.

Ping statistics for 12.12.12.4:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\>ping 12.12.12.6

Pinging 12.12.12.6 with 32 bytes of data:

Reply from 10.10.10.66: Destination host unreachable.
Reply from 10.10.10.66: Destination host unreachable.
Reply from 10.10.10.66: Destination host unreachable.
Reply from 10.10.10.66: Destination host unreachable.

Ping statistics for 12.12.12.6:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\>
```

Figure 4 PC1 Ping Test without EIGRP Routing Configuration on IP 12.12.12.4 and 12.12.12.6

```
C:\>ping 12.12.12.4

Pinging 12.12.12.4 with 32 bytes of data:

Reply from 10.10.10.66: Destination host unreachable.
Reply from 10.10.10.66: Destination host unreachable.
Reply from 10.10.10.66: Destination host unreachable.
Request timed out.

Ping statistics for 12.12.12.4:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\>ping 12.12.12.6

Pinging 12.12.12.6 with 32 bytes of data:

Reply from 10.10.10.66: Destination host unreachable.
Reply from 10.10.10.66: Destination host unreachable.
Reply from 10.10.10.66: Destination host unreachable.
Reply from 10.10.10.66: Destination host unreachable.

Ping statistics for 12.12.12.6:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\>
```

Figure 5 PC2 Ping Test without EIGRP Routing Configuration on IP 12.12.12.4 and 12.12.12.6

```

C:\>ping 10.10.10.68

Pinging 10.10.10.68 with 32 bytes of data:

Reply from 12.12.12.1: Destination host unreachable.
Reply from 12.12.12.1: Destination host unreachable.
Reply from 12.12.12.1: Destination host unreachable.
Reply from 12.12.12.1: Destination host unreachable.

Ping statistics for 10.10.10.68:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\>ping 10.10.10.69

Pinging 10.10.10.69 with 32 bytes of data:

Reply from 12.12.12.1: Destination host unreachable.
Reply from 12.12.12.1: Destination host unreachable.
Reply from 12.12.12.1: Destination host unreachable.
Reply from 12.12.12.1: Destination host unreachable.

Ping statistics for 10.10.10.69:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\>

```

Figure 6 PC3 Ping Test without EIGRP Routing Configuration on IP 10.10.10.68 and 10.10.10.69

```

C:\>ping 10.10.10.68

Pinging 10.10.10.68 with 32 bytes of data:

Reply from 12.12.12.1: Destination host unreachable.
Reply from 12.12.12.1: Destination host unreachable.
Reply from 12.12.12.1: Destination host unreachable.
Reply from 12.12.12.1: Destination host unreachable.

Ping statistics for 10.10.10.68:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\>ping 10.10.10.69

Pinging 10.10.10.69 with 32 bytes of data:

Reply from 12.12.12.1: Destination host unreachable.
Reply from 12.12.12.1: Destination host unreachable.
Reply from 12.12.12.1: Destination host unreachable.
Reply from 12.12.12.1: Destination host unreachable.

Ping statistics for 10.10.10.69:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\>

```

Figure 7 PC4 Ping Test without EIGRP Routing Configuration on IP 10.10.10.68 and 10.10.10.69

From Figure 4 to 7, they show an image that performs a ping test using the command line on windows, which means that PC1 until PC4 are not connected.

Table 1 Computer Connection Without EIGRP Routing

	IP COMPUTER	DESTINATION	RESULT
PC 1	10.10.10.68	12.12.12.4	NOT CONNECTED
PC 2	10.10.10.69	12.12.12.6	NOT CONNECTED
PC 3	12.12.12.4	10.10.10.68	NOT CONNECTED
PC 4	12.12.12.6	10.10.10.69	NOT CONNECTED

3.2. COMPUTER RELATIONSHIP WITH EIGRP ROUTING

At this stage, EIGRP routing was created or configured on a Cisco 2811 Router device. The testing process was carried out by pinging the computer's IP address. Ping test was done using 4 computers and 2 routers.

```
C:\>ping 12.12.12.4

Pinging 12.12.12.4 with 32 bytes of data:

Reply from 12.12.12.4: bytes=32 time<1ms TTL=126
Reply from 12.12.12.4: bytes=32 time=10ms TTL=126
Reply from 12.12.12.4: bytes=32 time<1ms TTL=126
Reply from 12.12.12.4: bytes=32 time=1ms TTL=126

Ping statistics for 12.12.12.4:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 10ms, Average = 2ms

C:\>ping 12.12.12.6

Pinging 12.12.12.6 with 32 bytes of data:

Reply from 12.12.12.6: bytes=32 time=30ms TTL=126
Reply from 12.12.12.6: bytes=32 time<1ms TTL=126
Reply from 12.12.12.6: bytes=32 time=11ms TTL=126
Reply from 12.12.12.6: bytes=32 time=22ms TTL=126

Ping statistics for 12.12.12.6:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 30ms, Average = 15ms

C:\>
```

Figure 8 PC1 Ping Test with EIGRP Routing Configuration on IP 12.12.12.4 and 12.12.12.6

```
C:\>ping 12.12.12.4

Pinging 12.12.12.4 with 32 bytes of data:

Reply from 12.12.12.4: bytes=32 time<1ms TTL=126
Reply from 12.12.12.4: bytes=32 time=10ms TTL=126
Reply from 12.12.12.4: bytes=32 time<1ms TTL=126
Reply from 12.12.12.4: bytes=32 time=1ms TTL=126

Ping statistics for 12.12.12.4:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 10ms, Average = 2ms

C:\>ping 12.12.12.6

Pinging 12.12.12.6 with 32 bytes of data:

Reply from 12.12.12.6: bytes=32 time=30ms TTL=126
Reply from 12.12.12.6: bytes=32 time<1ms TTL=126
Reply from 12.12.12.6: bytes=32 time=11ms TTL=126
Reply from 12.12.12.6: bytes=32 time=22ms TTL=126

Ping statistics for 12.12.12.6:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 30ms, Average = 15ms

C:\>
```

Figure 9 PC2 Ping Test with EIGRP Routing Configuration on IP 12.12.12.4 and 12.12.12.6

```
C:\>ping 10.10.10.68

Pinging 10.10.10.68 with 32 bytes of data:

Reply from 10.10.10.68: bytes=32 time=1ms TTL=126
Reply from 10.10.10.68: bytes=32 time=17ms TTL=126
Reply from 10.10.10.68: bytes=32 time=12ms TTL=126
Reply from 10.10.10.68: bytes=32 time=36ms TTL=126

Ping statistics for 10.10.10.68:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 1ms, Maximum = 36ms, Average = 16ms

C:\>ping 10.10.10.69

Pinging 10.10.10.69 with 32 bytes of data:

Reply from 10.10.10.69: bytes=32 time=1ms TTL=126
Reply from 10.10.10.69: bytes=32 time=12ms TTL=126
Reply from 10.10.10.69: bytes=32 time<1ms TTL=126
Reply from 10.10.10.69: bytes=32 time<1ms TTL=126

Ping statistics for 10.10.10.69:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 12ms, Average = 3ms

C:\>
```

Figure 10 PC3 Ping Test with EIGRP Routing Configuration on IP 10.10.10.68 and 10.10.10.69

```
C:\>ping 10.10.10.68

Pinging 10.10.10.68 with 32 bytes of data:
Reply from 10.10.10.68: bytes=32 time=1ms TTL=126
Reply from 10.10.10.68: bytes=32 time=17ms TTL=126
Reply from 10.10.10.68: bytes=32 time=12ms TTL=126
Reply from 10.10.10.68: bytes=32 time=36ms TTL=126

Ping statistics for 10.10.10.68:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 1ms, Maximum = 36ms, Average = 16ms

C:\>ping 10.10.10.69

Pinging 10.10.10.69 with 32 bytes of data:
Reply from 10.10.10.69: bytes=32 time=1ms TTL=126
Reply from 10.10.10.69: bytes=32 time=12ms TTL=126
Reply from 10.10.10.69: bytes=32 time<1ms TTL=126
Reply from 10.10.10.69: bytes=32 time<1ms TTL=126

Ping statistics for 10.10.10.69:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 12ms, Average = 3ms

C:\>
```

Figure 11 PC4 Ping Test with EIGRP Routing Configuration on IP 10.10.10.68 and 10.10.10.69

From Figure 8 to 11, they show an image that performs a ping test using the command line on windows which means that PC1 until PC4 can be connected.

Table 2 Computer Connection Using EIGRP

	IP COMPUTER	DESTINATION	RESULT
PC 1	10.10.10.68	12.12.12.4	CONNECTED
PC 2	10.10.10.69	12.12.12.6	CONNECTED
PC 3	12.12.12.4	10.10.10.68	CONNECTED
PC 4	12.12.12.6	10.10.10.69	CONNECTED

3.3. TESTING USING TRACEROUTE

At this stage, testing was carried out using a traceroute to find out which paths the computer traverses. Traceroute was done with computer 1 to computer 4 and vice versa.

```
C:\>tracert 12.12.12.4

Tracing route to 12.12.12.4 over a maximum of 30 hops:

  1  18 ms    0 ms    0 ms    10.10.10.66
  2   0 ms    0 ms    0 ms    11.11.11.2
  3   1 ms    1 ms    0 ms    12.12.12.4

Trace complete.

C:\>
```

```
C:\>tracert 12.12.12.4

Tracing route to 12.12.12.4 over a maximum of 30 hops:

  1  18 ms    0 ms    0 ms    10.10.10.66
  2   0 ms    0 ms    0 ms    11.11.11.2
  3   1 ms    1 ms    0 ms    12.12.12.4

Trace complete.

C:\>
```

Figure 12 Traceroute PC1 With EIGRP Routing Configuration on IP 12.12.12.4


```

C:\>tracert 10.10.10.68

Tracing route to 10.10.10.68 over a maximum of 30 hops:

  1    1 ms    0 ms    0 ms    12.12.12.1
  2    0 ms    0 ms    0 ms    11.11.11.1
  3    1 ms    0 ms    0 ms    10.10.10.68

Trace complete.
C:\>

```

Figure 13 Traceroute PC2 With EIGRP Routing Configuration on IP 10.10.10.68

Figure 12 and Figure 13 show the path that is passed by the connected PC after EIGRP routing the result is that PC 1 and PC 2 pass through the route or router that has been configured with EIGRP routing And the following routing table that has been configured on the router is shown in Figure 14 and Figure 15.

```

Router#sh ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

D    10.0.0.0/8 [90/30720] via 11.11.11.1, 00:01:50, FastEthernet0/0
D    11.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
D    11.0.0.0/8 is a summary, 00:01:51, Null0
C    11.11.11.0/24 is directly connected, FastEthernet0/0
C    12.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
D    12.0.0.0/8 is a summary, 00:01:51, Null0
C    12.12.12.0/24 is directly connected, FastEthernet0/1

Router#

```

Figure 14 Table Routing Router 1

```

Router#sh ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
D    10.0.0.0/8 is a summary, 00:02:46, Null0
C    10.10.10.0/24 is directly connected, FastEthernet0/1
D    11.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
D    11.0.0.0/8 is a summary, 00:02:46, Null0
C    11.11.11.0/24 is directly connected, FastEthernet0/0
D    12.0.0.0/8 [90/30720] via 11.11.11.2, 00:02:45, FastEthernet0/0

Router#

```

Figure 15 Table Routing Router 2

3.4. TESTING THE PROCESS USING THE GUI AND CLI

In this part of the test, the process was carried out using the GUI and CLI. This test showed the results in the form of time which can conclude the effectiveness of the time to configure EIGRP routing on Cisco Router 2811 devices.

Table 3 Testing Process Using GUI and CLI

PROCESS	GUI	CLI	DIFFERENCE
Add Ip Address	1,26 seconds	0,44 seconds	0,82 seconds

Routing Eigrp	1,20 seconds	7,84 seconds	6,64 seconds
Show Section	31,55 seconds	1,20 seconds	30,35 seconds
Show Route Eigrp	1,03 seconds	0,34 seconds	0,69 seconds
Show Interfaces Eigrp	0,87 seconds	0,36 seconds	0,51 seconds
Show Route All	0,90 seconds	0,31 seconds	0,59 seconds
Show Interfaces All	0,72 seconds	0,31 seconds	0,41 seconds
Tracking Ping	0,43 seconds	0,34 seconds	0,09 seconds
Tracking Traceroute	21,78 seconds	20,90 seconds	0,88 seconds
Delete Routing	1,00 seconds	2,34 seconds	1,34 seconds
Delete Interfaces	0,88 seconds	0,59 seconds	0,29 seconds
Save	32,76 seconds	0,72 seconds	32,04 seconds
Average	7,9 seconds	3 seconds	4,9 seconds

Table 3 shows that the best average result is on the CLI with a time of 3 seconds, because the CLI does not show output colors and web design shapes. Therefore, the CLI is faster but it only shows the outputs of text.

3.5. RESEARCH DEVELOPMENT

This research was conducted by developing the results of previous studies which was the research in the field of computer networks about network security using devices from Cisco. Where in configuring and monitoring Cisco devices, users/administrators must do management on a command line. It is because Cisco has not facilitated its users with a user interface-based configuration. In future research, researchers will try to build a web interface that is used for monitoring and management of the Cisco Router 2800.

4. CONCLUSION

Based on the implementation and discussion on "Website-Based Enhanced Interior Gateway Routing Protocol (EIGRP) on a Cisco 2811 Router Utilizing Cisco's Application Programming Interface (Api)," the conclusions are as follows:

1. EIGRP routing can be done web-based using the Cisco API so that there is no need for a command line that requires the ability to control text-based equipment directly.
2. Web-based EIGRP routing for routing management on the Cisco Router 2811 can be done remotely and at short distances using the terms of the availability of an internet network and a Web browser on the device used for access.

REFERENCES

- [1] Santoso, K.A., "Konfigurasi dan Analisis Performansi Routing OSPF Pada Jaringan LAN Dengan Simulator Packet Tracer versi 6.2.," In 2016 Jurnal Kajian Teknik Elektro, Vol. 1, No. 1,
- [2] A. H. Lubis, E. Julita, and M. Zarlis, "Analisis Routing EIGRP dalam Menentukan Router yang dilalui pada WAN," In Jurnal & Penelitian Teknik Informatik, Vol. 1, No. 2, April 2017
- [3] T. D. Purwanto, "Analisis Kinerja Dynamic Routing pada Protokol Routing EIGRP untuk Menentukan Jalur Terbaik dengan diffusing Update Algorithm (DUAL) (Dynamic Routing Performance Analysis on the EIGRP Routing Protokol to Determine the Best Path Using Diffusing Update Algorithm (DUAL)).," In Juita 2018, Vol. VI, No. 2, Nov. 2018
- [4] A. Syukur, and L. Julianti, "SIMULASI PEMANFAATAN DYNAMIC ROUTING PROTOCOL EIGRP PADA ROUTER DI JARINGAN UNIVERSITAS ISLAM RIAU BESERTA AUTENTIKASINYA," In JTIK, Vol. 5, No.1, Maret 2018
- [5] A. Ayuningtyas, Sudaryanto, and D. D. Cessara, "SISTEM MANAJEMEN VIRTUAL LOCAL AREA NETWORK (VLAN) PADA CISCO CATALYST 3750 BERBASIS WEB," In 2020 SIMETRIS, vol. 11, no. 1, April 2020
- [6] Sudaryanto, "The Effect of Multilayer Switch For Speed Data Transfer On Computer Network," In 2018 Compiler STT Adisutjipto Yogyakarta, Vol. 7, No. 2, Nov. 2018.
- [7] Sudaryanto, and D. Nurhayati, "MONITORING INTERFACES FASTETHERNET ON CISCO CATALYST 3750 TO ENSURE USE OF THE SECURITY COMPUTER NETWORK IN STTA COMPUTING LABORATORIES," In 2019 SENATIK, vol. V, Desember 2019
- [8] M. Haqqi, and M. Badrul, "SEGMENTASI JARINGAN DENGAN MENGGUNAKAN VIRTUAL LOCAL AREA NETWORK (STUDY KASUS PT. JALUR NUGRAHA EKAKURIR)," In Jurnal Teknik Komputer AMIK BSI, vol. II, No. 2, Agustus 2016
- [9] K. A. Santoso, "Konfigurasi dan Analisis Performansi Routing OSPF pada Jaringan LAN dengan Simulator Cisco Packet Tracer versi 6.2," In Jurnal Kajian Teknik Elektro, vol. 1, No. 1, November 2016

- [10] Ponidi, and S. Fitrajaya, "PERANCANGAN SISTEM INFORMASI PENDATAAN PENDUDUK BERBASIS WEB MENGGUNAKAN METODE WATERFALL PADA KECAMATAN GADINGREJO," In Jurnal TAM (Technology Acceptance Model), Vol. 4, Juli 2015