Implementation of ISP Network Service Management & Monitoring System

by

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Supervised by
Sabrina Tasnim

Submitted in partial fulfillment of the requirements for the degree of
Bachelor of Science in Computer Science and Engineering



DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
SONARGAON UNIVERSITY (SU)

October 2024

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APPROVAL

The project titled "**Implementation of ISP Network Service Management & Monitoring System**" submitted by Mehedi Hasan (CSE2101022016), Md. Masud Rana (CSE2101022028), Sakil Hossain (CSE2101022026), Md. Anisul Islam khan (CSE2101022013), Md. Imrul Kayes (CSE2101022050) to the Department of Computer Science and Engineering, Sonargaon University (SU), has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of Bachelor of Science in Computer Science and Engineering and approved as to its style and contents.

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DECLARATION

We, hereby, declare that the work presented in this report is the outcome of the investigation performed by us under the supervision of **Sabrina Tasnim,** Assistant Professor, Department of Computer Science and Engineering, Sonargaon University, Dhaka, Bangladesh. We reaffirm that no part of this Project has been or is being submitted elsewhere for the award of any degree or diploma.

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ABSTRACT

This project is being implemented on a virtual platform to gain practical knowledge and mastering the configuration of how internet service providers operate, deliver services to customers, and the types of devices and protocols used in the process. It also covers aspects of network monitoring and troubleshooting. We are using the EVE (Emulated Virtual Environment) platform for this project. EVE-NG is a well-known virtual emulator for networking practices, supporting multiple vendor devices such as Cisco, Juniper, Mikrotik, and Palo Alto, among others. By utilizing the EVE emulator, we aim to enhance our practical understanding of networking and improve efficiency in real-world scenarios. This hands-on experience will build confidence in applying acquired knowledge to production networks and provide training opportunities on a variety of vendor devices, including Cisco, Juniper, and Mikrotik.

ACKNOWLEDGEMENT

At the very beginning, we would like to express our deepest gratitude to the Almighty Allah for giving us the ability and the strength to finish the task successfully within the schedule time.

We would then like to thank our supervisor, **Sabrina Tasnim** for introducing us to the amazingly interesting world of provide networking knowledge. And she is the person who taught us how to perform project work efficiently. Without she and her continuous supervision, guidance and valuable advice, it would have been impossible for us to come at this point and have some output from the project. We are especially grateful to Ma'am for allowing us greater freedom in choosing the problems to work on, for his encouragement at times of disappointment.

We would like to convey our gratitude to **Brig. Gen. (Retd) Prof. Habibur Rahman Kamal**, (Dean, Faculty of Science & Engineering) and special gratitude our honorable departmental head **Prof**. **Bulbul Ahamed**, (Head, Department of Computer Science and Engineering) for their kind concern, discretion, friendly behavior and precious suggestions.

We would like to express our gratitude to all our teachers. Their motivation and encouragement in addition to the education they provided meant a lot to us.

Last but not the least, we would like to thank our family, our parents, for their encouragement, endless love and for supporting us spiritually throughout our lives.

LIST OF ABBREVIATIONS

ARP	Address Resolution Protocol
ASN	Autonomous System Number
BDIX	Bangladesh Internet Exchange
BGP	Border Gateway Protocol
CLI	Command Line Interface
DHCP	Dynamic Host Control protocol
DNS	Domain Name System
EBGP	External Border Gateway Protocol
EVE-NG	Emulated Virtual Environment Next Generation
FNA	Facebook Network Appliance
GGC	Google Global Cash
IBGP	Internal Border Gateway Protocol
IX	Internet Exchange
NAT	Network Address Translator
PING	Packet Internet Groper
PPPOE	Point to Point Protocol Over Ethernet
SNMP	Simple Network Management Protocol
SSH	Secure Shell
TELNET	Teletype Network

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Internet Service Provider (ISP) is a company or organization that offers services to access and use the internet. ISPs typically provide various levels of internet connectivity through different technologies such as fiber optics, broadband (DSL or cable), satellite, or wireless connections. They provide to both residential and business customers by offering a range of services.

Key Functions of an ISP:

Internet Access: ISPs offer different types of internet connections (fiber, DSL, cable, etc.) based on availability and customer needs.

Routing and Data Transfer: ISPs manage the routing of data packets across the internet, ensuring data flows between customers and websites or other internet users.

Customer Support: ISPs offer technical support for any issues related to connectivity or service.

1.2 Project Description:

We have done all the functionality in providing internet services through a virtual platform. And to do this we used 3 types of vendor devices like: Cisco, Juniper, Mikrotik routers. I have clearly highlighted the issue of how networking is done from receiving internet service from an upstream to reaching the end customer.

1.3 Project Tolls

- Virtual machine
- EVE-NG
- Cisco L3 Switch
- Juni per OS (Vmx series)
- Mikrotik OS v7.5 and v6.4
- Ethernet cable
- Putty, wireshark
- WinBox 3.41

1.4 Project Objects

We will use the EVE (Emulated Virtual Environment) platform to create the project. EVE-NG is a popular Virtual Emulator for networking practice. EVE-NG supports multiple vendor devices like: CISCO, Juniper, Mikrotik, palo alto etc. For gaining practical knowledge we select EVE emulator which is very helpful for increasing our network efficiency. Gaining practical knowledge and mastering the configuration of how internet service providers are performing their tasks and providing internet services at the customer level and what kind of devices are being used in providing internet services, what kind of protocols are being used, how are internet service monitoring etc. Gaining practical knowledge in networking and building self-confidence in applying the acquired knowledge to production networks. Will be able to train yourself including Cisco, Juniper, Mikrotik and also a lot of other vendor devices.

CHAPTER 2

SYSTEM OVERVIEW

2.1 Background System & Virtualization

We install EVE-NG on a type 2 virtualization server. At first, we install VMware workstation on windows server and then install EVE-NG on the Virtualization (VMware workstation). We can clearly understand the concept of EVE-NG virtualization with an example.

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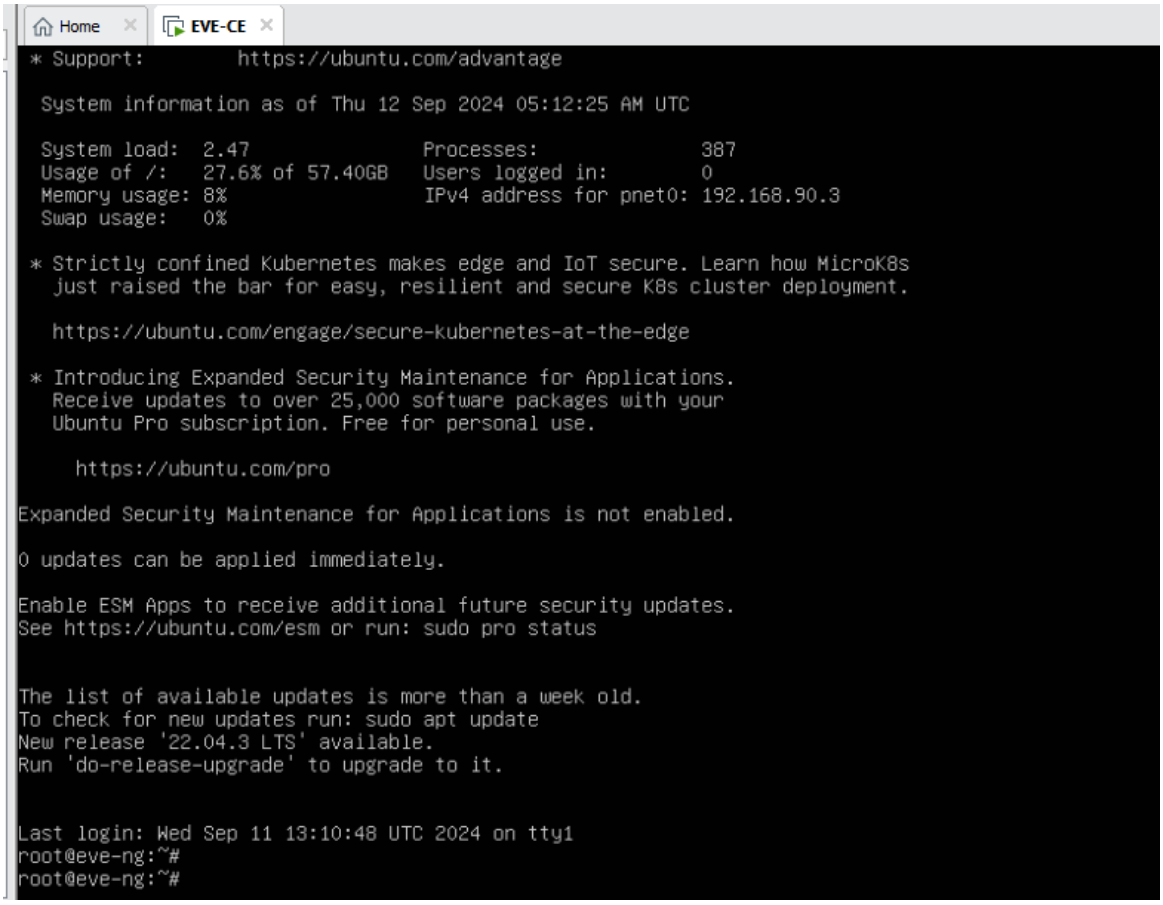


Fig 2.1: EVE-NG Machine on VMware workstation

2.2 OS installation and setup

We install all device OS on EVE-NG virtual machine using " WinScP " tool. And ensure licensing after the OS installation. We understood the installation process bellow image.

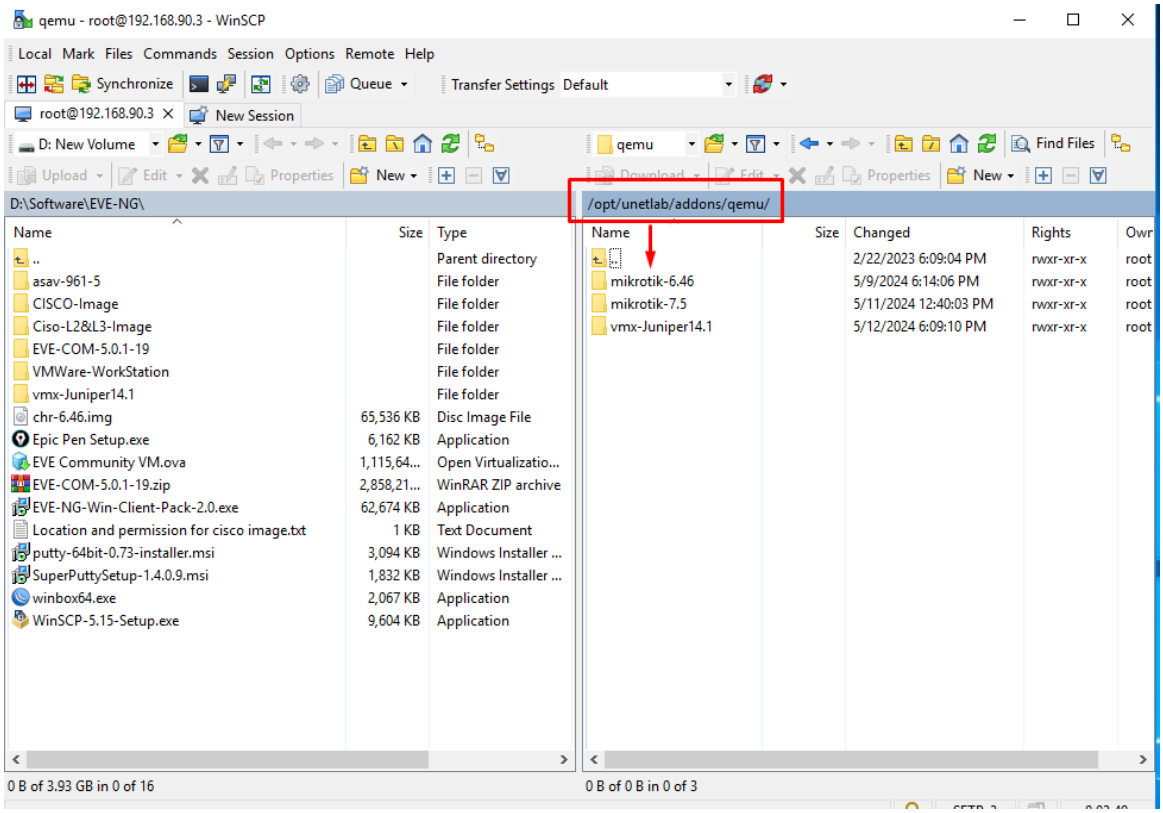


Fig: 2.2: Mikrotik and Juniper OS image

2.3 Cisco L2,L3 & Firewall OS installation process

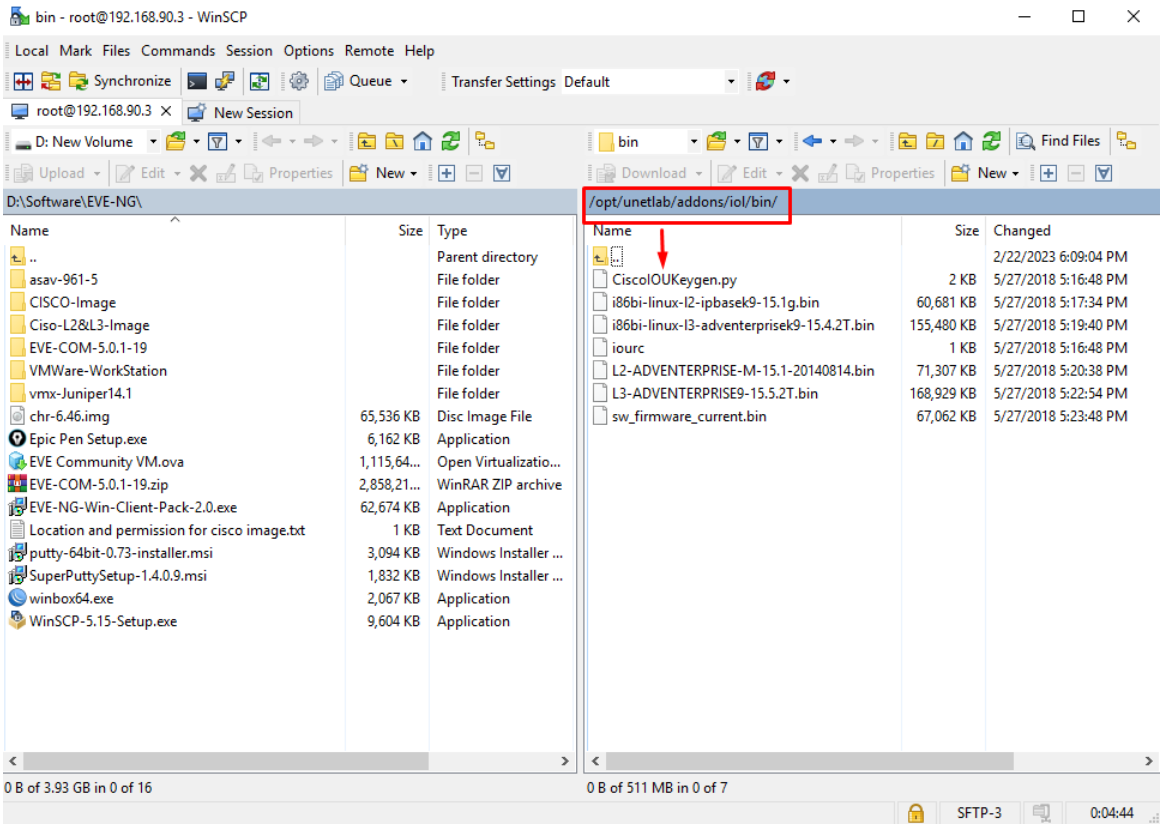


Fig 2.3: Cisco L2,L3 & Firewall OS image

2.4 Licensing and upgradation

This is a very important part of OS installation. After install OS on VM machine then we have to ensure license otherwise OS is not run properly. Below the license command that we run on the eve-ng machine.

opt/unetlab/wrappers/unl_wrapper -a fixpermissions

After each devie os installation we confirm to run license command on env-ng machine.

CHAPTER 3

DEVICE AND ROUTER

3.1Virtual GU mode

We install to this EVE-NG on a type 2 virtualization server. At first, we install VMware workstation on windows server and then install EVE-NG on the Virtualization (VMware workstation). All device like Juniper, Cisco and Mikrotik are installed on EVE-NG VM machine. For the GU mode we able to run each device. We will clearly understand virtual GU mode through the picture.

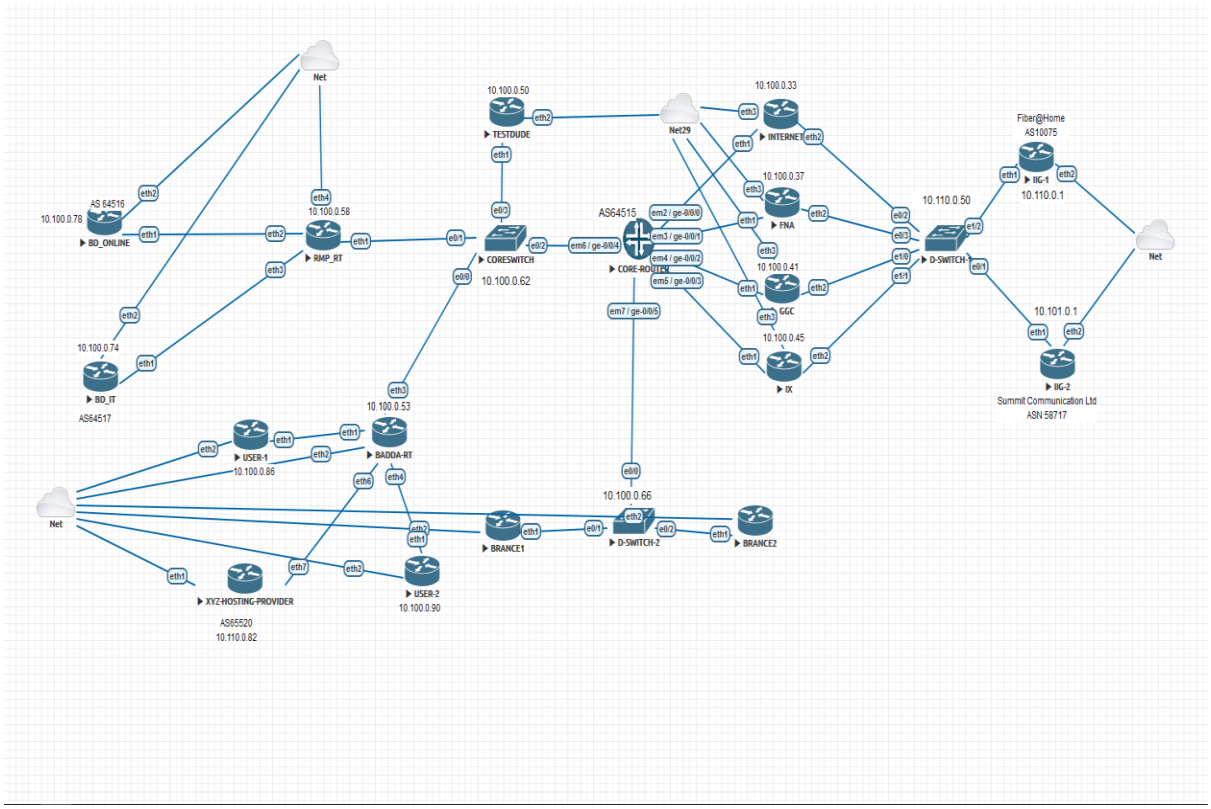


Fig 3.1: EVE-NG GU Mode

3.2 Juniper Router

Juniper routers are known for their high performance, reliability, and scalability, making them popular in both enterprise and service provider networks. They are built on Junos OS, which offers advanced routing features, security, and automation capabilities. Juniper routers are designed to handle high network traffic efficiently, ensuring low latency and fast data processing. We are using vmx OS that is use for virtualization.

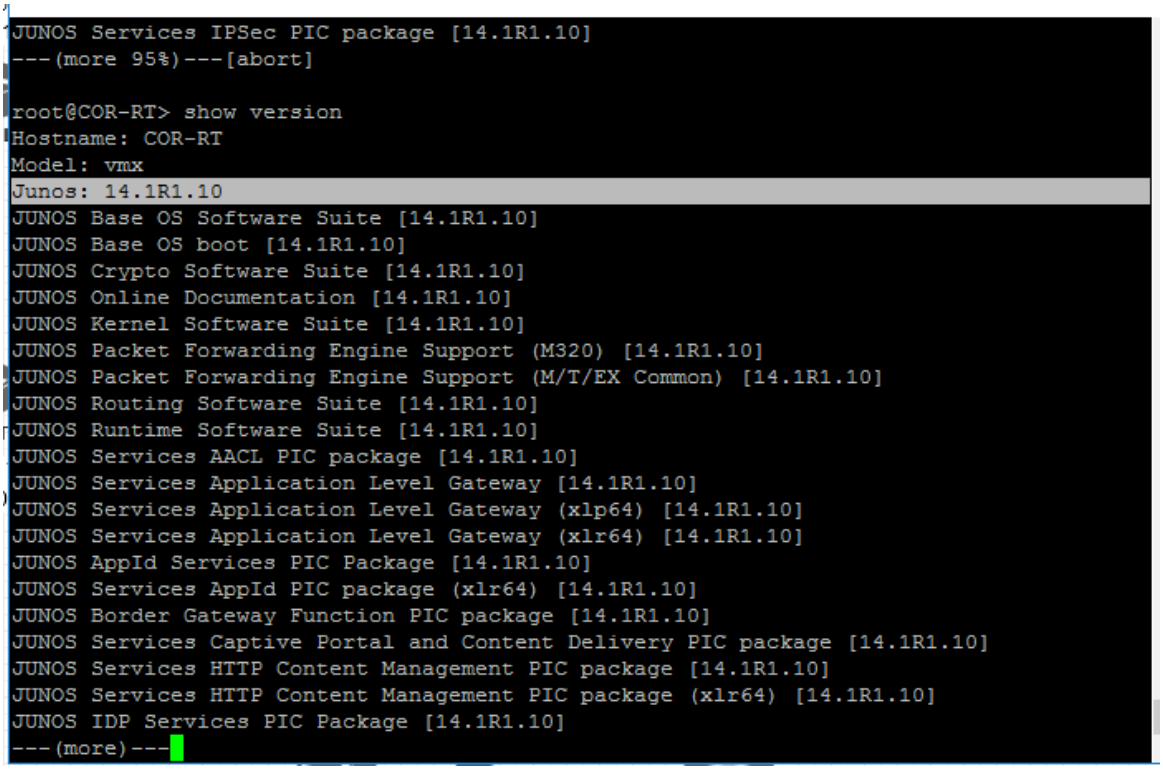


Fig : 3.2: Juniper Router CLI mode

3.3 Cisco Switch

We know the cisco vendor devices like Switch, Router, firewall. In this project we use l2 cisco switch for build Vlan base network.

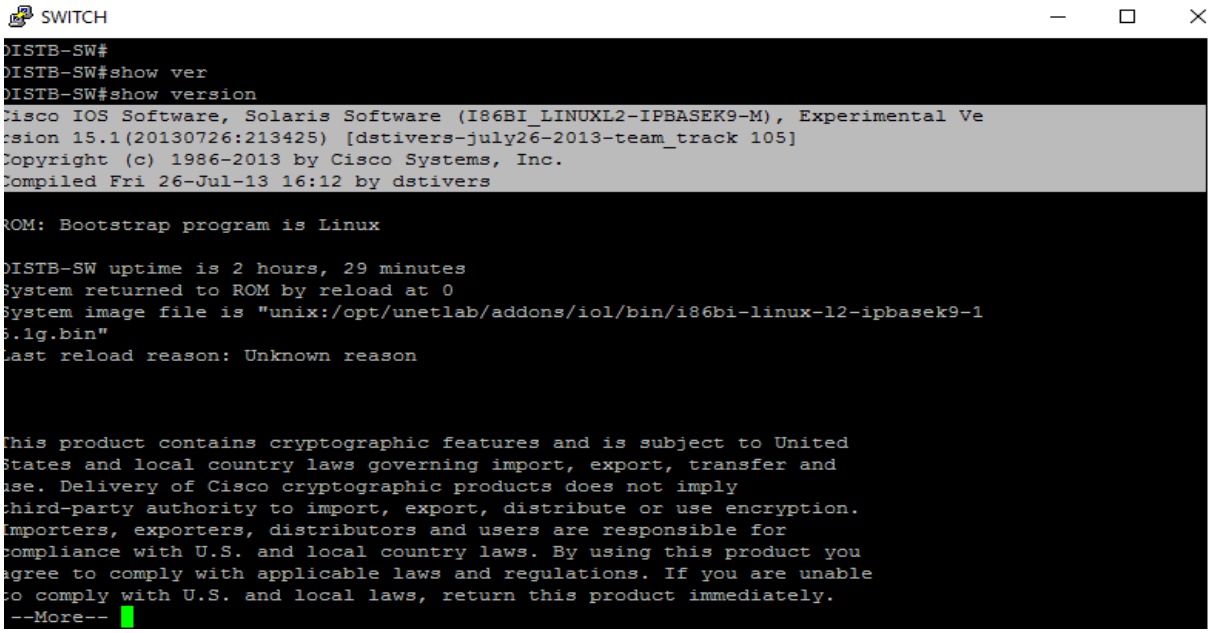


Fig 3.3: Cisco l2 switch CLI mode

3.4 Mikrotik Router OSv7

MikroTik routers are popular for their affordability, flexibility, and powerful features, making them suitable for both small businesses and enterprise-level networks. Powered by Router OS, they support advanced networking functions such as routing, firewall, VPN, bandwidth management, and hotspot functionality. MikroTik devices are known for their ease of configuration, offering a user-friendly interface through Winbox, a graphical configuration tool.



Fig 3.4: Mikrotik Router CLI mode

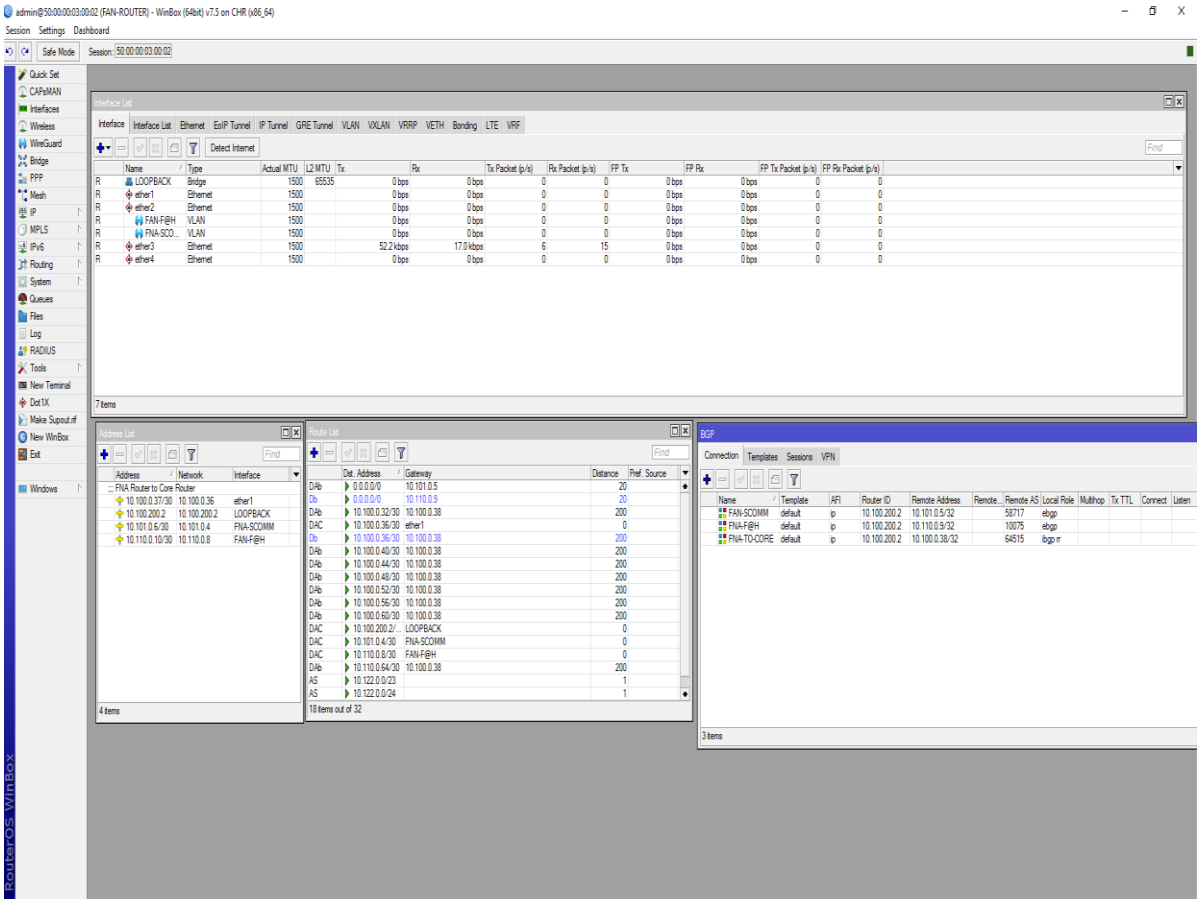


Fig 3.4.1 : Mikrotik Router GUI mode

CHAPTER 4

IP MANAGEMENT, DISTRIBTION & VLAN NETWORK DISTRIBUTION

4.1 What is AS and how it work ?

An Autonomous System (AS) is a group of IP networks run by one or more network operators with a single, clearly defined routing policy.

When exchanging exterior routing information, each AS is identified by a unique number.

There are two main types of Autonomous System Numbers (ASNs):

1.Public ASN

Public ASNs are used for identifying participate in global BGP routing on the public internet.

Range: 16-bit Public ASN: 1 to 64511

2. Private ASN

Private ASNs are used for networks that do not interact with the public internet, such as internal networks or when your network is behind a service provider's public AS.

Range: 64512 to 65534 for 16-bit

4.2 IP subnetting & Vlan network distribution

Here we used 10.110.0.0/22 prefix for IIG (F@H) and subnetting this prefix. At first, we convert 10.110.0.0/22 into /24 prefix.

AS Number : 10075

10.110.0.0/24
10.110.1.0/24
10.110.2.0/24
10.110.3.0/24

And p2p configuration we used /30 subnet within the 10.110.0.0/24 prefix. P2p configuration between upstream router and internet ,GGC,FNA and IX router we used to /30 IP prefix.

Device	P2p IP prefix	Vlan ID
IIG F@H to Internet Router	10.110.0.0/30	100
IIG F@H to GGC Router	10.110.0.4/30	101
IIG F@H to FNA Router	10.110.0.8/30	102
IIG F@H to IX Router	10.110.0.12/30	103

As the same procedure we configured with IIG 2 (Summit Com.) AS Number : 58717

10.101.0.0/24
10.101.1.0/24
10.101.2.0/24
10.101.3.0/24

Device	P2P IP Prefix	Vlan ID
IIG Summit to Internet Router	10.101.0.0/30	200
IIG Summit to GGC Router	10.101.0.4/30	201
IIG Summit to FNA Router	10.101.0.8/30	202
IIG Summit to IX Router	10.101.0.12/30	203

4.3 Core Network IP subnetting and p2p IP prefix distribution

Our AS Number is 64515 and main IP prefix are

10.100.0.0/22

10.120.0.0/22

10.100.200.0/22

AS Number: 64515

Internet, GGC, FNA and IX router to Core Router (Juniper) p2p IP prefix subnetting

Internet Router to Core Router	10.100.0.33/30
GGC Router to Core Router	10.100.0.41/30
FNA Router to Core Router	10.100.0.37/30
IX Router to IX Router	10.100.0.45/30

Now we describe Core Router to distribution router and client router IP subnetting

Router	P2P IP Prefix	VLN id
Core to Dude Server	10.100.0.49/30	10
Core to Badda Router	10.100.0.54/30	11
Core to Rampur Router	10.100.0.57/30	12
Core to distribution switch	10.100.0.61/30	888

Distribution router to Client Router IP subnetting

Device	P2p IP Prefix	VLAN ID
BD IT	10.100.0.73/30	
BD Online	10.100.0.76/30	
XYZ-Hosting provider	10.100.0.82/30	
USER-1	10.100.0.84/30	
USER-2	10.100.0.88/30	
BRANCE-1	192.168.0.1/30	VLAN-30
BRANCH-2	192.168.0.5/30	VLAN-31

CHAPTER 5

INTERNAL AND EXTERNAL ROUTING USING BGP ROUTING PROTOCOL

5.1 What is BGP and how it work?

Border Gateway Protocol (BGP) is a standardized exterior gateway protocol used to exchange routing information between different autonomous systems (AS) on the internet. It is essential for making routing decisions across large networks, such as the global internet.

How BGP Works:

1. **Routing Between AS**: BGP is used to manage how packets are routed between autonomous systems. An AS is a collection of IP networks under the control of a single organization.
2. **Path Vector Protocol**: BGP uses a path vector mechanism, where it advertises the complete path (AS numbers) that data will traverse to reach a destination.
3. **Routing Decisions**: BGP routers decide the best path based on factors like AS path length, policies, and network policies rather than simply choosing the shortest path.
4. **Types of BGP**:
    - **eBGP (External BGP)**: Used to exchange routes between different autonomous systems.
    - **iBGP (Internal BGP)**: Used within a single autonomous system for routing consistency.

BGP provides stability and control in how data is routed across the internet by allowing network operators to enforce policies and manage routes based on business or performance needs

5.2 EBGP Configuration with IIG Router

We configure eBGP with AS64515 and AS10075(IIG F@H) and also configure another IIG AS58717.

eBGP with AS64515 and 10075

[admin@IIG_F@H] > routing/bgp/connection/print

Flags: D - dynamic, X - disabled, I - inactive

0 name="INTERNET_AS64515"

remote.address=10.110.0.2/32 .as=64515

local.address=10.110.0.1 .role=ebgp

routing-table=main router-id=10.110.0.100 templates=default as=10075

nexthop-choice=force-self address-families=ip

output.redistribute=connected,static

.filter-chain=EXPORT-INTERNET-ROUTER

1 name="FNA-AS64515"

remote.address=10.110.0.10/32 .as=64515

local.address=10.110.0.9 .role=ebgp

routing-table=main router-id=10.110.0.100 templates=default as=10075

nexthop-choice=force-self address-families=ip output.redistribute=""

.default-originate=always

2 name="GGC-64515"

remote.address=10.110.0.6/32 .as=64515

local.address=10.110.0.5 .role=ebgp

routing-table=main router-id=10.110.0.100 templates=default as=10075

nexthop-choice=force-self address-families=ip output.redistribute=""

.default-originate=always

eBGP with AS64515 and AS58717

[admin@IIG-2-SCOMM] /routing/bgp/connection> print

Flags: D - dynamic, X - disabled, I - inactive

0 name="INTERNET -AS64515"

remote.address=10.101.0.2/32 .as=64515

local.address=10.101.0.1 .role=ebgp

routing-table=main router-id=10.101.0.100 templates=default as=58717

nexthop-choice=force-self address-families=ip

output.redistribute=static .filter-chain=EXOPORT_INTENET-ROUTER

.default-originate=always

1 name="FNA-AS64515"

remote.address=10.101.0.6/32 .as=64515

local.address=10.101.0.5 .role=ebgp

routing-table=main router-id=10.101.0.100 templates=default as=58717

nexthop-choice=force-self address-families=ip output.redistribute=""

.default-originate=always

2 name="GGC-AS64515"

remote.address=10.101.0.10/32 .as=64515

local.address=10.101.0.9 .role=ebgp

routing-table=main router-id=10.101.0.100 templates=default as=58717

nexthop-choice=force-self address-families=ip output.redistribute=""

.default-originate=always

3 name="IX-AS64515"

remote.address=10.101.0.14/32 .as=64515

local.address=10.101.0.13 .role=ebgp

routing-table=main router-id=10.101.0.100 templates=default as=58717

nexthop-choice=force-self address-families=ip output.redistribute=""

.default-originate=always

5.3 IBGP Configuration with Core and distribution Network

[**admin@INTERNET**] > routing/bgp/connection/print

Flags: D - dynamic, X - disabled, I - inactive

2 name="INTERNET-TO-CORE"

remote.address=10.100.0.34/32 .as=64515

local.address=10.100.0.33 .role=ibgp

routing-table=main router-id=10.100.200.1 templates=default as=64515

nexthop-choice=force-self address-families=ip

output.redistribute=connected,static,bgp .default-originate=always

[**admin@FAN-ROUTER**] > routing/bgp/connection/print

Flags: D - dynamic, X - disabled, I - inactive

2 name="FNA-TO-CORE"

remote.address=10.100.0.38/32 .as=64515

local.address=10.100.0.37 .role=ibgp-rr

routing-table=main router-id=10.100.200.2 templates=default as=64515

nexthop-choice=force-self address-families=ip

output.redistribute=connected,static .default-originate=always

[admin@GGC_ROUTER] > routing/bgp/connection/print

Flags: D - dynamic, X - disabled, I - inactive

2 name="GGC-TO-CORE"

remote.address=10.100.0.42/32 .as=64515

local.address=10.100.0.41 .role=ibgp

routing-table=main router-id=10.100.200.3 templates=default as=64515

nexthop-choice=force-self address-families=ip

[**admin@RMP_RTR**] > routing/bgp/connection/print

Flags: D - dynamic, X - disabled, I - inactive

0 name="CORE-ROUTER"

remote.address=10.100.0.57/32 .as=64515

local.address=10.100.0.58 .role=ibgp-rr

routing-table=main router-id=10.100.200.8 templates=default as=64515

nexthop-choice=propagate address-families=ip

output.redistribute=connected,static,vpn,dhcp,fantasy,modem

[admin@BADDA-RT] > routing/bgp/connection/print

Flags: D - dynamic, X - disabled, I - inactive

0 name="CORE-ROUTER"

remote.address=10.100.0.54/32 .as=64515

local.address=10.100.0.53 .role=ibgp-rr

routing-table=main router-id=10.100.200.7 templates=default as=64515

nexthop-choice=force-self address-families=ip

output.redistribute=connected,static,bgp

5.4 Prefix announcement and filtering

In this step we declare the IP prefix through BGP filtering. Filtering is a process that can filter and allow an IP to advertise to another router or not. Let's see an example:

Core router receive route form Internet Router and internet router gateway is : 10.100.0.33

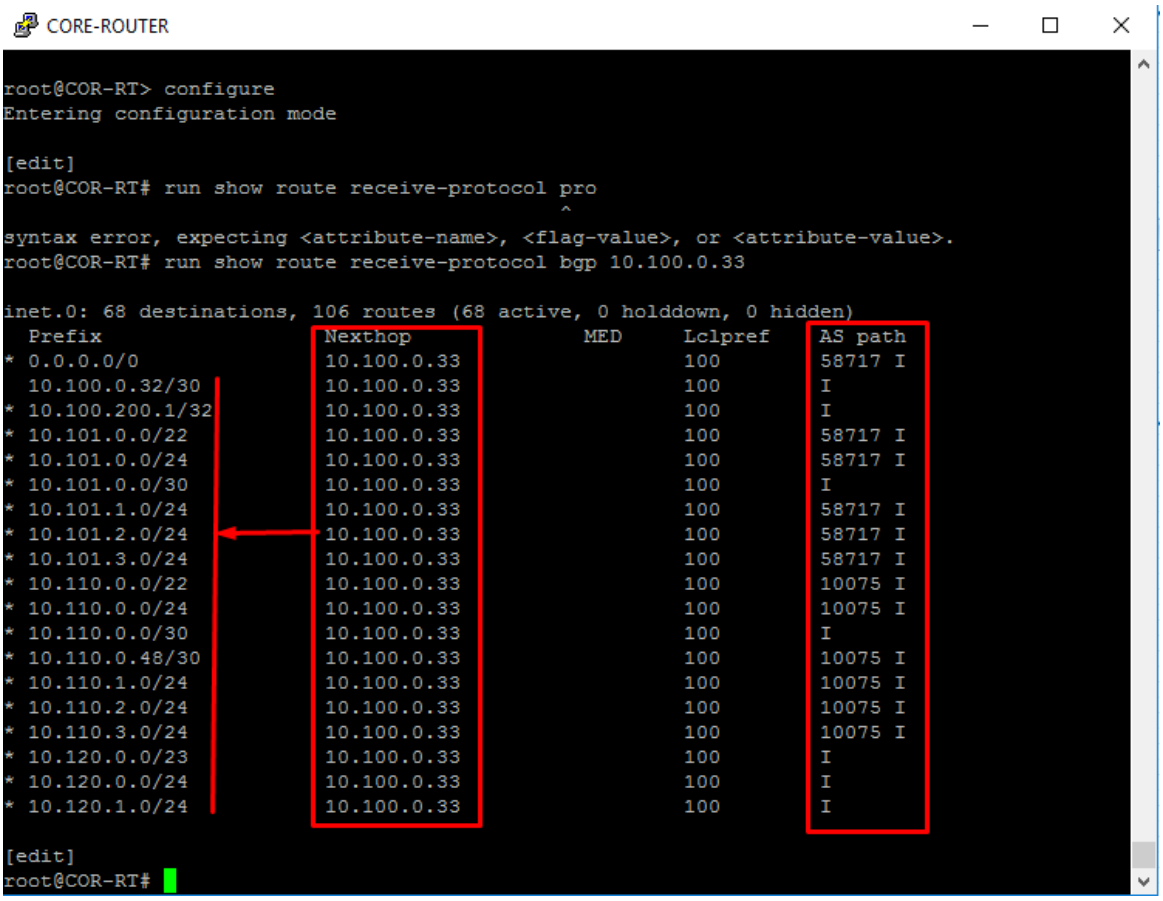


Fig 5.4: Receive route from internet router.

Advertising route from core router to FNA router

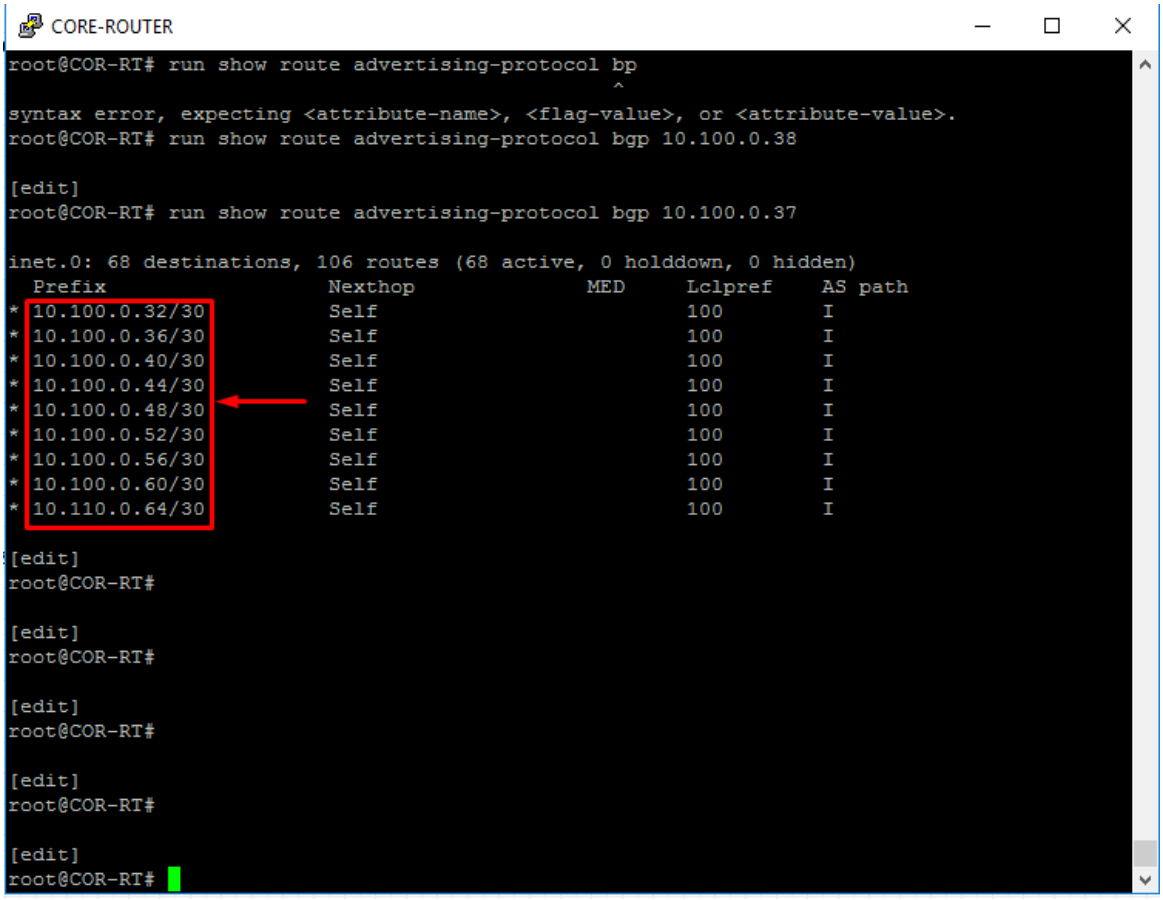


Fig: 5.5 Advertising route from core to FNA router.

Juniper router has a own policy system for prefix advertising and filtering. At 1st create a policy and this created policy apply to that BGP. Then check advertising and receiving route.

Client site advertising prefix filter rule on Mikrotik router.

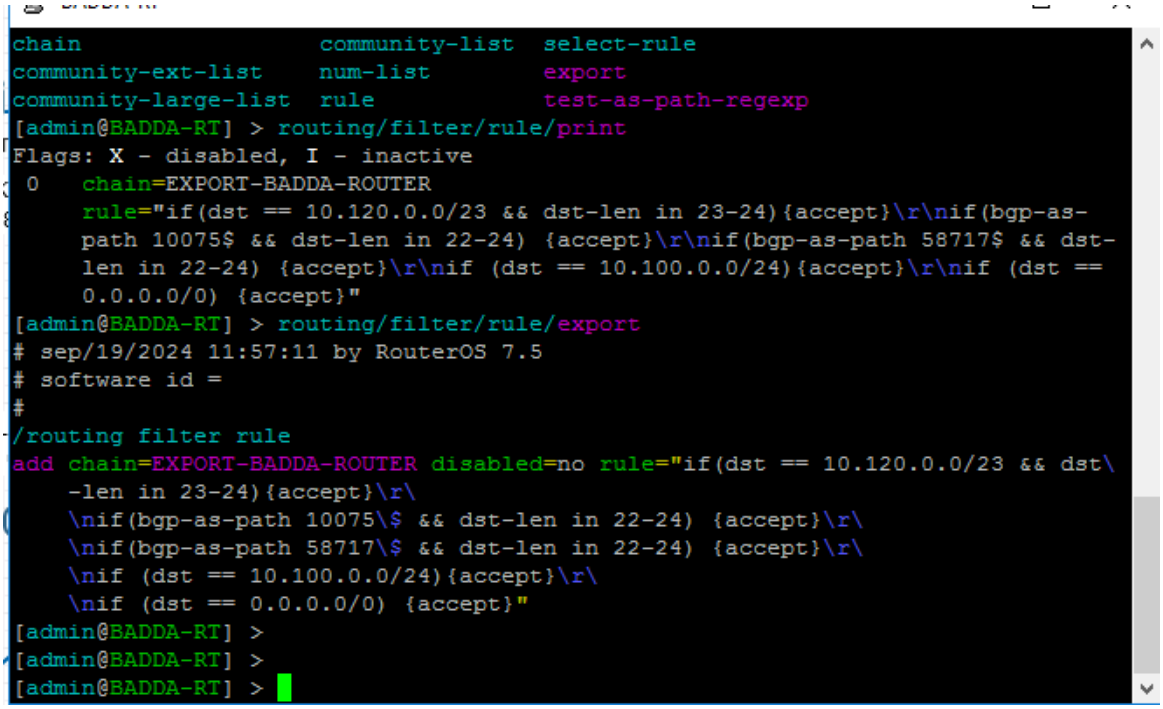


Fig 5.6: filter rule for XYZ-Hosting user.

From above this figure (Fig : 5.6) we see a filter rule and this filter rule applied a router named xyz-corporation. We used BGP AS number and a prefix length in filter rule. According usages requirement this user wants to connect IIG router through internet connectivity. So we create “ if BGP path is 10075 and 58717 and also prefix length is 22-24 then advertise otherwise not ” .

CHAPTER 6

SERVICE DISTRIBUTION

6.1 End user service distribution process.

ISP provider follow 3 type of delivery method to provide internet service. Static/Dynamic/PPOE connectivity.

Static Connectivity: This type connectivity we configure static IP address in both site (user and distribution end) and assigned an amount of bandwidth using queue method. Let's see an Example:

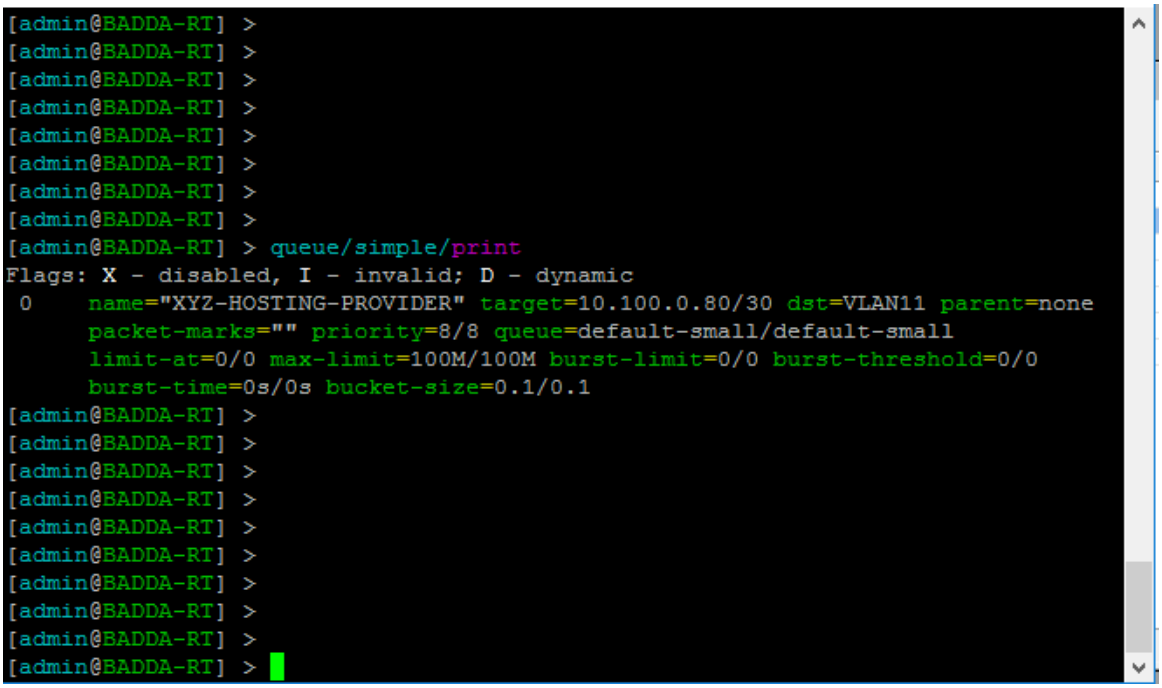


Fig 6.1: Static Queue for 100 Mb/s Bandwidth.

6.2 Dynamic Queue

Dynamic queue policy is widely used in the ISP industry to manage and distribute bandwidth efficiently among multiple users. This policy allows Internet Service Providers to dynamically allocate bandwidth to users based on their requirements, ensuring better management and resource utilization. We can clearly understand the concept of dynamic queue policy with an example.

```
3 * name="synchronous-default" kind=red red-limit=60 red-min-threshold=10
    red-max-threshold=50 red-burst=20 red-avg-packet=1000

4 * name="hotspot-default" kind=sfq sfq-perturb=5 sfq-allot=1514

5   name="20Mb/s_UPLOAD" kind=pcq pcq-rate=20M pcq-limit=50KiB
    pcq-classifier=src-address pcq-total-limit=2000KiB pcq-burst-rate=0
    pcq-burst-threshold=0 pcq-burst-time=10s pcq-src-address-mask=32
    pcq-dst-address-mask=32 pcq-src-address6-mask=128
    pcq-dst-address6-mask=128

6   name="20Mb/s_DOWNLOAD" kind=pcq pcq-rate=20M pcq-limit=50KiB
    pcq-classifier=dst-address pcq-total-limit=2000KiB pcq-burst-rate=0
    pcq-burst-threshold=0 pcq-burst-time=10s pcq-src-address-mask=32
    pcq-dst-address-mask=32 pcq-src-address6-mask=128
    pcq-dst-address6-mask=128

7   name="10Mbs_UPLOAD" kind=pcq pcq-rate=10M pcq-limit=50KiB
    pcq-classifier=src-address pcq-total-limit=2000KiB pcq-burst-rate=0
    pcq-burst-threshold=0 pcq-burst-time=10s pcq-src-address-mask=32
    pcq-dst-address-mask=32 pcq-src-address6-mask=128
    pcq-dst-address6-mask=128

8   name="10Mbs_DOWNLOAD" kind=pcq pcq-rate=10 pcq-limit=50KiB
    pcq-classifier=dst-address pcq-total-limit=2000KiB pcq-burst-rate=0
    pcq-burst-threshold=0 pcq-burst-time=10s pcq-src-address-mask=32
    pcq-dst-address-mask=32 pcq-src-address6-mask=128
    pcq-dst-address6-mask=128

9 * name="pcq-upload-default" kind=pcq pcq-rate=0 pcq-limit=50KiB
    pcq-classifier=src-address pcq-total-limit=2000KiB pcq-burst-rate=0
    pcq-burst-threshold=0 pcq-burst-time=10s pcq-src-address-mask=32
    pcq-dst-address-mask=32 pcq-src-address6-mask=128
    pcq-dst-address6-mask=128

10 * name="pcq-download-default" kind=pcq pcq-rate=0 pcq-limit=50KiB
    pcq-classifier=dst-address pcq-total-limit=2000KiB pcq-burst-rate=0
    pcq-burst-threshold=0 pcq-burst-time=10s pcq-src-address-mask=32
    pcq-dst-address-mask=32 pcq-src-address6-mask=128
    pcq-dst-address6-mask=128

11 * name="only-hardware-queue" kind=none

12 * name="multi-queue-ethernet-default" kind=mq-pfifo mq-pfifo-limit=50

13 * name="default-small" kind=pfifo pfifo-limit=10
```

Fig 6.2: Dynamic Queue.

6.3 Data Connectivity

We provide data server for 2 users. At first, we connect user with core router using static IP protocol. And those IP prefix advertise core end and IIG end.

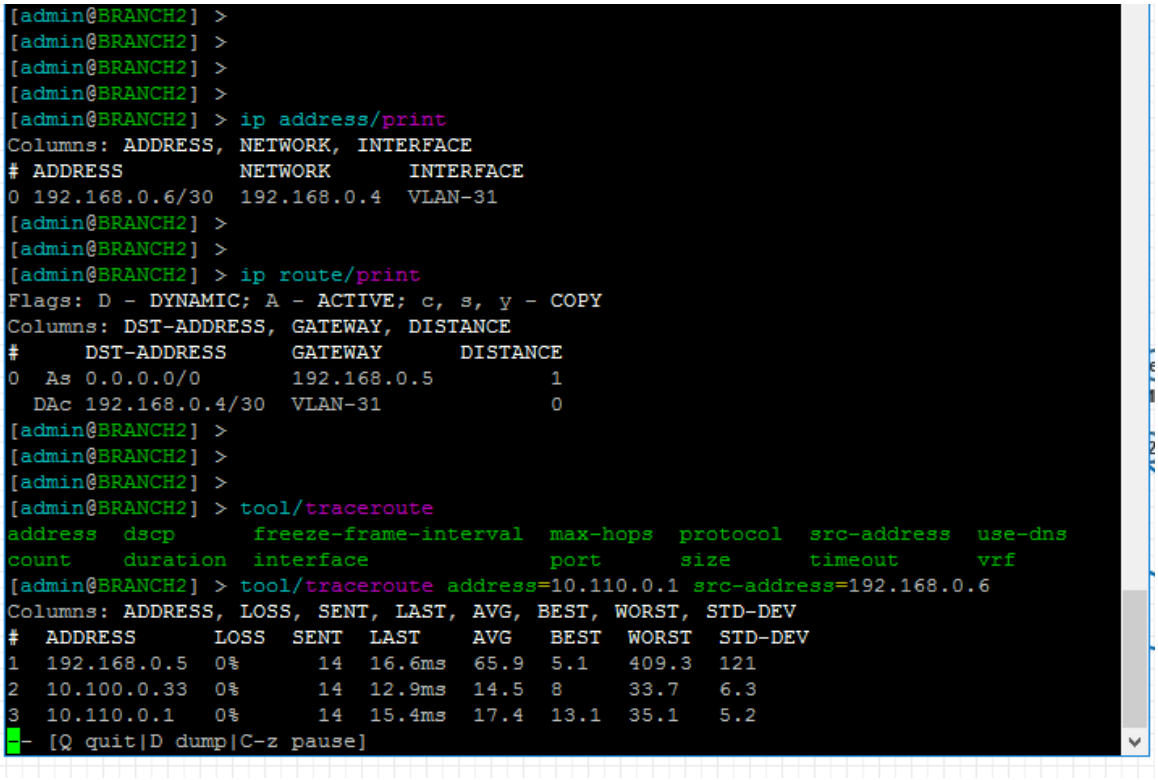


Fig 6.3 : Data Connectivity testing process.

CHAPTER 7

MONITORING SYSTEM

7.1 Dude Installation

Dude is fee application tool by Mikrotik, this tool is very popular to monitoring system.

1st we install a Mikrotik OS and then configure dude as the same version with Mikrotik OS, otherwise it'll not working. Let see the installation procedure.

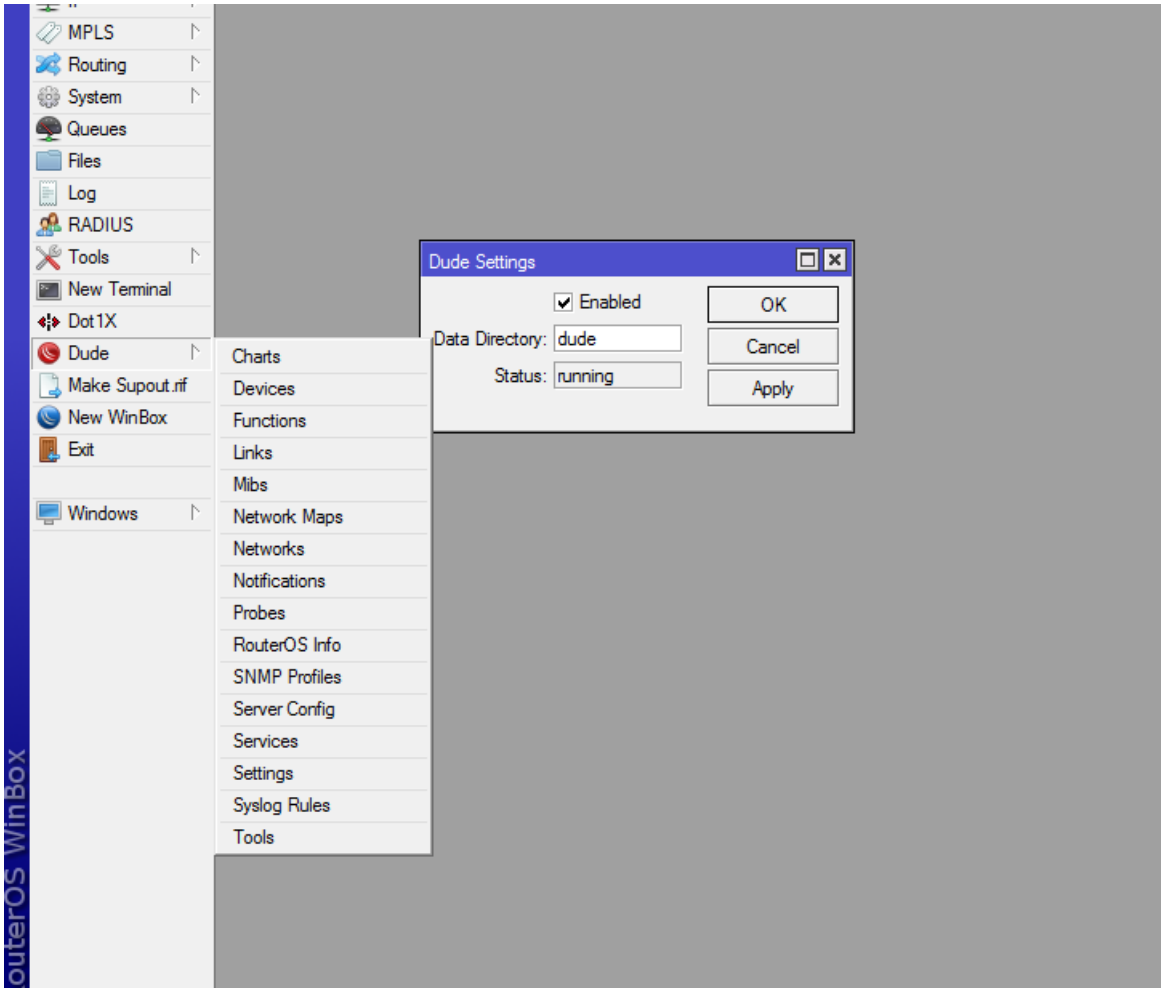


Fig 7.1 : Enable dude settings on Mikrotik Router.

7.2 Dude login panel: For the login you have to enter IP address port number and username and password. Let see the login panel below.

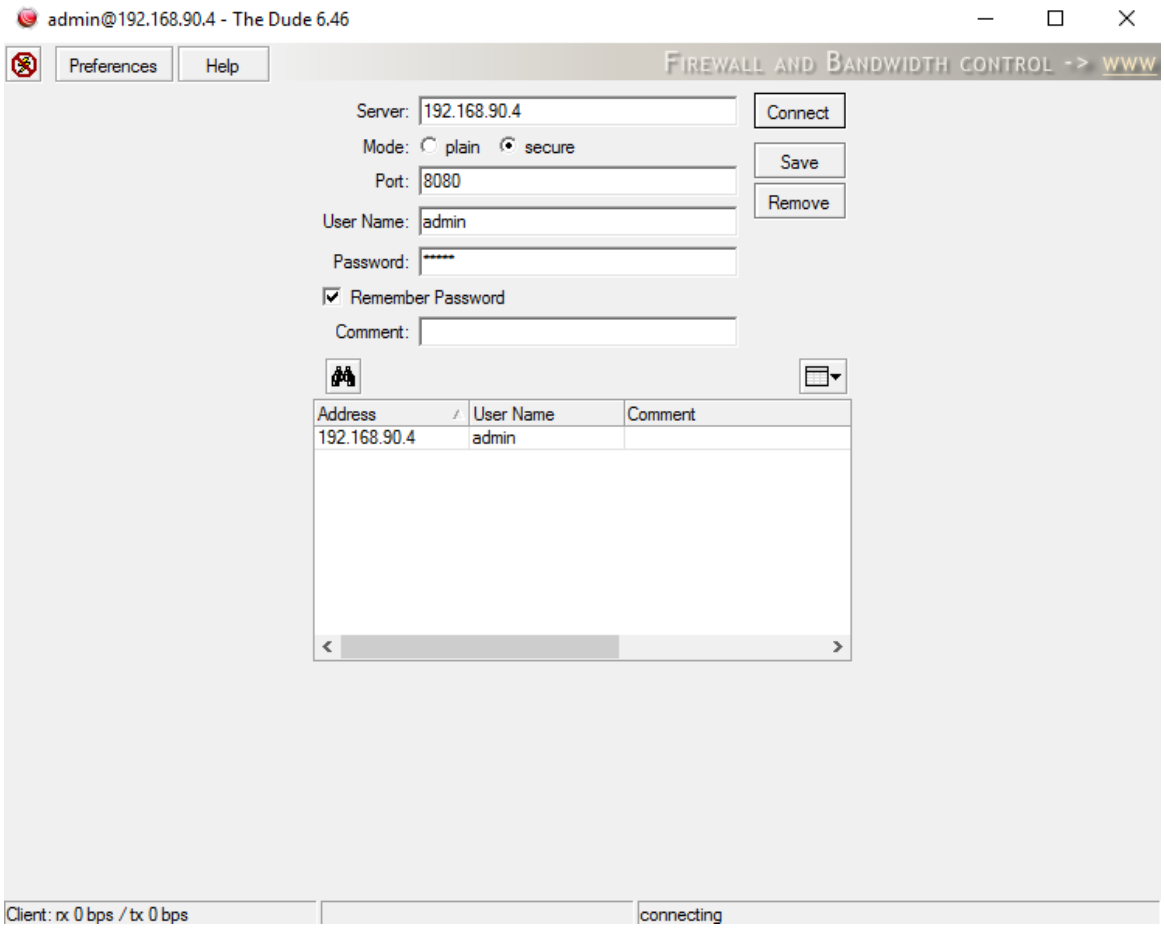


Fig 7.2 : Dude login panel

7.3 Dude server monitoring scenario

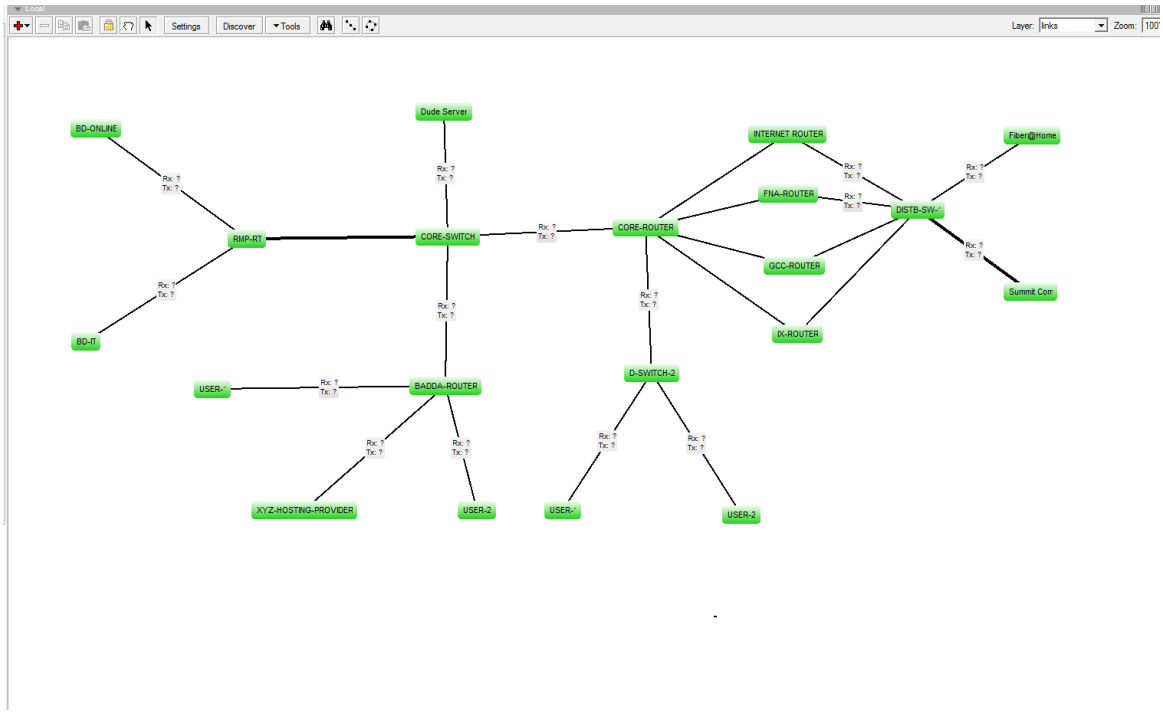


Fig 7.3 : Active device monitoring on dude server.

Now we see a device is red color due to technically down.

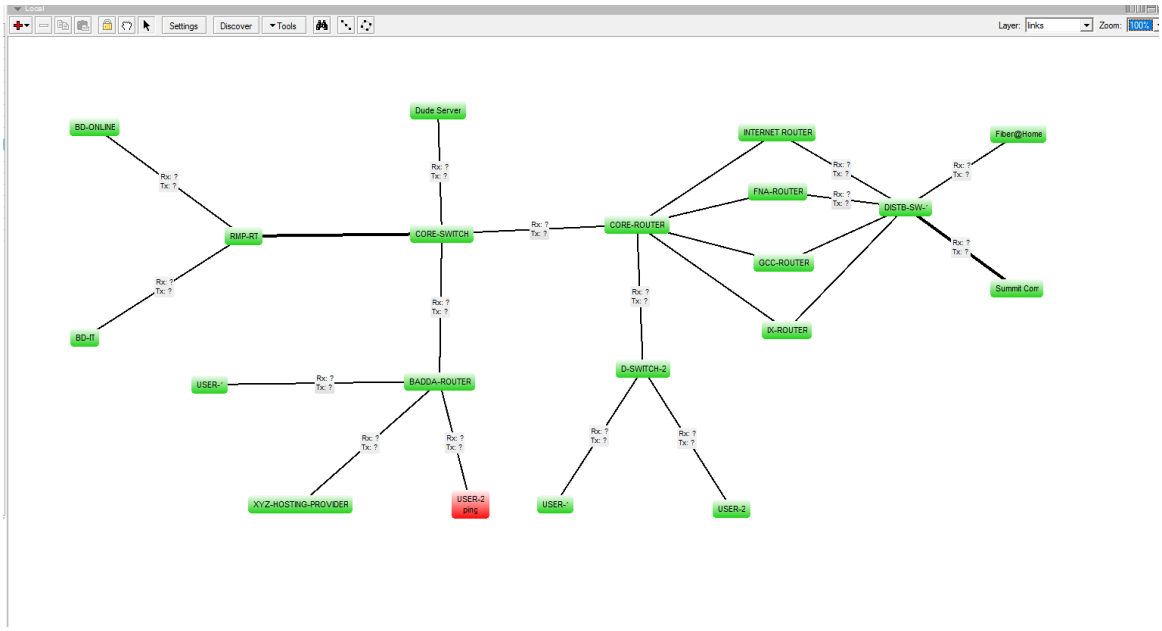


Fig 7.3.1: A device is down on dude

CHAPTER 8

CONCLUSION AND FEATURE WORK

8.1 Conclusion

To learning practical networking, ISP network is the best options. We design a topology based on ISP network and configuring different type of device like Cisco, Juniper and Mikrotik router. And configure BGP protocol for share route one router to another router. At the 1st to last to this project we learn from basic to advance networking method. Gaining practical knowledge in networking and building self-confidence in applying the acquired knowledge to production networks. Will be able to train yourself including Cisco, Juniper, Mikrotik and also a lot of other vendor devices. Ultimately, mastering these tools and technologies prepares us for efficiently managing and troubleshooting complex networks, making it an ideal learning path for aspiring network engineers.

8.2 Feature Plan

In the future, we plan to expand our knowledge by incorporating MPLS (Multiprotocol Label Switching) to improve network traffic management and ensure more efficient data routing within the ISP infrastructure. This will help optimize network performance and reduce delays, offering a better experience for users.

We also aim to implement DWDM (Dense Wavelength Division Multiplexing) and CWDM (Coarse Wavelength Division Multiplexing) technologies to enhance the capacity of our optical network, enabling higher data transmission rates and improving scalability for future growth.

Through these improvements, we aim to build a more secure, efficient, and scalable ISP network

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