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## **NETWORK CONFIGURATION IN CISCO PACKET TRACER**

# **HANDS-ON LAB**

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## Table of Content

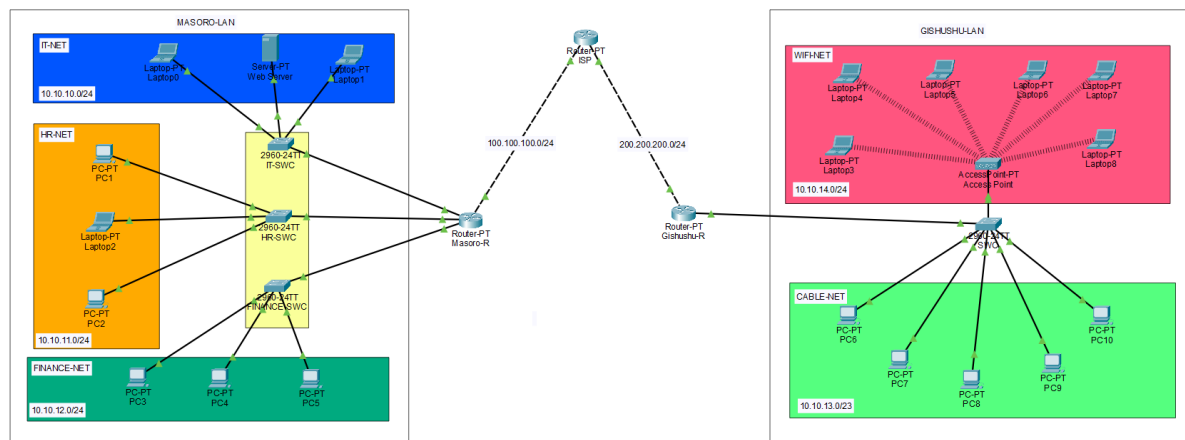
1. Introduction .....	1
2. Network Topology Design .....	1
3. IP Addressing Scheme and DHCP configuration .....	2
4. Routing between both LANs MASORO and GISHUSH.....	4
5. Remote Access Configuration (SSH).....	5
6. NAT (PAT & Static NAT) Configuration.....	5
7. STP/RSTP and Port Security .....	6
8. HTTP Web Server Setup .....	7
9. Mail Server Configuration .....	7
10. Verification and Troubleshooting .....	8
11. Achieved Outcomes .....	10
12. Faced Challenges.....	11
Summary .....	12

## 1. Introduction

The purpose of the activity was to design, configure, and verify a **small-scale network** for two LANs — **Masoro** and **Gishushu** — connected through an **ISP router**, implementing core networking concepts used in real-world environments. The exercise focused on several key networking skills, including:

- **Subnetting and IP addressing:** Assigning unique IP subnets to different departments (IT, HR, Finance, CableNet, and WIFI-NET) and configuring routers and switches accordingly.
- **DHCP configuration:** Automating IP assignment for clients while excluding critical addresses such as the DNS server.
- **Routing:** Enabling communication between subnets using static routing.
- Etc..

## 2. Network Topology Design



**Routers:** Used to make connect network and Acts as DHCP server

**Switch:** Connects multiple end devices

**End Devices (Server, PCs/Laptops):** Clients used in topology

### 3. IP Addressing Scheme and DHCP configuration

**Step 1:** Opened Router in Packet Tracer -> Opened CLI tab

**Step 2:** Enter Configuration global mode

```
29061> enable
29061# configure terminal
```

**Step 3:** Excluded IP address

```
29061(config)# ip dhcp excluded-address 10.10.10.10
```

I only had one Static IP address on server, this command ensures that this IP address exclude from DHCP pool

**Step 4:** Create DHCP Pool

```
29061(config)# ip dhcp pool IT-NET
29061(dhcp-config)# network 10.10.10.0 255.255.255.0
29061(dhcp-config)# default-router 10.10.10.1
29061(dhcp-config)# dns-server 10.10.10.10
```

```
29061> enable
29061# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
29061(config)# ip dhcp excluded-address 10.10.10.10
29061(config)# ip dhcp pool IT-NET
29061(dhcp-config)# network 10.10.10.0 255.255.255.0
29061(dhcp-config)# default-router 10.10.10.1
29061(dhcp-config)# dns-server 10.10.10.10
```

#### Explanation of commands

**enable:** this enable enter EXEC mode.

**configure terminal:** Enter global mode.

**ip dhcp exclude-address 10.10.10.10:** This tells dhcp pool to exclude that ip address.

**ip dhcp pool IT-NET:** This name of subnet you want pool address too.

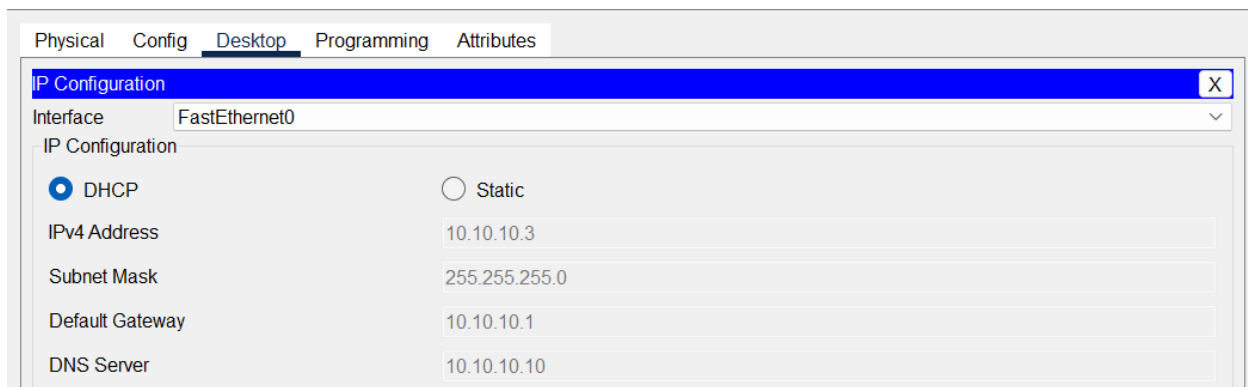
**network:** Shows range of network and specify subnet mask

**default-router:** shows the gateway clients will use

**dns-server:** Sets domain name server

**Step 5: Configure router interface**

```
29061(config)# interface GigabitEthernet8/0
29061(config-if)# ip address 10.10.10.1 255.255.255.0
29061(config-if)# no shutdown
29061(config-if)# exit
```

**On Clients laptops to get IP address Dynamically****Step 1: Open laptop device****Step 2: Navigate to Desktop tab****Step 3: Select IP configuration****Step 4: Select DHCP****Verification by using the command prompt****Step 1: Open laptop device****Step 2: Navigate to Desktop tab****Step 3: Select command prompt****Step 4: type ipconfig or ipconfig /all**

```
Cisco Packet Tracer PC Command Line 1.0
C:\>ipconfig

FastEthernet0 Connection: (default port)

    Connection-specific DNS Suffix...:
    Link-local IPv6 Address . . . . .: FE80::260:70FF:FEDB:B5A2
    IPv6 Address . . . . .: ::
    IPv4 Address . . . . .: 10.10.10.3
    Subnet Mask . . . . .: 255.255.255.0
    Default Gateway . . . . .: ::
                           10.10.10.1

Bluetooth Connection:

    Connection-specific DNS Suffix...:
    Link-local IPv6 Address . . . . .: ::
    IPv6 Address . . . . .: ::
    IPv4 Address . . . . .: 0.0.0.0
    Subnet Mask . . . . .: 0.0.0.0
    Default Gateway . . . . .: ::
                           0.0.0.0
```

#### 4. Routing between both LANs MASORO and GISHUSH

**Step 1:** Gave IP address to all subnets

**Step 2:** Assigned IP address on ISP

- Interface that face to MASORO-LAN

```
29061(config)# interface g9/0
29061(config-if)# ip address 100.100.100.2 255.255.255.0
29061(config-if)# no shutdown
```

- Interface that face to GISHUSHU-LAN

```
29061(config)# interface g8/0
29061(config-if)# ip address 200.200.200.2 255.255.255.0
29061(config-if)# no shutdown
29061(config-if)# exit
```

**Step 3:** Applied IP Route commands on GISHUSH-ROUTER

```
29061(config)# ip route 10.10.10.0 255.255.255.0 200.200.200.2
29061(config)# ip route 10.10.11.0 255.255.255.0 200.200.200.2
29061(config)# ip route 10.10.12.0 255.255.255.0 200.200.200.2
```

**Step 4:** Applied IP Route commands on MASORO-ROUTER

```
29061(config)# ip route 10.10.13.0 255.255.255.0 100.100.100.2
29061(config)# ip route 10.10.14.0 255.255.255.0 100.100.100.2
```

**Step 3:** Applied IP Route commands on ISP-ROUTER

```
29061(config)# ip route 10.10.10.0 255.255.255.0 100.100.100.1
29061(config)# ip route 10.10.11.0 255.255.255.0 100.100.100.1
29061(config)# ip route 10.10.12.0 255.255.255.0 100.100.100.1
29061(config)# ip route 10.10.13.0 255.255.255.0 200.200.200.1
29061(config)# ip route 10.10.14.0 255.255.255.0 200.200.200.1
```

**ip route 10.10.10.0 255.255.255.0 200.200.200.2:** This tells Gishushu router to use 200.200.200.2 port faces to ICP to send traffic to network has this IP 10.10.10.0 in Masoro LAN, and vice versa.

## 5. Remote Access Configuration (SSH)

```
29061-S3(config)# ip domain-name jmutangana.rw
29061-S3(config)# username 29061 secret 29061
29061-S3(config)# crypto key generate rsa
```

```
29061-S3(config)# ip ssh version 2
29061-S3(config)# enable secret 29061
29061-S3(config)# line vty 0 4
29061-S3(config-line)# transport input ssh
29061-S3(config-line)# login local
29061-S3(config-line)# exit
```

### Explanation of used Commands

**ip domain-name jmutangana.rw:** defines the domain name for the router because SSH requires a domain to generate RSA encryption keys.

**Username:** Allows to set name of user who is using the device.

**Secrete:** Allows to set secrete for user when try log in.

**Crypto key generate rsa:** Generates RSA key used for SSH encryption.

**ip ssh version 2:** Enable SSH version 2

**line vty 0 4:** Enters configuration for virtual terminal lines 0 to 4

**transport input ssh:** Restrict remote to SSH only.

**login local:** tells the router/switch to use local username and password

## 6. NAT (PAT & Static NAT) Configuration

### Step 1: Define inside and Outside Interface

```
29061(config)# interface g9/0
29061(config-if)# ip nat outside
29061(config-if)# exit
29061(config)# interface range g8/0 - g6/0
29061(config-if-range)# ip nat inside
29061(config-if-range)# exit
```

**ip nat outside:** Marks the WAN interface as outside

**ip nat inside:** Marks the LAN interfaces as inside for NAT

### Step 2: Create an Access List to define inside Address

```

29061(config)# access-list 11 permit 10.10.10.0 0.0.0.255
29061(config)# access-list 11 permit 10.10.11.0 0.0.0.255
29061(config)# access-list 11 permit 10.10.12.0 0.0.0.255
29061(config)# access-list 11 deny host 10.10.10.10

```

**Access-lists 11 permit 10.10.10.0 0.0.0.255:** Defines which private IPs are allowed to be translated (Masoro's LANs).

**access-lists 11 deny 10.10.10.10 0.0.0.255:** Excludes the server IP from translation

**Step 3:** Apply NAT Overload (PAT)

```

29061(config)# ip nat inside source list 11 interface g9/0 overload

```

**ip nat inside source list 11 interface g9/0 overload:** Tells the router to use the public IP of the outside interface (g9/0) for all internal users

**overload:** Enable PAT (Port Address Translation) many private IPs share one public IP, using different port numbers

## 7. STP/RSTP and Port Security

```

29061-S4(config)# interface range FastEthernet0/2 - 6
29061-S4(config-if-range)# switchport mode access
29061-S4(config-if-range)# switchport access vlan 13
29061-S4(config-if-range)# switchport port-security
29061-S4(config-if-range)# switchport port-security maximum 1
29061-S4(config-if-range)# switchport port-security mac-address sticky
29061-S4(config-if-range)# switchport port-security violation shutdown
29061-S4(config-if-range)# exit

```

### Explanation of used commands

**Interface range FastEthernet0/2 – 6:** This allows to apply configure same configuration on more than one port.

**switchport mode access:** forces port to work as access port.

**switchport access vlan 13:** Assign the port to vlan 13.

**switchport port-security:** Enables port security features on the port.

**switchport port-security maximum 1:** Limits each port to learn only one MAC addresss

**switchport port-security violation shutdown:** If violation occurs, the port goes into error.



**switchport port-security mac-address sticky:** Allows switch to store first connected MAC address in the running configuration

## 8. HTTP Web Server Setup

**Step 1:** Open Server

**Step 2:** Go to service tab

**Step 3:** Select HTTP on left side

**Step 4:** Enable on button on HTTP

The screenshot shows a configuration window with a left sidebar titled 'SERVICES' containing a list of services: HTTP, DHCP, DHCPv6, TFTP, DNS, SYSLOG, AAA, NTP, EMAIL, FTP, and IoT. The 'HTTP' service is selected. The main area is titled 'HTTP' and contains two sections: 'HTTP' and 'HTTPS'. Each section has a radio button for 'On' (selected) and a radio button for 'Off'.

## 9. Mail Server Configuration

**Step 1:** Open Server

**Step 2:** Go to service tab

**Step 3:** Select EMAIL on left side

**Step 4:** Enable (on) button to open SMTP

**Step 5:** Enter Domain Name

**Step 6:** Click set button

**Step 7:** Create user by Entering username and password

**Step 8:** Click on Plus Button on right side

The screenshot shows a configuration window with a top navigation bar containing tabs: Physical, Config, Services (selected), Desktop, Programming, and Attributes. The left sidebar is titled 'SERVICES' and lists various services, with 'EMAIL' selected. The main area is titled 'EMAIL' and contains two sections: 'SMTP Service' and 'POP3 Service'. Each section has a radio button for 'ON' (selected) and a radio button for 'OFF'. Below these sections, there is a 'Domain Name' field with the value 'auca.rw' and a 'Set' button. Underneath, there is a 'User Setup' section with 'User' and 'Password' fields. The 'User' field contains the text 'joseph' and 'alice'.

## 10. Verification and Troubleshooting

### 1. Device information

```
29061# show running-config
29061# show startup-config
```

### 2. Interface & IP Verification

```
29061# show ip interface brief
29061# show interfaces
```

### 3. Routing Verification

```
29061# show ip route
29061# show ip protocols
```

### 4. Nat Verification

```
29061# show ip nat translations
29061# show ip nat statistics
```

### 5. DHCP Verification

```
29061# show ip dhcp pool
29061# show ip dhcp binding
```

### 6. Access Control List (ACL) Verification

```
29061# show access-lists
29061# show running-config | include access-list
```

## 7.Vlan & Trunk Verification

```
29061-S4# show vlan brief
29061-S4# show interfaces trunk
29061-S4# show interfaces switchport
```

## 8. Port Security Verification

```
29061-S4# show port-security
29061-S4# show port-security interface f0/1
```

## 9.Connectivity Tests

```
29061# ping 10.10.10.1
29061# ping 10.10.13.1
29061# ping 100.100.100.2
```

## 10. Saving & Exiting

```
29061# copy running-config startup-config
29061# write
29061# write memory
29061# end
29061# exit
```

## Explanation of used Commands

**show-running-config:** Displays current configuration

**show startup-config:** Display saved configuration

**show ip interface brief:** Gives summary of all interface

**show interfaces:** Displays detailed info about every interface

**show ip route:** Shows the routing table, including directly connected.

**show protocols:** Lists all interfaces with their assigned IPs and protocol status

**show ip nat translations:** Displays the active NAT translation

**show ip nat statistics:** Displays how many translations exist.

**show ip dhcp pool:** Shows all configured DHCP pools with details

**show ip dhcp binding:** Shows current IPs leased to clients

**show access-lists:** List all ACLs configure on the devices

**show vlan brief:** shows all vlan configure on the switch

**show interface trunk:** verifies interface are operating as trunks

**show interfaces switchport:** shows switchport mode

**show port-security:** This summarize port-security status for all interfaces.

**show port-security interface fa0/1:** Display detailed port-security info for specific port

**ping:** used to test network reachability

**copy running-config startup-config:** Saves current configuration startup-config.

**write:** Saving configuration

**write memory:** Saving configuration

**end:** exiting any configuration mode.

**exit:** Exist the CLI

## 11. Achieved Outcomes

Connectivity Masoro ↔ Gishushu achieved.

Web server reachable on all clients.

Mail server operational across campuses.

Secure management via SSH.

VLANs, STP, and port security correctly configured.

## 12. Faced Challenges

In the **Gishushu LAN**, I initially struggled with assigning IP addresses to **WIFI-NET (10.10.14.0/24)** and **CABLE-NET (10.10.13.0/24)** because both networks were connected to the **same switch**, which in turn had only **one physical link to the router**. At first, I tried assigning only one IP address to the router port, but this did not allow both networks to communicate properly.

Later, I discovered the concept of **Router-on-a-Stick**, which allows a single physical router port to handle multiple IP subnets by creating **sub-interfaces**, each assigned to a specific VLAN. I configured the switch port connecting to the router in **trunk mode**, enabling it to carry traffic for multiple VLANs simultaneously. I then applied **NAT** on these sub-interfaces to allow the devices in both VLANs to access external networks.

Using this method, a single router port was able to serve multiple IP flows corresponding to their respective VLANs, resolving the connectivity issue and reinforcing my understanding of **inter-VLAN routing** and VLAN tagging.

I corrected by following these steps

**Step 1:** Configure sub-Interface

```
29061(config)# interface g8/0.13
29061(config-subif)# encapsulation dot1Q 13
29061(config-subif)# ip address 10.10.13.1 255.255.255.0
29061(config-subif)# ip nat inside
29061(config-subif)# exit
```

```
29061(config)# interface g8/0.14
29061(config-subif)# encapsulation dot1Q 14
29061(config-subif)# ip address 10.10.14.1 255.255.255.0
29061(config-subif)# ip nat inside
29061(config-subif)# exit
```

### Explanation of used Commands

**Interface g8/0.13:** creates a sub-interface .13 on physical interface g8/0

**Interface g8/0.14:** creates a sub-interface .14 on physical interface g8/0

**Encapsulation dot1Q:** Assigns VLA 13 to this sub-interface using 802.1Q trunking.

**Ip address 10.10.13.1 255.255.255.0:** Assigns IP address for CABLE-NET (VLAN 13)

**Ip nat inside:** Marks sub-interface as inside for NAT

**exit:** Exit from sub-interface

## Step 2: Switch port Trunking

```
29061-S4(config)# interface g0/1
29061-S4(config-if)# switchport mode trunk
29061-S4(config-if)# switchport trunk allowed vlan 13,14
```

## Explanation of use commands

**Interface g0/1:** entering the port connected to router

**switchport mode trunk:** Configure the switch port connectivity to router as trunk.

**switchport trunk allowed vlan 13,14:** Restrict the trunk to only VLAN 13 and VLAN 14

## Summary

During the activity, the following tasks were successfully completed:

1. **IP Addressing & Subnetting:**
  - a. Masoro LAN: IT-NET (10.10.10.0/24), HR-NET (10.10.11.0/24), FINANCE-NET (10.10.12.0/24)
  - b. Gishushu LAN: CABLE-NET (10.10.13.0/24), WIFI-NET (10.10.14.0/24)
  - c. All subnets configured with mask 255.255.255.0, DNS server 10.10.10.10.
2. **DHCP Configuration:**
  - a. Created pools for each subnet.
  - b. Excluded critical IPs (like the DNS server).
  - c. Configured default gateways and DNS settings for automated client IP assignment.
3. **Routing:** Static routing enabled on both Masoro and Gishushu routers to ensure inter-subnet communication and internet access via the ISP.
4. **VLANs & Trunking:**
  - a. Configured VLANs on the S4 switch.
  - b. Access ports assigned to appropriate VLANs.

- c. Trunk links set to carry multiple VLANs between switch and router.
- 5. **Port Security:**
  - a. Applied to all access ports, limiting the number of MAC addresses per port.
  - b. Sticky MAC addresses enabled and violation action set to shutdown.
- 6. **SSH Configuration:**
  - a. Local users created and encrypted passwords configured.
  - b. RSA keys generated, SSH version 2 enabled.
  - c. VTY lines configured for SSH login only.
- 7. Used commands like show ip interface brief, show running-config, show vlan brief, show port-security, show ip nat translations, and ping to confirm network connectivity, security, and proper configuration.

---

**END.**