



ADVENTIST UNIVERSITY OF CENTRAL AFRICA

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Contents

| | |
|---|----|
| 1. Executive Summary..... | 1 |
| 2. Objective | 1 |
| 3. Required Resources | 1 |
| 4. Network Topology Design | 1 |
| 5. IP Addressing Scheme | 2 |
| 6. Device Connections and Interface Types | 3 |
| 7. Hostname Configuration..... | 3 |
| 8. Remote Access Configuration (SSH)..... | 4 |
| 9. DHCP Configuration | 5 |
| 10. Advanced Configuration Requirements..... | 5 |
| 10.1 NAT (PAT & Static NAT)..... | 5 |
| 10.2 Routing..... | 5 |
| 10.3 STP/RSTP and Port Security | 5 |
| 10.4 HTTP Web Server Setup | 6 |
| 10.5 Mail Server Configuration..... | 7 |
| 11. Verification and Troubleshooting | 9 |
| 12. Saving Configuration | 9 |
| 13. Achieved Outcomes | 9 |
| 14. Conclusion..... | 9 |
| 15. Table of All Used Commands | 11 |
| 16. Table of Figures..... | 13 |

1. Executive Summary

This assignment focused on designing, configuring, and verifying a multi-campus network for AUCA, connecting the Masoro and Gishushu LANs. The main goals were to implement IP addressing, NAT, routing, secure remote access, DHCP services, server functionality, and network security features.

Key outcomes include:

- Seamless inter-campus communication.
- HTTP and mail server accessibility across both campuses.
- Secure management using Telnet and SSH.
- Port security and STP implementation for stability and loop prevention.

2. Objective

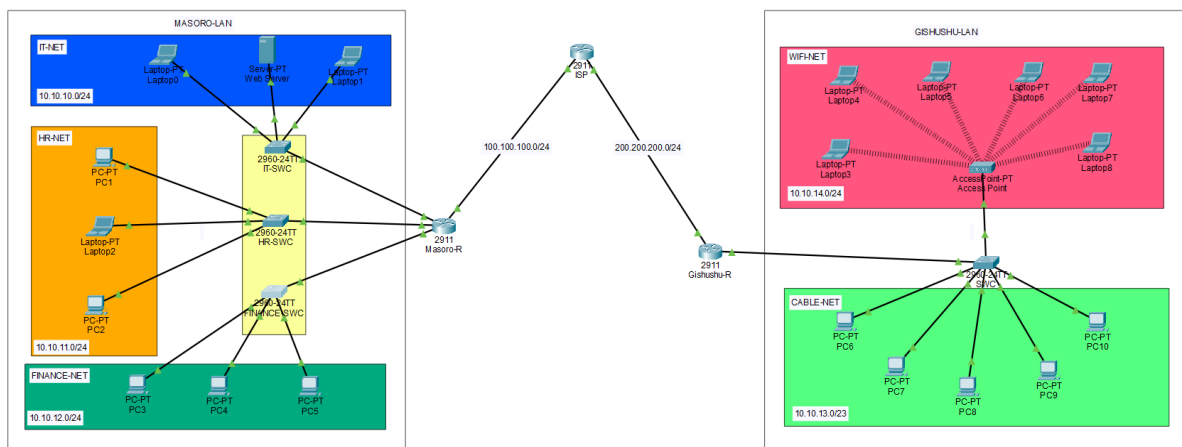
Design, configure, and test a network topology for AUCA to enable communication between Masoro and Gishushu LANs. Implement IP addressing, NAT, routing, DHCP, security, and server setups while verifying connectivity.

3. Required Resources

- **Software:** Cisco Packet Tracer (latest version)
- **Reference Materials:** Canvas LMS videos: "Packet Tracer Labs [v1–v3]"
- **Topology Diagram:** "AUCA Masoro+Gishushu LANs.png"

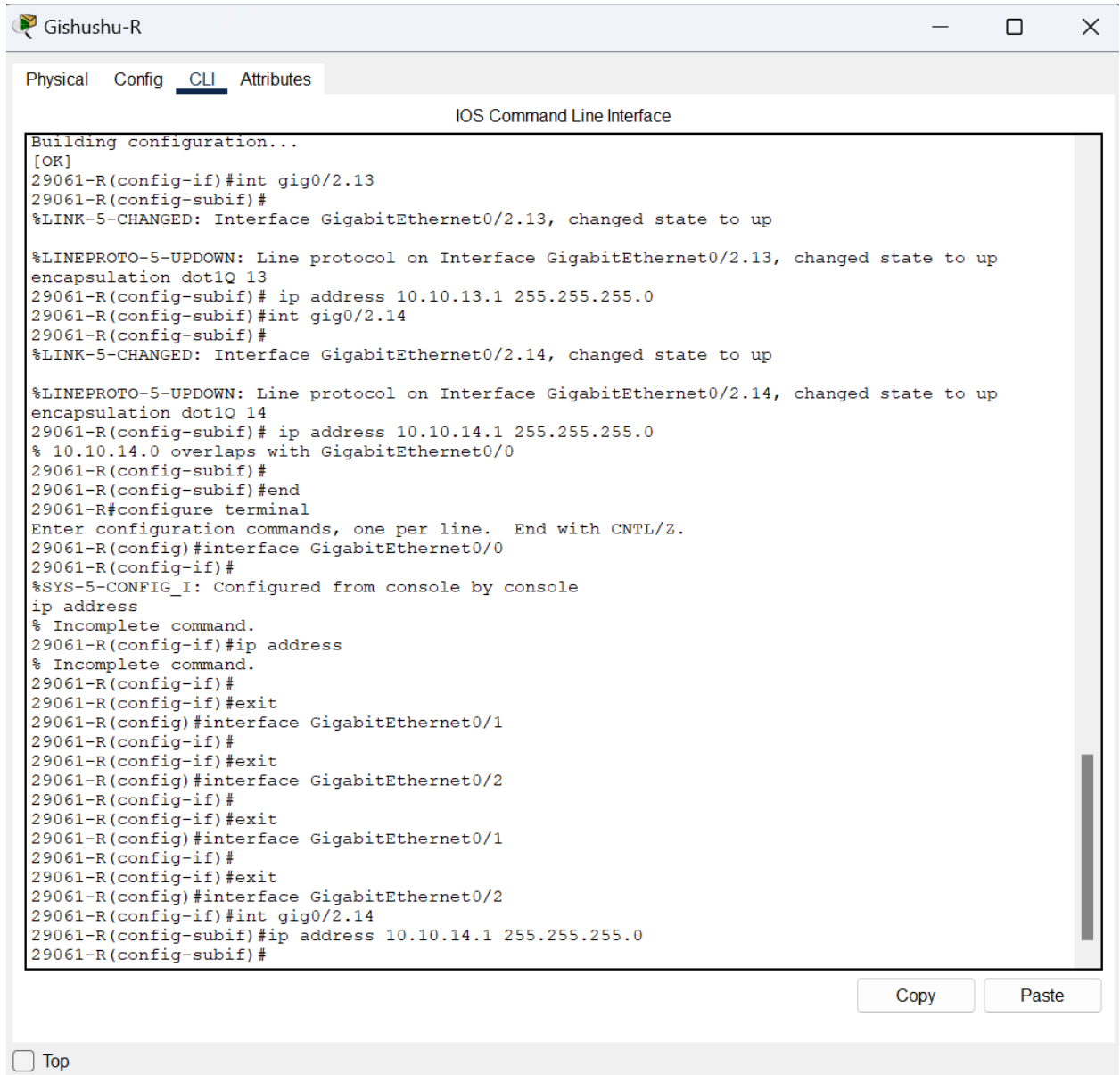
4. Network Topology Design

- Redesigned to separate departments (Administration, IT, Academic).
- Masoro and Gishushu connected via routers using Gigabit links.
- Each department assigned a unique VLAN/subnet.
- Labeling of all routers, switches, servers, PCs, laptops, and connections.



5. IP Addressing Scheme

- Sub-netting applied based on department and LAN size.
- Router interfaces assigned **last valid IP in subnet** as default gateway.
- Servers assigned **static IPs** for reliability.
- PCs/Laptops configured for **dynamic DHCP assignment**.
- DNS server set to **10.10.10.10**.



The screenshot shows a web-based interface for a Gishushu-R router. The 'CLI' tab is selected, displaying the IOS Command Line Interface. The configuration process is as follows:

```
Building configuration...
[OK]
29061-R(config-if)#int gig0/2.13
29061-R(config-subif)#
%LINK-5-CHANGED: Interface GigabitEthernet0/2.13, changed state to up

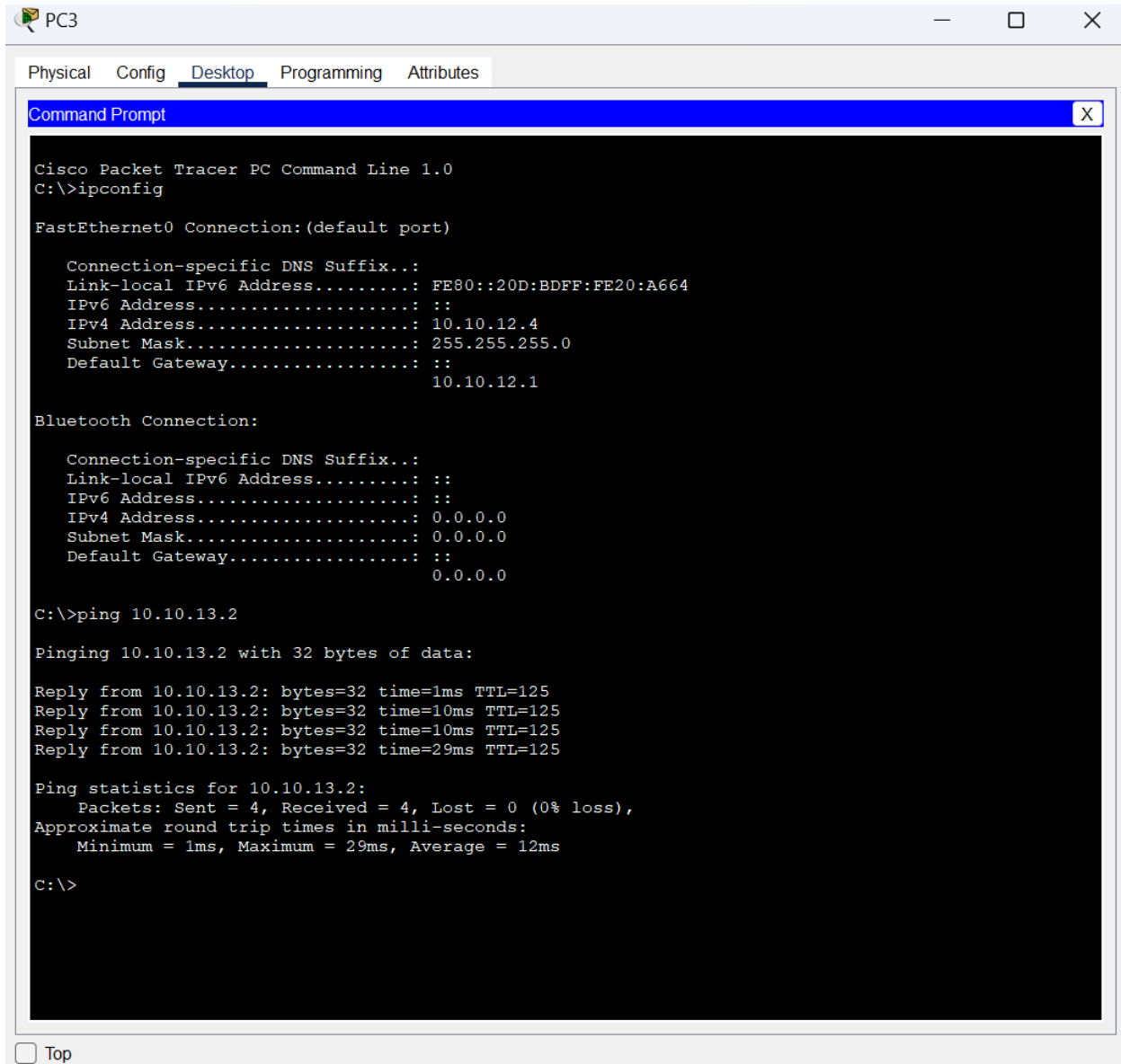
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/2.13, changed state to up
encapsulation dot1Q 13
29061-R(config-subif)# ip address 10.10.13.1 255.255.255.0
29061-R(config-subif)#int gig0/2.14
29061-R(config-subif)#
%LINK-5-CHANGED: Interface GigabitEthernet0/2.14, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/2.14, changed state to up
encapsulation dot1Q 14
29061-R(config-subif)# ip address 10.10.14.1 255.255.255.0
% 10.10.14.0 overlaps with GigabitEthernet0/0
29061-R(config-subif)#
29061-R(config-subif)#end
29061-R#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
29061-R(config)#interface GigabitEthernet0/0
29061-R(config-if)#
%SYS-5-CONFIG_I: Configured from console by console
ip address
% Incomplete command.
29061-R(config-if)#ip address
% Incomplete command.
29061-R(config-if)#
29061-R(config-if)#exit
29061-R(config)#interface GigabitEthernet0/1
29061-R(config-if)#
29061-R(config-if)#exit
29061-R(config)#interface GigabitEthernet0/2
29061-R(config-if)#
29061-R(config-if)#exit
29061-R(config)#interface GigabitEthernet0/1
29061-R(config-if)#
29061-R(config-if)#exit
29061-R(config)#interface GigabitEthernet0/2
29061-R(config-if)#int gig0/2.14
29061-R(config-subif)#ip address 10.10.14.1 255.255.255.0
29061-R(config-subif)#
```

At the bottom of the CLI window, there are 'Copy' and 'Paste' buttons. Below the CLI window, there is a 'Top' link with a checkbox.

6. Device Connections and Interface Types

- Servers connected via FastEthernet interfaces.
- Switches interconnected via GigabitEthernet interfaces.
- Straight-through cables used for PC to Switch, Router to router.
- Connectivity tested using ping and traceroute commands.



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

FastEthernet0 Connection:(default port)

    Connection-specific DNS Suffix...:
    Link-local IPv6 Address . . . . .: FE80::20D:BDFF:FE20:A664
    IPv6 Address . . . . .: ::
    IPv4 Address . . . . .: 10.10.12.4
    Subnet Mask . . . . .: 255.255.255.0
    Default Gateway . . . . .: ::
                                10.10.12.1

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

C:\>ping 10.10.13.2

Pinging 10.10.13.2 with 32 bytes of data:

Reply from 10.10.13.2: bytes=32 time=1ms TTL=125
Reply from 10.10.13.2: bytes=32 time=10ms TTL=125
Reply from 10.10.13.2: bytes=32 time=10ms TTL=125
Reply from 10.10.13.2: bytes=32 time=29ms TTL=125

Ping statistics for 10.10.13.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 1ms, Maximum = 29ms, Average = 12ms

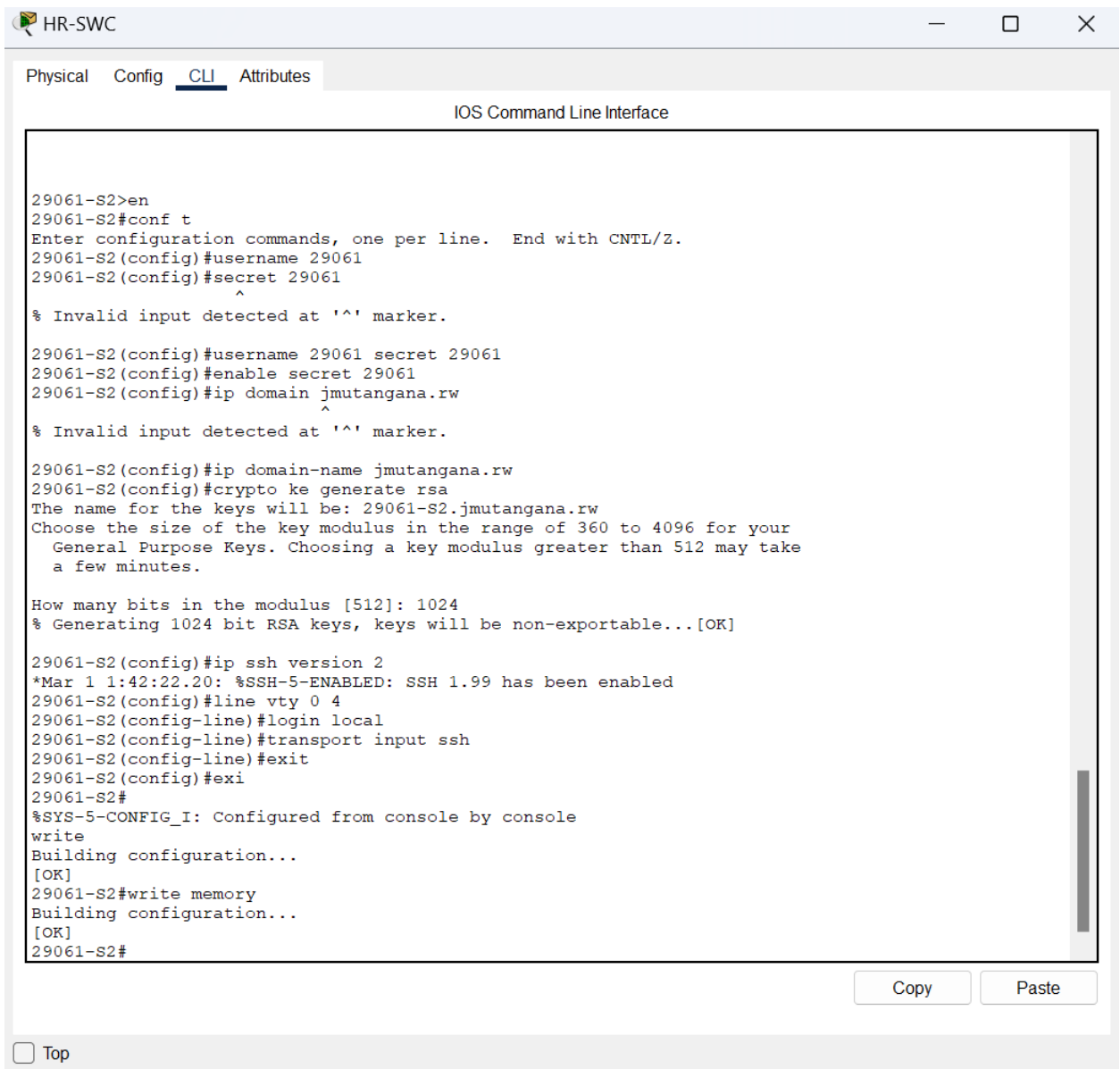
C:\>
```

7. Hostname Configuration

- Routers named: 29061-R
- Switches named: 29061-S1, 29061-S2, etc.

8. Remote Access Configuration (SSH)

- SSH enabled on all routers and switches.
- Username/password set to **29061**
- Domain name configured: jmutangana.rw



```
29061-S2>en
29061-S2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
29061-S2(config)#username 29061
29061-S2(config)#secret 29061
^
% Invalid input detected at '^' marker.
29061-S2(config)#username 29061 secret 29061
29061-S2(config)#enable secret 29061
29061-S2(config)#ip domain jmutangana.rw
^
% Invalid input detected at '^' marker.
29061-S2(config)#ip domain-name jmutangana.rw
29061-S2(config)#crypto ke generate rsa
The name for the keys will be: 29061-S2.jmutangana.rw
Choose the size of the key modulus in the range of 360 to 4096 for your
General Purpose Keys. Choosing a key modulus greater than 512 may take
a few minutes.
How many bits in the modulus [512]: 1024
% Generating 1024 bit RSA keys, keys will be non-exportable...[OK]
29061-S2(config)#ip ssh version 2
*Mar 1 1:42:22.20: %SSH-5-ENABLED: SSH 1.99 has been enabled
29061-S2(config)#line vty 0 4
29061-S2(config-line)#login local
29061-S2(config-line)#transport input ssh
29061-S2(config-line)#exit
29061-S2(config)#exi
29061-S2#
%SYS-5-CONFIG_I: Configured from console by console
write
Building configuration...
[OK]
29061-S2#write memory
Building configuration...
[OK]
29061-S2#
```

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Copy Paste

9. DHCP Configuration

- DHCP pools configured per campus VLAN.
- Default gateway, subnet mask, and DNS included in DHCP assignments.
- Server IPs excluded from pools.
- PCs and laptops verified to receive IP dynamically.

10. Advanced Configuration Requirements

10.1 NAT (PAT & Static NAT)

- PAT configured to allow multiple LAN IPs to access internet using single public IP.
- Static NAT applied to Masoro web server (10.10.10.10) to allow public access:

ip nat inside source static tcp 10.10.10.10 80 100.100.100.1 80

- NAT configured but **interfere with inter-campus communication** because after applying it connectivity stopped.

10.2 Routing

- Static routes defined for remote LAN networks.
- Default routes for unknown destinations configured.
- EIGRP enabled for automatic route discovery and redundancy.

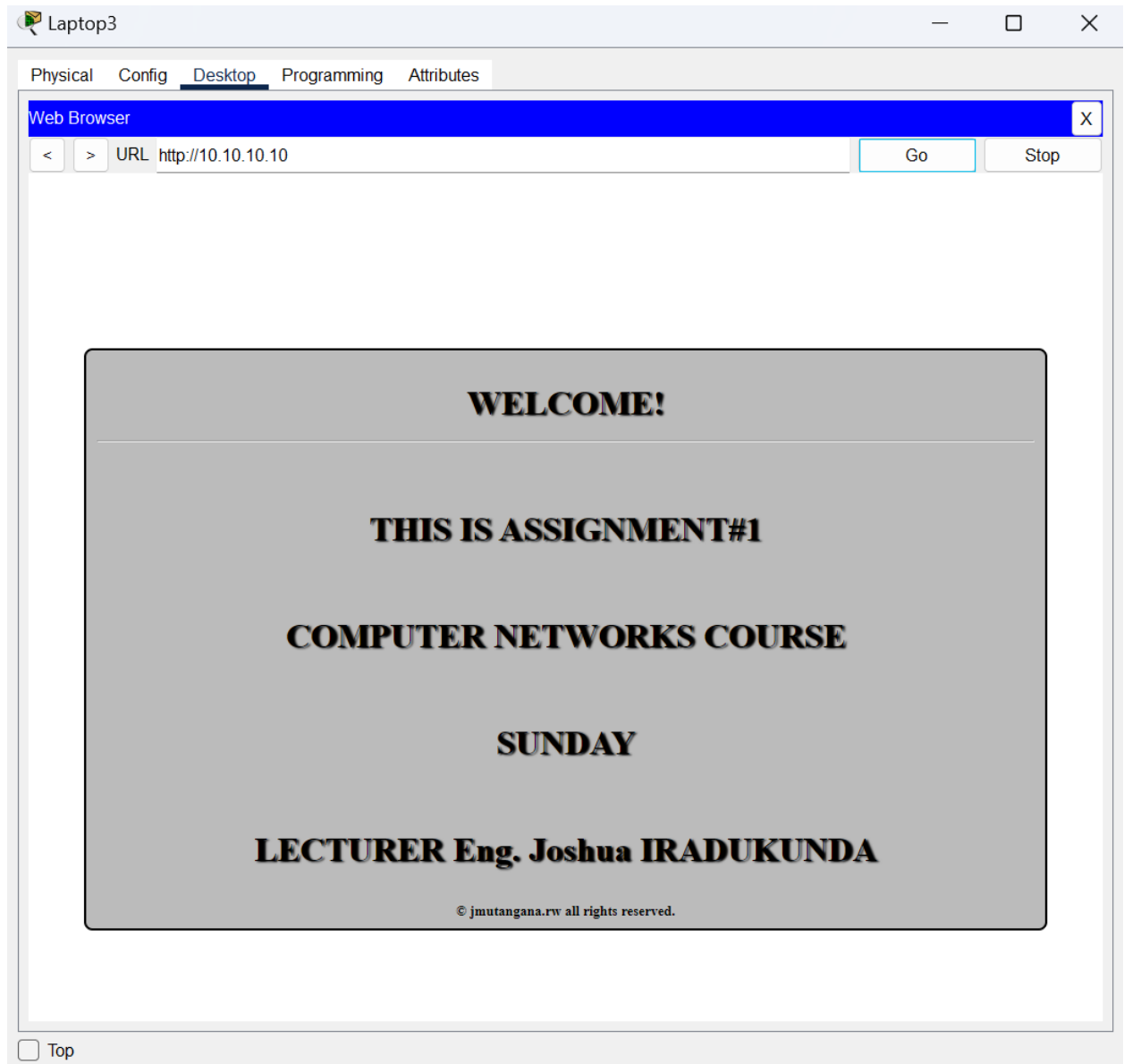
10.3 STP/RSTP and Port Security

- STP/RSTP enabled to prevent network loops.
- Port security applied to switch ports connecting to end devices:

MAC address limit, sticky learning, and violation action = shutdown.

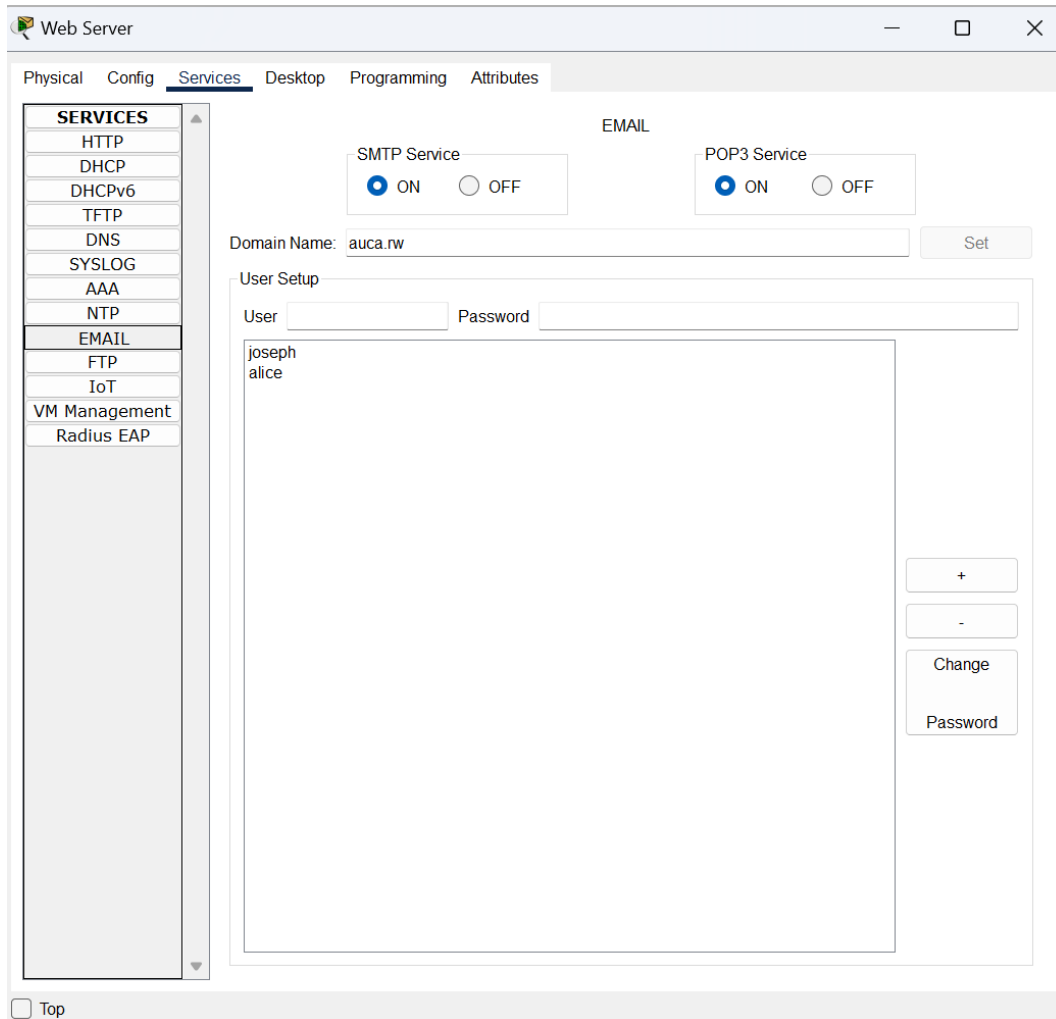
10.4 HTTP Web Server Setup

- Masoro web server configured with static IP (10.10.10.10).
- Access tested from Gishushu LAN and simulated internet.

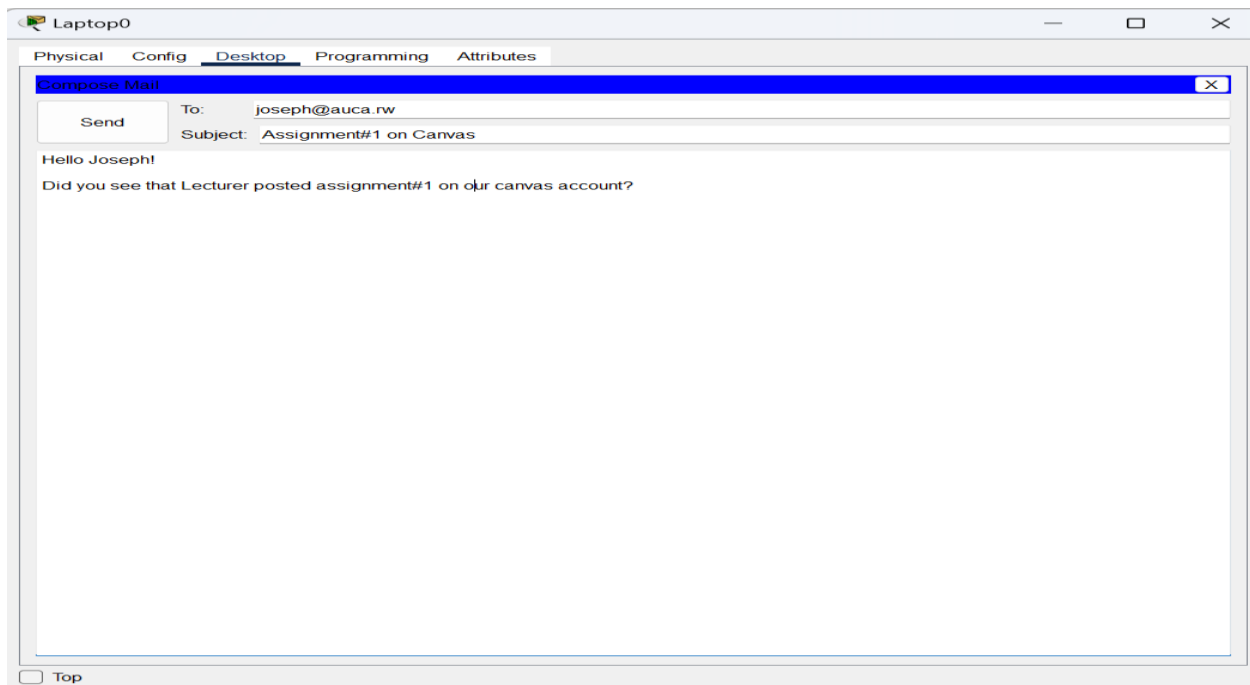


10.5 Mail Server Configuration

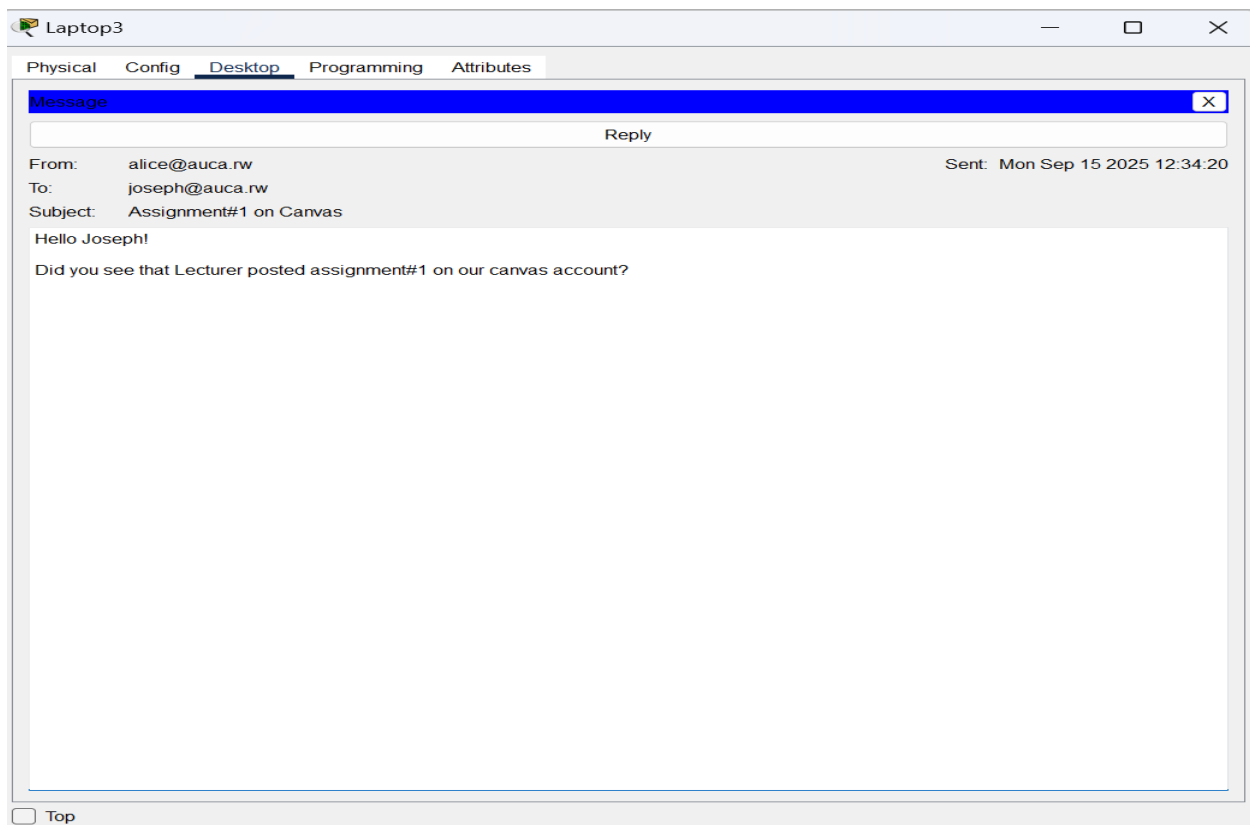
- Built-in mail server configured.
- Accounts created for two users across campuses.
- SMTP/POP3 configured.
- Successful sending/receiving tested between campuses.



Compose Email & Send



Email Received



11. Verification and Troubleshooting

Key commands used for verification:

- show ip interface brief → check IP assignment.
- show running-config → review full configuration.
- show vlan brief → verify VLAN setup.
- show ip dhcp binding → check DHCP leases.
- show ip nat translations → confirm NAT entries.
- show ip route → verify routing tables.
- show spanning-tree → confirm STP status.
- show port-security → verify port security settings.

12. Saving Configuration

- All devices saved using: **copy running-config startup-config**
- I Reloaded routers/switches verified persistent configurations.

13. 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.

14. Conclusion

This assignment provided hands-on experience in:

- Designing multi-campus networks.
- Configuring routers, switches, DHCP, and experience of routing .
- Implementing network security (SSH, port security, STP).
- Deploying servers and testing service availability.

Challenges: NAT interfering with inter-campus after configure NAT connectivity stopped.

Gishushu-R
— □ ×

Physical Config CLI Attributes

IOS Command Line Interface

| | | | | | |
|-----------------------|---------------|-----|--------|-----------------------|------|
| GigabitEthernet0/0 | unassigned | YES | manual | up | down |
| GigabitEthernet0/1 | 200.200.200.1 | YES | manual | up | up |
| GigabitEthernet0/2 | unassigned | YES | manual | up | up |
| GigabitEthernet0/2.13 | 10.10.13.1 | YES | manual | up | up |
| GigabitEthernet0/2.14 | 10.10.14.1 | YES | manual | up | up |
| FastEthernet0/3/0 | unassigned | YES | unset | up | down |
| FastEthernet0/3/1 | unassigned | YES | unset | up | down |
| FastEthernet0/3/2 | unassigned | YES | unset | up | down |
| FastEthernet0/3/3 | unassigned | YES | unset | up | down |
| Vlan1 | unassigned | YES | unset | administratively down | down |

```

29061-R#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
29061-R(config)#int gig0/1
29061-R(config-if)#ip nat outis
29061-R(config-if)#ip nat outside
29061-R(config-if)#int gig0/2.13
29061-R(config-subif)#ip nat inside
29061-R(config-subif)#int gig0/2.14
29061-R(config-subif)#ip nat inside
29061-R(config-subif)#ip nat ins
29061-R(config-subif)#ip nat inside source static tcp 10.10.10.10 80 100.100.100.250 80
29061-R(config)#int gig0/2.13
29061-R(config-subif)#ip nat inside source static tcp 10.10.10.10 80 100.100.100.250 80
29061-R(config)#acc
29061-R(config)#access-list 11 permit 10.10.13.0 0.0.0.255
29061-R(config)#access-list 11 permit 10.10.14.0 0.0.0.255
29061-R(config)#ip nat inside source list 11 int gig0/1 overload
29061-R(config)#e
% Ambiguous command: "e"
29061-R(config)#exi
29061-R#
%SYS-5-CONFIG_I: Configured from console by console
write
Building configuration...
[OK]
29061-R#copy ru
29061-R#copy running-config str
29061-R#copy running-config star
29061-R#copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
29061-R#

```

Copy
Paste

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15. Table of All Used Commands

| NO | Cisco Command | Device Applied to | Purpose | Full Command |
|----|-------------------------|---------------------------|---|--|
| 1 | en | All Switches & Routers | Enter EXEC mode | enable |
| 2 | Conf t | All Switches & Routers | Enter global c | Configure terminal |
| 3 | Int fa0/1 | All Switches | Configure specific fastethernet port | Interface fastEthener0/1 |
| 4 | Int fa0/2 | All Switches | Configure specific fastethernet port | Interface fastEthener0/2 |
| 5 | Int fa0/3 | All Switches | Configure specific fastethernet port | Interface fastEthener0/3 |
| 6 | Int fa0/4 | All Switches | Configure specific fastethernet port | Interface fastEthener0/4 |
| 7 | Int fa0/5 | All Switches | Configure specific fastethernet port | Interface fastEthener0/5 |
| 8 | Int fa0/6 | Gishuhsu Switches | Configure specific fastethernet port | Interface fastEthener0/6 |
| 9 | Int gig0/0 | On ISP & Masoro Routers | Configure specific gigabitEthernet port | Interface GigabitEthernet0/0 |
| 10 | Int gig0/1 | All Routers | Configure specific gigabitEthernet port | Interface GigabitEthernet0/1 |
| 11 | Int gig0/2 | All Routers | Configure specific gigabitEthernet port | Interface GigabitEthernet0/2 |
| 12 | Hostname | All Switches & Routers | Assign hostname for identification | Hostname 29061-R/ Hostname 29061-S1 |
| 13 | ip address | All routers, Switch VLANs | Assign IP to an interface | Ip address 10.10.10.1 255.255.255.0 |
| 14 | no shutdown | All routers, Switch VLANs | Enable interface | no shutdown |
| 15 | Ip dhcp pool | Routers | Create DHCP pool | Ip dhcp pool IT-NET |
| 16 | default-router | Routers | Define default gateway for dhcp clients | default-router 10.10.10.1 |
| 17 | Dns server | Routers | Define DNS server for dhcp clients | dns-server 10.10.10.10 |
| 18 | username | All routers, Switches | Create login account for Telnet/SSH | Username 29061 secret 29061 |
| 19 | ip domain-name | Routers,Switches | Set domain-name for SSH | ip domain-name jmutangana.rw |
| 20 | crypto key generate rsa | Routers, Switches | Generate keys for SSH | crypto key generate rsa |
| 21 | Line vty 0 4 | Routers & Switches | Configure Telnet/SSH lines | line vty 0 4 |

| | | | | |
|----|---|-----------------------------------|--|---|
| 22 | Login local | Routers & Switches | Use local credential for login | login local |
| 23 | transport input ssh | Routers & Switches | Force SSH login only | transport input ssh |
| 24 | switchport port-security | Switches | Enable port security on an interface | switchport port-security |
| 25 | switchport port-security maximum 1 | Switches | Allow only one MAC per port | switchport port-security maximum 1 |
| 26 | switchport port-security violation shutdown | Switches | Set action on violation | switchport port-security violation shutdown |
| 27 | Switchport mode access | Switches | Enable Access mode on specific port | Switchport mode access |
| | Switch mode trunk | Gishushu SWC | Enable trunk on port | Switch mode trunk |
| 28 | Switchport access vlan | Switches | Creating VLAN on switch port | Switchport vlan 13 |
| 29 | Switchport trunk allowed vlan | Gishushu-SWC | Uplink switchport to a router by VLANs | Switchport trunk allowed vlan 13,14 |
| 30 | Interface gig0/2.13 | Routers | Create subinterface for vlan 13 | Interface gig0/2.13 |
| 31 | Interface gig0/2.14 | Routers | Create subinterface for vlan 14 | Interface gig0/2.14 |
| 32 | encapsulation dotQ13 | Routers | Tags subinterfce g0/2.13 for vlan 13 | encapsulation dotQ13 |
| 33 | encapsulation dotQ14 | Routers | Tags subinterfce g0/2.13 for vlan 13 | encapsulation dotQ13 |
| 34 | Interface gig0/2.13 | Routers | Enter in subinterface 13 | Interface gig0/2.13 |
| 35 | Interface gigo/2.14 | Routers | Enter subinterface 14 | Interface gig0/2.14 |
| 36 | ip nat inside | Routers | Define inside NAT interface | ip nat inside |
| 37 | ip nat outside | Routers | Define outside NAT | ip nat outside |
| 38 | access-list 1 permit | Routers | Define traffic allowed | access-list 1 permit 10.10.10.0 0.0.0.255 |
| 39 | ip nat inside source list 1 interface s0/0/0 overload | Routers | Configure PAT | ip nat inside source list 1 interface gig0/0 overload |
| 40 | copy running-config startup-config | Routers and Switches | Save configurations | copy running-config startup-config |
| 41 | ipconfig | All client and server | Check ip configuration info | ipconfig |
| 42 | ping | All client and server | Check connectivity | ping 10.10.10.10 |
| 43 | Show int ip brief | Routers and Switches | Check ip address assigned to port | Show ip interface brief |
| 44 | Write memory | Routers and switch | Writing/save configurations | Write memory |
| 45 | Show ip nat translation | Masoro router and Gishushu router | To confirm NAT entries | Show ip nat translation |

| | | | | |
|----|----------------------------|--------------------|-----------------------------|----------------------------|
| 46 | no access-list 11 permit | | Disable access list | no access-list 11 permit |
| 47 | Show vlan brief | Routers & switches | Verify VLAN configuration | Show vlan brief |
| 48 | Show running-configuration | Routers & switches | Check active configurations | Show running-configuration |

16. Table of Figures

| Figure No | Title / Description of figure | Page |
|-----------|--|------|
| Figure 1 | Executive Summary | 1 |
| Figure 2 | Objective | 1 |
| Figure 3 | Required Resources | 1 |
| Figure 4 | Network Topology Design | 1 |
| Figure 5 | IP Addressing Scheme | 2 |
| Figure 6 | Device Connections and Interface Types | 3 |
| Figure 7 | Hostname Configuration | 3 |
| Figure 8 | Remote Access Configuration (SSH) | 4 |
| Figure 9 | DHCP Configuration | 5 |
| Figure 10 | Advanced Configuration Requirements | 5 |
| Figure 11 | Verification and Troubleshooting | 9 |
| Figure 12 | Saving Configuration | 9 |
| Figure 13 | Achieved Outcomes | 9 |
| Figure 14 | Conclusion | 9 |
| Figure 15 | Table of All Used Commands | 11 |
| Figure 16 | Table of Figures | 13 |