A Project Rubric On

"Small Office Network Design"

Submitted in partial fulfillment of the requirements for the award of the degree of

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Of

CHANDIGARH UNIVERSITY

Discover. Learn. Empower.

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BONAFIDE CERTIFICATE

Certified that this project report " Small Office Network Design" **is the bonafide work of "Neeraj Gupta " who carried out the project work under** my/our supervision.

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Submitted for the project viva-voce examination held on ……

INTERNAL EXAMINER

EXTERNAL EXAMINER

ACKNOWLEDGEMENT

We would like to convey our heartfelt gratitude to **Asst.Prof. Gagandeep Kaur** for her continuous support and help for the completion of this project. We are grateful to **Dr. Krishan Tuli, Head of the Department** for giving us such a great opportunity to work on this project. We are thankful for their encouragement and cooperation throughout this project. We would like to thank our Parents and Friends for their immense support. We work hard on this project and would like to take this time to thank each and every one of them who supported us directly or indirectly. It was indeed a great learning experience.

Table of Contents:

i. Executive Summary:

This project showcases a VLAN-based segmented network configured using Cisco Packet Tracer. It features static IP addressing, subnetting (/26), router-on-a-stick routing, and wireless integration using access points and SSIDs. The network contains various wired and wireless devices including PCs, printers, smartphones, tablets, and a laptop. The aim is to create a secure and well-structured environment for inter-device communication.

ii. Introduction:

Networking forms the backbone of modern communication. VLANs allow segmentation of a larger network into logical subnetworks, while static IP addressing provides predictable and secure device identification. This project demonstrates the setup and configuration of a multi-device network using a Cisco 2911 router and Cisco 2960 switch.

Key Points:

- VLANs improve security and traffic management by isolating broadcast domains.
- Static IP addressing ensures consistent communication paths for devices.
- Subnetting with /26 provides efficient IP usage and organizational structure.
- Router-on-a-stick enables inter-VLAN communication using subinterfaces.
- Wireless devices such as smartphones, tablets, and laptops are integrated using SSIDs for each VLAN.
- The network simulates a realistic small-office environment with full connectivity across devices and network segments. VLANs allow segmentation of a larger network into logical subnetworks, while static IP addressing provides predictable and secure device identification. This project demonstrates the setup and configuration of a multi-device network using a Cisco 2911 router and Cisco 2960 switch.

iii. Project Scope:

This project focuses on designing and implementing a subnetted, multi-VLAN network that combines both wired and wireless connectivity. The scope includes:

- Deployment of a Cisco 2911 router and 2960 switch.
- Configuration of four distinct VLANs for effective network segmentation.
- Use of /26 subnetting to accommodate a fixed number of devices per VLAN.
- Assignment of static IP addresses to all hosts, including PCs, printers, smartphones, and laptops.
- Implementation of router-on-a-stick routing for inter-VLAN communication.
- Integration of wireless devices using uniquely named SSIDs.
- Testing of device-to-device communication across VLANs, especially smartphone-to-printer communication.

The project simulates a real-world small office or departmental network where isolation, structure, and reliable device communication are essential.

3. Project Objectives:

- Create 4 VLANs and assign them to different ports on both routers' networks.
- Use /26 subnetting for efficient IP allocation across both routers.
- Implement static IP addressing across all devices.
- Enable wireless connectivity using access points and defined SSIDs.
- Implement router-on-a-stick on both routers for inter-VLAN communication.
- Establish inter-router connectivity to allow communication between both LANs.
- Ensure communication between smartphones and printers across the extended network.

4. Literature Review:

- **VLANs:** VLANs (Virtual LANs) are used to segment a network logically, improving performance and security.
- **Subnetting:** Dividing a large network into smaller subnets improves address management and network performance.

- **Static IP:** Static addressing provides control and avoids conflicts in small to mid-sized networks.

- **Router-on-a-Stick:** A method to allow communication between VLANs via subinterfaces on a single physical router interface.
- **Wireless Configuration:** Integration of wireless devices using access points and SSIDs improves device mobility.

5. Literature Review:

- **VLANs:** VLANs (Virtual LANs) are used to segment a network logically, improving performance and security.
- **Subnetting:** Dividing a large network into smaller subnets improves address management and network performance.
- **Static IP:** Static addressing provides control and avoids conflicts in small to mid-sized networks.
- **Router-on-a-Stick:** A method to allow communication between VLANs via subinterfaces on a single physical router interface.
- **Wireless Configuration:** Integration of wireless devices using access points and SSIDs improves device mobility.

6. Methodology

1. **Device Placement**: Place 2 routers, multiple switches, PCs, printers, smartphones, laptops, and access points across both networks.
2. **Subnet Design**: Create 4 subnets per router using the /26 mask (255.255.255.192), ensuring unique address ranges.
3. **VLAN Creation**: Assign VLANs to switch ports on both routers' networks.
4. **IP Addressing**: Assign static IPs to all devices within appropriate subnets, ensuring no overlap.
5. **Router Configuration**:
   - Configure subinterfaces on G0/0 of **Router0** and **Router1** with dot1Q encapsulation for their respective VLANs.
   - Assign IP addresses to the subinterfaces based on their VLAN's subnet.
6. **Trunk Ports**:
   - Configure trunk ports on switches connected to Router0 and Router1.

- Configure trunk port between routers using a crossover cable or intermediary switch.

7. **Routing Setup**: Use **static routing** or **RIP/EIGRP** between Router0 and Router1 for inter-network communication.
8. **Wireless Setup**: Deploy access points on both sides, configure SSIDs, and connect wireless clients accordingly.
9. **Testing**: Perform ping tests between VLANs and across both routers to ensure full connectivity.

7. Development Phases:

- **Phase 1**: Design overall topology with two routers and define IP subnetting.
- **Phase 2**: Set up hardware in Cisco Packet Tracer, including router-to-router connections.
- **Phase 3**: Configure VLANs, IPs, and router subinterfaces.
- **Phase 4**: Set up wireless access points and connect clients.
- **Phase 5**: Configure static routes or dynamic protocol for router-to-router communication.
- **Phase 6**: Test full connectivity, especially inter-router VLAN communication.

8. Challenges and Solutions

- **Issue**: Inter-router VLAN communication not working.
  Solution: Configured static routes between Router0 and Router1 and verified trunk port connectivity.
- **Issue**: IP address overlap between routers.
  Solution: Rechecked and redesigned subnets to ensure unique IP ranges on each side.
- **Issue**: Wireless clients couldn't communicate across networks.
  Solution: Verified routing, SSID configuration, and ensured trunk links support inter-VLAN routing.

9. Conclusion

This project successfully demonstrated a scalable, segmented network using dual routers, VLANs, and static IPs. Router-on-a-stick and inter-router communication allowed seamless cross-network connectivity. Wireless integration was successful, and all devices including smartphones and printers

could communicate as intended.

10. Future Enhancements

- Introduce network security policies and firewalls.
- Integrate DHCP for scalability.
- Monitor traffic using SNMP.
- Expand topology with multiple routers and switches.

11. Code Explanation/Detailed Network Setup

1. Device Overview

- **Router:** Cisco 2911 (x2)
- **Switch:** Cisco 2960 (x2)
- **End Devices (per network):** 8 PCs, 8 Printers, 8 Access pooint, 4 Laptop
- **Wireless Access Points:** 4 per network

---

2. Subnetting Plan (/26)

Router 0 Subnets:

- Subnet 1: 192.168.1.0/26 → Gateway: 192.168.1.1
- Subnet 2: 192.168.1.64/26 → Gateway: 192.168.1.65
- Subnet 3: 192.168.1.128/26 → Gateway: 192.168.1.129
- Subnet 4: 192.168.1.192/26 → Gateway: 192.168.1.193

Router 1 Subnets:

- Subnet 1: 192.168.2.0/26 → Gateway: 192.168.2.1
- Subnet 2: 192.168.2.64/26 → Gateway: 192.168.2.65
- Subnet 3: 192.168.2.128/26 → Gateway: 192.168.2.129
- Subnet 4: 192.168.2.192/26 → Gateway: 192.168.2.193

---

3. IP Address Assignment

Router 0 Devices:

- PC0: 192.168.1.2 /26 GW: 192.168.1.1
- PC1: 192.168.1.66 /26 GW: 192.168.1.65
- PC2: 192.168.1.130 /26 GW: 192.168.1.129
- PC3: 192.168.1.194 /26 GW: 192.168.1.193
- Printers follow similar addressing within subnets

Router 1 Devices:

- PC0: 192.168.2.2 /26 GW: 192.168.2.1
- PC1: 192.168.2.66 /26 GW: 192.168.2.65
- PC2: 192.168.2.130 /26 GW: 192.168.2.129

- PC3: 192.168.2.194 /26 GW: 192.168.2.193
- Printers follow similar addressing within subnets

---

4. VLAN Setup (Same for both switches with respective VLANs)

For Switch connected to Router 0

Switch> enable

Switch# configure terminal

Switch(config)# vlan 10

Switch(config-vlan)# name Admin

Switch(config)# vlan 20

Switch(config-vlan)# name Finance

Switch(config)# vlan 30

Switch(config-vlan)# name CS

Switch(config)# vlan 40

Switch(config-vlan)# name Users

For Switch connected to Router 1

Switch> enable

Switch# configure terminal

Switch(config)# vlan 50

Switch(config-vlan)# name Admin

Switch(config)# vlan 60

Switch(config-vlan)# name Finance

Switch(config)# vlan 70

Switch(config-vlan)# name CS

Switch(config)# vlan 80

Switch(config-vlan)# name Users

---

5. VLAN Port Assignment

Switch 0 (Router 0's switch)

interface range fa0/2 - 4

switchport mode access

```
 switchport access vlan 10
interface range fa0/5 - 7
 switchport mode access
 switchport access vlan 20
interface range fa0/8 - 10
 switchport mode access
 switchport access vlan 30
interface range fa0/11 - 13
 switchport mode access
 switchport access vlan 40
```

Switch 1 (Router 1's switch)

```
interface range fa0/2 - 4
 switchport mode access
 switchport access vlan 50
interface range fa0/5 - 7
 switchport mode access
 switchport access vlan 60
interface range fa0/8 - 10
 switchport mode access
 switchport access vlan 70
interface range fa0/11 - 13
 switchport mode access
 switchport access vlan 80
```

---

6. Router-on-a-Stick Configuration

🔧 Trunking Configuration (on both switches)

Assuming the routers are connected to their respective switches using port fa0/1 (adjust as needed):

```
interface fa0/1
 switchport mode trunk
```

🚦 Router 0 Configuration

```
enable
configure terminal
hostname Router0
interface g0/0.10
 encapsulation dot1Q 10
 ip address 192.168.1.1 255.255.255.192
interface g0/0.20
 encapsulation dot1Q 20
 ip address 192.168.1.65 255.255.255.192
interface g0/0.30
 encapsulation dot1Q 30
 ip address 192.168.1.129 255.255.255.192
interface g0/0.40
 encapsulation dot1Q 40
 ip address 192.168.1.193 255.255.255.192
! RIP Configuration
router rip
version 2
no auto-summary
network 192.168.1.0
```

🚦 **Router 1 Configuration**

```
enable
configure terminal
hostname Router1
interface g0/0.50
 encapsulation dot1Q 50
 ip address 192.168.2.1 255.255.255.192
interface g0/0.60
 encapsulation dot1Q 60
 ip address 192.168.2.65 255.255.255.192
```

```
interface g0/0.70
 encapsulation dot1Q 70
 ip address 192.168.2.129 255.255.255.192
interface g0/0.80
 encapsulation dot1Q 80
 ip address 192.168.2.193 255.255.255.192
```

! RIP Configuration

```
router rip
version 2
no auto-summary
network 192.168.2.0
```

---

8. Access Point and SSID Configuration

Router 0 APs:

- AP0: SSID = Admin-WIFI, VLAN 10
- AP1: SSID = Finance-WIFI, VLAN 20
- AP2: SSID = CS-WIFI, VLAN 30
- AP3: SSID = User-WIFI, VLAN 40

Router 1 APs:

- AP0: SSID = Admin-WIFI-R1, VLAN 50
- AP1: SSID = Finance-WIFI-R1, VLAN 60
- AP2: SSID = CS-WIFI-R1, VLAN 70
- AP3: SSID = User-WIFI-R1, VLAN 80

---

9. Wireless Device Setup

- Devices connect to respective SSIDs.
- Static IPs assigned within subnet range.

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10. Printer Setup

- Connected via FastEthernet.
- VLAN-based IP assignment (e.g., Printer0 → VLAN 10 → 192.168.1.10).

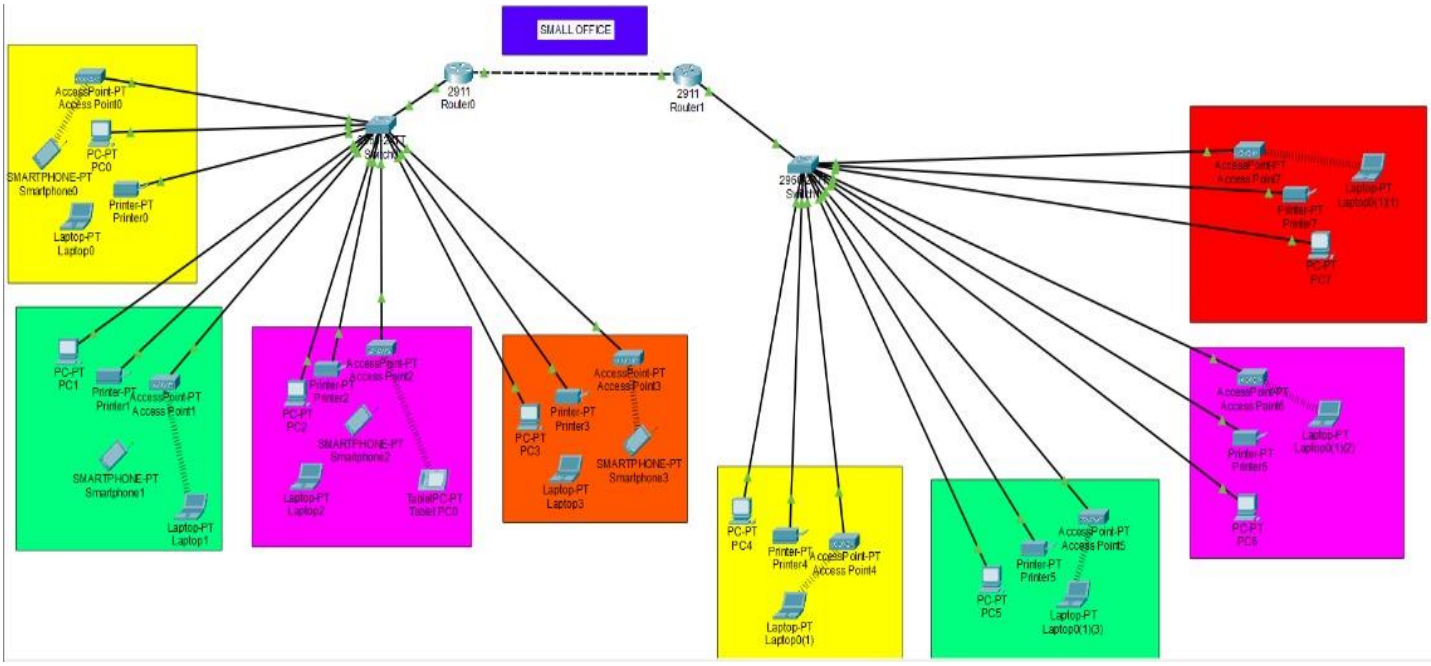
11. Smartphone to Printer Communication

- Ensure smartphones are in same VLAN as printers.
- Test connectivity using ping.

12. Troubleshooting Techniques

- Use commands: show ip interface brief, show vlan, ping.
- Verify VLAN setup and subinterfaces.

1. Screenshots Placeholder:



Router0

Physical Config CLI Attributes

IOS Command Line Interface

```
Router(config-subif)#ip address 192.168.1.1 255.255.255.192
Router(config-subif)#
Router(config-subif)#ex
Router(config)#
Router(config)#int gig0/0.20
Router(config-subif)#
%LINK-5-CHANGED: Interface GigabitEthernet0/0.20, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/0.20, changed state to
up

Router(config-subif)#encapsulation dot1Q 20
Router(config-subif)#ip address 192.168.1.65 255.255.255.192
Router(config-subif)#do wr
Building configuration...
[OK]
Router(config-subif)#ex
Router(config)#
Router(config)#int gig0/0.30
Router(config-subif)#
%LINK-5-CHANGED: Interface GigabitEthernet0/0.30, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/0.30, changed state to
up

Router(config-subif)#encapsulation dot1Q 30
Router(config-subif)#ip address 192.168.1.129 255.255.255.192
Router(config-subif)#do wr
Building configuration...
[OK]
Router(config-subif)#ex
Router(config)#int gig0/0.40
Router(config-subif)#
%LINK-5-CHANGED: Interface GigabitEthernet0/0.40, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/0.40, changed state to
```

Copy Paste

Switch0

Physical Config CLI Attributes

IOS Command Line Interface

```
Switch(config-if)#int f0/6
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 20
Switch(config-if)#int f0/7
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 20
Switch(config-if)#ex
Switch(config)#
Switch(config)#int f0/8
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 20
Switch(config-if)#int f0/9
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 20
Switch(config-if)#int f0/10
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 20
Switch(config-if)#ex
Switch(config)#
Switch(config)#int f0/11
Switch(config-if)#switchport mode access
Switch(config-if)#exit
Switch(config)#
Switch(config)#vlan 40
Switch(config-vlan)# name User
Switch(config-vlan)#ex
Switch(config)#int f0/11
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 40
Switch(config-if)#int f0/12
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 40
Switch(config-if)#int f0/13
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 40
Switch(config-if)#switchport access vlan 40
```

Copy Paste

Smartphone0

Physical | Config | Desktop | Programming | Attributes

IP Configuration

Interface: Wireless0

IP Configuration

- DHCP
- Static

IPv4 Address: 192.168.1.4
Subnet Mask: 255.255.255.192
Default Gateway: 192.168.1.1
DNS Server: 192.168.1.1

Access Point0

Physical | Config | Attributes

GLOBAL
Settings
INTERFACE
Port 0
Port 1

Port 1

Port Status: On
SSID: Admin-WIFI
2.4 GHz Channel: 6
Coverage Range (meters): 140.00

Authentication
- Disabled
- WEP
- WPA-PSK
- WPA2-PSK

WEP Key
PSK Pass Phrase: Admin@123
User ID
Password
Encryption Type: AES

Access Point1

Physical | Config | Attributes

GLOBAL
Settings
INTERFACE
Port 0
Port 1

Port 1

Port Status: On
SSID: Finance-WIFI
2.4 GHz Channel: 6
Coverage Range (meters): 140.00

Authentication
- Disabled
- WEP
- WPA-PSK
- WPA2-PSK

WEP Key
PSK Pass Phrase: Finance@123
User ID
Password
Encryption Type: AES

PC0

Physical | Config | Desktop | Programming | Attributes

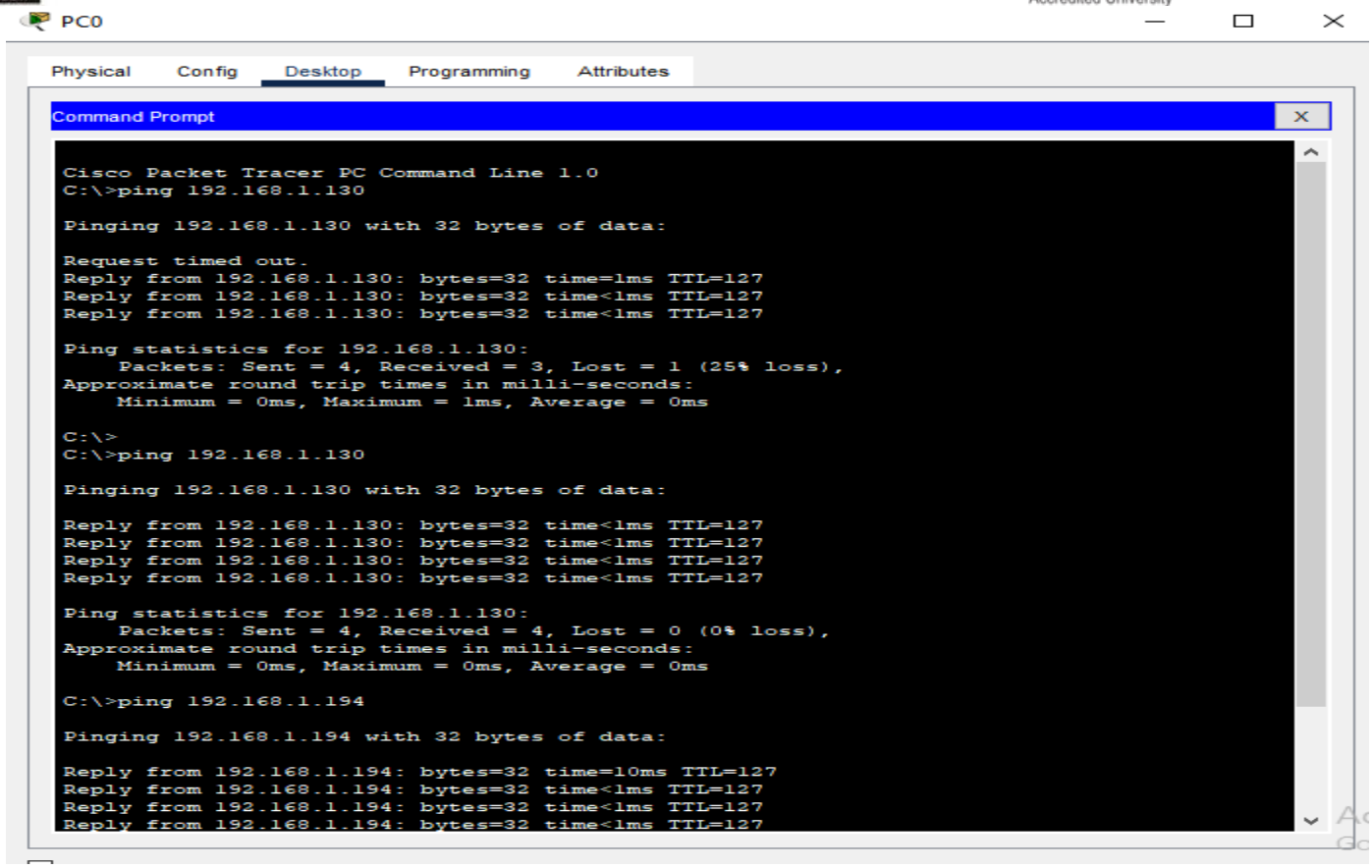
IP Configuration

Interface: FastEthernet0

IP Configuration

- DHCP
- Static

IPv4 Address: 192.168.1.2
Subnet Mask: 255.255.255.192
Default Gateway: 192.168.1.1
DNS Server: 192.168.1.1



11. References

- Cisco Networking Academy Course Materials
- Packet Tracer Labs and Documentation
- Cisco Official Docs