

A Project Rubric On

“Small Office Network Design”

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Of



CHANDIGARH
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BONAFIDE CERTIFICATE

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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 point, 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.
-

10. Printer Setup

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

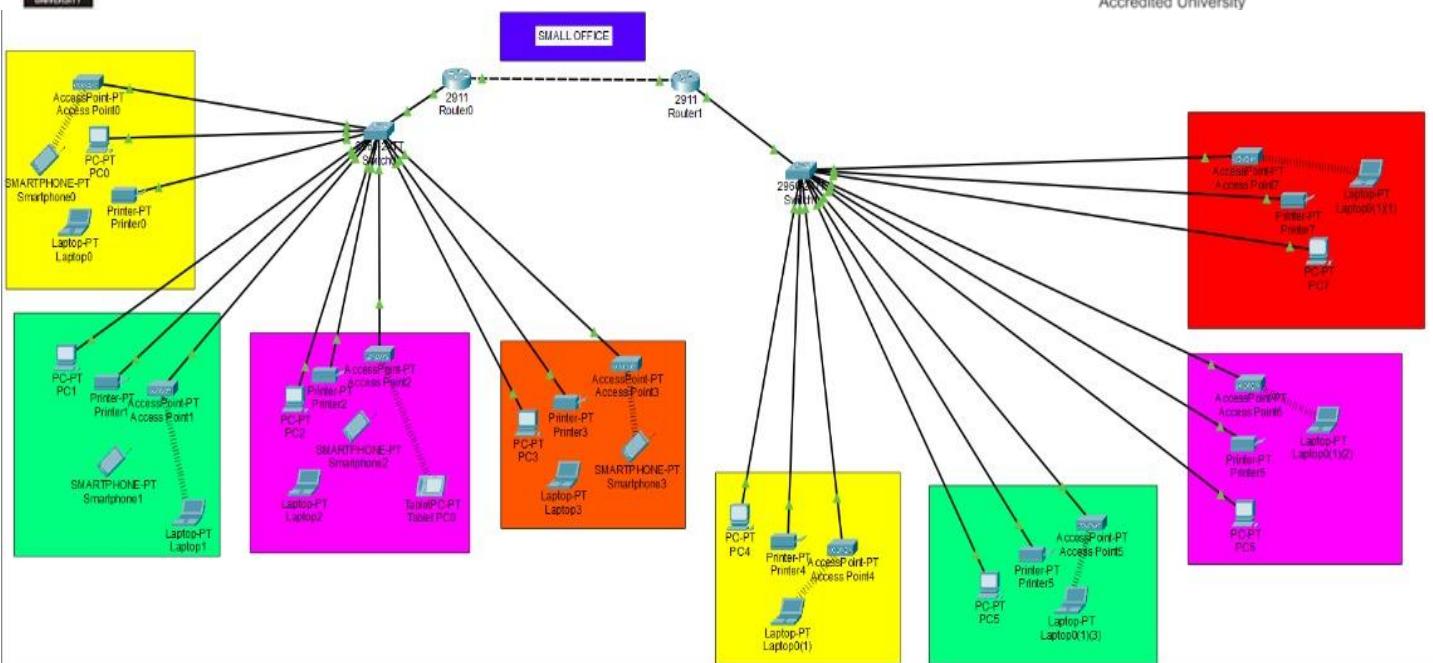
11. Smartphone to Printer Communication

- 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
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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 up

```

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)#exit
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)#exit
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)#exit
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

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	<input checked="" type="checkbox"/> On
SSID	Admin-WIFI
2.4 GHz Channel	6
Coverage Range (meters)	140.00
Authentication	<input type="radio"/> Disabled <input type="radio"/> WPA-PSK <input checked="" type="radio"/> WPA2-PSK
Encryption Type	<input type="radio"/> WEP <input checked="" type="radio"/> WPA2-PSK
WEP Key	
PSK Pass Phrase	Admin@123
User ID	
Password	
AES	



Access Point1

Physical Config Attributes

GLOBAL
Settings
INTERFACE
Port 0
Port 1

Port Status
SSID
2.4 GHz Channel
Coverage Range (meters)

Port 1

On

Finance-WIFI
6
140.00

Authentication
 Disabled WEP WPA2-PSK
WEP Key
PSK Pass Phrase
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

PC0

Physical Config Desktop Programming Attributes

Command Prompt

```
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 192.168.1.130

Pinging 192.168.1.130 with 32 bytes of data:

Request timed out.
Reply from 192.168.1.130: bytes=32 time=1ms TTL=127
Reply from 192.168.1.130: bytes=32 time<1ms TTL=127
Reply from 192.168.1.130: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.1.130:
  Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
  Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\>
C:\>ping 192.168.1.130

Pinging 192.168.1.130 with 32 bytes of data:

Reply from 192.168.1.130: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.1.130:
  Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
  Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>ping 192.168.1.194

Pinging 192.168.1.194 with 32 bytes of data:

Reply from 192.168.1.194: bytes=32 time=10ms TTL=127
Reply from 192.168.1.194: bytes=32 time<1ms TTL=127
Reply from 192.168.1.194: bytes=32 time<1ms TTL=127
Reply from 192.168.1.194: bytes=32 time<1ms TTL=127
```

11. References

- Cisco Networking Academy Course Materials
- Packet Tracer Labs and Documentation
- [Cisco Official Docs](#)