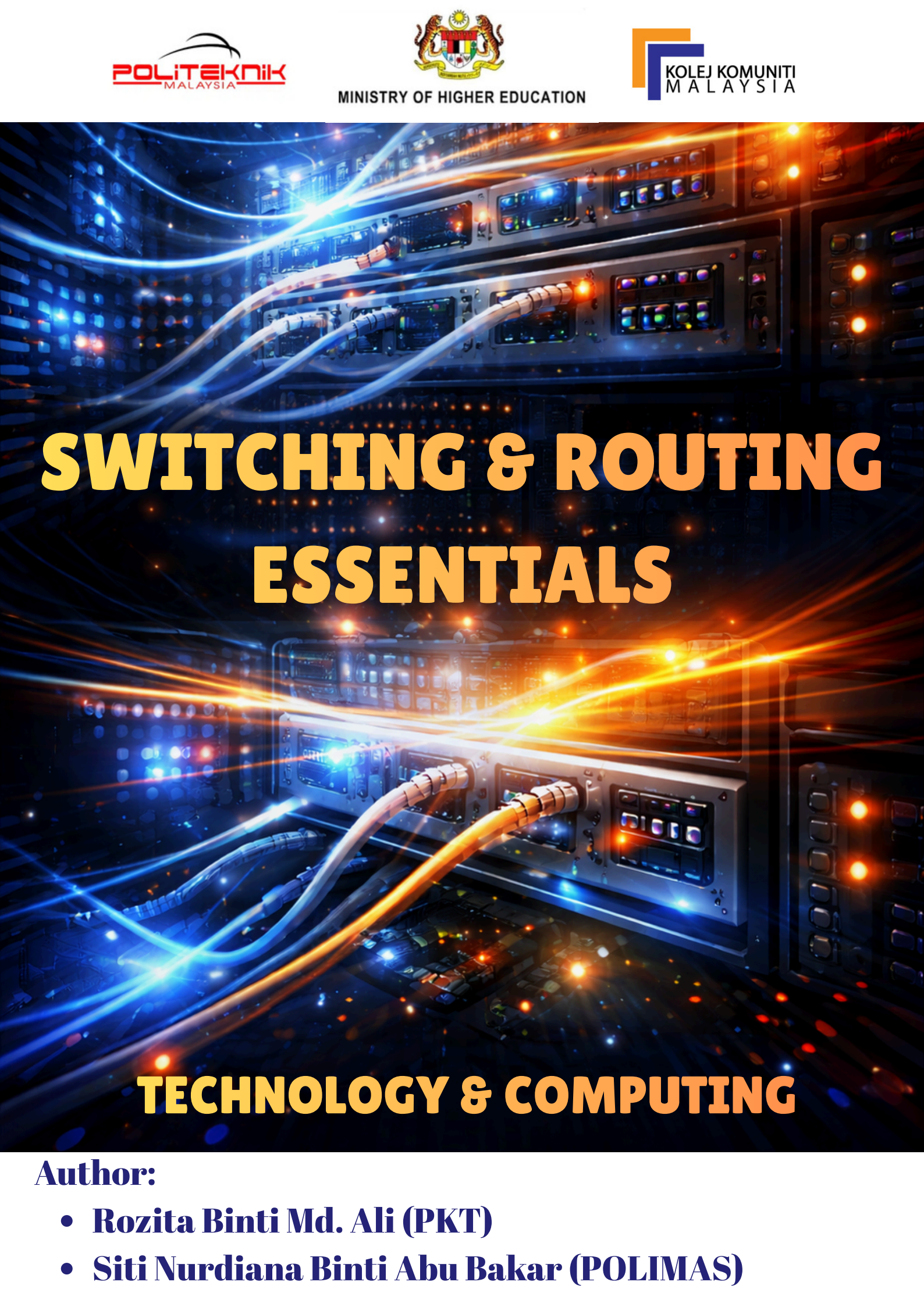




SWITCHING & ROUTING ESSENTIALS

TECHNOLOGY & COMPUTING

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SWITCHING & ROUTING ESSENTIALS



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Rozita & Siti Nurdiana
2026





INTRODUCTION

Switching and Routing Essentials is a course designed to help students understand how networks work behind the scenes. In today's world, almost everything we do like sending messages, browsing the internet, or using online apps is relies on fast and reliable networks. This course teaches students how switches and routers keep these networks running smoothly.

The course also covers important topics such as how devices are connected in a network, how traffic is managed, and how networks communicate using IPv4 and IPv6. One of the most valuable parts of this course is the hands-on lab work. In the lab, students get to install equipment, configure devices, and fix real network problems. These activities make the learning experience more practical and help students build real skills they can use in the future.

Overall, Switching and Routing Essentials gives students the knowledge and confidence to understand, set up, and troubleshoot small- to medium-sized networks. It also provides a strong foundation for more advanced networking courses and future careers in the IT field.



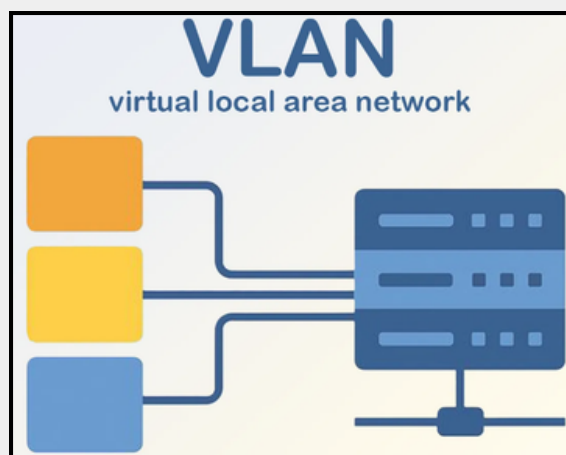
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CHAPTER 1:

VIRTUAL LOCAL AREA NETWORK & INTER-VLAN

- A **VLAN** is used to divide one physical network into smaller, separate virtual networks.
- Its also called **network segmentations**. Think of it like having different “groups” inside one big classroom. Even though everyone is in the same room, each group can talk only to its own members unless given permission.
- VLANs also can groups based on departments, functionality of devices and also by roles. VLANs help to:
 - ✓ Improve security by separating users or departments
 - ✓ Reduce network congestion
 - ✓ Organize devices more efficiently
 - ✓ Make network management easier
- While VLANs separate groups, sometimes these groups need to communicate. **Inter-VLAN** communication allows devices from different VLANs to talk to each other.
- Because VLANs are isolated, they cannot communicate on their own.
- A router or a Layer 3 switch is needed to route traffic between VLANs. This process is called inter-VLAN routing.
- Example: If a computer in VLAN 10 wants to send a file to a computer in VLAN 20, the traffic must pass through a router or a Layer 3 switch that knows how to connect those VLANs.



VLAN CONFIGURATIONS

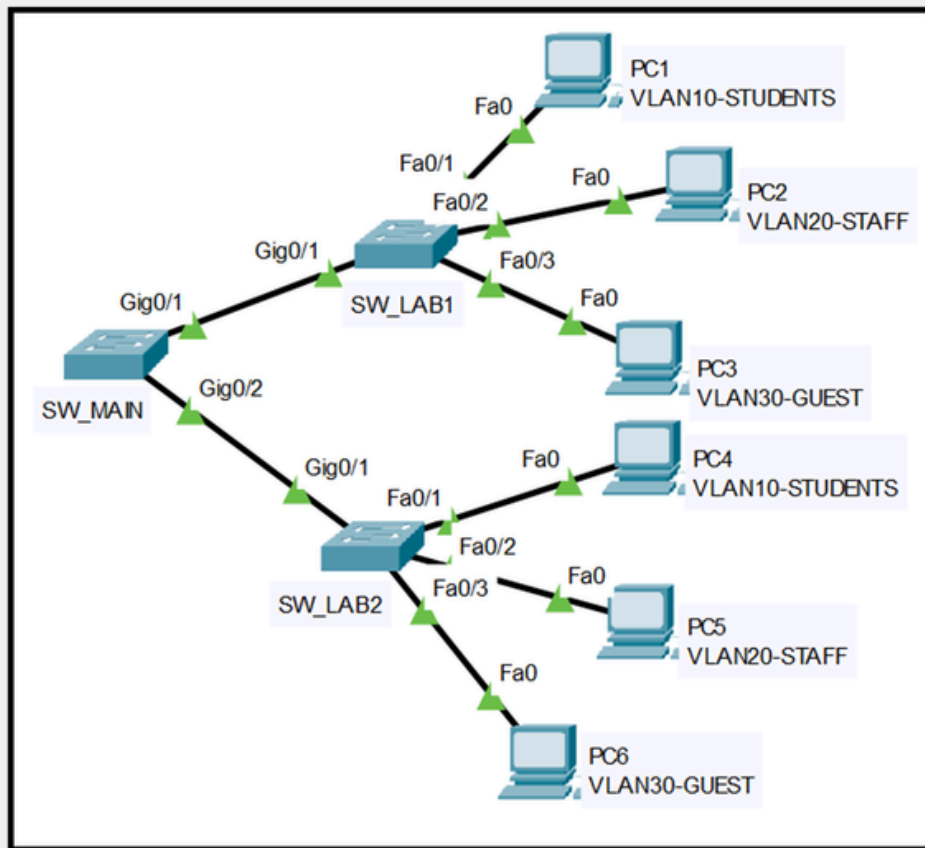


Figure 1 : Network Topology

Number	Item	Network Address/ IP Address	Method IP Assigning
1	VLAN10 – STUDENTS	192.168.10.0/24	DHCP
2	VLAN20 – STAFF	192.168.20.0/24	DHCP
3	VLAN12 – GUEST	192.168.30.0/24	DHCP

Table 1: Addressing Table

Scan code to view
VLAN Configuration



VLAN CONFIGURATIONS

SW_MAIN

1. Creating VLANs

```
SW_MAIN(config)#vlan 10
SW_MAIN(config-vlan)#name STUDENTS
SW_MAIN(config-vlan)#vlan 20
SW_MAIN(config-vlan)#name STAFF
SW_MAIN(config-vlan)#vlan 30
SW_MAIN(config-vlan)#name GUEST
```

2. Verify VLANs

```
SW_MAIN#show vlan
```

```
VLAN Name Status Ports
----
10 STUDENTS active -
20 STAFF active -
30 GUEST active -
SW_LAB1
```

1. Creating VLANs

```
SW_LAB1(config)#vlan 10
SW_LAB1(config-vlan)#name STUDENTS
SW_LAB1(config-vlan)#vlan 20
SW_LAB1(config-vlan)#name STAFF
SW_LAB1(config-vlan)#vlan 30
SW_LAB1(config-vlan)#name GUEST
```

2. Assign VLANs ID to interfaces

```
SW_LAB1(config)#int f0/1
SW_LAB1(config-if)#switchport mode access
SW_LAB1(config-if)#switchport access vlan 10
SW_LAB1(config-if)#ex
```

```
SW_LAB1(config)#int f0/2
SW_LAB1(config-if)#switchport mode access
SW_LAB1(config-if)#switchport access vlan 20
SW_LAB1(config-if)#ex
```

```
SW_LAB1(config)#int f0/3
SW_LAB1(config-if)#switchport mode access
SW_LAB1(config-if)#switchport access vlan 30
SW_LAB1(config-if)#ex
```

VLAN CONFIGURATIONS

1. Verify VLANs

```
SW_LAB1#show vlan
VLAN Name Status Ports
-----
10 STUDENTS active f0/1
20 STAFF active f0/2
30 GUEST active f0/3
```

SW_LAB2

1. Creating VLANs

```
SW_LAB1(config)#vlan 10
SW_LAB1(config-vlan)#name STUDENTS
SW_LAB1(config-vlan)#vlan 20
SW_LAB1(config-vlan)#name STAFF
SW_LAB1(config-vlan)#vlan 30
SW_LAB1(config-vlan)#name GUEST
```

2. Assign VLANs ID to interfaces

```
SW_LAB1(config)#int f0/1
SW_LAB1(config-if)#switchport mode access
SW_LAB1(config-if)#switchport access vlan 10
SW_LAB1(config-if)#ex
```

```
SW_LAB1(config)#int f0/2
SW_LAB1(config-if)#switchport mode access
SW_LAB1(config-if)#switchport access vlan 20
SW_LAB1(config-if)#ex
```

```
SW_LAB1(config)#int f0/3
SW_LAB1(config-if)#switchport mode access
SW_LAB1(config-if)#switchport access vlan 30
SW_LAB1(config-if)#ex
```

3. Verify VLANs

```
SW_LAB1#show vlan
VLAN Name Status Ports
-----
10 STUDENTS active f0/1
20 STAFF active f0/2
30 GUEST active f0/3
```

VLAN CONFIGURATIONS

Assigning IP Address to Hosts

1. VLAN10 – PC1

IP Configuration	
☒ DHCP	☐ Static
IPv4 Address	192.168.10.1
Subnet Mask	255.255.255.0

2. VLAN10 – PC4

IP Configuration	
☒ DHCP	☐ Static
IPv4 Address	192.168.10.2
Subnet Mask	255.255.255.0

3. VLAN20 – PC2

IP Configuration	
☒ DHCP	☐ Static
IPv4 Address	192.168.20.1
Subnet Mask	255.255.255.0

4. VLAN20 – PC5

IP Configuration	
☒ DHCP	☐ Static
IPv4 Address	192.168.20.1
Subnet Mask	255.255.255.0

VLAN CONFIGURATIONS

Assigning IP Address to Hosts

5. VLAN30 – PC3

IP Configuration	
☒ DHCP	☐ Static
IPv4 Address	192.168.30.2
Subnet Mask	255.255.255.0

6. VLAN30 – PC6

IP Configuration	
☒ DHCP	☐ Static
IPv4 Address	192.168.30.1
Subnet Mask	255.255.255.0

VLAN CONFIGURATIONS

Verify same VLAN communication

1. Ping from PC1 to PC4

```
Command Prompt

Cisco Packet Tracer PC Command Line 1.0
C:\>ping 192.168.10.2

Pinging 192.168.10.2 with 32 bytes of data:

Reply from 192.168.10.2: bytes=32 time=10ms TTL=128
Reply from 192.168.10.2: bytes=32 time<1ms TTL=128
Reply from 192.168.10.2: bytes=32 time<1ms TTL=128
Reply from 192.168.10.2: bytes=32 time<1ms TTL=128

Ping statistics for 192.168.10.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 10ms, Average = 2ms
```

2. Ping from PC2 to PC5

```
Command Prompt

Cisco Packet Tracer PC Command Line 1.0
C:\>ping 192.168.20.2

Pinging 192.168.20.2 with 32 bytes of data:

Reply from 192.168.20.2: bytes=32 time=6ms TTL=128
Reply from 192.168.20.2: bytes=32 time=2ms TTL=128
Reply from 192.168.20.2: bytes=32 time<1ms TTL=128
Reply from 192.168.20.2: bytes=32 time=2ms TTL=128

Ping statistics for 192.168.20.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 6ms, Average = 2ms
```

3. Ping from PC3 to PC6

```
Command Prompt

Cisco Packet Tracer PC Command Line 1.0
C:\>ping 192.168.30.1

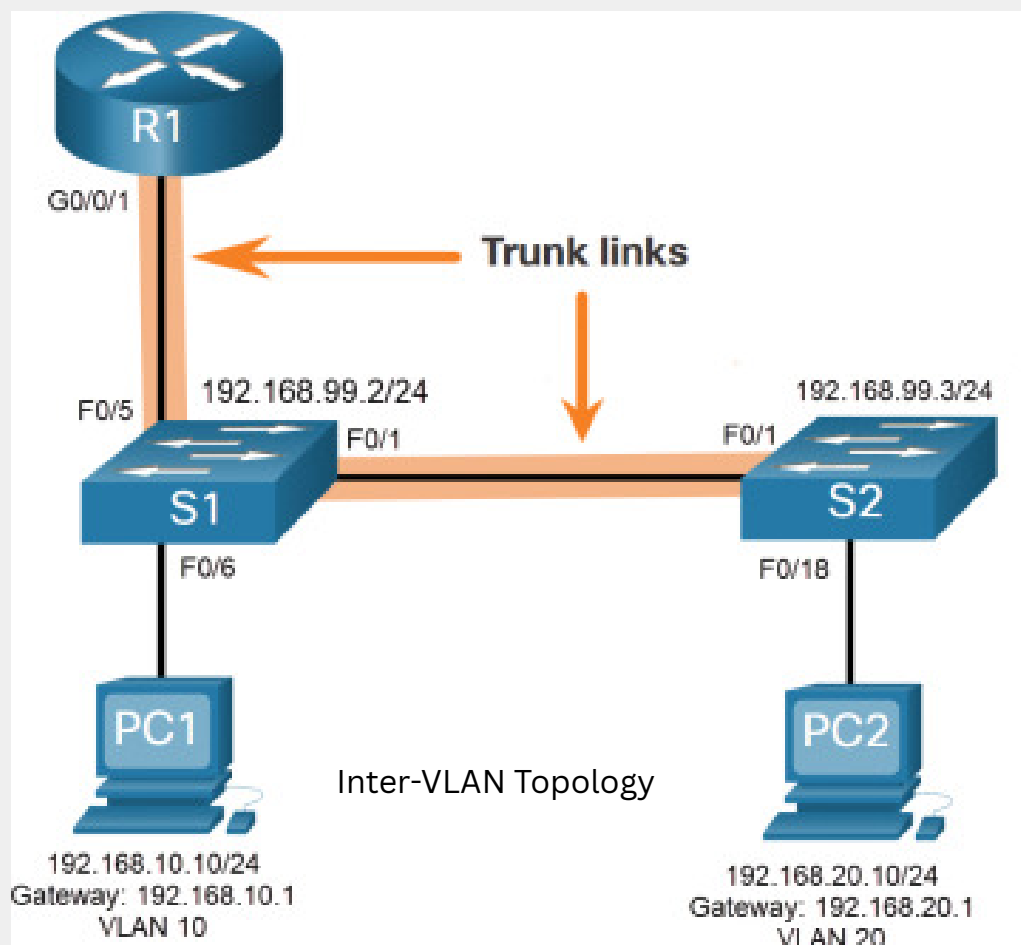
Pinging 192.168.30.1 with 32 bytes of data:

Reply from 192.168.30.1: bytes=32 time<1ms TTL=128
Reply from 192.168.30.1: bytes=32 time<1ms TTL=128
Reply from 192.168.30.1: bytes=32 time<1ms TTL=128
Reply from 192.168.30.1: bytes=32 time<1ms TTL=128

Ping statistics for 192.168.30.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

INTER-VLAN CONFIGURATIONS

Inter-VLAN Routing is a method that allows devices in different VLANs to communicate with each other through a router or Layer 3 switch. It acts like a bridge connecting separate network groups while keeping the network organized and secure.



INTER-VLAN CONFIGURATIONS

Inter-VLAN Routing is a method that allows devices in different VLANs to communicate with each other through a router or Layer 3 switch. It acts like a bridge connecting separate network groups while keeping the network organized and secure.

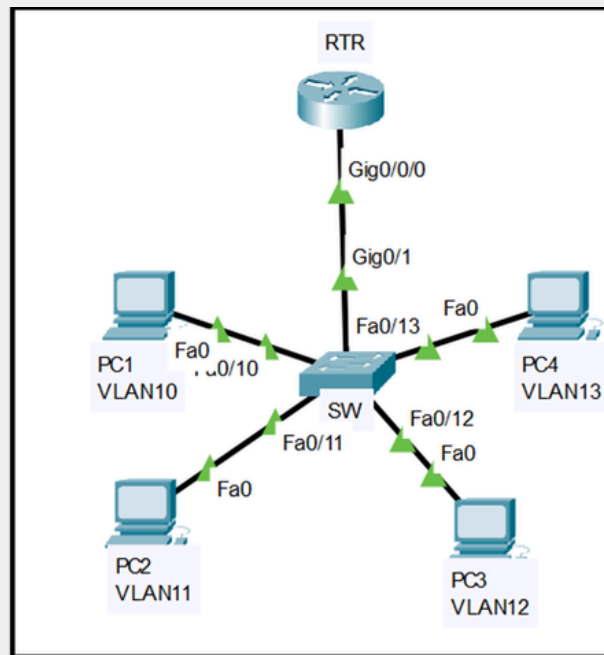


Figure 2 : Network Topology

Number	Item	Network Address/IP Address	Method IP Assigning
1	VLAN10	10.10.10.0/24	DHCP
2	VLAN11	10.10.11.0/24	DHCP
3	VLAN12	10.10.12.0/24	DHCP
4	VLAN13	10.10.13.0/24	DHCP

Table 2: Addressing Table

Scan code to view
Inter-VLAN Configuration



INTER-VLAN CONFIGURATIONS

SW

1. Creating VLANs

```
SW(config)#vlan 10
SW(config-vlan)#vlan 11
SW(config-vlan)#vlan 12
SW(config-vlan)#vlan 13
```

2. Assign VLANs ID to interfaces

```
SW(config)#int f0/10
SW(config-if)#switchport mode access
SW(config-if)#switchport access vlan 10
SW(config-if)#ex
SW(config)#int f0/11
SW(config-if)#switchport mode access
SW(config-if)#switchport access vlan 11
SW(config-if)#ex
SW(config)#int f0/12
SW(config-if)#switchport mode access
SW(config-if)#switchport access vlan 12
SW(config-if)#ex
SW(config)#int f0/13
SW(config-if)#switchport mode access
SW(config-if)#switchport access vlan 13
SW(config-if)#ex
```

3. Verify VLANs

```
SW_MAIN#show vlan
```

VLAN	Name	Status	Ports
10	VLAN0010	active	Fa0/10
11	VLAN0011	active	Fa0/11
12	VLAN0012	active	Fa0/12
13	VLAN0013	active	Fa0/13

INTER-VLAN CONFIGURATIONS

RTR

1. Configuring IP address to subinterfaces of G0/0/0.

```
RTR(config)#int g0/0/0
RTR(config-if)#no sh
RTR(config-if)#ex
RTR(config)#int g0/0/0.10
RTR(config-subif)#encapsulation dot1Q 10
RTR(config-subif)#ip add 10.10.10.1 255.255.255.0
RTR(config-subif)#no sh
RTR(config-subif)#ex
RTR(config)#int g0/0/0.11
RTR(config-subif)#encapsulation dot1Q 11
RTR(config-subif)#ip add 10.10.11.1 255.255.255.0
RTR(config-subif)#no sh
RTR(config-subif)#ex
RTR(config)#int g0/0/0.12
RTR(config-subif)#encapsulation dot1Q 12
RTR(config-subif)#ip add 10.10.12.1 255.255.255.0
RTR(config-subif)#no sh
RTR(config-subif)#ex
RTR(config)#int g0/0/0.13
RTR(config-subif)#encapsulation dot1Q 13
RTR(config-subif)#ip add 10.10.13.1 255.255.255.0
RTR(config-subif)#no sh
```

2. Verify communication between VLAN and default gateway.

i. Ping from PC1-VLAN10 to default gateway

Command Prompt

```
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 10.10.10.1

Pinging 10.10.10.1 with 32 bytes of data:

Reply from 10.10.10.1: bytes=32 time=3ms TTL=255
Reply from 10.10.10.1: bytes=32 time<1ms TTL=255
Reply from 10.10.10.1: bytes=32 time<1ms TTL=255
Reply from 10.10.10.1: bytes=32 time<1ms TTL=255

Ping statistics for 10.10.10.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 3ms, Average = 0ms
```

INTER-VLAN CONFIGURATIONS

ii. Ping from PC2-VLAN11 to default gateway

```
Command Prompt

Cisco Packet Tracer PC Command Line 1.0
C:\>ping 10.10.11.1

Pinging 10.10.11.1 with 32 bytes of data:

Reply from 10.10.11.1: bytes=32 time<1ms TTL=255
Reply from 10.10.11.1: bytes=32 time<1ms TTL=255
Reply from 10.10.11.1: bytes=32 time<1ms TTL=255
Reply from 10.10.11.1: bytes=32 time<1ms TTL=255

Ping statistics for 10.10.11.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

iii. Ping from PC3-VLAN12 to default gateway

```
Command Prompt

Cisco Packet Tracer PC Command Line 1.0
C:\>ping 10.10.12.1

Pinging 10.10.12.1 with 32 bytes of data:

Reply from 10.10.12.1: bytes=32 time<1ms TTL=255
Reply from 10.10.12.1: bytes=32 time<1ms TTL=255
Reply from 10.10.12.1: bytes=32 time<1ms TTL=255
Reply from 10.10.12.1: bytes=32 time<1ms TTL=255

Ping statistics for 10.10.12.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

iv. Ping from PC4-VLAN13 to default gateway

```
Command Prompt

Cisco Packet Tracer PC Command Line 1.0
C:\>ping 10.10.13.1

Pinging 10.10.13.1 with 32 bytes of data:

Reply from 10.10.13.1: bytes=32 time<1ms TTL=255
Reply from 10.10.13.1: bytes=32 time<1ms TTL=255
Reply from 10.10.13.1: bytes=32 time<1ms TTL=255
Reply from 10.10.13.1: bytes=32 time<1ms TTL=255

Ping statistics for 10.10.13.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms
```


CHAPTER 2:

FAULT TOLERANCE IN SWITCHED NETWORK

➤ In a switched network, it is important to make sure the network stays online even when something goes wrong. Devices, cables, or links can fail at any time, and without protection, these failures can cause network loops, slow performance, or complete disconnection.

➤ To prevent this, modern networks use several fault-tolerance technologies that keep the network running smoothly. Three important technologies are:

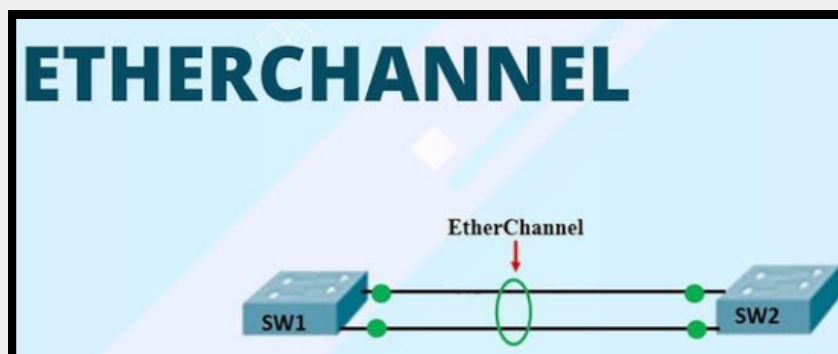
- ✓ Spanning Tree Protocol (STP)
- ✓ EtherChannel
- ✓ Hot Standby Router Protocol (HSRP).

➤ **STP** helps the network avoid switching loops by automatically blocking and unblocking redundant links. If one link fails, STP quickly activates another link so that traffic can continue to flow safely.

➤ **EtherChannel** combines multiple physical links into one logical connection. This increases bandwidth and also provides backup: if one cable breaks, the other links in the channel still keep the connection alive.

➤ **HSRP** provides router redundancy by allowing two or more routers to work together as a backup group. If the main router fails, another router immediately takes over so users do not lose connectivity.

➤ Understanding STP, EtherChannel, and HSRP helps students see how networks maintain stability, reduce downtime, and remain reliable even during unexpected problems. These technologies are essential for building strong, resilient switched networks that can support real-world needs.



STP CONFIGURATIONS

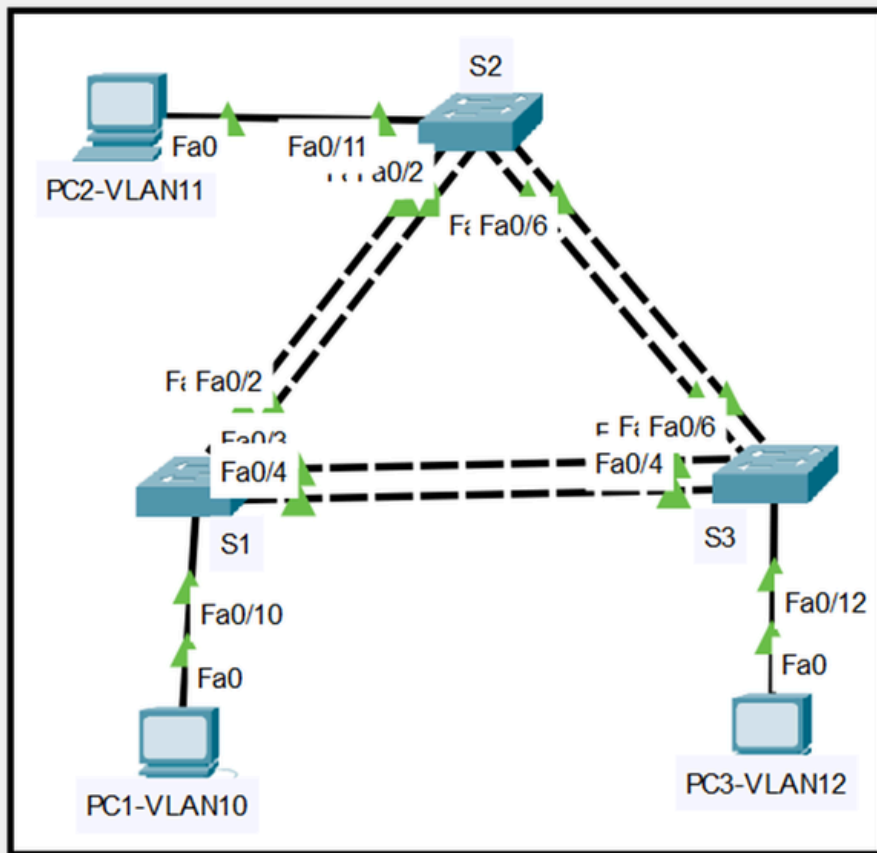


Figure 3: Network Topology

Number	Item	Network Address/IP Address	Method IP Assigning
1	PC1 - VLAN10	172.31.10.2/24	STATIC
2	PC2 - VLAN11	172.31.11.3/24	
3	PC3 - VLAN12	172.31.12.4/24	

Table 3: Addressing Table

Scan code to view
STP Configuration



STP CONFIGURATIONS

Configure STP mode

1. S1

```
S1(config)#spanning-tree mode pvst
```

2. S2

```
S2(config)#spanning-tree mode pvst
```

3. S3

```
S3(config)#spanning-tree mode pvst
```

Configure Spanning Tree PVST+ load balancing

1. S1

```
S1(config)#spanning-tree vlan 10,11,12,13,14 root primary
```

2. S2

```
S2(config)#spanning-tree vlan 10,11,12,13,14,15,16,17,18,19,20 root secondary
```

3. S3

```
S3(config)#spanning-tree vlan 15,16,17,18,19,20 root primary
```

Configure PortFast and BPDU guard on the switches

1. S1

```
S1(config)#int f0/10
```

```
S1(config-if)#spanning-tree portfast
```

```
S1(config-if)#spanning-tree bpduguard enable
```

2. S2

```
S2(config)#int f0/11
```

```
S2(config-if)#spanning-tree portfast
```

```
S2(config-if)#spanning-tree bpduguard enable
```

3. S3

```
S3(config)#int f0/12
```

```
S3(config-if)#spanning-tree portfast
```

```
S3(config-if)#spanning-tree bpduguard enable
```

STP CONFIGURATIONS

Verify Spanning-tree on switches

1. S1

```
S1#show spanning-tree
VLAN0001
Spanning tree enabled protocol ieee
Root ID Priority 32769
Address 0001.C710.773B
Cost 19
Port 3(FastEthernet0/3)
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 32769 (priority 32768 sys-id-ext 1)
Address 00D0.FFC8.15C5
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 20
```

Interface	Role	Sts	Cost	Prio.	Nbr	Type
Fa0/3	Root	FWD	19	128.3	P2p	
Fa0/2	Altn	BLK	19	128.2	P2p	
Fa0/1	Altn	BLK	19	128.1	P2p	
Fa0/4	Altn	BLK	19	128.4	P2p	

ETHERCHANNEL CONFIGURATIONS– LINK AGGREGATION CONTROL PROTOCOL (LACP)

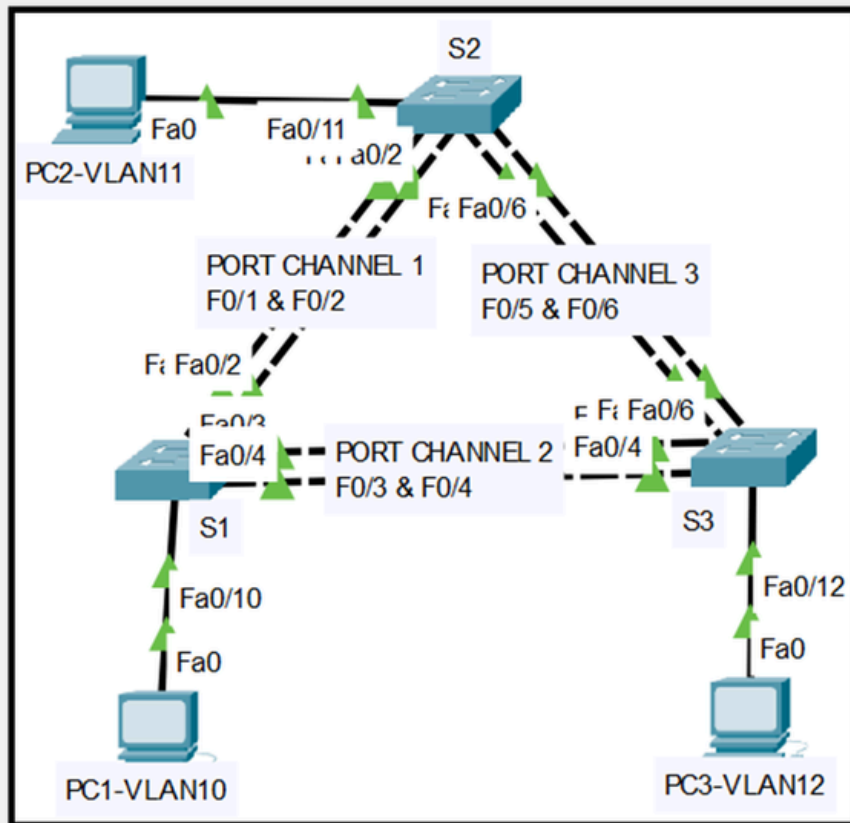


Figure 4: Network Topology

Number	Item	Network Address/IP Address	Method IP Assigning
1	PC1 - VLAN10	172.31.10.2/24	STATIC
2	PC2 - VLAN11	172.31.20.3/24	
3	PC3 - VLAN12	172.31.30.4/24	

Table 4: Addressing Table

LINK AGGREGATION CONTROL PROTOCOL (LACP)

S1

1. Creating interfaces port channel

```
S1(config)#int port-channel 1
S1(config-if)#switchport mode trunk
S1(config-if)#switchport trunk allowed vlan 10,11,12
S1(config-if)#ex
S1(config)#int port-channel 2
S1(config-if)#switchport mode trunk
S1(config-if)#switchport trunk allowed vlan 10,11,12
S1(config-if)#ex
```

2. Implement LACP on interfaces

```
S1(config)#int r f0/1-2
S1(config-if-range)#channel-group 1 mode active
S1(config-if-range)#ex
S1(config)#int r f0/3-4
S1(config-if-range)#channel-group 2 mode active
S1(config-if-range)#ex
```

3. Verify LACP Etherchannel

```
S1#show etherchannel summary
Flags: D - down P - in port-channel
I - stand-alone s - suspended
H - Hot-standby (LACP only)
R - Layer3 S - Layer2
U - in use f - failed to allocate aggregator
u - unsuitable for bundling
w - waiting to be aggregated
d - default port
```

Number of channel-groups in use: 2

Number of aggregators: 2

Group	Port-channel	Protocol	Ports
1	Po1 (SU)	LACP	Fa0/1 (P) Fa0/2 (P)
2	Po2 (SU)	LACP	Fa0/3 (P) Fa0/4 (P)

LINK AGGREGATION CONTROL PROTOCOL (LACP)

S2

1. Creating interfaces port channel

```
S2(config)#int port-channel 1
S2(config-if)#switchport mode trunk
S2(config-if)#switchport trunk allowed vlan 10,11,12
S2(config-if)#ex
S2(config)#int port-channel 3
S2(config-if)#switchport mode trunk
S2(config-if)#switchport trunk allowed vlan 10,11,12
S2(config-if)#ex
```

2. Implement LACP on interfaces

```
S2(config)#int r f0/1-2
S2(config-if-range)#channel-group 1 mode active
S2(config-if-range)#ex
S2(config)#int r f0/5-6
S2(config-if-range)#channel-group 3 mode active
S2(config-if-range)#ex
```

3. Verify LACP EtherChannel

```
S2#show etherchannel summary
Flags: D - down P - in port-channel
I - stand-alone s - suspended
H - Hot-standby (LACP only)
R - Layer3 S - Layer2
U - in use f - failed to allocate aggregator
u - unsuitable for bundling
w - waiting to be aggregated
d - default port
```

Number of channel-groups in use: 2

Number of aggregators: 2

Group	Port-channel	Protocol	Ports
1	Po1(SU)	LACP	Fa0/1(P) Fa0/2(P)
3	Po3(SU)	LACP	Fa0/5(P) Fa0/6(P)

LINK AGGREGATION CONTROL PROTOCOL (LACP)

S3

1. Creating interfaces port channel

```
S3(config)#int port-channel 2
S3(config-if)#switchport mode trunk
S3(config-if)#switchport trunk allowed vlan 10,11,12
S3(config-if)#ex
S3(config)#int port-channel 3
S3(config-if)#switchport mode trunk
S3(config-if)#switchport trunk allowed vlan 10,11,12
S3(config-if)#ex
```

2. Implement LACP EtherChannel on interfaces

```
S3(config)#int r f0/3-4
S3(config-if-range)#channel-group 2 mode active
S3(config-if-range)#ex
S3(config)#int r f0/5-6
S3(config-if-range)#channel-group 3 mode active
S3(config-if-range)#ex
```

3. Verify LACP EtherChannel

```
S3#show etherchannel summary
Flags: D - down P - in port-channel
I - stand-alone s - suspended
H - Hot-standby (LACP only)
R - Layer3 S - Layer2
U - in use f - failed to allocate aggregator
u - unsuitable for bundling
w - waiting to be aggregated
d - default port
```

Number of channel-groups in use: 2

Number of aggregators: 2

Group	Port-channel	Protocol	Ports
2	Po2(SU)	LACP	Fa0/3 (P) Fa0/4 (P)
3	Po3(SU)	LACP	Fa0/5 (P) Fa0/6 (P)

ETHERCHANNEL CONFIGURATIONS– PORT AGGREGATION PROTOCOL (PAgP)

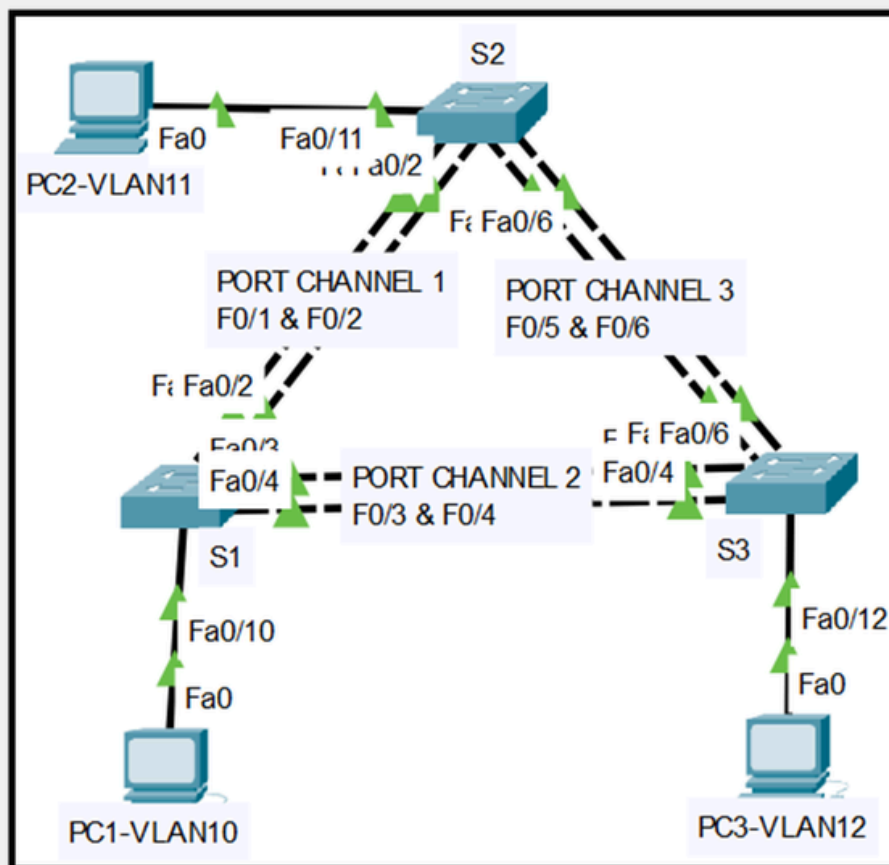


Figure 5: Network Topology

Number	Item	Network Address/IP Address	Method IP Assigning
1	PC1 - VLAN10	172.31.10.2/24	STATIC
2	PC2 - VLAN11	172.31.20.3/24	
3	PC3 - VLAN12	172.31.30.4/24	

Table 5: Addressing Table

PORT AGGREGATION PROTOCOL (PAgP)

Implement PAgP on interfaces

1. S1

```
S1(config)#int r f0/1-2
S1(config-if-range)#channel-group 1 mode desirable
S1(config-if-range)#ex
S1(config)#int r f0/3-4
S1(config-if-range)#channel-group 2 mode desirable
S1(config-if-range)#ex
```

2. S2

```
S2(config)#int r f0/1-2
S2(config-if-range)#channel-group 1 mode desirable
S2(config-if-range)#ex
S2(config)#int r f0/5-6
S2(config-if-range)#channel-group 3 mode desirable
S2(config-if-range)#ex
```

3. S3

```
S3(config)#int r f0/3-4
S3(config-if-range)#channel-group 2 mode desirable
S3(config-if-range)#ex
S3(config)#int r f0/5-6
S3(config-if-range)#channel-group 3 mode desirable
S3(config-if-range)#ex
```

Verify PAgP EtherChannel on switches

1. S1

```
SW1#sh etherchannel summary
Flags: D - down P - in port-channel
I - stand-alone s - suspended
H - Hot-standby (LACP only)
R - Layer3 S - Layer2
U - in use f - failed to allocate aggregator
u - unsuitable for bundling
w - waiting to be aggregated
d - default port
Number of channel-groups in use: 2
Number of aggregators: 2
Group Port-channel Protocol Ports
-----+-----+-----+-----+
1      Po1(SU)      PAgP      Fa0/1(P) Fa0/2(P)
2      Po2(SU)      PAgP      Fa0/3(P) Fa0/4(P)
```

PORT AGGREGATION PROTOCOL (PAgP)

1. S2

```
SW2#sh etherchannel summary
Flags: D - down P - in port-channel
I - stand-alone s - suspended
H - Hot-standby (LACP only)
R - Layer3 S - Layer2
U - in use f - failed to allocate aggregator
u - unsuitable for bundling
w - waiting to be aggregated
d - default port
Number of channel-groups in use: 2
Number of aggregators: 2
Group Port-channel Protocol Ports
-----+-----+-----+-----
1      Po1(SU)      PAgP      Fa0/1(P) Fa0/2(P)
2      Po3(SU)      PAgP      Fa0/5(P) Fa0/6(P)
```

2. S3

```
SW3#sh etherchannel summary
Flags: D - down P - in port-channel
I - stand-alone s - suspended
H - Hot-standby (LACP only)
R - Layer3 S - Layer2
U - in use f - failed to allocate aggregator
u - unsuitable for bundling
w - waiting to be aggregated
d - default port
Number of channel-groups in use: 2
Number of aggregators: 2
Group Port-channel Protocol Ports
-----+-----+-----+-----
1      Po2(SU)      PAgP      Fa0/3(P) Fa0/4(P)
2      Po3(SU)      PAgP      Fa0/5(P) Fa0/6(P)
```

CHAPTER 3:

DYNAMIC HOST CONFIGURATION PROTOCOL (DHCP)

- Have you ever connected your laptop, smartphone, or tablet to a Wi-Fi network and noticed that it starts working immediately without asking you to enter an IP address or any network settings? This convenience is made possible by DHCP (Dynamic Host Configuration Protocol).
- Think of DHCP as a network assistant that automatically provides devices with the information they need to communicate on the network. As soon as a device connects, DHCP assigns important settings such as an IP address, subnet mask, default gateway, and DNS server.
- Without DHCP, users would need to enter these settings manually for every device, which can be time-consuming and may lead to configuration errors. By automating this process, DHCP makes network management much easier, especially in environments such as homes, schools, and offices where many devices connect every day.
- In simple terms, DHCP helps devices join a network quickly and correctly. It keeps the network organized and allows users to focus on their work or activities instead of worrying about network configuration.

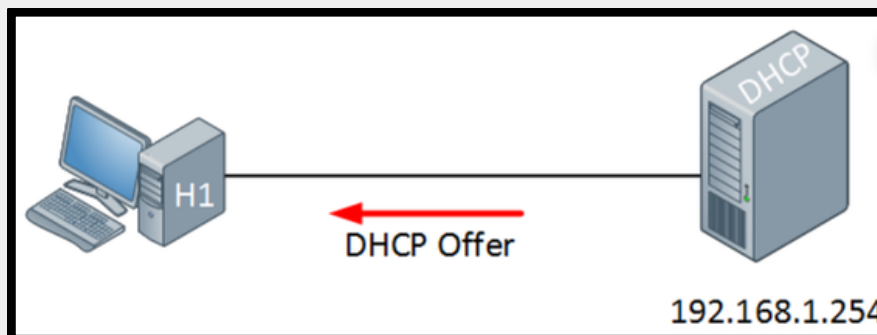


Figure 6: Network Topology

Scan code to view
DHCP Configuration



DYNAMIC HOST CONFIGURATION PROTOCOL (DHCP) CONFIGURATIONS

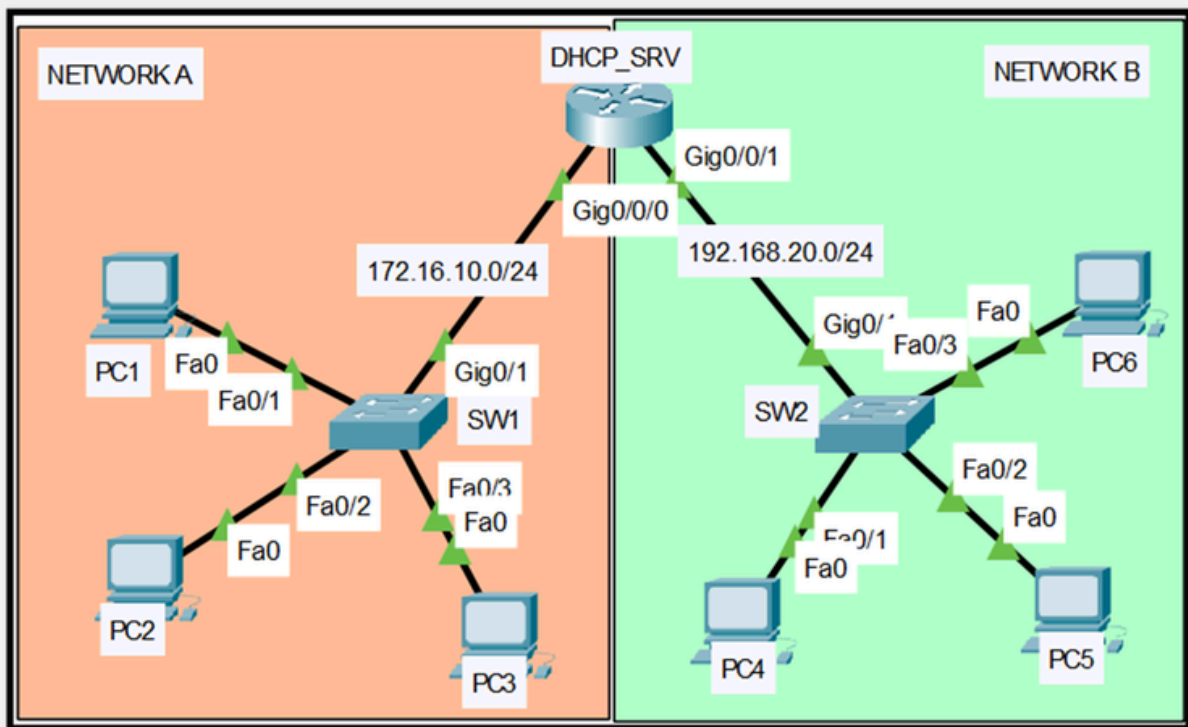


Figure 7: Network Topology

DHCP_SRV

Network A

1. Creating Address Pool

```
DHCP_SRV(config)#ip dhcp pool network-A
DHCP_SRV(dhcp-config)#network 172.16.10.0 255.255.255.0
DHCP_SRV(dhcp-config)#default-router 172.16.10.1
DHCP_SRV(dhcp-config)#dns-server 172.16.10.100
DHCP_SRV(dhcp-config)#domain-name network_A.com.my
DHCP_SRV(dhcp-config)#ex
```


DYNAMIC HOST CONFIGURATION PROTOCOL (DHCP) CONFIGURATIONS

1. Verify DHCP services

On Router

```
DHCP_SRV#show ip dhcp binding
```

```
IP address Client-ID/ Lease expiration  
Type Hardware address  
172.16.10.2 000C.CF02.7011 -  
Automatic  
172.16.10.3 00D0.BA9B.67A9 -  
Automatic  
172.16.10.4 00D0.D3E3.28A3 -  
Automatic
```

On Hosts

PC1



The screenshot shows a network configuration window titled "IP Configuration". It has two radio buttons: "DHCP" (which is selected) and "Static". Below these are five input fields for network parameters:

Parameter	Value
IPv4 Address	172.16.10.2
Subnet Mask	255.255.255.0
Default Gateway	172.16.10.1
DNS Server	172.16.10.100

DYNAMIC HOST CONFIGURATION PROTOCOL (DHCP) CONFIGURATIONS

PC2

IP Configuration	
☒ DHCP	☐ Static
IPv4 Address	172.16.10.3
Subnet Mask	255.255.255.0
Default Gateway	172.16.10.1
DNS Server	172.16.10.100

PC3

IP Configuration	
☒ DHCP	☐ Static
IPv4 Address	172.16.10.4
Subnet Mask	255.255.255.0
Default Gateway	172.16.10.1
DNS Server	172.16.10.100

DYNAMIC HOST CONFIGURATION PROTOCOL (DHCP) CONFIGURATIONS

Network B

1. Creating Address Pool

```
DHCP_SRV(config)#ip dhcp pool network-B
DHCP_SRV(dhcp-config)#network 192.168.20.0 255.255.255.0
DHCP_SRV(dhcp-config)#default-router 192.168.20.1
DHCP_SRV(dhcp-config)#dns-server 192.168.20.120
DHCP_SRV(dhcp-config)#domain-name network_B.com.my
DHCP_SRV(dhcp-config)#ex
```

2. Verify DHCP services

On router

```
DHCP_SRV#show ip dhcp binding

IP address Client-ID/ Lease expiration
Type Hardware address
192.168.20.2 0001.42E1.0716 -
Automatic
192.168.20.3 0060.709E.C824 -
Automatic
192.168.20.4 0002.176D.0A4C -
Automatic
```

DYNAMIC HOST CONFIGURATION PROTOCOL (DHCP) CONFIGURATIONS

On Hosts

PC4

IP Configuration	
☒ DHCP	☐ Static
IPv4 Address	192.168.20.2
Subnet Mask	255.255.255.0
Default Gateway	192.168.20.1
DNS Server	192.168.20.120

PC5

IP Configuration	
☒ DHCP	☐ Static
IPv4 Address	192.168.20.3
Subnet Mask	255.255.255.0
Default Gateway	192.168.20.1
DNS Server	192.168.20.120

PC6

IP Configuration	
☒ DHCP	☐ Static
IPv4 Address	192.168.20.4
Subnet Mask	255.255.255.0
Default Gateway	192.168.20.1
DNS Server	192.168.20.120

DYNAMIC HOST CONFIGURATION PROTOCOL (DHCP) CONFIGURATIONS – RELAY AGENTS

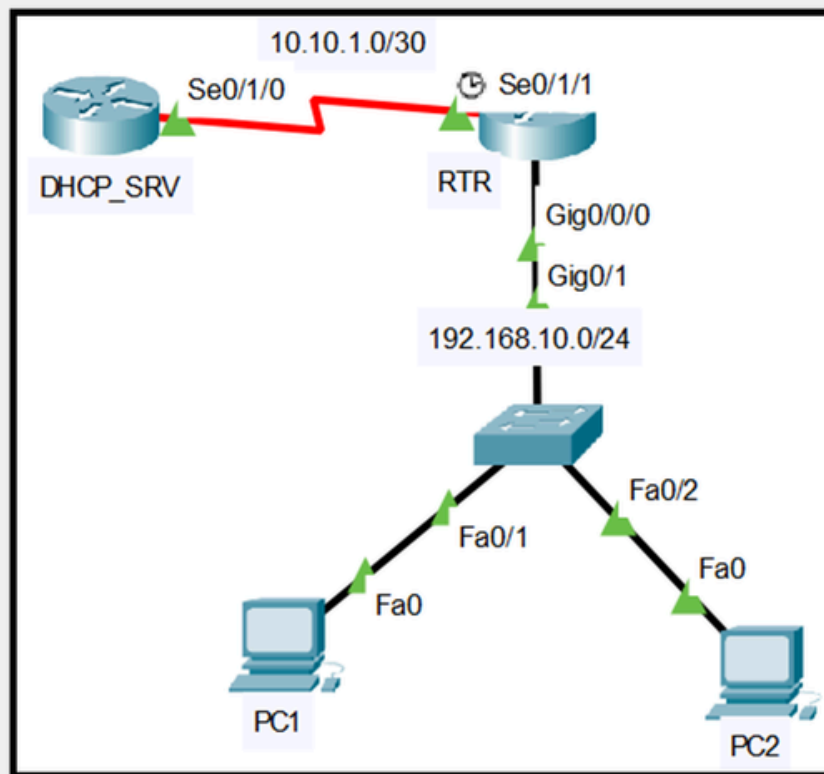


Figure 8: Network Topology

DHCP_SRV

1. Creating Address Pool

```
DHCP_SRV(config)#ip dhcp pool LAN
DHCP_SRV(dhcp-config)#network 192.168.10.0 255.255.255.0
DHCP_SRV(dhcp-config)#default-router 192.168.10.1
DHCP_SRV(dhcp-config)#dns-server 192.168.10.100
DHCP_SRV(dhcp-config)#domain-name lan.com.my
DHCP_SRV(dhcp-config)#ex
```

2. Setting IP Helper Address on RTR interfaces

```
RTR(config)#int g0/0/0
RTR(config-if)#ip helper-address 10.10.1.1
```

DYNAMIC HOST CONFIGURATION PROTOCOL (DHCP) CONFIGURATIONS – RELAY AGENTS

3. Verfiy DHCP Services

PC1

IP Configuration	
☒ DHCP	☐ Static
IPv4 Address	192.168.10.8
Subnet Mask	255.255.255.0
Default Gateway	192.168.10.1
DNS Server	192.168.10.100

PC2

IP Configuration	
☒ DHCP	☐ Static
IPv4 Address	192.168.10.9
Subnet Mask	255.255.255.0
Default Gateway	192.168.10.1
DNS Server	192.168.10.100

CHAPTER 4:

ROUTING PROTOCOLS

- Imagine the internet or a large network like a huge city. Every device including PCs, switches, routers are like buildings, and the data we send is like cars traveling from one place to another.
- Think of a computer network like a huge road system. Routers act like traffic police, guiding data (cars) to the right destination. To do this, routers need some way to decide which road (path) is the best. This decision-making method is called a **routing protocol**.
- A routing protocol is like Waze or Google Maps for routers. It helps routers:
 - ✓ Learn about other networks
 - ✓ Choose the fastest or most reliable path
 - ✓ Share route information with other routers
 - ✓ Update paths when something changes (e.g., a link goes down)
- Why do we need routing protocols? Because networks are:
 - ✓ Big
 - ✓ Always changing
 - ✓ Full of multiple paths
 - ✓ Too complex to manage manually
- Two Main Ways Routers Choose Paths. Routers can learn paths using:
 - ✓ Static Routing (Manual GPS)
 - ✓ Dynamic Routing (Automatic GPS / Waze)

CHAPTER 4:

ROUTING PROTOCOLS – STATIC ROUTING

- Static routing is like giving someone written directions and telling them: “Follow this exact path. Don’t change!”
- A network engineer manually enters the route into the router. The router will never change that path unless the engineer updates it.
- Benefits:
 - ✓ Simple to set up
 - ✓ Very stable
 - ✓ Good for small networks
 - ✓ Router uses almost no extra processing

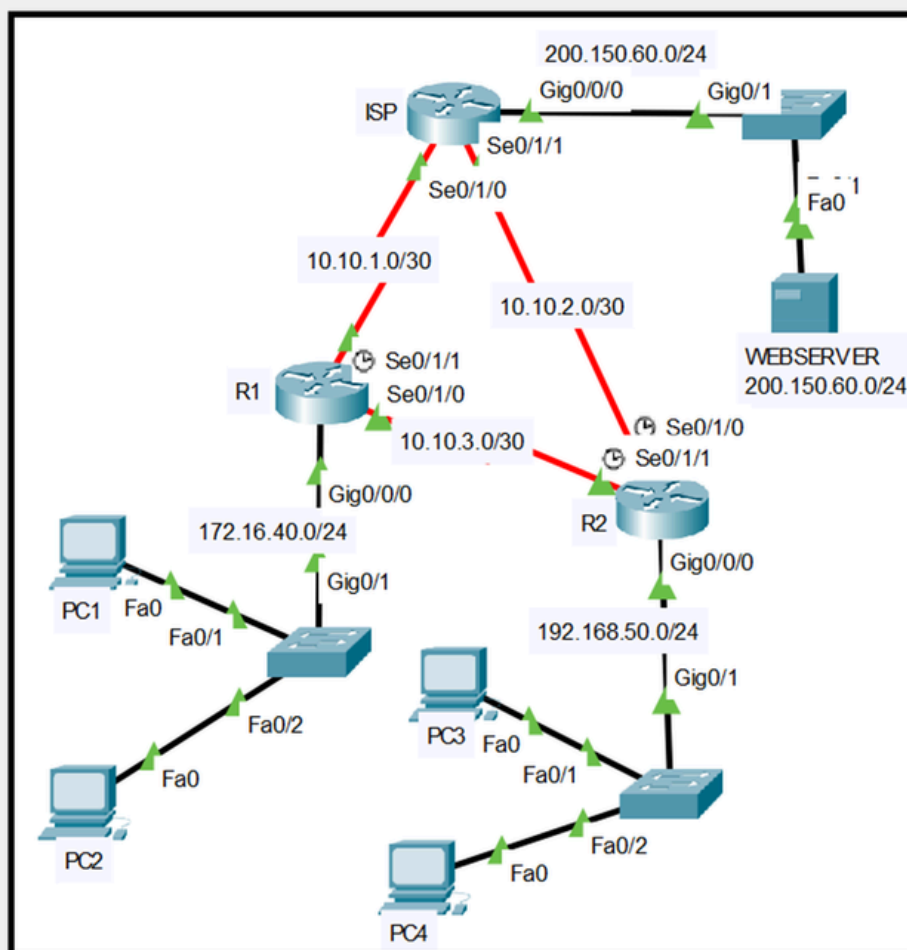


Figure 9: Network Topology

CHAPTER 4:

ROUTING PROTOCOLS – STATIC ROUTING

Number	Item	Network Address / IP Address	Method IP Assigning
1	R1		
	SO/1/1	10.10.1.1/30	Manual
	SO/1/0	10.10.3.1/30	Manual
	GO/0/0	172.16.40.1/24	Manual
2	R2		
	SO/1/1	10.10.3.2/30	Manual
	SO/1/0	10.10.2.2/30	Manual
	GO/0/0	192.168.50.1/24	Manual
3	ISP		
	SO/1/1	10.10.2.1/30	Manual
	SO/1/0	10.10.1.2/30	Manual
	GO/0/0	200.150.60.1/24	Manual
4	PC1 & PC2	172.16.40.0/24	DHCP
5	PC3 & PC4	192.168.50.0/24	DHCP

Table 6: Addressing Table

CHAPTER 4:

ROUTING PROTOCOLS – STATIC ROUTING

1. Identify Remote Network for every routers

R1

Bil	Network Address	Exit interface	Next Hop IP Address
1	10.10.2.0/30	S0/1/0	10.10.3.2
2	192.168.50.0/24	S0/1/0	10.10.3.2
3	200.150.60.0/24	S0/1/1	10.10.1.2

R2

Bil	Network Address	Exit interface	Next Hop IP Address
1	10.10.1.0/30	S0/1/1	10.10.3.1
2	172.16.40.0/24	S0/1/1	10.10.3.1
3	200.150.60.0/24	S0/1/0	10.10.2.1

ISP

Bil	Network Address	Exit interface	Next Hop IP Address
1	10.10.3.0/30	S0/1/0	10.10.1.1
2	172.16.40.0/24	S0/1/0	10.10.1.1
3	192.168.50.0/24	S0/1/1	10.10.2.2

CHAPTER 4:

ROUTING PROTOCOLS – STATIC ROUTING

1. Configure Static on every routers

R1

```
R1(config)#ip route 10.10.2.0 255.255.255.252 s0/1/0
R1(config)#ip route 192.168.50.0 255.255.255.0 s0/1/0
R1(config)#ip route 200.150.60.0 255.255.255.0 s0/1/1
```

R2

```
R2(config)#ip route 10.10.1.0 255.255.255.252 s0/1/1
R2(config)#ip route 172.16.40.0 255.255.255.0 s0/1/1
R2(config)#ip route 200.150.60.0 255.255.255.0 s0/1/0
```

ISP

```
ISP(config)#ip route 10.10.3.0 255.255.255.252 s0/1/0
ISP(config)#ip route 172.16.50.0 255.255.255.0 s0/1/0
ISP(config)#ip route 192.168.50.0 255.255.255.0 s0/1/1
```

2. Verify Static Route Configuration

i. Using command show ip route on routers

R1

```
R1#show ip route static
10.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
S 10.10.2.0/30 is directly connected, Serial0/1/0
S 192.168.50.0/24 is directly connected, Serial0/1/0
S 200.150.60.0/24 is directly connected, Serial0/1/1
```

R2

```
R2#sh ip route static
10.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
S 10.10.1.0/30 is directly connected, Serial0/1/1
172.16.0.0/24 is subnetted, 1 subnets
S 172.16.40.0 is directly connected, Serial0/1/1
S 200.150.60.0/24 is directly connected, Serial0/1/0
```

ISP

```
ISP#sh ip route static
10.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
S 10.10.3.0/30 is directly connected, Serial0/1/0
172.16.0.0/24 is subnetted, 1 subnets
S 172.16.50.0 is directly connected, Serial0/1/0
S 192.168.50.0/24 is directly connected, Serial0/1/1
```

CHAPTER 4:

ROUTING PROTOCOLS – STATIC ROUTING

Ping from PC1 to PC3

```
C:\>ping 172.16.40.2

Pinging 172.16.40.2 with 32 bytes of data:

Reply from 172.16.40.2: bytes=32 time=16ms TTL=126
Reply from 172.16.40.2: bytes=32 time=8ms TTL=126
Reply from 172.16.40.2: bytes=32 time=13ms TTL=126
Reply from 172.16.40.2: bytes=32 time=12ms TTL=126

Ping statistics for 172.16.40.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 8ms, Maximum = 16ms, Average = 12ms
```

Ping PC1 to WEBSERVER

```
C:\>ping 200.150.60.100

Pinging 200.150.60.100 with 32 bytes of data:

Reply from 200.150.60.100: bytes=32 time=17ms TTL=126
Reply from 200.150.60.100: bytes=32 time=13ms TTL=126
Reply from 200.150.60.100: bytes=32 time=11ms TTL=126
Reply from 200.150.60.100: bytes=32 time=13ms TTL=126

Ping statistics for 200.150.60.100:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 11ms, Maximum = 17ms, Average = 13ms
```



CHAPTER 4:

ROUTING PROTOCOLS – OPEN SHORTEST PATH FIRST (OSPF)

- **OSPF (Open Shortest Path First)** is a dynamic routing protocol that helps routers automatically find the best path to reach different networks.
- Think of OSPF like a smart navigation system for routers. It constantly studies the “map” of the network and chooses the shortest and fastest route for your data.

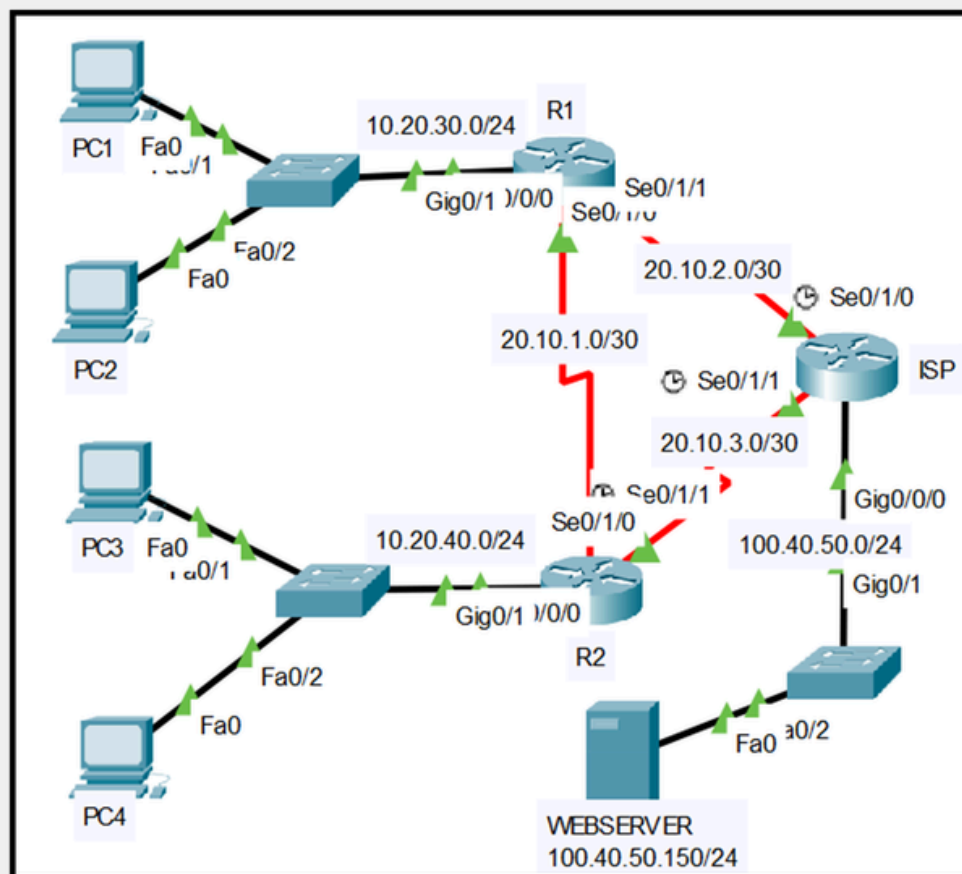


Figure 9: Network Topology

CHAPTER 4:

ROUTING PROTOCOLS – OPEN SHORTEST PATH FIRST (OSPF)

Number	Item	Network Address / IP Address	Method IP Assigning
1	R1		
	S0/1/1	20.10.2.1/30	Manual
	S0/1/0	20.10.1.1/30	Manual
	G0/0/0	10.20.30.1/24	Manual
2	R2		
	S0/1/1	20.10.3.1/30	Manual
	S0/1/0	20.10.1.2/30	Manual
	G0/0/0	10.20.40.1/24	Manual
3	ISP		
	S0/1/1	20.10.3.2/30	Manual
	S0/1/0	20.10.2.2	Manual
	G0/0/0	100.40.50.1/24	Manual
4	PC1 & PC2	10.20.30.0/24	DHCP
5	PC3 & PC4	10.20.40.0/24.0/24	DHCP

Table 7: Addressing Table

CHAPTER 4:

ROUTING PROTOCOLS – OPEN SHORTEST PATH FIRST (OSPF)

1. Configure OSPF on every routers

R1

```
R1(config)#router ospf 10
R1(config-router)#router-id 1.1.1.1
R1(config-router)#network 10.20.30.0 0.0.0.255 area 1
R1(config-router)#network 20.10.1.0 0.0.0.3 area 1
R1(config-router)#network 20.10.2.0 0.0.0.3 area 1
R1(config-router)#ex
```

R2

```
R2(config)#router ospf 10
R2(config-router)#router-id 2.2.2.2
R2(config-router)#network 10.20.40.0 0.0.0.255 area 1
R2(config-router)#network 20.10.1.0 0.0.0.3 area 1
R2(config-router)#network 20.10.3.0 0.0.0.3 area 13
R2(config-router)#ex
```

ISP

```
ISP(config)#router ospf 10
ISP(config-router)#router-id 3.3.3.3
ISP(config-router)#network 100.40.50.0 0.0.0.255 area 1
ISP(config-router)#network 20.10.3.0 0.0.0.3 area 1
ISP(config-router)#network 20.10.2.0 0.0.0.3 area 1
ISP(config-router)#ex
```


CHAPTER 4:

ROUTING PROTOCOLS – OPEN SHORTEST PATH FIRST (OSPF)

2. Verify OSPF configurations

i. Using command show ip route on routers

R1

```
R1#show ip route ospf
 10.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
O 10.20.40.0 [110/65] via 20.10.1.2, 00:04:33, Serial0/1/0
 20.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
O 20.10.3.0 [110/128] via 20.10.2.2, 00:02:44, Serial0/1/1
 100.0.0.0/24 is subnetted, 1 subnets
O 100.40.50.0 [110/65] via 20.10.2.2, 00:02:44, Serial0/1/1
```

R2

```
R2#show ip route ospf
 10.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
O 10.20.30.0 [110/65] via 20.10.1.1, 00:05:14, Serial0/1/1
 20.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
O 20.10.2.0 [110/128] via 20.10.1.1, 00:05:14, Serial0/1/1
 100.0.0.0/24 is subnetted, 1 subnets
O 100.40.50.0 [110/129] via 20.10.1.1, 00:03:24, Serial0/1/1
```

ISP

```
ISP#show ip route ospf
 10.0.0.0/24 is subnetted, 2 subnets
O 10.20.30.0 [110/65] via 20.10.2.1, 00:04:16, Serial0/1/0
O 10.20.40.0 [110/129] via 20.10.2.1, 00:04:16, Serial0/1/0
 20.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
O 20.10.1.0 [110/128] via 20.10.2.1, 00:04:16, Serial0/1/0
```

CHAPTER 4:

ROUTING PROTOCOLS – OPEN SHORTEST PATH FIRST (OSPF)

i. Using command ping to verify communication between hosts

Ping from PC1 to PC3

```
C:\>ping 10.20.40.2

Pinging 10.20.40.2 with 32 bytes of data:

Reply from 10.20.40.2: bytes=32 time=1ms TTL=126
Reply from 10.20.40.2: bytes=32 time=10ms TTL=126
Reply from 10.20.40.2: bytes=32 time=1ms TTL=126
Reply from 10.20.40.2: bytes=32 time=14ms TTL=126

Ping statistics for 10.20.40.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 1ms, Maximum = 14ms, Average = 6ms
```

Ping from PC1 to WEBSERVER

```
C:\>ping 100.40.50.150

Pinging 100.40.50.150 with 32 bytes of data:

Reply from 100.40.50.150: bytes=32 time=13ms TTL=126
Reply from 100.40.50.150: bytes=32 time=8ms TTL=126
Reply from 100.40.50.150: bytes=32 time=16ms TTL=126
Reply from 100.40.50.150: bytes=32 time=7ms TTL=126

Ping statistics for 100.40.50.150:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 7ms, Maximum = 16ms, Average = 11ms
```

Scan code to view
OSPF Configuration



CHAPTER 4:

ROUTING PROTOCOLS – ENHANCED INTERIOR GATEWAY ROUTING PROTOCOL (EIGRP)

➤ **EIGRP (Enhanced Interior Gateway Routing Protocol)** is a dynamic routing protocol developed by Cisco. Think of it as a super-smart GPS for routers. It helps routers automatically find the best, fastest, and most reliable path to send data across a network. It's known for being:

- ✓ fast
- ✓ efficient
- ✓ very smart with path choices

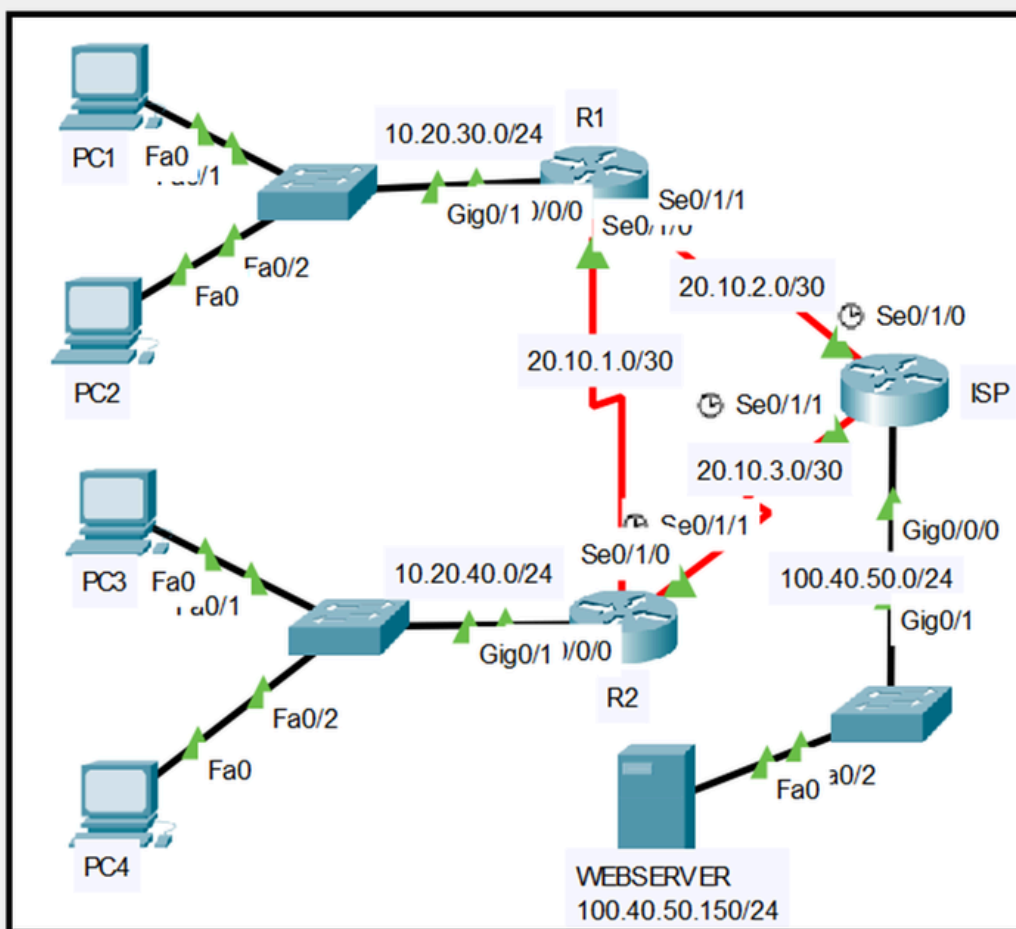


Figure 10: Network Topology

CHAPTER 4:

ROUTING PROTOCOLS – ENHANCED INTERIOR GATEWAY ROUTING PROTOCOL (EIGRP)

Number	Item	Network Address / IP Address	Method IP Assigning
1	R1		
	S0/1/1	20.10.2.1/30	Manual
	S0/1/0	20.10.1.1/30	Manual
	G0/0/0	10.20.30.1/24	Manual
2	R2		
	S0/1/1	20.10.3.1/30	Manual
	S0/1/0	20.10.1.2/30	Manual
	G0/0/0	10.20.40.1/24	Manual
3	ISP		
	S0/1/1	20.10.3.2/30	Manual
	S0/1/0	20.10.2.2	Manual
	G0/0/0	100.40.50.1/24	Manual
4	PC1 & PC2	10.20.30.0/24	DHCP
5	PC3 & PC4	10.20.40.0/24.0/24	DHCP

Table 8: Addressing Table

CHAPTER 4:

ROUTING PROTOCOLS – ENHANCED INTERIOR GATEWAY ROUTING PROTOCOL (EIGRP)

1. Configure EIGRP on every routers

R1

```
R1(config)#router eigrp 100
R1(config-router)#network 10.20.30.0
R1(config-router)#network 20.10.1.0
R1(config-router)#network 20.10.2.0
R1(config-router)#ex
```

R2

```
R2(config)#router eigrp 100
R2(config-router)#network 10.20.40.0
R2(config-router)#network 20.10.3.0
R2(config-router)#network 20.10.1.0
R2(config-router)#ex
```

ISP

```
ISP(config)#router eigrp 100
ISP(config-router)#network 100.40.50.0
ISP(config-router)#network 20.10.2.0
ISP(config-router)#network 20.10.3.0
ISP(config-router)#ex
```

CHAPTER 4:

ROUTING PROTOCOLS – ENHANCED INTERIOR GATEWAY ROUTING PROTOCOL (EIGRP)

1. Verify OSPF configurations

i. Using command show ip route on routers

R1

```
R1#show ip route eigrp
 10.0.0.0/8 is variably subnetted, 3 subnets, 3 masks
D 10.0.0.0/8 is a summary, 00:04:46, Null0
 20.0.0.0/8 is variably subnetted, 6 subnets, 3 masks
D 20.0.0.0/8 is a summary, 00:04:46, Null0
D 20.10.3.0/30 [90/2681856] via 20.10.1.2, 00:04:46, Serial0/1/0
  [90/2681856] via 20.10.2.2, 00:02:54, Serial0/1/1
D 100.0.0.0/8 [90/2170112] via 20.10.2.2, 00:02:54, Serial0/1/1
```

R2

```
R2#show ip route eigrp
 10.0.0.0/8 is variably subnetted, 3 subnets, 3 masks
D 10.0.0.0/8 is a summary, 00:07:38, Null0
 20.0.0.0/8 is variably subnetted, 6 subnets, 3 masks
D 20.0.0.0/8 is a summary, 00:07:38, Null0
D 20.10.2.0/30 [90/2681856] via 20.10.1.1, 00:06:10, Serial0/1/1
  [90/2681856] via 20.10.3.2, 00:04:18, Serial0/1/0
D 100.0.0.0/8 [90/2170112] via 20.10.3.2, 00:04:18, Serial0/1/0
```

ISP

```
ISP#show ip route eigrp
D 10.0.0.0/8 [90/2170112] via 20.10.3.1, 00:05:20, Serial0/1/1
  [90/2170112] via 20.10.2.1, 00:05:20, Serial0/1/0
 20.0.0.0/8 is variably subnetted, 6 subnets, 3 masks
D 20.0.0.0/8 is a summary, 00:05:20, Null0
D 20.10.1.0/30 [90/2681856] via 20.10.3.1, 00:05:20, Serial0/1/1
  [90/2681856] via 20.10.2.1, 00:05:20, Serial0/1/0
 100.0.0.0/8 is variably subnetted, 3 subnets, 3 masks
D 100.0.0.0/8 is a summary, 00:05:20, Null0
```

CHAPTER 4:

ROUTING PROTOCOLS – ENHANCED INTERIOR GATEWAY ROUTING PROTOCOL (EIGRP)

ii. Using command ping to verify communication between hosts

Ping from PC1 to PC3

```
C:\>ping 10.20.40.2

Pinging 10.20.40.2 with 32 bytes of data:

Reply from 10.20.40.2: bytes=32 time=1ms TTL=126
Reply from 10.20.40.2: bytes=32 time=10ms TTL=126
Reply from 10.20.40.2: bytes=32 time=1ms TTL=126
Reply from 10.20.40.2: bytes=32 time=14ms TTL=126

Ping statistics for 10.20.40.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 1ms, Maximum = 14ms, Average = 6ms
```

Ping from PC1 to WEBSERVER

```
C:\>ping 100.40.50.150

Pinging 100.40.50.150 with 32 bytes of data:

Reply from 100.40.50.150: bytes=32 time=13ms TTL=126
Reply from 100.40.50.150: bytes=32 time=8ms TTL=126
Reply from 100.40.50.150: bytes=32 time=16ms TTL=126
Reply from 100.40.50.150: bytes=32 time=7ms TTL=126

Ping statistics for 100.40.50.150:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 7ms, Maximum = 16ms, Average = 11ms
```

Scan code to view
EIGRP Configuration



CONCLUSION

This eBook has introduced the fundamental concepts of switching and routing, focusing on the configuration, operation, and troubleshooting of networks in IPv4 environments. Through the topics covered, readers have gained an understanding of how switches and routers work together to provide reliable end-to-end connectivity in small- to medium-sized networks.

The practical exercises and hands-on activities included in this eBook help strengthen technical skills in network installation, configuration, and problem-solving. In addition, emphasis has been placed on effective communication using appropriate networking terminology and diagrams, enabling learners to explain technical solutions to both technical and non-technical audiences.

By completing the learning activities in this eBook, students will be better prepared to configure and manage network devices, troubleshoot common networking issues, and demonstrate responsibility, leadership, and professionalism in real-world networking environments.

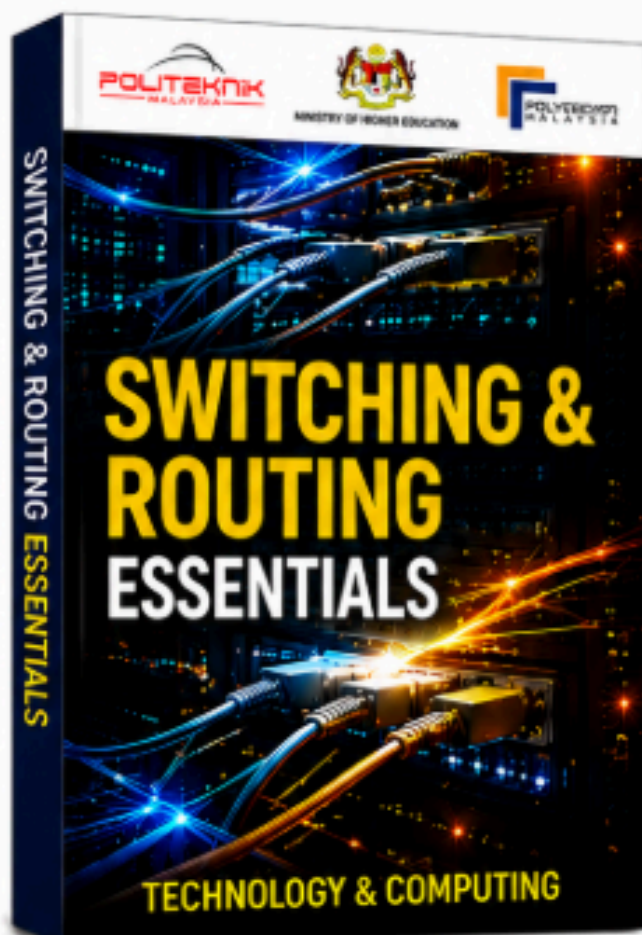
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A practical guide for networking students covering the fundamentals of switching and routing, IPv4 & IPv6, device configuration, and troubleshooting for small to medium-sized networks.

POLITEKNIK KUALA TERENGGANU
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Author:

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