CCNA LAB

INTRODUCTION TO NETWORKING

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This report highlights essential Cisco networking practices performed using **Cisco Packet Tracer** to build skills in **network device configuration** and **network communication analysis** within a simulated environment.

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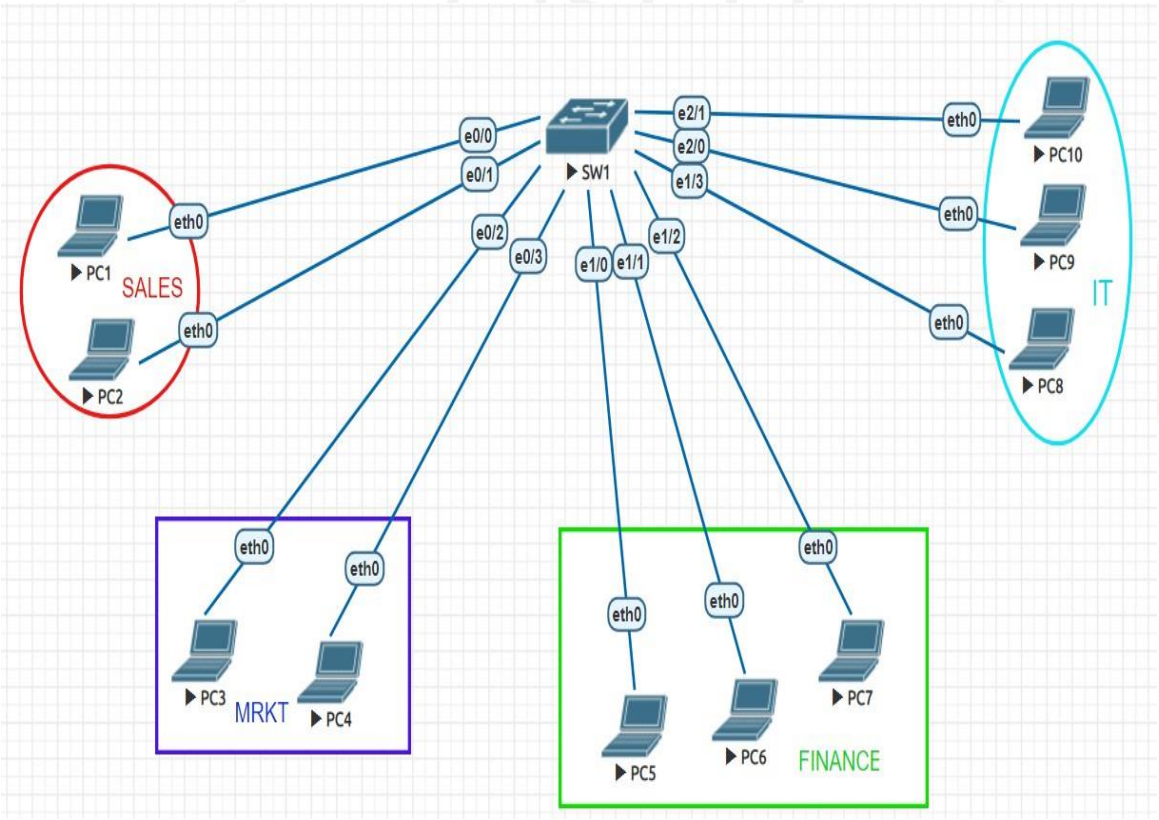
1 VLAN

VLAN stands for virtual local area network. VLAN is a technology we use for the purpose of Broadcast isolation or segregation of LAN.

Generally, what happen in company there is so many departments, for that each and every department require pc and to connect that pc we require Switch. If we buy different switch for each department the cost of IT infra will going to increase, to save that cost company implement VLAN on their switch.so here we go.



1.1 Steps

1.1.1 Create VLAN

- **VLAN 10 Sales**
- **VLAN 20 Marketing**
- **VLAN 30 Finance**
- **VLAN 40 IT**

1.1.2 IP Range

VLAN 10 - 192.168.10.0/27	For sales department require IP is 30
VLAN 20 - 192.168.20.0/26	For marketing department require IP is 42
VLAN 30 - 192.168.30.0/27	For finance department require IP is 25
VLAN 40 - 192.168.40.0/28	For IT department require IP is 14

1.1.3 Assign VLAN to the respected port as per diagram & assign IP to the pc

SOLUTION

So, start first with the switch

- **Switch> enable**
- **Switch#configure terminal**

1.1.3.1 Now we have to create VLAN

- **Switch(config)#vlan 10**
- **Switch(config)#name sales**
- **Switch(config)#exit**
- **Switch(config)#vlan 20**
- **Switch(config)#name mrkt**
- **Switch(config)#exit**
- **Switch(config)#Vlan 30**
- **Switch(config)#name finance**
- **Switch(config)#exit**
- **Switch(config)#vlan 40**
- **Switch(config)#name IT**
- **Switch(config)#exit**

1.1.3.2 Assignment of VLAN

Now open interface and assign VLAN

- **Switch(config)#interface ethernet 0/0**
- **Switch(config)#Switchport mode access**
- **Switch(config)#Switchport access vlan 10**
- **Switch(config)#Exit**
- **Switch(config)#interface ethernet 0/1**
- **Switch(config)#switchport mode access**
- **Switch(config)#switchport access vlan 10**
- **Switch(config)#exit**
- **Switch(config)#interface ethernet 0/2**
- **Switch(config)# switchport mode access**
- **Switch(config)# switchport access vlan 20**
- **Switch(config)# exit**
- **Switch(config)#interface ethernet 0/3**
- **Switch(config)# switchport mode access**
- **Switch(config)# switchport access vlan 20**
- **Switch(config)# exit**
- **Switch(config)#interface ethernet 1/0**
- **Switch(config)# switchport mode access**
- **Switch(config)# switchport access vlan 30**
- **Switch(config)# exit**

- **Switch(config)#interface ethernet 1/1**
- **Switch(config)# switchport mode access**
- **Switch(config)# switchport access vlan 30**
- **Switch(config)# exit**
- **Switch(config)#interface ethernet 1/2**
- **Switch(config)# switchport mode access**
- **Switch(config)# switchport access vlan 30**
- **Switch(config)# exit**
- **Switch(config)#interface ethernet 1/3**
- **Switch(config)# switchport mode access**
- **Switch(config)# switchport access vlan 40**
- **Switch(config)# exit**
- **Switch(config)#interface ethernet 2/0**
- **Switch(config)# switchport mode access**
- **Switch(config)# switchport access vlan 40**
- **Switch(config)# exit**
- **Switch(config)#interface ethernet 2/1**
- **Switch(config)# switchport mode access**
- **Switch(config)# switchport access vlan 40**
- **Switch(config)# exit**

Note- Assign IP to the respected VLAN Pc's

VERIFICATION

1. **Switch# show vlan**

```
Switch#show vlan

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Et2/2, Et2/3
10   sales                            active    Et0/0, Et0/1
20   mrkt                             active    Et0/2, Et0/3
30   finance                          active    Et1/0, Et1/1, Et1/2
40   IT                               active    Et1/3, Et2/0, Et2/1
1002 fddi-default                     act/unsup
1003 token-ring-default               act/unsup
1004 fddinet-default                  act/unsup
1005 trnet-default                    act/unsup
```

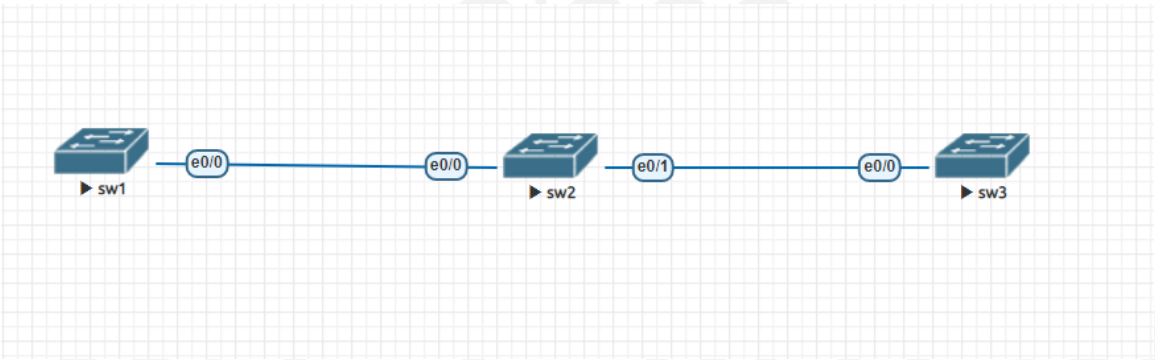
2. **Switch# Show running-config**

```
!
interface Ethernet0/0
 switchport access vlan 10
 switchport mode access
!
interface Ethernet0/1
 switchport access vlan 10
!
interface Ethernet0/2
 switchport access vlan 20
 switchport mode access
!
interface Ethernet0/3
 switchport access vlan 20
 switchport mode access
!
interface Ethernet1/0
 switchport access vlan 30
 switchport mode access
!
interface Ethernet1/1
 switchport access vlan 30
 switchport mode access
!
interface Ethernet1/2
 switchport access vlan 30
 switchport mode access
!
interface Ethernet1/3
 switchport access vlan 40
 switchport mode access
!
interface Ethernet2/0
 switchport access vlan 40
 switchport mode access
!
interface Ethernet2/1
 switchport access vlan 40
 switchport mode access
```

2 VTP

VTP stands for VLAN Trunking Protocol. why we use VTP? This is the important question we generally face. So, in the company there were almost 30-40 switches more or less. As engineer we need to configure each and every switch and if each switch has minimum 10 VLAN on it. It means 40 Switches x 10 VLAN per switch = 400 times you need create vlan.to reduce this task and to make all switches manageable we configure VTP.

So here we go,



2.1 Steps

SOLUTION

2.1.1 Create VLAN on sw1

- **sw1(config)#vlan 10**
- **sw1(config-vlan)#name sales**
- **sw1(config-vlan)#exit**
- **sw1(config)#vlan 20**
- **sw1(config-vlan)#name mrkt**
- **sw1(config-vlan)#exit**
- **sw1(config)#vlan 30**
- **sw1(config-vlan)#name IT**
- **sw1(config-vlan)#exit**
- **sw1(config)#vlan 40**
- **sw1(config-vlan)#name DC**
- **sw1(config-vlan)#exit**

2.1.2 Make interface trunk on sw1 eth0/0 and sw2 eth0/0 & eth0/1, sw3 eth0/0

2.1.2.1 On switch 1

- **sw1(config)#interface ethernet0/0**
- **sw1(config-if)#switchport trunk encapsulation dot1q**
- **sw1(config-if)#switchport mode trunk**
- **sw1(config-if)#exit**

2.1.2.2 On switch 2

- **sw2(config)#interface ethernet0/0**
- **sw2(config-if)#switchport trunk encapsulation dot1q**
- **sw2(config-if)#switchport mode trunk**
- **sw2(config-if)#exit**
- **sw2(config)#interface ethernet0/1**
- **sw2(config-if)#switchport trunk encapsulation dot1q**
- **sw2(config-if)#switchport mode trunk**
- **sw2(config-if)#exit**

2.1.2.3 On switch 3

- **sw3(config)#interface ethernet0/0**
- **sw3(config-if)#switchport trunk encapsulation dot1q**
- **sw3(config-if)#switchport mode trunk**
- **sw3(config-if)#exit**

2.1.3 Configure VTP mode, vtp domain, vtp password on all switches.

- **sw1(config)#vtp mode server**
- Device mode already VTP Server for VLANS.
- **sw1(config)#vtp domain ccn.com**
- Changing VTP domain name from NULL to ccn.com
- **sw1(config)#vtp password ccn@123**
- Setting device VTP password to ccn@123

- **sw2(config)#vtp mode client**
- Setting device to VTP Client mode for VLANS.
- **sw2(config)#vtp domain ccn.com**
- Domain name already set to ccn.com.
- **sw2(config)#vtp password ccn@123**
- Setting device VTP password to ccn@123

- **sw3(config)#vtp mode client**
- Setting device to VTP Client mode for VLANS.
- **sw3(config)#vtp domain ccn.com**
- Domain name already set to ccn.com.
- **sw3(config)#vtp password ccn@123**
- Setting device VTP password to ccn@123

VERIFICATION

Verification of #show vlan command

1. **Sw1**

```
sw1#show vlan

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Et0/1, Et0/2, Et0/3
10   sales                            active
20   mrkt                             active
30   IT                               active
40   DC                               active
1002 fddi-default                     act/unsup
1003 token-ring-default               act/unsup
1004 fddinet-default                  act/unsup
1005 trnet-default                    act/unsup
```

2. **Sw 2**

```
sw2#show vlan

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Et0/2, Et0/3
10   sales                            active
20   mrkt                             active
30   IT                               active
40   DC                               active
1002 fddi-default                     act/unsup
1003 token-ring-default               act/unsup
1004 fddinet-default                  act/unsup
1005 trnet-default                    act/unsup
```

3. **Sw 3**

```
sw3#show vlan

VLAN Name                              Status    Ports
---- --------------------------------- --------- -------------------------------
1    default                           active    Et0/1, Et0/2, Et0/3
10   sales                             active
20   mrkt                              active
30   IT                                active
40   DC                                active
1002 fddi-default                      act/unsup
1003 token-ring-default                act/unsup
1004 fddinet-default                   act/unsup
1005 trnet-default                     act/unsup
```

Verification of #show vtp status command

4. **Sw 1**

```
sw1#show vtp status
VTP Version capable             : 1 to 3
VTP version running             : 1
VTP Domain Name                 : ccn.com
VTP Pruning Mode                : Disabled
VTP Traps Generation            : Disabled
Device ID                       : aabb.cc80.1000
Configuration last modified by 0.0.0.0 at 6-1-22 11:38:59
Local updater ID is 0.0.0.0 (no valid interface found)

Feature VLAN:
--------------
VTP Operating Mode                : Server
Maximum VLANs supported locally   : 1005
Number of existing VLANs          : 9
Configuration Revision            : 4
MD5 digest                        : 0x4C 0xBB 0xB6 0x01 0x5F 0x0E 0x8D 0xE8
                                    0xC5 0xFC 0xD8 0x72 0x9B 0xB2 0xB5 0x46
```

5. **Sw 2**

```
sw2#show vtp status
VTP Version capable             : 1 to 3
VTP version running             : 1
VTP Domain Name                 : ccn.com
VTP Pruning Mode                : Disabled
VTP Traps Generation            : Disabled
Device ID                       : aabb.cc80.2000
Configuration last modified by 0.0.0.0 at 6-1-22 11:38:59

Feature VLAN:
--------------
VTP Operating Mode                : Client
Maximum VLANs supported locally   : 1005
Number of existing VLANs          : 9
Configuration Revision            : 4
MD5 digest                        : 0x4C 0xBB 0xB6 0x01 0x5F 0x0E 0x8D 0xE8
                                    0xC5 0xFC 0xD8 0x72 0x9B 0xB2 0xB5 0x46
```

6. **Sw 3**

```
sw3#show vtp status
VTP Version capable             : 1 to 3
VTP version running             : 1
VTP Domain Name                 : ccn.com
VTP Pruning Mode                : Disabled
VTP Traps Generation            : Disabled
Device ID                       : aabb.cc80.4000
Configuration last modified by 0.0.0.0 at 6-1-22 11:38:59

Feature VLAN:
--------------
VTP Operating Mode                : Client
Maximum VLANs supported locally   : 1005
Number of existing VLANs          : 9
Configuration Revision            : 4
MD5 digest                        : 0x4C 0xBB 0xB6 0x01 0x5F 0x0E 0x8D 0xE8
                                    0xC5 0xFC 0xD8 0x72 0x9B 0xB2 0xB5 0x46
```

Note – After VLAN data forwarding to each and every switch via vtp configuration we can assign VLAN to switchports with the help of Step 2 :- Assignment of VLAN

3 EtherChannel

EtherChannel is a technology use to Bundle/Aggregate the Link/Node/Port, with the use of some protocols such as LACP or PAgP.

Why we use EtherChannel?

When we face lack of bandwidth with links then at that time we configure EtherChannel to bundle the link and get combined speed. Like each interface is ethernet means 10MBPS of each then, if we bundle 3 link at a time then the combine speed will be 300 MBPS.

3.1 EtherChannel uses PAgP or LACP as a Negotiation Protocol

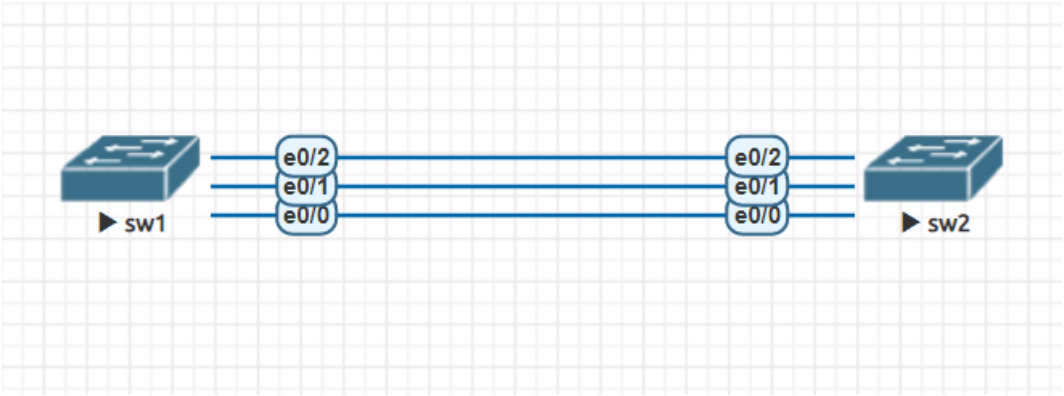
3.1.1 LINK AGGREGATION CONTROL PROTOCOL (LACP)

- LACP was made by IEEE and define with code of 802.3ad
- LACP is a Open Source and support all vendors in the market
- LACP adds up LACPDU to establish a etherchannel
- LACP has two modes
  1. Active – enable LACP unconditionally
  2. passive – enable LACP when LACP device is detected

3.1.2 PORT AGGREGATION CONTROL PROTOCOL (PAgP)

- PAgP was made by cisco.
- PAgP is a Cisco Proprietary Protocol. Hence, it only supports cisco devices
- PAgP has two modes
  1. Desirable – enable PAgP unconditionally
  2. Auto – enable PAgP when PAgP device is detected

So here we go,



3.1.3 Steps

Solution

3.1.3.1 Configure sw1 interface ethernet 0/0, 0/1, 0/2 for EtherChannel

Sw1

- **sw1(config)#interface range ethernet 0/0-2**
- **sw1(config)#channel-protocol lacp**
- **sw1(config-if-range)#channel-group 1 mode active**
- **Creating a port-channel interface Port-channel 1**
- **sw1(config-if-range)#exit**

3.1.3.2 Configure sw2 interface ethernet 0/0, 0/1, 0/2 for EtherChannel

sw2

- **sw2(config)#interface range ethernet 0/0-2**
- **sw1(config)#channel-protocol lacp**
- **sw2(config-if-range)#channel-group 1 mode active**
- **Creating a port-channel interface Port-channel 1**
- **sw2(config-if-range)#exit**

3.1.3.3 Configure sw1 to sw2 link as a trunk

Sw1

- **sw1(config)#interface range ethernet 0/0-2**
- **sw1(config-if-range)#switchport trunk encapsulation dot1q**
- **sw1(config-if-range)#switchport mode trunk**
- **sw1(config-if-range)#exit**

OR

- **sw1(config)#interface port-channel 1**
- **sw1(config-if)#switchport trunk encapsulation dot1q**
- **sw1(config-if)#switchport mode trunk**
- **sw1(config-if)#exit**

sw2

- **sw2(config)#interface range ethernet 0/0-2**
- **sw2(config-if-range)#switchport trunk encapsulation dot1q**
- **sw2(config-if-range)#switchport mode trunk**
- **sw2(config-if-range)#exit**

VERIFICATION

1. **SW 1**

```
sw1#show etherchannel summary
Flags:  D - down        P - bundled in port-channel
        I - stand-alone s - suspended
        H - Hot-standby (LACP only)
        R - Layer3      S - Layer2
        U - in use      N - not in use, no aggregation
        f - failed to allocate aggregator

        M - not in use, minimum links not met
        m - not in use, port not aggregated due to minimum links not met
        u - unsuitable for bundling
        w - waiting to be aggregated
        d - default port

        A - formed by Auto LAG


Number of channel-groups in use: 1
Number of aggregators:           1

Group  Port-channel  Protocol    Ports
------+-------------+-----------+-----------------------------------------------
1      Po1(SU)         LACP      Et0/0(P)    Et0/1(P)    Et0/2(P)
```

```
interface Port-channel1
 switchport trunk encapsulation dot1q
 switchport mode trunk
!
interface Ethernet0/0
 switchport trunk encapsulation dot1q
 switchport mode trunk
 channel-protocol lacp
 channel-group 1 mode active
!
interface Ethernet0/1
 switchport trunk encapsulation dot1q
 switchport mode trunk
 channel-protocol lacp
 channel-group 1 mode active
!
interface Ethernet0/2
 switchport trunk encapsulation dot1q
 switchport mode trunk
 channel-protocol lacp
 channel-group 1 mode active
!
```

2. SW 2

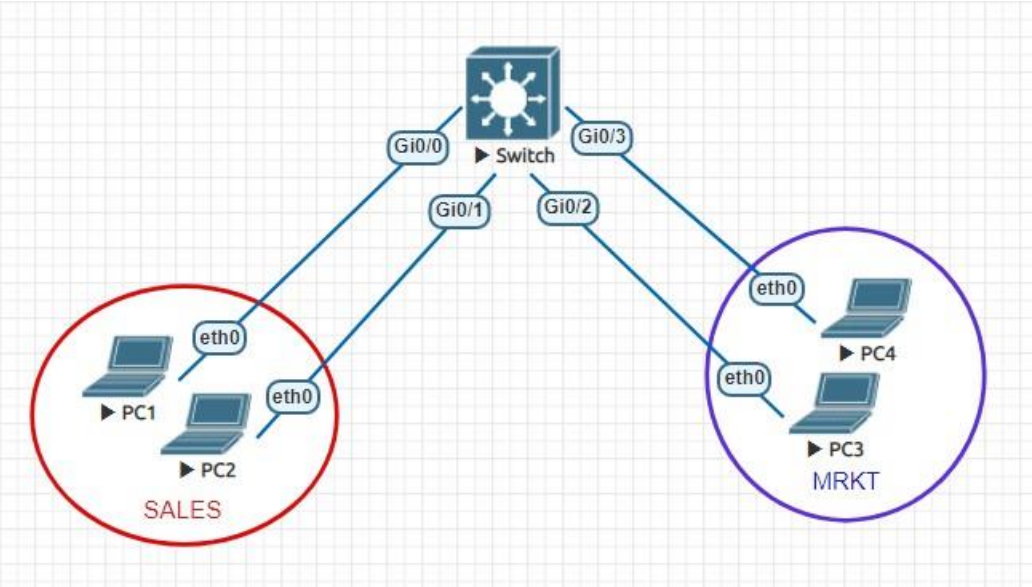
```
sw2#show etherchannel summary
Flags:  D - down        P - bundled in port-channel
        I - stand-alone s - suspended
        H - Hot-standby (LACP only)
        R - Layer3      S - Layer2
        U - in use      N - not in use, no aggregation
        f - failed to allocate aggregator

        M - not in use, minimum links not met
        m - not in use, port not aggregated due to minimum links not met
        u - unsuitable for bundling
        w - waiting to be aggregated
        d - default port

        A - formed by Auto LAG


Number of channel-groups in use: 1
Number of aggregators:           1

Group  Port-channel  Protocol    Ports
------+-------------+-----------+-----------------------------------------------
1      Po1(SU)         LACP      Et0/0(P)    Et0/1(P)    Et0/2(P)
```

```
!
interface Port-channel1
 switchport trunk encapsulation dot1q
 switchport mode trunk
!
interface Ethernet0/0
 switchport trunk encapsulation dot1q
 switchport mode trunk
 channel-protocol lacp
 channel-group 1 mode active
!
interface Ethernet0/1
 switchport trunk encapsulation dot1q
 switchport mode trunk
 channel-protocol lacp
 channel-group 1 mode active
!
interface Ethernet0/2
 switchport trunk encapsulation dot1q
 switchport mode trunk
 channel-protocol lacp
 channel-group 1 mode active
!
```

4 INTER VLAN ROUTING (IVR)

- Inter VLAN routing is method we use for the purpose of inter VLAN communication.
- Inter VLAN Routing is a new method to route between Multiple VLAN's.
- Inter VAN Routing require one device which is L3 Switch.

So here we go,



4.1 Steps

SOLUTION

4.1.1 Configure switch with VLAN 10 – SALES & VLAN 20 – MRKT

On switch,first we need to create vlan

- **Switch(config)#vlan 10**
- **Switch(config-vlan)#name SALES**
- **Switch(config-vlan)#exit**
- **Switch(config)#vlan 20**
- **Switch(config-vlan)#name MRKT**
- **Switch(config-vlan)#exit**

4.1.2 Implement VLAN on the respected interface as per Diagram

We need to apply vlan on interface

- **Switch(config)#interface range gigabitethernet0/0-1**
- **Switch(config-if-range)#switchport mode access**
- **Switch(config-if-range)#switchport access vlan 10**
- **Switch(config-if-range)#exit**
- **Switch(config)#interface range gigabitethernet0/2-3**
- **Switch(config-if-range)#switchport mode access**
- **Switch(config-if-range)#switchport access vlan 20**
- **Switch(config-if-range)#exit**

4.1.3 Create Default Gateway for the VLAN 10 & VLAN 20 PC's

Now, we need to configure interface vlan as a gateway for the PC's

- **Switch(config)#interface vlan 10**
- **Switch(config-if)#ip address 192.168.10.254 255.255.255.0**
- **Switch(config-if)#no shutdown**
- **Switch(config-if)#exit**
- **Switch(config-if)#interface vlan 20**
- **Switch(config-if)#ip address 192.168.20.254 255.255.255.0**
- **Switch(config-if)#no shutdown**
- **Switch(config-if)#exit**

Note - Now IP given on interface VLAN, will become a gateway for the PC to communicate over the VLAN.

VERIFICATION

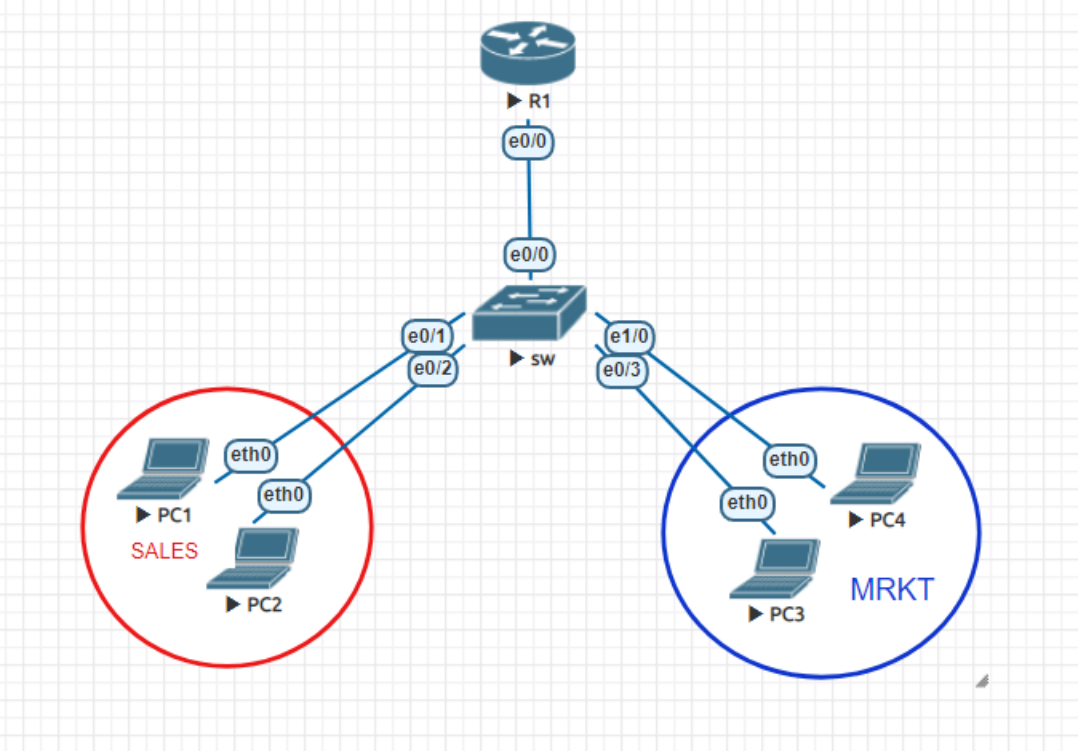
```
Switch#show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
GigabitEthernet0/0     unassigned      YES unset  up                    up
GigabitEthernet0/1     unassigned      YES unset  up                    up
GigabitEthernet0/2     unassigned      YES unset  up                    up
GigabitEthernet0/3     unassigned      YES unset  up                    up
GigabitEthernet1/0     unassigned      YES unset  up                    up
GigabitEthernet1/1     unassigned      YES unset  up                    up
GigabitEthernet1/2     unassigned      YES unset  up                    up
GigabitEthernet1/3     unassigned      YES unset  up                    up
Vlan10                 192.168.10.254  YES manual up                    up
Vlan20                 192.168.20.254  YES manual up                    up
```

```
Switch#show vlan

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Gi1/0, Gi1/1, Gi1/2, Gi1/3
10   SALES                            active    Gi0/0, Gi0/1
20   MRKT                             active    Gi0/2, Gi0/3
1002 fddi-default                     act/unsup
1003 token-ring-default               act/unsup
1004 fddinet-default                  act/unsup
1005 trnet-default                    act/unsup
```

5 ROUTER ON STICK (ROAS)

- Router On Stick is also method to establish communication between two or more VLAN.
- Router On Stick configuration is old Method
- It requires 2 devices that is Router and L2 Switch

so here we go,



5.1 Steps

SOLUTION

5.1.1 Configure VLAN 10 – SALES & VLAN 20 – MRKT

First we need to Create VLAN

- **SW(config)#vlan 10**
- **SW(config-vlan)#name SALES**
- **SW(config-vlan)#exit**
- **SW(config)#vlan 20**
- **SW(config-vlan)#name MRKT**
- **SW(config-vlan)#exit**

5.1.2 Implement VLAN on respected interface

We need to Assign VLAN

- **SW(config)#interface range ethernet 0/1-2**
- **SW(config-if-range)#switchport mode access**
- **SW(config-if-range)#switchport access vlan 10**
- **SW(config-if-range)#exit**

- **SW(config)#interface range ethernet 0/3 , ethernet 1/0**
- **SW(config-if-range)#switchport mode access**
- **SW(config-if-range)#switchport access vlan 20**
- **SW(config-if-range)#exit**

5.1.3 Make interface Trunk which is connected to Router

Now we have to create trunk

- **SW(config)#interface ethernet 0/0**
- **SW(config-if)#switchport trunk encapsulation dot1q**
- **SW(config-if)#switchport mode trunk**
- **SW(config-if)#exit**

5.1.4 Create a gateway on Router

Now, configure router

- **R1(config)#interface ethernet0/0**
- **R1(config-if)#no shutdown**
- **R1(config-if)#exit**

- **R1(config)#interface ethernet0/0.10**
- **R1(config-subif)#encapsulation dot1q 10**
- **R1(config-subif)#ip address 192.168.10.254 255.255.255.0**
- **R1(config-subif)#no shutdown**
- **R1(config-subif)#exit**

- **R1(config)#interface ethernet0/0.20**
- **R1(config-subif)#encapsulation dot1q 20**
- **R1(config-subif)#ip address 192.168.20.254 255.255.255.0**
- **R1(config-subif)#no shutdown**
- **R1(config-subif)#exit**

VERIFICATION

On Router

```
R1#show ip interface brief
Interface                  IP-Address      OK? Method Status                Protocol
Ethernet0/0                unassigned      YES unset  up                    up
Ethernet0/0.10             192.168.10.254  YES manual up                    up
Ethernet0/0.20             192.168.20.254  YES manual up                    up
Ethernet0/1                unassigned      YES unset  administratively down down
Ethernet0/2                unassigned      YES unset  administratively down down
Ethernet0/3                unassigned      YES unset  administratively down down
```

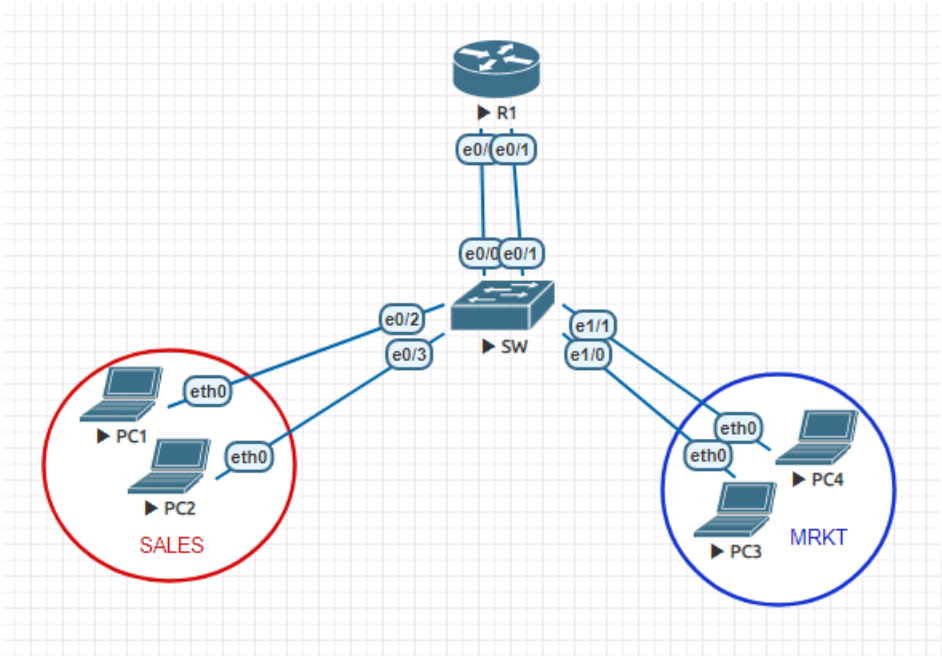
```
R1#show running-config | section interface Ethernet0/0
interface Ethernet0/0
 no ip address
interface Ethernet0/0.10
 encapsulation dot1Q 10
 ip address 192.168.10.254 255.255.255.0
interface Ethernet0/0.20
 encapsulation dot1Q 20
 ip address 192.168.20.254 255.255.255.0
```

On Switch

```
SW#show vlan

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Et1/1, Et1/2, Et1/3
10   SALES                            active    Et0/1, Et0/2
20   MRKT                             active    Et0/3, Et1/0
1002 fddi-default                     act/unsup
1003 token-ring-default               act/unsup
1004 fddinet-default                  act/unsup
1005 trnet-default                    act/unsup
```

```
SW#  show interface trunk

Port        Mode             Encapsulation  Status        Native vlan
Et0/0       on               802.1q         trunking      1

Port        Vlans allowed on trunk
Et0/0       1-4094

Port        Vlans allowed and active in management domain
Et0/0       1,10,20

Port        Vlans in spanning tree forwarding state and not pruned
Et0/0       1,10,20
```

5.2 METHOD 2



5.2.1 Creation of VLAN

- **SW(config)#vlan 10**
- **SW(config-vlan)#name SALES**
- **SW(config-vlan)#exit**
- **SW(config)#vlan 20**
- **SW(config-vlan)#name MRKT**
- **SW(config-vlan)#exit**

5.2.2 VLAN Assignment

- **SW(config)#interface range ethernet 0/2-3**
- **SW(config-if-range)#switchport mode access**
- **SW(config-if-range)#switchport access vlan 10**
- **SW(config-if-range)#exit**
- **SW(config)#interface range ethernet 1/0-1**
- **SW(config-if-range)#switchport mode access**
- **SW(config-if-range)#switchport access vlan 20**
- **SW(config-if-range)#exit**

5.2.3 Configure switch interface which is connected to the router

- **SW(config)#interface ethernet 0/0**
- **SW(config-if)#switchport mode access**
- **SW(config-if)#switchport access vlan 10**
- **SW(config-if)#exit**
- **SW(config)#interface ethernet 0/1**
- **SW(config-if)#switchport mode access**
- **SW(config-if)#switchport access vlan 20**
- **SW(config-if)#exit**

5.2.4 Now, configure router

- **R1(config)#interface ethernet 0/0**
- **R1(config-if)#ip address 192.168.10.254 255.255.255.0**
- **R1(config-if)#no shutdown**
- **R1(config-if)#exit**
- **R1(config)#interface ethernet 0/1**
- **R1(config-if)#ip address 192.168.20.254 255.255.255.0**
- **R1(config-if)#no shutdown**
- **R1(config-if)#exit**

NOTE:-In this method we are not configuring only one interface for multiple VLAN rather we are configuring multiple interfaces for multiple VLAN .that's why here we are not configuring trunk interface.

VERIFICATION

1. On Switch

```
SW#show vlan

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Et1/2, Et1/3
10   sales                            active    Et0/0, Et0/2, Et0/3
20   MRKT                             active    Et0/1, Et1/0, Et1/1
1002 fddi-default                     act/unsup
1003 token-ring-default               act/unsup
1004 fddinet-default                  act/unsup
1005 trnet-default                    act/unsup
```

2. On Router

```
R1#show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
Ethernet0/0            192.168.10.254  YES manual up                    up
Ethernet0/1            192.168.20.254  YES manual up                    up
Ethernet0/2            unassigned      YES unset  administratively down down
Ethernet0/3            unassigned      YES unset  administratively down down
```

```
R1#show running-config | section interface Ethernet
interface Ethernet0/0
 ip address 192.168.10.254 255.255.255.0
interface Ethernet0/1
 ip address 192.168.20.254 255.255.255.0
interface Ethernet0/2
 no ip address
 shutdown
interface Ethernet0/3
 no ip address
 shutdown
```

6 SPANNING TREE PROTOCOL (STP)

Spanning tree is a loop prevention mechanism, generally used to stop broadcast storm in a Switch based network topology.it uses election method to select a ROOT BRIDGE in a switch network to have control over a switch network. if switch will able to choose a root bridge, then all the traffic passes through that root bridge where, it uses.

6.1 Steps

6.1.1 SELECTION OF ROOT BRIDGE

6.1.1.1 lowest priority

- Default priority of every cisco switch is 32,768
- Then it adds up a VLAN ID so default VLAN is 1, hence ultimate value become a
- 32,769 (32,768+1)
- So, the default priority of every switch is same hence it tie up this criteria ,then the next criteria is

6.1.1.2 lowest MAC address

- The first question is how to calculate lowest mac address
- Here it is, MAC address is Hexadecimal value consist of numbers and alphabets
- 0 1 2 3 4 5 6 7 8 9 A B C D E F
- HERE 0 IS LOWEST, THEN MOVE IT FORWARD TO F IS HIGHEST

NOTE:- IF LOWEST PRORITY HIT THEN ROOT BRIDGE SELECTED ON THE BASIS OF LOWEST PRIORITY, IF THAT CRITERIA TIE UP THEN MOVE FORWARD TO LOWEST MAC ADDRESS.

6.1.2 SELECTION OF ROOT PORT

Root port get selected on the basis of port cost which is already assigned on interfaces.

Default Port Cost of interface

INTERFACE TYPE	PORT COST
ETHERNET (10MBPS)	100
FAST ETHERNET (100 MBPS)	19
1 GIGABIT ETHERNET (1 GBPS)	4
10 GIGABIT ETHERNET (10 GBPS)	2

Root port defines the nearest path to reach the destination.

So, the rule is

Root port - designated port [RP=DP]

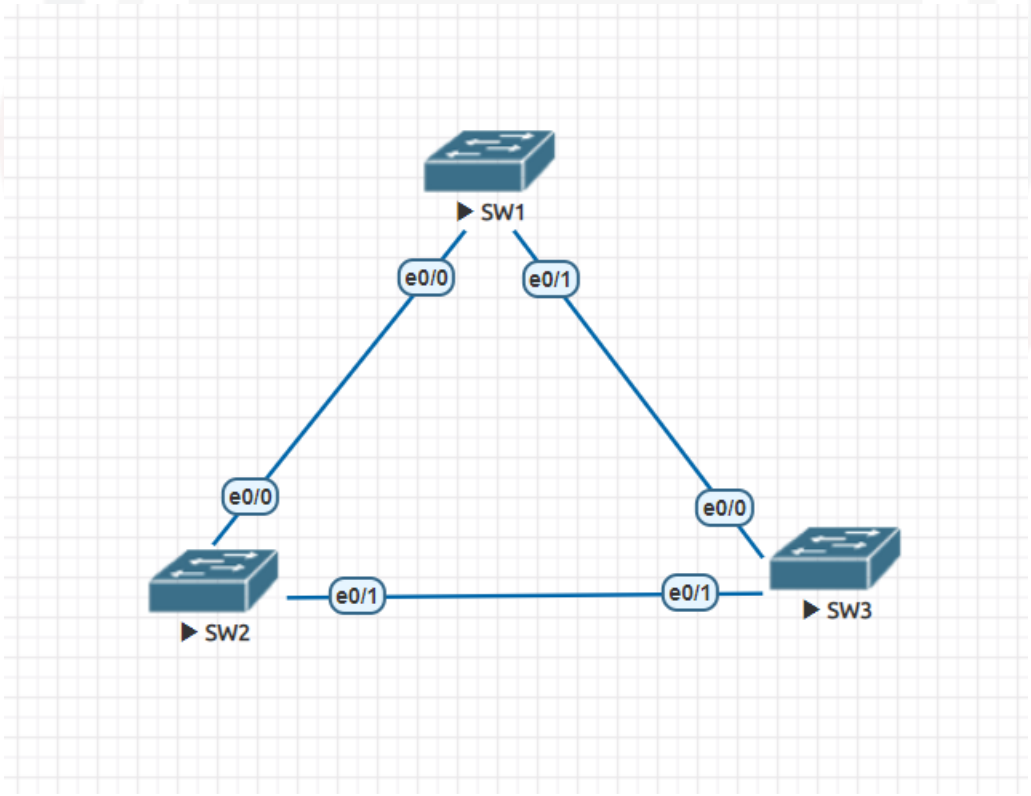
Root bridge has each port as designated port, and ports on other switches can be root port or block port.

6.1.3 SELECTION OF BLOCK PORT

In the process of selection of block port switch uses a lowest priority and lowest MAC address criteria again, the same criteria applied here as it is. If the lowest priority is equal, then it move toward the lowest mac address.

- **Verify the root bridge**
- **Change the root bridge**
- **Change the port cost**

So, let's start



In this picture

Sw-1 Will become a root bridge.

```
SW-1#show spanning-tree

VLAN0001
  Spanning tree enabled protocol rstp
  Root ID     Priority    32769
              Address     aabb.cc00.1000
              This bridge is the root
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    32769  (priority 32768 sys-id-ext 1)
              Address     aabb.cc00.1000
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time  300 sec

Interface           Role Sts Cost      Prio.Nbr Type
------------------- ---- --- --------- -------- --------------------------
Et0/0               Desg FWD 100       128.1    Shr
Et0/1               Desg FWD 100       128.2    Shr
Et0/2               Desg FWD 100       128.3    Shr
Et0/3               Desg FWD 100       128.4    Shr
```

Now see switch 1 has all port ad designated port

Now, we are going to change root bridge

We going to plan switch 2 must be root bridge and if switch 2 fails in network switch 3 will become a root bridge.

```
SW-2#show spanning-tree

VLAN0001
  Spanning tree enabled protocol rstp
  Root ID     Priority    32769
              Address     aabb.cc00.1000
              Cost        100
              Port        1 (Ethernet0/0)
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    32769  (priority 32768 sys-id-ext 1)
              Address     aabb.cc00.2000
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time  300 sec

Interface           Role Sts Cost      Prio.Nbr Type
------------------- ---- --- --------- -------- --------------------------
Et0/0               Root FWD 100       128.1    Shr
Et0/1               Desg FWD 100       128.2    Shr
Et0/2               Desg FWD 100       128.3    Shr
Et0/3               Desg FWD 100       128.4    Shr
```

In this switch 2 configuration we can clearly see eth 0/0 selected as root port cause the cost to reach the root bridge is only 100. if switch chooses other route it will take 200 cost, to reach the destination. (from switch 2 >switch 3 > switch 1= 200 cost)

Same goes with switch 3

```
SW-3#show spanning-tree

VLAN0001
  Spanning tree enabled protocol rstp
  Root ID     Priority    32769
              Address     aabb.cc00.1000
              Cost        100
              Port        1 (Ethernet0/0)
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    32769  (priority 32768 sys-id-ext 1)
              Address     aabb.cc00.3000
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time  300 sec

Interface           Role Sts Cost      Prio.Nbr Type
------------------- ---- --- --------- -------- --------------------------------
Et0/0               Root FWD 100       128.1    Shr
Et0/1               Altn BLK 100       128.2    Shr
Et0/2               Desg FWD 100       128.3    Shr
Et0/3               Desg FWD 100       128.4    Shr
```

In this switch eth0/0 will become a root bridge as the cost is 100, whereas if switch chooses a different path to reach the destination it will take more cost than usual (from switch 3 > switch 2 > switch 1= 200 cost)

Now what if we dedicatedly want to change the root bridge role from switch 1 to switch 2

So, we play with switch priority first because we won't change the mac address of the switches.

SW-2(config)#spanning-tree vlan 1 root primary

We make switch 2 as root bridge by giving above command

```
SW-2(config)#do show spanning-tree

VLAN0001
  Spanning tree enabled protocol rstp
  Root ID     Priority    24577
              Address     aabb.cc00.2000
              This bridge is the root
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    24577  (priority 24576 sys-id-ext 1)
              Address     aabb.cc00.2000
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time  300 sec

Interface           Role Sts Cost      Prio.Nbr Type
------------------- ---- --- --------- -------- --------------------------------
Et0/0               Desg FWD 100       128.1    Shr
Et0/1               Desg FWD 100       128.2    Shr
Et0/2               Desg FWD 100       128.3    Shr
Et0/3               Desg FWD 100       128.4    Shr
```

As a result of that command switch 2 act as a root switch

Now,

SW-3(config)#spanning-tree vlan 1 root secondary

By giving this above command we make switch 3 as a secondary root switch means if switch 2 fails as a root bridge. Then, switch 3 will become a root bridge.

Now how to change path cost

```
SW-3(config)#do show spanning-tree

VLAN0001
  Spanning tree enabled protocol rstp
  Root ID     Priority    24577
              Address     aabb.cc00.2000
              Cost        100
              Port        2 (Ethernet0/1)
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    28673  (priority 28672 sys-id-ext 1)
              Address     aabb.cc00.3000
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time  300 sec

Interface           Role Sts Cost      Prio.Nbr Type
------------------- ---- --- --------- -------- --------------------------------
Et0/0               Desg FWD 100       128.1    Shr
Et0/1               Root FWD 100       128.2    Shr
Et0/2               Desg FWD 100       128.3    Shr
Et0/3               Desg FWD 100       128.4    Shr
```

See, switch 3 has root port as eth 0/1 after changing the path cost. we make other port as a root port.

- **SW-3(config)#interface ethernet 0/0**
- **SW-3(config-if)#spanning-tree cost 10**
- **SW-3(config-if)#exit**

By applying such command on switch 3 ethernet 0/0, switch 1 – ethernet 0/0 & 0/1, switch 2 ethernet 0/0 we create root port on switch 3 from 0/1 to 0/0

```
SW-3(config)#do show spanning-tree

VLAN0001
  Spanning tree enabled protocol rstp
  Root ID     Priority    24577
              Address     aabb.cc00.2000
              Cost        20
              Port        1 (Ethernet0/0)
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    28673  (priority 28672 sys-id-ext 1)
              Address     aabb.cc00.3000
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time  300 sec

Interface           Role Sts Cost      Prio.Nbr Type
------------------- ---- --- --------- -------- --------------------------------
Et0/0               Root FWD 10        128.1    Shr
Et0/1               Altn BLK 100       128.2    Shr
Et0/2               Desg FWD 100       128.3    Shr
Et0/3               Desg FWD 100       128.4    Shr
```

7 ROUTING

Router is a device which we use for the purpose of routing. Now, there is a question what is routing. routing means to route a data packet between networks .in layman language routing means to show the path to the data packet.

here we go to the routing

routing has generally major two type

1. static routing
2. dynamic routing

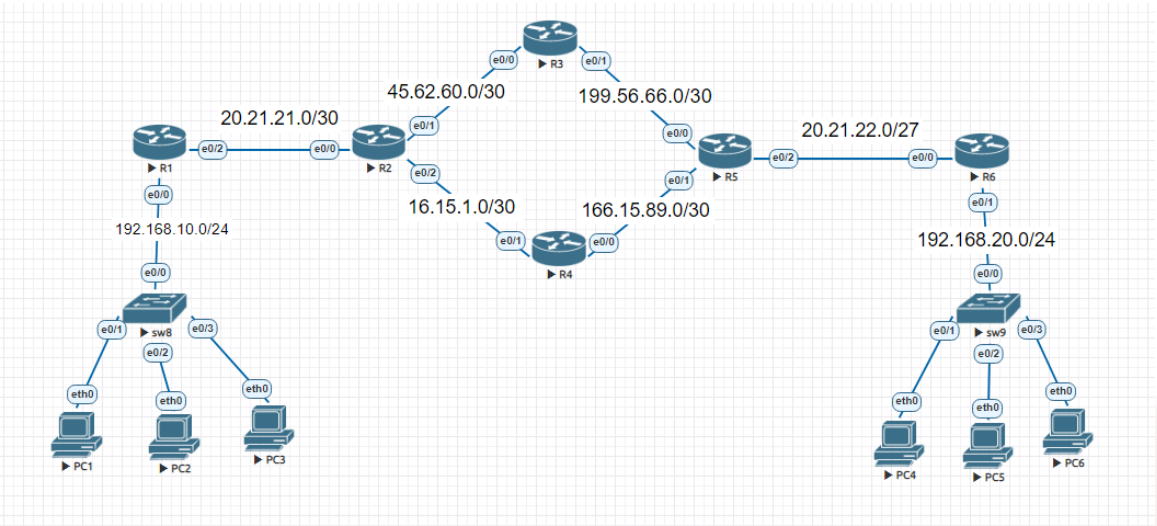
STATIC ROUTING - In this method we as a network engineer, have to define each and every route to the destination on every router till the destination.

DYNAMIC ROUTING - In this method we as a network engineer, have to only advertise the network which is directly connected to router. Dynamic Routing has different types of protocol, some of them are RIPv1 , RIPv2 , EIGRP , OSPF , ETC

7.1 STATIC ROUTING

LET'S START WITH THE STATIC ROUTING FIRST

- provide hostname accordingly
- Assign IP address to interface
- Do static routing, PC-1,2,3 should communicate withPC-4,5,6



R1

- **Router(config)#hostname R1**
- **R1(config)#interface ethernet 0/0**
- **R1(config-if)#ip address 192.168.10.254 255.255.255.0**
- **R1(config-if)#no shutdown**
- **R1(config-if)#exit**

- **R1(config)#interface ethernet 0/2**
- **R1(config-if)#ip address 20.21.21.1 255.255.255.252**
- **R1(config-if)#no shutdown**
- **R1(config-if)#exit**

R2

- **Router(config)#hostname R2**
- **R2(config)#interface ethernet 0/0**
- **R2(config-if)#ip address 20.21.21.2 255.255.255.252**
- **R2(config-if)#no shut**
- **R2(config-if)#exit**

- **R2(config)#interface ethernet 0/1**
- **R2(config-if)#ip address 45.62.60.1 255.255.255.252**
- **R2(config-if)#no shutdown**
- **R2(config-if)#exit**

- **R2(config)#interface ethernet 0/2**
- **R2(config-if)#ip address 16.15.1.1 255.255.255.252**
- **R2(config-if)#no shut**
- **R2(config-if)#exit**

R3

- **Router(config)#hostname R3**
- **R3(config)#interface ethernet 0/0**
- **R3(config-if)#ip address 45.62.60.2 255.255.255.252**
- **R3(config-if)#no shutdown**
- **R3(config-if)#exit**

- **R3(config)#interface ethernet 0/1**
- **R3(config-if)#ip address 199.56.66.1 255.255.255.252**
- **R3(config-if)#no shutdown**
- **R3(config-if)#exit**

R4

- Router(config)#hostname R4
- R4(config)#interface ethernet 0/1
- R4(config-if)#ip address 16.15.1.2 255.255.255.252
- R4(config-if)#no shutdown
- R4(config-if)#exit

- R4(config)#interface ethernet 0/0
- R4(config-if)#ip address 166.15.89.1 255.255.255.252
- R4(config-if)#no shutdown
- R4(config-if)#exit

R5

- Router(config)#hostname R5
- R5(config)#interface ethernet 0/0
- R5(config-if)#ip address 199.56.66.2 255.255.255.252
- R5(config-if)#no shutdown
- R5(config-if)#exit

- R5(config)#interface ethernet 0/1
- R5(config-if)#ip address 166.15.89.2 255.255.255.252
- R5(config-if)#no shutdown
- R5(config-if)#exit
- R5(config)#interface ethernet 0/2
- R5(config-if)#ip address 20.21.22.1 255.255.255.224
- R5(config-if)#no shutdown
- R5(config-if)#exit

R6

- **Router(config)#hostname R6**
- **R6(config)#interface ethernet 0/0**
- **R6(config-if)#ip address 20.21.22.2 255.255.255.224**
- **R6(config-if)#no shutdown**
- **R6(config-if)#exit**

- **R6(config)#interface ethernet 0/1**
- **R6(config-if)#ip address 192.168.20.254 255.255.255.0**
- **R6(config-if)#no shutdown**
- **R6(config-if)#exit**

Now, we have done with initial configuration part that is IP'S to the interface and hostname to router.

Well further we have to do is static routing. Let's start with it.

In static routing we have to define path to reach the destination.

Command for static routing

IP ROUTE <….Dest Network Address…...> <……Dest Subnet Mask….> <Next hop ip address>

```
R1(config)#do show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set

      20.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        20.21.21.0/30 is directly connected, Ethernet0/2
L        20.21.21.1/32 is directly connected, Ethernet0/2
      192.168.10.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.10.0/24 is directly connected, Ethernet0/0
L        192.168.10.254/32 is directly connected, Ethernet0/0
```

Before starting with routing there is no route to the destination of 192.168.20.0 network. so, we have to provide path for that network.

Start with **R1**,

R1(config)#ip route 192.168.20.0 255.255.255.0 20.21.21.2

- Destination network address- 192.168.20.0
- Destination subnet mask – 255.255.255.0
- Next hop ip address – 20.21.21.2

After static routing command, there is an additional route start with "S"

```
      20.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        20.21.21.0/30 is directly connected, Ethernet0/2
L        20.21.21.1/32 is directly connected, Ethernet0/2
      192.168.10.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.10.0/24 is directly connected, Ethernet0/0
L        192.168.10.254/32 is directly connected, Ethernet0/0
S     192.168.20.0/24 [1/0] via 20.21.21.2
```

Same thing we have to do with other routers, each router require path to reach the destination.

R2

R2(config)#ip route 192.168.20.0 255.255.255.0 45.62.60.2

R3

R3(config)#ip route 192.168.20.0 255.255.255.0 199.56.66.2

R5

R5(config)#ip route 192.168.20.0 255.255.255.0 20.21.22.2

We don't need to configure R6 cause R6 already has route which is directly connected to it. Represented with "C" in routing table.

```
      20.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        20.21.22.0/27 is directly connected, Ethernet0/0
L        20.21.22.2/32 is directly connected, Ethernet0/0
      192.168.20.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.20.0/24 is directly connected, Ethernet0/1
L        192.168.20.254/32 is directly connected, Ethernet0/1
```

When data came in the network of 192.168.20.0/24 then the PC gives back echo-reply to the source device. Because we were trying to ping that network PC.

So, in this case source device is 192.168.10.1 in the network of 192.168.10.0/24, and to give back a reply we don't have return route to the 192.168.10.0/24 network. Now we need to provide path to the destination network of 192.168.10.0/24.

R6

R6(config)#ip route 192.168.10.0 255.255.255.0 20.21.22.1

R5

R5(config)#ip route 192.168.10.0 255.255.255.0 166.15.89.1

R4

R4(config)#ip route 192.168.10.0 255.255.255.0 16.15.1.1

R2

R2(config)#ip route 192.168.10.0 255.255.255.0 20.21.21.1

Now we don't need to provide path to the R1 for 192.168.10.0 network because that network is directly connected to **R1**.

Now provide IP to pc and verify it by doing ping

```
VPCS> ip 192.168.10.1/24 192.168.10.254
Checking for duplicate address...
PC1 : 192.168.10.1 255.255.255.0 gateway 192.168.10.254

VPCS> ping 192.168.20.1

84 bytes from 192.168.20.1 icmp_seq=1 ttl=59 time=4.758 ms
84 bytes from 192.168.20.1 icmp_seq=2 ttl=59 time=3.515 ms
84 bytes from 192.168.20.1 icmp_seq=3 ttl=59 time=3.374 ms
84 bytes from 192.168.20.1 icmp_seq=4 ttl=59 time=2.740 ms
84 bytes from 192.168.20.1 icmp_seq=5 ttl=59 time=3.145 ms
```

Done with the static routing.

7.2 DEFAULT ROUTING

we have done static routing here. now there is a concept called default routing which is a part of static routing. Default routing basically forwarding data to some given IP and then that data can be forwarded by the device which is holding a given IP with the help of their routing table. when we do default routing on edge router we only create one default entry rest of the work is done by other router. we use default routing entry when we connect router to internet. And on internet there is a lot of networks which we can't define so there we use default entry to push all the data packets to particular IP which is belongs to ISP and then ISP do the main routing stuff.

Considering the static routing lab, where R1 is companies edge router which is connected with multiple networks.

R1

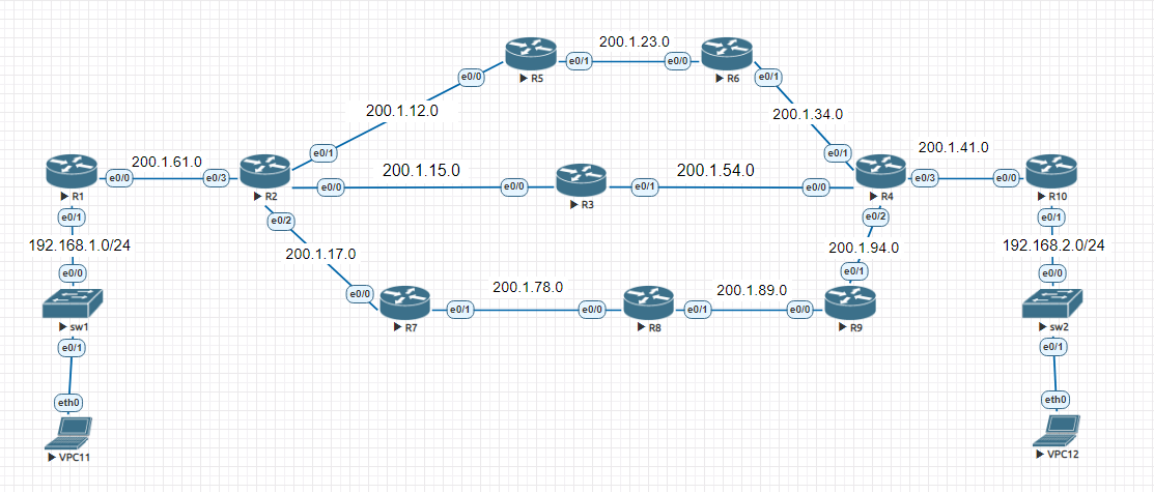
R1(config)#ip route 0.0.0.0 0.0.0.0 20.21.21.2

- Destination network address- 0.0.0.0 (UNKNOWN)
- Destination subnet mask – 0.0.0.0 (UNKNOWN)
- Next hop ip address – 20.21.21.2

Here we are telling the router that we don't know the path to reach the destination but we are forwarding that data on IP 20.21.21.2. So,20.21.21.2 can forward the data with their own routing table. Rest configuration is same.

8 ROUTING INFORMATION PROTOCOL (RIP)

- Rip is a dynamic routing protocol
- Rip uses Bellman Ford Algorithm
- Rip supports max 15 hop count
- Rip has AD value of 120
- Rip has a periodic update timer of 30 sec
- Rip has flush timer of 240 sec out of which 180 sec is a hold down timer & 60 sec is path update timer.
- Rip has two version- version 1(RIPv1) & version 2(RIPv2)
- Ripv1 uses broadcast address to send messages, ripv1 do not support authentication
- Ripv2 has multicast address – 224.0.0.9, ripv2 support authentication.



- Assign hostname to the devices
- IP address to interfaces & pc's
- Configure Routing

FROM THE ABOVE GIVEN LAB ASSIGN IP ADDRESS ACCORDINGLING

R1-R2	200.1.61.0/24	R2-R7	200.1.17.0/24
R2-R3	200.1.15.0/24	R7-R8	200.1.78.0/24
R3-R4	200.1.54.0/24	R8-R9	200.1.89.0/24
R4-R10	200.1.41.0/24	R9-R4	200.1.94.0/24
R2-R5	200.1.12.0/24	R1 LAN	192.168.1.0/24
R5 -R6	200.1.23.0/24	R10 LAN	192.168.2.0/24
R6-R4	200.1.34.0/24	---	---

After Assigning Ip on The Interfaces, Let's Move Further to The Routing

R1

- **R1(config)#router rip**
- **R1(config-router)#network 192.168.1.0**
- **R1(config-router)#network 200.1.61.0**
- **R1(config-router)#exit**

Here, we only have to advertise the directly connected network on router.

R2

- **R2(config)#router rip**
- **R2(config-router)#network 200.1.12.0**
- **R2(config-router)#network 200.1.15.0**
- **R2(config-router)#network 200.1.17.0**
- **R2(config-router)#network 200.1.61.0**
- **R2(config-router)#exit**

Now, we go through R7 to verify how rip works

R7

- R7(config)#router rip
- R7(config-router)#network 200.1.17.0
- R7(config-router)#network 200.1.78.0
- R7(config-router)#exit

R8

- R8(config)#router rip
- R8(config-router)#network 200.1.78.0
- R8(config-router)#network 200.1.89.0
- R8(config-router)#exit

R9

- R9(config)#router rip
- R9(config-router)#network 200.1.89.0
- R9(config-router)#network 200.1.94.0
- R9(config-router)#exit

R4

- R4(config)#router rip
- R4(config-router)#network 200.1.34.0
- R4(config-router)#network 200.1.54.0
- R4(config-router)#network 200.1.94.0
- R4(config-router)#network 200.1.41.0
- R4(config-router)#exit

R10

- R10(config)#router rip
- R10(config-router)#network 200.1.41.0
- R10(config-router)#network 192.168.2.0
- R10(config-router)#exit

8.1.1 Let's try to do ping from pc1 – pc2

```
pc1> ping 192.168.2.1

84 bytes from 192.168.2.1 icmp_seq=1 ttl=58 time=5.210 ms
84 bytes from 192.168.2.1 icmp_seq=2 ttl=58 time=3.513 ms
84 bytes from 192.168.2.1 icmp_seq=3 ttl=58 time=3.774 ms
84 bytes from 192.168.2.1 icmp_seq=4 ttl=58 time=3.974 ms
84 bytes from 192.168.2.1 icmp_seq=5 ttl=58 time=3.007 ms
```

8.1.2 Now try to do tracing

```
pc1> trace 192.168.2.1
trace to 192.168.2.1, 8 hops max, press Ctrl+C to stop
 1   192.168.1.254   1.737 ms  2.019 ms  3.228 ms
 2   200.1.61.2   1.596 ms  1.690 ms  2.507 ms
 3   200.1.17.2   2.792 ms  4.085 ms  2.148 ms
 4   200.1.78.2   1.657 ms  1.949 ms  3.443 ms
 5   200.1.89.2   3.711 ms  2.698 ms  1.550 ms
 6   200.1.94.2   1.866 ms  1.955 ms  4.700 ms
 7   200.1.41.2   4.191 ms  2.329 ms  1.805 ms
 8   *192.168.2.1   3.163 ms (ICMP type:3, code:3, Destination port unreachable)
```

See in the above trace, router chooses a route of R1--R2--R7--R8--R9--R4--R10

8.1.3 Let's go to the R2 to check the route

```
R2#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set

R      192.168.1.0/24 [120/1] via 200.1.61.1, 00:00:18, Ethernet0/3
R      192.168.2.0/24 [120/5] via 200.1.17.2, 00:00:07, Ethernet0/2
       200.1.12.0/24 is variably subnetted, 2 subnets, 2 masks
```

Router R2 chooses 200.1.17.2 path to reach the destination of 192.168.2.0 network

8.2 NOW CONFIGURE ROUTE OF R1—R2—R5—R6—R4—R10

R1—R2—R4—R10 were already configured. So, we have to configure the rest

R5

- **R5(config)#router rip**
- **R5(config-router)#network 200.1.12.0**
- **R5(config-router)#network 200.1.23.0**
- **R5(config-router)#exit**

R6

- **R6(config)#router rip**
- **R6(config-router)#network 200.1.23.0**
- **R6(config-router)#network 200.1.34.0**
- **R6(config-router)#exit**

8.2.1 NOW GO TO R2

```
R2#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set

R     192.168.1.0/24 [120/1] via 200.1.61.1, 00:00:23, Ethernet0/3
R     192.168.2.0/24 [120/4] via 200.1.12.2, 00:00:14, Ethernet0/1
      200.1.12.0/24 is variably subnetted, 2 subnets, 2 masks
```

Now see R2 chooses 200.1.12.2 path to reach the destination of 192.168.2.0 network.

8.2.2 pc1 tracing path to reach 192.168.2.1

```
pc1> trace 192.168.2.1
trace to 192.168.2.1, 8 hops max, press Ctrl+C to stop
 1   192.168.1.254   0.765 ms  1.730 ms  0.953 ms
 2   200.1.61.2   1.966 ms  1.198 ms  1.947 ms
 3   200.1.12.2   3.509 ms  3.366 ms  2.216 ms
 4   200.1.23.2   2.434 ms  2.088 ms  1.855 ms
 5   200.1.34.2   4.099 ms  4.993 ms  2.753 ms
 6   200.1.41.2   2.610 ms  1.971 ms  3.238 ms
 7   *192.168.2.1   9.625 ms (ICMP type:3, code:3, Destination port unreachable)
```

8.3 Now configure the path of R1—R2—R3—R4—R10

R3

- **R3(config)#router rip**
- **R3(config-router)#network 200.1.15.0**
- **R3(config-router)#network 200.1.54.0**
- **R3(config-router)#exit**

8.3.1 router R2 for routes update

```
R2#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set

R     192.168.1.0/24 [120/1] via 200.1.61.1, 00:00:23, Ethernet0/3
R     192.168.2.0/24 [120/3] via 200.1.15.2, 00:00:17, Ethernet0/0
      200.1.12.0/24 is variably subnetted, 2 subnets, 2 masks
```

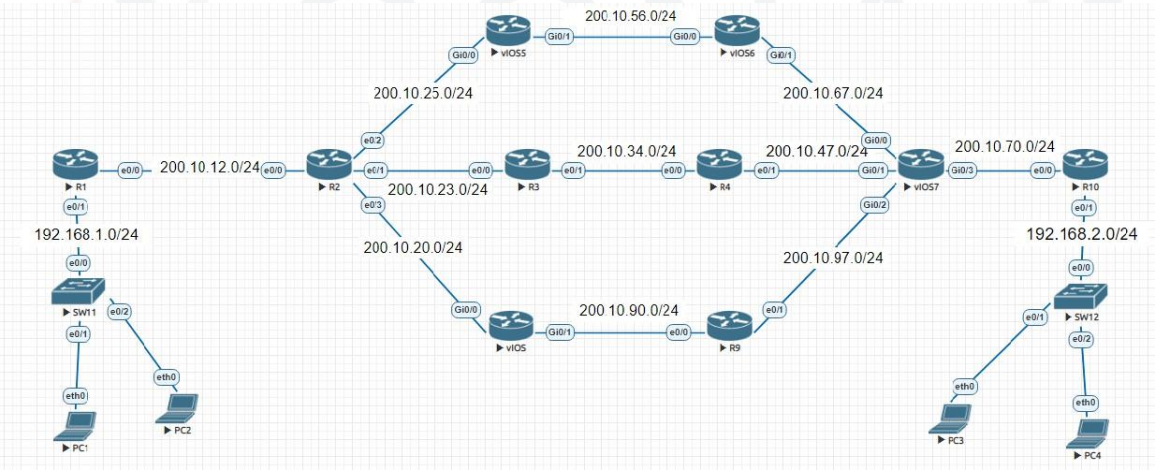
8.3.2 Now let's look at pc1 tracing

```
pc1> trace 192.168.2.1
trace to 192.168.2.1, 8 hops max, press Ctrl+C to stop
 1   192.168.1.254   0.765 ms  1.730 ms  0.953 ms
 2   200.1.61.2   1.966 ms  1.198 ms  1.947 ms
 3   200.1.12.2   3.509 ms  3.366 ms  2.216 ms
 4   200.1.23.2   2.434 ms  2.088 ms  1.855 ms
 5   200.1.34.2   4.099 ms  4.993 ms  2.753 ms
 6   200.1.41.2   2.610 ms  1.971 ms  3.238 ms
 7   *192.168.2.1   9.625 ms (ICMP type:3, code:3, Destination port unreachable)
```

So, here we are with the conclusion of RIP chooses lowest hop count path to reach the destination.

9 ENHANCED INTERIOR GATEWAY ROUTING PROTOCOL(EIGRP)

- Eigrp is a Dynamic routing protocol. Under this it is a Hybrid Protocol.
- Eigrp uses DUAL ALGORITHEM (Diffusing Update Algorithm)
- Eigrp support classless IP addressing, also support Authentication.
- Eigrp has AD value of 90
- Eigrp has hello timer of 5 sec and hold down timer is 15 sec. Eigrp do incremental update.
- Eigrp has Multicast address 224.0.0.10
- Eigrp has default hop count is 100. We can increase the limit till 255 hops.
- Eigrp uses Metric : Bandwidth + Delay (+MTU+Reliability+load)
- Eigrp make three table :- 1.Neighbor table 2.Topology table 3.Routing table



- Assign ip to the interfaces
- Assign hostname on devices
- Configure EIGRP routing

9.1 Assign ip and hostname to the devices

Now lets move to the Routing part

Firstly we choose middle part to route data (R1—R2—R3—R4—vIOS7—R10)

R1

- **R1(config)#router eigrp 100**
- **R1(config-router)#network 192.168.1.0 0.0.0.255**
- **R1(config-router)#network 200.10.12.0 0.0.0.255**
- **R1(config-router)#exit**

R2

- **R2(config)#router eigrp 100**
- **R2(config-router)#network 200.10.12.0 0.0.0.255**
- **R2(config-router)#network 200.10.25.0 0.0.0.255**
- **R2(config-router)#network 200.10.23.0 0.0.0.255**
- **R2(config-router)#network 200.10.20.0 0.0.0.255**
- **R2(config-router)#exit**

R3

- **R3(config)#router eigrp 100**
- **R3(config-router)#network 200.10.23.0 0.0.0.255**
- **R3(config-router)#network 200.10.34.0 0.0.0.255**
- **R3(config-router)#exit**

R4

- **R4(config)#router eigrp 100**
- **R4(config-router)#network 200.10.34.0 0.0.0.255**
- **R4(config-router)#network 200.10.47.0 0.0.0.255**
- **R4(config-router)#exit**

vIOS7

- vISO7(config)#router eigrp 100
- vISO7(config-router)#network 200.10.47.0 0.0.0.255
- vISO7(config-router)#network 200.10.67.0 0.0.0.255
- vISO7(config-router)#network 200.10.97.0 0.0.0.255
- vISO7(config-router)#network 200.10.70.0 0.0.0.255
- vISO7(config-router)#exit

R10

- R10(config)#router eigrp 100
- R10(config-router)#network 200.10.70.2 0.0.0.255
- R10(config-router)#network 192.168.2.0 0.0.0.0.255
- R10(config-router)#network 192.168.2.0 0.0.0.255
- R10(config-router)#exit

9.1.1 Now lets ping from PC1 – PC3

```
PC1> ping 192.168.2.1

84 bytes from 192.168.2.1 icmp_seq=1 ttl=58 time=33.137 ms
84 bytes from 192.168.2.1 icmp_seq=2 ttl=58 time=6.274 ms
84 bytes from 192.168.2.1 icmp_seq=3 ttl=58 time=16.597 ms
84 bytes from 192.168.2.1 icmp_seq=4 ttl=58 time=14.116 ms
84 bytes from 192.168.2.1 icmp_seq=5 ttl=58 time=12.713 ms
```

9.1.2 Now trace for path

```
PC1> trace 192.168.2.1
trace to 192.168.2.1, 8 hops max, press Ctrl+C to stop
 1   192.168.1.254   2.678 ms  5.613 ms  0.790 ms
 2   200.10.12.2   4.754 ms  2.201 ms  1.600 ms
 3   200.10.23.2   2.589 ms  1.996 ms  2.432 ms
 4   200.10.34.2   3.744 ms  5.336 ms  2.788 ms
 5   200.10.47.2   10.887 ms  8.903 ms  8.951 ms
 6   200.10.70.2   5.661 ms  3.093 ms  8.780 ms
 7   *192.168.2.1   8.572 ms (ICMP type:3, code:3, Destination
 port unreachable)
```

9.2 Now we have to configure new path R1—R2—vIOS—R9—vIOS7—R10

vIOS

- **vIOS(config)#router eigrp 100**
- **vIOS(config-router)#network 200.10.90.0 0.0.0.255**
- **vIOS(config-router)#network 200.10.20.0 0.0.0.255**
- **vIOS(config-router)#exit**

R9

- **R9(config)#router eigrp 100**
- **R9(config-router)#network 200.10.90.0 0.0.0.255**
- **R9(config-router)#network 200.10.97.0 0.0.0.255**
- **R9(config-router)#exit**

9.3 Now eigrp chooses route of R1—R2—vIOS—R9—vIOS7—R10

9.3.1 trace from PC1 to PC3

```
PC1> trace 192.168.2.1
trace to 192.168.2.1, 8 hops max, press Ctrl+C to stop
 1   192.168.1.254   1.053 ms  0.569 ms  0.585 ms
 2   200.10.12.2   0.993 ms  0.797 ms  0.862 ms
 3   200.10.20.2   15.397 ms  6.707 ms  4.480 ms
 4   200.10.90.2   5.058 ms  8.661 ms  5.224 ms
 5   200.10.97.2   32.548 ms  12.786 ms  12.535 ms
 6   200.10.70.2   14.830 ms  15.371 ms  12.013 ms
 7   *192.168.2.1   13.717 ms (ICMP type:3, code:3, Destination port unreachable)
```

9.4 Now configure upper route

vIOS5

- **vISO5(config)#router eigrp 100**
- **vISO5(config-router)#network 200.10.25.0 0.0.0.255**
- **vISO5(config-router)#network 200.10.56.0 0.0.0.255**
- **vISO5(config-router)#exit**

vIOS6

- **vIOS6(config)#router eigrp 100**
- **vIOS6(config-router)#network 200.10.56.0 0.0.0.255**
- **vIOS6(config-router)#network 200.10.67.0 0.0.0.255**
- **vIOS6(config-router)#exit**

9.4.1 Now router R2 chooses a upper path

```
R2(config)#do show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set

D      192.168.1.0/24 [90/307200] via 200.10.12.1, 00:00:09, Ethernet0/0
D      192.168.2.0/24 [90/307968] via 200.10.25.2, 00:00:14, Ethernet0/2
       200.10.12.0/24 is variably subnetted, 2 subnets, 2 masks
```

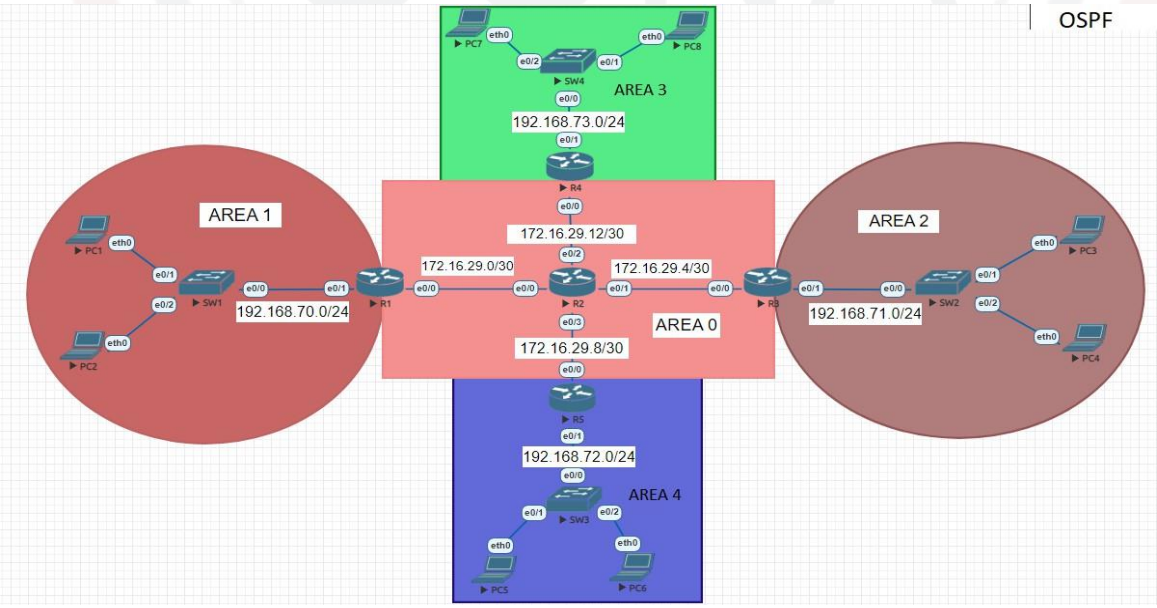
9.4.2 Now let's trace from PC1 to PC3

```
PC1> trace 192.168.2.1
trace to 192.168.2.1, 8 hops max, press Ctrl+C to stop
 1   192.168.1.254   0.823 ms  0.648 ms  0.686 ms
 2   200.10.12.2   0.976 ms  1.823 ms  1.363 ms
 3   200.10.25.2   19.500 ms  4.837 ms  10.388 ms
 4   200.10.56.2   15.936 ms  8.064 ms  13.643 ms
 5   200.10.67.2   20.538 ms  18.308 ms  22.251 ms
 6   200.10.70.2   20.940 ms  17.046 ms  13.785 ms
 7   *192.168.2.1   20.780 ms (ICMP type:3, code:3, Destination port unreachable)
```

10 OPEN SHORTEST PATH FIRST (OSPF)

- OSPF is dynamic routing protocol, under this ospf is a link state protocol.
- OSPF uses DIJKSTRA ALGORITHM or SPF (SHORTEST PATH FIRST) ALGORITHEM
- OSPF has AD value of 110
- OSPF uses multicast address 224.0.0.5 and 224.0.0.6
- OSPF supports classless routing and also supports authentication
- OSPF creates 3 Routing Table
    1. Neighbor table
    2. Database table
    3. Routing table

- OSPF do trigger update (incremental update + every 30 min whole routing table update)
- OSPF uses lowest bandwidth as a cost to reach the destination



- **Assign IP to the interfaces**
- **Assign hostname on devices**
- **Configure OSPF routing**

WE HAVE ALREADY GIVEN AN IP ADDRESS AND HOSTNAME TO THE DEVICES

R1

```
R1#show ip interface brief
Interface                  IP-Address      OK? Method Status                Protocol
Ethernet0/0                172.16.29.1     YES manual up                    up
Ethernet0/1                192.168.70.254  YES manual up                    up
Ethernet0/2                unassigned      YES unset  administratively down down
Ethernet0/3                unassigned      YES unset  administratively down down
```

R2

```
R2#show ip interface brief
Interface                  IP-Address      OK? Method Status                Protocol
Ethernet0/0                172.16.29.2     YES manual up                    up
Ethernet0/1                172.16.29.6     YES manual up                    up
Ethernet0/2                172.16.29.14    YES manual up                    up
Ethernet0/3                172.16.29.10    YES manual up                    up
```

R3

```
R3#show ip interface brief
Interface                  IP-Address      OK? Method Status                Protocol
Ethernet0/0                172.16.29.5     YES manual up                    up
Ethernet0/1                192.168.71.254  YES manual up                    up
Ethernet0/2                unassigned      YES unset  administratively down down
Ethernet0/3                unassigned      YES unset  administratively down down
```

R4

```
R4#show ip interface brief
Interface                  IP-Address      OK? Method Status                Protocol
Ethernet0/0                172.16.29.13    YES manual up                    up
Ethernet0/1                192.168.73.254  YES manual up                    up
Ethernet0/2                unassigned      YES unset  administratively down down
Ethernet0/3                unassigned      YES unset  administratively down down
```

R5

```
R5#show ip interface brief
Interface                  IP-Address      OK? Method Status                Protocol
Ethernet0/0                172.16.29.9     YES manual up                    up
Ethernet0/1                192.168.72.254  YES manual up                    up
Ethernet0/2                unassigned      YES unset  administratively down down
Ethernet0/3                unassigned      YES unset  administratively down down
```

We done with the verification of ip and hostname on the devices

Let’s move to the OSPF configuration

R1

- **R1(config)#router ospf 100**
- **R1(config-router)#network 192.168.70.0 0.0.0.255 area 1**
- **R1(config-router)#network 172.16.29.0 0.0.0.3 area 0**
- **R1(config-router)#exit**

R2

- **R2(config)#router ospf 100**
- **R2(config-router)#network 172.16.29.0 0.0.0.3 area 0**
- **R2(config-router)#network 172.16.29.4 0.0.0.3 area 0**
- **R2(config-router)#network 172.16.29.8 0.0.0.3 area 0**
- **R2(config-router)#network 172.16.29.12 0.0.0.3 area 0**
- **R2(config-router)#exit**

R3

- **R3(config)#router ospf 100**
- **R3(config-router)#network 172.16.29.4 0.0.0.3 area 0**
- **R3(config-router)#network 192.168.71.0 0.0.0.255 area 2**
- **R3(config-router)#exit**

R4

- **R4(config)#router ospf 100**
- **R4(config-router)#network 172.16.29.12 0.0.0.3 area 0**
- **R4(config-router)# network 192.168.73.0 0.0.0.255 area 3**
- **R4(config-router)#exit**

R5

- **R5(config)#router ospf 100**
- **R5(config-router)#network 172.16.29.8 0.0.0.3 area 0**
- **R5(config-router)#network 192.168.72.0 0.0.0.255 area 4**
- **R5(config-router)#exit**

VERIFICATION

- **#show ip route**

R1

```
      172.16.0.0/16 is variably subnetted, 5 subnets, 2 masks
C        172.16.29.0/30 is directly connected, Ethernet0/0
L        172.16.29.1/32 is directly connected, Ethernet0/0
O        172.16.29.4/30 [110/20] via 172.16.29.2, 00:11:15, Ethernet0/0
O        172.16.29.8/30 [110/20] via 172.16.29.2, 00:11:15, Ethernet0/0
O        172.16.29.12/30 [110/20] via 172.16.29.2, 00:11:03, Ethernet0/0
      192.168.70.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.70.0/24 is directly connected, Ethernet0/1
L        192.168.70.254/32 is directly connected, Ethernet0/1
O IA  192.168.71.0/24 [110/30] via 172.16.29.2, 00:09:58, Ethernet0/0
O IA  192.168.72.0/24 [110/30] via 172.16.29.2, 00:06:45, Ethernet0/0
```

R2

```
      172.16.0.0/16 is variably subnetted, 8 subnets, 2 masks
C        172.16.29.0/30 is directly connected, Ethernet0/0
L        172.16.29.2/32 is directly connected, Ethernet0/0
C        172.16.29.4/30 is directly connected, Ethernet0/1
L        172.16.29.6/32 is directly connected, Ethernet0/1
C        172.16.29.8/30 is directly connected, Ethernet0/3
L        172.16.29.10/32 is directly connected, Ethernet0/3
C        172.16.29.12/30 is directly connected, Ethernet0/2
L        172.16.29.14/32 is directly connected, Ethernet0/2
O IA  192.168.70.0/24 [110/20] via 172.16.29.1, 00:16:53, Ethernet0/0
O IA  192.168.71.0/24 [110/20] via 172.16.29.5, 00:15:26, Ethernet0/1
O IA  192.168.72.0/24 [110/20] via 172.16.29.9, 00:12:13, Ethernet0/3
```

R3

```
      172.16.0.0/16 is variably subnetted, 5 subnets, 2 masks
O        172.16.29.0/30 [110/20] via 172.16.29.6, 00:17:55, Ethernet0/0
C        172.16.29.4/30 is directly connected, Ethernet0/0
L        172.16.29.5/32 is directly connected, Ethernet0/0
O        172.16.29.8/30 [110/20] via 172.16.29.6, 00:17:55, Ethernet0/0
O        172.16.29.12/30 [110/20] via 172.16.29.6, 00:17:55, Ethernet0/0
O IA  192.168.70.0/24 [110/30] via 172.16.29.6, 00:17:55, Ethernet0/0
      192.168.71.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.71.0/24 is directly connected, Ethernet0/1
L        192.168.71.254/32 is directly connected, Ethernet0/1
O IA  192.168.72.0/24 [110/30] via 172.16.29.6, 00:14:31, Ethernet0/0
```

R4

```
      172.16.0.0/16 is variably subnetted, 5 subnets, 2 masks
O        172.16.29.0/30 [110/20] via 172.16.29.14, 00:16:57, Ethernet0/0
O        172.16.29.4/30 [110/20] via 172.16.29.14, 00:16:57, Ethernet0/0
O        172.16.29.8/30 [110/20] via 172.16.29.14, 00:16:57, Ethernet0/0
C        172.16.29.12/30 is directly connected, Ethernet0/0
L        172.16.29.13/32 is directly connected, Ethernet0/0
O IA  192.168.70.0/24 [110/30] via 172.16.29.14, 00:16:57, Ethernet0/0
O IA  192.168.71.0/24 [110/30] via 172.16.29.14, 00:16:57, Ethernet0/0
O IA  192.168.72.0/24 [110/30] via 172.16.29.14, 00:15:39, Ethernet0/0
      192.168.73.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.73.0/24 is directly connected, Ethernet0/1
L        192.168.73.254/32 is directly connected, Ethernet0/1
```

R5

```
      172.16.0.0/16 is variably subnetted, 5 subnets, 2 masks
O        172.16.29.0/30 [110/20] via 172.16.29.10, 00:16:37, Ethernet0/0
O        172.16.29.4/30 [110/20] via 172.16.29.10, 00:16:37, Ethernet0/0
C        172.16.29.8/30 is directly connected, Ethernet0/0
L        172.16.29.9/32 is directly connected, Ethernet0/0
O        172.16.29.12/30 [110/20] via 172.16.29.10, 00:16:37, Ethernet0/0
O IA  192.168.70.0/24 [110/30] via 172.16.29.10, 00:16:37, Ethernet0/0
O IA  192.168.71.0/24 [110/30] via 172.16.29.10, 00:16:37, Ethernet0/0
      192.168.72.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.72.0/24 is directly connected, Ethernet0/1
L        192.168.72.254/32 is directly connected, Ethernet0/1
```

We have verify the routing, now let's try to ping form PC1 to PC4

```
PC1> ping  192.168.71.2

84 bytes from 192.168.71.2 icmp_seq=1 ttl=61 time=5.260 ms
84 bytes from 192.168.71.2 icmp_seq=2 ttl=61 time=1.640 ms
84 bytes from 192.168.71.2 icmp_seq=3 ttl=61 time=2.058 ms
84 bytes from 192.168.71.2 icmp_seq=4 ttl=61 time=2.167 ms
84 bytes from 192.168.71.2 icmp_seq=5 ttl=61 time=2.199 ms
```

From PC1 to PC7

```
PC1> ping  192.168.73.1

84 bytes from 192.168.73.1 icmp_seq=1 ttl=61 time=4.014 ms
84 bytes from 192.168.73.1 icmp_seq=2 ttl=61 time=2.274 ms
84 bytes from 192.168.73.1 icmp_seq=3 ttl=61 time=3.176 ms
84 bytes from 192.168.73.1 icmp_seq=4 ttl=61 time=2.759 ms
84 bytes from 192.168.73.1 icmp_seq=5 ttl=61 time=2.184 ms
```

From PC1 to PC6

```
PC1> ping 192.168.72.2

84 bytes from 192.168.72.2 icmp_seq=1 ttl=61 time=4.491 ms
84 bytes from 192.168.72.2 icmp_seq=2 ttl=61 time=2.397 ms
84 bytes from 192.168.72.2 icmp_seq=3 ttl=61 time=2.732 ms
84 bytes from 192.168.72.2 icmp_seq=4 ttl=61 time=2.613 ms
84 bytes from 192.168.72.2 icmp_seq=5 ttl=61 time=3.566 ms
```

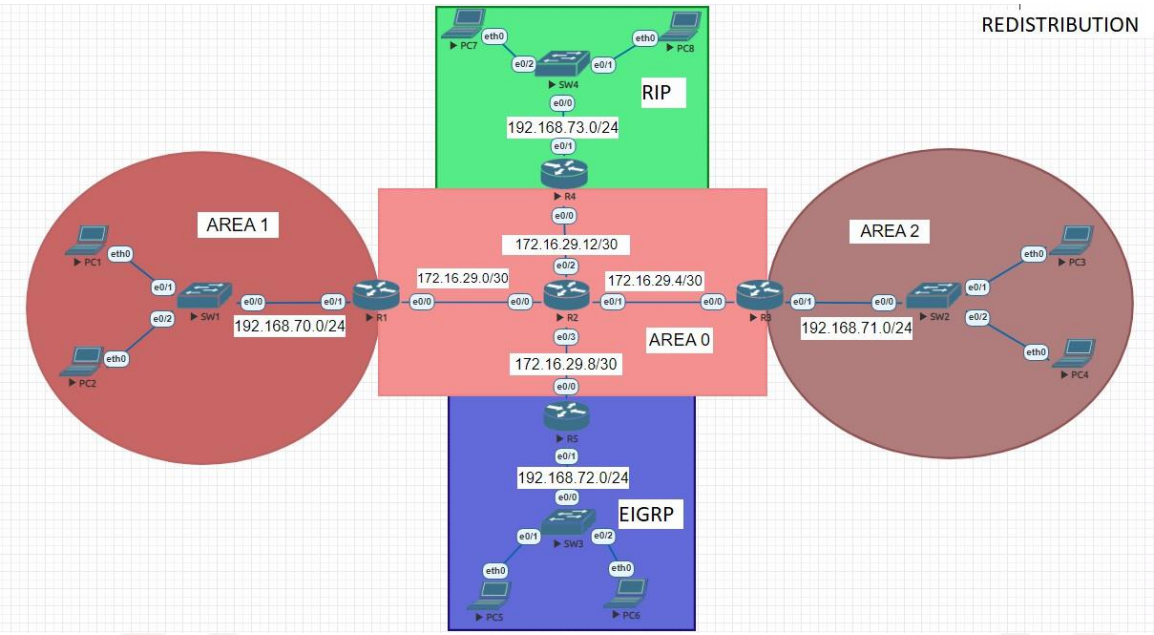
So, here we done with OSPF.

Till the time we have done routing with each single protocol like only lab with RIP/ EIGRP / OSPF individually. What if we want to do routing between multiple protocol like routing between RIP, EIGRP, OSPF at a same time, that's what we called "REDISTRIBUTION".

CONSIDER THIS LAB FOR REDISTRIBUTION

10.1 WE HAVE MADE SLIGHT CHANGES IN THE OSPF LAB FOR MAKE IT FIT FOR THE PURPOSE OF REDISTRIBUTION

- R4 ROUTER NOW PROCESS TWO PROTOCOL OF OSPF & RIPv2
- R5 ROUTER NOW PROCESS TWO PROTOCOL OF OSPF 100 & EIGRP 90



REST CONFIGURATION IS SAME.EXCEPT R4 and R5

R4

Interface ethernet 0/0 consist network of 172.16.29.12/30 will be advertise in OSPF and

Interface ethernet 0/1 consist network of 192.168.73.0/24 will be advertise in RIP .

- **R4(config)#router ospf 100**
- **R4(config-router)#network 172.16.29.13 0.0.0.3 area 0**
- **R4(config-router)#exit**
- **R4(config)#router rip**
- **R4(config-router)#version 2**
- **R4(config-router)#network 192.168.73.0**
- **R4(config-router)#exit**

See there is no route on R2 router for 192.168.73.0/24 network cause R2 is in ospf and 192.168.73.0/24 is in RIP

```
      172.16.0.0/16 is variably subnetted, 8 subnets, 2 masks
C        172.16.29.0/30 is directly connected, Ethernet0/0
L        172.16.29.2/32 is directly connected, Ethernet0/0
C        172.16.29.4/30 is directly connected, Ethernet0/1
L        172.16.29.6/32 is directly connected, Ethernet0/1
C        172.16.29.8/30 is directly connected, Ethernet0/3
L        172.16.29.10/32 is directly connected, Ethernet0/3
C        172.16.29.12/30 is directly connected, Ethernet0/2
L        172.16.29.14/32 is directly connected, Ethernet0/2
O IA  192.168.70.0/24 [110/20] via 172.16.29.1, 01:08:29, Ethernet0/0
O IA  192.168.71.0/24 [110/20] via 172.16.29.5, 01:07:02, Ethernet0/1
```

Let's do it

- **R4(config)#router ospf 100**
- **R4(config-router)#redistribute rip subnets**
- **R4(config-router)#exit**
- **R4(config)#router rip**
- **R4(config-router)#redistribute ospf 100 metric 1**
- **R4(config-router)#exit**

Now see R2 will have 192.168.73.0/24 network in his routing table

```
      172.16.0.0/16 is variably subnetted, 8 subnets, 2 masks
C        172.16.29.0/30 is directly connected, Ethernet0/0
L        172.16.29.2/32 is directly connected, Ethernet0/0
C        172.16.29.4/30 is directly connected, Ethernet0/1
L        172.16.29.6/32 is directly connected, Ethernet0/1
C        172.16.29.8/30 is directly connected, Ethernet0/3
L        172.16.29.10/32 is directly connected, Ethernet0/3
C        172.16.29.12/30 is directly connected, Ethernet0/2
L        172.16.29.14/32 is directly connected, Ethernet0/2
O IA  192.168.70.0/24 [110/20] via 172.16.29.1, 01:17:35, Ethernet0/0
O IA  192.168.71.0/24 [110/20] via 172.16.29.5, 01:16:08, Ethernet0/1
O E2  192.168.73.0/24 [110/20] via 172.16.29.13, 00:04:25, Ethernet0/2
```

R5

Interface ethernet 0/0 consist network of 172.16.29.8/30 will be advertise in OSPF and

Interface ethernet 0/1 consist network of 192.168.72.0/24 will be advertise in EIGRP .

- **R5(config)#router ospf 100**
- **R5(config-router)#network 172.16.29.8 0.0.0.3 area 0**
- **R5(config-router)#exit**
- **R5(config)#router eigrp 90**
- **R5(config-router)#network 192.168.72.0 0.0.0.255**
- **R5(config-router)#exit**

See there is no route on R2 router for 192.168.72.0/24 network cause R2 is in ospf and 192.168.72.0/24 is in EIGRP

```
      172.16.0.0/16 is variably subnetted, 8 subnets, 2 masks
C        172.16.29.0/30 is directly connected, Ethernet0/0
L        172.16.29.2/32 is directly connected, Ethernet0/0
C        172.16.29.4/30 is directly connected, Ethernet0/1
L        172.16.29.6/32 is directly connected, Ethernet0/1
C        172.16.29.8/30 is directly connected, Ethernet0/3
L        172.16.29.10/32 is directly connected, Ethernet0/3
C        172.16.29.12/30 is directly connected, Ethernet0/2
L        172.16.29.14/32 is directly connected, Ethernet0/2
O IA  192.168.70.0/24 [110/20] via 172.16.29.1, 01:29:20, Ethernet0/0
O IA  192.168.71.0/24 [110/20] via 172.16.29.5, 01:27:53, Ethernet0/1
O E2  192.168.73.0/24 [110/20] via 172.16.29.13, 00:16:10, Ethernet0/2
```

Now we have to advertise EIGRP network in OSPF and vice versa

- **R5(config)#router eigrp 90**
- **R5(config-router)#redistribute ospf 100 metric 10000 1000 255 255 1500**
- **R5(config-router)#exit**

Here 10000 is a bandwidth of interface,1000 is a delay of the ethernet interface,255 is a reliability,255 is a load, 1500 is MTU

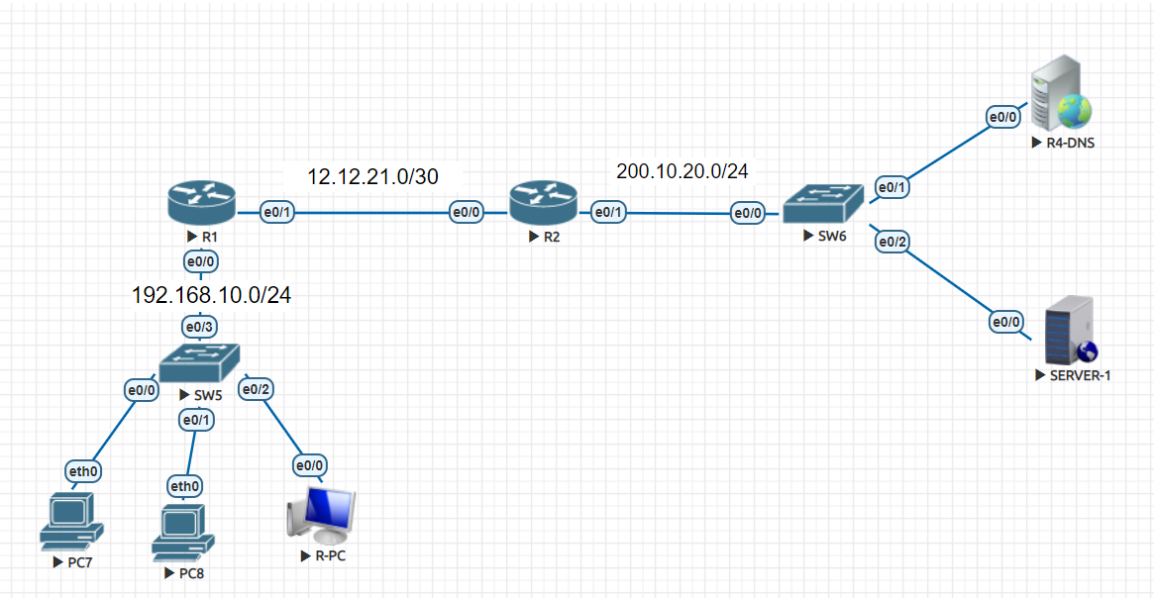
- **R5(config)#router ospf 100**
- **R5(config-router)#redistribute eigrp 90 subnets**
- **R5(config-router)#exit**

Now we can see 192.168.72.0/24 network in R2's routing table

```
      172.16.0.0/16 is variably subnetted, 8 subnets, 2 masks
C        172.16.29.0/30 is directly connected, Ethernet0/0
L        172.16.29.2/32 is directly connected, Ethernet0/0
C        172.16.29.4/30 is directly connected, Ethernet0/1
L        172.16.29.6/32 is directly connected, Ethernet0/1
C        172.16.29.8/30 is directly connected, Ethernet0/3
L        172.16.29.10/32 is directly connected, Ethernet0/3
C        172.16.29.12/30 is directly connected, Ethernet0/2
L        172.16.29.14/32 is directly connected, Ethernet0/2
O IA  192.168.70.0/24 [110/20] via 172.16.29.1, 01:35:56, Ethernet0/0
O IA  192.168.71.0/24 [110/20] via 172.16.29.5, 01:34:29, Ethernet0/1
O E2  192.168.72.0/24 [110/20] via 172.16.29.9, 00:00:12, Ethernet0/3
O E2  192.168.73.0/24 [110/20] via 172.16.29.13, 00:22:46, Ethernet0/2
```

We have done with the REDISTRIBUTION task…

11 DHCP and DNS



IN THIS ABOVE LAB we are going to configure DHCP, DNS first

So, what is DHCP (dynamic host configuration protocol), it is the protocol we generally used to assign IP address automatically.

And what is DNS (domain name system/server), it is the service we use to resolve domain name to IP address. like if we put www.google.com in our web browser, it redirects us to that website but in actual scenario we are heading towards the ip address of that particular web site instead. cause devices won't understand domain name rather they recognize ip address which is associated with that domain name just like

Example: www.google.com = 142.250.183.4

- Configure R1 LAN network with the IP range of 192.168.10.0/24
- Assign ip to the pc through DHCP
- Then, do routing on all devices
- Configure R4-DNS as a DNS server
- Try to ping www.ccn.com which is SERVER-1

11.1 IP's of the devices

R1	Eth0/0 – 192.168.10.254/24	Eth0/1 – 12.12.21.1/30
R2	Eth0/0 – 12.12.21.2/30	Eth0/1 – 200.10.20.30/24
R4-DNS	ETH 0/0 – 200.10.20.10/24	
SERVER-1	ETH 0/0 – 200.10.20.20/24	

Let's do it

- **R1(config)#ip dhcp pool CCN-LAN**
- **R1(dhcp-config)#network 192.168.10.0 255.255.255.0**
- **R1(dhcp-config)#default-router 192.168.10.254**
- **R1(dhcp-config)#dns-server 200.10.20.10**
- **R1(dhcp-config)#lease 0 12**
- **R1(dhcp-config)#exit**

- To configure DHCP we need 4 basic things that is IP, subnet mask, default gateway and DNS
- From network command we provide IP and subnet mask
- From default-router command we have provide a default gateway
- From DNS-SERVER command we provided a DNS server IP
- And by giving lease command we provided a lease period for that assigning IP

11.1.1 R1(config)#ip dhcp excluded-address 192.168.10.254

(If we want to remove any IP from that DHCP POOL, just to avoid duplicate IP's)

VERIFICATION

```
R1#show ip dhcp pool

Pool CCN-LAN :
 Utilization mark (high/low)    : 100 / 0
 Subnet size (first/next)       : 0 / 0
 Total addresses                : 254
 Leased addresses               : 1
 Pending event                  : none
 1 subnet is currently in the pool :
 Current index        IP address range                    Leased addresses
 192.168.10.2         192.168.10.1     - 192.168.10.254    1
```

```
R1#show ip dhcp binding
Bindings from all pools not associated with VRF:
IP address          Client-ID/              Lease expiration        Type
                    Hardware address/
                    User name
192.168.10.1        0100.5079.6668.07       Feb 15 2023 02:48 PM    Automatic
```

Then, how to ip to the VPC and R-PC

VPC

```
VPCS> ip dhcp
DDORA IP 192.168.10.1/24 GW 192.168.10.254
```

R-PC, this is actually a router considering and acting as a PC

- **R-PC(config)#interface ethernet 0/0**
- **R-PC(config-if)#ip address dhcp**
- **R-PC(config-if)#no shutdown**
- **R-PC(config-if)#exit**

To verify that give command

```
R-PC#show ip interface  brief
Interface                  IP-Address      OK? Method Status                Protocol
Ethernet0/0                192.168.10.2    YES DHCP   up                    up
Ethernet0/1                unassigned      YES unset  administratively down down
Ethernet0/2                unassigned      YES unset  administratively down down
Ethernet0/3                unassigned      YES unset  administratively down down
```

3 so now do routing on all devices here we running eigrp on router you can do any routing

R1

- **R1(config)#router eigrp 100**
- **R1(config-router)#network 192.168.10.0 0.0.0.255**
- **R1(config-router)#network 12.12.21.0 0.0.0.3**
- **R1(config-router)#exit**

R2

- **R2(config)#router eigrp 100**
- **R2(config-router)#network 12.12.21.0 0.0.0.3**
- **R2(config-router)#network 200.10.20.0 0.0.0.255**
- **R2(config-router)#exit**

R-PC

- **R-PC(config)#ip route 0.0.0.0 0.0.0.0 192.168.10.254**

R-DNS

- **R4-DNS(config)#ip route 0.0.0.0 0.0.0.0 200.10.20.30**

SERVER-1 (www.ccn.com)

- **www.ccn.com(config)#ip route 0.0.0.0 0.0.0.0 200.10.20.3**
- **4 now start the dns server on R4-DNS**
- **R4-DNS(config)#ip dns server**
- **R4-DNS(config)#ip host www.ccn.com 200.10.20.20**

First command is to start DNS server port number udp-53

And second command is to bind domain name with ip address

11.1.2 5 now ping the www.ccn.com consist ip 200.10.20.20

```
VPCS> ping www.ccn.com
www.ccn.com resolved to 200.10.20.20

84 bytes from 200.10.20.20 icmp_seq=1 ttl=253 time=7.019 ms
84 bytes from 200.10.20.20 icmp_seq=2 ttl=253 time=3.204 ms
84 bytes from 200.10.20.20 icmp_seq=3 ttl=253 time=4.116 ms
84 bytes from 200.10.20.20 icmp_seq=4 ttl=253 time=1.287 ms
84 bytes from 200.10.20.20 icmp_seq=5 ttl=253 time=4.267 ms
```

12 NETWORK TIME PROTOCOL (NTP)

- NTP is a network time uses UDP port -123
- Basically, NTP uses on all LAN as well as WAN devices just to sync time of their devices with NTP server, if time of those won't match then internet won't be able to work on that device.
- With the help of NTP we generate logs of the devices to solve the issues which generally occur in Enterprise environment. if time is mismatching then the troubleshoot will be more difficult.

We are going to consider lab which we used for the DHCP & DNS configuration

R2 (NTP Master)

- **R2(config)#interface loopback 1**
- **R2(config-if)#ip address 10.10.10.1 255.255.255.255**
- **R2(config-if)#no shutdown**
- **R2(config-if)#exit**

- **R2(config)#ntp master 1**
- **R2(config)#ntp source loopback 1**

Here we specify the NTP master stratum number 1 which mean it is most trusted NTP server in a network and we specify the source interface from where NTP broadcast will happen

R1(NTP Client)

- **R1(config)#ntp server 10.10.10.1**

Here we specify the NTP servers ip address which is R2's loopback 1 interface ip address

Now the NTP authentication is totally optional

R1

- **R1(config)#ntp authentication-key 1 md5 ccn**
- **R1(config)#ntp authenticate**

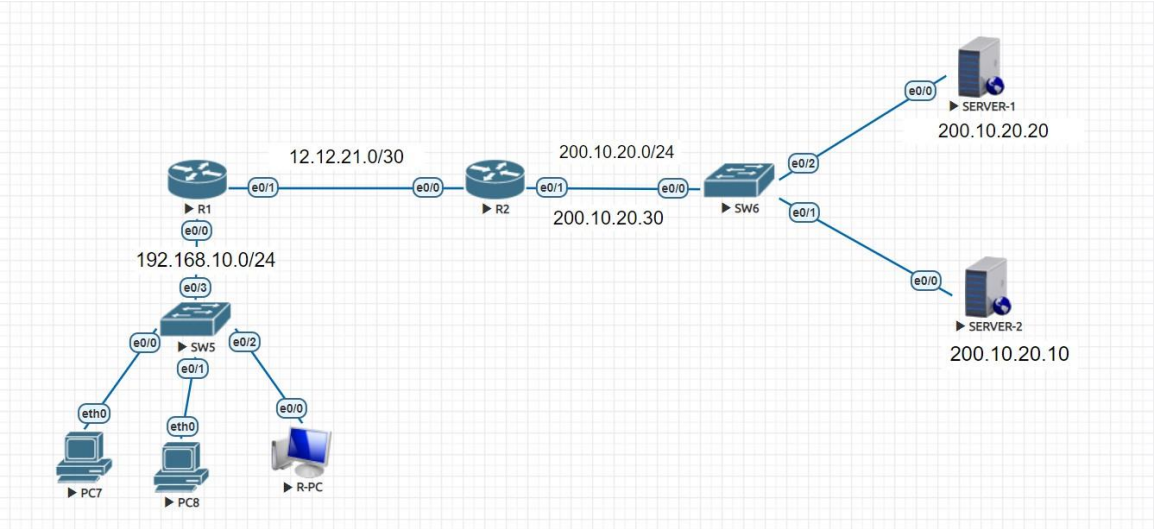
R2

- **R2(config)#ntp authentication-key 1 md5 ccn**
- **R2(config)#ntp authenticate**

VERIFICATION

R1#show ntp status OR R1#show ntp association

13 TELNET, SSH, HTTP, HTTPS



TELNET

Telnet is a remote access service works under TCP and uses port number 23 .generally telnet sends data in clear text format.

SSH

SSH is also a remote access service works under tcp and uses port number 22 . Genrally , ssh send data in encrypted format over the networks .it encrypts data through rsa algorithm, and consist key size of 2048 bit which is market standard.

Now configure the TELNET, SSH, HTTP, HTTPS on devices

- Assign IP according to networks represents in diagram
- Configure SERVER 1 for TELENT service
- Configure SERVER 2 for SSH service
- Configure SERVER 1 for HTTP service
- Configure SERVER 2 for HTTPS service

R1	ETH 0/0 192.168.10.254/24		ETH 0/1 12.12.21.1/30
R1- INTERNAL NETWORK PC	PC7 192.168.10.1/24	PC8 192.168.10.2/24	R-PC 192.168.10.3/24
R2	ETH 0/0 12.12.21.2/24		
SERVER 1	ETH 0/0 200.10.20.20/24		
SERVER 2	ETH 0/0 200.10.20.10		

13.1 TELNET

ON SERVER 1

- **SERVER-1(config)#line vty 0 4**
- **SERVER-1(config-line)#transport input telnet**
- **SERVER-1(config-line)#login local**
- **SERVER-1(config-line)#exit**
- **Local username & password creation**
- **SERVER-1(config)#username ccn privilege 15 password ccn**

Here, line vty means virtual teletype which means a connection over a networks or connection which is virtual. console access is direct access but telnet access is virtual access on device. transport input telnet means the data travels over a network should only connect to a telnet service activated on a device .and, login local means at the time of login device should ask username & password which is verified from local user database which is created on device.

How to take access?

For that we need a router(R-PC) in eve-ng setup

Router# telnet <destination_ip_address> <desired_service_port>

```
R-PC#telnet 200.10.20.20 23
Trying 200.10.20.20 ... Open

User Access Verification

Username: ccn
Password:
SERVER-1#
```

13.2 SSH

SSH on server 2

- **SERVER-2(config)#line vty 0 4**
- **SERVER-2(config-line)#transport input ssh**
- **SERVER-2(config-line)#login local**
- **SERVER-2(config-line)#exit**
- **SERVER-2(config)#crypto key generate rsa modulus 2048 label mypubkey**
- **Username & password**
- **SERVER-2(config)#username ccn privilege 15 password ccn**

Here line vty means virtual teletype which means a connection over a networks or connection which is virtual .then , 0 4 means at a time 5 line connection can be activate .transport input ssh means the data travels over a network should only connect to a ssh service activated on a device .and , login local means at the time of login device should ask username & password which is verified from local user database which is created on device. Crypto key command is to start the encryption process of the data through rsa algorithem with standard key 0f 2048 bit.

How to take access?

Router# ssh -l <username> <destination_ip_address>

```
R-PC#ssh -l ccn 200.10.20.10
Password:

SERVER-2#
SERVER-2#
SERVER-2#
```

13.3 HTTP

HTTP on server 1

- **SERVER-1(config)#ip http server**

By applying above command, we are enabling TCP port 80 which we generally use to take GUI access.

VERIFICATION

Router# telnet <destination_ip_address> <desired_port>

With the command we get a output of […..open] means http is enable on device

```
R-PC#telnet 200.10.20.20 80
Trying 200.10.20.20, 80 ... Open
```

13.4 HTTPS

https on server 2

- **SERVER-2(config)#ip http secure-server**

By applying this command we are enabling tcp port 443 on device which we genrally use to take secure GUI access

To additional security we enable authentication

- **SERVER-2(config)#ip http authentication local**

By applying this command we are enabling authentication on devices through local user database.

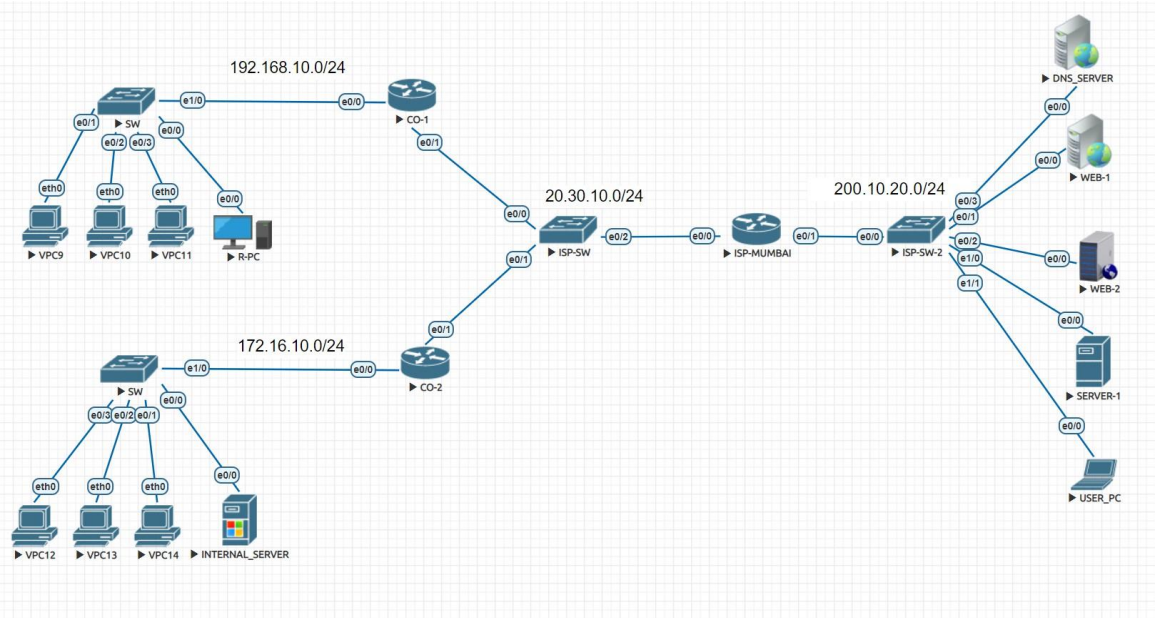
VERIFICATION

Router# telnet <destination_ip_address> <desired_port>

With the command we get a output of […..open] means https is enable on device

```
R-PC#telnet 200.10.20.10 443
Trying 200.10.20.10, 443 ... Open
```

14 ACCESS-CONTROL LIST (ACL)



Provide IP to the devices.

SECTION	DEVICE NAME	IP ON INTERFACE
COMPANY - 1	CO-1	ETH0/0= 192.168.10.254/24 ETH0/1= 20.30.10.10/24
	VPC9	192.168.10.1/24
	VPC10	192.168.10.2/24
	VPC11	192.168.10.3/24
	R-PC	192.168.10.100/24
COMPANY - 2	CO-2	ETH0/0= 172.16.10.254/24 ETH 0/1 = 20.30.10.20/24
	VPC12	172.16.10.1/24
	VPC13	172.16.10.2/24
	VPC14	172.16.10.3/24
	INTERNAL_SERVER	172.16.10.100/24

ISP	ISP-MUMBAI	ETH0/0 = 20.30.10.30/24 ETH0/1= 200.10.20.10/24
OTHERS	DNS_SERVER	200.10.20.20/24
	WEB-1	200.10.20.30/24
	WEB-2	200.10.20.40/24
	SERVER-1	200.10.20.50/24
	USER_PC	200.10.20.60/24

Do Routing on devices (Any kind of Routing)

Create a ACL for company - 1

- **R-PC should TELNET WEB-1 and WEB-2**
- **R-PC should SSH WEB-1 and WEB-2**
- **R-PC should HTTP WEB-1 and WEB-2**
- **R-PC should HTTPS WEB-1 and WEB-2**
- **Network of 192.168.10.0/24 should PING DNS_SERVER & SERVER-1**
- **R-PC should PING/TELNET/SSH/HTTP/HTTPS to SERVER-1 (www.ccn.com)**

Create A ACL For Company – 2

- **USER_PC should TELNET INTERNAL_SERVER**
- **USER_PC should SSH INTERNAL_SERVER**
- **USER_PC should HTTP INTERNAL_SERVER**
- **USER_PC should HTTPS INTERNAL_SERVER**
- **USER_PC should PING a Network of 172.16.10.0/24**

SOLUTION

R-PC SHOULD TELNET WEB-1 AND WEB-2

- ip access-list extended in-out
  1. permit tcp host 192.168.10.100 host 200.10.20.30 eq telnet
  2. permit tcp host 192.168.10.100 host 200.10.20.40 eq telnet
- ip access-list extended out-in
  3. permit tcp host 200.10.20.30 host 192.168.10.100 ack
  4. permit tcp host 200.10.20.40 host 192.168.10.100 ack

R-PC SHOULD SSH WEB-1 AND WEB-2

- ip access-list extended in-out
  1. permit tcp host 192.168.10.100 host 200.10.20.30 eq 22
  2. permit tcp host 192.168.10.100 host 200.10.20.40 eq 22

In first entry we are provided permission of ack to the TCP given IP, so again we don't need to do it

R-PC SHOULD HTTP WEB-1 AND WEB-2

- ip access-list extended in-out
  1. permit tcp host 192.168.10.100 host 200.10.20.30 eq 80
  2. permit tcp host 192.168.10.100 host 200.10.20.40 eq 80

R-PC SHOULD HTTPS WEB-1 AND WEB-2

- ip access-list extended in-out
  1. permit tcp host 192.168.10.100 host 200.10.20.30 eq 443
  2. permit tcp host 192.168.10.100 host 200.10.20.40 eq 443

NETWORK OF 192.168.10.0/24 SHOULD PING DNS_SERVER & SERVER-1

- ip access-list extended in-out
  1. permit icmp 192.168.10.0 0.0.0.255 host 200.10.20.20 echo
  2. permit icmp 192.168.10.0 0.0.0.255 host 200.10.20.50 echo
- ip access-list extended out-in
  1. permit icmp host 200.10.20.20 192.168.10.0 0.0.0.255 echo-reply
  2. permit icmp host 200.10.20.50 192.168.10.0 0.0.0.255 echo-reply

R-PC SHOULD PING/TELNET/SSH/HTTP/HTTPS TO SERVER-1 (www.ccn.com)

- ip access-list extended in-out
  1. permit tcp host 192.168.10.100 host 200.10.20.50 eq www
  2. permit tcp host 192.168.10.100 host 200.10.20.50 eq 443
  3. permit tcp host 192.168.10.100 host 200.10.20.50 eq 22
  4. permit tcp host 192.168.10.100 host 200.10.20.50 eq telnet
  5. permit icmp host 192.168.10.100 host 200.10.20.50 echo
- ip access-list extended out-in
  1. permit tcp host 200.10.20.50 host 192.168.10.100 ack
  2. permit icmp host 200.10.20.50 host 192.168.10.100 echo-reply

USER_PC SHOULD TELNET INTERNAL_SERVER

- ip access-list extended out-in
- permit tcp host 200.10.20.60 host 172.16.10.100 eq 23

USER_PC SHOULD SSH INTERNAL_SERVER

- ip access-list extended out-in
- permit tcp host 200.10.20.60 host 172.16.10.100 eq 22

USER_PC SHOULD HTTP INTERNAL_SERVER

- ip access-list extended out-in
- permit tcp host 200.10.20.60 host 172.16.10.100 eq 80

USER_PC SHOULD HTTPS INTERNAL_SERVER

- ip access-list extended out-in
- permit tcp host 200.10.20.60 host 172.16.10.100 eq 443

USER_PC SHOULD PING NETWORK OF 172.16.10.0/24

- ip access-list extended out-in
- permit icmp host 200.10.20.60 172.16.10.0 0.0.0.255 echo

WE HAVE TO PERMIT ROUTING PROTOCOL BECAUSE THAT PROTOCOL SENDING HELLO MESSGAES AND BLOCKED BY ACL

- ip access-list extended out-in
- permit eigrp any any

VERIFICATION

COMPANY-1

```
CO-1#show ip access-lists
Extended IP access list in-out
    10 permit tcp host 192.168.10.100 host 200.10.20.30 eq telnet
    20 permit tcp host 192.168.10.100 host 200.10.20.40 eq telnet
    30 permit tcp host 192.168.10.100 host 200.10.20.30 eq 22
    40 permit tcp host 192.168.10.100 host 200.10.20.40 eq 22
    50 permit tcp host 192.168.10.100 host 200.10.20.30 eq www
    60 permit tcp host 192.168.10.100 host 200.10.20.40 eq www
    70 permit tcp host 192.168.10.100 host 200.10.20.30 eq 443
    80 permit tcp host 192.168.10.100 host 200.10.20.40 eq 443
    90 permit icmp 192.168.10.0 0.0.0.255 host 200.10.20.20 echo
    100 permit icmp 192.168.10.0 0.0.0.255 host 200.10.20.50 echo
Extended IP access list out-in
    10 permit tcp host 200.10.20.30 host 192.168.10.100 ack
    20 permit tcp host 200.10.20.40 host 192.168.10.100 ack
    30 permit icmp host 200.10.20.20 192.168.10.0 0.0.0.255 echo-reply
    40 permit icmp host 200.10.20.50 192.168.10.0 0.0.0.255 echo-reply
    50 permit eigrp any any (964 matches)
```

COMPANY-2

```
CO-2#show ip access-lists
Extended IP access list in-out
    10 permit tcp host 172.16.10.100 host 200.10.20.60 ack
    20 permit icmp host 172.16.10.100 host 200.10.20.60 echo-reply (10 matches)
Extended IP access list out-in
    10 permit tcp host 200.10.20.60 host 172.16.10.100 eq telnet
    20 permit tcp host 200.10.20.60 host 172.16.10.100 eq 22
    30 permit tcp host 200.10.20.60 host 172.16.10.100 eq www
    40 permit tcp host 200.10.20.60 host 172.16.10.100 eq 443
    50 permit icmp host 200.10.20.60 172.16.10.0 0.0.0.255 echo (10 matches)
    60 permit eigrp any any (396 matches)
```

15 STANDARD ACL

- Basically, We Do Make Standard Access-Control List For Permit/Deny Source Traffic Only Unlike Extended ACL Where We Permit/Deny Source To Destination Traffic With The Control Of Protocol & Services As Well
- Standard ACL permit source traffic and allow all kinds of traffic on that give ip or a network/subnet

Let's make Standard ACL

CREATION

- **Router(config)#ip access-list standard lan-wan**
- **Router(config)#permit host 192.168.10.1 ……..(permit single ip with all source traffic)**

OR

- **Router(config)#permit 192.168.10.0 0.0.0.255…permit whole network with all source traffic)**
- **Router(config)#deny any**

IMPLEMENTATION

- **Router(config)#interface ethernet 0/0**
- **Router(config)#ip access-group lan-wan in**
- **Router(config)#exit**

VERIFICATION

- **Router# show ip access-list** .....**(show all acl)**

OR

- **Router#show ip access-list lan-wan** ..... **(show only lan-wan acl)**

Allowing all kinds of source traffic will make it more vulnerable that's why we use extended ACL, otherwise we use Standard ACL for NAT/PAT configuration or VPN configuration.

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