Advanced Computer Networking

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الدراسات الاولية / المرحلة الرابعة / الفصل الاول

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Computer Networks

Forth Class

First Course

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Computer Networks

LAB1: Router Management

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Lab 1: Router management

Main Topics:

- Routers & switches similarities and differences: form-factors, ports numbering, port status, …etc.
- Definition of configuration.
- Device management types and comparison (cons and pros of each):

1. Inband (data ports e.g. Fast Ethernet …etc. & protocols e.g. TELNET and SSH).
2. Out-of-band (management ports e.g. console port (Router), RS-232 (PC) & Terminal program).

- Cisco router main hardware components (Flash, NVRAM and DRAM) and software components (POST, IOS, Startup Conf. and Running Conf.)
- Cisco router boot process.
- Cisco IOS features and modes: User-EXEC, Privileged-EXEC, Global Configuration and Interface Configuration.

Procedure:

1. Run Cisco Packet Tracer.
2. Connect the topology shown in Fig.1

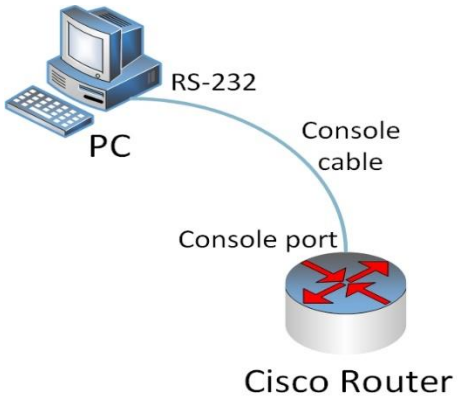

Fig.1

3. Click on PC and select Desktop>Terminal.
4. Use the parameters shown in Fig.2 in the Terminal program.

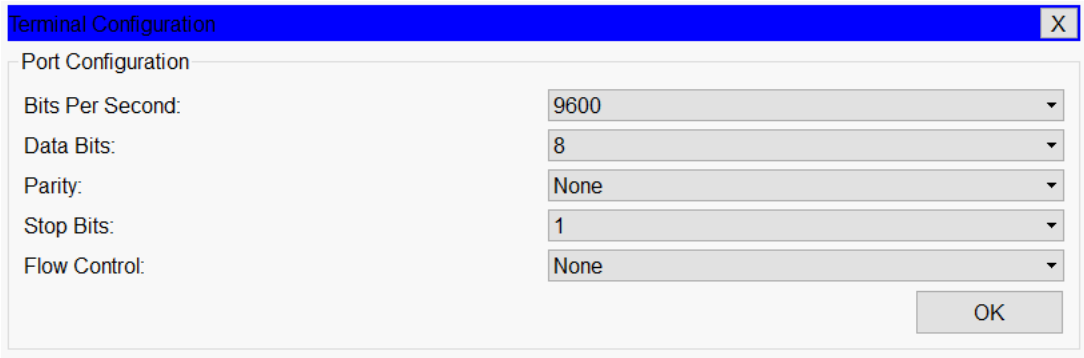

Fig.2

5. Now, we can access the router IOS as shown in Fig.3

```
Cisco 1841 (revision 5.0) with 114688K/16384K bytes of
memory.
Processor board ID FTX0947Z18E
M860 processor: part number 0, mask 49
2 FastEthernet/IEEE 802.3 interface(s)
191K bytes of NVRAM.
63488K bytes of ATA CompactFlash (Read/Write)
Cisco IOS Software, 1841 Software (C1841-ADVIPSERVICESK9-
M), Version 12.4(15)T1, RELEASE SOFTWARE (fc2)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2007 by Cisco Systems, Inc.
Compiled Wed 18-Jul-07 04:52 by pt_team


         --- System Configuration Dialog ---

Would you like to enter the initial configuration dialog?
[yes/no]:
```

Fig.3

6. Note that the initial configuration dialog is appeared only when there is no Startup configuration and we can escape it by typing (no) or just (n) then press ENTER.
7. Press RETURUN (ENTER), the prompt (Router>) is shown, (Router) is the default hostname of the device which can be changed if we like to (this will be explained later in

another lab), and (>) is the User-EXEC mode which is the mode with the least privileges level.

8. Type (?) to help you to display the commands (with description) used in this mode then type (s?) to display the commands in this mode that start with letter (s) as shown in Fig.4

```
Router>?
Exec commands:
  <1-99>      Session number to resume
  connect     Open a terminal connection
  disable     Turn off privileged commands
  disconnect  Disconnect an existing network connection
  enable      Turn on privileged commands
  exit        Exit from the EXEC
  logout      Exit from the EXEC
  ping        Send echo messages
  resume      Resume an active network connection
  show        Show running system information
  ssh         Open a secure shell client connection
  telnet      Open a telnet connection
  terminal    Set terminal line parameters
  traceroute  Trace route to destination
Router>s?
show  ssh
```

Fig.4

9. When we type (sh?), it will display the commands that start with (sh) which is unique to (show) command only, so (show) command can be abbreviated to (sh). To display the keywords after (show) command just type (sh ?) as shown in Fig.5. Note that the list of the keywords does not fit in one page (use ENTER to display the next line, SPACE to display the next page or Q to quit),

```
Router>sh ?
  arp            Arp table
  cdp            CDP information
  class-map      Show QoS Class Map
  clock          Display the system clock
  controllers    Interface controllers status
  crypto         Encryption module
  dot11          IEEE 802.11 show information
  flash:         display information about flash: file system
  frame-relay    Frame-Relay information
  history        Display the session command history
  hosts          IP domain-name, lookup style, nameservers, and host table
  interfaces     Interface status and configuration
  ip             IP information
  ipv6           IPv6 information
  lldp           LLDP information
  policy-map     Show QoS Policy Map
  pppoe          PPPoE information
  privilege      Show current privilege level
  protocols      Active network routing protocols
  queue          Show queue contents
  queueing       Show queueing configuration
  sessions       Information about Telnet connections
 --More-- |
```

Fig.5

10. To display the keywords after (show) command which started with letter (p), type (sh p?), then to type (show privileges), it can be abbreviated to (sh pri) and to find the next keywords just type (sh pri ?), when (<cr> i.e. carriage return) appeared, it means that it is the end of the command and press ENTER to execute it as shown in Fig.6

```
Router>sh p?
policy-map  pppoe  privilege  protocols
Router>sh pri?
privilege
Router>sh pri ?
  <cr>
Router>sh pri
Current privilege level is 1
Router>
```

Fig.6

11. Note that the privilege level for the User-EXEC mode is 1, and to enter to higher level mode (which is Privileged-EXEC mode) type (enable) command or (en), the prompt will be changed from (Router>) to (Router#).
12. As with User-EXEC mode, we can use (?) to help for displaying the commands used in this mode. Also note that the privilege level is changed to 15. See Fig.7

```
Router>en
Router#sh pri
Current privilege level is 15
Router#?
Exec commands:
  <1-99>      Session number to resume
  auto        Exec level Automation
  clear       Reset functions
  clock       Manage the system clock
  configure   Enter configuration mode
  connect     Open a terminal connection
  copy        Copy from one file to another
  debug       Debugging functions (see also 'undebug')
  delete      Delete a file
  dir         List files on a filesystem
  disable     Turn off privileged commands
  disconnect  Disconnect an existing network connection
  enable      Turn on privileged commands
  erase       Erase a filesystem
  exit        Exit from the EXEC
  logout      Exit from the EXEC
  mkdir       Create new directory
  more        Display the contents of a file
  no          Disable debugging informations
  ping        Send echo messages
  reload      Halt and perform a cold restart
 --More--
```

Fig.7

13. Any configuration must be done in the Global Configuration mode, to enter to this sub-mode we must type (configure terminal) command or (conf t) in the Privileged-EXEC mode, the prompt will be changed from (Router#) to (Router(config)#), and any interface specific configuration (for example fastethernet 0/0) must be done in the Interface Configuration mode by typing (interface fastethernet 0/0) command or (int f0/0) in the Global Configuration mode, the prompt will be changed from (Router(config)#) to (Router(config-if)#) as shown in Fig.8

```
Router#conf t
Enter configuration commands, one per line.  End with
CNTL/Z.
Router(config)#int f0/0
Router(config-if)#
```

Fig.8

14. To exit to the previous mode, type (exit) command or (ex). Also we can press CTRL+Z from any sub-mode to exit directly to the Global Configuration mode.

Computer Networks

LAB2: Basic IP Configuration

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Lab 2: Basic IP Configuration

Main Topics:

- Explain how to enable and assign IP address to the interfaces of Cisco router.
- Explain how to check the status and IP address of the interfaces of Cisco router.
- Troubleshooting the IP connectivity between the interfaces of Cisco router.

Procedure:

1. Run Cisco Packet Tracer.
2. Connect the topology shown in Fig.1

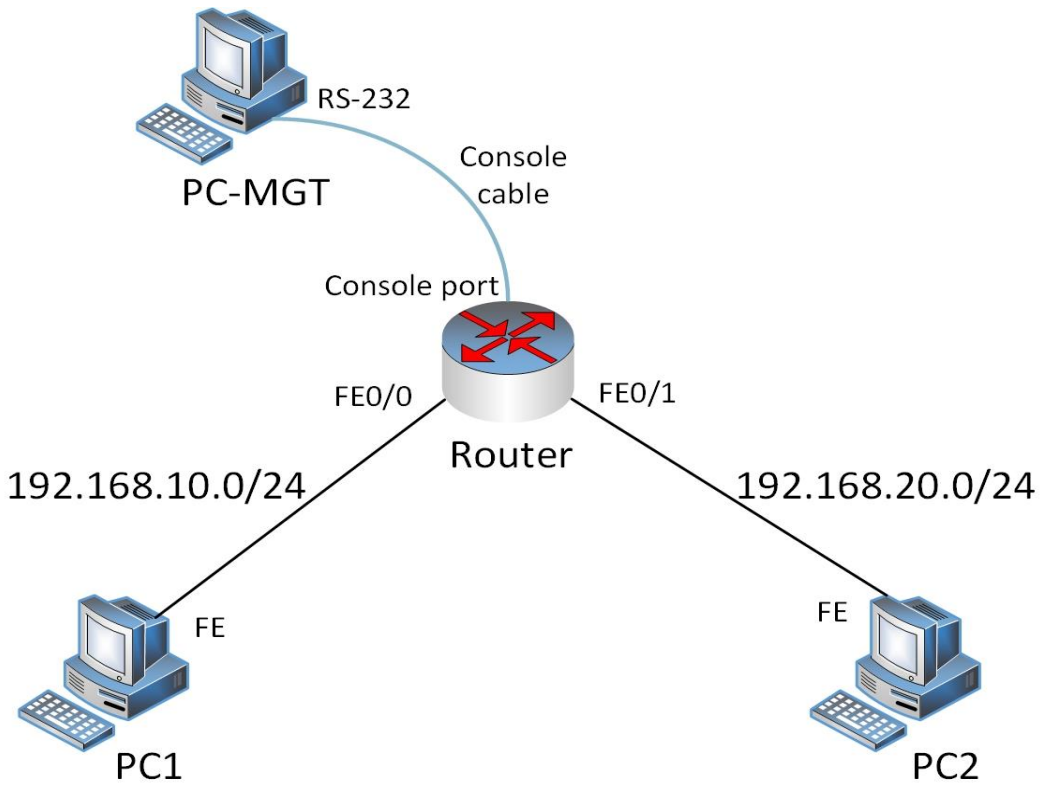

Fig.1

3. Access the Router IOS via console from PC-MGT (as we did in Lab1).
4. Before doing any configuration, check the IP address and the status of the interfaces of the router by typing (show ip interface brief) command in the Privileged EXEC mode as shown in Fig.2 (Note that abbreviations can be used when typing the commands as explained previously in Lab1).

```
Router#
Router#sh ip int br
Interface              IP-Address      OK? Method Status                Protocol
FastEthernet0/0        unassigned      YES unset  administratively down down
FastEthernet0/1        unassigned      YES unset  administratively down down
Vlan1                  unassigned      YES unset  administratively down down
Router#
```

Fig.2

5. From the output of Fig. 2, it is seen that both FE0/0 and FE0/1 have no IP address assigned to them and are administratively down (shutdown) which is the default for Cisco router. So, Assign the first IP address of each subnet to FE0/0 and FE0/1 and enable both of them using (ip address) and (no shutdown) commands in the Interface Configuration mode as shown in Fig.3

```
Router>
Router>en
Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#int f0/0
Router(config-if)#ip add 192.168.10.1 255.255.255.0
Router(config-if)#no shut

Router(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up

Router(config-if)#int f0/1
Router(config-if)#ip add 192.168.20.1 255.255.255.0
Router(config-if)#no shut

Router(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/1, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up

Router(config-if)#
```

Fig.3

6. The output of (show ip interface brief) command will show that both FE0/0 and FE0/1 have IP address assigned and become up as in Fig. 4

```
Router#sh ip int br
Interface              IP-Address      OK? Method Status                Protocol
FastEthernet0/0        192.168.10.1    YES manual up                    up
FastEthernet0/1        192.168.20.1    YES manual up                    up
Vlan1                  unassigned      YES unset  administratively down down
Router#
```

Fig.4

7. After completing the IP configuration of the router, it is time to do the IP configuration for the PCs by click on the PC the go to Desktop>IP Configuration then assign the second IP address in the range of each subnet, the subnet mask and the IP address of the router as the default gateway. Fig.5 shows the IP configuration for PC1.

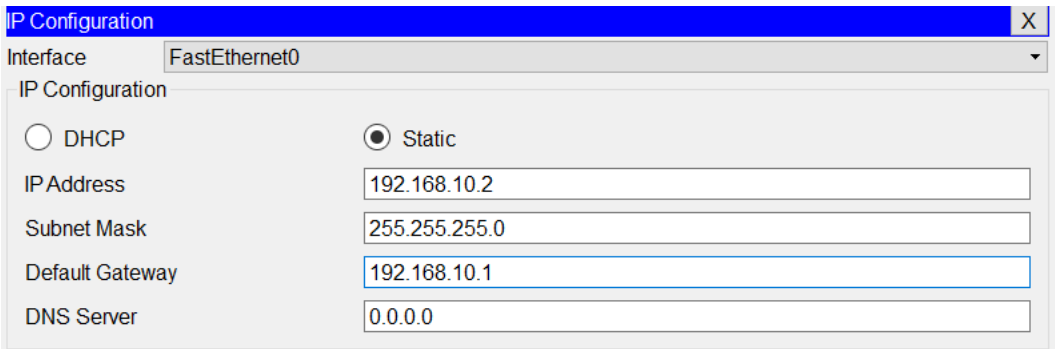

Fig.5

8. Finally, check the IP connectivity between PC1 and PC2 using (ping) command by clicking on one of them then press Desktop>Command Prompt as shown in Fig.6.

Command Prompt

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

FastEthernet0 Connection:(default port)

   Link-local IPv6 Address.........: FE80::201:63FF:FE0C:A322
   IP Address......................: 192.168.10.2
   Subnet Mask.....................: 255.255.255.0
   Default Gateway.................: 192.168.10.1

Bluetooth Connection:

   Link-local IPv6 Address.........: ::
   IP Address......................: 0.0.0.0
   Subnet Mask.....................: 0.0.0.0
   Default Gateway.................: 0.0.0.0

C:\>ping 192.168.20.2

Pinging 192.168.20.2 with 32 bytes of data:

Request timed out.
Reply from 192.168.20.2: bytes=32 time<1ms TTL=127
Reply from 192.168.20.2: bytes=32 time=1ms TTL=127
Reply from 192.168.20.2: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.20.2:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\>
```

Fig.6

Computer Networks

LAB3: DHCP Configuration

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Lab 3: DHCP Configuration

Main Topics:

- Basic DHCP understanding (manual vs automatic IP address assignment).
- Selecting DHCP pool from the IP addresses range of the subnet.
- Configuring Cisco router as DHCP server for the PCs.
- Troubleshooting the DHCP configuration.

Procedure:

1. Run Cisco Packet Tracer.
2. Connect the topology shown in Fig.1

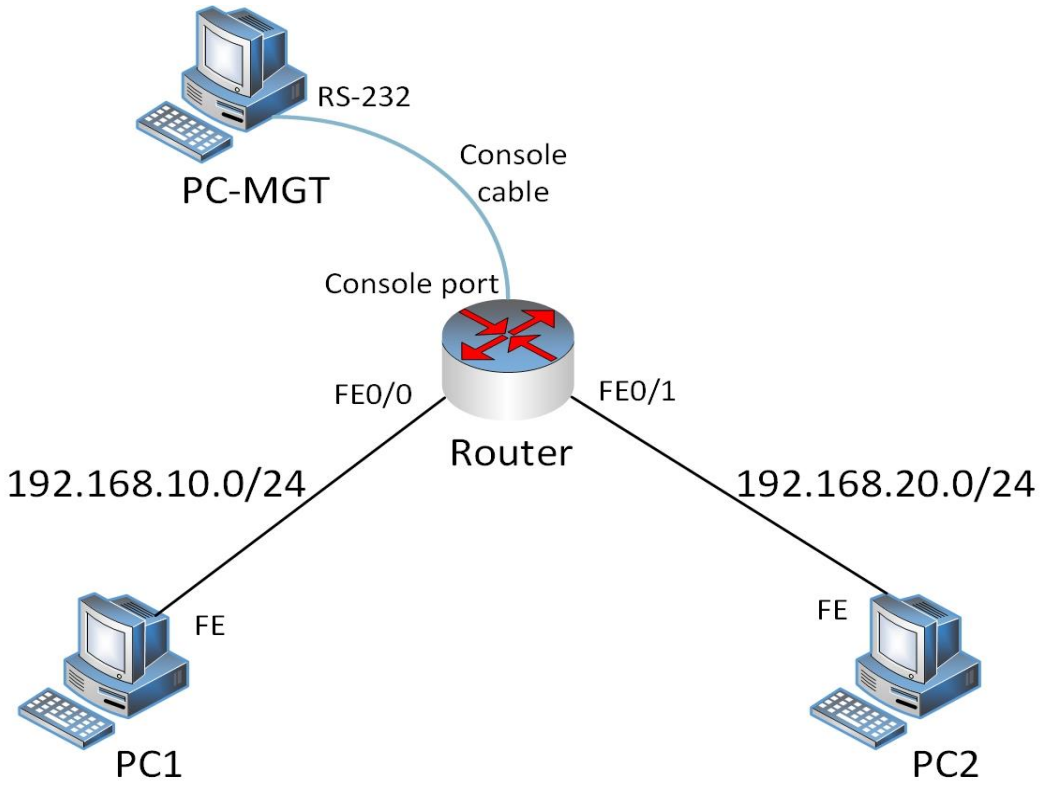

Fig.1

3. Access the Router IOS via console from PC-MGT (as we did in Lab1).
4. Assign the first IP address of each subnet to FE0/0 and FE0/1 and enable both of them (as we did in Lab2), then check this configuration using (show ip interface brief) command.
5. Two DHCP pools is required, one for each subnet. Suppose that the range of the first DHCP pool is from 192.168.10.10 to 192.168.10.30 and the range of the second pool is from 192.168.20.10 to 192.168.20.30. These two ranges are used for automatic IP address assignment.
6. To configure Cisco router as DHCP server, first step is to exclude any IP address outside the DHCP pools above from these subnets using (ip dhcp excluded-address) command as shown in Fig.2.

```
Router(config)#
Router(config)#ip dhcp ex 192.168.10.1 192.168.10.9
Router(config)#ip dhcp ex 192.168.10.31 192.168.10.254
Router(config)#ip dhcp ex 192.168.20.1 192.168.20.9
Router(config)#ip dhcp ex 192.168.20.31 192.168.20.254
Router(config)#
```

Fig.2

7. The second step is to configure the DHCP pool using (dhcp pool) command, then set the network/subnet using (network) command and the default gateway using (default-router) command inside DHCP Configuration mode as shown in Fig.3.

```
Router(config)#ip dhcp pool SUBNET10
Router(dhcp-config)#network 192.168.10.0 255.255.255.0
Router(dhcp-config)#default 192.168.10.1
Router(dhcp-config)#ex
Router(config)#ip dhcp pool SUBNET20
Router(dhcp-config)#network 192.168.20.0 255.255.255.0
Router(dhcp-config)#default 192.168.20.1
Router(dhcp-config)#
```

Fig.3

8. After completing the DHCP configuration of the router, it is time to do the automatic IP configuration for the PCs by click on the PC then press Desktop>IP Configuration then

select (DHCP) option, the PCs will automatically get the IP address configuration from the DHCP pool configured in the router if everything is done successfully as shown in Fig. 4 for PC1.

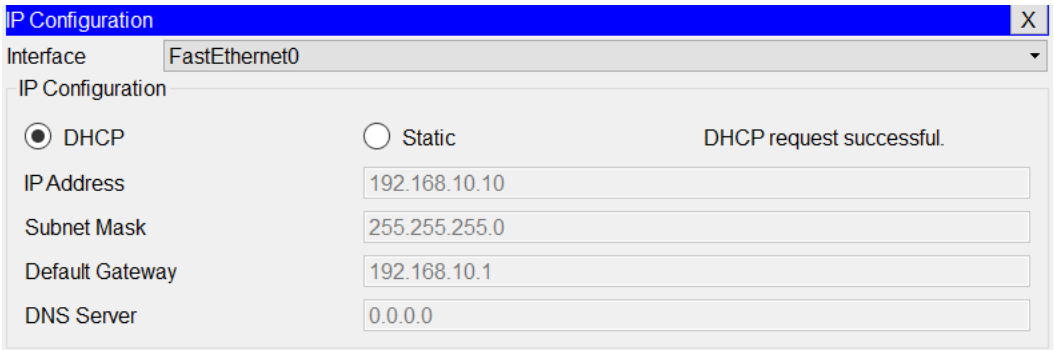

Fig.4

9. To check the DHCP clients with their automatically obtained IP addresses and hardware (MAC) addresses, type (show ip dhcp binding) command as shown in Fig.5.

```
Router#sh ip dhcp bind
IP address       Client-ID/              Lease expiration        Type
                 Hardware address
192.168.10.10    0001.630C.A322           --                     Automatic
192.168.20.10    0004.9A4A.39D7           --                     Automatic
Router#
```

Fig.5

10. Finally, check the IP connectivity between PC1 and PC2 using (ping) command (as we did in Lab2).

Computer Networks

LAB4: Static Routing

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Lab 4: Static Routing

Main Topics:

- What is the routing?
- Routing table and its contents: code, destination, next hop, AD and metric.
- Directly connected routes.
- Types of routing: static vs dynamic (cons and pros).
- Some types of static routes: default, network, host and float.
- Static routing configuration in Cisco router.

Procedure:

1. Run Cisco Packet Tracer.
2. Connect the topology shown in Fig.1

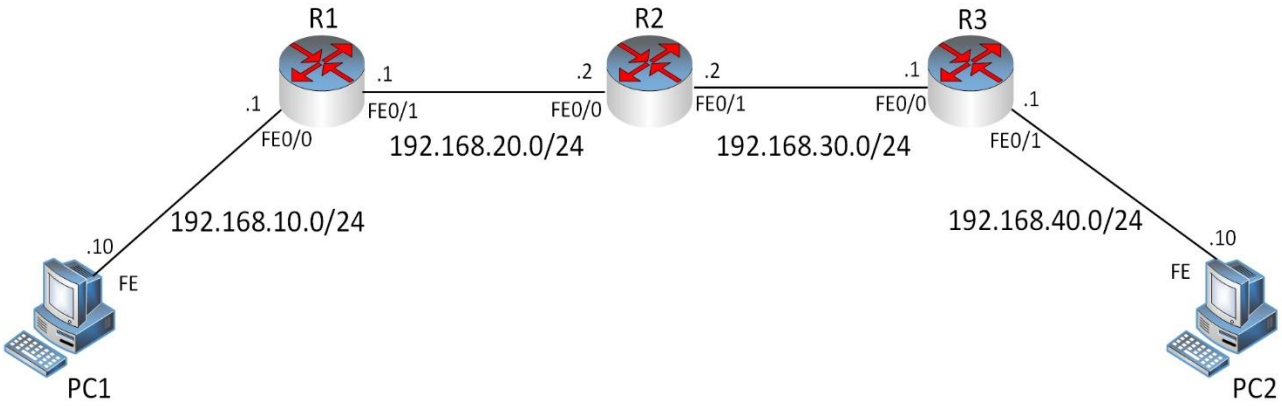

Fig.1

3. Assign the IP address, subnet mask and default gateway for PC1 and PC2.
4. Configure the IP address for the interfaces (FE0/0 and FE0/1) of all routers and enable them, then use (show ip interface brief) command to check that FE0/0 and FE0/1 of all

routers are up and have the IP addresses assigned correctly. Also, change the name of the routers to R1, R2 and R3 using (hostname) command to make it easier for identifying between them, Fig.2 shows how to change the name of the first router.

```
Router(config)#
Router(config)#host R1
R1(config)#
```

Fig.2

5. Display the routing table of each router by using (show ip route) command. Note that each router will automatically add routes to the directly connected subnets to its routing table with code (C) and which interface is connected to as shown in Fig.3

```
R1#sh ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
       i - IS-IS, 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

Gateway of last resort is not set

C    192.168.10.0/24 is directly connected, FastEthernet0/0
C    192.168.20.0/24 is directly connected, FastEthernet0/1
```

```
R2#sh ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
       i - IS-IS, 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

Gateway of last resort is not set

C    192.168.20.0/24 is directly connected, FastEthernet0/0
C    192.168.30.0/24 is directly connected, FastEthernet0/1
```

```
R3#sh ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
       i - IS-IS, 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

Gateway of last resort is not set

C    192.168.30.0/24 is directly connected, FastEthernet0/0
C    192.168.40.0/24 is directly connected, FastEthernet0/1
```

Fig.3

6. If we try to ping from PC1 to PC2 (or vice versa), it will be unreachable as shown in Fig.4 because the subnets of both of PC1 and PC2 must be reachable and existed in the routing table of all the routers in the path between them, otherwise any packet received by any router will be dropped if the destination of this packet is not existed in the routing table.

```
Command Prompt                                                          X

Packet Tracer PC Command Line 1.0
C:\>ipconfig

FastEthernet0 Connection:(default port)

   Link-local IPv6 Address.........: FE80::2E0:F7FF:FE93:C70C
   IP Address......................: 192.168.10.10
   Subnet Mask.....................: 255.255.255.0
   Default Gateway.................: 192.168.10.1

Bluetooth Connection:

   Link-local IPv6 Address.........: ::
   IP Address......................: 0.0.0.0
   Subnet Mask.....................: 0.0.0.0
   Default Gateway.................: 0.0.0.0

C:\>ping 192.168.40.10

Pinging 192.168.40.10 with 32 bytes of data:

Reply from 192.168.10.1: Destination host unreachable.
Reply from 192.168.10.1: Destination host unreachable.
Reply from 192.168.10.1: Destination host unreachable.
Reply from 192.168.10.1: Destination host unreachable.

Ping statistics for 192.168.40.10:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\>
```

Fig.4

7. Add routes to the subnets of PC1 and PC2 (192.168.10.0/24 and 192.168.40.0/24) in all routers as static routes which include the destination subnet (if not existed as directly connected route) and the next hop to reach this destination subnet using (ip route) command as shown in Fig.5.

```
R1(config)#ip route 192.168.40.0 255.255.255.0 192.168.20.2
```

```
R2(config)#ip route 192.168.10.0 255.255.255.0 192.168.20.1
R2(config)#ip route 192.168.40.0 255.255.255.0 192.168.30.1
```

```
R3(config)#ip route 192.168.10.0 255.255.255.0 192.168.30.2
```

Fig.5

8. Display the routing tables of the routers using (ip route) command after adding the static routes to the routers as shown in Fig.6.

```
R1#sh ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
       i - IS-IS, 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

Gateway of last resort is not set

C    192.168.10.0/24 is directly connected, FastEthernet0/0
C    192.168.20.0/24 is directly connected, FastEthernet0/1
S    192.168.40.0/24 [1/0] via 192.168.20.2
```

```
R2#sh ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
       i - IS-IS, 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

Gateway of last resort is not set

S    192.168.10.0/24 [1/0] via 192.168.20.1
C    192.168.20.0/24 is directly connected, FastEthernet0/0
C    192.168.30.0/24 is directly connected, FastEthernet0/1
S    192.168.40.0/24 [1/0] via 192.168.30.1
```

```
R3#sh ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
       i - IS-IS, 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

Gateway of last resort is not set

S    192.168.10.0/24 [1/0] via 192.168.30.2
C    192.168.30.0/24 is directly connected, FastEthernet0/0
C    192.168.40.0/24 is directly connected, FastEthernet0/1
```

Fig.6

9. From Fig.6, note that the static routes are displayed in the routing table with code (S),and include the destination, the next hop and the numbers between brackets [1/0], the first number represents the administrative distance (AD) (i.e. the trustworthy of the route) of the static route which is 1 by default but it can be changed to any value between 1 and 255 (like in float static route) and the second number represents the metric which is unusable in the static routing but it is very important parameter in the dynamic routing.
10. Check the IP connectivity between PC1 and PC2 after adding the static routes to the routers, Fig.7 shows that (ping) command from PC1 to PC2 is reachable and successful, it also shows the traceroute list from PC1 to PC2.

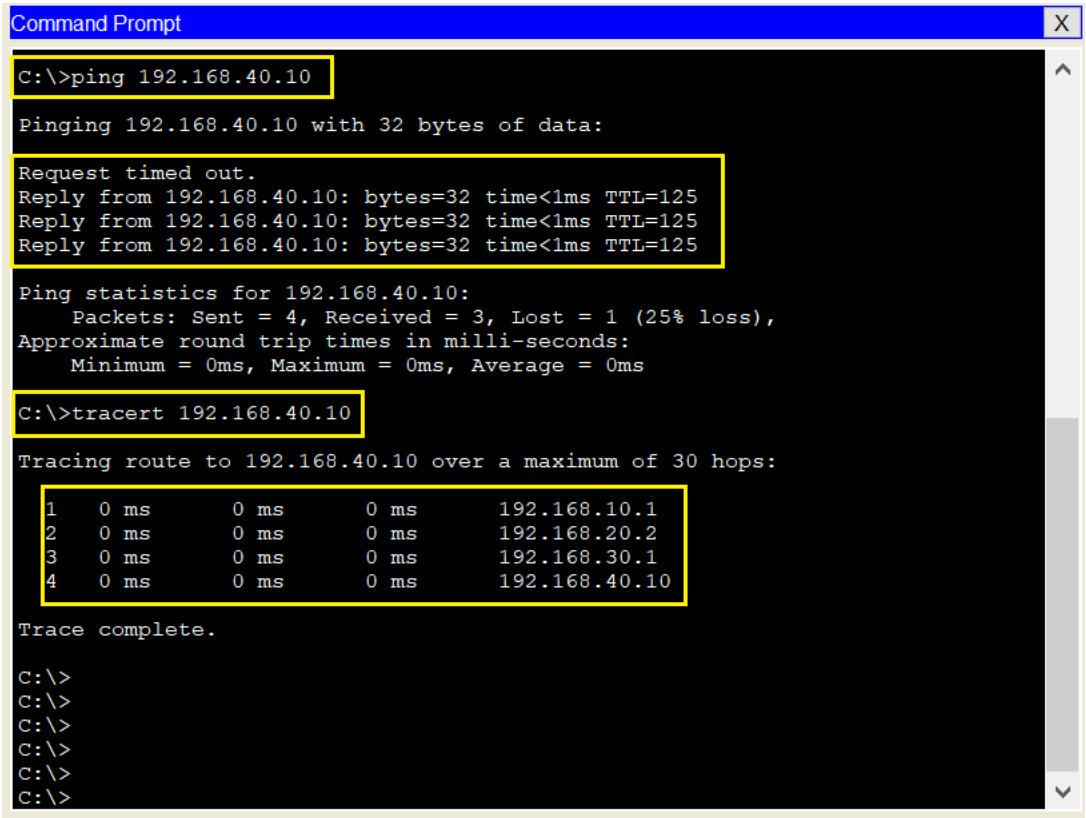

Fig.7

Computer Networks

LAB5: Dynamic Routing – Distance Vector

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Lab 5: Dynamic Routing – Distance Vector

Main Topics:

- What is the dynamic routing?
- What is routing protocol?
- Distance vector dynamic routing (cons and pros).
- Stateful vs stateless routing protocol.
- RIP as distance vector routing protocol.
- RIP versions: v1 vs v2.
- RIP timers: update, invalid, flush and holddown.
- Convergence time.
- Hop count as a metric for RIP with maximum number of hops is equal to 15.
- Routing loop and some techniques to avoid it like: split horizon, route poisoning and holddown timer.

Procedure:

1. Run Cisco Packet Tracer.
2. Connect the topology shown in Fig.1

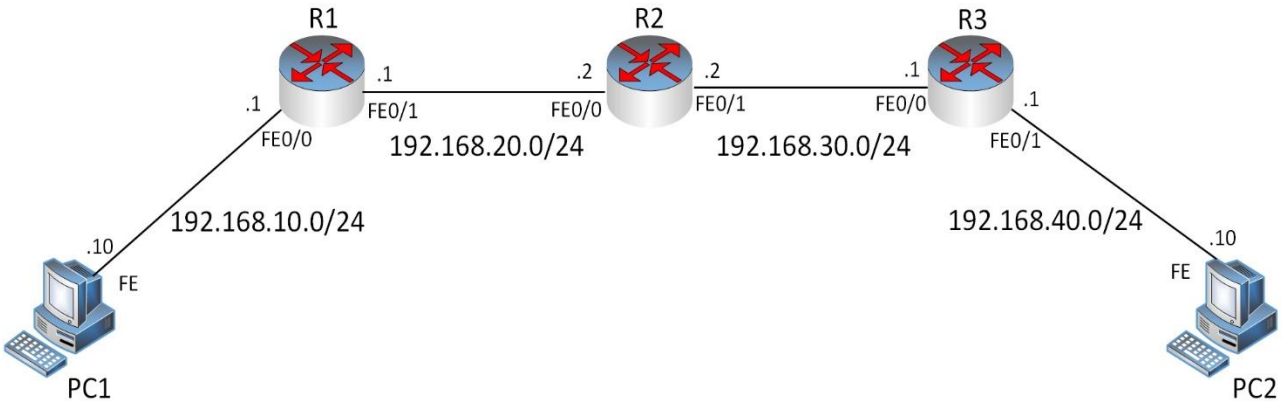

Fig.1

3. Assign the IP address, subnet mask and default gateway for PC1 and PC2.
4. Change the name of the routers to R1, R2 and R3 using (hostname) command and configure the IP address for the interfaces (FE0/0 and FE0/1) of all routers and enable them, then use (show ip interface brief) command to check that FE0/0 and FE0/1 of all routers are up and have the IP addresses assigned correctly.
5. Instead of adding the unreachable subnets to the routing table manually (static), the routing table can be updated dynamically with RIP. To configure RIP in the router, use (router rip) command then in the Router Configuration mode add the subnets (directly connected) to be advertised by the router to other routers using (network) command as shown in Fig.2.

```
R1(config)#router rip
R1(config-router)#net 192.168.10.0
R1(config-router)#net 192.168.20.0
```

```
R2(config)#router rip
R2(config-router)#net 192.168.20.0
R2(config-router)#net 192.168.30.0
```

```
R3(config)#router rip
R3(config-router)#net 192.168.30.0
R3(config-router)#net 192.168.40.0
```

Fig.2

6. To display the routing table of the routers, type (show ip route) as shown in Fig.3 (the routing tables after the convergence time).

```
R1#sh ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
       i - IS-IS, 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

Gateway of last resort is not set

C    192.168.10.0/24 is directly connected, FastEthernet0/0
C    192.168.20.0/24 is directly connected, FastEthernet0/1
R    192.168.30.0/24 [120/1] via 192.168.20.2, 00:00:08, FastEthernet0/1
R    192.168.40.0/24 [120/2] via 192.168.20.2, 00:00:08, FastEthernet0/1
```

```
R2#sh ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
       i - IS-IS, 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

Gateway of last resort is not set

R    192.168.10.0/24 [120/1] via 192.168.20.1, 00:00:22, FastEthernet0/0
C    192.168.20.0/24 is directly connected, FastEthernet0/0
C    192.168.30.0/24 is directly connected, FastEthernet0/1
R    192.168.40.0/24 [120/1] via 192.168.30.1, 00:00:02, FastEthernet0/1
```

```
R3#sh ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
       i - IS-IS, 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

Gateway of last resort is not set

R    192.168.10.0/24 [120/2] via 192.168.30.2, 00:00:20, FastEthernet0/0
R    192.168.20.0/24 [120/1] via 192.168.30.2, 00:00:20, FastEthernet0/0
C    192.168.30.0/24 is directly connected, FastEthernet0/0
C    192.168.40.0/24 is directly connected, FastEthernet0/1
```

Fig.3

7. Note that the routes that are updated with each router using RIP are labeled with (R) code and include the destination subnet, the next hop, the interface that received the routing information and two numbers between brackets, the first one represents the AD of RIP (the default value is 120) and the second number represents the metric which is the hop count between the router and the destination subnet.

8. To display some general information about the routing protocols running in the router (including RIP), type (show ip protocols) command. Fig.4 shows that this command display some of RIP information in R2 like RIP timers, RIP versions, networks (or subnets) to advertise, the received updates and their sources, AD and others

```
R2#sh ip pro
Routing Protocol is "rip"
Sending updates every 30 seconds, next due in 18 seconds
Invalid after 180 seconds, hold down 180, flushed after 240
Outgoing update filter list for all interfaces is not set
Incoming update filter list for all interfaces is not set
Redistributing: rip
Default version control: send version 1, receive any version
  Interface             Send  Recv  Triggered RIP  Key-chain
  FastEthernet0/0       1     2 1
  FastEthernet0/1       1     2 1
Automatic network summarization is in effect
Maximum path: 4
Routing for Networks:
        192.168.20.0
        192.168.30.0
Passive Interface(s):
Routing Information Sources:
        Gateway         Distance      Last Update
        192.168.20.1         120      00:00:13
        192.168.30.1         120      00:00:11
Distance: (default is 120)
```

Fig.4

9. Check the IP connectivity between PC1 and PC2 using (ping) and (tracert) commands like what we did in Lab4.

Computer Networks

LAB6: Dynamic Routing – Link State

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Lab 6: Dynamic Routing – Link-State

Main Topics:

- Link-state dynamic routing (cons and pros)
- OSPF as link-state dynamic routing protocol.
- OSPF properties (open standard, stateless, fast and loop-free).
- Different tables of OSPF: LSDB, neighbor (adjacencies) table and routing table.
- OSPF messages: DBD, LSR, LSU and LSAck.
- OSPF area types: backbone, stub, transit, …etc.
- OSPF router types: IR, ABR, BR and ASBR.
- OSPF router attributes: DR and BDR.
- Loopback interface and its advantages and Router ID (RID).
- OSPF AD and metric.
- OSPF configuration in Cisco router.

Procedure:

1. Run Cisco Packet Tracer.
2. Connect the topology shown in Fig.1

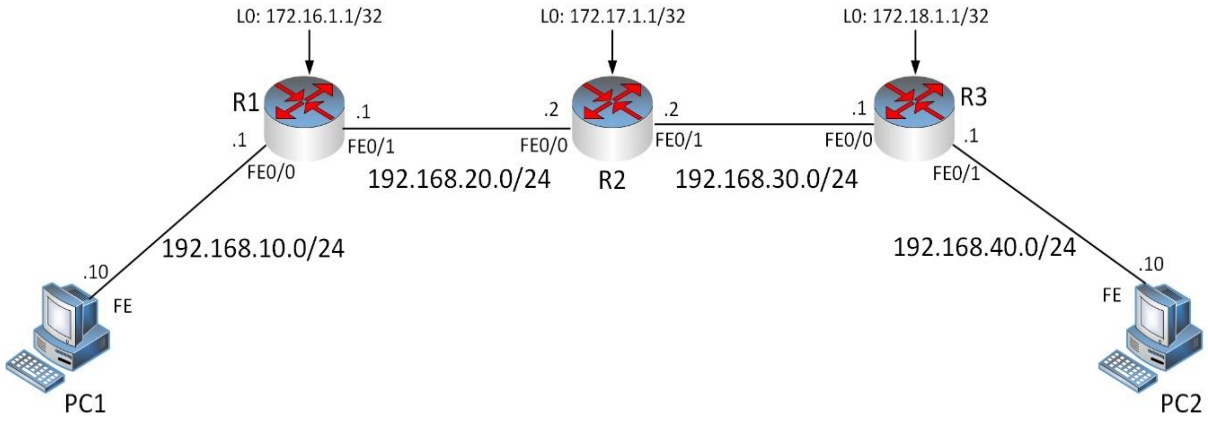

Fig.1

3. Assign the IP address, subnet mask and default gateway for PC1 and PC2.
4. Change the name of the routers to R1, R2 and R3 using (hostname) command and configure the IP address for the interfaces (FE0/0 and FE0/1) of all routers and enable them.
5. Configure a virtual loopback interface for the routers and assign the IP addresses (shown in Fig.1) to these interfaces. The main reason to configure the loopback interface is because these interfaces are always up so the routers will be accessible even when one of the physical interfaces is down (via another physical interface if existed and possible), also the loopback interface is used as the RID to elect the DR and BDR. Fig.2 shows how to configure the loopback interface in R1.

```
R1(config)#int l0

R1(config-if)#
%LINK-5-CHANGED: Interface Loopback0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up

R1(config-if)#ip add 172.16.1.1 255.255.255.255
R1(config-if)#
```

Fig.2

6. Use (show ip interface brief) to check that the physical interfaces (FE0/0 and FE0/1) and the virtual interfaces (L0) of all routers are up and have the IP addresses assigned correctly as shown in Fig.3 (for R1).

```
R1#sh ip int br
Interface              IP-Address      OK? Method Status                Protocol
FastEthernet0/0        192.168.10.1    YES NVRAM  up                    up
FastEthernet0/1        192.168.20.1    YES NVRAM  up                    up
Loopback0              172.16.1.1      YES manual up                    up
Vlan1                  unassigned      YES NVRAM  administratively down down
```

Fig.3

7. To configure OSPF routing protocol, let us first assume that all routers are within the backbone area (area 0) then use (router ospf <process_id>) command, in the Router

Configuration mode use (network 0.0.0.0 255.255.255.255 area 0) command instead of adding each subnet or network individually (like what we did in RIP in Lab4), network (0.0.0.0) with wildcard (255.255.255.255) means match anything (including all the subnets or networks of the physical and virtual interfaces of the router) to advertise to the neighboring routers as shown in Fig.4.

```
R1(config)#router ospf 1
R1(config-router)#net 0.0.0.0 255.255.255.255 area 0
```

Fig.2

8. To display the routing table of the routers, use (show ip route) command. Fig.3 shows the routing table of R1 after the convergence time. Note that the routes that are updated with each router using OSPF (including the routes to the loopback interfaces of other routers) are labeled with (O) code and include the destination subnet, the next hop, the interface that received the routing information and two numbers between brackets, the first one represents the AD of OSPF (the default value is 110) and the second number represents the metric which is the accumulated cost of all the links between the router and the destination subnet, the cost of the link is equal to 10^8/bandwidth(bps). (Note that the bandwidth of Fast Ethernet is 100 Mbps).

```
R1#sh ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
       i - IS-IS, 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

Gateway of last resort is not set

     172.16.0.0/32 is subnetted, 1 subnets
C       172.16.1.1 is directly connected, Loopback0
     172.17.0.0/32 is subnetted, 1 subnets
O       172.17.1.1 [110/2] via 192.168.20.2, 00:01:34, FastEthernet0/1
     172.18.0.0/32 is subnetted, 1 subnets
O       172.18.1.1 [110/3] via 192.168.20.2, 00:00:15, FastEthernet0/1
C    192.168.10.0/24 is directly connected, FastEthernet0/0
C    192.168.20.0/24 is directly connected, FastEthernet0/1
O    192.168.30.0/24 [110/2] via 192.168.20.2, 00:00:25, FastEthernet0/1
O    192.168.40.0/24 [110/3] via 192.168.20.2, 00:00:15, FastEthernet0/1
```

Fig.3

9. To display general information about the routing protocols (including OSPF) running in the router, type (show ip protocols) command. Fig.4 shows the output of this command in R2 which displays some of OSPF information like RID, number of areas, networks (or subnets) to advertise, the received updates and their sources, AD and others

```
R2#sh ip pro

Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 172.17.1.1
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    0.0.0.0 255.255.255.255 area 0
  Routing Information Sources:
    Gateway         Distance      Last Update
    172.16.1.1           110      00:17:06
    172.17.1.1           110      00:15:58
    172.18.1.1           110      00:15:58
  Distance: (default is 110)
```

Fig.4

10. Display the OSPF neighbor (adjacencies) table of the routers using (show ip ospf neighbor) command. Fig.5 shows the neighbor table of R2 which includes some information like neighbor RID, neighbor state, neighbor physical IP address and the interface of the router that is used to communicate with that neighbor. Note that R2 is DR with R1 while it is BDR with R3.

```
R2#sh ip ospf ne

Neighbor ID     Pri   State           Dead Time   Address         Interface
172.16.1.1        1   FULL/DR         00:00:32    192.168.20.1    FastEthernet0/0
172.18.1.1        1   FULL/BDR        00:00:34    192.168.30.1    FastEthernet0/1
```

Fig.5

11. Check the IP connectivity between PC1 and PC2 using (ping) and (tracert) commands like what we did in previous labs.

Computer Networks

LAB7: Virtual LAN

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Lab 7: VLAN Management

Main Topics:

- What is a VLAN? Virtual LAN: separate an existing physical network into multiple logical networks. Thus, each VLAN creates its own broadcast domain. Communication between two VLANs can only occur through a router that is connected to both.
- Why using VLAN? To improve network performance by the separation of large broadcast domains into smaller ones, for security.
- VLAN Types.(Default, Data, Voice, Management, Native)
- How to configure VLAN?

Procedure:

1. Run Cisco Packet Tracer.
2. Connect the topology shown in Fig.1

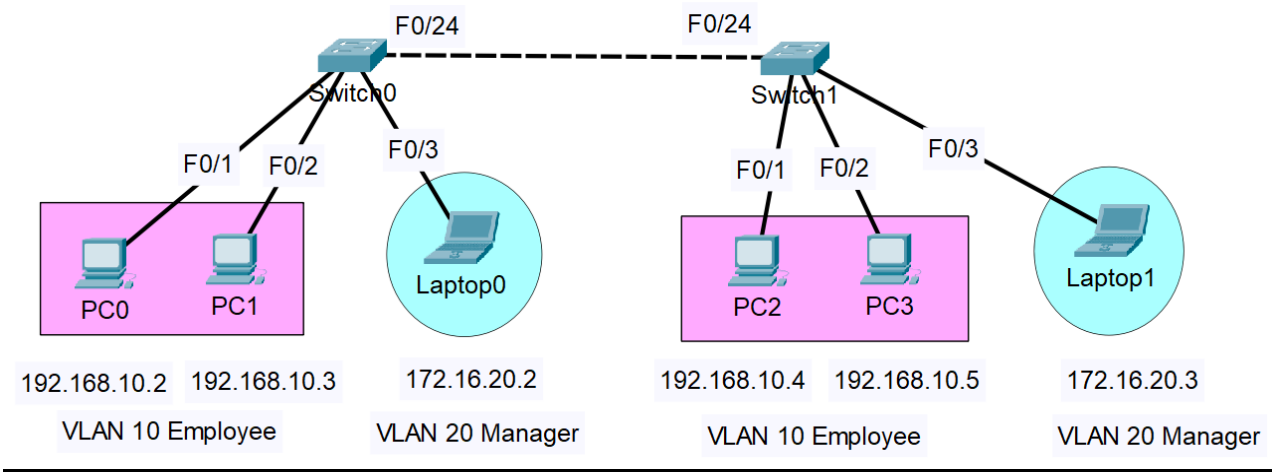

Fig.1

3. Click on each switch to show vlan information briefly (see Fig. 2) , all interfaces under **one default vlan**.

```
Switch>
Switch>en
Switch#sh vlan br

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Fa0/1, Fa0/2, Fa0/3, Fa0/4
                                                Fa0/5, Fa0/6, Fa0/7, Fa0/8
                                                Fa0/9, Fa0/10, Fa0/11, Fa0/12
                                                Fa0/13, Fa0/14, Fa0/15, Fa0/16
                                                Fa0/17, Fa0/18, Fa0/19, Fa0/20
                                                Fa0/21, Fa0/22, Fa0/23, Fa0/24
1002 fddi-default                     active
1003 token-ring-default               active
1004 fddinet-default                  active
1005 trnet-default                    active
```

Fig.2

4. Assign the IP address and subnet mask statistically for PC0, PC1, PC2, PC3, Laptop0 and Laptop1.Click on **PC => Desktop => IP Configuration => Static**

Fig.3 show the IP configuration for PC0

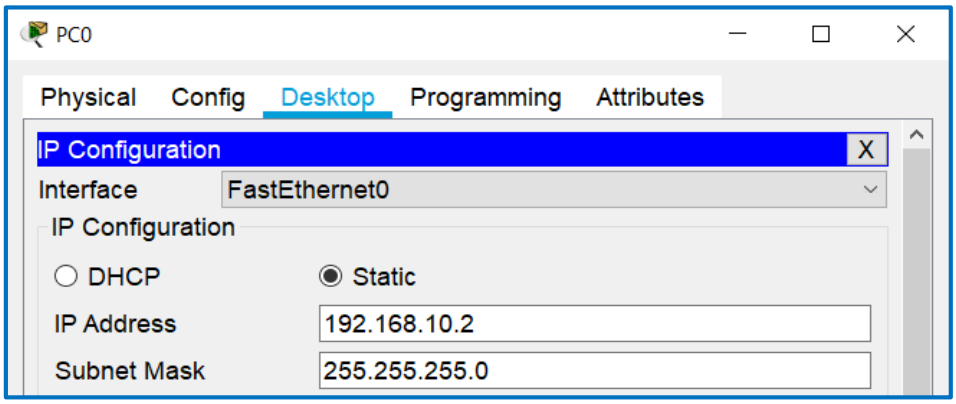

Fig.3

5. For each switch, click on switch and select **CLI** to define VLAN in global configuration mode (shown in Fig.4)

Use **(vlan vlan-id),** (**name vlan-name**) then **exit**

```
Switch(config)#vlan 10
Switch(config-vlan)#name employee
Switch(config-vlan)#ex
Switch(config)#vlan 20
Switch(config-vlan)#name manager
Switch(config-vlan)#ex
```

Fig.4

6. for each switch: Distribute switch Interfaces range (shown in Fig.5).

Use (**Interface range fastethernet0/ from – to**).Use (**Switchport mode access**) and then (**Switchport access vlan vlan-id**)

```
Switch(config)#int ra f0/1-2
Switch(config-if-range)#sw mo acc
Switch(config-if-range)#sw acc vlan 10
Switch(config-if-range)#ex
Switch(config)#int f0/3
Switch(config-if)#sw mo acc
Switch(config-if)#sw acc vlan 20
Switch(config-if)#ex
```

Fig.5

7. Activate interface between the two switches, use (**switch mode trunk**) as shown in Fig.6a**.**To display trunk interface information , use**(sh int trunk)** see Fig.6b

Note that trunk mode between 2 routers, router-switch and 2 switches.

```
Switch(config)#int f0/24
Switch(config-if)#sw mo tr
Switch(config-if)#ex
Switch(config)#ex
```

Fig.6

```
Switch>sh int tr
Port        Mode        Encapsulation  Status       Native vlan
Fa0/24      on          802.1q         trunking     1

Port        Vlans allowed on trunk
Fa0/24      1-1005

Port        Vlans allowed and active in management domain
Fa0/24      1,10,20

Port        Vlans in spanning tree forwarding state and not pruned
Fa0/24      1,10,20
```

Fig.6b

8. To display brief information about vlan, click on **switch => CLI**, for each switch use **show vlan brief** in privilege mode (shown in Fig.7) .Also, you can use (**sh int switchport**) to display detail information about the swichport.

```
Switch(config)#do sh vlan br

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Fa0/4, Fa0/5, Fa0/6, Fa0/7
                                                Fa0/8, Fa0/9, Fa0/10, Fa0/11
                                                Fa0/12, Fa0/13, Fa0/14, Fa0/15
                                                Fa0/16, Fa0/17, Fa0/18, Fa0/19
                                                Fa0/20, Fa0/21, Fa0/22, Fa0/23
                                                Fa0/24, Gig0/1, Gig0/2
10   employee                         active    Fa0/1, Fa0/2
20   manager                          active    Fa0/3
1002 fddi-default                     active
1003 token-ring-default               active
1004 fddinet-default                  active
1005 trnet-default                    active
```

Fig.7

9. Finally, check the IP connectivity between PC0 and PC2 using (ping) bidirectional by clicking on **PC0 => Desktop => command prompt** (shown in Fig.8a and Fig.8b).

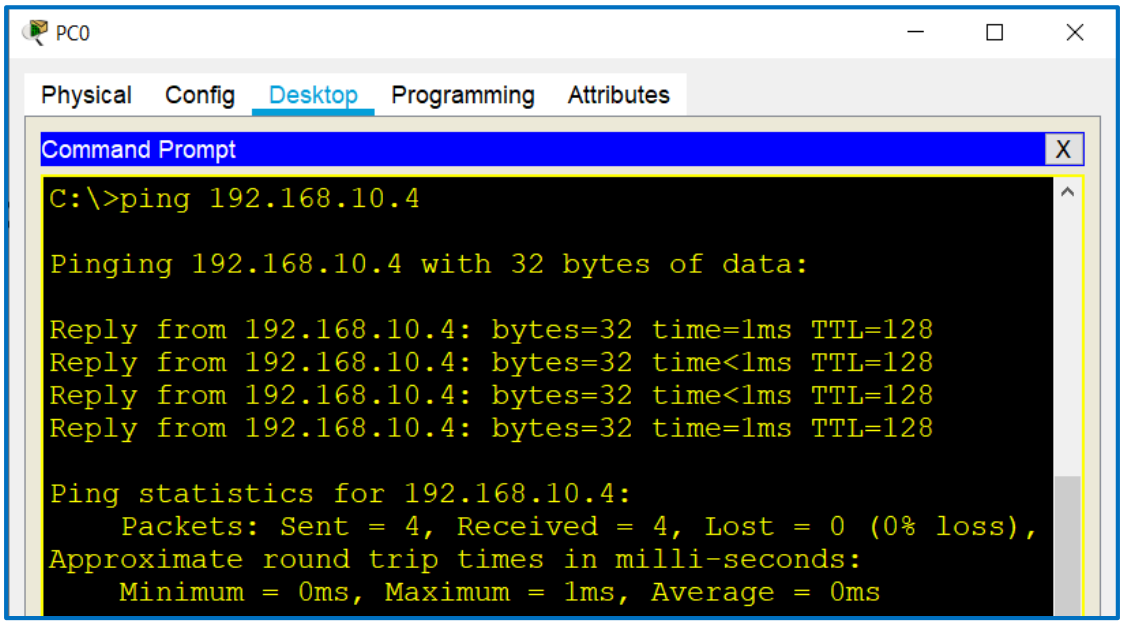

Fig.8a

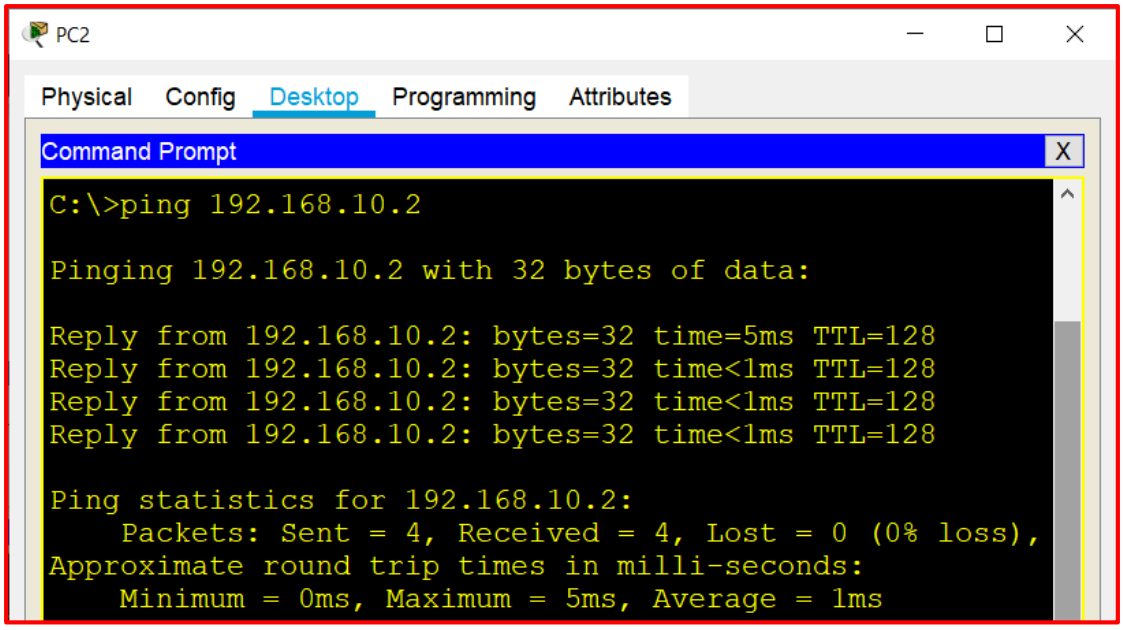

Fig.8b

Also, check the IP connectivity between Laptop0 and Laptop1 by using **ping** (see Fig.9a and Fig.9b)

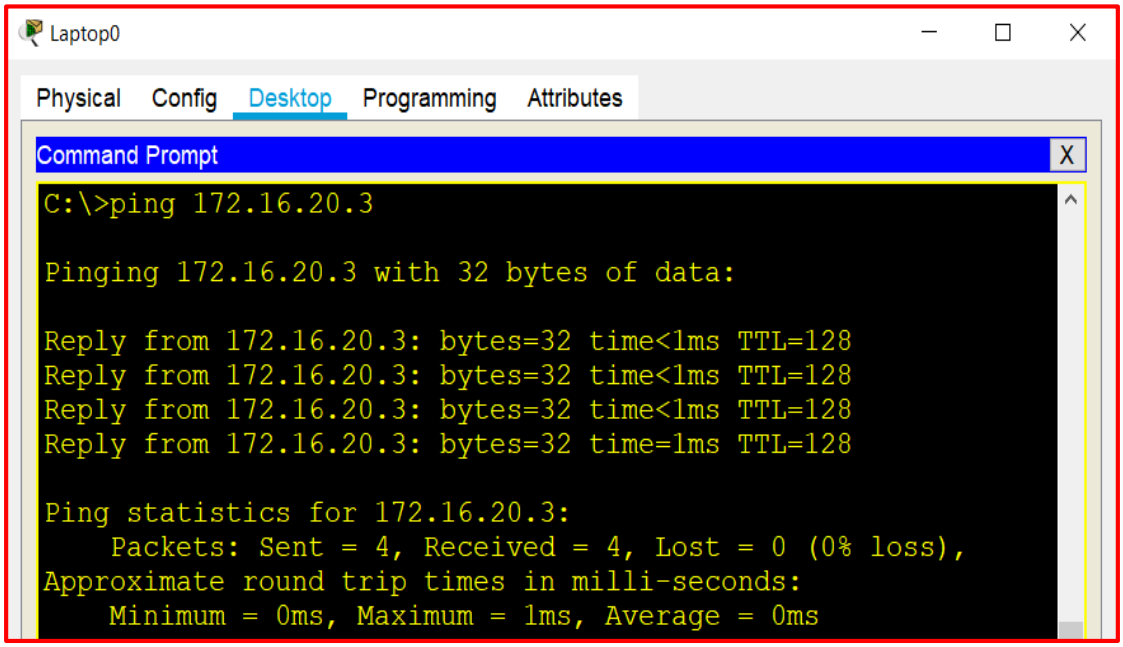

Fig.9a

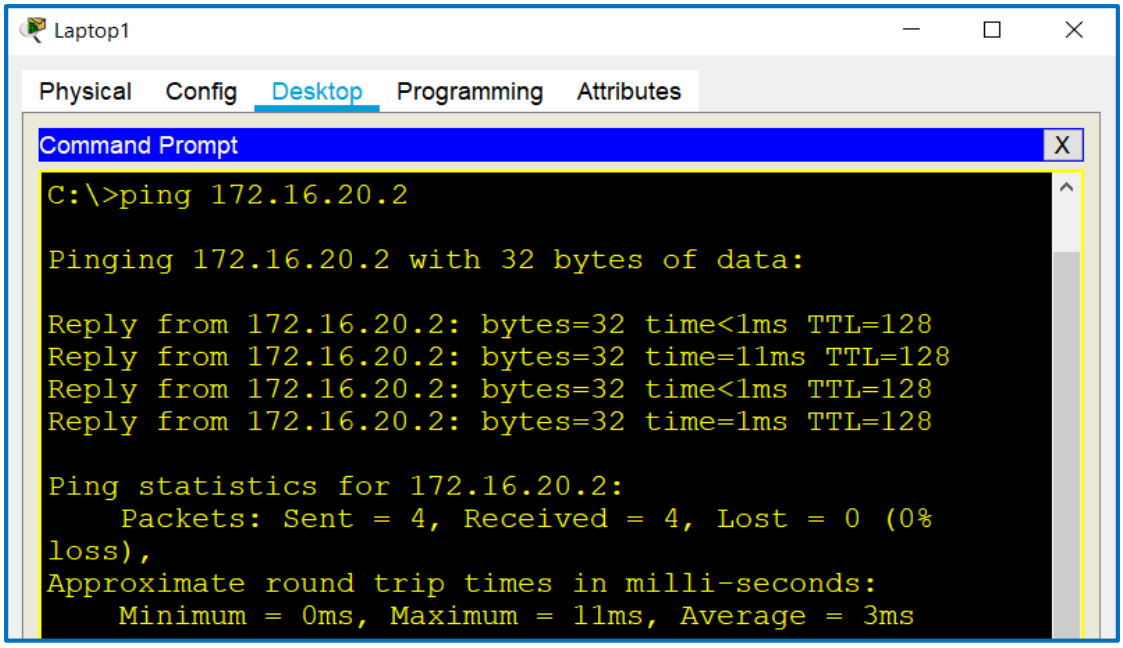

Fig.9b

Best Wishes

Computer Networks

LAB8: Inter VLAN Routing on Router or Multilayer Switch

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LAB8: Inter-VLAN Routing on Router or Multilayer Switch

Main Topics:

- Apply the same scenario in LAB7
  - Define 2 VLANs for each switch.
  - Distribute the interfaces range for each VLAN.
  - Configure the access and trunk ports.
- VLAN troubleshooting?

The problem is that, there is no communication between the different VLANs

To solve this problem, two options can be applied, either A or B as follows:

A. Router with a VLAN trunk connecting to a LAN switch (known as **router-on-a-stick**, or **ROAS**)

B. Multilayer Switch is a (Layer 3 switch).

ROUTER	MULTILAYER SWITCH
Divide Physical Interface (F0/0) into 2 Virtual Sub Interfaces	**Configure Switch Virtual Interface (SVI) for each VLAN**
int F0/0.10 => **encapsulation dot1q 10** => ip address 192.168.10.1 255.255.255.0 => no shutdown => ex **int F0/0.20** => **encapsulation dot1q 20** => ip add 172.16.0.1 255.255.0.0 => no shutdown => ex int F0/0 no sh ex	**int vlan 10** => ip address 192.168.10.1 255.255.255.0 => no shutdown => ex **int vlan 20** => ip add 172.16.0.1 255.255.0.0 => no shutdown => ex
Trunk Port Configuration	
int F0/4 and int F0/24 => switchport mode trunk => ex	int F0/24 => switchport mode trunk => **switchport trunk encapsulation dot1q** => no sh => ex
Routing Table	
sh ip route	ip routing sh ip route

Lab8-Part1: Inter-VLAN Routing on Router

1. Run Cisco Packet Tracer.

2. Connect the topology shown in Fig.1

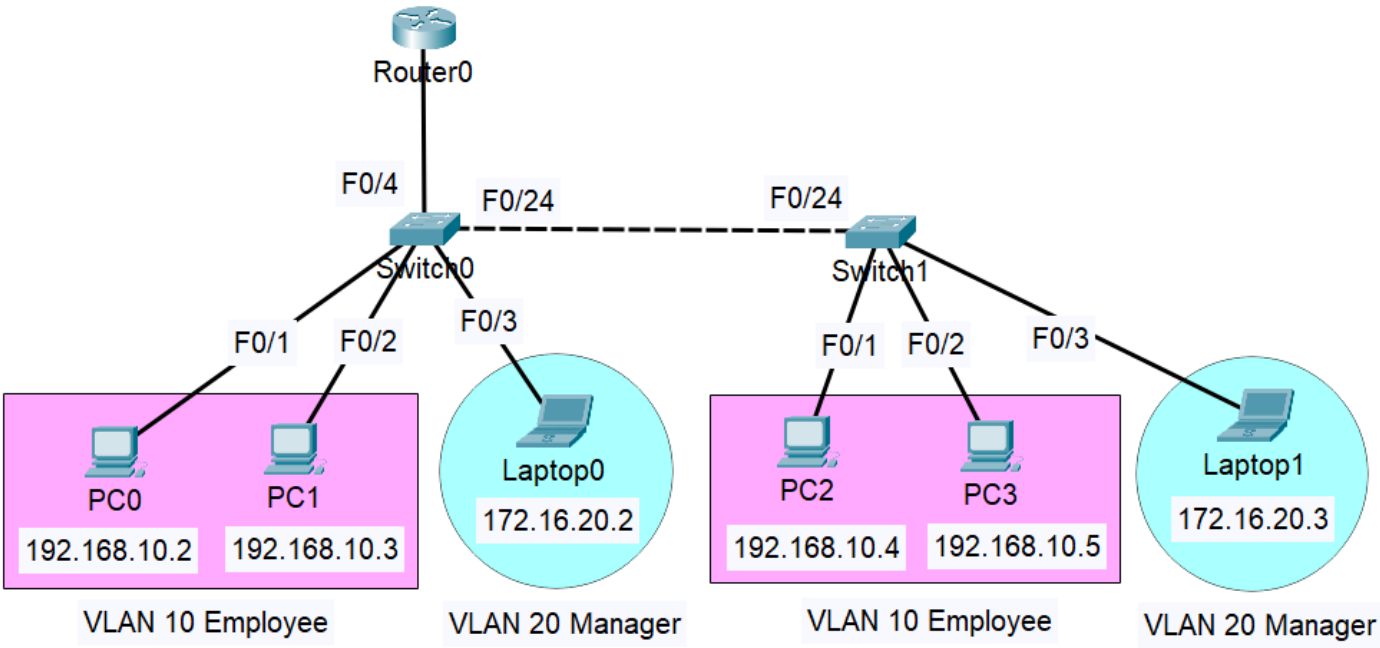

Fig.1

3. Repeat the same steps in LAB7. The problem is that, the clients of VLAN 10 cannot access/communicates to the clients of VLAN 20 and vice versa. Fig.2 show ping from PC0 to Laptop0, each one attached to different VLAN.

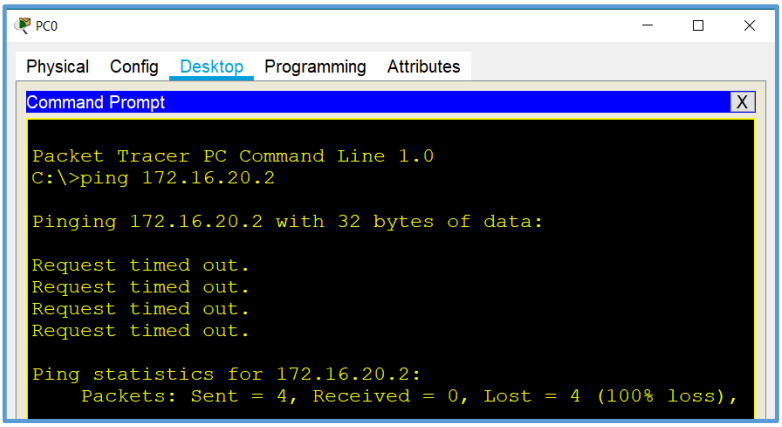

Fig.2

4. To solve this problem, we can use Router by divide the physical interface into two sub interfaces logically using (**interface f0/0.no**), then an encapsulation protocol using the command (**encapsulation dot1q** vlan-id) which enables 802.1Q and associates one specific VLAN with a certain sub interface, after that use (**ip address** gateway mask) then **no shutdown** and **exit** commands (see Fig.3a and Fig.3b)

```
Router(config)#int f0/0.10
Router(config-subif)#en dot1q 10
Router(config-subif)#ip add 192.168.10.1 255.255.255.0
Router(config-subif)#no sh
Router(config-subif)#ex
```

Fig.3a

```
Router(config)#int f0/0.20
Router(config-subif)#en dot1q 20
Router(config-subif)#ip add 172.16.0.1 255.255.0.0
Router(config-subif)#no sh
Router(config-subif)#ex
```

Fig.3b

5. Activate the int F0/0 as shown in Fig.4.

```
Router(config)#int f0/0
Router(config-if)#no sh
Router(config-if)#ex
```

Fig.4

6. Display the two sub interfaces of the router (see Fig.5a) use (**show ip interface brief**) command in mode 2 or (**do sh ip int br**), if your command is executed in mode 3 of router or more. Then, use (**show ip route**), to display the two direct networks related to the two sub interfaces F0/0.10 and F0/0.20 as shown in Fig.5b.

```
Router(config)#do sh ip int br
Interface              IP-Address      OK? Method Status                Protocol
FastEthernet0/0        unassigned      YES unset  up                    up
FastEthernet0/0.10     192.168.10.1    YES manual up                    up
FastEthernet0/0.20     172.16.0.1      YES manual up                    up
FastEthernet0/1        unassigned      YES unset  administratively down down
Vlan1                  unassigned      YES unset  administratively down down
```

Fig.5a

```
Router0
Physical   Config   CLI   Attributes
                IOS Command Line Interface
Router#sh ip rou
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
       i - IS-IS, 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

Gateway of last resort is not set

C    172.16.0.0/16 is directly connected, FastEthernet0/0.20
C    192.168.10.0/24 is directly connected, FastEthernet0/0.10
```

Fig.5b

7. Activate the two interfaces of the link between switch and Router as trunk using (**switch mode trunk**) at each interface as shown in Fig.6a**.** To display the trunk interface information, use **(show interface trunk)** as shown in Fig.6b

```
Switch(config)#int f0/4
Switch(config-if)#sw mo tr
Switch(config-if)#ex
```

Fig.6a

```
Switch#sh int tr
Port        Mode         Encapsulation  Status        Native vlan
Fa0/4       on           802.1q         trunking      1
Fa0/24      on           802.1q         trunking      1

Port        Vlans allowed on trunk
Fa0/4       1-1005
Fa0/24      1-1005

Port        Vlans allowed and active in management domain
Fa0/4       1,10,20
Fa0/24      1,10,20

Port        Vlans in spanning tree forwarding state and not pruned
Fa0/4       1,10,20
Fa0/24      1,10,20
```

Fig.6b

8. Enter the Gateway IPs to PC0, PC1, PC2, PC3, Laptop0 and Laptop1. Fig.7 shows ip configuration for PC0 and Laptop0.

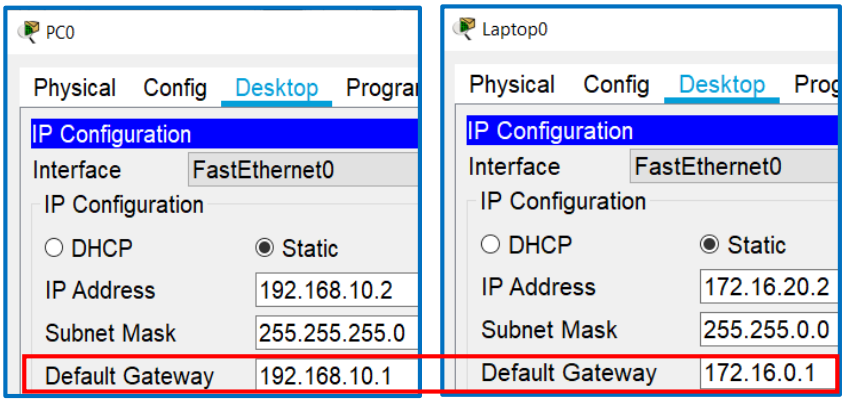

Fig.7

9. Finally, check the IP connectivity between PC0 (VLAN10) and Laptop0 (VLAN20) using (**ping**) and (**tracert**) bidirectional (Fig.8a).

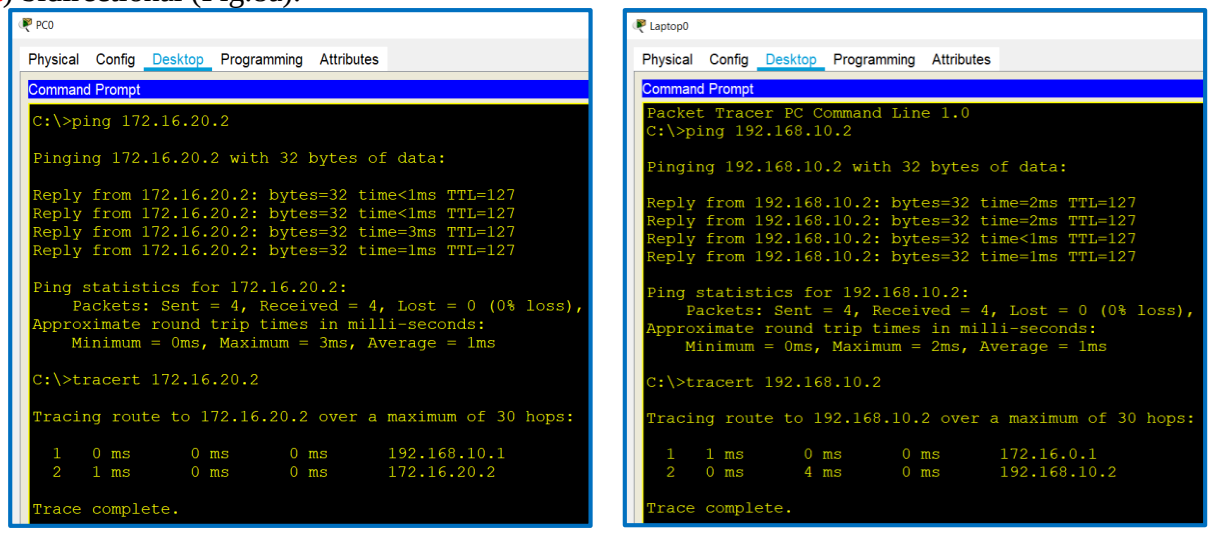

Fig.8a

Also, check the IP connectivity between PC0 and Laptop1 using **ping** and **tracert** (Fig.8b)

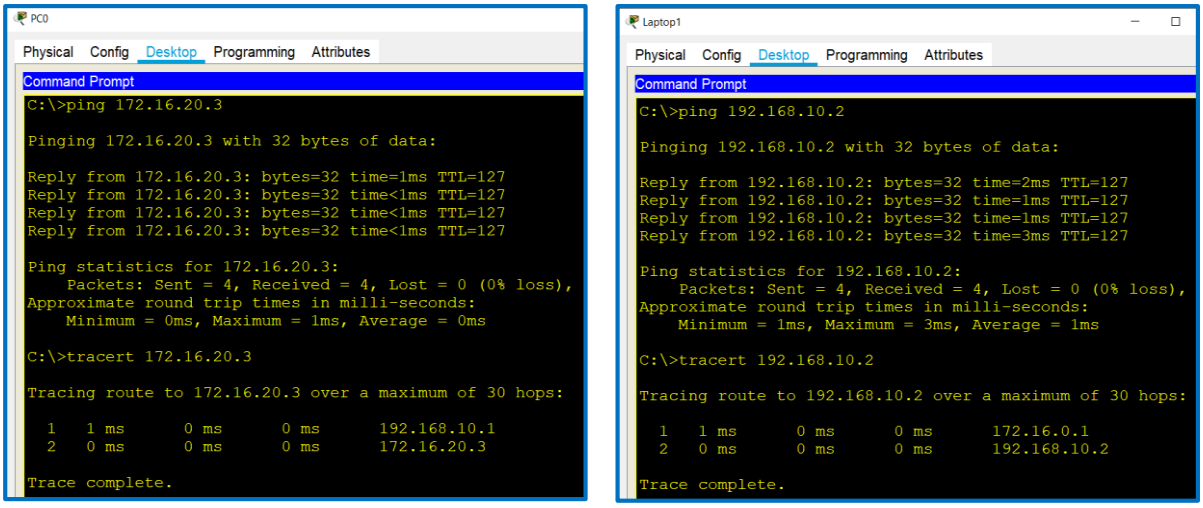

Fig.8b

Lab8-Part2: Inter-VLAN Routing on Multilayer Switch

Multilayer Switch support Switch Virtual Interfaces (SVIs), logical interfaces that can perform routing. They behave like a physical interface of a router: they have an IP address, and they insert a connected route into the routing table. However, they are completely virtual SVI.

Procedure

1. Run Cisco Packet Tracer.
2. Connect the topology shown in Fig.1

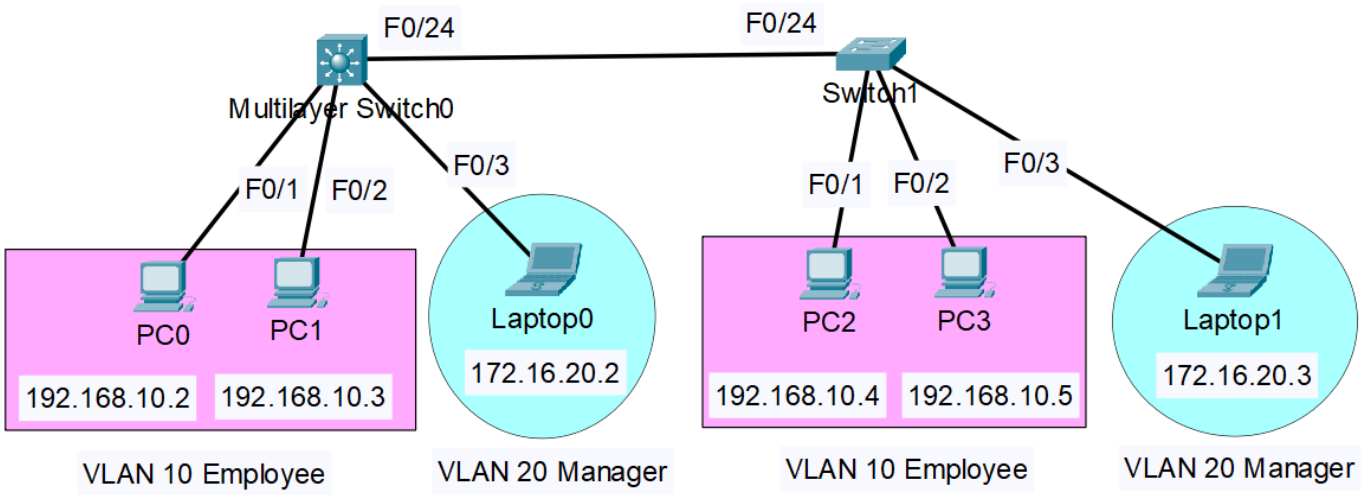

Fig.1

3. Configure virtual interface for each vlan by using (**interface vlan** vlan-id), after that use (**ip address ip-address mask**) then **no shutdown** and **exit** (see Fig.2)

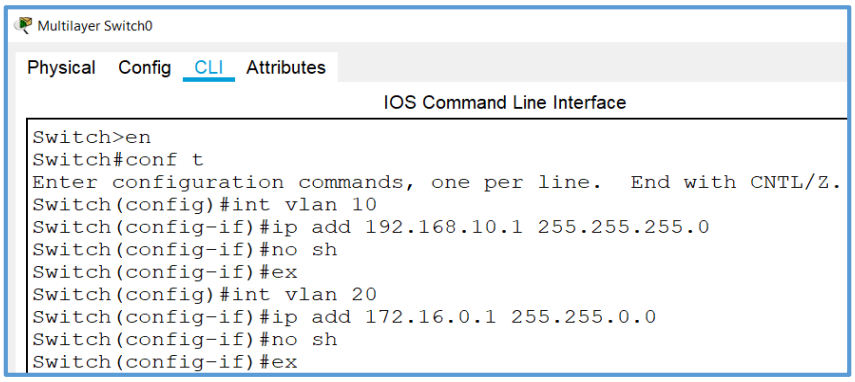

Fig.2

4. Display all ports information included virtual interfaces information using (**show ip interface brief**) in mode 2 (see Fig.3)

```
Vlan10                 192.168.10.1     YES manual up
Vlan20                 172.16.0.1       YES manual up
```

Fig.3

5. Use (**ip routing**) and then (**show ip route**) which clarify two direct networks related to the VLANs as shown in Fig.4.

```
Multilayer Switch0
Physical  Config  CLI  Attributes
                IOS Command Line Interface
Switch(config)#ip routing
Switch(config)#do sh ip rou
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
       i - IS-IS, 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

Gateway of last resort is not set

C    172.16.0.0/16 is directly connected, Vlan20
C    192.168.10.0/24 is directly connected, Vlan10
```

Fig.4

6. Configure the Trunk port by using (**int** F0/24), then (**switchport mode trunk**).After that activate the encapsulation protocol by using (**switchport trunk encapsulation dot1q**) which enable 802.1Q protocol then **no shutdown** and **exit**. (see Fig.5a)
After that, use (**show interface trunk**) to display all information about the trunk port (see Fig.5b)

```
Switch(config)#int f0/24
Switch(config-if)#sw mo tr
Switch(config-if)#sw tr en dot1q
Switch(config-if)#no sh
Switch(config-if)#ex
```

Fig.5a

```
Multilayer Switch0
Physical  Config  CLI  Attributes
                IOS Command Line Interface
Switch#sh int tr
Port        Mode         Encapsulation  Status        Native vlan
Fa0/24      on           802.1q         trunking      1

Port        Vlans allowed on trunk
Fa0/24      1-1005

Port        Vlans allowed and active in management domain
Fa0/24      1,10,20

Port        Vlans in spanning tree forwarding state and not pruned
Fa0/24      1,10,20
```

Fig.5b

7. **Repeat Step8 and Step9 from LAB8-PART1** to check connectivity between different VLANs hosts.

Best Wishes

Computer Networks
LAB9

Reviewed by:

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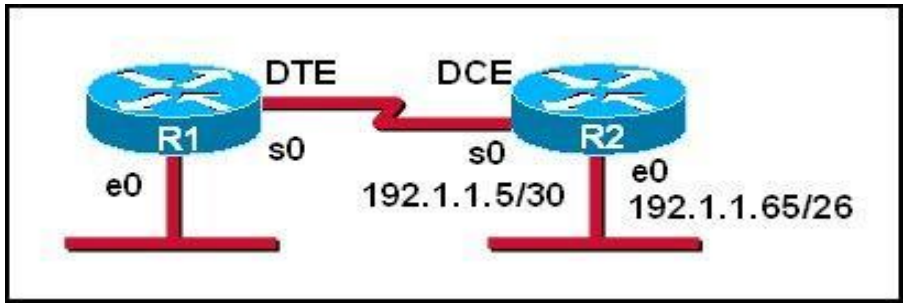
Forth Class

Q: Which series of commands will configure router R1 for LAN-to-LAN communication with router R2? The enterprise network address is 192.1.1.0/24 and the routing protocol in use is RIP. (Choose three)

A , D , F

Answer ……..



A.
R1 (config)# interface ethernet 0
R1 (config-if)# ip address 192.1.1.129 255.255.255.192
R1 (config-if)# no shutdown

B.
R1 (config)# interface ethernet 0
R1(config-if)#ip address 192.1.1.97 255.255.255.192
R1 (config-if)# no shutdown

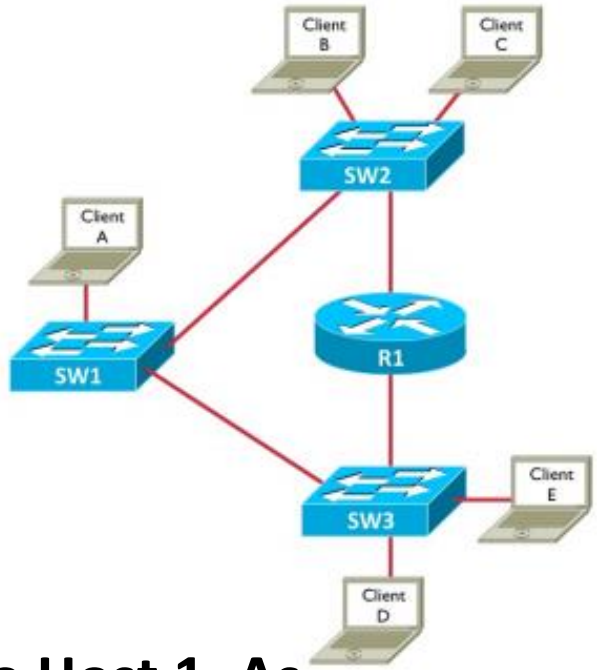
C.
R1 (config)# interface serial 0
R1 (config-if)# ip address 192.1.1.4 255.255.255.252
R1 (config-if)# clock rate 56000

D.
R1 (config)# interface serial 0
R1(config-if)#ip address 192.1.1.6 255.255.255.252
R1 (config-it)# no shutdown

E.
R1 (config)# router rip
R1 (config-router)# network 192.1.1.4
R1 (config-router)# network 192.1.1.128

F.
R1 (config)# router rip
R1 (config-router)# version 2
R1 (config-router)# network 192.1.1.0

Questions needs your own solutions
(No answers supported in current slide)

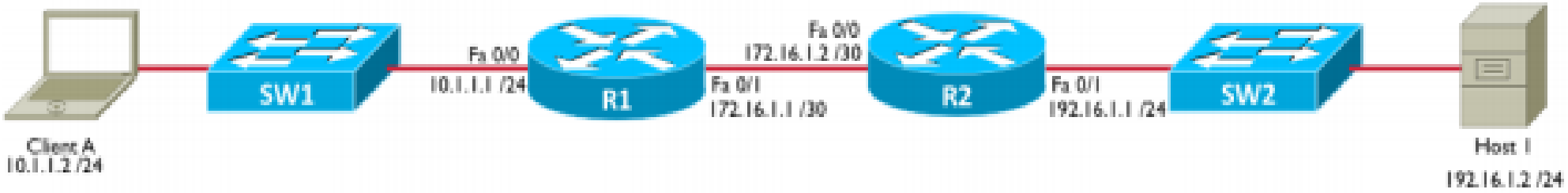


Q: Given the following topology, how many collisions are their? Answer …….

a. 3 b. 4 c. 5 d. 9 e. None of the above

Q: In the diagram below, Client A is sending a packet to Host 1. As the packet is coming into the Fa 0/0 interface on router R2, what is the source IP address in the packet's header? Answer ……

a. 10.1.1.1 b. 172.16.1.2 c. 192.16.1.1 d. 10.1.1.2 e. 172.16.1.1 f. 192.16.1.2



Q: Given the topology with three LANs (12, 16 and 50) hosts and three WAN links. Use the IP 192.168.53.0/24 to assign VLSM to the subnets?

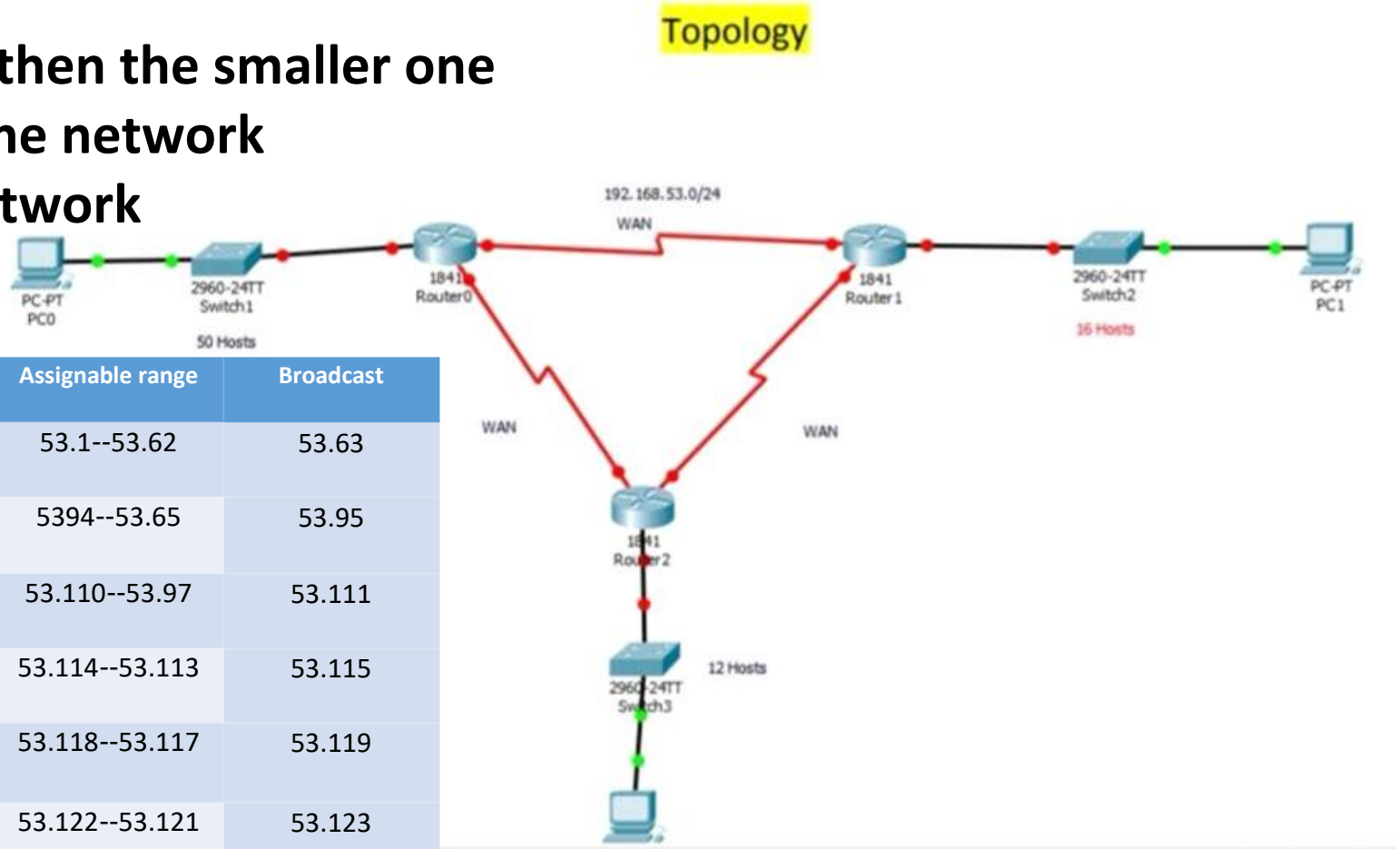
- Solution steps:

1- Start with the largest network, then the smaller one

2- Find the number of devices in the network

3- Calculate addresses for each network

4- Calculate the network mask



Subnet name	Needed size	Allocated size	Address	Mask	Assignable range	Broadcast
Network1	50	62	192.168.53.0	255.255.255.192=>26	53.1--53.62	53.63
Network2	16	30	192.168.53.64	255.255.255.224=>27	5394--53.65	53.95
Network3	12	14	192.168.53.96	255.255.255.240=>28	53.110--53.97	53.111
Network4	2	2	192.168.53.112	255.255.255.252=>30	53.114--53.113	53.115
Network5	2	2	192.168.53.116	255.255.255.252=>30	53.118--53.117	53.119
Network6	2	2	192.168.53.120	255.255.255.252=>30	53.122--53.121	53.123

Questions needs your own solutions
(No answers supported in current slide)

Q- What is the destination address in the header of a broadcast frame?

a- 0.0.0.0 b- 255.255.255.255 c- 11-11-11-11-11-11 d- FF-FF-FF-FF-FF-FF

Answer ……..

Q- What are two functions of a router? (Choose two.)

a- A router connects multiple IP networks

b- It controls the flow of data via the use of Layer 2 addresses

c- It determines the best path to send packets

d- It provides segmentation at Layer 2

e- It builds a routing table based on ARP requests

Answer ……..

Q- Which two items are used by a host device when performing an ANDing operation to determine if a destination address is on the same local network? (Choose two.)

a- destination IP address b- destination MAC address c- source MAC address

d- subnet mask e- network number **Answer ……..**

Thank you

Computer Networks
LAB10

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Forth Class

Q1:Match an element from Set-A to an element from Set-B

Set _A	Set_B
IPv6	SSH
OSPF	MASK
ICMP	Ring
24 PORT	Router
POOL	PING
SECURED PROTOCOL	TCP
FAST	OS
SUBNET	48 bits
Handshaking	UDP
Topology	Monitoring tool
Gateway	SWITCH
Linux	Flow label
MAC	DHCP
Wireshark	Link state

Set _A	Set_B
IPv6	Flow label
OSPF	Link state
ICMP	PING
24 PORT	SWITCH
POOL	DHCP
SECURED PROTOCOL	SSH
FAST	UDP
SUBNET	MASK
Handshaking	TCP
Topology	Ring
Gateway	Router
Linux	OS
MAC	48 bits
Wireshark	Monitoring tool

Questions needs your own solutions
(No answers supported in current slide)

Q: You are assigning IP addresses to hosts in the 192.168.4.0 /26 subnet. Which two of the following IP addresses are assignable IP addresses that reside in that subnet?

Answer …….

a. 192.168.4.0 b. 192.168.4.63 c. 192.168.4.62 d. 192.168.4.32 e. 192.168.4.64

Q: A host in your network has been assigned an IP address of 192.168.181.182 /25. What is the subnet to which the host belongs?

a. 192.168.181.128 /25 b. 192.168.181.0 /25 c. 192.168.181.176 /25
d. 192.168.181.192 /25 e. 192.168.181.160 /25

Answer …….

Q: Compare: Link local vs. unique local vs. Global unicast (IPv6 addresses) with examples.

Q:-Compare (management and data ports) of router. Which one is inband ports and which of them is out of band.

- Management port-(out of band) Ex: Consol and Aux ports
- Data port-(inband) …. Fastethernet Gigaethernet, Serial , …

Q:-Define: Reliability of network

Reliability measures the likelihood that the link will fail in some way and can be either variable or fixed. Examples of variable-reliability metrics are the number of times a link has failed or the number of errors it has received within a certain time period. Fixed-reliability metrics are based on known qualities of a link as determined by the network administrator. The path with highest reliability would be selected as best.

Questions needs your own solutions
(No answers supported in current slide)

Q: Multiple choice questions:

1- Which one of the following is a Class C IP address? Answer …….

a- 10.10.14.118 b- 135.23.112.57 c-191.200.199.199 d- 204.67.118.54

2. What must a routing protocol be able to do to support VLSM? Answer …….

a. Multicast b. Automatically summarize networks to a common mask

c. Advertise the mask for each subnet in the routing update. d. None of the above

3- Refer to the exhibit. Consider that the main power has just been restored. PC3 issues a broadcast IPv4 DHCP request.

To which port will SW1 forward this request? Answer ……..

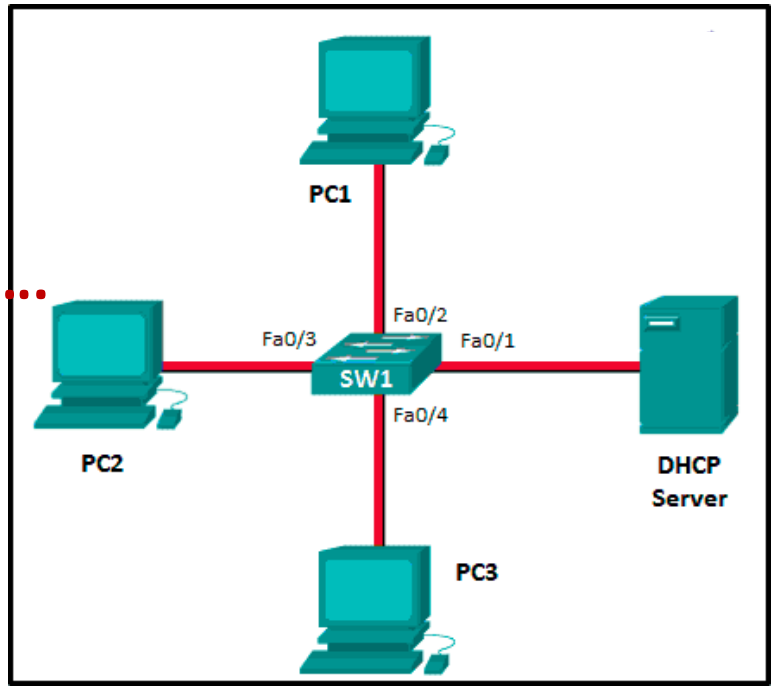
a- to Fa0/1 only

b- to Fa0/1 and Fa0/2 only

c- to Fa0/1, Fa0/2, and Fa0/3 only

d- to Fa0/1, Fa0/2, Fa0/3, and Fa0/4

e- to Fa0/1, Fa0/2, and Fa0/4 only



Thank you

Computer Networks
LAB11

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Forth Class

Q: Answer the following about IPv6?

1- Convert the following IPv6 address to the equivalent shorthand address? 2001:0123:0000:0001:ABCD:0000:0000:0110

2001:123:0:0001:ABCD::0110

2- Convert the following shorthand IPv6 address to the equivalent complete address? Fe80::1

FE80:0:0:0:0:0:0:0001

3- IPv6 can be enabled on Interface of router using the following command …… with enabling the IPv6 unicst routing protocol using the global mode configuration of router using the command ……..

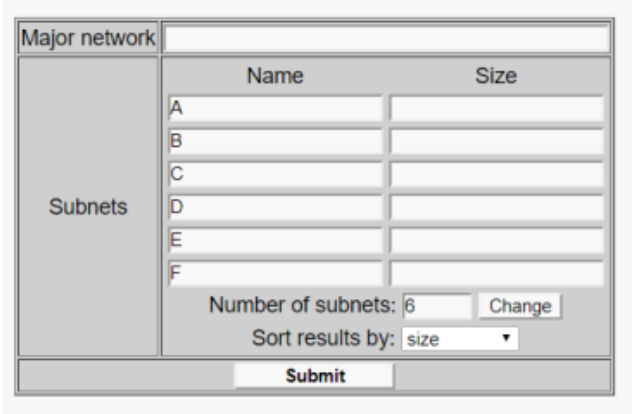
```
Router> enable
Router# configure terminal
Routerconfig)# interface Fastethernet 0/0
Router(config-if)# ipv6 enable
Router(config-if)# exit
```

```
Router(config)# ipv6 unicast-routing
```

Questions needs your own solutions
(No answers supported in current slide)

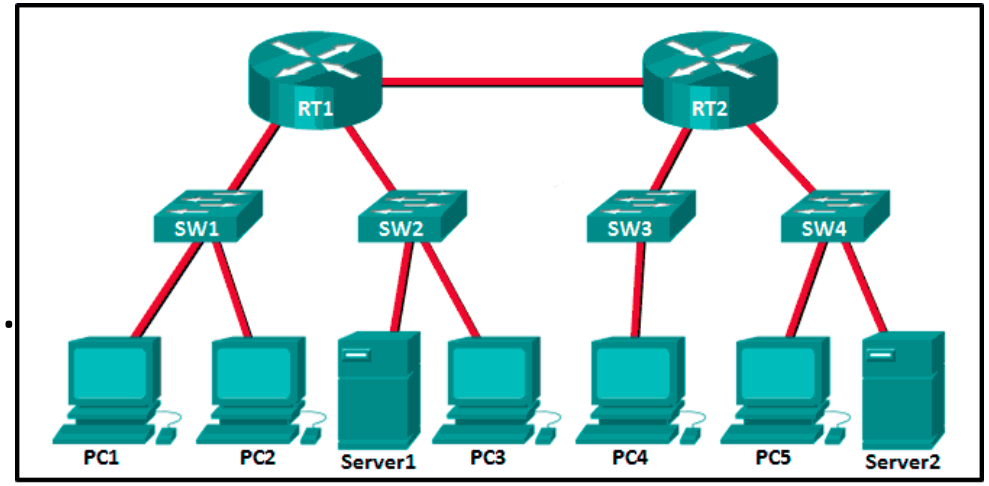
Q- Given 5 subnets with hosts (30, 48, 102, 2, and 64) and IP 192.168.34.60/22, write down the detailed network information for each subnet. Then calculate how much available IPs.

[Answer] Hint : First, try your own manual solution,
then check your solution using Google search for
VLSM IP calculator such as http://www.vlsm-calc.net/



Q: Refer to the exhibit. Fill in the blanks.

There are ..... collision domains in the topology.
There are ..... broadcast domains in the topology.



Q: Fill in the blanks:

1.1- In transport layer, port numbers range from 0 to 65535 but only port numbers 0 to 1023 are reserved for privileged services and designated as **well-known ports**.

1.2- Registered ports are in the range 1024 to 49151

1.3- Dynamic ports are in the range 49152 to 65535

2- In IPv6 address, the subnet part occupies 16 bits, or 0000 to FFFF as range in hexadecimal.

3- The range of **IPv4 multicast** addresses is 224.0.0.0 to 239.255.255.255

Questions needs your own solutions
(No answers supported in current slide)

Q: Answer True or False in [ ]:

1- [ ] Today **fiber-optic** cable is the media of choice for backbone networks.

2- [ ] The fundamental difference between a **switch and a router** is that a switch belongs only to its local network and a router belongs to two or more local networks.

3- [ ] **Quality of Service** routing is a special type of connection-oriented routing in which different connections are assigned different priorities

4- [ ] **Wi-fi** is a wireless specification for personal area networking (PAN) of desktop computers, peripheral devices, mobile phones, pagers, portable stereos, and other hand held devices.

5- [ ] **Modulation** can be used to make a signal conform to a specific pathway.

6- [ ] The highest capacity wireless media is **satellite microware**.

Thank you

COMPUTER NETWORKS

Classful Addressing

By:

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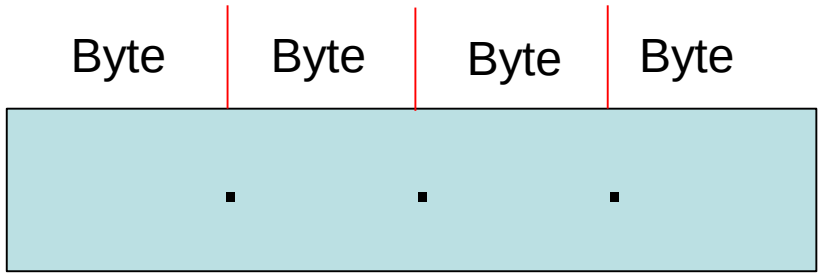
Fourth Class

IPv4

- **IP** stand for **Internet Protocol**
- 32 Bits => **4** bytes , separated by dot (.), unique during connection
- Byte = 8 bits => 8*4 =**32 bits**
- Each byte written in decimal
- Consist of 2 parts
  - **Net ID** (for subnet)
  - **Host ID** (for host)



IP Address Classes

Address Class	1st octet range (decimal)	1st octet bits (green bits do not change)	Network(N) and Host(H) parts of address	Default subnet mask (decimal and binary)	Number of possible networks and hosts per network
A	1-127**	00000001-01111111	N.H.H.H	255.0.0.0	128 nets (2^7) 16,777,214 hosts per net (2^24-2)
B	128-191	10000000-10111111	N.N.H.H	255.255.0.0	16,384 nets (2^14) 65,534 hosts per net (2^16-2)
C	192-223	11000000-11011111	N.N.N.H	255.255.255.0	2,097,152 nets (2^21) 254 hosts per net (2^8-2)
D	224-239	11100000-11101111	NA (multicast)		
E	240-255	11110000-11111111	NA (experimental)		

** All zeros (0) and all ones (1) are invalid hosts addresses.

Subnet Mask

is used to let devices differentiate between NetID and HostID

Class A

N.H.H.H /8

Subnet mask = 255.0.0.0

Class B

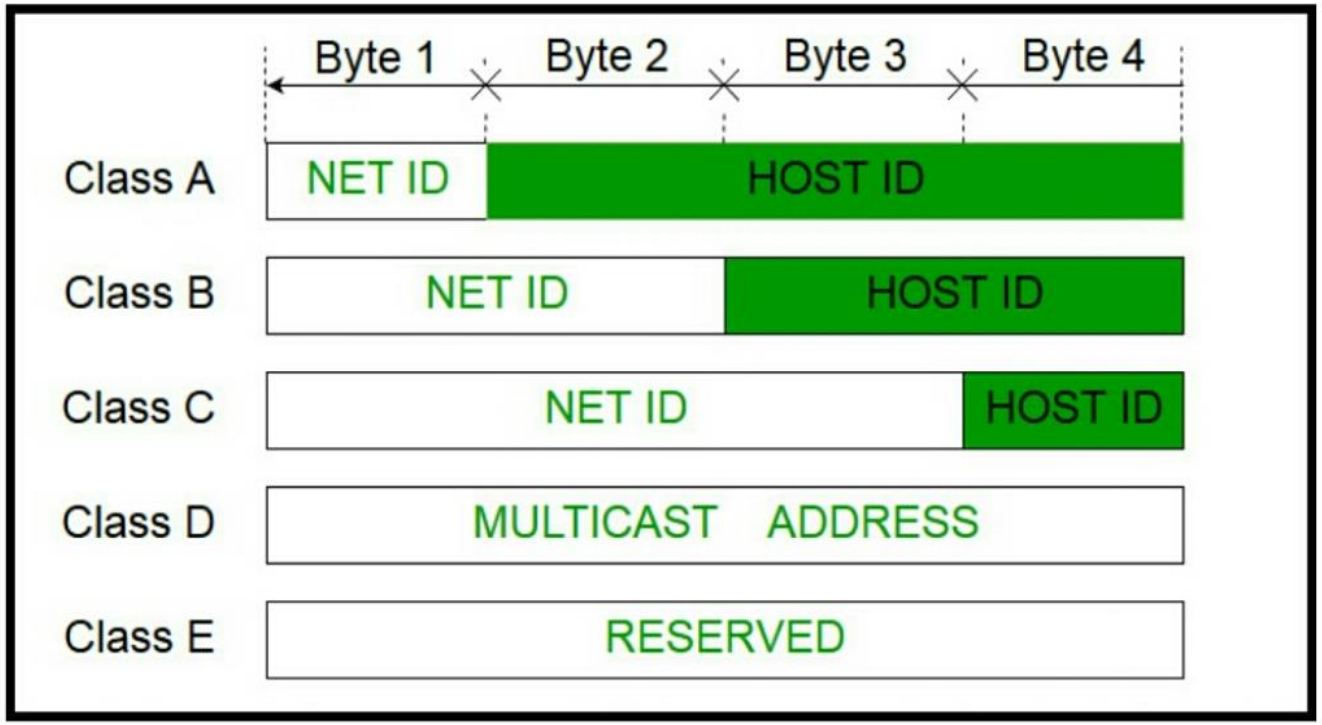
N.N.H.H /16

Subnet mask = 255.255.0.0

Class C

N.N.N.H /24

Subnet mask = 255.255.255.0



Rules for Assigning Host ID

- Within any network, **the host ID must be unique to that network**.
- While **finding the total number of host IP addresses**, There are 2 IP addresses which can **NOT** be used in addressing a host which must be decreased from the total count
  - Subnet IP (always 0)
  - Broadcast IP (always 255)

Class A

- **Host ID** => **24 bits =>** large number of hosts.
- **Network ID** => **8 bits => /8**
  - The higher order bit of the first octet is always set to **0**.
  - The remaining **7** bits in first octet are used to determine **network ID**.
- **Special Address**
  - **0.0.0.0 /8** : used to communicate within the current network.
  - **127.0.0.0 - 127.255.255.255 /8** : IPv4 Loop-back addresses

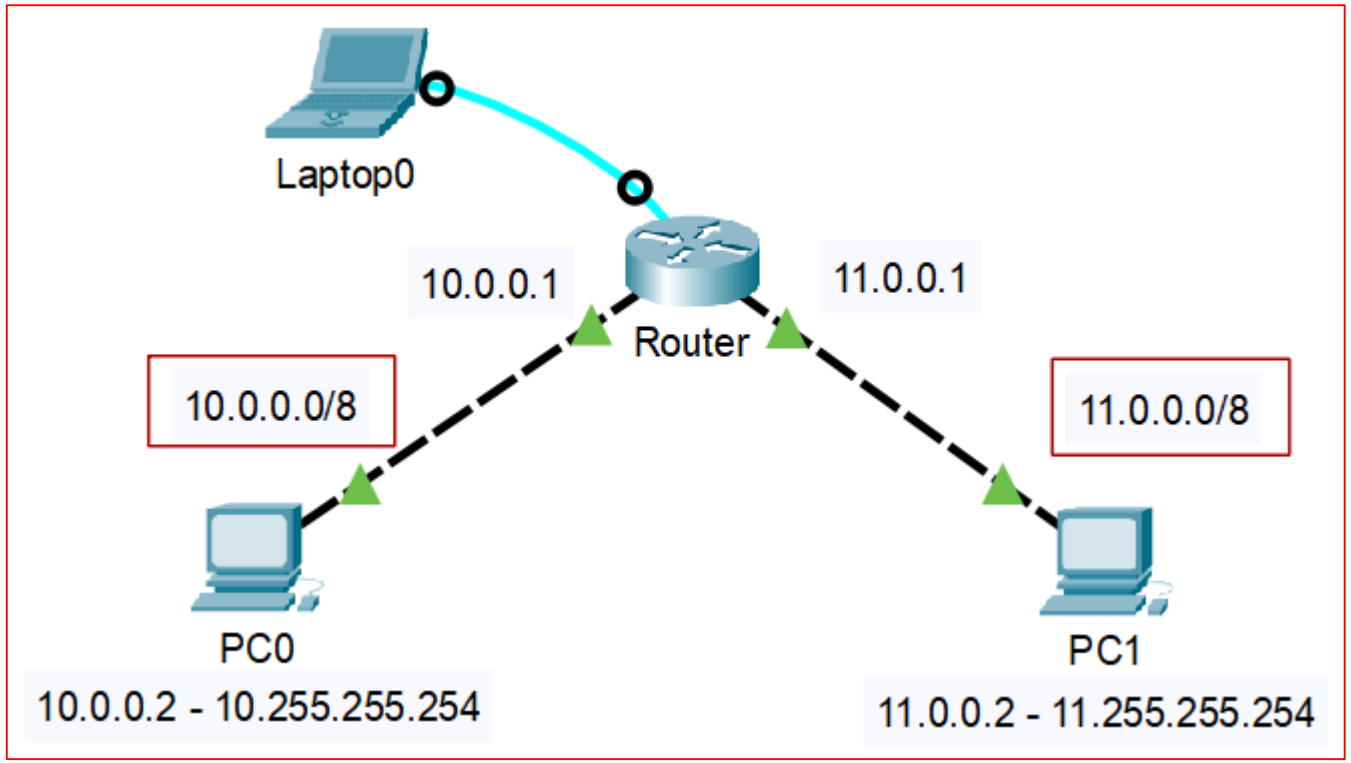
IP Address Range	Default Subnet Mask	No. of Net.s	No. of Hosts
1 – 126	255.0.0.0	2^7=128	(2^24)-2=16,777,214

Example

10.0.0.0 /8

- **Net ID** =>10.0.0.0
- **Mask** => 255.0.0.0
- **Broadcast** => 10.255.255.255
- **Host ID => Net ID +1 – Broadcast - 1**

  10.0.0.1 – 10.255.255.254
- **Gateway IP** => 10.0.0.1



Class B

- **Host ID => 16 bits**
- **Network ID => 16 bits**
  - The higher order bits of the first octet of IP addresses are always set to **10**.
  - The remaining **14** bits are used to determine **network ID**.
- **Special Address**

  169.254.0.0 /16 : Link local addresses

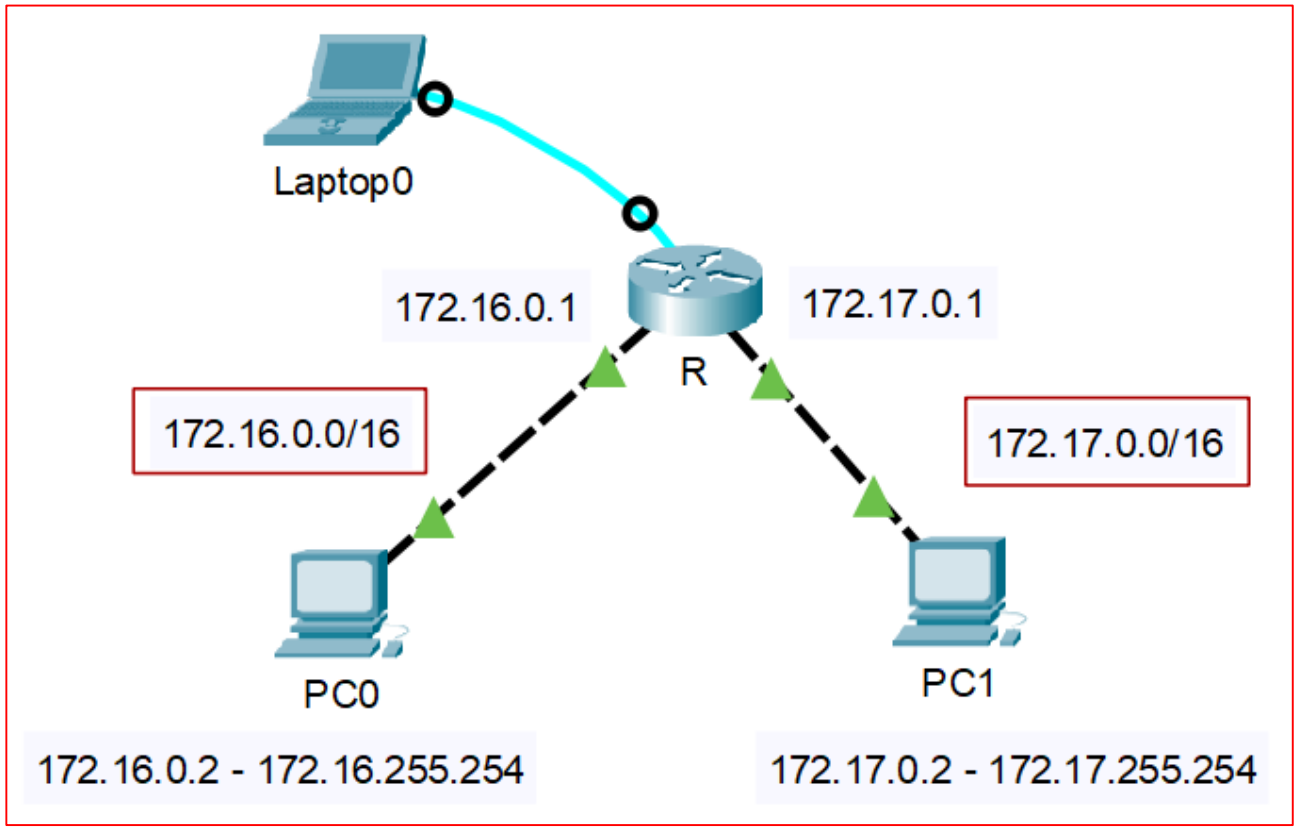
IP Address Range	Default Subnet Mask	No. of Net.s	No. of Hosts
128-191	255.255.0.0	2^14 = 16384	(2^16)-2 = 65534

Example

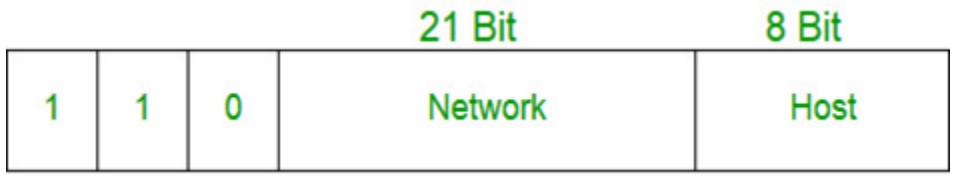
172.16.0.0 /16

- **Net ID** =>172.16.0.0
- **Mask** => 255.255.0.0
- **Broadcast** => 172.16.255.255
- **Host ID => Net ID +1 – Broadcast - 1**

  172.16.0.1 – 172.16.255.254
- **Gateway IP** => 172.16.0.1



Class C



- **Host ID => 8 bits**
- **Network ID => 24 bits**
  - The higher order bits of the first octet of IP addresses are always set to **110**.
  - The remaining **21 bits** are used to determine **network ID**.

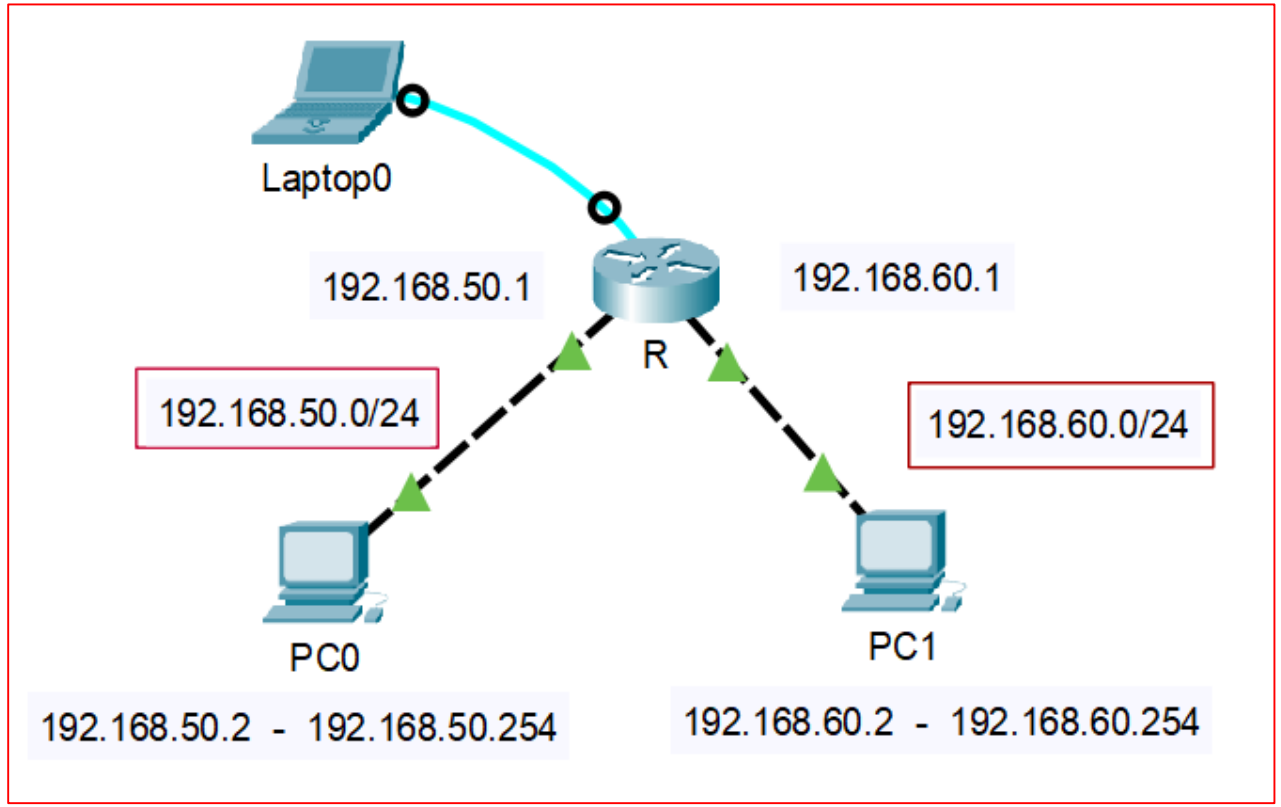
IP Address Range	Default Subnet Mask	No. of Net.s	No. of Hosts
192-223	255.255.255.0	2^21=2097152	(2^8)-2=254

Example

192.168.50.0 /24

- **Net ID** => **192.168.50**.0
- **Mask** => **255.255.255**.0
- **Broadcast** => 192.168.50.**255**
- **Host ID** => **Net ID +1** – **Broadcast - 1**

  192.168.50.**1** – 192.168.50.**254**
- **Gateway IP** => 192.168.50.**1**

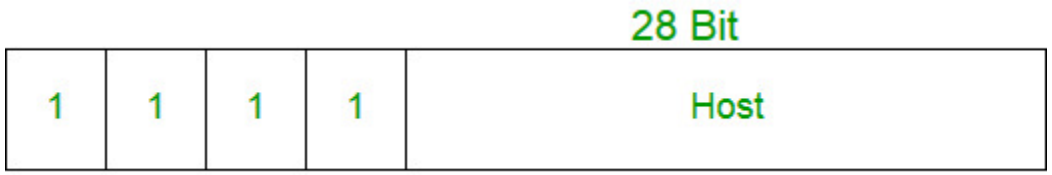


Class D

- IP address are reserved for **multi-casting**.
- The higher order bits of the first octet of IP addresses are always set to **1110**.
- The remaining bits are for the address that interested hosts recognize.
- Class D does not posses any sub-net mask.
- IP addresses ranges from **224.0.0.0 – 239.255.255.255**

Class E

- IP addresses belonging to class E are reserved for **experimental and research purposes**.
- IP addresses ranges from **240.0.0.0 – 255.255.255.254**.
- This class doesn't have any sub-net mask.
- The higher order bits of first octet are always set to **1111**.



Problems with Classful Addressing

- **Class A** : Millions of address are wasted.
- **Class B** : Many of address are wasted.
- **Class C** : Number of addresses available is so small that it can't cater the needs of organizations.
- **Class D** addresses are used for multicast routing.
- **Class E** addresses are reserved for experimental and research.

Since, Classful networking was replaced by Classless Inter-Domain Routing (CIDR) in 1993.

Thank You