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Lab 4: IP – 12 November 2004, *Station 5*, no partners

<u>D.1</u>

Choice of IP addresses: I used a scheme that was offset by 4*20 from Figure 1:

```
A:eth2 192.168.0.120 (MAC 'c4')
B:eth2 192.168.0.121 (MAC 'd1')
C:eth2 192.168.0.130 (MAC 'b9')
D:eth2 192.168.0.131 (MAC 'c2')
Router1:eth0/0 192.168.0.122 (MAC 'c8')
Router1:eth0/1 192.168.0.132 (MAC 'c9')
```

C.1.f

```
cisco_7010_5top#show interfaces
Ethernet0/0 is up, line protocol is up
  Hardware is cxBus Ethernet, address is 0000.0c50.80c8 (bia 0000.0c50.80c8)
  Internet address is 192.168.0.122/28
...
Ethernet0/1 is up, line protocol is up
  Hardware is cxBus Ethernet, address is 0000.0c50.80c9 (bia 0000.0c50.80c9)
  Internet address is 192.168.0.132/28
...
```

C.1.gh

```
cisco_7010_5top#sh ip route
...
     192.168.0.0/28 is subnetted, 2 subnets
C       192.168.0.112 is directly connected, Ethernet0/0
C       192.168.0.128 is directly connected, Ethernet0/1
```

C.1.ijk

Ethereal at B:eth2

```
No. Time        Source              Destination         Protocol Info
  1 0.000000    00:50:fc:57:87:c4   ff:ff:ff:ff:ff:ff   ARP      Who has 192.168.0.121? Tell 192.168.0.120
  2 0.000000    00:50:fc:57:87:d1   00:50:fc:57:87:c4   ARP      192.168.0.121 is at 00:50:fc:57:87:d1
  3 0.000000    192.168.0.120       192.168.0.121       ICMP     Echo (ping) request
  4 0.000000    192.168.0.121       192.168.0.120       ICMP     Echo (ping) reply
  5 0.990055    192.168.0.120       192.168.0.121       ICMP     Echo (ping) request
  6 0.990055    192.168.0.121       192.168.0.120       ICMP     Echo (ping) reply
  7 5.000279    00:50:fc:57:87:d1   00:50:fc:57:87:c4   ARP      Who has 192.168.0.120? Tell 192.168.0.121
  8 5.000279    00:50:fc:57:87:c4   00:50:fc:57:87:d1   ARP      192.168.0.120 is at 00:50:fc:57:87:c4

  9 137.467681  00:50:fc:57:87:c4   ff:ff:ff:ff:ff:ff   ARP      Who has 192.168.0.130? Tell 192.168.0.120
 10 137.467681  00:00:0c:50:80:c8   00:50:fc:57:87:c4   ARP      192.168.0.130 is at 00:00:0c:50:80:c8
 11 137.467681  192.168.0.120       192.168.0.130       ICMP     Echo (ping) request
 12 138.467737  192.168.0.120       192.168.0.130       ICMP     Echo (ping) request
 13 138.467737  192.168.0.130       192.168.0.120       ICMP     Echo (ping) reply

 14 194.530870  00:50:fc:57:87:c4   ff:ff:ff:ff:ff:ff   ARP      Who has 192.168.0.131? Tell 192.168.0.120
 15 194.530870  00:00:0c:50:80:c8   00:50:fc:57:87:c4   ARP      192.168.0.131 is at 00:00:0c:50:80:c8
 16 194.530870  192.168.0.120       192.168.0.131       ICMP     Echo (ping) request
 17 195.530926  192.168.0.120       192.168.0.131       ICMP     Echo (ping) request
 18 195.530926  192.168.0.131       192.168.0.120       ICMP     Echo (ping) reply
```

Ethereal at C:eth2

```
No. Time        Source              Destination         Protocol Info
  1 0.000000    00:00:0c:50:80:c9   ff:ff:ff:ff:ff:ff   ARP      Who has 192.168.0.130?  Tell 192.168.0.132
  2 0.000000    00:50:fc:55:e3:b9   00:00:0c:50:80:c9   ARP      192.168.0.130 is at 00:50:fc:55:e3:b9
  3 1.000056    192.168.0.120       192.168.0.130       ICMP     Echo (ping) request
  4 1.000056    00:50:fc:55:e3:b9   ff:ff:ff:ff:ff:ff   ARP      Who has 192.168.0.120?  Tell 192.168.0.130
  5 1.000056    00:00:0c:50:80:c9   00:50:fc:55:e3:b9   ARP      192.168.0.120 is at 00:00:0c:50:80:c9
  6 1.000056    192.168.0.130       192.168.0.120       ICMP     Echo (ping) reply

  7 57.063189   00:00:0c:50:80:c9   ff:ff:ff:ff:ff:ff   ARP      Who has 192.168.0.131?  Tell 192.168.0.132
  8 57.063189   00:50:fc:57:87:c2   00:00:0c:50:80:c9   ARP      192.168.0.131 is at 00:50:fc:57:87:c2
  9 58.063245   192.168.0.120       192.168.0.131       ICMP     Echo (ping) request
 10 58.063245   00:50:fc:57:87:c2   ff:ff:ff:ff:ff:ff   ARP      Who has 192.168.0.120?  Tell 192.168.0.131
 11 58.063245   00:00:0c:50:80:c9   00:50:fc:57:87:c2   ARP      192.168.0.120 is at 00:00:0c:50:80:c9
 12 58.063245   192.168.0.131       192.168.0.120       ICMP     Echo (ping) reply
```

At B, we see the ARP and ICMP transactions (1 through 8) between A and B, as expected. We see also the traffic between A and C, A and D because B shares collision domain with A. At B, though, we see only one Reply packet for pings to C and D. This is because the first Request packet does not reach C, for example. Router1 cannot forward the Request packet because it does not know the destination MAC address.

At C (packets# 1,2), the Router has broadcast an ARP request for C's hardware address, and received a response. So then, the Router's internal intelligence knows that A is on its port 0/0, and C is on its port 0/1, but not before the first Request packet is lost.

At B (packet# 10), we see Router1:eth0/0 sending an ARP response to A with its own MAC address, meaning "Send me your packets destined for C." So the ***second*** Request from A reaches C (packet# 3).

C then broadcasts an ARP request (C packet# 4) for the address of A. The router knows it can reach A from its port 0, so it immediately sends an ARP response (C packet# 5) telling C to send packets destined for A, to Router port 1. The Reply of C goes out (C packet 6) and is received at B (packet# 13) and therefore at A on the same hub.

The same order of events is shown for ping from A to D.

No router configuration is needed, because the single Router is able to determine which hosts are connected to each of its ports directly.

D.2

Choice of IP addresses: I used a scheme that was offset by 4*20 from Figure 2:

```
A:eth2 192.168.0.120
B:eth2 192.168.0.121
C:eth2 192.168.0.130
D:eth2 192.168.0.131
Router1:eth0/0 192.168.0.122
Router1:eth0/1 192.168.0.145
Router2:eth0/0 192.168.0.132
Router2:eth0/1 192.168.0.146
```

C.2.c

Router1:
```
cisco_7010_5top#sh ip route
       192.168.0.0/28 is subnetted, 2 subnets
C       192.168.0.112 is directly connected, Ethernet0/0
C       192.168.0.144 is d10_5
```

Router2:
```
cisco_7000_5bottom#sh ip route
     192.168.0.0/28 is subnetted, 2 subnets
C       192.168.0.128 is directly connected, Ethernet0/0
C       192.168.0.144 is directly connected, Ethernet0/1
cisco_7000_5bottom#
```

C.2.d

Your Host Port & IP address	**Port x/y**	**Port x/y IP address**	**Connected?**
192.168.0.120	E 0/0 of router 1	192.168.0.122	yes
192.168.0.120	E 0/1 of router 1	192.168.0.145	yes
192.168.0.120	E 0/1 of router 2	192.168.0.146	no reply
192.168.0.120	E 0/0 of router 2	192.168.0.132	unreachable
192.168.0.120	E 2 of host C	192.168.0.130	unreachable

There is no reply from 192.168.0.146 because no route table entries exist to tell Router2 how to direct ICMP Reply packets destined for network “112.” (Host A is on network 192.168.0.112.) Router1 and Router2 are directly connected to network “144”, so Host A can send ICMP Request packets to address 192.168.0.146 (assisted by ARP transactions that inform the data link layer of Router1 how to forward packets to 192.168.0.146), but Router2 can not reply.

Likewise, ICMP Request packets from Host A can not reach network “128” (Hosts C and D) because Router1 has no route table entry for that network.

C.3.b

The logic of the “ip route” commands are: associate (in the routing table) the remote network with the address of a device connected to a node that is accessible to this router. For Router1, the remote network is 192.168.0.128, and the accessible device/node address is 192.168.0.146. For Router2, the remote network is 192.168.0.112, and the accessible device/node address is 192.168.0.145.

C.3.c

Router1:

```
cisco_7010_5top#sh ip route
     192.168.0.0/28 is subnetted, 3 subnets
C       192.168.0.112 is directly connected, Ethernet0/0
S       192.168.0.128 [1/0] via 192.168.0.146
C       192.168.0.144 is directly connected, Ethernet0/1
cisco_7010_5top#
```

Router2:

```
cisco_7000_5bottom#sh ip route
     192.168.0.0/28 is subnetted, 3 subnets
S       192.168.0.112 [1/0] via 192.168.0.145
C       192.168.0.128 is directly connected, Ethernet0/0
C       192.168.0.144 is directly connected, Ethernet0/1
cisco_7000_5bottom#
```

C.3.d

Your Host Port & IP address	**Port x/y**	**Port x/y IP address**	**Connected?**
192.168.0.120	E 0/0 of router 1	192.168.0.122	yes
192.168.0.120	E 0/1 of router 1	192.168.0.145	yes
192.168.0.120	E 0/1 of router 2	192.168.0.146	yes
192.168.0.120	E 0/0 of router 2	192.168.0.132	yes
192.168.0.120	E 2 of host C	192.168.0.130	1 lost, 1 received

At this point, packets destined for network 192.168.0.128 will be forwarded by Router1 to IP Address 192.168.0.146. This will ensure their delivery, because IP address 192.168.0.146 is Router2 port1, and network “128” is on Router2 port0. Therefore Router2 can forward the packets.

Likewise, Router2 will forward packets destined for network “112,” via IP address 192.168.0.145. This means Router1 port1 will receive them, and Router1 port0 is on network “112.”

Therefore ARP and ICMP packets can be routed between Host A on network 112, and Hosts C and D on network “128.” In this case, pinging twice from A to C yields the same behavior as in the first procedure. The two routers now “look like” a single router, to hosts on the two external networks.

C.4

Source Host port & IP address	**Port X**	**Port X IP address**	**IP address of nodes along the path**
192.168.0.120	E 0/0 of router 1	192.168.0.122	192.168.0.122
192.168.0.120	E 0/1 of router 1	192.168.0.145	192.168.0.122
192.168.0.120	E 0/1 of router 2	192.168.0.146	192.168.0.122, 192.168.0.146
192.168.0.120	E 0/0 of router 2	192.168.0.132	192.168.0.122, 192.168.0.146
192.168.0.120	E 2 of host C	192.168.0.130	192.168.0.122, 192.168.0.146, 192.168.0.130

D.3

Router Port	**IP Address**	**Subnet Mask**	**Subnet Number**
Router 1 E0/0	192.168.0.122	255.255.255.240	192.168.0.112
Router 1 E0/1	192.168.0.145	255.255.255.240	192.168.0.144
Router 2 E0/0	192.168.0.132	255.255.255.240	192.168.0.128
Router 2 E0/1	192.168.0.146	255.255.255.240	192.168.0.144

D.4

The subnet mask distinguishes the network address (subnet number) from the host ID, within the format of the IP address. In this way a subnet number can represent a network with group of hosts connected to it. This simplifies the configuration in the routing table – access to a group of hosts can be configured, using only one table entry.