



Politecnico di Milano

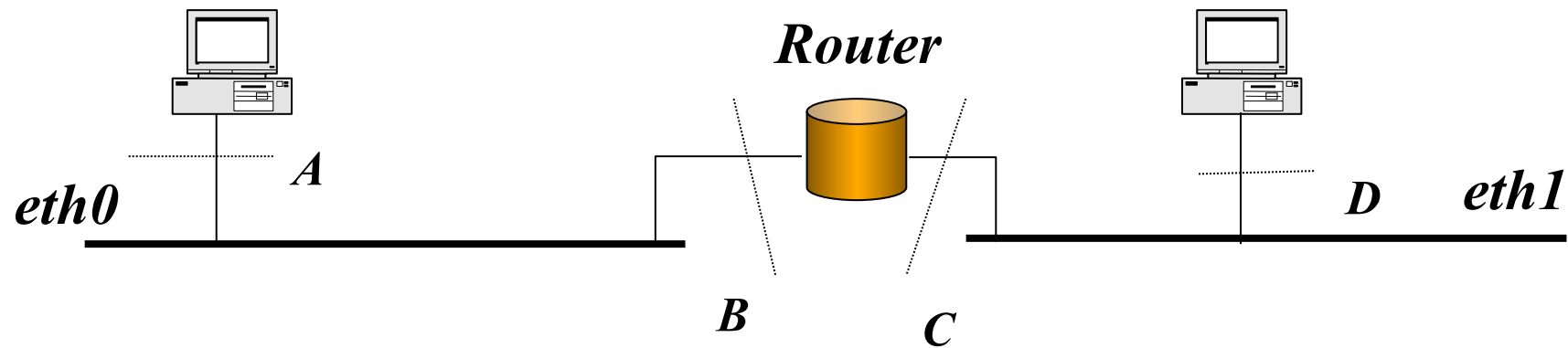
Scuola di Ingegneria Industriale e dell'Informazione

E6

Forwarding

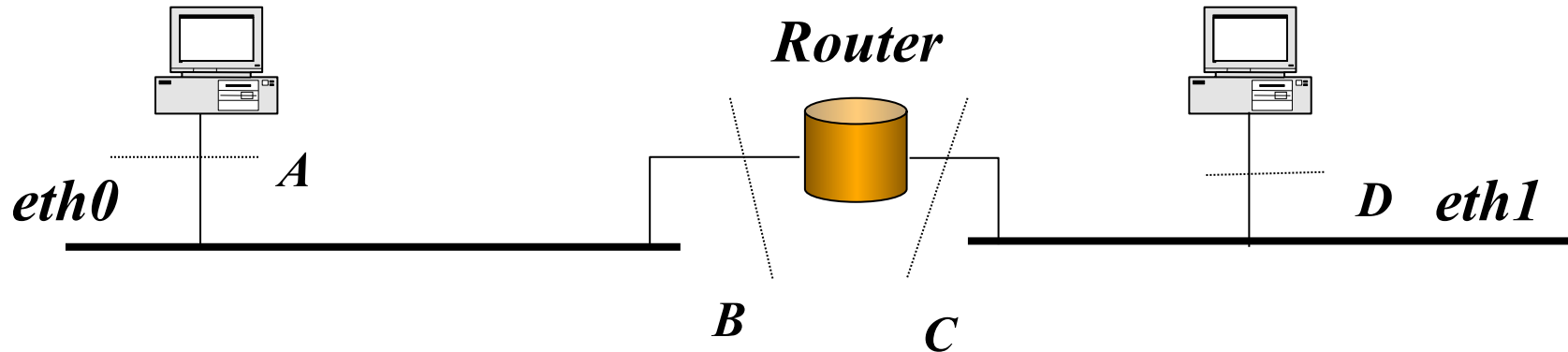
Exercise 1

- Consider the network in the figure where interfaces are identified with capital letters:



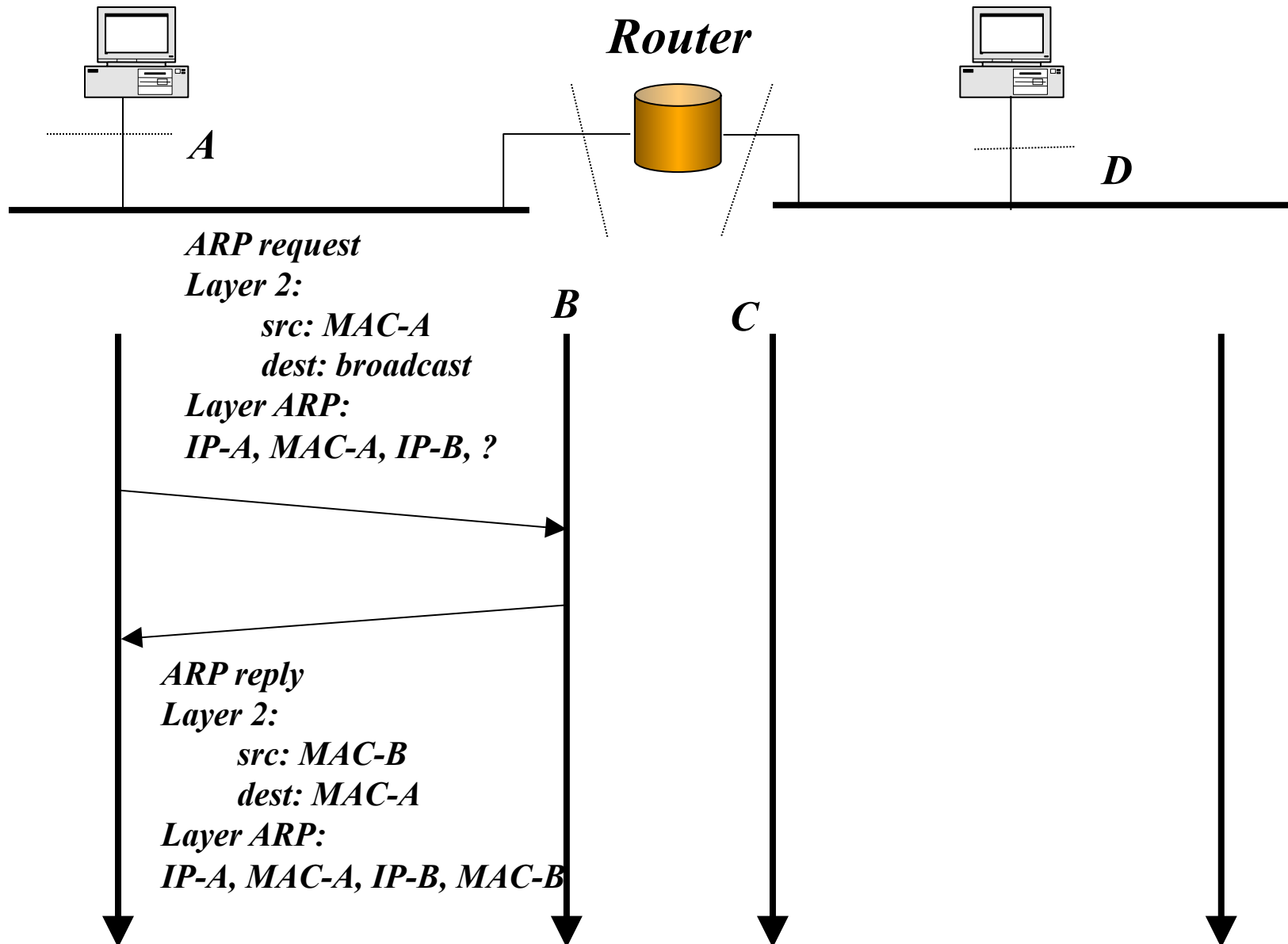
- Denote with IP-x and MAC-x, with $x=[A,B,C,D]$, IP addresses and MAC addresses respectively
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Exercise 1

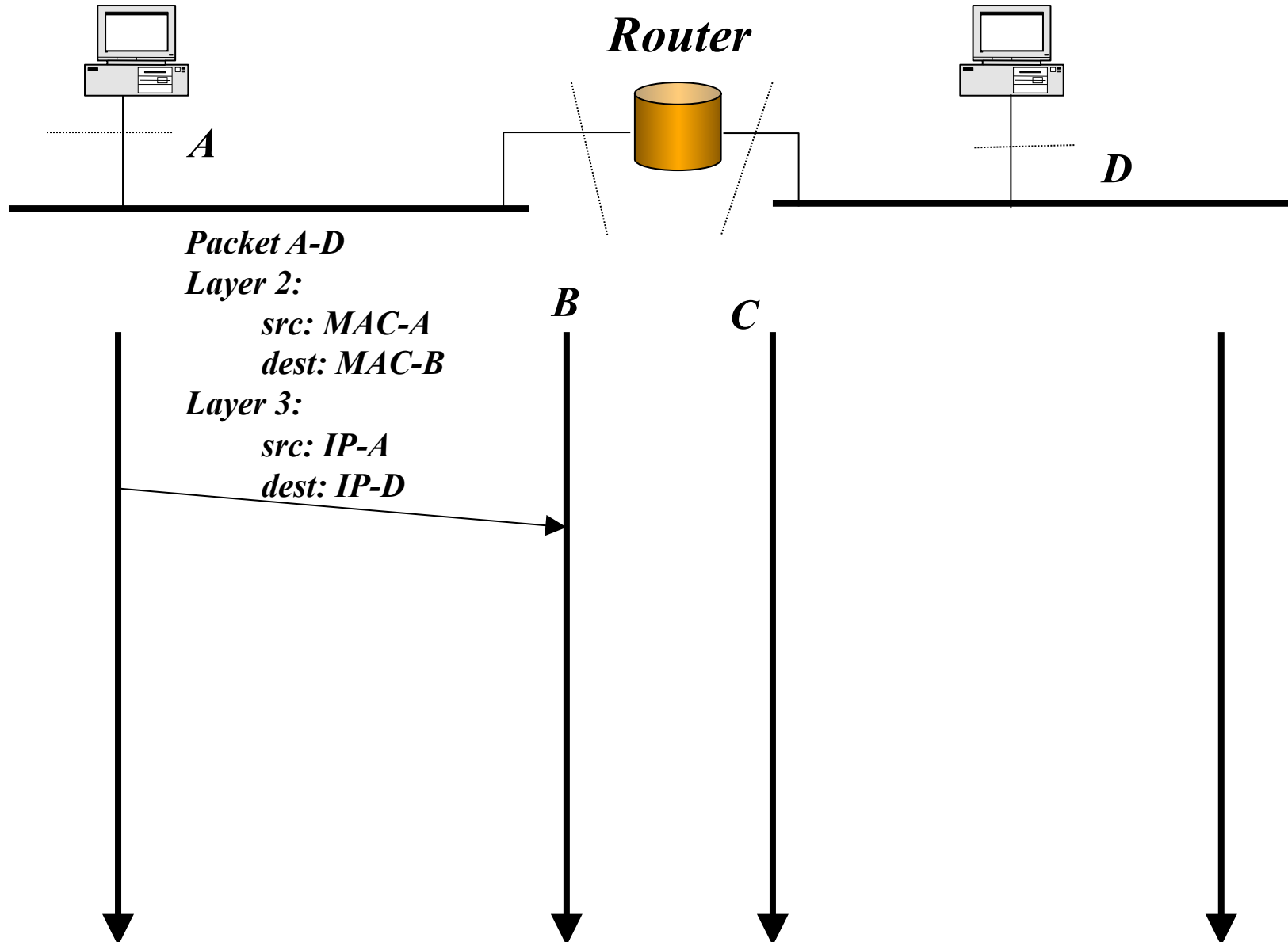


- Assume ARP tables of A, D and the router are empty
 - Host A has to send an IP packet to IP-D. Once received the packet, host D has to send a reply back to IP-A
- a) Indicate graphically the packets transmitted and for each of the (on each of the ethernet networks crossed) the addresses included in the PDUs of layer 2 (ethernet) and 3 (IP or ARP)

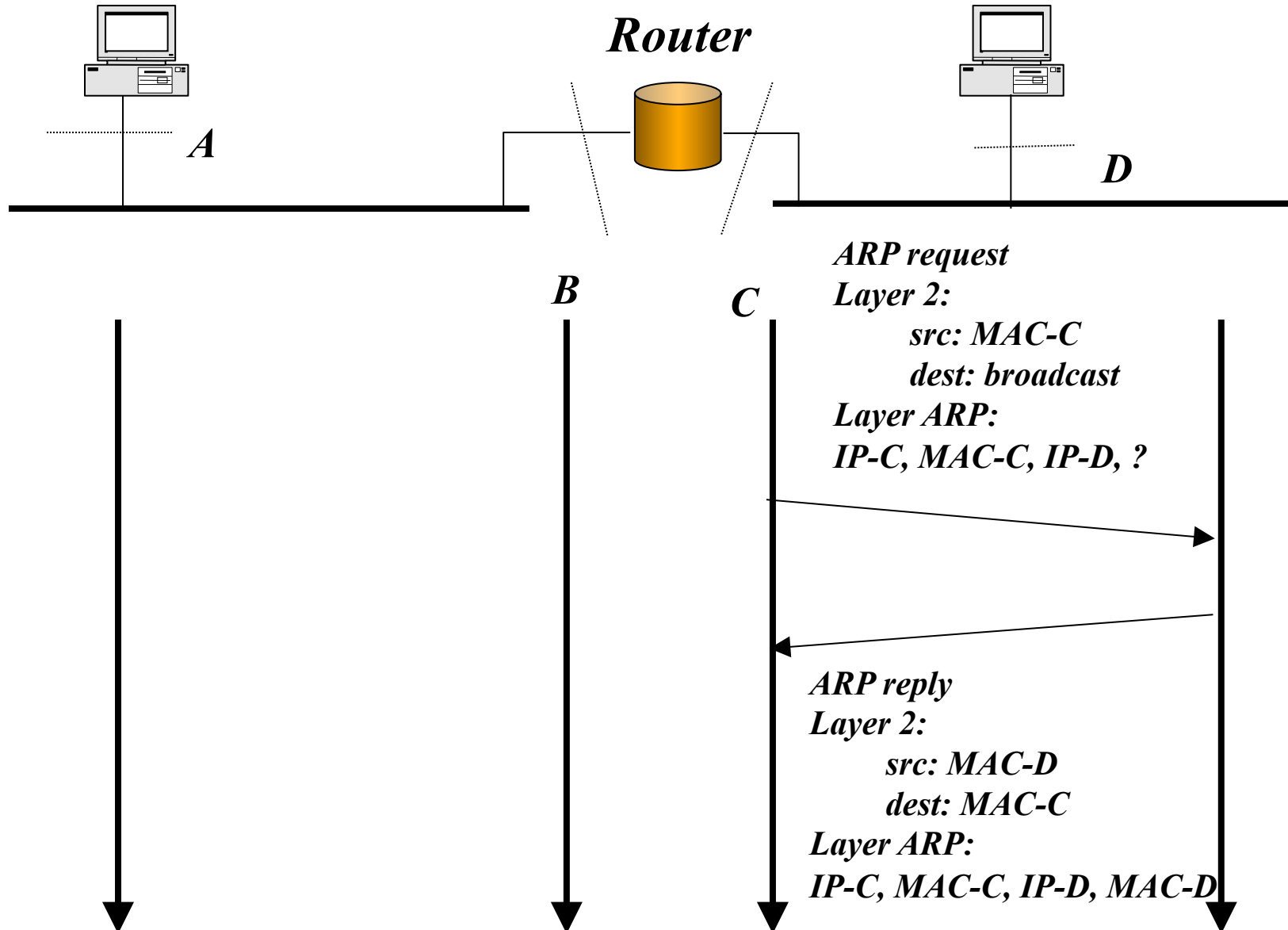
Solution 1



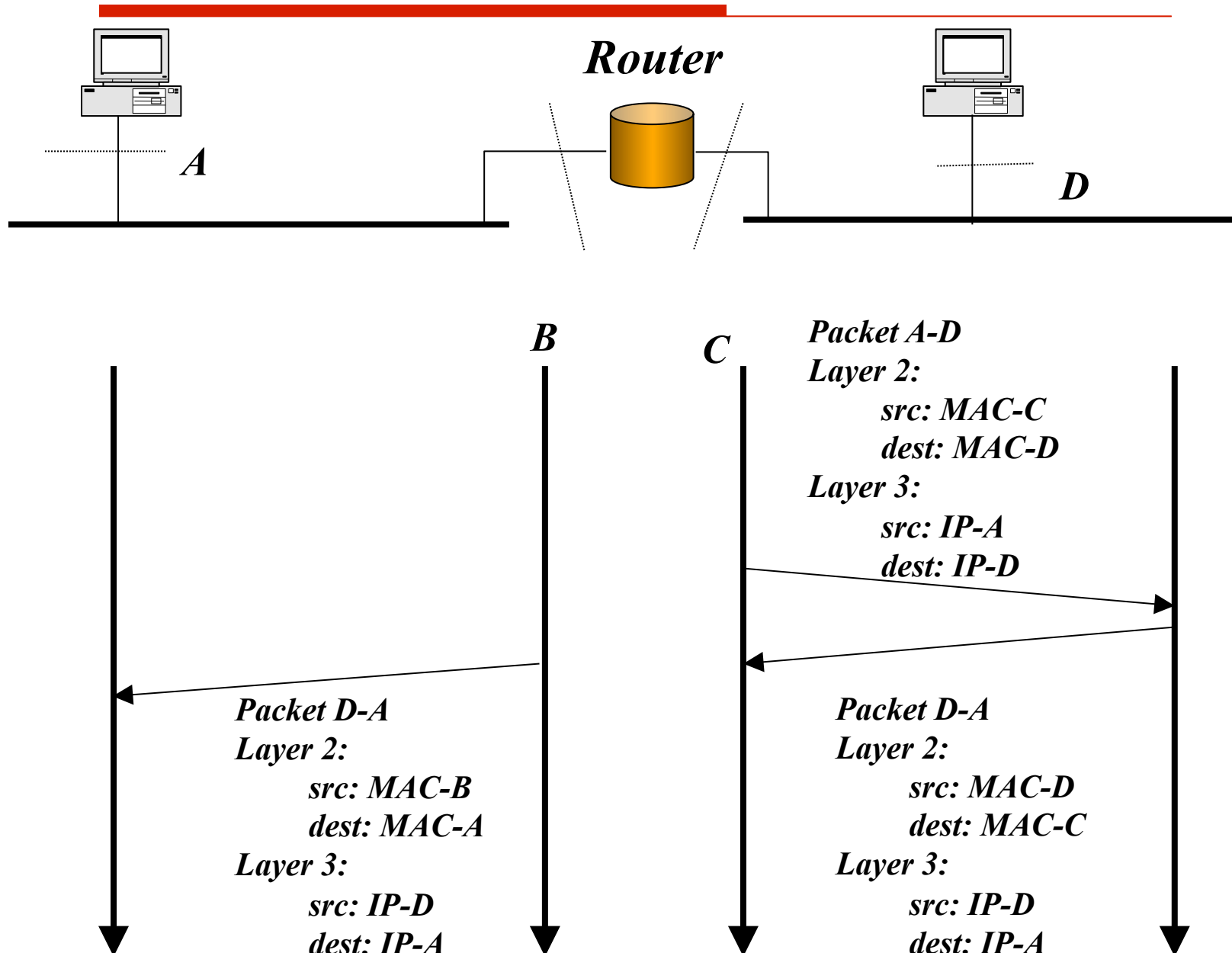
Solution 1



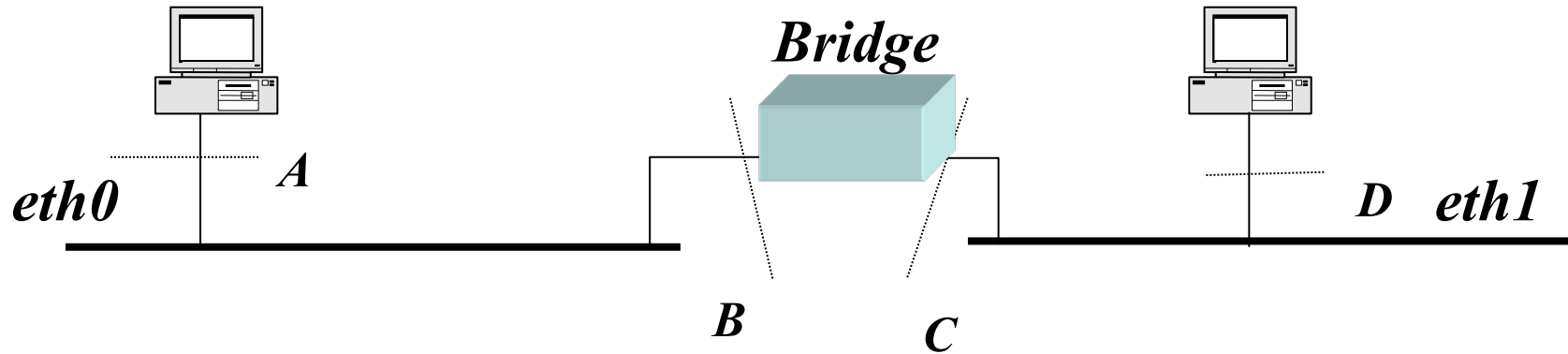
Solution 1



Solution 1

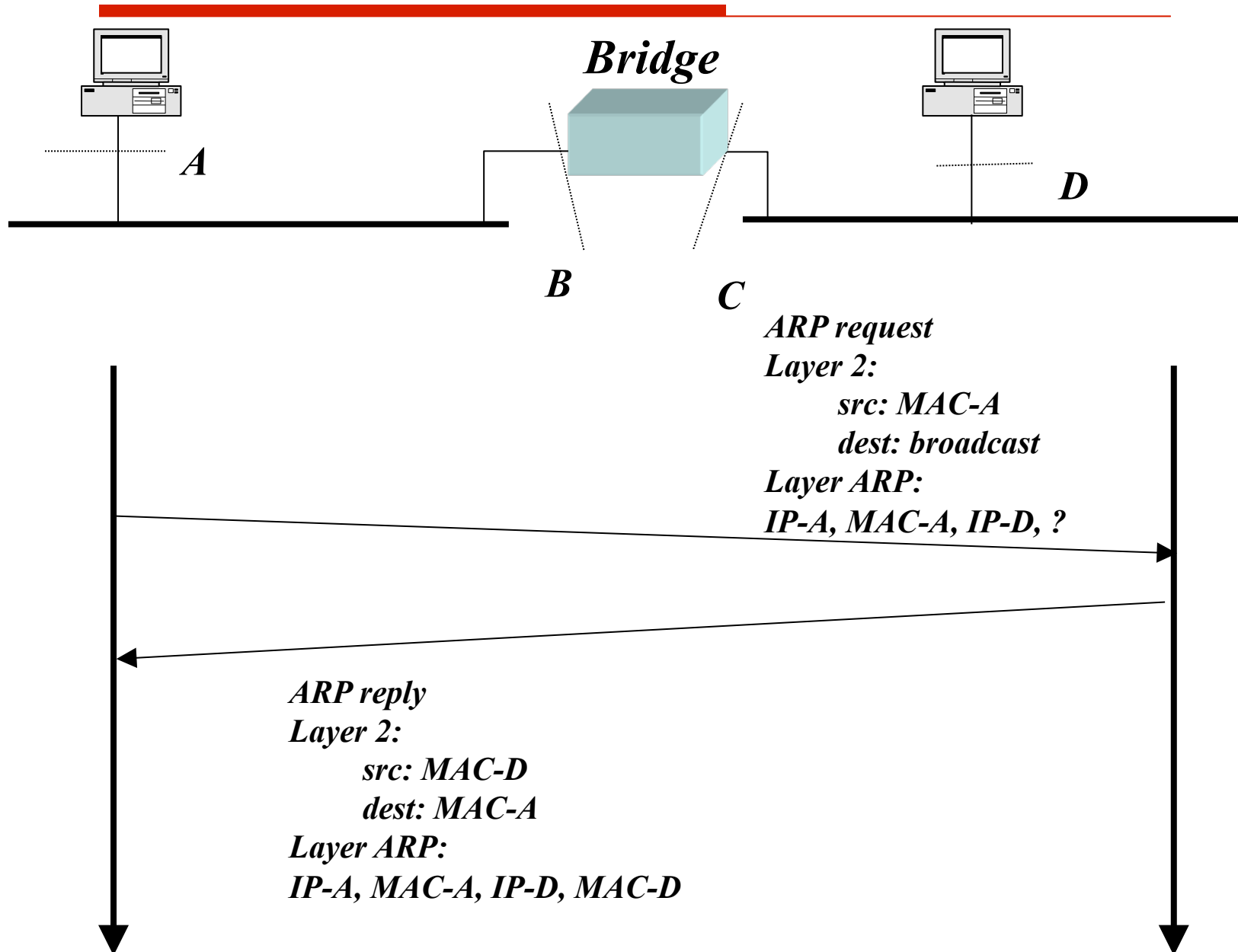


Exercise 2

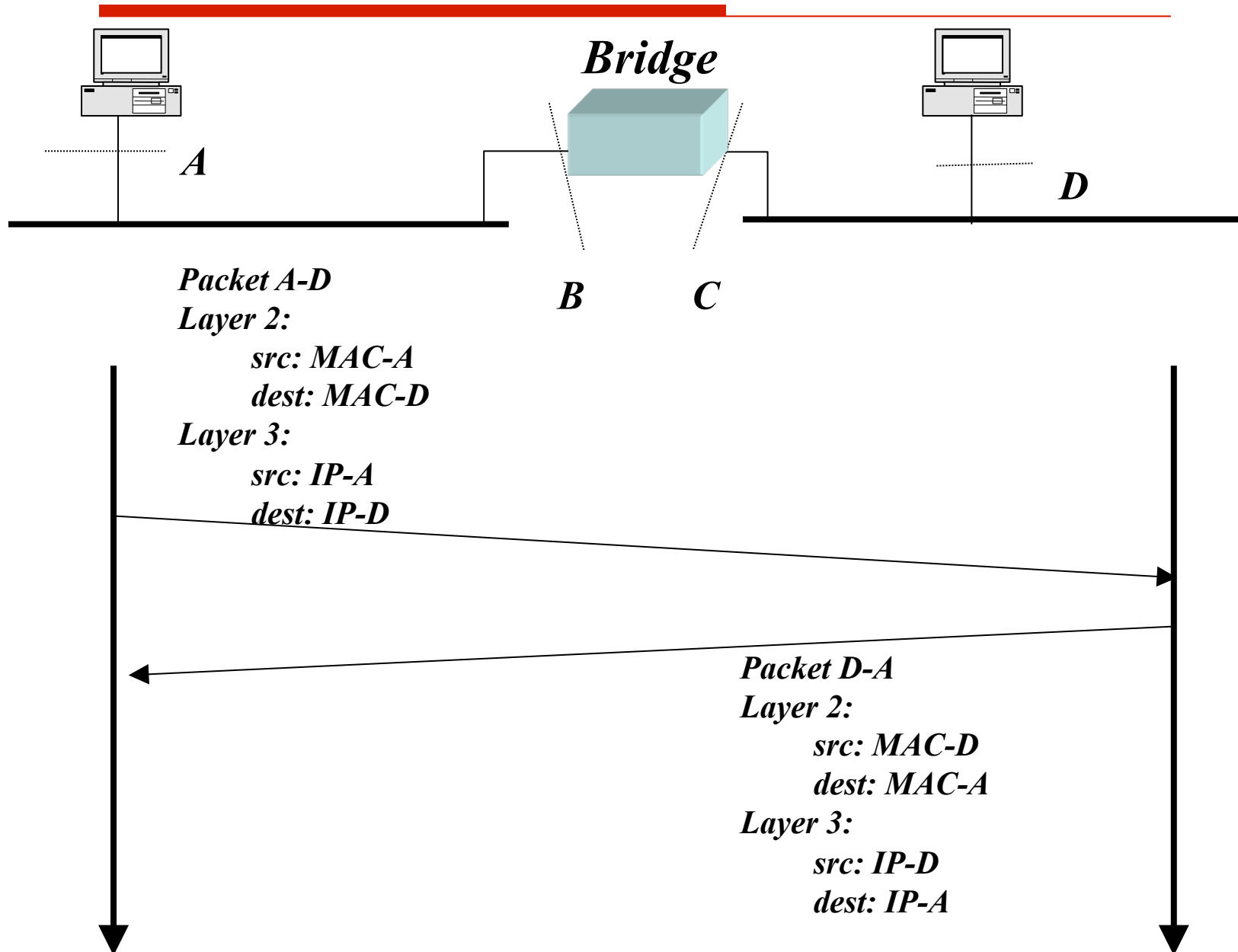


b) The same in the case the node is a bridge (layer 2 switch)

Solution 2

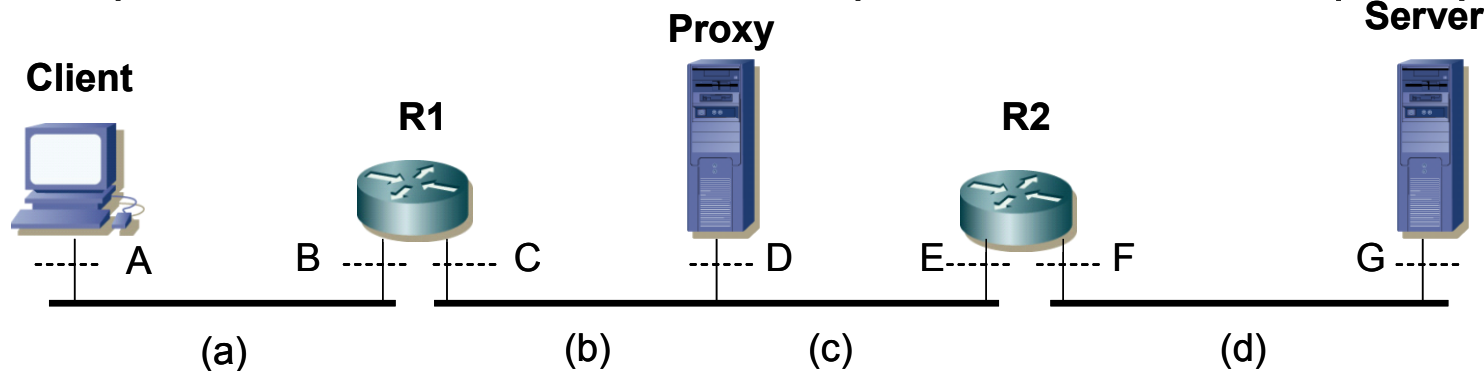


Solution 2

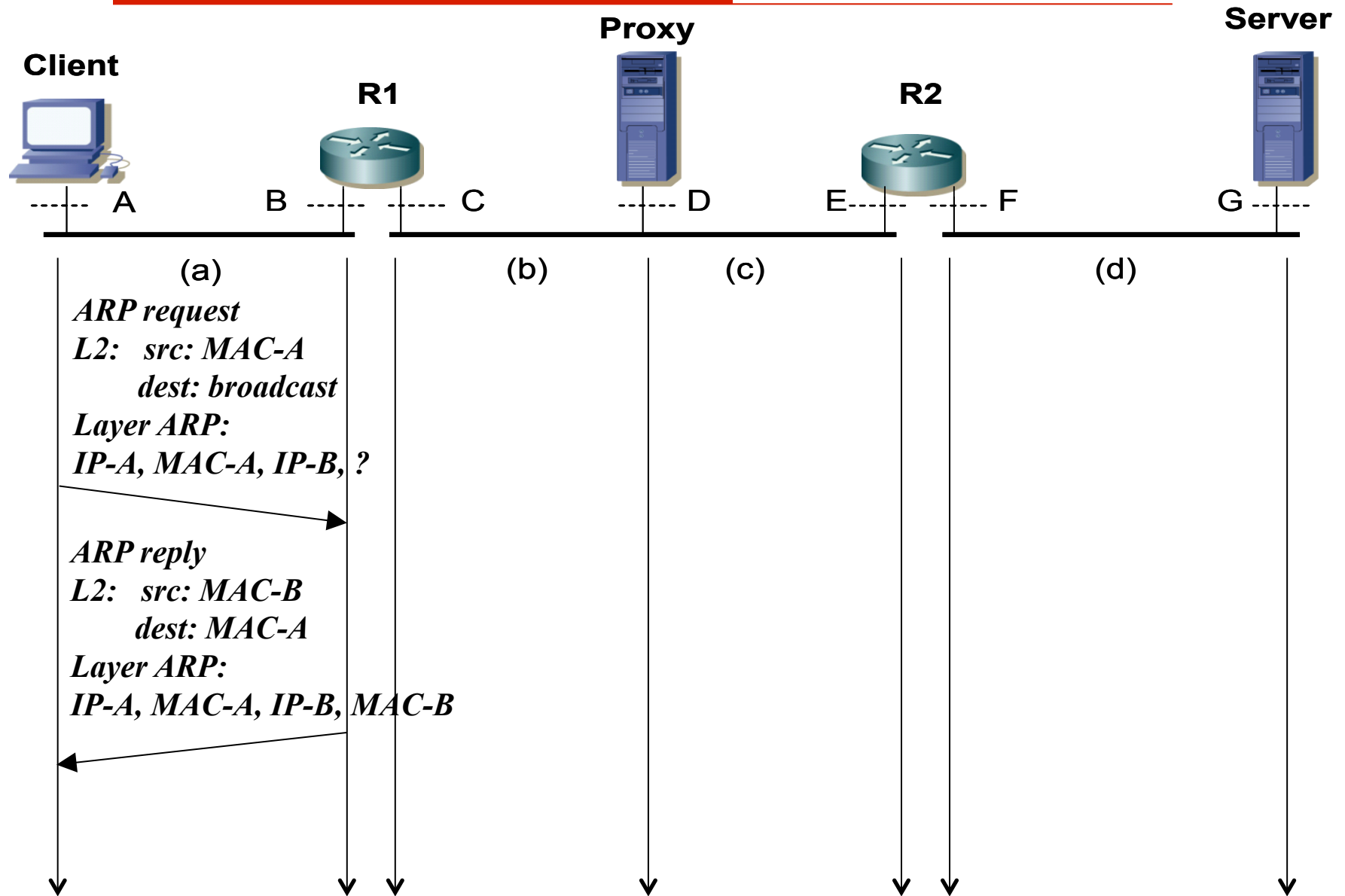


Exercise 3

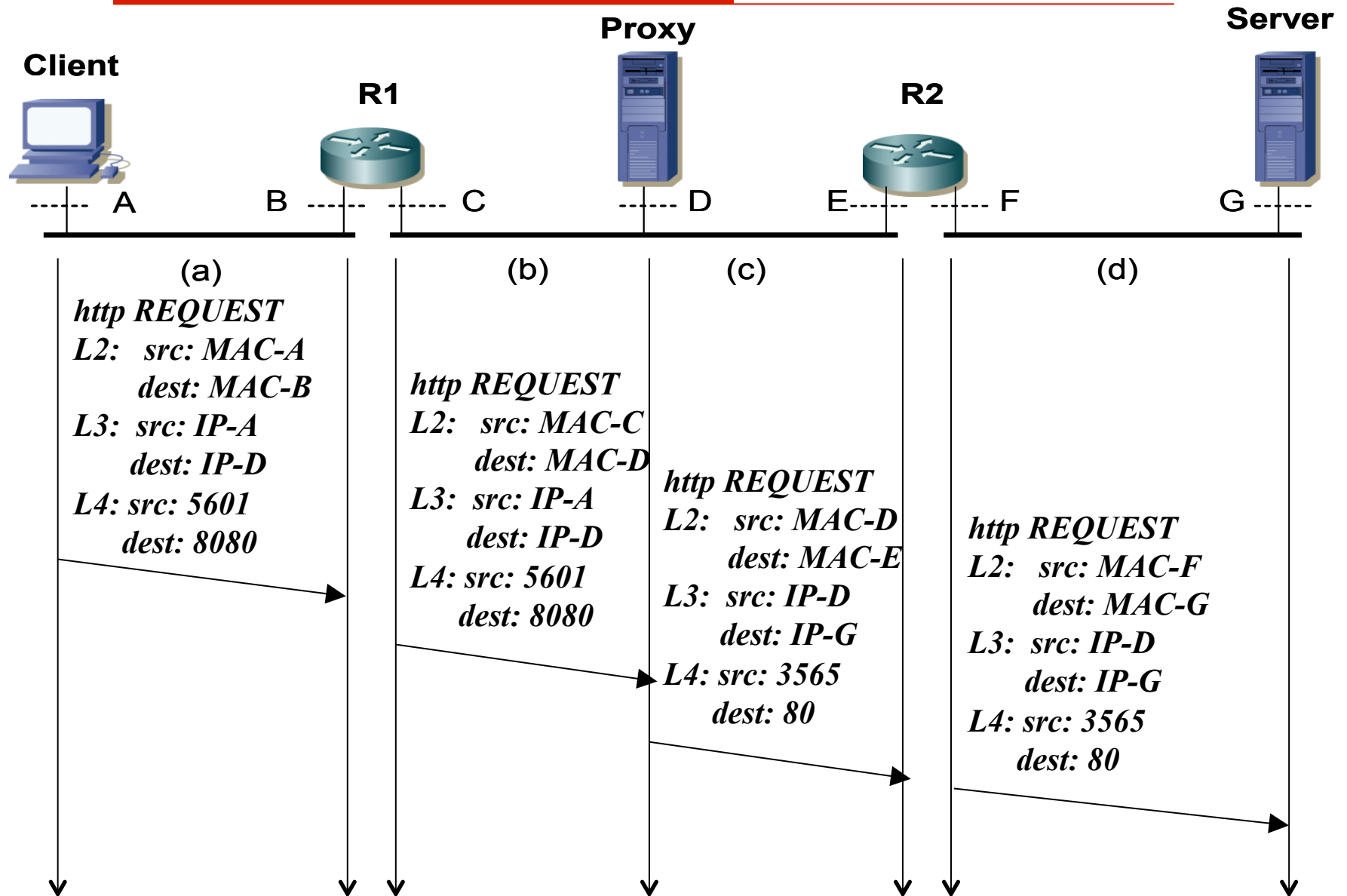
- Consider the network in the figure where interfaces are indicated with capital letters and MAC-x and IP-x, $x=[A,B,C,D,E,F,G]$, are MAC and IP addresses respectively. Assume ARP table of the Client is empty while those of the others have already all mappings between MAC and IP addresses. In the Client host there is an http client active with the Proxy configured as http proxy. The Client sends a request to the Server where there is a http server active; the Server then replies back to the Client. Assume the proxy has no valid copy of the web content requested by the Client
- Indicate graphically the packets transmitted on network segments (a), (b), (c), and (d) for for each of them the addresses/ports contained in the PDUs at layers 2, 3 and 4 (use port 80 for web server and port 8080 for the proxy).



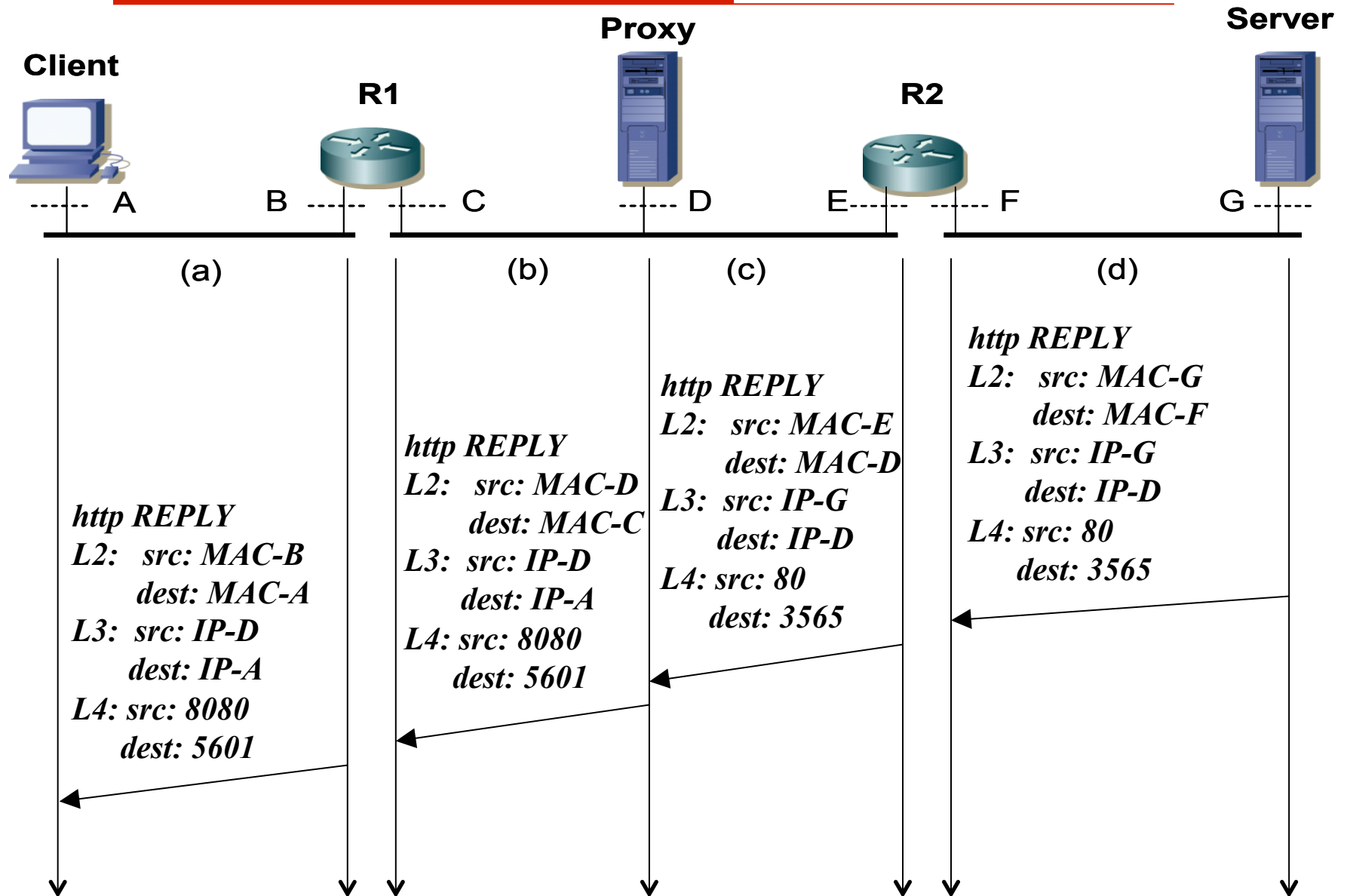
Solution 3



Solution 3



Solution 3



Exercise 4

- A router has the following routing table and interface configuration

network	netmask	first hop
131.175.21.0	255.255.255.0	131.17.123.254
131.175.16.0	255.255.255.0	131.17.78.254
131.56.0.0	255.255.0.0	131.17.15.254
131.155.0.0	255.255.0.0	131.17.15.254
0.0.0.0	0.0.0.0	131.17.123.254

interface eth0	
IP address	131.17.123.1
netmask	255.255.255.0

interface eth1	
IP address	131.17.78.1
netmask	255.255.255.0

interface eth2	
IP address	131.17.15.12
netmask	255.255.255.0

- Indicate how packets with the following destination addresses are forwarded:
 - 131.17.123.88
 - 131.56.78.4
 - 190.78.90.2

Solution 4

network	netmask	first hop
131.175.21.0	255.255.255.0	131.17.123.254
131.175.16.0	255.255.255.0	131.17.78.254
131.56.0.0	255.255.0.0	131.17.15.254
131.155.0.0	255.255.0.0	131.17.15.254
0.0.0.0	0.0.0.0	131.17.123.254

interface eth0

IP address	131.17.123.1
netmask	255.255.255.0

interface eth1

IP address	131.17.78.1
netmask	255.255.255.0

interface eth2

IP address	131.17.15.12
netmask	255.255.255.0

- ❑ 131.17.123.88
 - ❑ Direct forwarding on eth0
 - ❑ 131.56.78.4
 - ❑ Forwarded to 131.17.15.254 (route 3)
 - ❑ 190.78.90.2
 - ❑ Forwarded to 131.17.123.254 (default route)
-

Exercise 5

- A router has the following routing table and interface configuration

eth0

192.170.123.4
255.255.255.0

eth1

192.170.124.4
255.255.255.0

Network	Netmask	Next Hop
191.138.112.0	255.255.240.0	192.170.123.1
191.138.96.0	255.255.224.0	192.170.124.1
191.138.0.0	255.255.0.0	192.170.123.2
191.138.160.0	255.255.224.0	192.170.124.2
0.0.0.0	0.0.0.0	192.170.123.3

- The router receive packets with the following destinations:
 1. 191.138.163.13
 2. 191.138.113.32
 3. 131.175.123.244
 4. 255.255.255.255
 5. 192.170.123.255 from eth1
 6. 0.0.0.3 from eth0
 - Indicate for each packet how the forwarding is handled, indicating the type of forwarding (direct, indirect), the *next hop* and the line of the routing table in case of indirect forwarding, the output interface in case of direct forwarding.
-

Solution 5

191.138.163.13 AND

1. /20 = 191.138.160.0

2. /19 = 191.138.160.0

3. /16 = 191.138.0.0 — OK

4. /19 = 191.138.160.0 — OK

5. /0 = 0.0.0.0

	Network	Netmask	Next Hop
1	191.138.112.0	255.255.240.0	192.170.123.1
2	191.138.96.0	255.255.224.0	192.170.124.1
3	191.138.0.0	255.255.0.0	192.170.123.2
4	191.138.160.0	255.255.224.0	192.170.124.2
5	0.0.0.0	0.0.0.0	192.170.123.3

Indirect forwarding to
192.170.124.2

Solution 5

191.138.113.32 AND

1. /20 = 191.138.112.0

2. /19 = 191.138.96.0

3. /16 = 191.138.0.0

4. /19 = 191.138.112.0

5. /0 = 0.0.0.0

	Network	Netmask	Next Hop
OK 1	191.138.112.0	255.255.240.0	192.170.123.1
OK 2	191.138.96.0	255.255.224.0	192.170.124.1
OK 3	191.138.0.0	255.255.0.0	192.170.123.2
OK 4	191.138.160.0	255.255.224.0	192.170.124.2
OK 5	0.0.0.0	0.0.0.0	192.170.123.3

Indirect forwarding to
192.170.123.1

Solution 5

131.175.123.244 AND

1. /20 No match

2. /19 No match

3. /16 No match

4. /19 No match

5. /0 = 0.0.0.0

OK

	Network	Netmask	Next Hop
1	191.138.112.0	255.255.240.0	192.170.123.1
2	191.138.96.0	255.255.224.0	192.170.124.1
3	191.138.0.0	255.255.0.0	192.170.123.2
4	191.138.160.0	255.255.224.0	192.170.124.2
5	0.0.0.0	0.0.0.0	192.170.123.3

Indirect forwarding to
192.170.123.3

Solution 5

□ eth0
192.170.123.4
255.255.255.0

□ eth1
192.170.124.4
255.255.255.0

	Network	Netmask	Next Hop
1	191.138.112.0	255.255.240.0	192.170.123.1
2	191.138.96.0	255.255.224.0	192.170.124.1
3	191.138.0.0	255.255.0.0	192.170.123.2
4	191.138.160.0	255.255.224.0	192.170.124.2
5	0.0.0.0	0.0.0.0	192.170.123.3

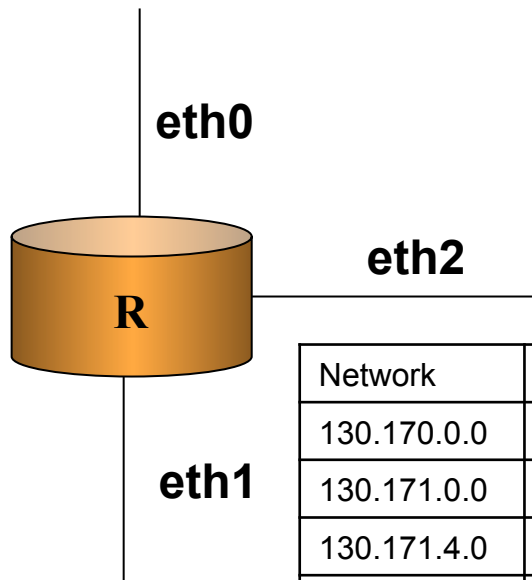
□ 255.255.255.255
■ Limited broadcast, packet is discarded

□ 192.170.123.255 from eth1
■ Direct forwarding on net 192.170.123.0 through eth0

□ 0.0.0.3 from eth0
■ Limited unicast, packet is discarded

Exercise 6

- ❑ A router has the following routing table and interface configuration
- ❑ If router received 8 packets with destination addresses indicated below
- ❑ Indicate for each packet how the forwarding is handled, indicating the type of forwarding (direct, indirect), the *next hop* and the line of the routing table in case of indirect forwarding, the output interface in case of direct forwarding.



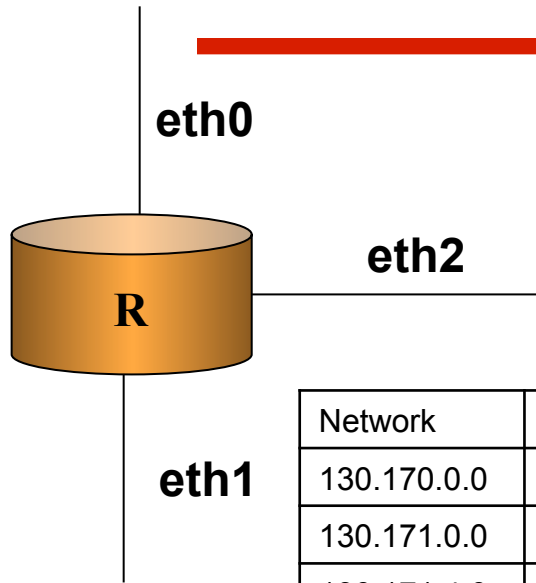
Interface	IP Address	Netmask
Eth0	131.175.123.235	255.255.255.0
Eth1	131.175.123.129	255.255.255.128
Eth2	131.175.122.0	255.255.255.0

Network	Netmask	Next Hop
130.170.0.0	255.255.0.0	131.175.123.1
130.171.0.0	255.255.0.0	131.175.123.132
130.171.4.0	255.255.252.0	131.175.122.2
130.170.10.0	255.255.254.0	131.175.122.3
0.0.0.0	0.0.0.0	131.175.123.3

RECEIVED PACKETS

- A. 131.175.123.64 from eth2
- B. 131.175.123.255 from eth0
- C. 131.175.123.132 from eth2
- D. 130.170.132.240 from eth1
- E. 130.170.11.64 from eth1
- F. 130.171.5.125 from eth1
- G. 156.198.34.14 from eth0
- H. 0.0.0.132 from eth1

Solution 6

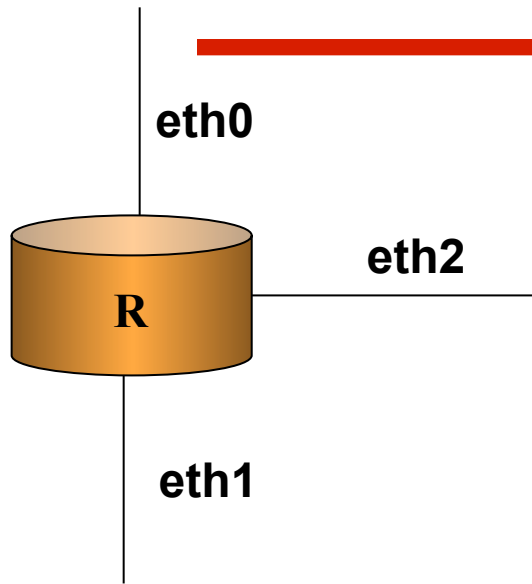


Interface	IP Address	Netmask
Eth0	131.175.123.235	255.255.255.0
Eth1	131.175.123.129	255.255.255.128
Eth2	131.175.122.0	255.255.255.0

Network	Netmask	Next Hop
130.170.0.0	255.255.0.0	131.175.123.1
130.171.0.0	255.255.0.0	131.175.123.132
130.171.4.0	255.255.252.0	131.175.122.2
130.170.10.0	255.255.254.0	131.175.122.3
0.0.0.0	0.0.0.0	131.175.123.3

- A. 131.175.123.64 from eth2
direct forwarding through eth0
 - B. 131.175.123.255
scartato perchè broadcast di eth0
 - C. 131.175.123.132
direct forwarding through eth1
-

Solution 6

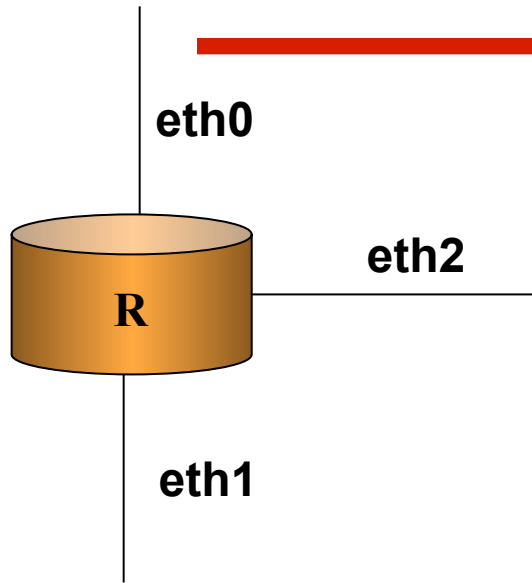


Interface	IP Address	Netmask
Eth0	131.175.123.235	255.255.255.0
Eth1	131.175.123.129	255.255.255.128
Eth2	131.175.122.0	255.255.255.0

Network	Netmask	Next Hop
130.170.0.0	255.255.0.0	131.175.123.1
130.171.0.0	255.255.0.0	131.175.123.132
130.171.4.0	255.255.252.0	131.175.122.2
130.170.10.0	255.255.254.0	131.175.122.3
0.0.0.0	0.0.0.0	131.175.123.3

- D.** 130.170.132.240 from eth1
Indirect forwarding, first line routing table,
NH: 131.175.123.1
 - E.** 130.170.11.64 from eth1
Indirect forwarding, fourth line routing table,
NH: 131.175.122.3
 - F.** 130.171.5.125 from eth1
Indirect forwarding, third line routing table,
NH: 131.175.122.2
-

Solution 6



Interface	IP Address	Netmask
Eth0	131.175.123.235	255.255.255.0
Eth1	131.175.123.129	255.255.255.128
Eth2	131.175.122.0	255.255.255.0

Network	Netmask	Next Hop
130.170.0.0	255.255.0.0	131.175.123.1
130.171.0.0	255.255.0.0	131.175.123.132
130.171.4.0	255.255.252.0	131.175.122.2
130.170.10.0	255.255.254.0	131.175.122.3
0.0.0.0	0.0.0.0	131.175.123.3

- G.** 156.198.34.14 from eth0
Indirect forwarding, last line routing table,
NH: 131.175.123.3
 - H.** 0.0.0.132 from eth1
limited unicast, packet is discarded
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