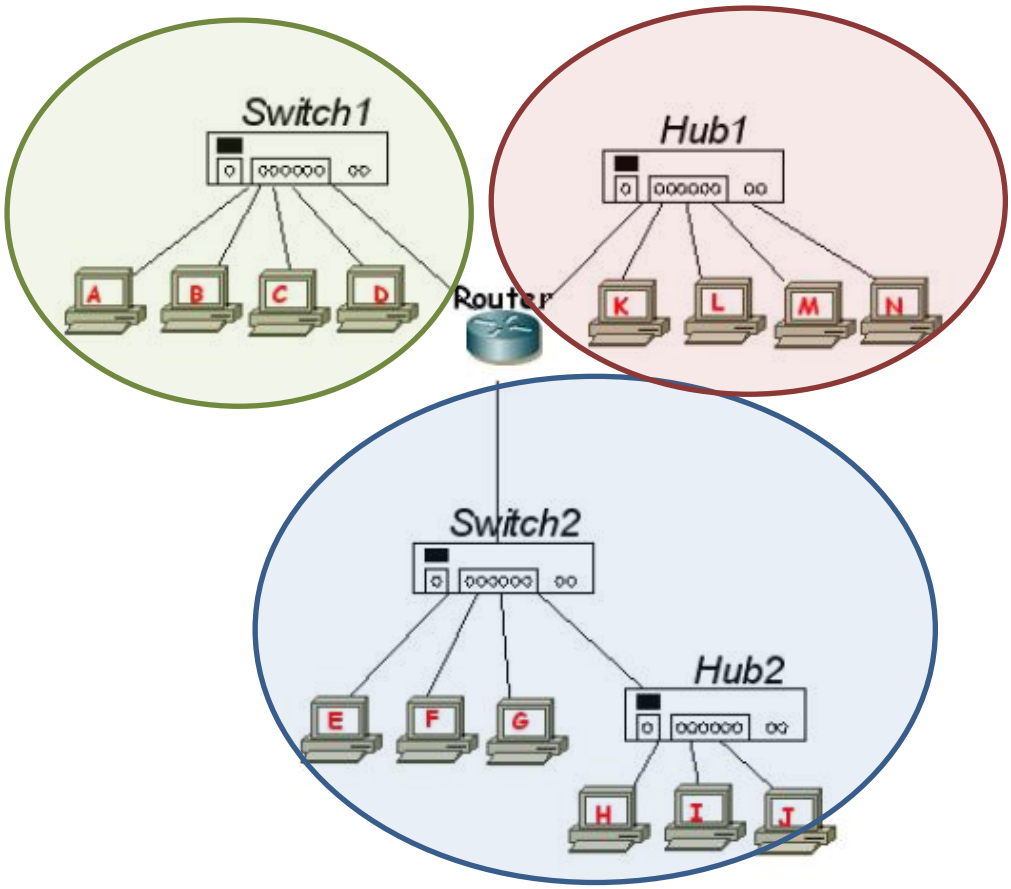
1. Given the topology shown in the figure:



All network adapters used are Ethernet based. We assume that the router is properly configured and working; we also suppose that the switches know the location of all machines.
Answer the following questions:

a) How many broadcast domains are there? Show them on the figure.
Solution: 3, one for each port of the router.

b) If J performs a broadcast, which hosts will receive a copy of the frame?
Solution: E, F, G, H, I

c) If K sends a datagram to J, which network card will receive a copy of the frame containing the datagram?

Solution: L, M, N, H, I, and J will receive a copy of the frame. However, none of them will pass the information to a higher level, except J that will pass it.

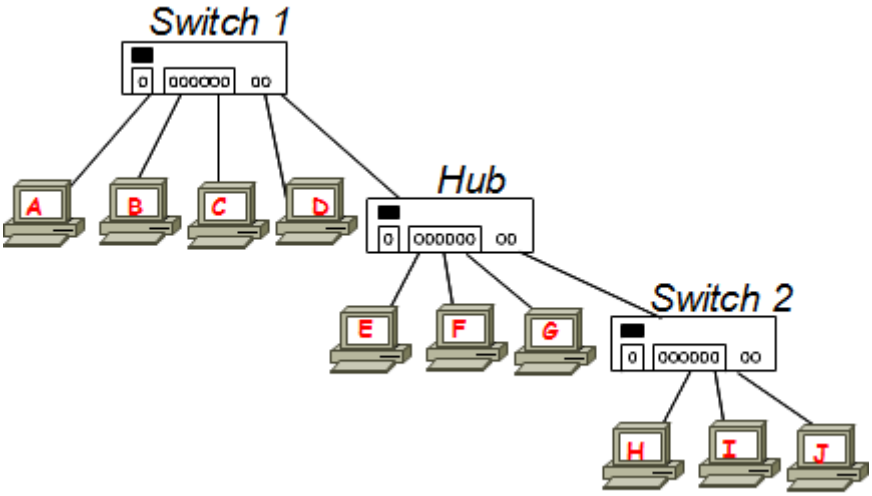
d) The computer E starts sending frames to H. Moments later J initiates sending to I; is there a possibility for a collision to occur? Explain why.

Solution: Yes, because switch2 and J are connected to a hub, and therefore both are in the same collision domain.

e) Is it possible to have simultaneously a transfer from A to B, one from C to J and another from E to F? Explain why.

Solution: Yes, A, B, and C are connected to the same switch, however because switches separate collision domains there is no problem between these simultaneous transmissions. The same happen with the transmission between E and F.

2. Given the topology shown in the figure:



All network adapters used are Ethernet based. We assume the switches know the location of all machines.

a) If A performs a broadcast, which hosts will receive a copy of the frame?

Solution: All the station will receive a copy of the frame

b) If A sends a datagram to J, which network card will receive a copy of the frame containing the datagram?

Solution: E, F, G, and J, although only J will pass a copy of the frame to the higher level

c) The computer B starts sending frames to E. Moments later G initiates sending to H; is there a possibility for a collision to occur? Explain why.
Solution: Yes, because switch1 and G are connected to a hub, which does not separate collision domains.

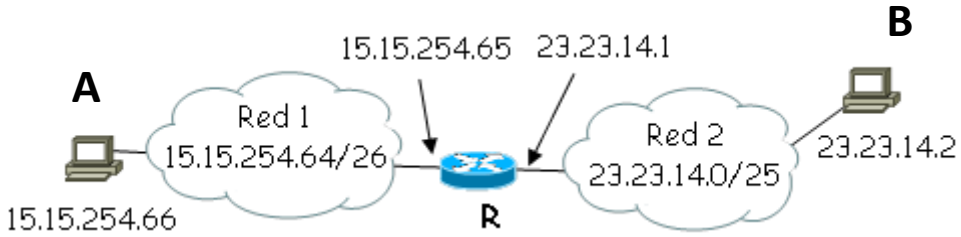
d) The computer B starts sending frames to E. Moments later C initiates sending to J; is there a possibility for a collision to occur? Explain why.

Solution: No, because B and C are connected to a switch, which separates collision domains. In our case, switch1 will transmit to the hub first the frame from B, and then the frame from C.

e) Is it possible to have simultaneously a transfer from A to B, one from D to G and another from I to J? Explain why.

Solution: Yes, A, B, and D are connected to the same switch, however because switches separate collision domains there is no problem among these simultaneous transmissions. The same happen with the transmission between I and J.

3. Consider the configuration in the following Figure:



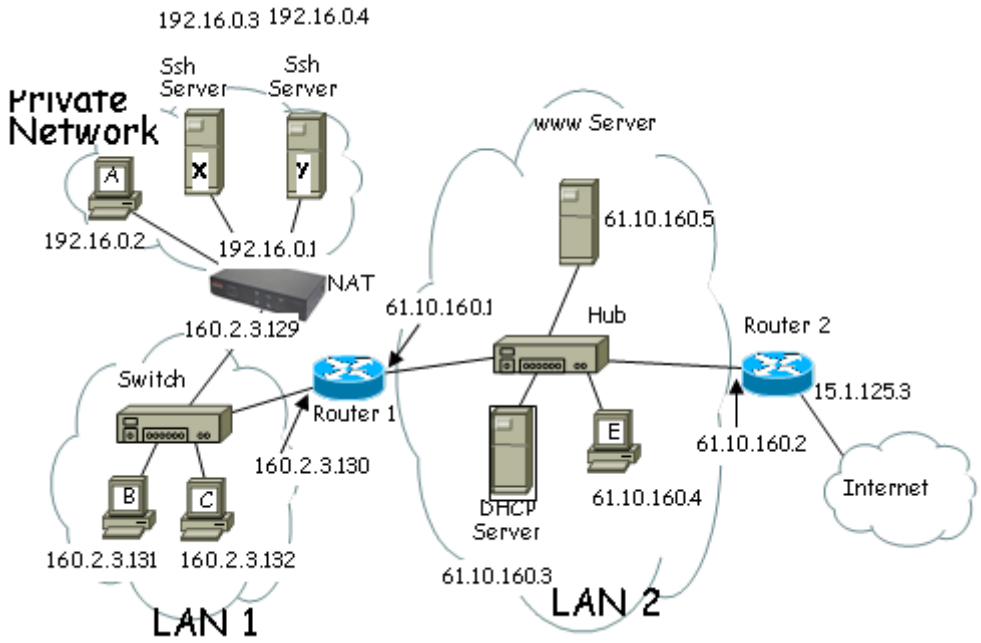
a) In the table below, write the header fields of each frame generated in LAN 1 and 2 when **A** sends a IP datagram to **B**. **A** only knows **B** IP address (but not **B** MAC address). All ARP caches are empty.

MAC Header			IP Header		
Source MAC address	Destination MAC address	Protocol	Source IP address	Destination IP address	Packet function
A	Broadcast	ARP			ARP request to obtain the MAC address of the router
R_1	A	ARP			ARP reply
A	R_1	IP	15.15.154.66	23.23.14.2	A sends the IP datagram to the router
R_1	Broadcast	ARP			ARP request to obtain the MAC address of B
B	R_1	ARP			ARP reply
R_1	B	IP	15.15.154.66	23.23.14.2	Router forwards the IP datagram to B

b) If LAN 1 uses private IP addresses (10.0.0.0/26) and the router R is a NAT router, write the header fields of each frame generated in LAN 1 and 2 when **A** sends a IP datagram to **B**. **A** only knows **B** IP address (but not **B** MAC address). All ARP caches are empty. The new address of A is 10.0.0.1

MAC Header			IP Header		
Source MAC address	Destination MAC address	Protocol	Source IP address	Destination IP address	Packet function
A	Broadcast	ARP			ARP request to obtain the MAC address of the router
R_1	A	ARP			ARP reply
A	R_1	IP	10.0.0.1	23.23.14.2	A sends the IP datagram to the router. A uses its private IP address. When the router receives this IP datagram, it should change this private IP address by its public IP address
R_1	Broadcast	ARP			ARP request to obtain the MAC address of B
B	R_1	ARP			ARP reply
R_1	B	IP	23.23.14.1	23.23.14.2	Router forwards the IP datagram to B. Notice that the source IP address is the public IP address of the router NAT

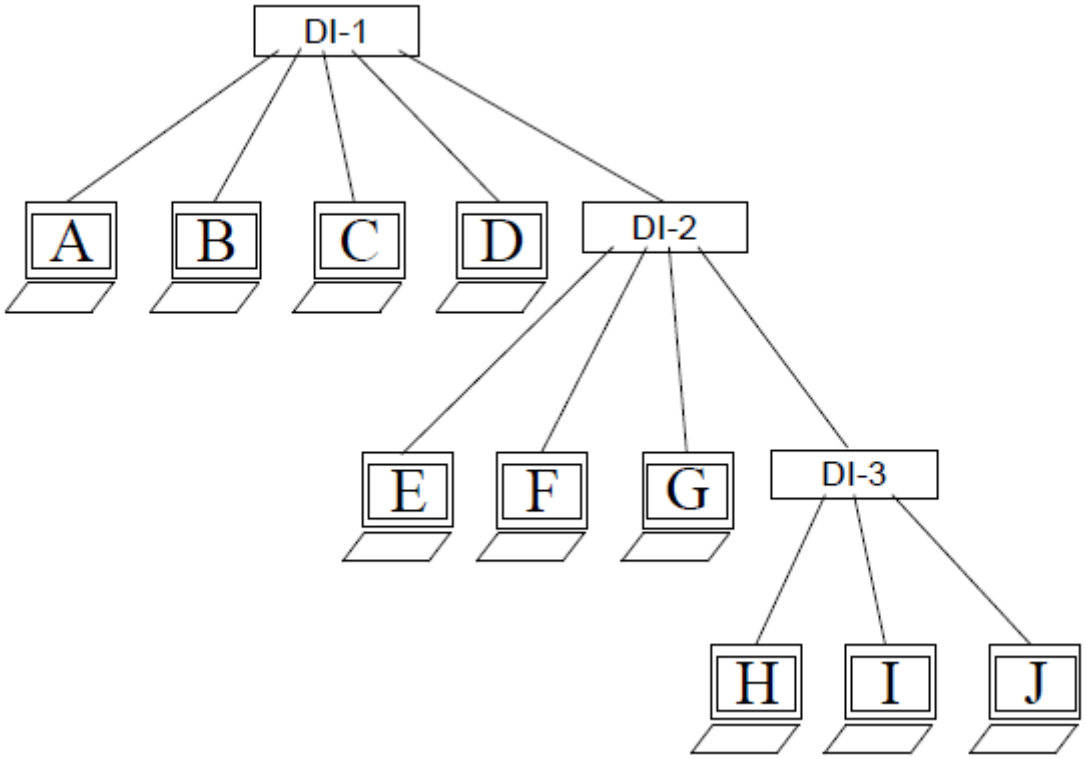
4. Consider the configuration in the following Figure:



a) Computer **A** want to establish a TCP connection with the **Web Server**. In the table below, write the header fields of each frame that the network interface of computer E receives as consequence of this process till **Web Server** receives the TCP connection sent by **A**. **A** only knows **Web Server** IP address (but not **Web Server** MAC address). All ARP caches are empty.

MAC Header			Related IP addresses		
Source MAC address	Destination MAC address	Protocol	Source IP address	Destination IP address	Packet function
R_{12}	FF:FF:FF:FF:FF:FF (Broadcast)	ARP	61.10.160.1	61.10.160.5	ARP request to obtain the MAC address of the Web server
WWW	R_{12}	ARP	61.10.160.5	61.10.160.1	ARP reply
R_{12}	WWW	IP	160.2.3.129	61.10.160.5	IP Datagram containing the request of the TCP connection

5. In the following diagram, DI-1, DI-2, and DI-3 are interconnection devices (Router, Switch, and/or Hub). Indicates which interconnection device isD1-1, DI-2, and DI-3 in each of the following cases:



a) If A sends a frame to J, E, F, G and J will receive a copy of the frame

Solution:
DI-1 and DI-3 are switches and DI-2 is a hub.
Justification:

If A sends a frame and B, C, and D does not receive it, DI-1 should be a switch (or a Router, both, switch and router, separate collision domain). If E, F, and G receive the frame is because DI-2 is a Hub. If H, and I does not receive the frame is because DI-3 is a switch (or a router).

b) If A performs a broadcast, B, C,D, and DI-2 will receive a copy of the frame. Moments later, H sends a frame to A, and only A receives the frame

Solution:
DI-2 is a router, and DI-1 and DI-3 are switches.
Justification:

If A performs a broadcast, only the nodes connected to the same LAN than A will receive it. So, if B, C, D, and DI-2 receive the broadcast is because

DI-2 is a router. Routers separate broadcast domains. If moments later, H sends a frame to A and only A receive it, DI-1 and DI-3 are switches (DI-3 can be also a router)

c) B starts sending a frame to I, at the same time, J starts sending a frame to B, in such a way that B is sending and receiving simultaneously. Both, I and B receive a copy of the original frame without collisions.

Solution:
DI-1, DI-2, and DI-3 are switches (also they can be routers).
Justification:
DI-1, DI-2, and DI-3 should be a device able to separate collision domains, because during the transmission does not happen any collision. Also, we can say that DI-1 works in a full duplex mode, because it is able to send and receive simultaneously.

d) There is a transfer from A to B, and simultaneously one from D to G, and another from I to J. A collision occurs, and is received by hosts: E,F,G,H,I, and J.

Solution:
DI-1 is a switch (or a router) and, DI-2 and DI-3 are hubs
Justification:
The nodes affected by the collision are E, F, G (connected to DI-2) and H, I, J (connected to DI-3), so DI-2 and DI-3 are hubs (hubs do not separate collision domains). However, the nodes connected to DI-1 are not affected by the collision, this implies that DI-1 is a switch (or router) able to separate collision domains.