Exercise on ARP

Question 1:

Consider the network shown above. Assume ARP caches at the hosts and routers are empty initially, and that routing data tables are already set up in the hosts and the routers. Also assume that each host knows the IP addresses of all other hosts.

Three events occur in the following sequence:
A. Host I sends an IP datagram to host II,
B. Host II sends an IP datagram to host III, and
C. Host III sends an IP datagram to host I.

Answer the following questions for each of the above three events:

1. State your assumption on how the datagram is routed (i.e., through what networks).
2. Is an ARP request issued? What is the IP address being resolved in the ARP request? What is the resolved MAC address? Who sends the ARP request and who sends the ARP reply?
3. For each network on the end-to-end path between the hosts, what is the destination IP address and source IP address in the packet header? What are destination and source MAC addresses (if applicable)?

Note that IP subnet addresses are three byte numbers such as 131.12.16, and the host IDs are indicated on each interface, such as .3 for host I. Thus, for example, the IP address of Host I’s interface is 131.12.16.3. The Ethernet MAC addresses are also shown next to each interface.

Case (A):

1. State your assumption on how the datagram is routed (i.e., through what networks).

   The IP datagram is sent from host I to the router and then on the PPP link to host II.

2. Is an ARP request issued? What is the IP address being resolved in the ARP request? What is the resolved MAC address? Who sends the ARP request and who sends the ARP reply?

   On the Ethernet 131.12.16: The IP address being resolved is 13.12.16.50; The resolved MAC address is 0:0:6:ef:3d. Host I sends the ARP request and the router sends the ARP reply. The router does a proxy reply for host II since the latter is on a PPP link, which means it has no MAC address.

3. For each network on the end-to-end path between the hosts, what is the destination IP address and source IP address in the packet header? What are destination and source MAC addresses (if applicable)?

   The destination IP address is 131.12.16.50 and source IP address is 131.12.16.3 on both
the Ethernet and the PPP link.

On the 131.12.16 Ethernet: the destination MAC address is 0:0:6:f:ef:3d and the source MAC address is 1:2:1:5:6e:7d. The frame sent on the PPP link has no MAC addresses since it is a PPP frame (Point-to-point implies it is not a shared LAN and hence there is no need for MAC addresses).

Case B:

1. State your assumption on how the datagram is routed (i.e., through what networks).
   The datagram is sent on the PPP link to the router and then on the Ethernet to host III.

2. Is an ARP request issued? What is the IP address being resolved in the ARP request? What is the resolved MAC address? Who sends the ARP request and who sends the ARP reply?
   On the Ethernet 140.160.91: The IP address being resolved is 140.160.91.4; The resolved MAC address is 0:1:6:5:32:4f. The router sends this ARP request and host III sends the ARP reply. There is no ARP on the PPP link since it is not a shared network.

3. For each network on the end-to-end path between the hosts, what is the destination IP address and source IP address in the packet header? What are destination and source MAC addresses (if applicable)?
   On both the PPP link and the Ethernet, the destination IP address is 140.160.91.4 and the source IP address is 131.12.16.50.

   There are no MAC addresses in the frame sent on the PPP link. On the Ethernet, the destination MAC address is 0:1:6:5:32:4f and the source MAC address is 3:2f:5e:5f:4d:1a.

Case C:

1. State your assumption on how the datagram is routed (i.e., through what networks).
   From host III through the Ethernet to the router and then on the Ethernet to host I.

2. Is an ARP request issued? What is the IP address being resolved in the ARP request? What is the resolved MAC address? Who sends the ARP request and who sends the ARP reply?
   No ARP request is issued. This is because “normally, when a system receives an ARP request addressed to it, in addition to sending the ARP reply it also saves the requestor’s hardware address and IP address in its own ARP cache” [Stevens book]. Thus host III has the IP address 140.160.91.1 to MAC address 3:2f:6e:5f:4d:1a mapping in its ARP cache. Since the IP address of the destination host I, 131.12.16.3 indicates that this host is on a different subnet from the sending host (host III), the latter sends the datagram to the router. Hence it only looks for the ARP address of the router’s interface on subnet 140.160.91. Similarly, the router would have already stored the MAC address of host I’s interface on its Ethernet subnet because it received an ARP request in case (a).

3. For each network on the end-to-end path between the hosts, what is the destination IP address and source IP address in the packet header? What are destination and source MAC addresses (if applicable)?
   On both Ethernet LANs, the destination IP address is 131.12.16.3 and source IP address is 140.160.91.4.

   On the 140.160.91 Ethernet, the source MAC address is 0:1:6:5:32:4f and the destination MAC address is 3:2f:5e:5f:4d:1a. On the 131.12.16 Ethernet, the source MAC address is 0:0:6:f:ef:3d and the destination MAC address is 1:2:1:5:6e:7d.