CS 168 | Introduction to the Internet |
Fall 2017 | Scott Shenker | Discussion 7: DHCP and ARP

1 Multiple Choice

(1) Which protocol does a host use to learn its own IP address?

(a) DHCP
(b) DNS
(c) ARP
(d) ICMP
(e) None of these

Solution: (a) DHCP

(2) Which protocol does a host use to learn its own MAC address?

(a) DHCP
(b) DNS
(c) ARP
(d) ICMP
(e) None of these

Solution: (e) None of these

(3) Which protocol does a host use to learn the MAC address of another host on the same network?

(a) DHCP
(b) DNS
(c) ARP
(d) ICMP
(e) None of these

Solution: (c) ARP

(4) DHCP is a protocol in which of the following layers?

(a) Physical
(b) Datalink
(c) Network
(d) Transport
(e) Application

Solution: (e) Application

(5) ARP is a protocol in which of the following layers?

(a) Physical
(b) Datalink
(c) Network
(d) Transport
(e) Application

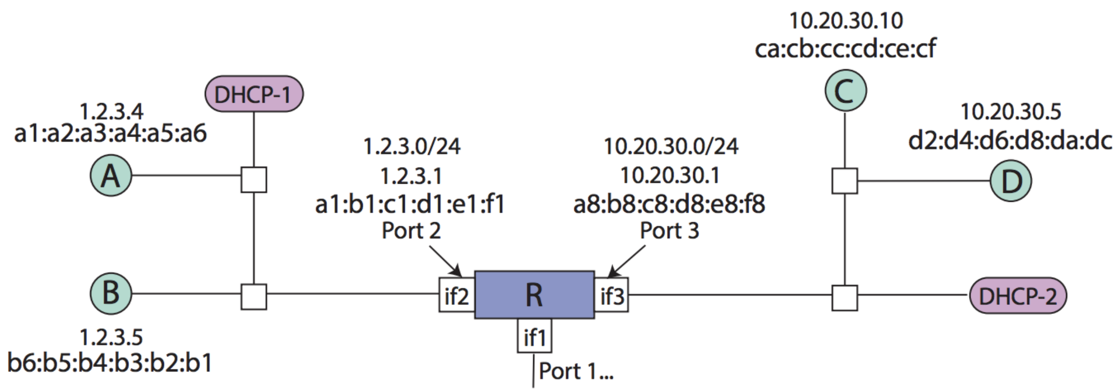
Solution: (b) Datalink

(6) Which of the following can a host learn with DHCP? Select all that apply.

(a) Its own MAC address.
(b) Its own IP address.
(c) The MAC address of another host.
(d) The IP address of another host.
(e) The IP address of its first-hop router.
(f) The MAC address of its first-hop router.
(g) Its own subnet mask.

Solution: (b) It's own IP address, (e) The IP address of its first-hop router, and (g) Its own subnet mask.

2 Host-to-Host



Consider the above topology. Here, two networks are connected through router *R*. *R* has three interfaces, each associated with a port, MAC address, IP address, and subnet.

We are going to consider what happens when *A* sends a packet to *C*. Assume that *A* just attached to the network, but already knows the IP address of *C* (10.20.30.10). No hosts or routers have sent any previous ARP requests.

(1) First *A* needs to learn its own IP address, subnet mask, and the IP of its first-hop router by using DHCP. For each of the following DHCP messages, indicate the messages timing in the packet exchange (1 is first, 4 is last), who sends the message, and whether the message is broadcast or unicast.

Message	Order	Sender	Message Type
DHCP request	3	Client	Broadcast
DHCP ACK	4	Server	Broadcast
DHCP discovery	1	Client	Broadcast
DHCP offer	2	Server	Broadcast

(2) Using this information, how does *A* determine if *C* is on the same subnet?

Solution: *A* uses its IP address, its subnet mask, and *C*'s IP address. If computing the bitwise AND between *A*'s IP and the subnet mask and computing the bitwise AND between *C*'s IP and the subnet mask yields the same result, then *A* and *C* are on the same subnet. If this is true, then *C* is on the same subnet as *A*. In this example, we have:

$$\begin{aligned} A\text{'s subnet}: &\ \underline{11111111\ 11111111\ 11111111}\ 00000000 \\ A\text{'s IP}: &\ \underline{00000001\ 00000010\ 00000011}\ 00000100 \\ C\text{'s IP}: &\ \underline{00001010\ 00010100\ 00011110}\ 00001010 \end{aligned}$$

The underscored portions are the network addresses, and since they are not equal, A and C are on different subnets.

(3) Given that C is not on the same subnet as A, A must send the packet to its first hop router R. Which requests and responses are exchanged before this can happen?

Request	Response
ARP request for 1.2.3.4	ARP response: 1.2.3.4
ARP request for 1.2.3.1	ARP response: 1.2.3.1
ARP request for 10.20.30.10	ARP response: 10.20.30.10
ARP request for a1:a2:a3:a4:a5:a6	ARP response: a1:a2:a3:a4:a5:a6
ARP request for a1:b1:c1:d1:e1:f1	ARP response: a1:b1:c1:d1:e1:f1
ARP request for ca:cb:cc:cd:ce:cf	ARP response: ca:cb:cc:cd:ce:cf

(4) Is the ARP request broadcast or unicast? What about the ARP response?

Solution: The ARP **request** is broadcast. After all, were trying to learn the MAC address, so we would have no idea, which address to use for unicast. The ARP **response** is unicast. By looking at the source MAC address in the ARP request, the responder can tell which address to unicast the response to.

(5) In the packet A now sends to R, what are the source and destination IP and MAC addresses?

Source IP: 1.2.3.4 (A's IP)

Source MAC: a1:a2:a3:a4:a5:a6 (A's MAC)

Destination IP: 10.20.30.10 (C's IP)

Destination MAC: a1:b1:c1:d1:e1:f1 (MAC of if2)

(6) How does R know which interface to forward A's packet on?

Solution: R looks in its routing table for a prefix that matches 10.20.30.10. Assuming that the routing state has converged, R's forwarding table maps packets destined for 10.20.30.0/24 to port 3.

(7) Now R has the packet. List all remaining packets that are exchanged until C receives the packet from A.

Solution:
R sends an ARP request for 10.20.30.10.
R receives an ARP response from C containing ca:cb:cc:cd:ce:cf.
R sends the packet to C.

(8) What are the source and destination IP and MAC addresses for the packet that R sends to C?

Source IP: 1.2.3.4 (A's IP)

Source MAC: a8:b8:c8:d8:e8:f8 (MAC of if3 on R)

Destination IP: 10.20.30.10 (C's IP)

Destination MAC: ca:cb:cc:cd:ce:cf (*C*'s MAC)