Lab 4 Address Resolution Protocol

1. Physical address and logical address

Please refer to the Textbook and corresponding lecture slides for the details of Physical address (MAC address) and Logical address (IP address).

2. ARP protocol introduction

Please refer to the Textbook and corresponding lecture slides for the details of ARP protocol.

3. ARP datagram format

Figure 2-1 shows the ARP datagram format:

<table>
<tr><td colspan="2">Hardware type (16 bits)</td><td>Protocol type (16bits)</td></tr>
<tr><td>Hardware address length (8 bits)</td><td>Protocol address length (8 bits)</td><td>Operation code (16 bits)</td></tr>
<tr><td colspan="3">Sender protocol address (e.g., 6 bytes for Ethernet)</td></tr>
<tr><td colspan="3">Sender logical address (e.g., 4 bytes for IP)</td></tr>
<tr><td colspan="3">Target hardware address (e.g., 6 bytes for Ethernet) (ignored in the request frame)</td></tr>
<tr><td colspan="3">Target logical address (e.g., 4 bytes for IP)</td></tr>
</table>

Figure 2-1

Some fields of ARP datagram format:

(1) **Hardware type**: 16 bits, specifies the type of networks running ARP. Each LAN based on their types is assigned to an integer. e.g., Ethernet hardware type is 1. ARP is available on any networks.

(2) **Protocol type**: 16 bits, specifies the protocol type. e.g., the value of this field for IPv4 is 0x0800. The permitted values share a numbering space with those for EtherType. ARP is available in any upper layer protocol.

(3) **Hardware address length**: 8 bits, length of hardware address using byte as unit. e.g., Ethernet address size is 6 bytes, so the mapped hardware address length is 6.

(4) **Protocol address length**: 8 bits, length of packet logical address using byte as unit. e.g., IPv4 size is 4 bytes, so the mapped protocol address length is 4.

(5) **Operation code**: 16 bits, specifies the operation that the sender is performing: **1 for request, 2 for reply**.

(6) **Sender hardware address**: MAC address of the sender.

(7) **Sender protocol address**: logical address of the sender, e.g., 4 bytes for IP address.

(8) **Target hardware address**: MAC address of the intended receiver. Its value is 0 in ARP request if the target MAC address is unknown for the sender.

(9) **Target protocol address**: specifies the target logical address.

4. ARP encapsulation

ARP datagram can be directly encapsulated in the data link frames. The value of Type filed, 0x0806, specifies the frame carries an ARP packet.

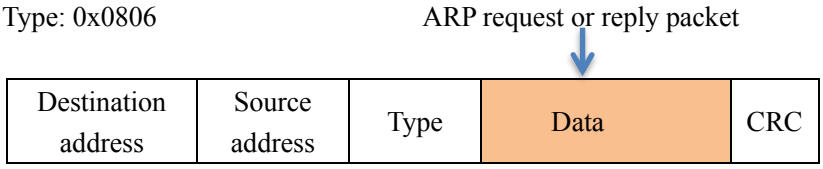

Figure 2-2 4. ARP encapsulation

5. ARP operational process

Steps of packet transmitting process:

(1) The sender obtains the receiver's IP address

(2) Sender creates an ARP request which contains the sender's MAC address, the sender's IP address and the receiver's IP address. The receiver's MAC address is filled with 0.

(3) Pass the packet to data link layer and encapsulate it within an Ethernet frame, using sender's MAC address as source address and physical broadcast address as destination address.

(4) Because the frame contains a broadcast address, each host and router in the current network will receive it. The ARP request will be processed by ARP protocols on each host. Then, all hosts, except the destination, will discard the request.

(5) The destination host responses with an ARP reply packet, which contains its MAC address and unicast it back to the sender.

(6) The sender receives the ARP reply packet and gets the destination host MAC address.

Please refer to the Textbook and corresponding lecture slides for more details of ARP conversation.

6. High speed ARP cache

In protocol realization, it's unneccessary to send ARP request packet everytime. Each host maintains a high speed ARP cache, which is the mapping between IP and MAC address.

IP address	MAC address
202.98.13.1	00-E0-4C-3D-89-76
202.98.13.2	00-E0-4C-3D-C5-03
202.98.13.3	00-E0-4C-4D-BA-92
.....	.....

Figure 2-4 ARP high speed cache

When sending a packet, a host will check its ARP cache table to find whether the

destination MAC address exists. If so, use it as the destination MAC. Otherwise, the host sends an ARP request to get the destination MAC address and write it into the ARP cache table.

When the item of the table is not used for a period of time, it will be removed from the table.

On Windows, we can use command “arp -a" to display the whole ARP cache, and “arp -d" to empty the cache.

Figure 2-5 shows the process of using and updating process of ARP chache:

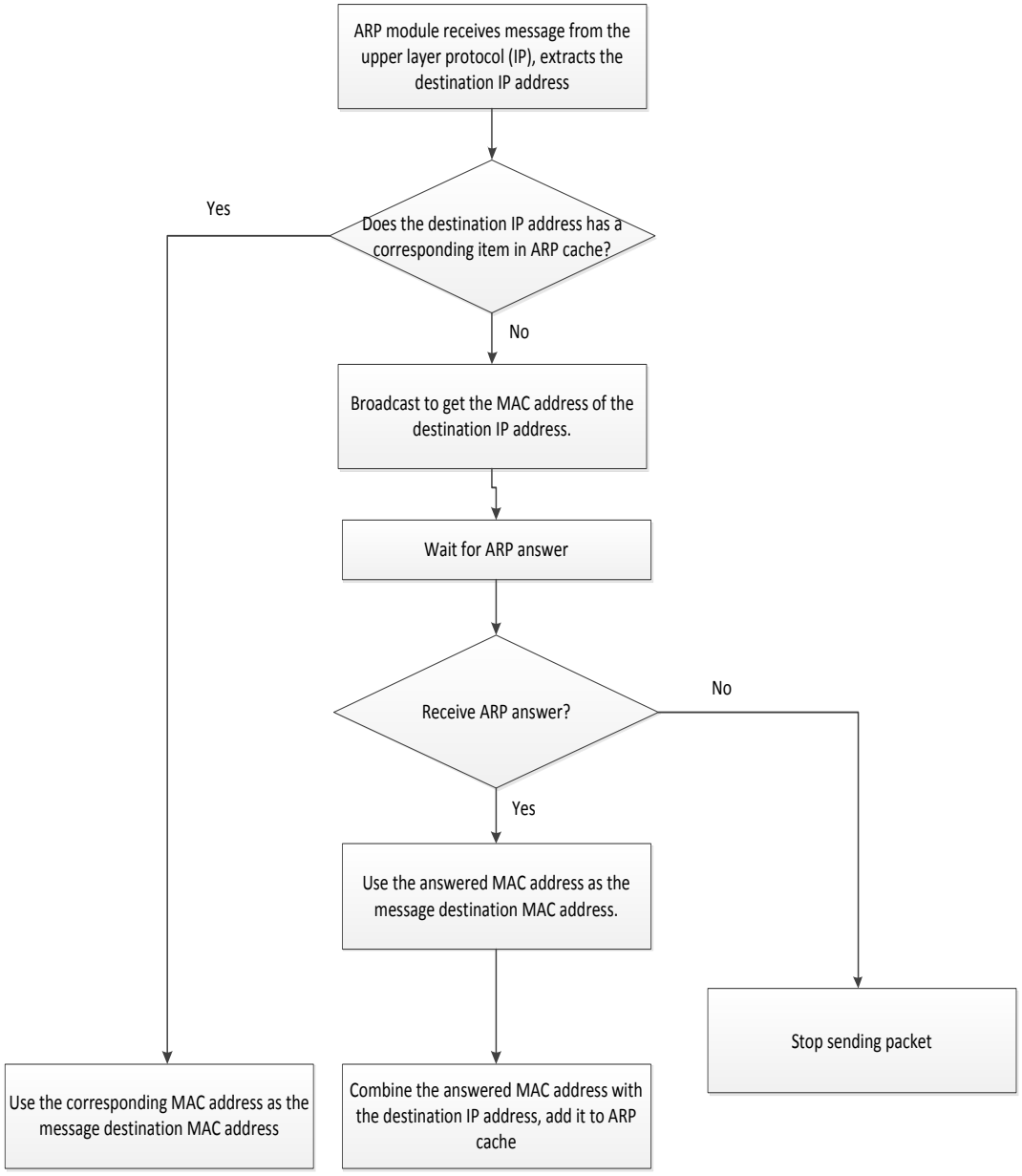

Figure 2-5 using and updating process of ARP cache

7. ARP proxy

ARP proxy can be used in subnetting. When an ARP request is sent from one network to another, the router which connect it can answer the request. This router will send the packet to the destination host or router when it receive an IP packet.

Figure 2-6 shows that ARP proxy answers the ARP request for a destination IP address 141.23.56.23.

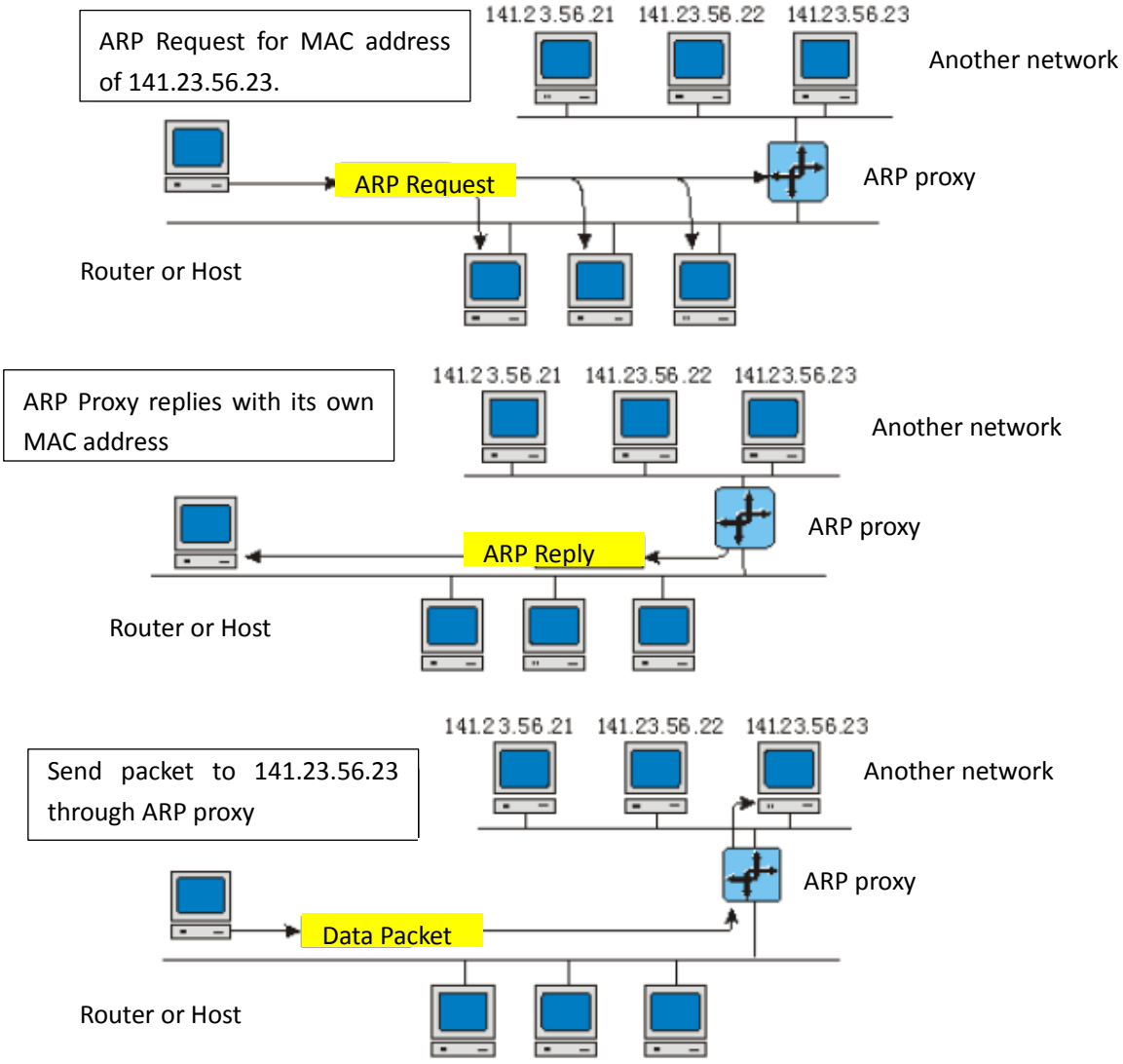

Figure 2-6 Proxy ARP