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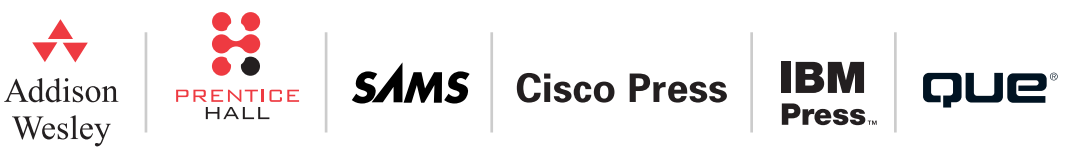


As briefly introduced in Chapter 2, "Node Addressing Schemes," proxy ARP is used in ONS GNEs to simplify ENE addressing and routing; proxy ARP may not lead to optimal routing when multiple paths are available. This chapter discusses the details of proxy ARP and how it is used in ONS. Issues related to proxy ARP and appropriate solutions are provided.

ARP Sniffing is something entirely different. Although it too is implemented in ONS to simplify addressing, it is done for ease of access in the field by technicians. This little-known feature becomes quite handy when you need to access large numbers of NEs that are in different IP subnets.

Before proxy ARP and ARP Sniffing are described in this chapter, however, a review of ARP is provided.

Address Resolution Protocol

NOTE
A MAC address is often expressed in 12 hexadecimal digits (upper- or lowercase) grouped into six or three groups and separated with a dash (-), a colon (:), or a dot (.). For example, a broadcast MAC address can be expressed as FF-FF-FF-FF-FF-FF.

Address Resolution Protocol, or ARP, is an IP tool used to map an IP address to a Layer 2 address in a broadcast network, such as a LAN. On such a network, an IP host must map its target IP address to a LAN address, or Media Access Control (MAC) address, to deliver the packets. This address is sometimes called the hardware address, because it is often burned into the MAC controller. A MAC address is a 48-bit number often expressed in hexadecimal digits. Each MAC controller should have a universally unique address.

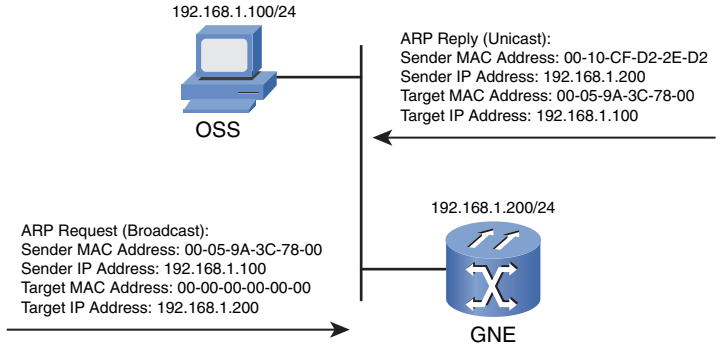
An IP host initially may or may not know its target MAC address. To dynamically learn such an address, the host uses ARP. There are two types of ARP messages: Request and Reply. If a host knows the target host's IP address but not the MAC address, it sends a Request, with the target MAC address field left blank or zeroed out. An ARP Request on an Ethernet LAN is a broadcast frame with the EtherType set to 0x0806.

Because the Request is a broadcast frame, it is received by all the hosts on the same LAN segment. When a host receives such a frame, it inspects the frame, determines that it is an ARP Request, and caches the hardware and IP address in its local ARP cache. It then compares the target IP address in the frame with its own IP address. If there is a match, the

 Please see page 154 for more details.

receiving host formulates an ARP Reply frame. This frame is a unicast frame sent to the original sender with the EtherType set to 0x0806. In the frame, the sender's hardware address is filled out. Figure 3-1 shows a sample exchange taking place between the OSS station and the GNE, where the workstation is initiating the exchange.

FIGURE 3-1
ARP message exchange



Upon receiving the ARP Reply, the original sender extracts the information and caches it in its ARP table. It can then formulate an Ethernet frame with the correct destination MAC address to deliver the IP packet.

How does a host determine that it needs to send an ARP Request? It uses its routing table and the locally configured subnet information. When a host is ready to send an IP packet with a known unicast destination IP address, it first searches its routing table using the longest match rule. If a matching entry is found, it determines whether a next-hop address is attached. No next hop is needed if the matching entry is a connected route, because the destination is on the local network. The host then checks its ARP cache to see whether there is an entry for the next-hop address or the destination (if on the same network). If not, an ARP Request is generated.

If the routing table search does not generate a specific match, the host uses the default route if one exists. The default route is the last resort route for all destinations that are not specifically listed in the routing table. The host sends an ARP Request for the default router's MAC address if the address is not already cached.

Gratuitous ARP is a special use of ARP. A gratuitous ARP is an ARP Request or Reply with both sender and target IP addresses filled out with the sender's own IP address. The target MAC address is set to the broadcast address. The gratuitous ARP is often used to update all the hosts on the same subnet with the sender's new IP address or to check for duplicate IP addresses. In many implementations, a gratuitous ARP is sent when an interface becomes active.

There is also another form of ARP: Reverse ARP (RARP). RARP uses the same concept of ARP but for the reverse of address resolution: finding a protocol (IP) address that matches a known hardware address. It is used in some networks by hosts that do not have their IP address assigned, and they need to get such mapping from a host or server that maintains this information. The EtherType for RARP is 0x8035. Note that RARP is not used by ONS.

Proxy ARP

When discussing general subnetting rules in Chapter 2, the following was mentioned:

> A subnet should be contiguous; that is, two identical subnets should not be seen in two disconnected segments because this leads to subnet fragmentation.

This is a good rule to adhere to when designing subnets. As shown in Chapter 2, breaking that rule may cause connectivity issues. However, in some cases for various reasons, subnets are indeed fragmented. To maintain the connectivity between fragments of the same subnet, a proxy ARP server (RFC 925) may be inserted.

Figure 3-2 shows an example in which proxy ARP may be used. In this example, two hosts are configured with a /24 mask with the same subnet address. The router is configured with two /25 addresses. Both interfaces of the router are enabled for proxy ARP service.

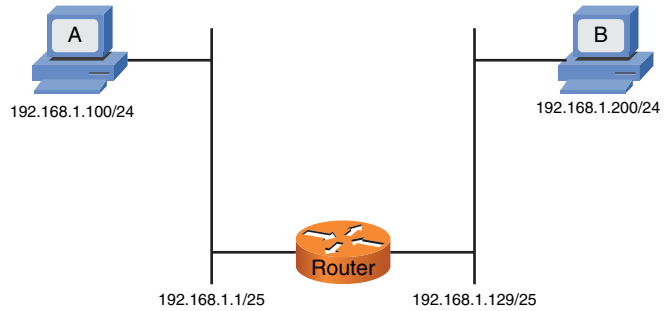


FIGURE 3-2
Simple example of proxy ARP service

The following discussion applies to Cisco routers running IOS. If host A is to send packets to host B, it needs to ARP for host B's MAC address. Because the ARP frame is a broadcast, the router drops it (from the router's point of view, host B is on a different broadcast domain), and host B never hears it. Because the router is enabled as a proxy ARP server (the default) and it is connected to the subnet that the host may be on, the router responds with its own MAC address to host A on behalf of host B (regardless of whether host B is or is not in its ARP cache). If the router does not have host B in its ARP cache, it issues its own ARP Request for host B, which is done after the router responds to host A's ARP Request. Host A then sends its packets for host B to the router's MAC address, and the router delivers the packets to host B. Host B goes through the same process to reach host A.

This seems to be a lot of work for such a simple network, and indeed it is. A simpler solution would be to reconfigure the subnets on hosts A and B, unless the hosts do not have such capabilities, the administrators do not want to change the configurations for some reason, or hosts are misconfigured with a wrong mask or a missing default gateway.

An ONS node automatically runs proxy ARP service (PAS) and responds to ARP Requests coming from the LAN interface for IP host addresses, called clients, that are reachable via DCC or static host routes. This means only GNEs can perform PAS.

Figure 3-3 shows a simple ONS PAS in action. All three NEs plus the router's LAN interface are in the same IP subnet. The GNE's MAC address is 00:10:cf:d2:2e:d2.

 Please see page 154 for more details.

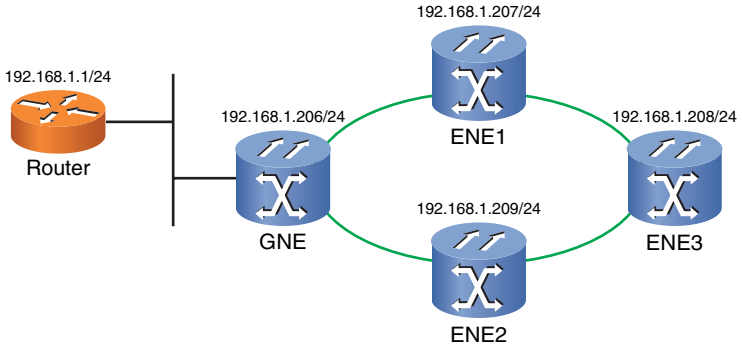


FIGURE 3-3
Simple example of ONS proxy ARP service

Successful ping responses to both ENEs from the router result in the ARP cache, as shown in Listing 3-1. The GNE's MAC address is mapped to all three IP addresses, an indication that GNE is performing PAS for the three ENEs. In other words, all three ENEs are PAS clients.

LISTING 3-1 Router's ARP Table

```
Internet  192.168.1.206       97   0010.cfd2.2ed2  ARPA   FastEthernet1
Internet  192.168.1.207      220   0010.cfd2.2ed2  ARPA   FastEthernet1
Internet  192.168.1.208      220   0010.cfd2.2ed2  ARPA   FastEthernet1
Internet  192.168.1.209      220   0010.cfd2.2ed2  ARPA   FastEthernet1
```

Before discussing the rules for ONS PAS, it is important to introduce a few more terms. The PAS on a GNE uses the following bits of information:

- OSPF database
- LAN interface status
- Routing table

 Please see page 154 for more details.