Applications of Frame Relay

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After looking at frame relay architecture, technology, and protocols, you'd think you would be all ready to implement a frame relay network. In the real world, however, getting fra
it sounds in a technology discussion.

This chapter presents some of the special problems IP, IBM SNA, and voice traffic pose for frame relay and describes the solutions that have been developed.

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Frame Relay and IP

The TCP/IP protocol suite has become a widely accepted standard for network communications. IP, the Internet Protocol, is the component of the TCP/IP suite that is responsible f
operates at layer 3, the network layer. (TCP operates at layer 4.)

IP is a best-effort delivery service that carries layer 3 protocol data units called IP datagrams from source systems to destination systems. Frame relay is very well-suited to carrying
is bursty in nature. Frame relay and IP are a well-matched team—they work well together to make efficient use of wide area bandwidth.

Figure 10.1 shows the relationship between the IP and frame relay protocols.

The sections that follow present some of the ways that frame relay circuits are used within IP networks and explain inverse ARP, which is a shortcut that automates a key step in co
relay.

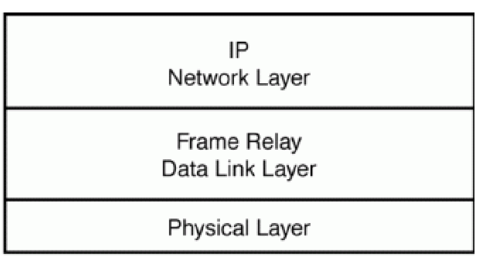

Figure 10.1: IP and frame relay layering.
See full-sized image.

Using Frame Relay in an IP Network

A frame relay circuit can simply be used as a replacement for a point-to-point leased line in an IP network. For example, Site A and Site B in Figure 10.2 are connected by a frame r
leased line. 199.17.28.200 and 199.17.28.201 are the IP addresses assigned to the router interfaces that connect to the frame relay virtual circuit.

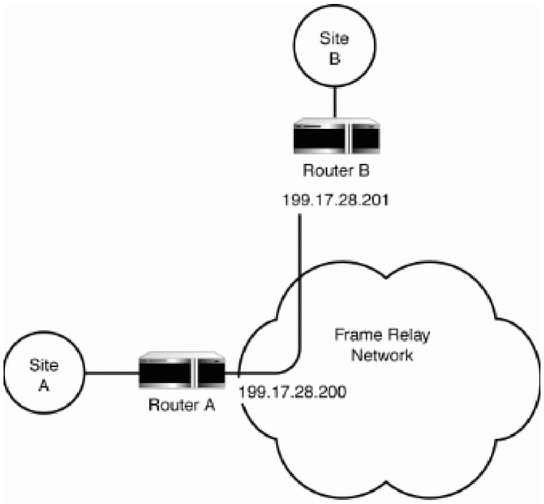

Figure 10.2: Replacing a leased line with a frame relay circuit.
See full-sized image.

Virtual IP Subnets

Multiple IP routers can be connected into a frame relay configuration that behaves like a virtual LAN—or in IP terminology, a virtual IP subnet. An IP subnet is a set of syste
some special characteristics:

- Their IP addresses start with the same network and subnet numbers.
- Any system can communicate directly with any other system in the subnet. Data will not flow through an intermediate router.

Figure 10.3 shows three routers that are connected by frame relay circuits. This is a fully meshed set of connections—that is, each system has direct connections to the oth
directly with the other systems.

A set of fully meshed systems can be treated as a virtual IP subnet. In Figure 10.3, each interface is given an IP address that starts with the same network and subnet numb
separate frame relay virtual circuits at each interface, each interface has been assigned a single IP address.

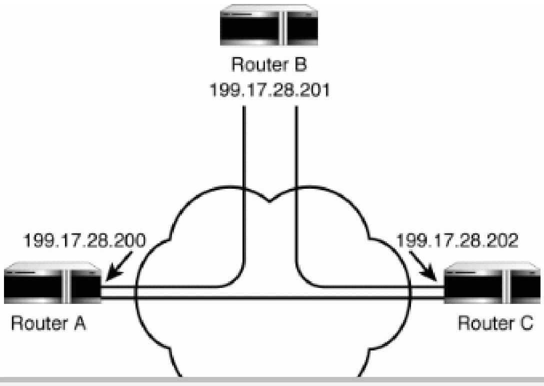

Figure 10.3: A virtual IP subnet.
See full-sized image.

In Figure 10.4, a new circuit has been set up between Router A and Router D. Router D is not fully meshed with the other routers, and the connection between Routers A a
IP addresses are assigned at each endpoint of the connection.

Thus:

- Sometimes, a single IP address can be assigned to an entire frame relay interface.
- In other cases, one or more DLCIs form a subinterface. Each subinterface is assigned an IP address. (It also is possible to leave the endpoint of a point-to-point conn relevant to the present discussion.)

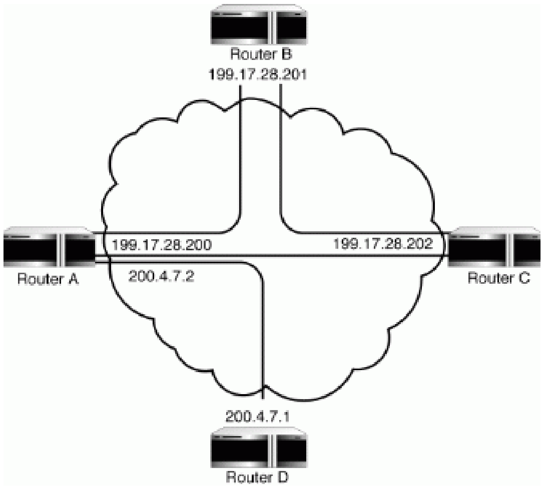

Figure 10.4: Adding a new IP subnet.
See full-sized image.

Packaging IP Datagrams

Figure 10.5 shows the simple IETF encapsulation that is used to carry IP datagrams. Recall that ISO has assigned the NLPID value X'CC to IP. The frame relay address field is
the IP NLPID.

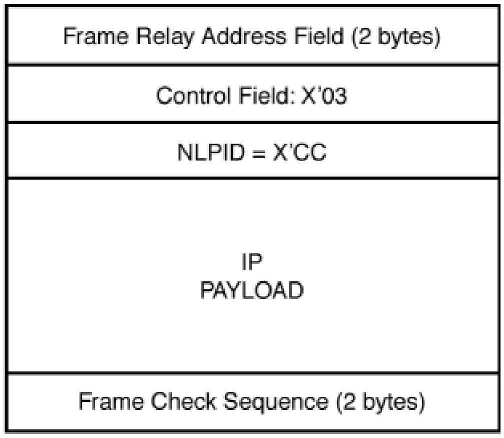

Figure 10.5: IETF encapsulation for IP.

The section in Chapter II-6 titled "Frames with Unique NLPIDs" contains a listing of an encapsulated IP datagram (see Listing 6.1, "Network Layer Protocol ID Value").

Address Resolution Protocol (ARP)

Systems on a LAN transmit data to one another by wrapping the payload in a LAN frame whose header contains the layer 2 Media Access Control (MAC) address of the de
cannot communicate with a neighbor until it has discovered the neighbor's MAC address. This discovery step is carried out by means of a procedure called the Address Re

Figure 10.6 shows how ARP operates for IP systems on an Ethernet LAN. Host A, which has IP address 172.16.1.40, wants to connect to Server B, which has IP address 172.1
message asking the system that has IP address 172.16.1.1 to respond. Server B replies, providing its Ethernet MAC address.

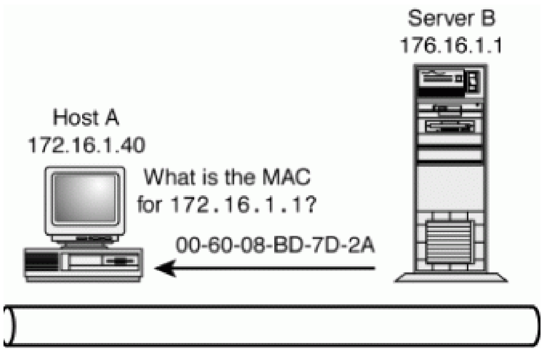

Figure 10.6: Using ARP to discover a system's MAC address.
See full-sized image.

Host A maintains an Ethernet ARP table that records layer 3 IP address to layer 2 MAC address translations. Host A uses the server's response to add a new row to this tab

IP Address	MAC Address
172.16.1.1	00-60-08-BD-7D-2A

ARP is not confined to IP and Ethernet. It is used to translate many different layer 3 network address types to many different layer 2 interface address types. The fields in ar
Note that an ARP request has operation code 1 and the response has operation code 2. The desired (target) hardware address is set to X'000000000000 in the outgoing re

The example shown in Table 10.1 relates to Ethernet and Ethernet hardware addresses. But note how flexible the ARP message format is. It was designed to be used with a

Table 10.1 Fields in an ARP Message

Field	Field Size	Ethernet Example
Type of hardware	2 bytes	Ethernet = 1
Type of layer 3 protocol	2 bytes	IP = X'0800
Length of each hardware address	1 byte	6 for Ethernet
Length of each protocol address	1 byte	4 for IP
Operation code	2 bytes	ARP request = 1;ARP response = 2
Source hardware address	As indicated	006008A124D1
Source protocol address	As indicated	172.16.1.40
Target hardware address	As indicated	In a request,000000000000
Target protocol address	As indicated	172.16.1.1

Inverse ARP

ARP allows a system to build a table that maps the IP addresses of systems on a LAN to the layer 2 MAC addresses of the systems. Inverse ARP, however, makes it even ea
addresses of systems connected by a frame relay virtual LAN to the layer 2 DLCIs of the circuits that connect to the systems.

The routers in Figure 10.7 are interconnected by frame relay circuits and form a virtual LAN.

Router A needs to find out the IP addresses of its neighbors before it can forward traffic to them using the IP protocol. Router A also needs to match each neighbor's IP ac
neighbor. That is, Router A needs a table of the form:

IP Address	DLCI Number
199.17.28.201	21
199.17.28.202	22

The left column holds the IP address of a neighbor that Router A wants to reach. The right column identifies the circuit that leads to that neighbor.

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