Transporting Legacy SNA Traffic Over Frame Relay
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Payoff
Transporting SNA traffic over frame relay has obvious cost benefits—network managers can continue the application of their SNA devices without reconfiguring their networks. Eliminating the overhead associated with polling minimizes congestion and provides more available bandwidth for actual data transportation, which yields greater network performance without the purchase of additional bandwidth.

Introduction
For years, IBM mainframe installations the world over have formed the basis for host-centric networks. These networks support many of the world's largest business enterprises (e.g., airlines, financial firms, government agencies, transportation companies, and utilities). All these networks share communications with remote locations.

Early networks, for the most part, were composed of slow, asynchronous, analog point-to-point or multidrop lines. To guarantee the quality of data transmission, IBM developed a telecommunications protocol known as Systems Network Architecture (SNA).

Although SNA is a successful and reliable transmission solution, users must still manage with a multitude of low-speed lines, each of which represents a single point of failure. However, because of its reliability, network managers still use SNA to support mission-critical applications while they consider other alternatives.

SNA Transport Strategies
Some mainframe users have attempted to upgrade their front-end processors and remote controllers to support frame relay access, but have found the process to be costly. Furthermore, this upgrade may not represent a long-term solution as IBM migrates its mainframe product line toward distributed client/server environments. In keeping with this trend toward mixed networks—which must support multiple protocols including Token Ring, Ethernet, and Novell (IPX)—routers have become the solution of choice because of their ability to encapsulate SNA traffic in the IP.

Devices built around IP-based architectures use one of two basic methods:

- SDLC to LLC conversion combined with TCP/IP encapsulation.
- Direct TCP/IP encapsulation of the SDLC frame to carry native SDLC traffic from a 3270 SDLC-type device through the network.

The name for these processes may vary by vendor and the protocol overhead may also vary with each device. Overhead approaching 70 bytes per packet is the mean, while data link switching (DLSw) can add as much as 50 bytes per packet.

Once these SNA packets have been encapsulated, they can be encapsulated into frame relay packets. This is not true of frame relay switches, which eliminate the IP overhead by placing SNA frames directly into frame relay frames.
IP routing has not proven to be satisfactory for some users because running SNA through routers has resulted in unpredictable performance in some networks. Another problem is that the cost levels for routers have been higher than some frame relay switches, which also integrate voice traffic.

**Why Frame Relay?**

Frame relay, which can trace its origins to ISDN, has matured into a practical and affordable replacement for low-speed, dedicated, private-line networks. For example, typical frame relay service is provisioned at 56K bps as compared with 4.8 or 9.6K bps for an SDLC multidrop line. In some cases, frame relay service can be provisioned at T1/E1 levels ranging in channel speeds from 128K bps to 1.53M bps (fractional to full T1).

Frame relay for the user is a straightforward service in which there are logically defined data link connection identifiers (DLCIs). In addition, permanent virtual circuits (PVCs) or permanent logical links (PLLs) provide for a virtual permanent connection. Frame relay transparently passes most protocols if the endpoint frame relay access device (FRAD) supports encapsulation (DLSw or RFC 1490).

**Guaranteed Bandwidth**

Frame relay networks provide a guaranteed bandwidth to each PVC; however, any unused bandwidth can be shared among several active users. The guaranteed bandwidth of a PVC is specified as the committed information rate (CIR). A user's traffic may exceed the CIR rate and is referred to as the burst rate of the PVC. Traffic that exceeds the CIR rate may be eligible for discard.

**Frame Relay Switching for More Efficient Network Operation**

A FRAD located at the user's node is required to transform data into frame relay packets. A frame consists of a flag, which indicates the beginning and end of a data packet. A frame header contains the destination of the data in the data packet. The user data is the data to be transmitted. A FCS validates the integrity of the data. Frames may be variable in length. The frame relay network is composed of a group of interconnected switches that relay data across the network. The DCLI information contained in the header is used to forward the data across the network to its destination.

The frame relay switch uses a two-step process to forward a frame of information. First, the network management tool checks the integrity of the frame using the frame check sequence (FCS). If the network manager finds an error, the frame is discarded. Second, the network manager validates the DLCI destination address. If the address is invalid, the packet is discarded. Any frame that is not discarded is forwarded to its destination. Because the network manager makes no attempt to correct a frame or request a retransmission, the network can operate more efficiently, leaving error recovery to the end stations.

**More Performance for Less Money**

FRADs are a more cost-effective approach for SNA networks because they simply convert SNA traffic into a frame relay packet leaving the SNA data intact. Because the FRADs do not have to support multiprotocol routing (as do routers), they are more efficient and cost less. Furthermore, packet-based transport mechanisms offer a predictable performance for SNA networks.
For example, in an IP network, packets containing time-sensitive information could get delayed behind a router queue while waiting to get transferred across the network. Frame relay transport mechanisms, on the other hand, offer a predictable performance by providing a connection-oriented session between devices in a remote site and the mainframe host. Furthermore, prioritizing mechanisms ensures that priority packets get through.

**How SNA Traffic Is Carried Across Frame Relay**

A frame relay network frames native SNA packets and sends them on their way. This is accomplished by a well-defined encapsulation process. Two possible encapsulation technologies for transporting information across a frame relay network are DLSw and RFC 1490.

**DLSw**

DLSw only supports the encapsulation of SNA, APPN, and NetBIOS traffic across a frame relay network. DLSw is an effective solution in an IP-based backbone supporting SNA and APPN multiprotocol environments. This is particularly true when a network has some native TCP/IP traffic.

The strength in the DLSw technology is its ability to dynamically locate SNA, APPN, or NetBIOS destinations using the destination's layer 2 MAC address. DLSw conducts the destination location process using a search protocol. This protocol is an optimized version of source-route bridging's (SRB) broadcast search mechanism across a wide area network (WAN) using TCP/IP.

The DLSw technology involves the administration and management of 32-bit IP addresses, which requires defining the IP and the address at all remote local area network (LAN) bridge/routers as well as at each source DLSw bridge/router. In addition to defining DLSw-specific IP addresses, it is also necessary to specify all SRB-related parameters such as LAN segment numbers, bridge numbers, and MAC addresses at all destinations. This is definitely not a “plug-and-play” process.

DLSw does not support SNA or advanced peer-to-peer networking (APPN) routing or any kind of session layer switching between mainframes or APPN nodes. DLSw does support virtual point-to-point connections between pairs of MAC addresses across a TCP/IP WAN.

**RFC 1490**

RFC 1490 is the industry standard and an enhancement to the original RFC 1294 standard for frame relay encapsulation. RFC 1490 provides a low-overhead, highly optimized means for transporting SNA and APPN traffic. It also supports other multiprotocol traffic across a WAN. RFC 1490 is best suited for packet-switched networks, particularly when a network is totally frame relay-oriented.

RFC 1490 does not require the same amount of predefinition as DLSw. For example, in contrast to DLSw, RFC 1490 administration only involves layer 2 PVC setup and definition to begin operation over a frame relay network. In contrast to DLSw, an RFC 1490 solution provides a greater level of service than DLSw (e.g., bandwidth allocation and traffic prioritization). Some RFC routers can complement the inherent transparent alternate routing within a frame relay network by serving as frame relay switches. These switches also support dialback, which provides a vital disaster recovery resource.
RFC 1490 encapsulates SNA/APPN traffic directly within a frame relay with just a 10-byte-type control and logical link control, type 2 (LLC2) header prefixing the SNA message units (with no other protocols or headers involved). RFC 1490 is a layer 2 minimum overhead, with an ultralight encapsulation technique including frame relay flags, 2-byte address fields, and frame relay sequence. The total overhead for any SNA/APPN message unit is 16 bytes. Therefore, RFC 1490's overhead is minimal compared with that of DSLw, as DSLw relies on TCP/IP and requires two TCP connections between every remote bridge and router and the central site bridges and routers.

Thus, a network with 250 remote sites would need 500 TCP connections at the central site. For this reason, if a network manager was to use frame relay to support the WAN fabric of a network with SNA or APPN traffic, RCF 1490 would be more efficient for integrating it with other multiprotocol traffic.

**Frame Relay Efficiencies for SNA**

The technology of frame relay devices has gone through several developmental evolutions that have made it possible for the end user to realize an expanded application of frame relay. In comparing traditional SNA WAN technology, it is easy to see the advantages of transporting SNA traffic over frame relay. For example, because frame relay uses the same framing and CRC bits as SDLC, all FEP SDLC line interface couplers (LICs), data service unit/channel service units (DSU/CSUs), and modems can be used with frame relay.

**Improved Throughput**

With typical network access ranging from 56/64K bps to T1/E1 (1.55M bps), network throughput is greatly improved over the more traditional 4.8 to 9.6K-bps line speeds associated with SNA networks. Because SDLC and frame relay are software implementations on an FEP, no hardware changes are required to support frame relay transport. In addition, migrating SDLC host applications to frame relay requires no software changes.

Unlike SNA, frame relay can transport multiple protocols providing support for mixed or hybrid client/server networks. Frame relay also supports point-to-point or many-to-many connectivity.

**Increased Bandwidth**

Guaranteed bandwidth is ensured through the PVC's established committed information rate with the ability to support a burst mode above the CIR rate. Traffic such as voice or video can be prioritized over regular data traffic to ensure that it reaches its destination. Some carriers provide high-priority PVCs (priority PVC services), which can be dedicated to mission-critical SNA, voice, or video applications. In this scenario, a high-priority PVC might be sampled four times as often as a low-priority PVC.

**Interoperability**

Newer releases of IBM's Network Control Program (NCP) software provide an SNA boundary network node with connectivity between a PU4 to a PU2 device across a frame relay network. It is possible to establish connectivity across a frame relay network between an SNA node (PU2) and a front-end processor (FEP). This software also allows connectivity between a 3174 and an FEP.
SNA Network Interconnect (SNI) provides for the interconnection of two SNA networks over frame relay via an SNA link. This capability allows users on one SNA network to access resources on another SNA network.

With IBM's incorporation of the RFC 1490 standard across its current product line, interoperability between IBM and other IBM frame relay products can be established. In this scenario, interoperability requires SDLC to be converted to LLC2.

Unlike a dedicated network, meshed frame relay networks provide the user with a number of alternate routes, guaranteeing that all traffic that is not discard-eligible can reach its destination.

**Better Functional Support**

Although not all FRADs are the same, more advanced frame relay switches provide a much higher level of functional support. For example, if a PVC is experiencing high levels of traffic, the originating terminal can invoke flow control or metering to ensure that all traffic stays under the CIR level for the PVC being accessed. In addition, the network can send a backward explicit notification (BECN) bit or a backward explicit notification bit to inform the endpoint device of a potential problem. In this instance, the endpoint device can regulate the flow of data to ensure that high-priority data can get through.

**Network Backup**

Frame relay provides fault tolerance with the inherent ability to reroute in the event of a failed route. Frame relay networks also tend to be more robust and less prone to error as opposed to more traditional network arrangements. However, outages can occur on the local loop that supports a remote location's access to the frame relay network. To meet this contingency, dial backup circuits may be used to restore service if the dedicated 56K-bps link goes out of service.

Dial-up ISDN with one B channel can support 64K-bps service, which can be used to access an open port on the network. Regardless of the type of restoration that is in place, dial backup, address security, flexibility, and ease of installation are all important issues that network managers must address.

**Practical Applications of Frame Relay**

Frame relay provides a less expensive alternative than leased-line services while providing bandwidth for such added services as LAN, voice, and fax traffic. For example, if the right equipment is used to interface the network, the network planner can integrate voice, data, and fax. This strategy makes it possible to aggregate all information traffic across the frame relay network.

**AS/400 Networks**

Exhibit 1 shows a typical AS/400 network arrangement. The network links form a star topology, radiating from the hub to the outer periphery. In this example, CX 900 switches are at the periphery with a CX 1000 switch at the central site (mainframe). At each of the customer's remote locations there will be either an IBM 5394 or a third-party controller, as well as a LAN running NetWare for SAA. The CX 900s located at these sites convert the SDLC link protocol running from the cluster controller to frame relay protocol using the RFC 1490 encapsulation protocol. The central site CX 1000 converts the RFC 1490
protocol back to SDLC for presentation to the AS/400. The CX 1000 also “spoofs” the SDLC polling appearing as a cluster controller.

**Star-Configured Network**

In this solution, only the CX 1000 and CX 900 were added to establish a corporate network across a public frame relay network. No changes were required to the cluster controller parameters or other network equipment.

Exhibit 2 illustrates a multidrop or multipoint network architecture, possibly the most popular of all AS/400 network designs. Converting this type of network requires virtual multipoint mapping, which requires the CX 1000/900s to map the controllers from a point-to-point line to a multipoint line. This remapping allows the AS/400 to think that it is operating over a multipoint line when in fact it is running over public frame relay.

**Multipoint, Multidrop Network**

**Support for Voice Traffic**

Exhibit 3 shows another AS/400-based network in which a mix of IP/IPX/SNA and AppleTalk protocols is to be transported over frame relay. LANs as well as legacy nodes in several of the remote locations require integration into the network. In these locations, servers are running SNA emulators that allow them to appear as SDLC-attached controllers. TCP/IP and IPX traffic also comes from other servers in the same remote offices.

**Hybrid Network with IP, IPX, and SNA**

In this network arrangement, the CX 900 was able to function as a router sending traffic over the frame relay network back to its ultimate destination. In this network, the CX 900 may also have to transport a mix of SNA, IP, and IPX over a single communications link (DCLI). It should also be noted that in Exhibit 2, voice traffic is integrated over the frame relay network.

In this scenario, each of the remote locations has two voice channels configured on the CX 900. These voice channels are attached to the local telephone system and appear as off-premise extension-type connections. At the host, the CX 1000 provides support for each of the channels coming back from the remote locations. These appear as separate extensions on the PBX at the host site. This allows the remote offices to make calls to other locations or to the corporate headquarters.

Companies using this strategy have saved a great deal of money on their voice traffic by piping it over the data network. Some users have reported tremendous savings in overseas calls by riding over their international frame relay network.

**Special Application Servers**

AS/400s are frequently used to support a LAN as a special application server. In this scenario, the clients might access the AS/400 over an Ethernet. The CX 900 can be linked directly to the Ethernet via an LLC2 interface. The CX 900 can link to other remote CX 900s that interface with a remote cluster controller via an SDLC interface. A transparent Token Ring-to-Ethernet bridge might be used to link a Token Ring to an Ethernet
backbone. Again, the CX 900 would be used to indirectly link traffic between the Token Ring and any of the other remote locations over the frame relay network.

**Conclusion**

In these times of belt tightening, network managers are under pressure to protect their investment in the existing network infrastructure. As SNA network managers strive to improve their network’s performance, they must do so without any risk to the core business.

SNA over frame relay has obvious cost benefits. The application of frame relay to transport native SNA directly allows network administrators to continue the application of their SNA devices without reconfiguring their network devices. Eliminating the overhead associated with polling minimizes congestion and provides more available bandwidth for actual data transportation. This strategy allows the end user to realize greater network performance without buying more bandwidth.

Furthermore, reducing local polling removes an overhead burden from the FEP, freeing processing cycles for other tasks. This reduces expensive FEP upgrades while providing much better network throughput. The key here is the selection of the right level of FRAD equipment to provide the maximum advantage of frame relay service. Not all frame relay access devices are created equal. When provisioning a frame relay network, terminals should provide the following capabilities:

- Termination of an SDLC protocol.
- SDLC mapping to eliminate tasks from the AS/400.
- Supporting the AS/400 SDLC host.
- Supporting RFC 1490.
- Supporting Annex G.
- Supporting data compression for bursty LAN traffic.
- Supporting IPX and AppleTalk routing.
- Supporting LAN routing.
- Supporting voice/fax.
- Supporting international connections.

Using these criteria as a guide, migrating to frame relay need not be done on a wholesale basis. Selecting a frame relay switch that provides a flexible platform is a key to upward expansion. This strategy allows network managers to plan for the future as their application mix begins to expand, requiring such high-priority services as video and voice integration.

**Author Biographies**

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