The physical layer (OSI Layer 1) protocols describe how to provide electrical, mechanical, operational, and functional connections to the services of a communications service provider.

The data link layer (OSI Layer 2) protocols define how data is encapsulated for transmission toward a remote location and the mechanisms for transferring the resulting frames. A variety of different technologies are used, such as Frame Relay and ATM. Some of these protocols use the same basic framing mechanism, High-Level Data Link Control (HDLC), an ISO standard, or one of its subsets or variants.

Many WAN users do not make efficient use of the fixed bandwidth that is available with dedicated, switched, or permanent circuits because the data flow fluctuates. Communications providers have data networks available to more appropriately service these users. In packet-switched networks, the data is transmitted in labeled frames, cells, or packets. Packet-switched communication links include Frame Relay, ATM, X.25, and Metro Ethernet.

Common Packet Switching WAN Technologies

The most common packet-switching technologies used in today’s enterprise WAN networks include Frame Relay, ATM, and legacy X.25.

X.25 is a legacy network-layer protocol that provides subscribers with a network address. Virtual circuits can be established through the network with call request packets to the target address. The resulting SVC is identified by a channel number. Data packets labeled with the channel number are delivered to the corresponding address. Multiple channels can be active on a single connection.

Typical X.25 applications are point-of-sale card readers. These readers use X.25 in dialup mode to validate transactions on a central computer. For these applications, the low bandwidth and high latency are not a concern, and the low cost makes X.25 affordable.

X.25 link speeds vary from 2400 b/s up to 2 Mb/s. However, public networks are usually low capacity with speeds rarely exceeding above 64 kb/s.

X.25 networks are now in dramatic decline being replaced by newer layer 2 technologies such as Frame Relay, ATM, and ADSL. However, they are still in use in many portions of the developing world, where there is limited access to newer technologies.

Frame Relay

Although the network layout appears similar to X.25, Frame Relay differs from X.25 in several ways. Most importantly, it is a much simpler protocol that works at the data link layer rather than the network layer. Frame Relay implements no error or flow control. The simplified handling of frames leads to reduced latency, and measures taken to avoid frame build-up at intermediate switches help reduce jitter. Frame Relay offers data rates up to 4 Mb/s, with some providers offering even higher rates.

Frame Relay VCs are uniquely identified by a DLCI, which ensures bidirectional communication from one DTE device to another. Most Frame Relay connections are PVCs rather than SVCs.

Frame Relay provides permanent, shared, medium-bandwidth connectivity that carries both voice and data traffic. Frame Relay is ideal for connecting enterprise LANs. The router on the LAN needs only a single interface, even when multiple VCs are used. The short-leased line to the Frame Relay network edge allows cost-effective connections between widely scattered LANs.

ATM

Asynchronous Transfer Mode (ATM) technology is capable of transferring voice, video, and data through private and public networks. It is built on a cell-based architecture rather than on a frame-based architecture. ATM cells are always a fixed length of 53 bytes. The ATM cell contains a 5 byte ATM header followed by 48 bytes of ATM payload. Small, fixed-length cells are well suited for carrying voice and video traffic because this traffic is intolerant of delay. Video and voice traffic do not have to wait for a larger data packet to be transmitted.

The 53 byte ATM cell is less efficient than the bigger frames and packets of Frame Relay and X.25. Furthermore, the ATM cell has at least 5 bytes of overhead for each 48-byte payload. When the cell is carrying segmented network layer packets, the overhead is higher because the ATM switch must be able to reassemble the packets at the destination. A typical ATM line needs almost 20 percent greater bandwidth than Frame Relay to carry the same volume of network layer data.

ATM was designed to be extremely scalable and can support link speeds of T1/E1 to OC-12 (622 Mb/s) and higher.

ATM offers both PVCs and SVCs, although PVCs are more common with WANs. And as with other shared technologies, ATM allows multiple VCs on a single leased-line connection to the network edge