IMAGE TRANSMISSION

Image transmission across networks is achieved in one of three ways:

- The image is moved across the network from a Web server to a workstation with a Web browser.
- The image is transferred from one machine to another using standard file transfer protocols such as FTP (in the TCP/IP environment) or File Transfer Access and Management (FTAM) in an Open Systems Interconnection (OSI) environment.
- Imaging servers are accessed through the Z39.50 computer-to-computer information retrieval protocol.

As of 2000, the first option, moving an image from a Web server to a workstation with a Web browser, is the most popular. Only limited use is made of FTP and FTAM. Z39.50 is increasing in popularity as libraries agree to link their systems. It can be used not only with a Windows-based or GUI (graphical user interface) client, but also with a Web-based patron access catalog client. All these approaches require substantial bandwidth.

Bandwidth Requirements for Images

A compressed image file of one simple journal page may require more than 30 times the transmission capacity as the same information coded in ASCII. Although a 9,600 bps (bits per second or 9.6 Kbps) circuit moves one ASCII-encoded page in two seconds, an image file of the same page may take up to 50 seconds at 200-dpi resolution and up to 156 seconds at 400-dpi resolution. The times are greater than textbook calculations would suggest because any transmission includes overhead for signaling, error checking, synchronizing bits, and so on. Users must use a 1.54 Mbps circuit to achieve transmission times of under one second for an image of simple journal page.

Rarely is a circuit used by only one workstation at a time. Typically, a circuit has as many as 20 devices connected to it, several of which are active at any one time. Although not all are accessing images, users must always expect that more than one workstation is seeking to download an image at any one time. For that reason, eight to 15 seconds may be required when the circuit is busy.

Upgrading Cabling

Many older automated library systems support dumb (ASCII) terminals wired to the central site using Category 3 UTP (unshielded twisted-pair) wires and voice grade telephone circuits from remote locations to the central site. The transmission rate required to support terminals is only 9,600 bps (or 9.6 Kbps), so a library or archive experiences few bandwidth problems when using dumb terminals. Even PCs operating in terminal emulation mode pose no problems. Newer automated library systems that use client-server architecture require greater bandwidth, typically 56 Kpbs. Image transmission requires even more.

Libraries and archives with Category 3 wiring should replace that wiring with Category 5 UTP cabling. Fortunately, this is less expensive than the original installation was because the Category 3 wiring can be used to pull the Category 5 UTP cabling through walls, plenums, and columns. Although fiber-optic cabling can also be

used, it has little additional benefit except for the potential additional bandwidth that might in the future be realized for the backbone of a large LAN. At this time both category 5 UTP and fiber-optic cabling can support up to 1,000 Mbps or 1.0 Gbps. A standards committee is working on a standard for 10 Gbps fiber optic, a capacity that Category 5 UTP is unlikely to achieve. Given the facts that fiber optic is more costly and difficult to install, Category 5 UTP is the better choice for most organizations.

Upgrading LANs

Libraries with LANs (local area networks) more than five years old often have telecommunications hardware and software that limit bandwidth to 1.0 Mbps, but the cable is Cat 5 UTP, a medium that can handle bandwidth up to 1.0 Gbps. Although 1.0 Mbps is enough to support a single image workstation, it is not enough to support several of them, so libraries and archives in this situation need to replace telecommunications hardware and software.

LANs installed in the past three years usually use a 10 Mbps contention scheme called Ethernet; and networks now being installed typically support 100 Mbps. Both are adequate for image transmission, although libraries and archives with more than 100 workstations in a single facility may find it necessary to upgrade to 100 Mbps.

Assuming Category 5 UTP is in place, the components that may have to be upgraded are hubs, switches, routers, and CSU/DSUs.

Hubs are connection points for devices in a LAN. A hub contains multiple ports so several devices near one another can be connected to the network. A passive hub serves simply as a conduit for the data; an intelligent hub includes additional features that enable an administrator to monitor the traffic passing through the hub. Hubs are widely used in small- to mid-size libraries and archives because the are relatively inexpensive (a few hundred dollars each) and are well-suited for low to moderate data traffic volume.

Switches are similar to hubs, but they filter as well as forward data. They offer many features that go beyond those in an intelligent hub. They can handle more devices and greater traffic volumes than hubs so they are used in mid-size and large libraries and archives. They typically cost several thousand dollars each.

Routers are devices that connect LANs to one another, including LANs that use different protocols, for example, Ethernet and Token Ring LANs—the latter a protocol used over large LANs with hundreds or thousands of nodes, usually in organizations that also have many Ethernet LANs.

Hubs, switches and routers rated at less than 10 Mbps should be replaced as soon as there are signs of poor network performance—or, ideally, in anticipation of poor network performance. Rather than specifying 10BaseT Ethernet, specify 10/100BaseT/TX Ethernet. That specification means the devices detect the speed of each attached device so the line speed can be adjusted. It avoids replacing the NICs (network interface cards) in those PCs with 100 Mbps cards.

Avoic 100VG-AnyLAN since it's not popular. Even Hewlett-Packard, the main promoter of this high-speed alternative, now supports 100BaseTX.

Upgrading WANs

WANs (wide area networks) are networks that consist of two or more LANs connected to one another using the facilities of a telephone company or other carrier. Most existing WANs used by libraries and archives use 56 Kbps point-to-point circuits, but an increasing number are using T-1 circuits that offer 1.544 Mbps of

bandwidth, or fractional T-1 circuits rated at 64, 128, 256, 512, or 768 Kbps. Libraries and archives with WANs with bandwidth less than 1.54 Mbps may have to upgrade to full T-1 to support access by multiple workstations from a remote location to the central site via a WAN.

The most capital outlay a library or archive incurs when upgrading a WAN is the replacement of the modems, multiplexors, or DSU/DSUs. A modem connects a single device to a telecommunications line; a multiplexor connects multiple devices to a telecommunications line; and a CSU/DSU performs protective and diagnostic services for a telecommunications line and connects devices to it. The CSU/DSU, which stands for channel service unit/data service unit, is a high-powered and expensive (several thousand dollars) multiplexor. It is required to connect a device to a T-1 or T-3 telecommunications line.

The ongoing expense of a WAN is greater than the initial capital outlay. A full T-1 circuit may cost anywhere from $400 to several thousand dollars a month, depending on the distance. Many libraries and archives that have facilities scattered over a wide geographic area have found frame relay service to be a better alternative than regular T-1 service because the pricing is independent of distance. You pay only for the bandwidth you require, but the minimum price typically is $150 to $500 per location served.

In wide area networking, transition to T-3 (45 Mbps) speed is already underway. Plans are underway to upgrade the national network (the Internet) in the next few years, perhaps to 1.0 gigabits per second (1.0 Gbps).

Standards Issues

Closely related to the issue of bandwidth is compression. When data is compress by 10 to 40 times, the bandwidth demands on a network are reduced. The choice of compression algorithm then becomes important because the compatibility of all the components of a network can be achieved only when there is conformity to standards.

The first group of compression standards for imaging were for monochrome images and derived from the fax industry—The International Telegraph and Telephone Consultative Committee (CCITT for the French version of the name) Group 3 and 4 fax compression algorithms. Both Group 3 and Group 4 CCITT are lossless compression algorithms. These are used for monochrome images and are available in a range of software and hardware implementations. Group 4 algorithms are rapidly supplanting Group 3 algorithms since they offer more effective compression. (Fax machines most often use Group 3 algorithms since they are less vulnerable to minor errors in data transmission, which are common over the telephone network in fax transmission. In a fully digital environment, such errors do not occur, and Group 4 compression algorithms, which assume such an error-free environment, can be used to gain higher compression levels).

Even as Group 4 CCITT is supplanting Group 3 CCITT, newer compression algorithms are displacing Group 4 CCITT. The most important of these are the Joint Photographic Experts Group (JPEG) and Motion Picture Experts Group (MPEG) standards. The former is discussed in several other chapters. The latter is not widely used as yet because most networks lack the bandwidth required to support the rapid transmission of moving images.

One of the most serious standards concerns for imaging involves formats for the transfer of images. This includes some means of encoding information in a header that describes the resolution at which the image was encoded, the size of the image, and other data. Long term, this may be subsumed under the evolving Office Document Architecture (ODA) compound document standards, but in the near term these standards are incomplete and not widely implemented.

In the absence of another alternative, many ad hoc standards have proliferated in the marketplace, including Tagged Image File Format (TIFF) and PDF. Of these, TIFF seems the more widely accepted and supported within libraries and archives. PDF seems to be more widely accepted and supported on the Internet.

BMP, a bit-mapped graphics format used in the Windows environment, is generally used only in local systems, not when images are to be moved over a WAN.