INTERNET AND WAN ACCESS OPTIONS

By Richard W. Boss

Three decades ago libraries had two simple choices when seeking to access a remote computer: dial-up or leased voice-grade telephone circuits. In most cases, bandwidth was limited to 1,200 to 9,600 bits per second or 1.2 to 9.6 Kbps. Both dial-up and leased voice-grade circuits continue to be available, but bandwidth over voice-grade circuits now is a minimum 56 Kbps when suitable hardware is used. For many libraries 56 Kbps is not enough, however, because they are seeking to access both the graphics-rich Internet from a number of PCs simultaneously and to maintain a WAN (Wide Area Network) to connect multiple library facilities to an integrated library system and other local electronic resources.

When bandwidth of more than 56 Kbps is required, the choice now is among a large number of so-called "broadband" options offered by telephone companies (telcos), cable companies, and wireless companies. However, the definition of "broadband" is imprecise. Sellers of data communication services generally refer to any bandwidth that is 128 Mbps or greater as "broadband." The Federal Communications Commission, which has not defined the term "broadband", defines "high-speed services" as those supporting at least 200 Kbps in at least one direction. The International Telecommunications Union uses the term "broadband" only for a minimum of 1.544 Mbps in at least one direction.

Not all options described in this TechNote are available in all areas, but almost every library has several options available.

OPTIONS

Telcos have at least 70 percent of the data communication market. However, cable companies doubled market share from 12 to almost 25 percent between 2005 and 2007. Wireless

companies, including those using satellites and microwave technology, account for most of the balance.

Telco Options

Telcos offer a wide range of options, including dial-up, leased voice-grade circuits, ISDN, frame relay, ATM, DSL, T-1, OC, and FTTP.

Dial-up circuits, which are not considered broadband, utilize inexpensive modems and support download (receiving) and upload (sending) speeds of up to 56 Kbps over voice-grade telephone lines. The service is measured on the basis of distance, time of day, and length of connection. Dial-up can be a cost effective way to access the Internet if a circuit is within a single local calling area and is used fewer than 20 hours per week. Only the smallest of libraries use dial-up to access the Internet.

Leased voice-grade circuits can be voice-grade analog, conditioned analog, or digital. An analog circuit is limited to download and upload speeds of 56 Kbps unless multiple circuits are combined. A leased circuit is dedicated; therefore, it is always open and available for use. Analog service is priced on the basis of distance. If the distance is greater than 15 miles, it often is more cost effective to contract for an option that is distance independent. The most common telco offering that does not base prices on distance is a leased frame relay circuit. The most common digital circuits are ISDN and DSL. They are described in the following paragraphs.

ISDN (Integrated Services Digital Network) is an international communications standard for sending voice, data, and video over digital telco circuits. ISDN supports data transfer rates of 64 Kbps. Two lines usually are combined to provide a rate of 128 Kbps. ISDN circuits are limited to 20,000 feet; therefore, the user must be close to a telco switching station. The service is priced on a flat rate approved by a state public utility commission. Increasingly, small

libraries are choosing DSL over ISDN because 128 Kbps is not enough bandwidth for accessing today's graphics rich Internet.

DSL (Digital Subscriber Lines) refers to all types of digital telco circuits, the two main categories being ADSL and SDSL. DSL is similar to ISDN in that it requires a short run of less than 20,000 feet to a telco switching station. However, DSL offers much higher rates--up to 32 Mbps for downloads and up to 1 Mbps for uploads. When the download rate is greater than the upload rate, the category is ADSL (Asymmetric Digital Subscriber Line); when the download and upload rates are the same, the category is SDSL (Symmetric Digital Subscriber Line). SDSL became available at 10 Mbps download and upload in 2007. The service is priced on the basis of bandwidth. DSL is a popular choice for small libraries.

Frame Relay is based on transferring data in packets via a T-1 telco circuit. It provides mid-range service between ISDN and ATM. It is available not only at the full T-1 bandwidth of 1.544 Mbps, but also as ***fractional frame relay.*** While 64, 128, 256, 512, 640, 768, and 896 Kbps are common fractional frame relay offerings; most telcos limit the number of choices to four. Because the circuits are shared, bandwidth is not guaranteed. When there is not enough bandwidth available, the bandwidth is shared and the excess data is temporarily buffered. The service is priced on the basis of the number of ports (the connections at the locations) and the bandwidth. Distance is not an element in the pricing; therefore, it is particularly attractive when the distance to an ISP is more than 15 miles and/or the WAN covers a large geographic area. Frame relay is particularly attractive when there are at least eight ports because the fixed price of the virtual circuit, which connects the ports, is then distributed over a large number of locations.

Reliability and speed have been improved in recent years by the use of the Multiprotocol Label Switching (MPLS) protocol, a protocol that involves setting up a specific path for a given sequence of data packets, thus saving the time needed for a router to look up the address to the next node to forward the packet.

ATM (Asynchronous Transfer Mode) is based on transferring data in packets of a fixed size over a telco circuit. ATM creates a fixed channel or route whenever data transfer begins. The packets travel together and because they are of fixed size, travel very rapidly--up to 10 Gbps.
However, the pre-specified bit rates are 155 and 622 Mbps.

ATM uses the MPLS protocol described above. It differs from TCP/IP, the protocol of the Internet, in which the packets take different routes from source to destination. Prices are based on bandwidth and distance. ATM has lost market share since the beginning of this century because it is complex and costly for all but the largest organizations.

T-1 is a leased telco circuit supporting data rates of 1.544 Mbps per second. A T-1 line actually consists of 24 individual channels, each of which supports 64 Kbps. Most telcos offer the option of leasing just some of these individual channels, known as ***fractional T-1 access***. Because the circuits are dedicated, bandwidth is guaranteed. The service is priced on the basis of bandwidth and distance. When a T-1 circuit is used solely for data transmission, it is designate DS-1; when it is used for both data and voice, it is designated integrated T-1. Increasingly, mid-size libraries are using T-1 to access the internet and for connecting multiple facilities into a wide area network.

T-3 is a leased telco circuit supporting data rates of 43 Mbps. A T-3 line actually consists of 28 T-1s or 672 individual channels, each of which supports 64 Kbps. When a T-3 circuit is used solely for data transmission, it is designated DS-3; when it is used for both data and voice, it is designated integrated T-3. T-3 is a choice of many consortia and large libraries as it wide enough to transmit full motion, real-time video, and very large databases over a busy network.

OC (Optical Carrier) is used to specify the speed of fiber option networks. It is a leased

telco circuit that uses supporting data rates of 155.52 Mbps (OC-3), 622.08 Mbps (OC-12), 1.244 Gbps (OC 224), 2.488 Gbps (OC-48), and 9.952 Gbps (OC-192). And 13.21 Gbps (OC-256). OC-3 is the equivalent of 100 T-1s; OC-12 consists of 4 OC-3s; OC-48 is the equivalent of 4 OC-12s; etc. OC-3 and higher are used by major ISPs (Internet Service Providers).

FTTP (Fiber to the Premises), is the latest offering of telcos. While telcos have used fiber for years to a node or neighborhood, the "last mile" from a neighborhood cabinet to the subscriber has been over twisted pair copper or cable. As of mid-2008, it was available only in a few major metropolitan areas, but billions were being spent to extend fiber to individual businesses and homes. Telcos such as Verizon (FIOS) and AT&T (U-Verse) are offering speeds of up to 10 Mbps downstream and 2 Mbps upstream as the basic service and 50 Mbps downstream and 20 Mbps upstream as a premium service.

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Cable Companies

Cable companies limited their offering to television for many years, but began to realize the potential of data over cable early in this century. ***CATV modems***, also known as cable modems, are devices that allow high-speed access to the Internet or to a remote computer via a cable company's coaxial and fiber optic cable circuits. As of mid-2008, cable companies were installing fiber at nearly twice the rate of coaxial cable in order to increase bandwidth and reduce costs.

The Data Over Cable Service Interface Specification (DOCSIS) is the dominant cable standard. DOCSIS 3.0 was the current standard as of mid-2008. It provides for bonding multiple 6 MHz channels to boost bandwidth to 100 Mbps or more.

There are more than two dozen Multi-System Operators (MSOs) in the U.S. These are companies that have multiple local cable systems. Eighty percent of them were offering cable solely to residential customers as of mid-2008. However, the minority were pursuing non-

residential customers for broadband data transmission.

Pricing is based on bandwidth, with 20 Mbps the basic service and premium service from 50 to 100 Mbps. Most of the libraries relying on cable companies for data transmission are small. Over three-fourths of them have purchased bundled service that combine television, telephone, and data; or telephone and data. It is this bundling that has set off intensive price competition with telcos. Cable companies are particularly competitive with telcos when a library is seeking to support from eight to twelve concurrent users.

Wireless Companies

The early offerings of wireless data transmission relied on satellites. The companies that offer data via satellite usually lease capacity from satellite owners and resell it in smaller units. Because most organizations using satellite technology for data transmission are national and global in scope, the companies that lease satellite service typically offer capacity in much larger bundles than a library can afford. Prices are based solely on the bandwidth required, and bandwidth is usually offered by the Gigabyte. The reliability and quality of transmission is subject to the adverse effects of weather and faulty targeting of the satellite dish.

Microwave has been more popular than satellite technology. The technology, which is called WIMAX (Worldwide Interoperability for Microwave Access) is based on the IEEE 802.16 standard. WIMAX is very different from Wi-Fi, the wireless technology used in Local Area Networks (LANs). WIMAX usually is offered as a Metropolitan Area Network (MAN), a WAN that covers a limited geographic area. The maximum distance is approximately 30 miles and the maximum bandwidth is 70 Mbps, but the maximum available bandwidth goes down as the distance increases. Most offerors provide only 2, 4, 6, 8, 10 and 12 Mbps services.

Companies that provide cellular telephone service are increasingly offering data

transmission. There are scores of companies that provide wireless telephone service. An increasing number of these are now offering data communication, usually at a flat monthly rate. Among the largest of these companies are VoiceStream Wireless Corp. and Boingo Wireless Inc. The focus has been on supporting PDAs and other handheld devices. However, AT&T, AT&T Wireless Services, Cingular Wireless, and Intel have launched AProject Rainbow, an effort to build a nationwide high-speed wireless service based on the IEEE 802.11b wireless network standard. Within a local area users would have 11 Mbps service for a flat monthly rate based on the number of minutes in the contract. It may take several years and billions of dollars to complete the nationwide network. Presumably, it will be introduced a few localities at a time.

DETERMINING THE NEED

The first step in selecting an option is determining the amount of bandwidth required. While a single PC accessing the Internet used to require at least 56 Kbps of bandwidth, the increased availability of massive databases, audio, graphics, and streaming video has more than quadrupled the desirable minimum per workstation accessing the Internet. Increasingly, libraries are planning on a minimum of 256 Kbps per concurrent internet user.

Libraries with branches, or libraries in an automation consortium, will require a WAN to connect the remote peripherals in library facilities to the central site. Presumably, each site will have a mix of remote peripherals, including circulation and patron access catalog workstations. Some facilities may have technical services workstations. Each type will have different bandwidth requirements. The requirements will also vary from one integrated library system to another because of differences in design. For example, the extensive use of Java has reduced bandwidth requirements. Bandwidth requirements for an integrated library system should, therefore, be obtained from the vendor of the system. However, most integrated library systems require less bandwidth per remote peripheral than is required for Internet access.

A library hosting its own Web site will need greater upstream speed that is offered by

many of the options.

Once the current bandwidth requirement has been determined, a projection of future need should be made. If it is likely that more bandwidth will be needed in future years, the options that should be pursued are those that can be scaled up as needed. Scalability is most limited with ISDN and DSL, although telcos are increasing DSL bandwidth from year to year.

If the technology and the terms of the contract permit it, the bandwidth can be increased to a higher level when needed. While the rate will increase, there should be no penalties for changing to a higher bandwidth tier.

Changing from one option to another can be costly. At best, it may involve a change in hardware; at worst, it may involve a change in vendor. If the change occurs before the contract period is up, there may very well be an early termination penalty. It is, therefore, a good idea to confirm that there is a growth path and acceptable terms for the option selected.

COSTS

The costs for equipment vary from under $50 for a basic dial-up modem to many thousands of dollars for a satellite dish. More significant are the monthly costs for access. These are based not only on the amount of bandwidth required, but also the pricing formula of the service provider and the regulations under which the service provider operates. For example, frame relay is twice as expensive in some areas of the Southwest than it is in some areas of New England. In the former case, the local telco seeks to recover all of the cost of building the infrastructure for frame relay from the users of the technology; in the latter case, the local telco seeks to spread the cost of building the infrastructure for frame relay over its entire customer base. The public utilities commissions of the states approved these approaches.

Two-year contracts generally are less expensive than one-year contracts, and month-to-month contracts are most expensive of all. Three-year and five-year contracts are sometimes available, but they often lock a library into a rate which is attractive at the time a choice is made, but unattractive after two years because data communication rates have a tendency to go down from year to year.

In 2007, the range of U.S. telco prices ranged from $20 to more than $1,000 per month. Dial-up cost as little as $20 per month, basic DSL approximately $40 per month, FTTP as little as $60 per month (for 15 Mbps upload and 2 Mbps download), T-1 $300 to $400 per month, and OC-3 more than $1,000 a month. Cable broadband typically cost $40 per month. With the exception of cellular data service, which may cost as little as $60 per month; wireless service generally costs more than $400 per month.

Given the many options and great differences in pricing, the best basis for comparison among options is to calculate the cost per Megabit per second (Mbps). In 2007, some options cost seven times as much per Mbps as others. A rule of thumb is to look for more options whenever a cost is quoted at more than $40 per month per Mbps.

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