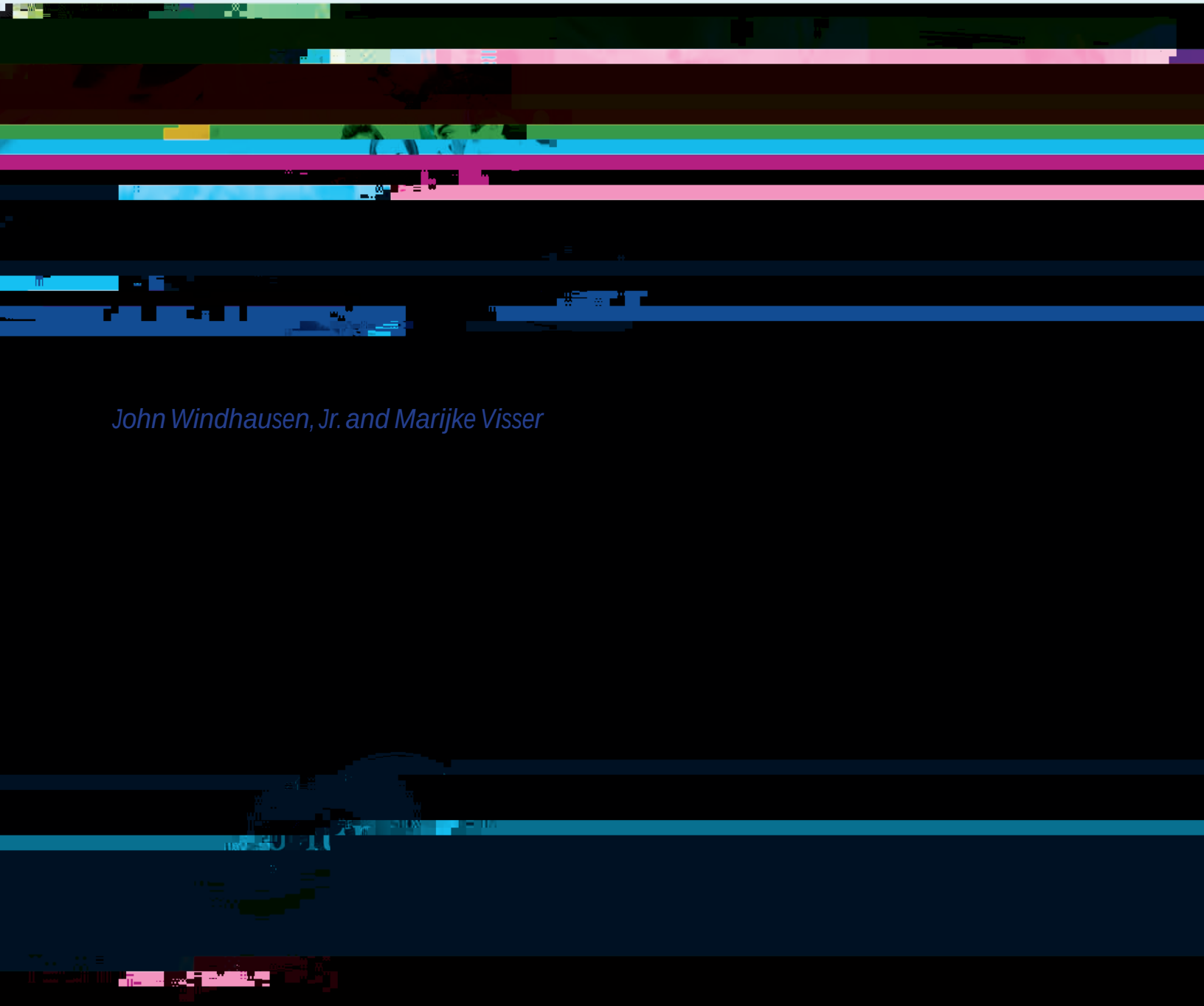
Fiber to the Librar

Ho P blic Libraries Can Bene t from Using Fiber Optics for their Broadband Internet Connection



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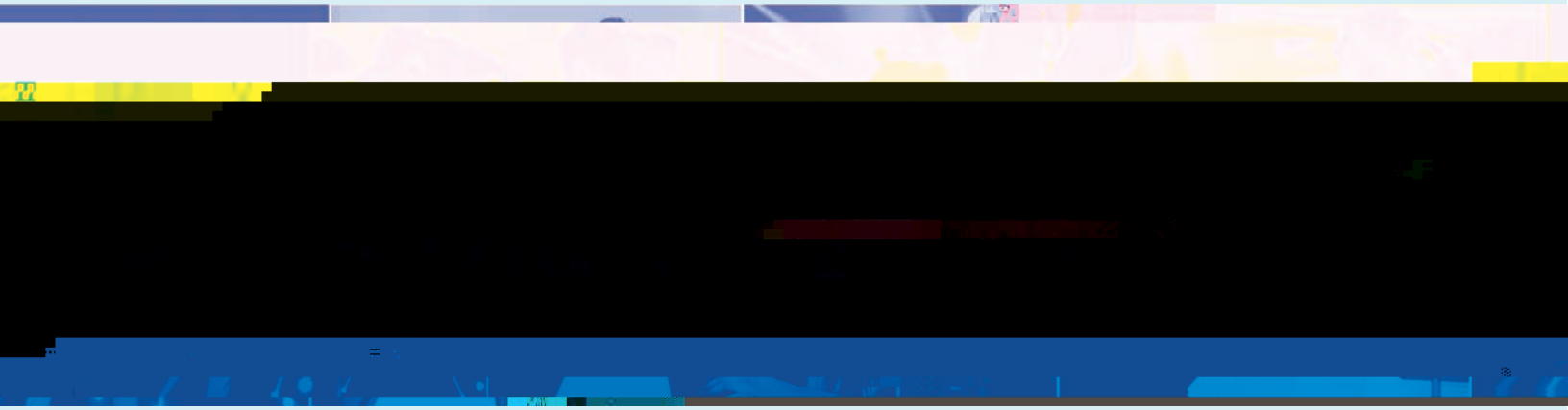

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Fiber to the Library

How Public Libraries Can Benefit from Using Fiber Optics for eir Broadband Internet Connection

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Introduction

Broadband access is enormously important if libraries are to fulfill their mission of serving the American public. People of all ages and backgrounds increasingly depend on the local library's public access computers, Internet access, and reference support to search for jobs, take classes, complete homework assignments, obtain medical information, and receive government information and services. A local library's Internet capabilities can also play an essential role in disaster response and the provision of emergency services.

Unfortunately, the ability of local libraries to meet these community needs is in jeopardy because of inadequate broadband capacity. ere have been several recent news accounts of library patrons waiting in line to use public access computers,[3] and research indicates that libraries increasingly lack su cient broadband capacity.[4] Libraries depend on broadband not just to provide public access to the Internet, but also to conduct their basic operations, including circulation, cataloging, and interlibrary loan. ese multiple uses of the same broadband connection are combining to create severe congestion.

e public's demand on library Internet access will surge as a result of the advent of streaming of high-definition video over the Internet, the increasing prevalence of online job training and employment applications, consumers' growing need for e-government services, and rising numbers of computer terminals and wireless laptop computer users. Instead of waiting for the need to materialize before initiating technology planning, libraries would be better served by anticipating the need and seeking forward-looking solutions today.

To this end, libraries should strongly consider moving to a fiber-based broadband platform. From a technical perspective, fiber optics is the most robust technology

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[3] Richard Co en,, Free Reso rces Dra Residents to Libraries, The Record, March 17, 2009. Accessed March 24, 2009, .le is.com;, B siness Brisk at Area Libraries: In Bad Times, Free Reso rces are a Hot Commodit , Febr ar 2, 2009, a ailable at http:// . ashingtonpost.com/ p-d n/content/

currently available. In contrast to other technologies, such as digital subscriber line (DSL), cable modem, wireless, or satellite, fiber optics provides almost unlimited capacity. As detailed in this paper, a fiber connection gives a library the flexibility to introduce new, innovative services while adapting to the future information needs of its community. In some cases, the costs of a fiber connection may be in the same range as those of obtaining multiple T1 circuits. Yet fiber can o er much more bandwidth and facilitate the addition of even more capacity simply by changing the electronics at either end of the fiber cable. For many libraries, then, fiber is the technology of choice for the twenty-first century.[5]

Fiber allows a library to think beyond basic services and introduce new services and applications that it may previously have been unable to provide because of limited bandwidth.

Some libraries have already been able to obtain a fiber optic circuit for their broadband connection. In Michigan, for instance, 14 percent of libraries have a fiber connection as of mid-2009, and Jackson County libraries expect to have fiber in place by the end of 2009.[6] Fiber has been built to serve the libraries in Beaver County outside of Pittsburgh, Pennsylvania. It is also being used by libraries in a number of other states, including Tennessee, Wisconsin, California, and Mississippi.

e process of obtaining a fiber connection may not be easy, however. For example, no standard process exists for ordering a fiber circuit or leasing fiber capacity. e ability of a library or consortium of libraries to obtain fiber connectivity will vary from location to location, and a library will often have to explore several avenues. Whether or not there is su cient middle-mile connectivity to the Internet will also be an important consideration.[7]

Libraries also have available a variety of options for meeting these challenges. In some cases, they can obtain a fiber connection directly from their local telephone or cable company, a fiber builder, or an Internet service provider (ISP). Other libraries will fare better by partnering with nearby anchor institutions in a municipal-wide network, or they can contract with their state research and education network for a fiber connection. ese options are discussed in detail later in this policy brief.[8]

ALA has prepared this paper to assist libraries in understanding the benefits of fiber optic technology and to suggest strategies they can consider when exploring how to obtain fiber connectivity. No attempt is made to o er a comprehensive and detailed road map for obtaining a fiber connection; given the variety of circumstances in di erent locations, no one solution will work for all. Rather, the purpose of this paper is to

[5] As e plained in more detail belo , the costs of obtaining a ber connection can ar signi cantl from location to location and from pro ider to pro ider. Terrain or other iss es can ca se ber optic sol tions to be cost-prohibiti e in some remote locations. See Appendi B for a disc ssion of sing a satellite as an alternati e to ber optics.

[6] Based on an inter ie ith a leading broadband pro ider in Michigan.

[7] In its R ral Broadband Report, the Federal Comm nications Commission (FCC) describes, middle mile facilities as, the facilities that are commonl sed to connect the 'last mile' ISP [Internet ser ice pro ider] ith an Internet backbone ser ice pro ider (p. 48). And, an ISP pro iding ser ice to s bscribers in a r ral area m st obtain connections to a node of an Internet backbone ser ice pro ider. The facilities making this connection are among those commonl referred to as 'middle-mile' facilities (p. 67).

[8] It is not recommended that libraries seek to take on the task of installing or o ning their o n ber net ork, as the total costs of o nership and maintenance are likel to e ceed their reso rces. This paper ses the term, obtain a ber connection to mean that the librar rece es a ber-based circ it from a third part , either a commercial or go ernment pro ider.

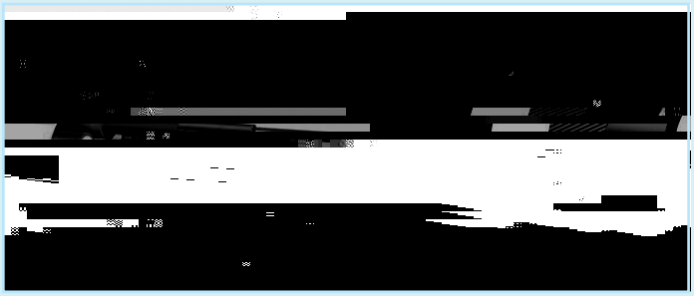
address at a high level some of the basic issues involved in obtaining a fiber connection, which ALA encourages every library to explore.[9]

e next section summarizes the benefits to libraries of having a fiber optic connection. is is followed by a review of options libraries have for obtaining fiber. e fourth section details various strategies for financing a library's fiber optic connection, while the fifth lists questions libraries should ask when considering how to acquire such a connection. In addition, two appendices are provided: Appendix A describes the process used to install a fiber line, while Appendix B examines satellite service as an alternative to fiber for some libraries.

The Basics of Fiber Optic Transmission Technology

A ber optic line is a thin strand of glass that is capable of carr ing data in different a elengths of light. Most non- ber technologies can carr data at rates of from 1 megabit per second (Mbps) to perhaps 200 Mbps. In contrast, a single strand of ber can carr at least 10 gigabits (10,000 megabits) per second. F rthermore, a single ber optic cable ma carr se eral ber strands, so the tr e capacit of a ber optic cable is\ irt all nlimited. The act al transmission speed depends on the electronic eq ipment sed at either end of the cable. To pgrade the speed, it is necessar onl to change the electronics; no change is necessar to the transmission cable itself. For these reasons, ber optics is often described as a, f t re-proof technolog .

Fiber optic cables are increasingl becoming the standard technolog of choice. In the United States, ber optic cables long ago replaced micro a e and satellite as the primar transmission medi m for long-distance telephone and Internet traf c, and most large b sinesses and ni ersities alread ha e local ber connections. Man m nicipalities are deplo ing ber to ser e anchor instit tions (schools, hospitals, cit go ernments, and sometimes libraries), and man ne ho sing de elopments install ber in the gro nd to ser e each ho sehold. Japan and Korea ha e implemented national programs to install ber to homes, and se eral other co ntries (S eden, the Netherlands, France, A stralia, and Ne Zealand) are beginning to do so as ell. Most e perts no recogni/ e that e er home, b siness, and instit tion that ser es the p blic ill req ire a ber optic connection to meet its technolog needs in the foreseeable f t re.



A single ber optic cable ma carr se eral ber strands, so the tr e capacit of a ber optic cable is\ irt all nlimited.

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[9] The Comm nit TeleStr ct re Initiati e (CTI) rst identi ed, ber to the librar as an important national goal in 2007. Under the leadership of Don Means, Fo nder and Principal of Digital Village Associates, CTI held a orkshop in Sa salito, California, to demonstrate the bene ts of ber to the librar .

Benefits of Fiber to the Library

ere are two ways to think about the benefits to libraries of having a fiber connection. First, fiber allows a library to think beyond basic services and introduce new services and applications that it may previously have been unable to provide because of limited bandwidth. Libraries with reliable, high-speed connections are incorporating interactive Web-based applications to engage their users. ey are adding podcasts of book talks, video on demand, geotagging of local landmarks, patron-tagged catalogs, and tweets of the latest fiction to their websites. Young adult librarians are asking teens to post book reviews on blogs and wikis; many hold live chat sessions or provide a platform on their websites for teens to discuss issues with which they are concerned. Innovative programming can include holding webinars, streaming video of community events, and providing real-time videoconferencing for distance education courses. A fiber connection also permits equivalent upload and download speeds—a distinct advantage compared with other technologies, such as DSL and cable modem, that provide a less robust uploading capability.

Second, new services and applications aside, upgrading to a fiber connection may soon be necessary simply to keep pace with changes in technology and the public's growing data needs. To take one example, the nation recently converted from analog to high-definition video signals. e advantage of this shift is that the quality of a video will be much higher. e disadvantage is that real-time job training videos or distance learning classes transmitted in high-definition format require much more bandwidth than analog video signals. For instance, a single real-time high-definition video stream over an Internet connection may require 2.5 Mbps of service, larger than the capacity of the entire T1 connection many libraries have today.[10] An increasing number of websites have video clips embedded into their home pages, which means that simply surfing the web requires significant bandwidth. e demand for greater bandwidth is also driven by e-government services and the need for access to employment, career, and business information. In addition, to reduce their costs, many companies and government agencies are requiring that consumers apply for jobs or government benefits online rather than in person or over the telephone. While doing so may save them money, they are, in e ect, shifting the burden onto libraries, often the only source of free Internet access in a community.

Libraries that simply rely on existing broadband connections that provide less than high-speed capacity will inevitably fall behind.

ese trends indicate that libraries cannot just maintain the status quo. Libraries that simply rely on existing broadband connections that provide less than high-speed capacity will inevitably fall behind.

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Many libraries respond to increased demand for Internet access by adding a second T1 (1.5 Mbps) connection or upgrading to a DS3 (45 Mbps) connection. In many cases, this may not be the best choice. Adding a second T1 line or upgrading to a DS3 line requires that the library upgrade its network hardware, such as by purchasing a new router or an additional serial interface in an existing router, at a potential cost of $5,000. Yet many libraries report that when they add a second T1 line, the additional capacity becomes filled up immediately. Rather than incurring these costs with technology that will likely be inadequate in just a few years, it may be wiser in the long run for the library to obtain a fiber connection that could last for decades.

Options for Fiber Deployment

Once a library has decided to obtain fiber, it will need to choose among several options for deploying the connection; no one solution fits all. ere are at least four options, described below.

Leasing a Fiber Connection from a Commercial Provider

Libraries can obtain a fiber connection by contracting with the local telephone or cable company or other commercial provider. A commercial provider may already have deployed a fiber network in the community, and a connection between the library and that network may be only a short distance. In most instances, however, the company may prefer to provide a given amount of bandwidth without specifying the technology to be employed. Companies often provide standard contract or tari rates for di erent amounts of bandwidth. Negotiation with the provider may be necessary to find a mutually acceptable fiber solution.

Some telephone companies are deploying fiber to the node, a network architecture that can be useful to a library. In this type of network, the telephone company deploys fiber from its central o ce to a cabinet (or a node) in the neighborhood, and copper is used from the node to the library.[11] e library can most likely use existing routing and switching equipment, although some reconfiguration should be expected.

A fiber-to-the-node network can deliver higher bandwidth than would be available on a pure copper circuit, and for that reason can be a worthwhile first step for libraries. However, the remaining "last mile" copper segment between the library and the node restricts the capacity of the circuit. From the perspective of "future-proofing" the library's network, then, bringing

fiber all the way to the library's door is a better long-term solution. A library should work with other anchor institutions in its vicinity to advocate as forcefully as possible for the service provider to deploy a fully fiber-based solution.

Using a Competitive Bid Process to Award a Contract to Serve Multiple Libraries

Another approach is for libraries to solicit competitive bids from commercial providers for a fiber-based solution. Rather than having a single fiber optic cable installed to serve an individual library, a group of libraries may choose to develop a region-wide fiber network that will serve multiple libraries.

Building a regional library network can save costs and provide more e ciencies in at least two ways:

A "bulk" order is likely to yield a less expensive price per library; and

Multiple libraries can aggregate their tra c to a central hub. e costs of the hub can be shared, and the direct link to the ISP can also be shared, thereby reducing transmission costs.

Examples of the Competitive Bid Option

One main librar ith fo r branches in Tennessee ent thro gh the E-rate competiti e bidding process to seek high-speed capacit ser ices incl ding 100 Mbps ser ice at the main librar and 10 Mbps at each of the branches. The pro ider that as selected to pro ide ser ices as a res lt of the competiti e bidding process is an Eligible Telecomm nications Pro ider. Thanks to the E-rate s pport, the librar s stem is able to pa for these high-speed connections.

In another e ample, the librar s stem in Bea er Co nt , Penns l ania, opted to deplo ber to all 11 libraries in the region. Before the ber as installed, each librar had a cable modem and three to fo r comp ters sharing the broadband connection. The ber pro ider, not a telephone compan , connected each of the 11 libraries ith ber back to the main librar , located at the comm nit college. The pro ider aggregated the traf c from all 11 libraries onto a single high-capacit connection to a carrier hotel in Pittsb rgh, here there as a connection to the Internet backbone pro ided b Internet2.

Participating in a Municipal Fiber Network

A library may be included in an overall municipal fiber network designed to serve anchor institutions in the community. is option may be even less expensive than seeking bids from commercial providers to serve multiple libraries simply because the number of additional entities using the fiber network is larger. e city may also have easier or less expensive access than commercial providers to rights-of-way.

is option depends on the local government's willingness to undertake such a fiber project and on community partnerships. Today, businesses, schools, social service

organizations, health care facilities, governments—and, of course, libraries—all require a robust and sustainable Internet connection to provide their services. All of these entities can benefit from a fiber connection. e library can take the lead in the establishment of a community network, but to be successful, may need to look beyond its usual partners. Reaching out to the business community and small telecommunications

Financing the Library's Fiber Connection

Perhaps the biggest question raised about fiber to the library is the cost, including both the up-front costs of deploying the fiber and ongoing maintenance and/or leasing costs. It is extremely di cult to give even a range of standard costs, as they vary substantially from location to location and from provider to provider. erefore, each library must perform its own cost analysis.

In our research, ALA has uncovered anecdotal evidence indicating that the costs of obtaining a fiber connection can sometimes be more reasonable than previously thought. For instance, when interviewing companies that provide fiber connections, we were told that the up-front costs to the company will often fall in the range of $20,000 to $40,000 in urban or suburban areas. e cost estimates varied significantly, however.[13] Some libraries received estimates of less than $20,000, while others received estimates well over $100,000.

Several factors account for this variation. For instance, if a fiber network is already deployed nearby, the cost of extending it to the library will be relatively low. And in general, the more remote the location of the library, the higher the costs are likely to be. As noted, costs will also vary from provider to provider. A company that specializes in deploying fiber (a "fiber builder") may have lp-frerl ald

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State Broadband Programs

Even before the passage of the ARRA by the federal government, several states had embarked on their own broadband funding programs. For instance, California, Idaho, Illinois, Virginia, and several other states provide funding to enhance broadband capabilities. Libraries should explore these opportunities for obtaining funding for a fiber connection in addition to pursuing the federal programs. Spurred by ARRA funding programs, many states are accelerating their statewide broadband strategies. It is important for libraries to participate in the development of such plans and be identified by their state as a key priority.

Questions to Ask When Considering How to Acquire a Fiber Connection

ALA encourages libraries to explore which of the options detailed above provides the best strategy for upgrading their broadband capacity. In some remote locations (for instance, in extremely rural areas), libraries may need to seek alternatives to fiber (e.g., cable, wireless, or satellite [see Appendix B]). In many communities, however, some fiber deployment is likely to be both necessary and realistic, and at least one of the options discussed above is likely to o er a solution.

e following are among the questions a library should ask as it explores a fiber strategy:

Is there a contract held by another entity (state government, higher education institution, county government) from which you can purchase fiber-based service?

Are there existing commercial providers that o er fiber-based services you could purchase?

If there is more than one provider locally, do you have the resources and expertise to create a request for proposals (RFP)?

Is there an existing fiber network owned by a local or nearby municipality, utility, or electric cooperative from which you can purchase fiber capacity?

Is there su cient middle-mile capacity from the ISP to the backbone network to support investment in the last-mile connection?

Do you have or can you hire a fiber design engineer to design a network? If not, here are some additional questions to ask:

- Is there a fiber node or a fiber network already in the community?
- How far is the library from that fiber?
- What are the area's ISPs?
- What kind of local and state telecommunications ordinances are in place?
- What is the geographic makeup of the area?
- Is the library in a rural, suburban, or metropolitan area?
- Is the library part of a library consortium (i.e., county, regional, or state)?
- Is the library part of a branch system?
- What is the current technological infrastructure of the library?

e answers to these questions will vary depending on the individual library's circumstances and will influence the costs of obtaining a fiber connection. In addition to these questions, the library should carefully assess its current capacity needs and understand the network as it is presently configured. Such a site inventory can help the library understand its current bandwidth use and anticipate future needs.

To take advantage of the ARRA broadband funding—which must be expended within three years of receipt—libraries must be able to estimate the timeline necessary to complete a fiber upgrade project. A time estimate should be negotiated with the fiber company as part of the contract.

Conclusion

Fiber optic technology provides unique capabilities that are unmatched by other transmission media. e capacity of a fiber cable is almost unlimited; a fiber connection is often capable of carrying several hundred Gbps, and may be easily upgraded by changing the equipment used to transmit the data. e costs of and processes for installing fiber are so closely linked to local circumstances that libraries will need to understand what influencing factors are at play in their communities. Strong leadership and a willingness to partner with people and organizations that can act as champions will help libraries of all sizes make the case for supporting a fiber to the library initiative.

Strong leadership and a willingness to partner with people and organizations that can act as champions will help libraries of all sizes make the case for supporting a fiber to the library initiative.

Libraries need to be proactive and take advantage of publicly available sources of information on what is necessary for establishing a fiber connection. Using such sources, it is possible, in some communities, to determine whether multiple carriers could supply a fiber optic line, as well as where fiber is already laid. Libraries can use this information to estimate the costs of obtaining a fiber connection. In many cases, a library may find it worthwhile to pay a little more for a fiber connection because of the greater bandwidth it provides and/or the ease of upgrading the bandwidth to accommodate future growth and service needs.

Regardless of whether a library negotiates with an ISP or fiber provider to obtain a fiber connection, decides to obtain a fiber optic network by partnering with other community anchor institutions, or opts to connect to a local node, it will need to have a precise site inventory prepared before starting the project. is inventory should include a plan for meeting future broadband needs, as well as for sustaining the network. When negotiating terms of service with the provider, the library should address network maintenance, recurring costs, and accountability for end-to-end service. Fiber optics may be the surest path to adequate long-term bandwidth capacity, but the library will need to have an equally sure plan for sustaining the connection.

Appendix A: Installing the Fiber Line

Appendix B: Satellite Options for Broadband

A fiber optic Internet connection is not necessarily the right broadband solution for all libraries. In some regions of the country, libraries may find that their best broadband alternative is satellite.

From the perspective of a rural library, a satellite connection operates similarly to a hybrid copper/fiber connection with an Ethernet hand-o . e satellite provides access to the Internet up to the library's "door," and a satellite modem "translates" the signal to an internal Ethernet network. In this case, the satellite company routes incoming information (packets) via microwave signals sent from its own satellite dish to a satellite orbiting the earth and back down to the library's dish. From the library's satellite dish, the signal goes through a satellite modem that connects the computers to the satellite network. e process is reversed for outgoing information. Upload and download speeds vary depending on the satellite provider and the packages it o ers. Download speeds are often faster than upload speeds, with one company o ering 1.5 Mbps down and 256 Kbps up, and another o ering 5 Mbps down and 300 Kbps up ($95.90 per month and $349.99 per month plus installation, respectively). In addition to the monthly service fees, there are several initial one-time fees: an installation charge; a start-up fee for activating the service (for example, $99.95 for lease start-up costs); and an equipment cost for the satellite dish, modem, cable lines, and internal routers.

Satellite service is available virtually throughout the United States and is not dependent on an existing fiber or cable line being in the area. It does, however require a clear view of the southern sky so that signals can be sent to and received from the orbiting satellite.[16] Moreover, while satellite is a solution for communities for which fiber is cost-prohibitive, it also has some drawbacks compared with fiber. First, it is not future-proof. Second, because of the transmission technology, there is often at least a half-second delay (latency) between the time an end user sends a piece of information out and it is received at the other end. e delay is unavoidable because satellites are located 22,000 miles above the earth's surface. In practice, this delay can interfere with the streaming of a video or disrupt interactive games. Users will notice a decrease in performance with these bandwidth-intensive applications. In addition to latency issues, weather can a ect the quality and speed of satellite service.[17]

[16] For more information and comparisons of broadband options, see High Speed Internet at http:// .high-speed-internet-access-g ide.com/.

[17] See http:// . ildbl e.com/abo tWildbl e/qaa.jsp#5_6 for an e ample of one satellite pro ider.

Acknowledgments

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Central Mississippi Library System

First Regional Library System

Hancock County Library System

Mississippi Library Commission

South Mississippi Regional Library System

Abo t the A thors

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Related Work from OITP

R . / . / . . , E-Ra , by Carrie Lowe
The federal Ed cation-rate (E-rate) program pro ides libraries ith disco nts on telecomm ni-cations ser ices. Lo e describes the comple it of the c rrent program r les and application process, b t q ickl shatters some common m ths abo t the program. O erall, libraries sho ld take greater ad antage of the E-rate program to s pport their ongoing broadband e penses.

R . / q L/b a C . , a / , a . , F . , B a ba
Man librarians recogni/ e the importance of impro ed broadband capabilities, b t lack the reso rces to obtain them. This report disc sses the technical, nancial, and administrati e challenges that libraries face in pgrading broadband capabilities, and ho regional librar cooperati es can help to o ercome these challenges.

O . , G L , , / OITP', P b / L/b a C . , / . S . . by Timothy Vollmer
Vollmer disc sses the st d 's ke ndings, barriers to increasing broadband for libraries, and methods to o ercome the challenges libraries face. The article concl des b recommend-ing that libraries need to plan for f t re connecti it needs, form s pporti e partnerships in the librar comm nit , and be part of the p blic debate o er broadband deplo ment.

These works are accessible at **http://www.ala.org/oitp**.

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