

# Fiber to the Library

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



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## *How Public Libraries Can Benefit from Using Fiber Optics for Their 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. There have been several recent news accounts of library patrons waiting in line to use public access computers,<sup>3</sup> and research indicates that libraries increasingly lack sufficient broadband capacity.<sup>4</sup> 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. These multiple uses of the same broadband connection are combining to create severe congestion.

The 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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<sup>3</sup> Richard Cowen, "Free Resources Draw Residents to Libraries," *The Record*, March 17, 2009. Accessed March 24, 2009, [www.lexis.com](http://www.lexis.com); "Business Brisk at Area Libraries: In Bad Times, Free Resources are a Hot Commodity," February 2, 2009, available at <http://www.washingtonpost.com/wp-dyn/content/article/2009/02/01/AR2009020102331.html?hpid=topnews>. Accessed June 12, 2009; also see "Job Seeking in U.S. Public Libraries" (2009), <http://www.ala.org/ala/research/initiatives/plftas/issuesbriefs/Issues%20brief-jobs.pdf>.

<sup>4</sup> See the Public Library Funding & Technology Access Study, available online at <http://www.ala.org/ala/research/initiatives/plftas/index.cfm>.

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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 offer 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.<sup>5</sup>

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.<sup>6</sup> 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.

The 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. The 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 sufficient middle-mile connectivity to the Internet will also be an important consideration.<sup>7</sup>

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. These options are discussed in detail later in this policy brief.<sup>8</sup>

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 offer a comprehensive and detailed road map for obtaining a fiber connection; given the variety of circumstances in different locations, no one solution will work for all. Rather, the purpose of this paper is to

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<sup>5</sup> As explained in more detail below, the costs of obtaining a fiber connection can vary significantly from location to location and from provider to provider. Terrain or other issues can cause fiber optic solutions to be cost-prohibitive in some remote locations. See Appendix B for a discussion of using a satellite as an alternative to fiber optics.

<sup>6</sup> Based on an interview with a leading broadband provider in Michigan.

<sup>7</sup> In its Rural Broadband Report, the Federal Communications Commission (FCC) describes “middle mile” facilities as “the facilities that are commonly used to connect the ‘last mile’ ISP [Internet service provider] with an Internet backbone service provider” (p. 48). And “an ISP providing service to subscribers in a rural area must obtain connections to a node of an Internet backbone service provider. The facilities making this connection are among those commonly referred to as ‘middle-mile’ facilities” (p. 67).

<sup>8</sup> It is not recommended that libraries seek to take on the task of installing or owning their own fiber network, as the total costs of ownership and maintenance are likely to exceed their resources. This paper uses the term “obtain” a fiber connection to mean that the library receives a fiber-based circuit from a third party—either a commercial or government provider.

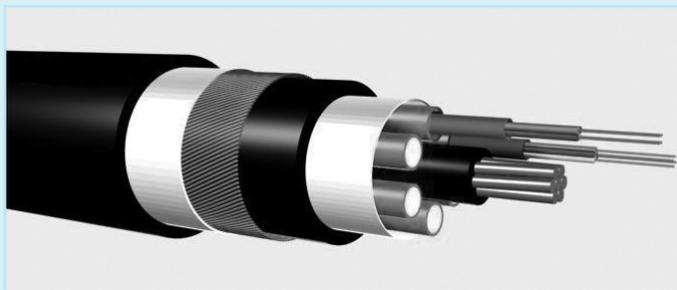
address at a high level some of the basic issues involved in obtaining a fiber connection, which ALA encourages every library to explore.<sup>9</sup>

The next section summarizes the benefits to libraries of having a fiber optic connection. This is followed by a review of options libraries have for obtaining fiber. The 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 fiber optic line is a thin strand of glass that is capable of carrying data in different wavelengths of light. Most non-fiber technologies can carry data at rates of from 1 megabit per second (Mbps) to perhaps 200 Mbps. In contrast, a single strand of fiber can carry at least 10 gigabits (10,000 megabits) per second. Furthermore, a single fiber optic cable may carry several fiber strands, so the true capacity of a fiber optic cable is virtually unlimited. The actual transmission speed depends on the electronic equipment used at either end of the cable. To upgrade the speed, it is necessary only to change the electronics; no change is necessary to the transmission cable itself. For these reasons, fiber optics is often described as a "future-proof" technology.

Fiber optic cables are increasingly becoming the standard technology of choice. In the United States, fiber optic cables long ago replaced microwave and satellite as the primary transmission medium for long-distance telephone and Internet traffic, and most large businesses and universities already have local fiber connections. Many municipalities are deploying fiber to serve anchor institutions (schools, hospitals, city governments, and sometimes libraries), and many new housing developments install fiber in the ground to serve each household. Japan and Korea have implemented national programs to install fiber to homes, and several other countries (Sweden, the Netherlands, France, Australia, and New Zealand) are beginning to do so as well. Most experts now recognize that every home, business, and institution that serves the public will require a fiber optic connection to meet its technology needs in the foreseeable future.



A single fiber optic cable may carry several fiber strands, so the true capacity of a fiber optic cable is virtually unlimited.

Illustration by S.R. Leffler. Licensed under the Creative Commons Attribution ShareAlike 3.0.

<sup>9</sup> The Community TeleStructure Initiative (CTI) first identified "fiber to the library" as an important national goal in 2007. Under the leadership of Don Means, Founder and Principal of Digital Village Associates, CTI held a workshop in Sausalito, California, to demonstrate the benefits of fiber to the library.

## Benefits of Fiber to the Library

There 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. They 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. The advantage of this shift is that the quality of a video will be much higher. The 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.<sup>10</sup> An increasing number of websites have video clips embedded into their home pages, which means that simply surfing the web requires significant bandwidth. The 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 effect, shifting the burden onto libraries, often the only source of free Internet access in a community.

These 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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<sup>10</sup> See the Public Library Funding & Technology Access Study, available online at <http://www.ala.org/ala/research/initiatives/plftas/index.cfm>.

## Testimonials on Fiber to the Library

The following testimonials were offered by librarians or network managers at libraries that have recently converted to a fiber solution. These testimonials emphasize the frustrations libraries experience in trying to keep pace with the increasingly bandwidth-heavy applications and websites their users are accessing and more important, how that frustration is relieved by having adequate bandwidth to accommodate users' needs.\*

We had so many problems with up/down service with the old circuit that I was about to pull some wire and put some tin cans on it...Fiber has definitely made a positive difference for our library...we will have to explore a larger circuit due to the extreme overuse of the new circuit (already), but I am pleased as far as up/down time is concerned.

...a library with twenty PACs [public access computers] needs more than a T1. Before everything on the Internet was video [high speed was not necessary]; now everything is video, and one PC on Disney.com can take up a T1... Libraries are getting busier with the economy's downturn; this shows in job searching.

Before we made the move, we had frequent daily periods when our ILS [integrated library system] was down for hours at varying branches because there was insufficient bandwidth...If your branch had not been able to connect to [the ILS] during the extremely busy after-school hours, you were usually not going to be able to connect until after 5:30 each day when branches started closing for the day. Branches had to write down circulation information and enter it after peak network hours. Although we had this great automation system, at times, we were working as though we didn't have it, simply because we had insufficient bandwidth...

...since all traffic was routed through Headquarters, the public computer users were affected as well. Pages were slower to load and to respond. Patrons needing assistance from the reference staff in locating information were not helped as efficiently...Users using our ILS catalog from home had slower response time. It affected all users—both staff and patrons...Once we upgraded [to fiber], all of those problems were solved.

...we are able to have enough bandwidth to take care of the [ILS] needs, 13 patron PACs, and 3 OPACs [online public access catalogs], plus staff and any wireless patron-owned laptops [referring to a shared fiber system].

The larger pipes (6 Mbps) afford the regional library system faster speed, better connections, and more reliability. Interestingly, whenever we introduce bigger and faster connections, the bandwidth used in those connections is almost immediately "used up" by our Internet-loving patrons.

The library is partnering with a state employment and training agency [name withheld] and setting up videoconferencing for job interviews. So people come to the library to practice and do actual interviews. [one nonprofit fiber company's description of what one library is able to do now that fiber has been installed]

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\*These anecdotes originate from personal phone conversations and e-mails between the authors and staff in libraries that recently implemented a fiber optic Internet connection. The quotes are from rural branch libraries, metropolitan branch libraries, and a network manager of a metropolitan system. The information was gathered in April and May 2009.

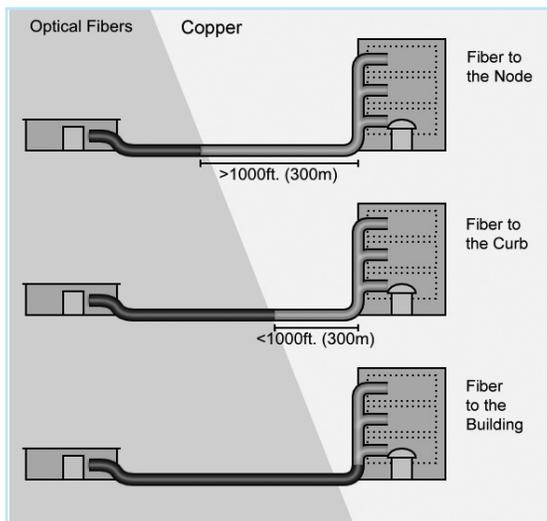
Many libraries respond to increased demand for Internet access by adding a second T1 (1.5 Mbps) connection or upgrading to a DS3 (45 Mbps) connection. In many cases, this may not be the best choice. Adding a second T1 line or upgrading to a DS3 line requires that the library upgrade its network hardware, 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. There 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 tariff rates for different amounts of bandwidth. Negotiation with the provider may be necessary to find a mutually acceptable fiber solution.



A schematic illustrating how FTTx architectures vary with regard to the distance between the optical fiber and the end user. The building on the left is the central office; that on the right is one of the buildings served by the central office. Dotted rectangles represent separate living or office spaces within the same building. Illustration by Riick. licensed under the Creative Commons Attribution ShareAlike 3.0 License.

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 office to a cabinet (or a node) in the neighborhood, and copper is used from the node to the library.<sup>11</sup> The 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

<sup>11</sup> The fiber-to-the-node option is most often possible in suburban locations where new construction includes fiber or where providers are switching copper systems to fiber.

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 efficiencies in at least two ways:

- A “bulk” order is likely to yield a less expensive price per library; and
- Multiple libraries can aggregate their traffic to a central hub. The 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 library with four branches in Tennessee went through the E-rate competitive bidding process to seek high-speed capacity services including 100 Mbps service at the main library and 10 Mbps at each of the branches. The provider that was selected to provide services as a result of the competitive bidding process is an Eligible Telecommunications Provider. Thanks to the E-rate support, the library system is able to pay for these high-speed connections.

In another example, the library system in Beaver County, Pennsylvania, opted to deploy fiber to all 11 libraries in the region. Before the fiber was installed, each library had a cable modem and three to four computers sharing the broadband connection. The fiber provider, not a telephone company, connected each of the 11 libraries with fiber back to the main library, located at the community college. The provider aggregated the traffic from all 11 libraries onto a single high-capacity connection to a “carrier hotel” in Pittsburgh, where there was a connection to the Internet backbone provided by 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. This 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. The city may also have easier or less expensive access than commercial providers to rights-of-way.

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

## An Example of the Municipal Fiber Network Option

A number of municipalities have begun deploying fiber networks to serve their communities, often including libraries. For example, the city of Rose Hill, Virginia, deployed a fiber optic network in 2007 that provides high-speed Internet connectivity to 150 homes, the Rose Hill Elementary School, the Rose Hill Public Library, and several small businesses. Funding for this fiber network came from a variety of federal and state sources and was spearheaded by U.S. Congressman Rick Boucher.\*

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\* Statement of Congressman Rick Boucher. Rose Hill Fiber Optic Project Lighting Event. June 11, 2007.  
[http://www.boucher.house.gov/index.php?option=com\\_content&task=view&id=1119&Itemid=&bsb\\_midx=-2](http://www.boucher.house.gov/index.php?option=com_content&task=view&id=1119&Itemid=&bsb_midx=-2)

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. The 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 providers can yield additional and unexpected allies. However, librarians should be aware that efforts to provide services to the general public through a municipal network may be opposed by the incumbent telecommunications carrier or restrained in some manner by state utility commission regulations or state statutes.

### Working with a State Research and Education Network

More than 30 states have nonprofit research and education networks whose specialty is providing high-bandwidth networking capability to state government offices and other anchor institutions statewide.<sup>12</sup> Libraries can leverage such a network to meet their needs.

## Examples of Working with a State Research and Education Network

In Michigan, the Merit Network is a nonprofit network owned by the state's public universities. Merit provides a 1 gigabit per second (Gbps) fiber connection to the Ann Arbor main library and also serves the city's other four libraries. In another case, a direct fiber connection was provided by a nonprofit state research and education network owned and operated by the universities in the state. In this case, the up-front cost of providing the fiber connection to the library was only \$16,000 because a fiber cable had already been laid in the neighborhood, which meant that the new fiber connection for the library was relatively short. The network provider recovered the cost of building the connection by assessing a monthly charge to the library over three years.

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<sup>12</sup> See <http://www.thequilt.net/>.

## 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 difficult to give even a range of standard costs, as they vary substantially from location to location and from provider to provider. Therefore, 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. The cost estimates varied significantly, however.<sup>13</sup> 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 lower costs than an incumbent provider.

In addition to up-front deployment costs, several types of maintenance costs must be anticipated. For instance, if the fiber is installed over telephone or electric poles (aerial fiber), there may be per-pole charges or maintenance costs associated with storm damage. Also, most libraries choose to purchase a monthly maintenance contract as insurance in case the fiber is broken (for instance, by construction) or if it needs to be moved (for instance, to accommodate a new highway or building). Libraries are not required to purchase such a contract and can choose to self-insure; however, if the fiber is broken or needs to be moved, the costs can be significant—as much as the initial investment or more.

Another difficulty in estimating the costs of fiber to the library is that the costs to the service provider may be quite different from the price paid by the library. Many of the initial deployment costs are rolled into the maintenance costs, and both are recovered by the service provider in a monthly charge to the library (see below). Libraries will need to obtain specific price information from the service provider before deciding how best to pursue the fiber option.

Several options for financing a fiber connection are summarized below. In all cases, however, it is important to consider the total cost of receiving the service, including not only deployment, but also such ongoing costs as maintenance, fiber electronics upgrades, network monitoring, and technical staff requirements.

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<sup>13</sup> See Appendix A for a description of some of the factors that affect the costs of deploying fiber.

## Amortizing the Cost in the Library's Monthly Payment

As discussed above, many fiber providers will recoup the costs of deploying the fiber connection through higher monthly payments. Some nonprofit providers will seek only to recover their costs and will reduce monthly charges after receiving compensation for their construction costs. One provider, for example, charged the library a higher monthly amount for three years until it had recovered the up-front deployment costs; at the end of the third year, the monthly charge dropped substantially. Commercial providers, however, often assess a monthly charge for use of the fiber with no end date.

## Obtaining E-rate Assistance

A library may be able to take advantage of E-rate discounts if it obtains commercially available capacity (services) from an Eligible Telecommunications Provider. The E-rate program, however, has many specific requirements. For instance, dark fiber is not currently E-rate eligible.<sup>14</sup> It is also important to emphasize that the leasing of fiber from a municipality is not eligible for E-rate discounts.

## Obtaining a Grant or Loan from the Federal Government's Broadband Programs

The federal economic stimulus legislation (American Recovery and Reinvestment Act, or ARRA) provides a total of \$7.2 billion in funding for broadband connectivity. The Act divides these funds between the programs of two federal agencies: the National Telecommunications and Information Administration (NTIA) within the Department of Commerce is responsible for \$4.7 billion, while the Rural Utilities Service (RUS) within the Department of Agriculture is responsible for \$2.5 billion. NTIA's broadband program, the Broadband Technology Opportunities Program (BTOP), specifically mentions libraries as entities eligible for this funding. The program requirements governing the first round of funding were issued on July 1, 2009. Members of the library community should examine these programs closely to determine their library's eligibility for obtaining a grant or loan.<sup>15</sup>

In addition to applying for a grant or loan under one of these two ARRA programs, libraries should contact their local telephone company, cable company, or other service provider to determine whether they can be included in any plans the provider has to apply for a grant or loan. The ARRA programs have generated a great deal of interest within the telecommunications industry, and many providers are applying for grants and loans under the programs. The ARRA specifically indicates that providing service to community institutions such as libraries is one of the key goals of the legislation. Therefore, including libraries in an application is likely to increase the chances of receiving funding, and commercial providers have a strong incentive to work with libraries in their application process.

*Spurred by ARRA funding programs, many states have been accelerating their statewide broadband strategies. It is important for libraries to participate in the development of such strategies and be identified by their state as a key priority.*

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<sup>14</sup> Dark fiber refers to laid fiber with no electronics attached at the ends of the cable to allow information packets or traffic to be sent across it.

<sup>15</sup> Detailed information about federal broadband stimulus developments may be found at <http://www.ala.org/knowyourstimulus>, a Web resource of ALA's Washington Office. Federal information about these programs is available at <http://www.broadbandusa.gov>.

## 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 offer a solution.

The 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 offer 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 sufficient 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?

The 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. The 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. The 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.

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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. This 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

To understand how a fiber provider arrives at its fee structure, it is helpful to consider the process used to install a fiber line to the library. The provider begins the fiber to the library build-out with a preliminary site review. For a buried fiber line, this review includes determining the following:

- How far the library is from any existing fiber;
- Whether there are conduits in the library to reach to the existing fiber;
- Whether the physical entry point at the library is adequate to pull fiber through those conduits;
- Whether the equipment room is equipped with appropriate power, space, and heating, ventilation, and air conditioning (HVAC) systems;
- What kind of housing is available for the fiber splicing; and
- Whether different libraries will be networked together.

After the site review, the provider develops a design plan for the library. This plan includes estimates of the timeframe for the project, as well as costs. To help derive these estimates, the company assesses the geography of the area; for example, the more rock that is in the way, the higher the cost and the more time-intensive the process.

The provider will need to acquire any necessary construction permits, determine public rights-of-way, negotiate any private easements, verify whether there are construction moratoriums in place, and obtain any necessary waivers. For example, one community limits opening manhole covers to once every three years; before starting a fiber project, a provider may have to obtain a waiver. Finally, the company must procure any equipment necessary for the project.

Some fiber companies prefer to string fiber on telephone poles rather than invest in burying fiber cables. While this may be the most cost-effective and practical approach in some areas, the provider must still determine who owns the poles and whether there is enough room for an additional line, be granted permission to attach a fiber line, and calculate the cost. Wire clearances are determined by local, state, and federal regulations. Poles are not necessarily owned by the same entity, nor are prices standardized. All of these factors can be significant and contribute to the time and cost of a fiber to the library project, and a fiber company needs to be adept at working through them.

In addition to these costs incurred by the fiber provider that affect the total cost to the library, preliminary site renovations within the library may be necessary. Those costs will most likely be the responsibility of the library, but can be addressed in the initial contract negotiations.

## 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-off. The 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. The process is reversed for outgoing information. Upload and download speeds vary depending on the satellite provider and the packages it offers. Download speeds are often faster than upload speeds, with one company offering 1.5 Mbps down and 256 Kbps up, and another offering 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.<sup>16</sup> 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. The 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 affect the quality and speed of satellite service.<sup>17</sup>

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<sup>16</sup> For more information and comparisons of broadband options, see High Speed Internet at <http://www.high-speed-internet-access-guide.com/>.

<sup>17</sup> See [http://www.wildblue.com/aboutWildblue/qaa.jsp#5\\_6](http://www.wildblue.com/aboutWildblue/qaa.jsp#5_6) for an example of one satellite provider.

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### ***Regional Library Cooperatives and the Future of Broadband***

Many librarians recognize the importance of improved broadband capabilities, but lack the resources to obtain them. This report discusses the technical, financial, and administrative challenges that libraries face in upgrading broadband capabilities, and how regional library cooperatives can help to overcome these challenges.

### ***On-the-Ground Lessons from OITP's Public Library Connectivity Study by Timothy Vollmer***

Vollmer discusses the study's key findings, barriers to increasing broadband for libraries, and methods to overcome the challenges libraries face. The article concludes by recommending that libraries need to plan for future connectivity needs, form supportive partnerships in the library community, and be part of the public debate over broadband deployment.

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



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