


# Making Connections: Lessons from Five Shared Library Networks



ALA Office for Information Technology Policy



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# Making Connections: Lessons from Five Shared Library Networks





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## SUMMARY



The core mission of libraries is to connect people with ideas and information. Increasingly vital to fulfilling that mission is providing users with no-fee public access to the Internet. This publication profiles five library networks that have, through varying approaches, achieved success in upgrading their broadband connectivity to provide this essential service:

- The Ohio Public Library Information Network (OPLIN) is a centralized system, funded by the state government, that provides local broadband connections to all the main public libraries in the State of Ohio at no charge to the libraries. OPLIN's branch libraries obtain their own local broadband connection. OPLIN also serves as the Internet service provider (ISP) for and provides technical support to all the libraries in the state.
- The West Virginia Library Commission (WVLC) operates a centralized Statewide Library Network (SLN) that connects all libraries in the state with a standardized DS1 connection. The WVLC also standardized libraries' technology infrastructure at the state level so that technical support staff can quickly and easily find solutions to technical problems that arise.
- Wisconsin's BadgerNet provides comprehensive end-to-end service, including a statewide backbone network and middle-mile and last-mile connectivity, to nearly all of the public libraries in the state. Wisconsin libraries are organized into 17 regional library systems that manage wide area networks (WANs) and provide technical support. Wisconsin also has a state universal service fund that subsidizes the cost of local broadband connections for K-12 schools and public libraries and provides additional state aid to regional library systems.
- The Maine School and Library Network (MSLN) was one of the first statewide networks, initially funded in 1996 from telephone company overcharging of its customers. Unlike the networks of other states, MSLN does not have a central backbone, but funds direct connections from each school and library to two aggregation points operated by the State of Maine's ISP (UNET). Like Wisconsin, Maine funds library connectivity in part from a state surcharge on in-state telephone services.
- The Peninsula Library System (PLS) serves 35 branch libraries in San Mateo County (California). After encountering severe congestion on its Peninsula Libraries Automated Network (PLAN), PLS recently upgraded the network to fiber-based services from AT&T.

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*Leadership from the library community was critically important in convincing policy makers to authorize and fund the network.*

The case studies of these five networks revealed both commonalities and variations that are instructive for other libraries seeking to establish a successful network. Common themes such as the following were identified:

- **Leadership and cooperation**—Leadership from the library community was critically important in convincing policy makers to authorize and fund the network, but no one person bore this responsibility. Libraries usually worked together with schools and other state agencies to cooperate on a comprehensive network plan.
- **Aggregation of demand and services**—Rather than each library obtaining its own bandwidth independently, these library systems sought to involve the entire library community in joint planning to design a shared network. For instance, by aggregating traffic in a hub, libraries can obtain a lower-cost connection to the Internet, and by purchasing local broadband connections in bulk, they can obtain lower prices for each local broadband circuit. Sharing technical staff, training, and E-rate support also can reduce expenses.
- **State Library involvement**—A common characteristic of the four statewide networks<sup>1</sup> is the active involvement of the State Library and the state librarian.

Variations among the case study networks include the following:

- **Funding sources vary**—OPLIN is a state agency that receives direct appropriations from the Ohio state government. The WVLC receives a variety of grant funds from foundations in addition to state government funding. MSLN was initiated by the state regulatory commission, which found that the telephone company had overcharged consumers and directed some of the excess earnings to fund a new school and library network. Both the Maine and Wisconsin networks are funded in part by state universal service fees collected from intrastate communications services. PLS is funded by member fees derived from city and county property taxes.
- **The technologies used to provide local broadband connections also vary**—West Virginia recently succeeded in converting all libraries to a T1 (DS1) connection (1.5 megabits per second [Mbps]), while Wisconsin is converting its libraries to a 3 Mbps service. Maine is considering replacing its T1-based network with a fiber-based network. Ohio is transitioning some of its circuits to fiber-based Ethernet circuits. And PLS has already upgraded all of its libraries to a 5–10 Mbps service over a fiber connection.
- **Some of the networks provide all the funding for libraries' local broadband connections, while others do not**—OPLIN funds the entire cost of local broadband connections for main libraries but not for branch libraries. Wisconsin provides subsidies that substantially reduce the costs of local library (and school) broadband connections. Maine does not fund local connections, but it helps libraries obtain E-rate assistance. West Virginia provides the entire cost of its libraries' local connections.

<sup>1</sup> PLAN is a countywide network.



- **Some of the library networks are integrated with other state agencies, while some serve only the library community**—Wisconsin’s BadgerNet serves all state agencies as well as libraries. MSLN serves schools in addition to libraries. The West Virginia, Ohio, and PLS networks serve only libraries.
- **The five networks have widely varying governing structures**—Some of these structures do not include local library representatives in network governance: The Maine Public Utilities Commission governs MSLN; Wisconsin’s Department of Administration governs BadgerNet; and the West Virginia Library Commission administers SLN. OPLIN and PLS, in contrast, are governed by member library representatives.

*[T]here is no single recipe for a successful library network; rather, the case studies provide a set of options for other libraries to consider as they go forward.*

The five case studies demonstrate, then, that there is no single recipe for a successful library network; rather, the case studies provide a set of options for other libraries to consider as they go forward. Options derived from experience with several different networks can be combined to form a solution tailored to the unique circumstances of a particular community, region, or state, meeting the needs of users and increasing the chances for success.

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# 1 INTRODUCTION



Libraries are at the forefront of providing no-fee Internet access to the public. In 1994, just 8.2 percent of public libraries provided this service;<sup>2</sup> as of 2009, 100 percent of libraries do so. While this is a vital role in every community, the library is the only source of no-fee public Internet access in 71 percent of communities.<sup>3</sup>

The core mission of libraries is to connect people with ideas and information. Internet access makes it possible for libraries to fulfill this mission through online resources that can, for example, help people find jobs, improve their skills, access government services, create small businesses, complete school homework, and conduct research. Libraries have reported high demand for Internet access; indeed, in the majority of libraries, the demand for public-access computers far outweighs the supply.<sup>4</sup>

As demand for public access to the Internet grows, so, too, does the need for higher bandwidth in the library. In some communities, libraries play the important role of broadband anchor institution; in other words, by obtaining high-bandwidth connections, they drive the deployment of advanced technologies to communities that might be unable to obtain that level of service through residential demand alone.

In short, libraries that are able to meet the demand for no-fee public Internet access play a vital role in serving both their users and their communities. To help libraries achieve this capability, the Bill & Melinda Gates Foundation initiated the Opportunity Online Broadband Grant Program. This program provides funding and support to help State Library agencies in seven states—Massachusetts, New York, Virginia, Arkansas, Kansas, California, and Texas—develop leadership and improve library connectivity to the Internet. The American Library Association’s Office for Information Technology Policy (OITP) is participating in this program, providing research and consulting services to state libraries, as well as developing publications that address key issues salient to the program’s goals.<sup>5</sup>

The purpose of this publication is to provide a snapshot of five different library networks that provide users with no-fee Internet access. Libraries can establish such networks in many different ways and with various leadership structures, so the case study sites were

*[L]ibraries that are able to meet the demand for no-fee public Internet access play a vital role in serving both their users and their communities.*

<sup>2</sup> John Carlo Bertot, Charles R. McClure, and Patricia Diamond Fletcher, *The National Survey of U.S. Public Libraries and the Internet* (Washington, D.C.: American Library Association, Office for Information Technology Policy, 1997).

<sup>3</sup> Denise M. Davis et al., *Libraries Connect Communities 3: Public Library Funding and Technology Access Study* (Chicago: American Library Association, 2009).

<sup>4</sup> *Ibid.*

<sup>5</sup> For additional information regarding the Gates Foundation program, see <http://www.gatesfoundation.org/press-releases/Pages/faster-internet-connections-in-libraries-081218.aspx>.

selected to represent a sample of differing but equally successful networks. The objective was not to provide replicable models, but to highlight approaches that might guide future network development efforts.

Section 2 presents an overview of the five case study networks. This overview serves as essential background for a discussion of lessons learned from the case studies in Section 3. Sections 4 through 8 then offer a detailed discussion of each case study. Two appendices are also included: Appendix A contains a technical primer on broadband connectivity and networking strategies for those unfamiliar with these concepts, while Appendix B provides a glossary of terms that was developed for the state summits associated with the Opportunity Online Broadband Grant Program and updated for this publication.

*Strong leadership was an essential element in the development of each of these five networks.*

#### METHODOLOGY

A team of OITP researchers reviewed relevant publications, including state laws and regulations and network plans and reports, and interviewed network staff members and their managers to gather information on the five library networks featured in this publication. The researchers then analyzed the data to identify similarities and differences among the networks. This research took place between January and November 2009.

## 2 OVERVIEW OF THE CASE STUDY NETWORKS



The case studies focused on five networks:

- The Ohio Public Library Information Network (OPLIN)
- The West Virginia Statewide Library Network (SLN)
- Wisconsin's BadgerNet
- The Maine School and Library Network (MSLN)
- California's Peninsula Libraries Automated Network (PLAN)

The first four of these are state networks, while the last is regional (in California's San Mateo County).

### Ohio Public Library Information Network

OPLIN is a centralized system whose primary function is to provide broadband connections to the main public libraries in the state. In addition, OPLIN is the Internet service provider (ISP) for all the libraries in Ohio and provides access to a set of information databases that libraries might not be able to afford on their own. All of these services are provided at no direct cost to the libraries.

Unlike many other statewide library networks, OPLIN coordinates the acquisition and installation of the physical network connecting libraries to the Internet. It is transitioning those connections to fiber-based Ethernet circuits.<sup>6</sup> As a result, Ohio libraries generally have faster Internet connections than those in many other states: about 60 percent of Ohio libraries report having broadband connections that are faster than 1.5 megabits per second (Mbps), compared with the national average of 45 percent.<sup>7</sup>

### West Virginia's Statewide Library Network

The West Virginia Library Commission (WVLC) established the centralized SLN to provide all of the state's public library systems with broadband Internet connections and a wide variety of technical assistance, including support for the online catalog. SLN provides Internet access, e-mail communication, and web support to all public libraries in the state.

*Ohio libraries generally have faster Internet connections than those in many other states.*

*[West Virginia's] Statewide Library Network provides Internet access, e-mail communication, and web support to all public libraries in the state.*

<sup>6</sup> <http://www.oplin.lib.oh.us/content/strategic-plan-fy-2009-2011>.

<sup>7</sup> Davis, et al., *Libraries Connect Communities*.

*Perhaps the biggest reason for Wisconsin's success in connecting users to the Internet is the creation of BadgerNet, one of the largest state networks in the country.*

*In 1996, Maine implemented the Maine School and Library Network, one of the first statewide networks to provide connections to the Internet for all schools and libraries.*

Without SLN, many West Virginia libraries could not operate modern library systems, maintain computer equipment, or offer Internet-based services to users.<sup>8</sup>

The key to SLN's success is a uniform approach to network design and service that lends itself to economies of scale. The WVLC has encouraged all libraries to join the network, enhancing its ability to aggregate demand and further upgrade connections. The WVLC took a similar approach to technology and E-rate support, centralizing these services at the state level.

### **Wisconsin's BadgerNet**

Wisconsin's public libraries are highly connected to the Internet; all public libraries have at least a 1.5 Mbps connection, and most are planning to increase to at least 3 Mbps before the end of 2009. As of the end of 2008, 97 percent of the state's population could access wireless Internet at their local public library.<sup>9</sup>

Perhaps the biggest reason for Wisconsin's success in connecting users to the Internet is the creation of BadgerNet, one of the largest state networks in the country.<sup>10</sup> BadgerNet extends to all of the state's 72 counties, providing next-generation voice, data, and video services to state agencies, local governments, schools, and libraries. It provides a statewide backbone network, as well as middle-mile and last-mile connectivity. This comprehensive end-to-end service is one of the reasons a very high percentage of schools and libraries in the state are connected to BadgerNet.

### **Maine School and Library Network**

In 1996, Maine implemented MSLN, one of the first statewide networks to provide connections to the Internet for all schools and libraries. MSLN was later codified by the state legislature and is now funded by a combination of federal (E-rate) and state surcharges on telephone bills. As a result, Maine's libraries have much greater connectivity than is the case in most states; about 75 percent of those that participate in MSLN have one T1 line (1.5 Mbps), and the remainder have two T1 lines (the maximum available through MSLN).

MSLN funds direct local connections from each school and library to two aggregation points operated by the ISP for the State of Maine. The network uses standard T1 connections, which are easy to provision and troubleshoot. By aggregating its purchasing power, MSLN can obtain prices for these circuits far lower than those an individual library could negotiate.

The network design and technologies used by MSLN are now under stress because of the growth in Internet demand. Maine is therefore considering shifting to a new network design that would rely on local fiber optic and wireless connections to the Maine research and education backbone network.

<sup>8</sup> West Virginia Library Commission, *Library Services and Technology Act Five Year Plan* (Charleston, West Virginia: West Virginia Library Commission, 2007). Available at <http://librarycommission.lib.wv.us/html/publications/LSTA20082012.pdf>.

<sup>9</sup> <http://www.wla.lib.wi.us/legis/USF.htm>.

<sup>10</sup> See Access Wisconsin's website at <http://www.accesswis.com/about>.

## California's Peninsula Libraries Automated Network

The Peninsula Library System (PLS),<sup>11</sup> located in California's San Mateo County, serves the county's eight public library jurisdictions and the San Mateo Community College District. The PLS Administrative Council, composed of library directors from PLS member libraries, is responsible for overseeing PLAN, which currently serves only PLS.

All branches of the eight public library jurisdictions in PLS have participated in PLAN since its inception. Member libraries share the up-front and ongoing maintenance costs of the central system, the connectivity costs of the transmission system,<sup>12</sup> and the support staff that manage and operate the system. PLS created and maintains the network with funds from membership fees, which are derived from city and county property taxes. The PLAN department is responsible for the day-to-day operation of the network, and provides PLS libraries with a variety of telecommunications and broadband services through a centralized information technology (IT) department. PLS applies for federal E-rate discounts for eligible costs of operating PLAN, excluding Internet access and internal connection costs.

PLS initially relied on a traditional hub-and-spoke frame relay design in which the individual libraries (spokes) were served with DS1 (T1) connections. This design has been replaced by a new fiber-based Layer 2 Ethernet service. Each library now has fiber inside the building connecting it to the network. The majority of the libraries connect at 5 Mbps, which is more than triple the 1.5 Mbps (Frame Relay DS1) they had previously. However, a number of larger libraries have implemented 10 Mbps and have already seen usage peak at or near circuit capacity.

*The majority of the libraries [in California's Peninsula Libraries Automated Network] connect at 5 Mbps....However, a number of larger libraries have implemented 10 Mbps and have already seen usage peak at or near circuit capacity.*

<sup>11</sup> The Peninsula Library System website is located at <http://plsinfo.org>. The Pacific Library Partnership website is located at <http://plpinfo.org>.

<sup>12</sup> Until 1994, PLAN used an existing countywide civil defense microwave communications system. The libraries needed to finance only one additional microwave tower for this communications network to provide direct line-of-sight signal transmission to all the libraries.





### 3 LESSONS LEARNED FROM THE CASE STUDIES



Developers of the five networks that served as case studies confronted similar challenges in different settings as they worked to implement their respective solutions. The approaches they used to address these challenges offer valuable lessons for other library systems seeking to initiate, develop, maintain, or improve a network. In this section, these lessons learned are organized according to seven key characteristics of a successful library network project as revealed by the case studies:<sup>13</sup>

- Leadership, cooperation, and the ability to learn from past successes
- Aggregation of demand and services
- Use of demonstrations
- Provision of technical support and training for library staff
- Multiple funding sources
- Role for library representatives in network governance
- Involvement of the State Library

While these characteristics emerged as common themes from the case studies, they take varying forms across the five networks, and not every network displays all seven characteristics. These variations among the case studies are as informative as their commonalities. There is no single recipe for the development of a library network; rather, the case studies provide a set of options that libraries interested in forming a network may consider as they go forward. Options derived from experience with several different networks can be combined to form a solution tailored to the unique circumstances of a particular community, region, or state, meeting the needs of users and increasing the chances for success.

#### Leadership, Cooperation, and the Ability to Learn from Past Successes

Strong leadership was an essential element in the development of each of the five networks. At the same time, leadership was distributed among different players at the state, regional, and local levels and was not the exclusive domain of one person or organization. Moreover, cooperation among these players was a hallmark of the effort. The case studies also illustrate

*There is no single recipe for the development of a library network; rather, the case studies provide a set of options that libraries interested in forming a network may consider as they go forward.*

<sup>13</sup> These characteristics correspond to many of the elements of the Collaboration Planning Process Model identified by OITP in a 2007 study: Rick Weingarten et al., *Public Library Connectivity Project: Findings and Recommendations* (Washington, D.C.: American Library Association, Office for Information Technology Policy, 2007). Available at [http://www.ala.org/ala/aboutala/offices/oitp/publications/booksstudies/Public\\_%20Library\\_Conn.pdf](http://www.ala.org/ala/aboutala/offices/oitp/publications/booksstudies/Public_%20Library_Conn.pdf).

how the various organizations involved often drew on the experiences of other successful cooperative projects to help in the development of their network.

In the formative stage of the Ohio Public Library and Information Network (OPLIN), public libraries that wanted to emulate successful school and academic networks broached the idea of a public library network with the state library association. This association, later called the Ohio Library Council (OLC), assumed a leadership role, and two OLC staff members organized planning and advocacy efforts that led to OPLIN's development.

The West Virginia Network was the first network to centralize the state's computing and data needs. Statewide Library Network (SLN) leadership acknowledged learning from this first statewide network during the project development.

Taking a cooperative approach similar to that applied in the development of OPLIN, Wisconsin's local and regional libraries and State Library officials worked together to define the libraries' role in BadgerNet. A past collaborative project to establish a distance learning video network was a key factor in the creation of a 1993 Governor's Blue Ribbon Telecommunications Infrastructure Task Force, which in turn recommended the creation of BadgerNet.

The Maine School and Library Network (MSLN) was also the result of cooperation between statewide library associations and the State Library agency.

Finally, the member libraries of California's Peninsula Library System (PLS) developed the Peninsula Libraries Automated Network (PLAN) based on their past success with a common circulation and catalog system. Perhaps the most important factor contributing to the success of PLAN is the spirit and habit of cooperation among PLS members. Since 1982, member libraries have been cooperating to operate a joint circulation system. Such collaborations require that libraries engage in significant give-and-take to modify long-standing local policies and procedures so as to accommodate a centralized system. This habit of collaboration led to the success of other collective endeavors, including PLAN.

**Lessons Learned:** While strong leadership is important, cooperation is essential. No single person provided the leadership for the development of any of these networks. Rather, a group of leaders from every level—state, regional, and local—provided joint leadership, and such a broad base of support fostered a sense of inclusiveness among all parties. Leaders also came from outside government as in Ohio, where the OLC provided leadership for OPLIN, and in Maine, where state associations banded together to establish MSLN. Network project leaders can also learn from successful cooperative projects not concerned solely with issues of connectivity.

## Aggregation of Demand and Services

Aggregation of demand is an acknowledged successful approach to network management. Among its benefits are:

- Improved planning
- Support for a business case for providers to deploy broadband
- More affordable pricing
- Sharing of costs

Aggregation of demand allowed the establishment of each of the five successful networks profiled here, and its benefits have contributed to the networks' continued success. For example, MSLN aggregates library traffic to two nodes, which results in lower recurring expenses for Internet access.

Aggregation offers other, less obvious benefits. An example is streamlining and standardization of members' E-rate participation. All of the statewide networks profiled here regularly file for E-rate discounts on behalf of their members or offer assistance to members in doing so. A centralized application relieves the burden on individual libraries. MSLN files an aggregated application for federal E-rate discounts and an application for Maine's state universal service fund. Wisconsin files one aggregated E-rate application that includes every K-12 school district and public library on BadgerNet (about 910 sites), and also completes all the required follow-up. Considering that the most frequently cited reason for libraries' nonparticipation in the E-rate program is the complexity of the process, this is a very real benefit with tangible results.

Standardization is a key requirement for aggregation. OPLIN, MSLN, PLS, and BadgerNet require the same router configuration for every library site; SLN requires that all members have the same network equipment; and every school and library on BadgerNet has the same standard Ethernet interface. Standardization avoids the logistical challenges associated with customization. It also allows for aggregation of technical support services. The benefits of aggregating technical support are readily apparent in West Virginia, where these services are typically beyond the means of individual public libraries with limited budgets and staff expertise. MSLN employs a shared project manager to provide planning guidance to individual libraries, a service that would otherwise be too costly for individual libraries.

**Lessons Learned:** Aggregation of demand and services is a proven strategy for successful networks, leading to reduced costs for equipment, access, and technical services and increased efficiencies in staffing and operational functions.

## Use of Demonstrations

OITP's past research suggests that technology demonstrations are necessary to convince a library's community to support a major new effort such as a regional or statewide network. Such demonstrations, while providing essential training to library staff, also serve a critical outreach and public relations function. For example, during the initial phase of network development, OPLIN staff members visited libraries around the state to demonstrate how access to the Internet would help their users.

While demonstrations can be very helpful in growing network membership, their usefulness does not end with the network's establishment. OPLIN and SLN representatives continue to provide information on network services and their use at annual conferences and meetings. Other library systems offer ongoing training on new resources provided via the network and on how library staff can use these resources to improve library services and ultimately benefit the library's patrons. Demonstrations can also help achieve the network's sustainability when used as an advocacy tool for continued funding and support of network projects.

**Lessons Learned:** Demonstrations are useful not only in making the case for network membership, but also in serving as valuable teaching tools, demonstrating new resources and services, and helping to advocate for continued network support.

## Provision of Technical Support and Training for Library Staff

Library networks are complex technical entities that support many users and applications; it is unreasonable to expect local library staff, especially those in smaller or rural libraries, to provide comprehensive technical support for the network. All the networks profiled here provide members with some level of technical support and training in how to solve technical problems. The level of support ranges from handling all network problems to training local librarians in problem solving. Two of the networks—PLAN and BadgerNet—continuously monitor network traffic and respond with solutions when they are needed.

The case studies demonstrate several innovative approaches to supporting large networks:

- In a centralized model, OPLIN manages a support center that offers members a first line of defense for network troubleshooting.
- MSLN employs one circuit rider whose responsibilities include focusing on resource-poor libraries with the most serious problems and developing technical skills among local library staff.
- SLN has network support staff in offices throughout the state and, like MSLN, works to develop the technical skills of library staff.
- In Wisconsin, regional library systems serve as the first point of contact to assist with troubleshooting and the installation of new equipment and software.
- In California, PLS meets the need for network-level support only; its member libraries all have technical support staff on site.

**Lessons Learned:** Comprehensive technical support by qualified staff is necessary to maintain a healthy network. Successful networks provide members with technical support and/or training in solving technical problems using a range of delivery methods and organizational models. Training strategies targeting individual member libraries increase members' self-sufficiency, which is especially helpful for those networks that lack funds for comprehensive support and whose members are unable to fund dedicated technical staff.

## Multiple Funding Sources

The networks profiled here rely on various revenue streams, such as grant funds, telecommunications settlement funds, universal service funds, state general funds, and local library funding. The five networks were established in economically favorable times, when state and other funds were more readily available for large capital projects than is the case today. Nevertheless, all the networks face the challenge of securing ongoing funding. Even Maine, which has the most stable source of funding (state and federal universal service funds), struggles with balancing the need for increased network services with limited funding resources.

The major sources of funding for the statewide networks have historically been state tax funds and universal service funds (both the federal E-rate program and state-based programs). During the last year, however, tax revenues have decreased sharply in almost every state, and both OPLIN and SLN were in danger of losing significant state funding. California's PLS, funded primarily by member fees derived from local property taxes, has yet to see any significant reductions as assessments of property lag at least one year behind tax collections.

Federal universal service funds are relatively stable. However, the total of applications for discounts is approaching fund availability, absent any policy intervention. Additionally, some organizations find the requirements for obtaining such funds to be onerous or contrary to their policies.

**Lessons Learned:** No funding source for networks is free of risk. Advocacy approaches used and refined during the establishment of a network must be reactivated and sustained to maintain tax-based funding in a highly competitive arena. Networks that use and continually look for ways to support network services with universal service funds may find that these sources are more reliable than tax-based funding.

## Role for Library Representatives in Network Governance

The five case study networks have widely varying governance and management structures. For example:

- The Maine Public Utilities Commission (MPUC) governs MSLN.
- Wisconsin's Department of Administration manages BadgerNet.
- The West Virginia Library Commission administers SLN.

All of these networks are dependent on the network's information technology (IT) staff for ensuring the day-to-day management of network operations. But just as there are differences in network management (e.g., some may be outsourced), there are also differences in overall network governance and how much input the library community has to make decisions or to set network policy. For example, the OPLIN governing board in Ohio consists solely of member library representatives. Wisconsin's BadgerNet Advisory Council includes representatives of all network users including libraries, K-12 schools, higher education and

state government. The Advisory Council advises the state Administration Department in areas like member bandwidth needs and planning for the next generation network. California's PLS allows the technical staff of member libraries to be involved with network issues through a committee structure.

**Lessons Learned:** Even though these networks are managed by professional IT staff, it is important that some venue be available for network users—including libraries—to have input into decisions that impact network use and that the network's users be part of any planning process for future network enhancements and developments.

## Involvement of the State Library

One common characteristic of the statewide networks is the active involvement of the State Library:

- The State Library of Ohio has strong influence over OPLIN operations and development as a result of its authority to appoint all of the network's board members.
- The State Library in West Virginia operates SLN.
- In Wisconsin, the State Library influences BadgerNet planning and operations through its seat on the BadgerNet Council.

Although MSLN's governing board is the Maine Public Utilities Commission (MPUC), the state librarian is responsible for suggesting policy and for representing the interests of libraries before the MPUC. Furthermore, the Maine State Library has staff members responsible for assessing the needs of MSLN members and for preparing an annual report that outlines the network's needs and presents an annual budget request.

**Lessons Learned:** The State Library continues to play an important role in the four statewide networks profiled for this study.



## History

The Ohio Public Library Information Network (OPLIN) began to take shape in 1994 when a small group of librarians from a suburban library system discussed the need for a statewide public library network similar to the networks used by academic libraries (OhioLink) and K-12 libraries (INFOhio).<sup>14</sup> This group of librarians reached out to the Ohio Library Council (OLC, then known as the Ohio Library Association), which helped to develop a plan to create the network and lobbied state legislators for the funding to build it. Fran Haley, who had recently joined the OLC, was instrumental in bringing together experienced individuals to develop the network plan and in inviting the entire library community to participate in the process.

Greg Byerly, who had previously directed OhioLink, was hired by the OLC to draft the initial plan for OPLIN. He also worked to allow the state's public libraries to purchase telecommunications services from the statewide SOMACS (State of Ohio Multi-Agency Communications System) contract. The SOMACS contract provides postalized rates for its telecommunications circuits, so that the monthly price remains the same regardless of the length of the circuit or the location of the library.

OPLIN was created by state law in 1995. With the persistence of the OLC and the support of the legislature and then-Governor Voinovich, OPLIN was initially allocated \$4.85 million. Before the state budget was passed in 1995, an additional \$8 million was added to fund startup costs to network public libraries. The OPLIN board decided to provide funds for the initial installation connecting branch libraries to the network, but not to support recurring costs for these connections. The board also decided to provide a telecommunications line for one library site (usually the main library) and to support its recurring costs in addition to purchasing computers so that each library would have two public workstations with which to access OPLIN.

All but one of the 251 main library systems in Ohio joined OPLIN immediately.<sup>15</sup> Local boards passed a resolution for each library system to join, and each established its own Internet access policy for the network.

<sup>14</sup> OhioLink was created in the mid-1980s for academic libraries. INFOhio was established in 1991 for K-12 schools. All three networks—OPLIN, OhioLink, and INFOhio—remain separate as they all have different functions and governance structures. Through Libraries Connect Ohio (LCO), the Ohio libraries and library organizations work together for the collective purchasing of information resources. The list of resources is available at <http://ohioweblibrary.org/>.

<sup>15</sup> The one library system that did not join was in Youngstown, Ohio. Youngstown was an early adopter of fiber, and all its schools, libraries, and public agencies have their own connectivity.

*All but one of the 251 main library systems in Ohio joined the Ohio Public Library Information Network immediately.*

The library system pursued funding for the project at the right time, as the state budget was flush, and the overall economic situation in the state was favorable. Funds remained even after OPLIN had been built, allowing the libraries to purchase subscriptions to databases and other electronic materials.

## Services

*[OPLIN's] mission is to ensure that all Ohio residents have fast, free public Internet access through the state's local public library systems.*

OPLIN provides both broadband Internet connections and information services to Ohio public libraries. Its mission is to ensure that all Ohio residents have fast, free public Internet access through the state's local public library systems, as well as the use of high-quality research and reference databases not available free of charge on the World Wide Web. OPLIN provides these services at no cost to the libraries.

Unlike the situation in many other states, OPLIN coordinates the acquisition and installation of the physical telecommunications circuits that connect the main libraries to the network's hub in Columbus.<sup>16</sup> (Most other library networks deliver content and services primarily via a physical network provided by some other organization.) As described in more detail below, OPLIN leases circuits for the main libraries under two contracts the state has with telecommunications service providers. Branch libraries, however, must obtain their own local broadband telecommunications connection to their main library.

OPLIN also serves as the Internet service provider (ISP) for all public libraries in Ohio. It manages mail servers and provides the libraries with e-mail services. In addition, OPLIN provides web hosting services for those libraries with their own website.

## User Support and Communications

The OPLIN Support Center serves as the first line of defense for database problems and network troubleshooting. The center received 2,304 library technical service requests in fiscal year 2008, the majority of which related to e-mail issues.<sup>17</sup> The OPLIN Support Center is open only during the workweek; after-hours and weekend calls are directed to the State of Ohio's Network Operations Center.

OPLIN communicates with its members in a number of ways. It operates three e-mail lists: one for nontechnical topics, one for the OPLIN office to announce new services and important changes to existing services, and one for technical topics. OPLIN also publishes a quarterly newsletter, participates on social networking websites, publishes three blogs, and has a website.<sup>18</sup>

<sup>16</sup> For more information about these circuits, see "Telecommunications and Broadband Services" below.

<sup>17</sup> OPLIN Report to Stakeholders for Fiscal Year 2008. <http://www.oplin.lib.oh.us/sites/default/files/2008AnnualReport.pdf>.

<sup>18</sup> <http://www.oplin.lib.oh.us/>.



## Telecommunications and Broadband Services

As mentioned above, OPLIN obtains the local telecommunications circuits for all but one of the main libraries in the State of Ohio.<sup>19</sup> These circuits connect the main library to the OPLIN hub in Columbus. As part of a state agency, OPLIN is authorized to lease these circuits under two state contracts: the SOMACS contract, serviced largely by AT&T and used to lease traditional T1 circuits that provide a capacity of 1.5 megabits per second (Mbps), and a separate contract for fiber-based Ethernet services. OPLIN often transitions main libraries that need upgraded capacity to an Ethernet connection, but these Ethernet services are not available statewide.<sup>20</sup>

OPLIN also provides its members with continuous monitoring of broadband traffic. Every quarter, traffic statistics for each main library are reviewed to see whether traffic patterns warrant an upgrade to a fiber-based Ethernet circuit (or DS1 or DS3 if Ethernet is not available). The additional bandwidth and coordination for implementation are handled by OPLIN at no charge to the main library.



## Network Structure

In addition to the local circuits that connect the main libraries to the OPLIN hub, OPLIN maintains a high-capacity connection from its hub to the Internet over a shared, channelized DS3 connection that is managed by the Ohio Office of Information Technology (OIT). The OIT router manages traffic to OPLIN-provided resources, to the Internet, or back to other OPLIN member libraries. The bandwidth charge for this connection to the Internet is the fastest-growing expense for OPLIN.

As Figure 1 indicates, each main library receives a router provided by OPLIN to connect its circuit to the OPLIN hub. Management of this router is carried out collaboratively between OPLIN staff and the engineering group within OIT. The router represents the demarcation point between OPLIN services and the main library's local area network (LAN). Each main library is responsible for its own LAN management services. OPLIN offers each main library a subnet of 32 publicly routable Internet Protocol (IP) addresses. Each main library administers these addresses following its own policies.

<sup>19</sup> The main libraries account for only about one-third of all library buildings in Ohio. As explained below, branch libraries must obtain their own broadband connections.

<sup>20</sup> OPLIN can be described as a hybrid hub-and-spoke network. The circuits obtained through the SOMACS contract follow the hub-and-spoke model, but the Ethernet circuits do not.

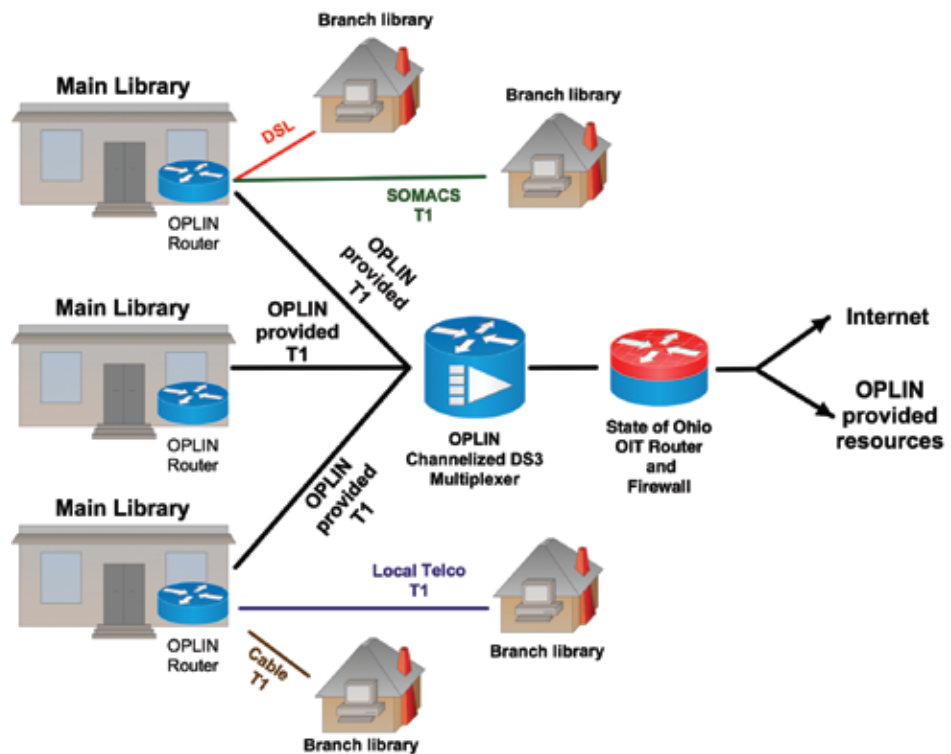


FIGURE 1. Structure of OPLIN.

As noted, OPLIN does not provide the local broadband connections for branch libraries. The branch libraries associated with each main library system can use a variety of options for connecting to the main library. In many cases, the SOMACS contract allows libraries to pay for a postalized T1, which is available statewide for only \$400 per month. Figure 1 shows this option in green.

While the SOMACS contract is available to any branch library, occasionally less expensive options exist. Some branches choose to purchase a digital subscriber line (DSL) circuit to connect virtually to the main library through a virtual private network (VPN). That option is shown in red in Figure 1. On other occasions, the branch library is located close enough to the main library that a local telephone company can connect both locations with a DS1<sup>21</sup> for less than the \$400 per month under the SOMACS contract. The purple line in Figure 1 highlights this option. Finally, in some communities, cable TV companies offering telecommunications services can provide a branch library with either a DS1 or an Ethernet connection. That option is shown in the figure in brown.

Fiber is another option that is gaining popularity among libraries in Ohio. The State of Ohio has signed a separate contract that includes AT&T's Optical Ethernet Metropolitan

<sup>21</sup> A T1 connection is equivalent to 1.5 Mbps. It should be noted that the "T1" designation usually associated with the 1.5 Mbps speed is a manufacturer-specific term. The phrase "digital signal" (abbreviated "DS") followed by a corresponding number is the proper generic identifier. For example, a DS1 connection is the general designation for a 1.5 Mbps connection.

Area Network (OPT-E-MAN). OPT-E-MAN is typically provisioned via a fiber connection with bandwidth increments as low as 5 Mbps and scalable to 100 Mbps. Libraries that can purchase fiber-based service are ideally positioned to add bandwidth quickly and less expensively than is the case with traditional telephone company services (e.g., T1/DS1, T3/DS3). Pricing for Ethernet services can vary significantly from location to location. The price for a 10 Mbps circuit can range from \$600 per month to about \$1,000 per month, not including router management fees and Internet access bandwidth.<sup>22</sup>

## Governance

OPLIN is an independent state agency within the State Library of Ohio. It is governed by a board of eleven members selected by the State Library Board from the staffs of member public libraries and current or past trustees. The OPLIN Executive Director and the State Librarian or his/her designees serve as ex officio board members.

Stephen Hedges has served as OPLIN's Executive Director since 2006 and supervises four staff members. OPLIN receives fiscal and logistical support services from the State Library of Ohio and contracts with OIT for assistance with network management.

OPLIN is now defined in the Ohio Revised Code. Until recently, it was a line item in the State Library budget, meaning that it technically ceased to exist every 2 years. OPLIN is now part of the permanent law, which allows it to take advantage of longer service contracts.

## Finance

The majority of OPLIN's budget—58 percent—is spent on purchasing Internet connections to public libraries, which it regards as its most important role. Another 30 percent is spent on databases, which make up about a third of the total cost of the Ohio Web Library database collection. About 2 percent of OPLIN's budget is allocated by the legislature for grant subsidies to local libraries to help defray the cost of filtering Internet content; another 1 percent funds conferences and other training for public librarians. The remaining 9 percent of the budget is used for all other costs—rent, salaries and benefits (for five staff), supplies, postage, office equipment, etc. Thus more than 90 percent of the OPLIN budget is spent on direct services to public libraries, and less than 10 percent on administrative costs.<sup>23</sup>

From the network's inception in the fiscal year (FY) 1995 budget bill through FY 2007, annual funding for OPLIN varied between \$5 million and \$8 million each year. Because of the state's recent fiscal problems, OPLIN's budget was reduced in 2008 and 2009, and additional reductions may occur in 2010.<sup>24</sup>

*The majority of OPLIN's budget—58 percent—is spent on purchasing Internet connections to public libraries, which it regards as its most important role.*

<sup>22</sup> Pricing tables are available at: <http://www.oit.ohio.gov/SDD/Contracts/GigEService.aspx>.

<sup>23</sup> See <http://www.oplin.org/oplin/circuit/July2009.pdf>.

<sup>24</sup> The governor's FY 2010 budget proposal supports OPLIN funding at the 95 percent level. This budget also proposes to switch the source of OPLIN's funding from the General Revenue Fund to the Public Library Fund. Ohio's Public Library Fund is the major source of funding for the state's public libraries. The governor's budget proposes to provide \$3,702,150 for OPLIN operations out of this fund, with an additional \$2 million in spending authority from E-rate reimbursements and other nonstate revenue.

To make up for the loss of state revenue, OPLIN has entered into an agreement with eTech Ohio to manage its E-rate applications this year. OPLIN expects that eTech Ohio's E-rate expertise will lead to more federal E-rate discounts than in the past. Libraries can call on eTech Ohio for E-rate consulting, and eTech Ohio will also be conducting E-rate workshops.



## History

Many West Virginians depend on their public libraries for Internet access.<sup>25</sup> The West Virginia Library Commission (WVLC) established the centralized Statewide Library Network (SLN) to meet this need. Beginning in the 1990s, the WVLC received a federal grant for a project to connect West Virginia public libraries with 56 kilobits per second (Kbps) frame relay lines leased from Bell Atlantic (now Verizon) and other providers. By 1999, all but 3 of West Virginia's 177 public libraries were connected.

The West Virginia Network (WVNET), the state's Internet service provider, was also instrumental in developing SLN. WVNET was established in 1975 to centralize the state's computing and data needs. It originally connected the colleges and universities in West Virginia to its central hub, and later grew to serve government offices, K-12 schools, and libraries. WVNET established a statewide intranet in 1994 and continues to provide Internet connectivity to libraries today. WVNET reports to the West Virginia Higher Education Policy Commission and is aided by a Computer Advisory Board, with representatives from higher education and other users of WVNET.

*By 1999, all but 3 of West Virginia's 177 public libraries were connected.*

Internet access spurred demand at libraries across the state for such resources as electronic journals, shared library resources, e-mail, and learning programs. Meeting this demand required more robust connections, so the Library Network 2000 plan was developed to upgrade and standardize the libraries' hardware and software. Technicians visited every library in the network and installed suitable cabling, reprogrammed equipment, issued new Internet Protocol (IP) addresses, and provided standardized Internet connections. The network staff received a Governor's Award and a National Association of State Information Resource Executives nomination for the planning and implementation of the Network 2000 project.

In September 2002, Verizon provided a \$1.6 million grant (over 2 years) for the Digital Bridge Project, designed to upgrade the 56 Kbps connections with DS1 (1.5 megabits per second [Mbps]) lines. As of summer 2009, all 177 libraries had been connected with a DS1 line.

Today, the success of this upgraded network is evident in libraries across West Virginia. At a March 2009 WVLC meeting, the Director of Weirton's Mary H. Weir Library, Rik

<sup>25</sup> <http://www.wvlc.lib.wv.us/html/publications/LSTA20082012.pdf>.

Rekowski, reported that the library's Internet center had 16,000 visitors every year in a town with a population of only 18,748.<sup>26</sup>

Sandy Bumgardner, Director of the Upshur County Library, a service center for several



libraries in very rural areas, said that many community residents lack access to high-speed Internet in their homes because dial-up access is their only affordable choice. Furthermore, a number of residents who live in areas with affordable Internet access have cancelled their home subscriptions to save money. These residents use the libraries' public-access computers to search the Internet, write résumés, and complete job applications.

Further upgrades are planned for SLN. By 2012, the network will offer Ethernet connections that will operate approximately 10 times faster than T1.<sup>27</sup>

## Services

SLN provides all the state's public libraries with Internet access, e-mail communication, data lines, hubs and switches, and technical support. Libraries may also receive funding and support for a shared integrated library system (ILS).

In many other states, technical support for network services is the responsibility of the individual library. West Virginia is different in that the libraries receive, at no charge, the following services:

- Wide area networking, local area networking, and wireless access support
- Help desk services
- Router installation and maintenance
- PC software/hardware replacement and maintenance
- UNIX hardware/software maintenance
- ILS (if shared with other libraries)
- Hubs, switches, and associated cabling (both installation and maintenance)
- Equipment contract support
- Data circuit installation and maintenance

<sup>26</sup> West Virginia Library Commission, Meeting Minutes, March 4, 2009. Available at <http://www.wvlc.lib.wv.us/html/commissionmtg042409/minutes.pdf>.

<sup>27</sup> West Virginia Library Commission, *LSTA Five-Year Plan 2008–2012*. Available at <http://www.imls.gov/pdf/5yrplans/WVplan2012.pdf>.

- Network monitoring
- E-rate support

West Virginia made the strategic decision to centralize technology support for its libraries at the state level. As a result, it achieves excellent statewide coverage with just 11 technicians. Each of the technicians directly supports libraries within an assigned region of the state, but he or she also provides support to neighboring regions when the need arises.

Most of West Virginia's public libraries had limited access to technical support before the WVLC filled this role. Libraries now have access to technology assistance for simple problems, such as printer jams, and more complex problems, such as router maintenance.

Network technicians also visit libraries to offer library staff members training on various topics, including using the Internet, e-mail, and online databases; establishing remote computer repair options; and completing E-rate applications. Network personnel also provide training sessions during annual library functions and offer classes throughout the year. For example, one SLN technician teaches simple troubleshooting measures to library staff so they can solve technical problems independently instead of calling a technician.

SLN's technical support takes a variety of other forms. A series of public service announcements provides basic information about computer viruses, how to perform software updates, and other troubleshooting tips. In addition, SLN maintains four regional desktop computer labs that allow library staff in those regions to access training without driving long distances or staying overnight. Two mobile laptop labs are available for on-site training in more remote libraries.

Significant to this centralization of technical support is the standardization of the network equipment and configuration and deployment processes. Any member of the SLN staff, regardless of the region of assignment, can walk into any library and know what equipment and network configuration to expect. In addition, technicians can implement upgrades to the network without having to customize each library's infrastructure.

According to Mark Esslinger, Director of the Wayne County Libraries, "The main benefit of having a statewide network is that it eliminates the need for duplication of service if every county had to run its own network. The state is able to provide more qualified support than a county could. In the long run, it saves money. If there is a problem, there is one number the local library has to call for assistance. The state office always has somebody on staff qualified to assist with networking issues. Some of the counties may not have access to qualified technicians due to the rural nature of some areas of the state."<sup>28</sup>

## Network Structure

The West Virginia Department of Administration manages a statewide contract for telecommunications services. All public libraries are connected to SLN by purchasing

*Any member of the SLN staff, regardless of the region of assignment, can walk into any library and know what equipment and network configuration to expect.*

<sup>28</sup> Mark Esslinger E-mail to WVLC, September 3, 2009.

a DS1 from this contract; all of the state's 177 libraries now have a DS1 connection. Ordering and installation of the circuit are coordinated by the WVLC.

Depending on the location of a library, the DS1 connects to either the northern data center in Morgantown or the state capital of Charleston in the south. Traffic destined for the Internet is handed off to WVNET, and the rest remains within SLN.

To comply with the Children's Internet Protection Act (CIPA), the WVLC provides Internet filtering using Netsweeper software hosted on the state backbone network. The WVLC shares this service with other state agencies that must filter Internet traffic, allowing the expense to be spread across a larger pool of members. An advantage of the design of SLN is that only Internet traffic is filtered through Netsweeper. Centralizing the filtering tools has eliminated the need for individual libraries or systems to purchase their own filtering software. See Figure 2.

This large network requires careful bandwidth monitoring. The WVLC monitors the bandwidth use of individual libraries as well as the statewide network via a monitoring network operations center in Charleston. The monitoring software provides hourly/daily/monthly bandwidth charts for each library, audible/visual outage reports, and battery temperatures.

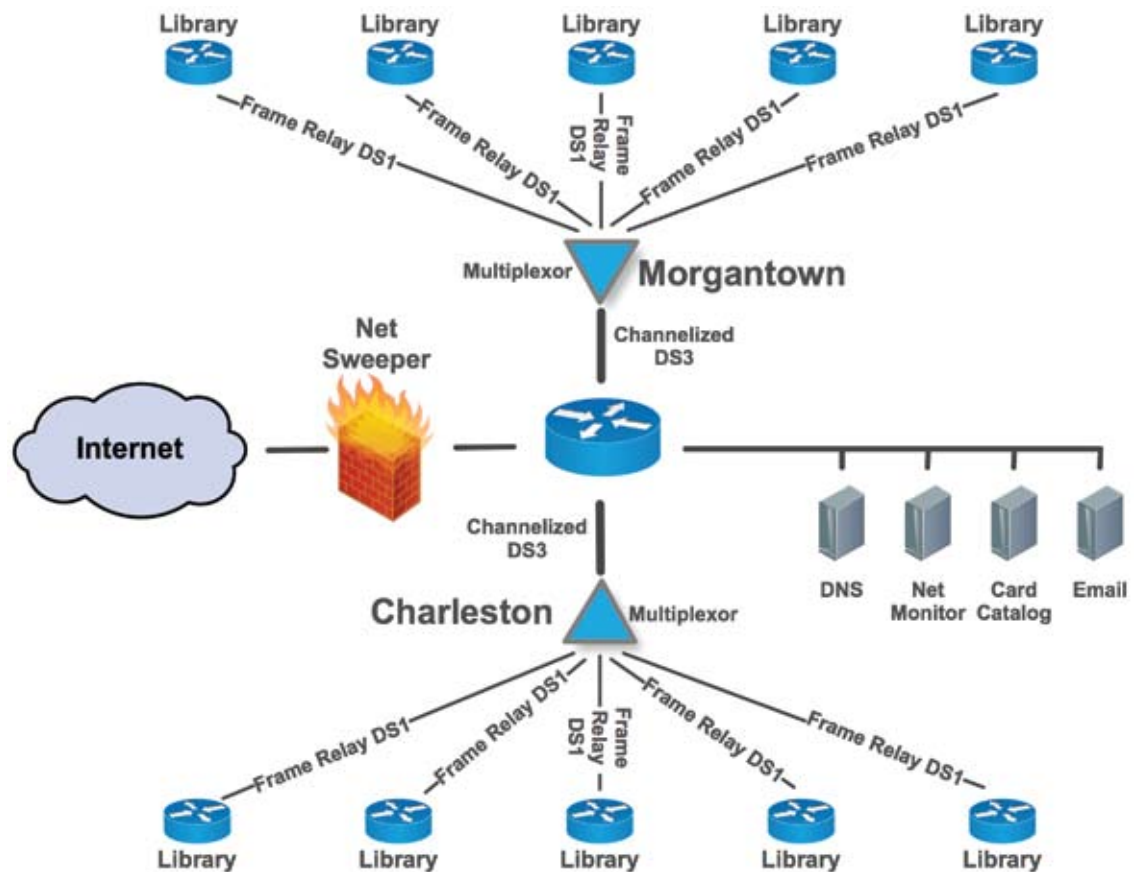


FIGURE 2. Configuration of West Virginia's State Library Network.



## Governance

The WVLC, which established SLN, consists of seven members, all of whom are appointed by the governor and confirmed by the state senate. The WVLC appoints a secretary who serves as State Librarian and manages the WVLC Network Services department, one of the four departments within the commission's office. As noted earlier, the WVLC centralizes support for libraries at the state level and achieves statewide coverage with only 11 staff members.

A key to SLN's success is the uniform approach to network design and service, which lends itself to economies of scale. The WVLC has encouraged all libraries to join the network, giving it more power to aggregate demand and further upgrade connections. As discussed previously, the WVLC takes a similar approach to technology and E-rate support, centralizing these services at the state level to derive benefits from the aggregation of service provision.

The WVLC developed and expanded SLN through a combination of advocacy and strong leadership. It directly recruited public libraries, which were added to the network as funds became available. At its inception, the network also included four academic libraries. As of 2009, there are two. One left the network as a result of a change in administration, and the other joined a private college consortium. The network includes other non-public library participants as well. The Archives and History Library, a department of the state's Division of Culture and History, shares a catalog server with the WVLC. A few K-12 schools have also been added to SLN. Under state law, the WVLC cannot make direct grants to school libraries, so it pays for the cost of adding them as users of the integrated catalog software.

## Finance

SLN has enjoyed strong support from the West Virginia legislature and has tapped other funding sources as well. In 1996, the WVLC, WVNET, and the West Virginia Department of Education successfully implemented a \$2.5 million grant from the U.S. Department of Education.<sup>29</sup> The first libraries received Internet access under this grant. Additional funding through federal and state grants expanded the number of libraries in SLN. The final public libraries added to the network benefited from federal Library Services and Technology Act (LSTA) funds. Also in 1996, the legislature provided a one-time allocation of \$1 million for upgrades and allocated \$1 million for ongoing support. In March 1998, a \$1.9 million grant from the Bill & Melinda Gates Foundation provided computers for the state's public libraries. A July 2002 grant of \$991,281 from the State Telecommunications Users' Council allowed SLN to purchase servers.

<sup>29</sup> The InfoMine Project, developed by a consortium of the WVLC and public, academic, and school libraries, was funded with a \$2.5 million grant from the U.S. Department of Education and supplemented with grants from the U.S. Department of Commerce and the Appalachian Regional Commission. The InfoMine grant ended in 1996. For additional information, see *West Virginia Library Commission 2003–2007 Library Services and Technology Act Five Year Plan*, available online at <http://www.imls.gov/pdf/5yrplans/WVplan.pdf>.

In addition to state and foundation grant funding, the WVLC applies annually for E-rate discounts for SLN. The average E-rate discount rate in 2009 was 76 percent.

State legislators cut SLN's fiscal year 2010 budget by 28 percent or \$347,000 from its \$1.1 million budget in fiscal year 2009.<sup>30</sup> This reduction will most likely slow the upgrading of SLN libraries' local area networks, including evaluating and replacing wiring, switches, and other critical network components. The WVLC also plans to support SLN with some LSTA funds. This funding shift will reduce amounts available for other library programs typically supported by LSTA funds, including direct grants to local libraries.

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<sup>30</sup> West Virginia Library Commission, Meeting Minutes, June 29, 2009. Available at <http://www.wvlc.lib.wv.us/MeetingBook081409.pdf>.

## 6 WISCONSIN'S BADGERNET NETWORK



### History

Since as early as the 1970s, Wisconsin has been one of the nation's leaders in creating long-haul video networks to provide distance learning to schools. In 1993, to build on this success, then-Governor Thompson established a Governor's Blue Ribbon Telecommunications Task Force. The task force was charged to (1) develop a vision for a statewide telecommunications network for educational institutions and government agencies and (2) recommend changes in state statutes and policy to remove barriers to the realization of this vision. In its planning for the statewide infrastructure, the task force also was required to consider and integrate Wisconsin's existing K-12 video network—consisting of more than 8,000 miles of fiber throughout the state at the time—into the network plans.

The Wisconsin Department of Public Instruction (DPI), which houses the State Library Agency, advocated for consideration of library needs in the network's development, and libraries played an active role in the planning effort. The State Library and several members of regional library systems participated in the task force and made their concerns and interests known to the task force participants and to legislators.

The task force recommended the creation of BadgerNet in 1993, and the legislature adopted most of the task force's recommendations in 1995. Libraries were specifically included in the statute as eligible to access the BadgerNet network. Shortly thereafter, the legislature created the TEACH (Technology for Educational ACHievement) program to help schools and libraries obtain and sustain their use of technology.<sup>31</sup>

BadgerNet was created at a time when the economy was stable and growing. This economic stability allowed the state sufficient time to undertake the 3-year effort and engage many stakeholders in the development of the statewide network. Additionally, the positive economic climate and the growth of telecommunications services in the late 1990s allowed the legislature to add revenue to the state's universal service fund (which collects funds from in-state telecommunications providers) to fund the TEACH program.

Following another two-year planning process, in March 2005, the Wisconsin Department of Administration (DOA) entered into a new \$116.7 million, 5-year agreement with the consortium of telecommunications providers that deliver BadgerNet services for a new converged, higher-capacity data and video network called the BadgerNet Converged

*The State Library and several members of regional library systems participated in the task force and made their concerns and interests known to the task force participants and to legislators.*

<sup>31</sup>The TEACH program is unrelated to the federal TeachforAmerica program.

Network (BCN).<sup>32</sup> The transition to the new network was completed on September 1, 2006. The State Library Agency helped coordinate this transition. At that time, BCN was the largest state network of its type that AT&T, the prime vendor, had under contract.

## Services

Wisconsin's seventeen regional library systems are required to assist their member libraries in matters related to technology in exchange for state funding. In this regard, they play an important role in addressing local public library broadband and Internet connectivity needs. Among the services they provide:

- The regional library systems manage wide area networks (WANs) for their member libraries. The WANs are part of the regional network infrastructure that ultimately connects to the BadgerNet backbone at four locations in the state. WANs are used primarily for shared integrated library system traffic and Internet access. Of the services offered through the BCN contract, the libraries most frequently use the WAN service, which links remote libraries to the headquarters of the regional library system in a hub-and-spoke network design.
- All seventeen systems provide consulting for the purchase of computer software and hardware.
- Many systems also offer centralized purchasing for software and hardware, which allows member libraries to obtain a lower price than they could negotiate individually.
- Sixteen of the seventeen regional systems make information technology (IT) staff available as the first point of contact to assist with troubleshooting and the installation of new software and hardware.



BadgerNet also offers high-resolution, real-time interactive video to approximately 350 K-12 schools. Included in these video services are a network scheduling function and specialized equipment that permits three or more locations to be joined together in a videoconference. Classes offered over the network are an integral part of instruction, with as many as thirty-two separate conferences linking more than a hundred classrooms during a single hour.

Finally, BadgerNet offers network support and help desk service around the clock.

<sup>32</sup> Although the terms "BadgerNet" and "BCN" are now often used interchangeably, "BadgerNet" tends to be an umbrella term used to describe the overall network in its past and present incarnations and the administration of the network. BCN is often used to refer specifically to the current physical network and the contract governing that network that runs from 2006 through 2011.

## Network Structure

BadgerNet serves state government, some local governments, universities, technical colleges and tribal nations, and most of the state's K-12 school districts and public libraries. All state agencies are required to use BadgerNet; 900 state agency remote locations use the data network capability of the system to connect to their agency headquarters in Madison. In total, the network exceeds 2,400 end-points spread across each of the state's 72 counties. Although library participation is voluntary, about 97 percent of Wisconsin's public libraries have connected to the Internet via BadgerNet since the mid-1990s. As noted, the libraries generally use a WAN topology such that individual library circuits connect back to the headquarters of the regional library system. The regional system then aggregates the Internet traffic of its member libraries and provides a direct connection to the Internet service provider (ISP). This can be seen in Figure 3.

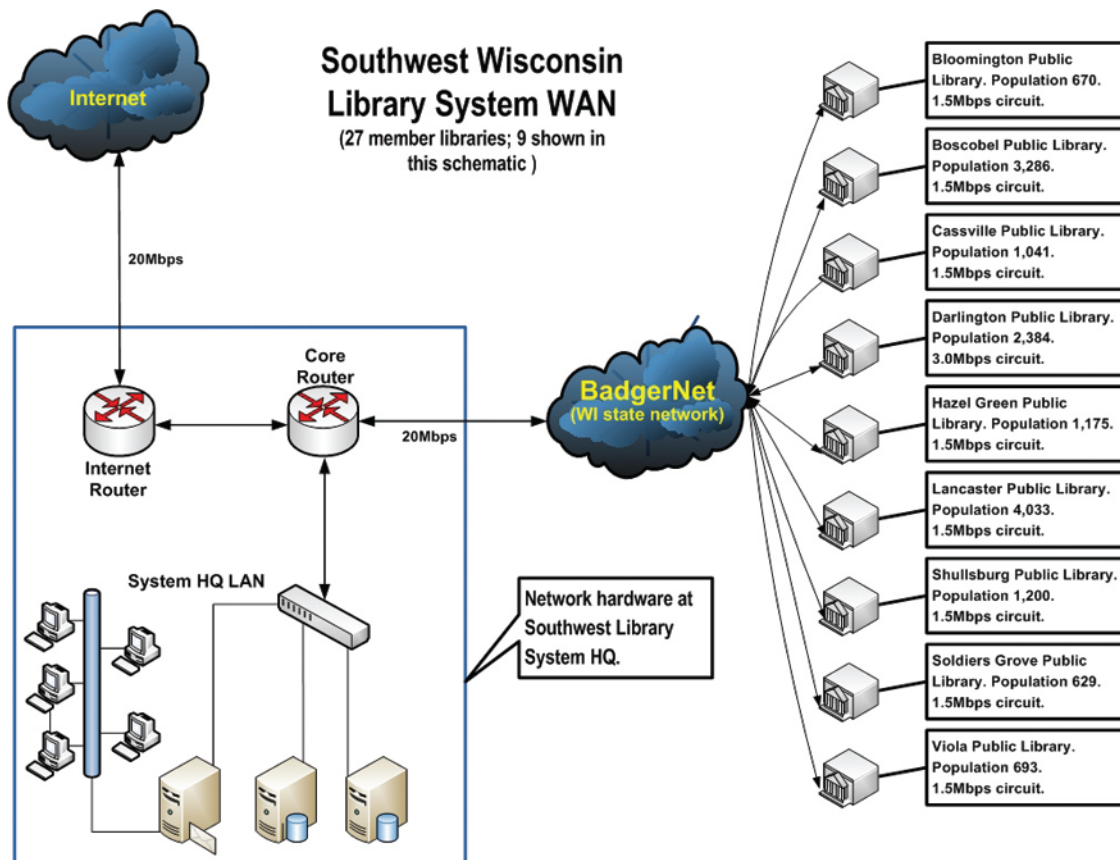


FIGURE 3. An example of BadgerNet's structure.

AT&T serves as BCN's prime contractor, although additional services are provisioned by a consortium of telecommunications providers that includes other local telephone companies. Fortunately for the regional public library systems, the BCN contract allows the local provider to provision service in a variety of ways while ensuring that each library's interface is always the same 10/100 Ethernet port. Routing of traffic through the aggregation

and core layers of the network is always the same as well, regardless of the access layer technology. Without exception, Wisconsin's regional library systems have adopted the hub-and-spoke WAN design. Choosing one library, often the headquarters of the regional library system, to act as the hub provides equipment consolidation advantages as well as bandwidth and port access to the Internet.

Two aspects of BCN are somewhat unusual and particularly beneficial to Wisconsin's library connectivity.

*Without exception, Wisconsin's regional library systems have adopted the hub-and-spoke WAN design.*

First, the BCN contract covers all three network layers (a local access connection, an aggregation point, and a core).<sup>33</sup> Most statewide networks provide the backbone, but the library or library system must acquire the local access connection on its own. BCN, through the TEACH program, subsidizes the cost of the local connections in addition to maintaining the backbone. The network's comprehensive end-to-end service is one reason why almost every public library in the state uses BCN.

Second, BCN includes an Ethernet port as the end-user interface. An Ethernet port makes it extremely easy for the library to connect its equipment (such as a firewall, local switch, or router) to the network because the interface will always be an industry standard 10/100 Ethernet port. Because BCN uses Ethernet connections, the library can purchase flexible increments of bandwidth. In other words, the library can increase its capacity to 3 megabits per second (Mbps), 5 Mbps, 10 Mbps, 15 Mbps, 20 Mbps, etc. (traditional telephone company offerings are limited to either 1.5 Mbps or 45 Mbps).

Some of the larger telephone companies, such as AT&T and Verizon, and some larger independent phone companies deploy fiber optic cables to libraries requesting high-speed circuits. Typically, fiber is deployed for sites needing 10 Mbps or greater, but some companies deploy fiber to sites with as little as 3 Mbps in anticipation of future growth. The BCN portfolio of services does not, however, include asymmetrical services, such as digital subscriber line (DSL), microwave, and satellite technology alternatives, because it was too difficult to include every available technology and keep the service consistent. Even though these options are not available through BCN, some library systems purchase DSL services outside of the BCN contract; DSL is often used for patron wireless Internet access.

## Governance

BadgerNet is the state's telecommunications network; it does not provide Internet service. Most BadgerNet users (e.g., state government, schools, and libraries) receive their Internet access via WiscNet.<sup>34</sup> WiscNet is a not-for-profit association that operates under the auspices of the University of Wisconsin-Madison. It is governed by a board of directors representing member institutions. A representative from the State Library

<sup>33</sup> As described in Appendix A, there are typically three layers of a broadband network: (1) the local access connection (often a cable or telephone company line) from the library building to a central aggregation center; (2) the aggregation layer (often a computer and high-capacity line that carries the traffic of multiple libraries); and (3) the core, consisting of large routers and very high-capacity connections to the backbone network.

<sup>34</sup> See <http://www.wiscnet.net>.

and a representative from the regional library systems are on the board. WiscNet started providing Internet access in 1991 to 26 colleges and universities in the state. When the first BadgerNet network was built in the mid-1990s, WiscNet expanded its services to include K-12 schools and public libraries.

BadgerNet is administered by the network office in the DOA. The BadgerNet Advisory Council advises the DOA and the service provider on customer issues relating to the network contract, the operation of the network, and the process for developing timely solutions for services provided under the contract; it also provides a forum for planning. The council is made up of representatives from constituent groups, including one representative of a regional public library system and a representative of the State Library.

## Finance

BadgerNet and its service vendor operate under a 5-year contract, and prices are stable for libraries within this contract period. Under the TEACH program, schools, libraries, and other eligible institutions pay a reduced rate for their broadband connections; the remainder is paid by the TEACH program. Schools and libraries pay \$100 per month for a broadband connection up to 3 Mbps and \$250 per month for a connection between 4 and 100 Mbps. The BCN contract ends in 2011, and the BadgerNet Advisory Council is actively planning for the network's future contract service requirements.

The BadgerNet contract charges the same rate to each library regardless of the distance between the library and the aggregation node. These postalized rates ensure that rural libraries pay the same monthly price for access to the BadgerNet network as urban and suburban libraries.

For public libraries in the state, the average membership fee in WiscNet is about \$450 per year. More than 90 percent of the libraries have this fee paid by their regional library system.

From its inception, BadgerNet required its vendors to build in rural as well as urban areas and to offer postalized rates. While this helped reduce the price for rural libraries to connect to the network, it has caused problems in urban areas. Some urban libraries, especially in the Milwaukee area, are finding that they can save money by purchasing service from other providers instead of from BCN.

The TEACH program uses state universal service funds to subsidize local access connections to BadgerNet for K-12 schools, public libraries, and regional library systems. TEACH pays for equipment, the installation costs for the local data lines and video links to BadgerNet, and a portion of the monthly service costs.

TEACH receives its funding from the state's universal service fund<sup>35</sup> and from the federal E-rate program.<sup>36</sup> On an annual basis, TEACH spends approximately \$13.8 million

*Postalized rates ensure that rural libraries pay the same monthly price for access to the BadgerNet network as urban and suburban libraries.*

<sup>35</sup> The portion of TEACH that subsidizes the cost of the monthly connections to BadgerNet is called the Educational Telecommunications Access Program. This program is the largest of 13 programs included in the state's universal service fund.

<sup>36</sup> TEACH files one consolidated E-rate application on behalf of more than 900 K-12 schools and libraries on BadgerNet.

to subsidize network costs for schools and libraries. The subsidy for public libraries and regional public library systems is approximately \$3 million annually. TEACH received additional spending authority in the fiscal year 2007-2009 budget, which enabled more than 60 percent of the state's public libraries to increase their bandwidth at no direct cost to the library.

Separate from the funding for the TEACH program, the state's universal service fund also provides an increasing amount of state aid to regional library systems. In prior years, the state universal service fund has generated \$5 million for state aid to library systems. The state's fiscal year 2009-2011 budget funds the regional library systems totally out of the state's universal service fund, increasing the contribution by \$11 million annually.





## History<sup>37</sup>

The Maine School and Library Network (MSLN) was created after a coordinated 2-year planning effort led by Maine’s library and education communities. In fall 1994, three organizations in the library community—the Maine Library Association, the Maine Educational Media Association (representing school librarians), and the Maine Library Commission—joined forces to represent the interests of public libraries before the Maine Public Utilities Commission (MPUC).<sup>38</sup> The result of these efforts was the creation of MSLN, one of the earliest and most comprehensive state programs to improve libraries’ Internet connections.

This advocacy effort focused on an investigation by the MPUC into allegations that NYNEX<sup>39</sup> had overcharged its customers. After the libraries formally intervened and participated actively in the case, MPUC Chair Thomas Welch announced on May 1, 1995, that he wanted to permit NYNEX “to use up to \$4 million [a year for 5 years] of the [\$15 million] rate reduction we require to provide rate reductions [including equipment] or other services to the libraries and schools of Maine.” It was left to NYNEX to work with others, including schools and libraries, to develop a plan for implementing this rate reduction. A group led by librarians and including schools, the MPUC, telecommunications carriers, the cable companies, and the University of Maine negotiated intensely over the summer of 1995. Ultimately, the group settled on a plan to provide 56 kilobits per second (Kbps) frame relay connections for all public schools and libraries in the state, with free Internet access, including equipment and free network support services. The Internet service provider (ISP) would be the University of Maine System Network (UNET).

*The Maine State Library Network [is] one of the earliest and most comprehensive state programs to improve libraries’ Internet connections.*

<sup>37</sup> Much of this background on the Maine network is based on P. Schroeder, “Organizing Advocacy for Network Services in Maine: Political Background for a Successful Initiative,” *Proceedings of INET96: The Internet-Transforming Our Society Now* (1996). Available at [http://www.isoc.org/inet96/proceedings/e7/e7\\_5.htm](http://www.isoc.org/inet96/proceedings/e7/e7_5.htm).

<sup>38</sup> According to Schroeder, the entire effort began when a single public librarian from mid-coast Maine asked the MPUC staff why libraries had to pay commercial (business) rates for telephone service. The MPUC staff told her that was the charge in the telephone company tariff, but also advised her that she could form a group of ten ratepayers to file a formal complaint with the MPUC that would initiate an investigation. The librarian asked the state library association to assist in filing the complaint. This initiated a round of discussion and analysis that ultimately led to the decision by the three organizations to join forces and intervene in the MPUC rate proceeding.

<sup>39</sup> NYNEX later became known as Verizon. In 2008, Verizon sold its service in Maine, New Hampshire, and Vermont to FairPoint. FairPoint is now the dominant provider of local telephone service in Maine and is the primary provider for MSLN.

The MPUC adopted the plan proposed by the librarians and others on January 5, 1996.<sup>40</sup> The initial MSLN plan called for an allocation of \$20 million to connect more than a thousand public schools and libraries in Maine for 5 years. Maine's Supreme Court upheld the commission's decision on March 15, 1996, when it issued a decision refusing to consider an appeal of the ratepayer case.

A parallel effort was undertaken in the state legislature to establish the legitimacy of the MPUC action. To guide this effort, the library organizations formed a Joint Legislative Committee to advocate for the expansion of the MPUC's authority to grant discounted rates and services for libraries. A few weeks after the Supreme Court decision, the Maine Legislature approved a bill that amended the MPUC's authority.

In 1999, the Maine Legislature codified the program and provided funding to continue MSLN beyond its initial 5-year period. The legislation allowed the MPUC to collect a surcharge on intrastate telephone services and deposit the revenues into the Maine Telecommunications Education Access Fund (MTEAF).<sup>41</sup> Once the legislature had authorized this new source of funding, MSLN became known as MSLN2.<sup>42</sup>

Maine is now considering how to upgrade MSLN to accommodate the growth in Internet usage.<sup>43</sup> The bandwidth available through MSLN "is now at its practical limits and is no longer meeting current needs of schools and libraries; in its current structure, it cannot scale to meet future needs."<sup>44</sup> The Department of Education and the Maine State Library are considering how to provide 100 Mbps capacity to all schools and libraries, but acknowledge that doing so will require a new strategy for procuring service and recognition that no single technology will best serve all regions of the state.

Schools and libraries are consolidating traffic in central locations to reduce costs, but these central locations require more bandwidth than is currently available. As a result, some schools have opted out of MSLN and negotiated alternative connections from ISPs that can provide them greater bandwidth. This strategy may meet the individual school's needs, but it does not allow for economies of scale and cost efficiencies that come from a homogeneous network.<sup>45</sup>

The Department of Education believes that it should develop an upgrade strategy based on fiber optic technology. It believes this is a "future-proof" technology that can scale to

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<sup>40</sup> Maine's state budget was relatively balanced in the mid-1990s, but it had little impact on the decision to build and fund MSLN because the network's costs were covered by the telephone company's overearnings. Instead, the library community and others were responsible for generating public support for using these ratepayer funds to provide connectivity to schools and libraries, rather than returning the funds to the public.

<sup>41</sup> Codified in 35-A M.R.S.A. § 7104-B. The rule implementing the Maine Telecommunications Education Access Fund is contained in Chapter 285.

<sup>42</sup> Notwithstanding the official name change to MSLN2 that resulted from the legislature's action, the network is still commonly known as MSLN.

<sup>43</sup> See "A Framework for the Next Generation Maine School and Library Network, Prepared by University of Maine System ITS at the request of the Commissioner of the Maine Department of Education," available at [http://www.noc.maine.edu/doc/Framework\\_for\\_the\\_Next\\_Generation\\_of\\_MSLN.PDF](http://www.noc.maine.edu/doc/Framework_for_the_Next_Generation_of_MSLN.PDF).

<sup>44</sup> *Id.*, at 3.

<sup>45</sup> The document notes several examples of such cost efficiencies, such as coordinated application support, connections to Internet2 backbones, more efficient traffic management, more efficient allocation of Internet address space, and use of a single centralized help desk.

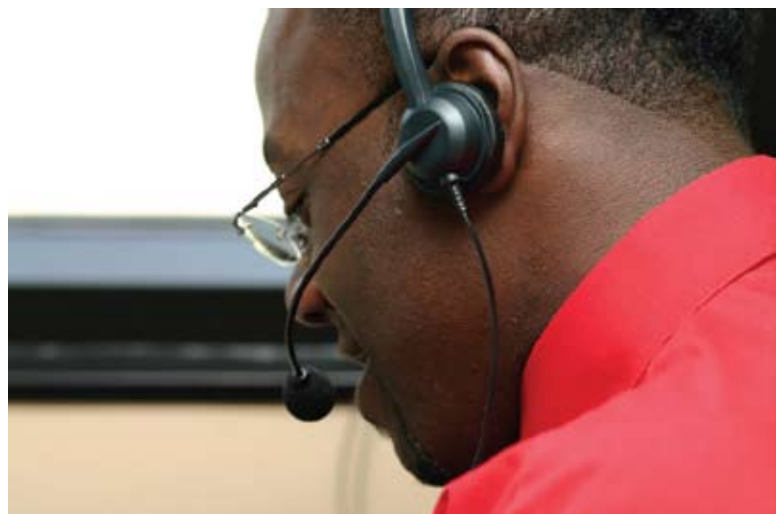
*Schools and libraries are consolidating traffic in central locations to reduce costs, but these central locations require more bandwidth than is currently available.*

very high data rates through upgrading of only the end equipment. The department also acknowledges that fiber may be too expensive in some areas. It notes that wireless service can be a practical solution for service to islands off the coast of Maine, as well as some very rural communities. To move forward on this approach, the department recommends engaging in a collaborative effort with the research and education communities—something several other states, particularly Connecticut, Rhode Island, Missouri, and Iowa, are doing.

## Services

As noted in Section 2, MSLN is one of the first statewide networks to provide Internet connections for all schools and libraries. Participation in MSLN is voluntary, and 49 of Maine's 271 public libraries do not receive MSLN Internet services. These 49 libraries have other connections, often through their community's cable company contract; a few have no Internet connection.

MSLN also offers technical support through a circuit rider service that provides advice and assistance by phone, e-mail, and in person to solve MSLN members' technical problems. Currently, MSLN funds a single circuit rider position. The circuit rider visits schools and libraries to assist them, assess their future broadband needs, and hear concerns. The circuit rider focuses on the sites with the most serious problems and with the fewest local resources to solve those problems. Because the circuit rider cannot address the needs of every library, the program tries to train local libraries to develop their own sustainable uses of MSLN without ongoing technical dependence on a circuit rider, and to integrate circuit rider efforts with those of other training programs through the State Library and the Department of Education.



Since 2007, the State Library has been a community partner in WebJunction, the web-based training service for the library community. In addition, Maine's three regional library systems offer workshops and other continuing education activities to member libraries. The State Library also offers limited training through its coordinator of learning and technology, who coordinates training efforts with the regional library systems. In addition, the Maine Association of School Libraries provides some training opportunities for school librarians.

## Network Structure

The network supporting Maine's libraries is an interesting case study since it defies the typical rules for the establishment of a network. Almost invariably, networks emerge from a need to access a resource or application. The need exists before the network is built or significantly modified because few have the vision or the resources to build it otherwise.

The State of Maine took the unusual step of creating the network first, when libraries were only beginning to need access to the Internet. Maine thus developed a very simple design to serve its needs.

Two main characteristics of successful library networks are aggregation and centralization. MSLN achieves both of those key characteristics, but in an unusual way. Rather than three distinct layers that aggregate traffic (a local access connection, an aggregation point, and a core),<sup>46</sup> MSLN allows each school and library to use a local access circuit (56 Kbps or 1.544 megabits per second [Mbps]) to connect directly to UNET (the ISP) and the Internet.

*Two main characteristics of successful library networks are aggregation and centralization. MSLN achieves both of those key characteristics, but in an unusual way.*

The flat MSLN network structure makes it easier for individual sites to connect directly to each other through the Internet, so that any library can host a resource that any or all MSLN libraries can access. (A hierarchal design does not necessarily prohibit direct connections between locations, but it often narrows the opportunities.)

As noted earlier, the original plan called for each school and library to have a 56 Kbps frame relay circuit connecting the school/library to UNET. In 1998, the MPUC approved upgrading of schools and libraries to a T1 connection if they were exceeding the capacity of their 56 Kbps connection.

As shown in Figure 4, the network aggregates library traffic to two UNET nodes within the state (located in Portland and Bangor) rather than a library system's main library. That design, coupled with standard, ubiquitous transport (T1), allows MSLN to offer consistent service across the state for any library to use. An additional benefit of aggregating all the library traffic is a lower monthly recurring expense for Internet access. The average cost of Internet access measured by the megabit always decreases as more traffic is aggregated.

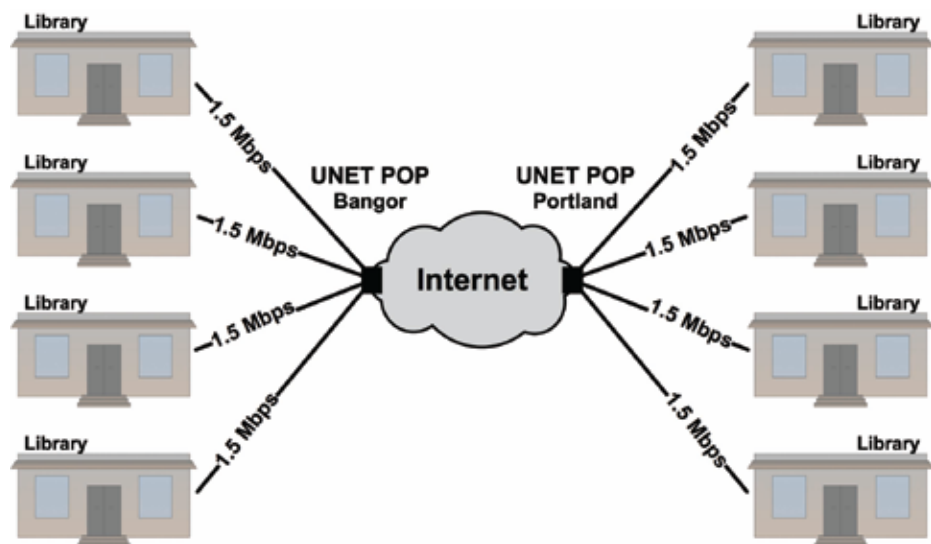


FIGURE 4. Configuration of MSLN.

<sup>46</sup> See note 33.

The downside of a flat network structure with only two aggregation points is that traffic destined for a centrally managed library resource (or for another library) must traverse the Internet to reach its destination. This route means that Internet traffic must travel a greater physical distance; the result is added delay, which may cause a potential drop in service. The Internet treats all traffic equally and will not recognize “high-priority” traffic even if marked as such by a library. Therefore, high-priority packets are not delivered over lower-priority packets. While these can be genuine issues, they have not affected libraries using MSLN.

## Governance

The MPUC is the governing body of MSLN. The commission decided to retain ultimate responsibility and authority over the network since ratepayer monies were being used to support it. However, the commission created an advisory board with limited defined functions necessary to administer the fund and the network. In 2007, the legislature disbanded the MSLN advisory board.

The state librarian and the commissioner of the State Department of Education are now responsible for policy and for representing the interests of libraries and schools before the MPUC. Each agency has staff members responsible for assessing the needs of libraries and schools and preparing an annual report to the MPUC that outlines the network’s needs and a budget request for the next year.

The project manager provides day-to-day management of MSLN, including oversight of schools and libraries regarding the use of MSLN Internet bandwidth, development of recommendations to the Department of Education and Maine State Library on future bandwidth growth, coordination of circuit moves, and changes of circuits. The project manager also consults with school and library personnel on the impact on bandwidth of their technology initiatives.



## Finance

Libraries that decide to participate in MSLN have the advantage of requesting service from a contract held jointly between the Maine Department of Education and the State Library. Compared with other library networks, Maine’s is unique in many respects but not when it comes to aggregating its purchasing power. MSLN offers a significantly lower price for T1 service than an individual library could ever hope to obtain for the same service because the MSLN contract offers the telephone company the opportunity to provide the service on a statewide basis. Offering 900 T1s is more economical for a carrier than providing one T1, and the carrier’s contract pricing reflects that cost savings. In Maine, T1 services

are purchased from FairPoint for any location in the state, even if the provider is an independent telephone company. MSLN can offer a fixed price for T1 service to any library in the state regardless of the local provider. This aggregation also relieves the individual library of the burden of requesting and evaluating proposals for connectivity to meet the federal E-rate requirements. Certainly one of the factors for success for libraries in Maine is the ability to purchase or upgrade standard service from an existing contract anywhere in the state.

MSLN is funded by two surcharges on telecommunications services: the federal E-rate program surcharge on interstate services and the Maine Telecommunications Education Access Fund (MTEAF) surcharge on intrastate services. E-rate discounts pay for approximately 60 percent of network costs, and the state program funds the remaining 40 percent.

No later than March 1 of each year, the Department of Education and the State Library file a joint proposal for support for the next fiscal year. After a prescribed comment period, the MPUC issues an order by May 1 that establishes the amount to be collected from contributing state telecommunications carriers and a level of funding for libraries that do not apply for the federal E-rate program.<sup>47</sup>

MSLN funding should remain steady for the foreseeable future as the network's revenue is generated through the federal and state universal service funds and not through state appropriations. The MTEAF collection changes from year to year depending on MSLN needs. MSLN administrators are aware of the need to keep the assessment rate as low as possible, and they lowered the request rate for fiscal year 2008.

In fiscal year 2007, the annual cost for MSLN was approximately \$4.4 million. Funds from MTEAF pay for telecommunications services, Internet access, internal connections, computers, training, and content. In addition, MTEAF funds:

- The circuit rider, who helps primarily small schools and libraries
- A consultant to assist with the federal E-rate process
- An administrator to collect the surcharges from telecommunications carriers
- A project manager to work with schools and libraries and track needs
- Free access to a variety of databases

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<sup>47</sup> The most recent joint request from the Department of Education and State Library is available at <http://www.maine.gov/mpuc/msln/MSLN-PUC%20Report-Final%20report%20turned%20into%20PUCI.pdf>.



## History

The Peninsula Library System (PLS), located in California's San Mateo County, was established in 1971 to serve the county's eight public library jurisdictions and the San Mateo Community College District. In 1982, PLS decided to automate its circulation system and created the Peninsula Libraries Automated Network (PLAN). PLAN evolved into a shared integrated library system with a union catalog that allows library users to access materials from all member libraries with one library card number. All branches of the eight public library jurisdictions in PLS have participated in PLAN since its inception.

When the network continued to slow under increased use and bandwidth limitations, PLAN libraries joined with the Community College District library in 1995 to help address the network's broadband issues. PLAN eventually moved its telecommunications infrastructure to the Community College District. By doing so, PLAN became eligible to connect with the California Internet2 backbone<sup>48</sup> and CalREN.<sup>49</sup>

In September 2007, PLS began to evaluate its future network capacity needs. As part of this evaluation, planners interviewed librarians from each PLS member to assess network strengths and shortfalls. A common challenge identified by many of those interviewed was slow or failing computer applications due to insufficient bandwidth.

In December 2007, PLS received two upgrade recommendations from its network consultants:

- Immediately implement hierarchical quality of service (QoS). QoS allows the most important applications to receive preferential treatment while lower-priority traffic utilizes the remaining bandwidth.
- Replace the existing frame relay network with a fiber-based network, and upgrade the routers and switches that make up the PLAN infrastructure.

After issuing a request for proposals, PLS awarded a contract to AT&T of California to serve all of the PLS libraries with its fiber-based OPT-E-MAN service. Not only did AT&T offer the lowest monthly recurring service rate, but the company also waived

*All branches of the eight public library jurisdictions in the Peninsula Library System have participated in the Peninsula Libraries Automated Network since its inception.*

<sup>48</sup> Internet2 is a not-for-profit advanced networking consortium comprising more than 200 U.S. universities in cooperation with 70 leading corporations, 45 government agencies, laboratories, and other institutions of higher learning, as well as more than 50 international partner organizations. See <http://www.internet2.edu/about/>.

<sup>49</sup> CalREN is operated by the Corporation for Education Network Initiatives in California (CENIC).

nearly \$500,000 in fiber construction fees. AT&T's initial cost estimate to extend fiber from the curb into each of 33 remote libraries (San Mateo Community College already had an AT&T OPT-E-MAN circuit for its own networking needs at the beginning of the deployment) was \$495,000 (\$14,500 per library). Fortunately, management within AT&T identified San Francisco Bay Area libraries as strategically important and reduced or eliminated fiber installation costs in order to win or maintain library business. This ability of the vendor to view libraries as strategic customers was critical to the success of the upgrade project.



The only one-time costs incurred by PLS were for the purchase of equipment and professional services (device configuration and project management). The monthly recurring price offered to PLS for OPT-E-MAN service for a 5 Mbps circuit is \$1,025 per month (compared with \$1,100/per month for 3 Mbps under the old frame relay service). The PLS price for a 10 Mbps circuit is \$1,225 per month. At the head-end, PLS purchased a 1 gigabit link (1,000 Mbps) for \$2,575 per month. By June 2009, PLS had upgraded its network to provide each of its libraries with a fiber connection.

The deployment of fiber to each library and the transition to the new network took approximately 14 months. A number of issues contributed to delays in project completion. Most of the PLS library buildings are owned by county or municipal governments, so PLS did not have the authority to give AT&T permission to pull innerduct or fiber inside the library. Any work within the building or on the library grounds had to be coordinated among various groups. Site survey meetings included AT&T's conduit subcontractor, its electrical contractor, a PLS representative, an AT&T engineer, a library representative, and the building owner.

Although the need to coordinate among multiple government agencies caused project delays, PLS hired an experienced project manager who relieved the system of coordination responsibilities. The manager had multiple years of experience with state government and telecommunications companies, and his expertise and presence contributed to PLAN's successful upgrade. In such large projects, it is essential for library systems to have their own project manager and not rely solely on the telecommunications company to provide coordination and oversight.

Once the fiber had been installed and tested, PLS converted the libraries to the new network within 2 weeks. PLS contracted for implementation services with network consultants to ensure a smooth transition from the legacy network to the fiber network. These consultants were also charged with transitioning knowledge to the local team, allowing them to maintain the network after the conversion.



## Services

PLAN is responsible for the day-to-day operation of the network and provides PLS libraries with a variety of telecommunications and broadband services through a centralized information technology (IT) department. In addition to the IT director, PLAN staff members include a database administrator, systems engineer, network administrator, and assistant database administrator/project manager.

These technicians supervise wide area network (WAN) services (network connectivity and network monitoring), local area network (LAN) services (switch and router hardware administration), and enterprise services (integrated library system, patron computer time management, e-mail, web hosting, and 24/7 help desk support). In addition, PLAN staff members organize training for member library staff and negotiate reduced costs for training and equipment purchases. The community college administers firewall services for the network.



## Network Structure

Until the recent network upgrade to fiber-based services, PLS relied on a traditional hub-and-spoke frame relay design provisioned by AT&T. San Mateo Community College served as the hub of the network, and the individual libraries (spokes) were served with DS1 connections.

Today, patron and administrative workstations are placed in separate virtual local area networks (VLANs) within each library.<sup>50</sup> In Figure 5, the administrative VLAN is shown in red and the patron VLAN in blue. Creating separate VLANs for patrons and administrators reduces opportunities for security violations. Typically, each library has at least one wireless access point, and some of the larger libraries have as many as five. PLS created a VLAN (shown in orange in Figure 5) for wireless users as well, thereby isolating them from administrative traffic.

<sup>50</sup> Like most service providers, PLS designed and implemented a standard network for most libraries and deviated only when necessary.

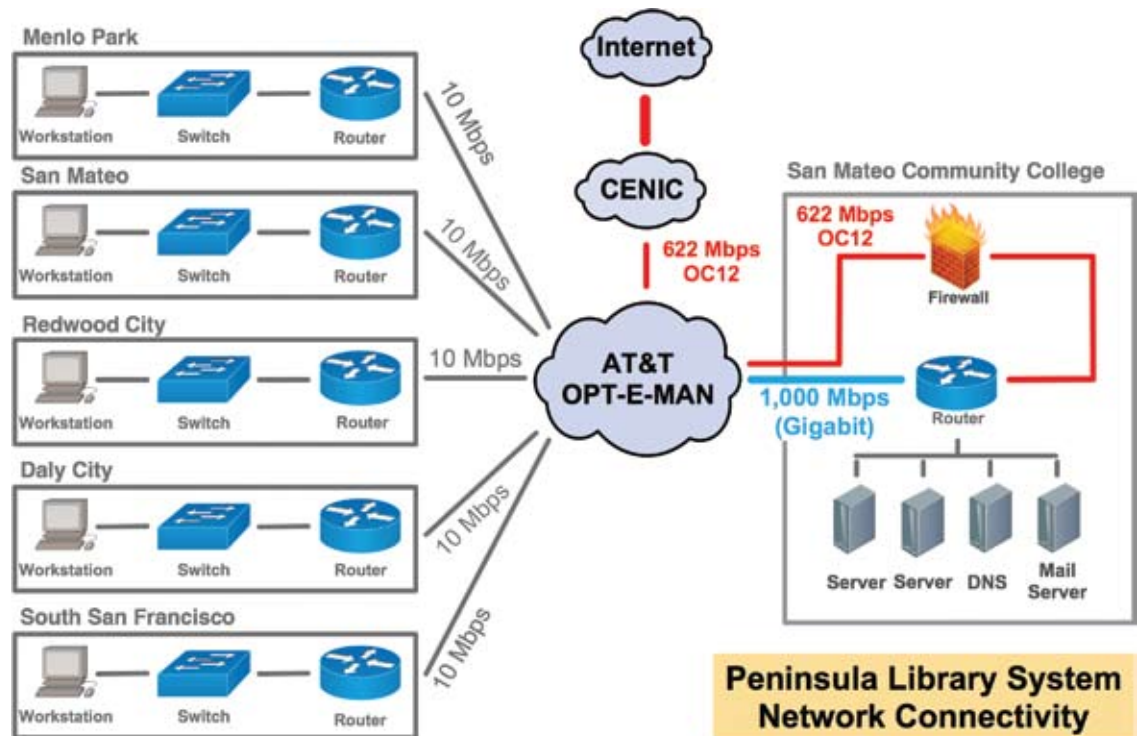


FIGURE 5. Typical PLS library network configuration.

*Each library now has fiber inside the building connecting it to the network.*

Each library now has fiber inside the building connecting it to the network. The majority of the libraries connect at 5 Mbps, which is more than triple the 1.5 Mbps (frame relay DS1) they had previously. However, a number of larger libraries implemented 10 Mbps and have already seen usage peak at or near circuit capacity. The process for increasing bandwidth is simple, requiring only a request that specifies the bandwidth amount desired and the date by which the increase is needed. Each PLS library pays for an increase in bandwidth.

In PLAN's current hub-and-spoke design, traffic entering AT&T's fiber-based Ethernet network is routed to the core of the PLAN network at San Mateo Community College. PLAN centralizes services, such as e-mail, the integrated library system (ILS), and firewall services, at the college data center. Any traffic originating at a remote library and terminating at another remote library will travel to the network core and be redirected by the PLAN head-end router. However, most of the traffic originating from remote libraries travels to the Internet.

## Governance

PLS was one of fifteen statewide library systems authorized under the California Library Services Act. As a result of recent consolidation efforts spearheaded by the California State Library, library systems in California now number eight. In July 2009, PLS combined three library systems to form the Pacific Library Partnership (PLP). This new library system was established through a joint powers agreement; however, the four participating library

systems, including PLS, retain a great deal of autonomy and maintain an independent system administrative council and their own joint powers agreement.

The PLS Administrative Council, composed of library directors from PLS member libraries, is responsible for overseeing PLAN. PLAN currently serves only PLS, and PLS administrators have no immediate plans to expand it to serve other PLP members.

## Finance

PLS supports 35 library branches. It is funded primarily by member libraries, which in turn are supported largely through local property tax revenue. PLS also receives support under the California Library Services Act, the federal Library Services and Technology Act (LSTA), and local contracts for special services.

Member libraries share the up-front and ongoing maintenance costs of the central system, the connectivity costs of the transmission system,<sup>51</sup> and the support staff that manage and operate the system. PLS created and maintains the network with funds from its general budget.

PLS applies for federal E-rate discounts for eligible costs of operating PLAN, excluding Internet access and internal connection costs. PLS's discount rate is 50 percent.

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<sup>51</sup> Until 1994, PLAN used an existing countywide civil defense microwave communications system. The libraries needed to finance only one additional microwave tower for this communications network to provide direct line-of-sight signal transmission to all the libraries.



## APPENDIX A A TECHNICAL PRIMER ON BROADBAND CONNECTIVITY AND NETWORKING STRATEGIES

The five library networks profiled in this publication have several critical factors in common. In each case, individual libraries have worked together to implement a broadband solution that achieves technical efficiencies and cost savings that could not have been realized by each library individually. This appendix explains the underlying networking strategies used for these library networks to reduce their broadband costs and improve service for staff and patrons.

First, some of the basic elements of broadband connectivity are described. The second section reviews some of the low-cost options available to individual libraries that are encountering congestion difficulties and are seeking ways to ensure that their administrative operations can continue to function even as patrons' Internet usage increases. Some options will enable libraries to maximize bandwidth throughput while ensuring that administrative applications are prioritized over Internet traffic. The final section explains the benefits of cooperating with other libraries in addressing the need for greater bandwidth. These strategies generally fall into one of two categories—aggregation of bandwidth or consolidation of hardware and expertise. Using examples with actual prices available to libraries in Wisconsin, the discussion demonstrates how aggregating Internet bandwidth will reduce libraries' monthly recurring expenses. In addition, the advantages of consolidating services and technical support across a library network are described.

### Basic Elements of Broadband Connectivity

Obtaining broadband connectivity for libraries can be challenging; it requires acquiring a basic level of knowledge of the subject, learning a new vocabulary, and gaining familiarity with a range of technologies. Further complicating matters, libraries may have a choice of service providers and technology options. Libraries have important decisions to make to ensure that they provide the best and most cost-effective service to their patrons and their administrative staff.

A broadband network typically comprises three layers (see Figure 6):

- The local *access* connection layer (often a cable or telephone company line) from the library building to a central aggregation center
- The *aggregation* point layer (a router or large switch), which aggregates traffic from multiple locations
- The *core* layer (routers or large connection points) in the backbone network

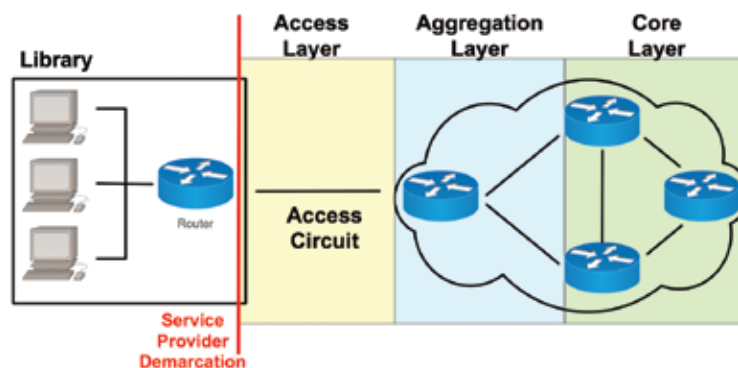


FIGURE 6. Layers of a broadband network.

Typically, the library obtains an access circuit from a telephone or cable company and then connects to a different service provider that manages both the core and aggregation layers. The Maine School and Library Network is an example of this approach, as each member contracts and pays for an access layer circuit that connects to one of two aggregations nodes.

Sometimes, however, a single entity provides all three levels layers of connectivity. For example, most Wisconsin libraries receive all their network components from a single provider (BadgerNet) with a single point of contact.

A third scenario is also possible, in which each of the three layers is provided by a different service provider. For instance, one entity, such as a state government or university, may manage the core layer of the network; an interexchange carrier (IXC), cable TV provider, or local telephone company may provide the aggregation layer; and the library system may purchase an access layer circuit directly from a local service provider. In such cases, the library would benefit from contacting the information technology (IT) department within the municipality, the county, and/or a university to determine whether a single service offering is available to reduce the complexity of working with three different providers.

## Low-cost Options for Managing Growth in Internet Usage

One of the most common networking issues facing libraries is determining how to handle the explosive growth of Internet usage, which directly drives bandwidth needs. To serve their patrons better, most libraries are increasing the number of computers dedicated to patron use. The ease of installing wireless access points in libraries also increases the demand on bandwidth, mainly for Internet access. Without question, the single most repeated comment related to library networking is, “When the students arrive after school, all our applications slow down.” This situation is especially problematic when Internet use by patrons shares the same broadband circuits as administrative applications such as integrated library system (ILS) traffic because applications will time out if they cannot receive a response during periods of heavy network congestion. Indeed, several libraries report that critical administrative applications slow down to the point of failure during times of peak usage by their patrons. There are several low-cost options for addressing this issue.<sup>52</sup>

### Adding a Digital Subscriber Line (DSL)

One option available to libraries is simply to order an additional circuit and dedicate one circuit to patron use and the other to administrative/staff use. For instance, the library can install a separate DSL dedicated to use by patrons. DSL service is less reliable than other connection options, but is ideal for offering faster Internet access to library patrons who, as a group, are willing to tolerate occasional downtime in exchange for faster connections.

As depicted in Figure 7, libraries can maintain their own high-quality connection to the head-end for administrative use and even some patron access to the Internet. A DSL circuit is then added specifically for patron use. An asymmetrical service like DSL is ideal for Internet traffic; traffic uploads are usually less than one-quarter of traffic downloads. Depending on the equipment in the library, it is relatively easy to add multiple DSL lines and dramatically increase the total path capacity to the Internet. Prices can vary substantially among providers, but many libraries can receive five times the amount of DSL bandwidth for the rate they currently pay for a T1 circuit.

<sup>52</sup> For libraries that can afford to plan for the long run, obtaining a fiber connection may provide the best option. Fiber optic cables can carry an almost unlimited amount of traffic, and they are seen as a “future-proof” technology. ALA has published a separate paper addressing this option, entitled *Fiber to the Library: How Public Libraries Can Benefit from Using Fiber Optics for Their Broadband Internet Connection*, September 2009, John Windhausen, Jr. and Marijke Visser.

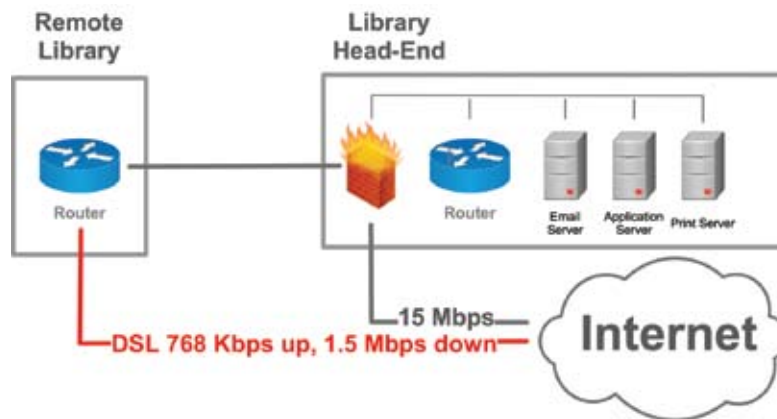


FIGURE 7. Adding a digital subscriber line (DSL) to accommodate patrons' Internet use.

Use of DSL has disadvantages as well. A firewall must be installed at the library to protect patron and administrative computers—an additional expense. Without a firewall, the library with DSL and every library that connects to that library are at risk. Furthermore, adding bandwidth to alleviate congestion may not solve the congestion problem because patron demand may fill up the additional circuit quickly. Furthermore, some libraries may not have the funding to afford the monthly cost of leasing an additional circuit.

### Dividing the Existing Circuit into Two Channels

Networking techniques allow a single circuit to be separated into two logical connections, one for administrative traffic and one for patron traffic. With this option, each channel is allocated a fixed amount of capacity. This approach is cost-effective because it uses a single physical circuit rather than two, but it is inefficient. When patron traffic peaks, it cannot overflow into the reserve set aside for administrative traffic. Because the channel allocation is fixed, some of the capacity of the circuit that is reserved for one type of traffic may be unused even when there is strong demand for the other type of traffic. The ideal situation would allow both Internet and administrative traffic to consume the entire bandwidth available, with administrative traffic having priority.

### Implementing Quality of Service (QoS)

QoS is one of the leading trends in data networking. QoS recognizes the qualitative differences in data streams transmitted concurrently over the same circuit and prioritizes some types of traffic over others. Higher-priority traffic can be identified by its origination Internet Protocol (IP) address, destination IP address, or application port number. Once the traffic has thus been classified, the router or Layer 2 switch can ensure that the higher-priority traffic takes precedence across the network. When higher-priority traffic is not present, the bandwidth is available for lower-priority traffic.

Figure 8(a) shows a specific moment in time at a library. The blue line represents library staff administrative traffic, while the red line represents the traffic generated by library patrons. Some patrons use the computers supplied by the library, while others have brought a laptop with them. The applications typically accessed by patrons—such as online educational videos, job-training classes, and e-government applications that may have sizable pictures or video files—are likely to require large amounts of bandwidth. Without QoS, traffic is not prioritized, so administrative and patron traffic compete for whatever bandwidth is available at the moment it is requested.

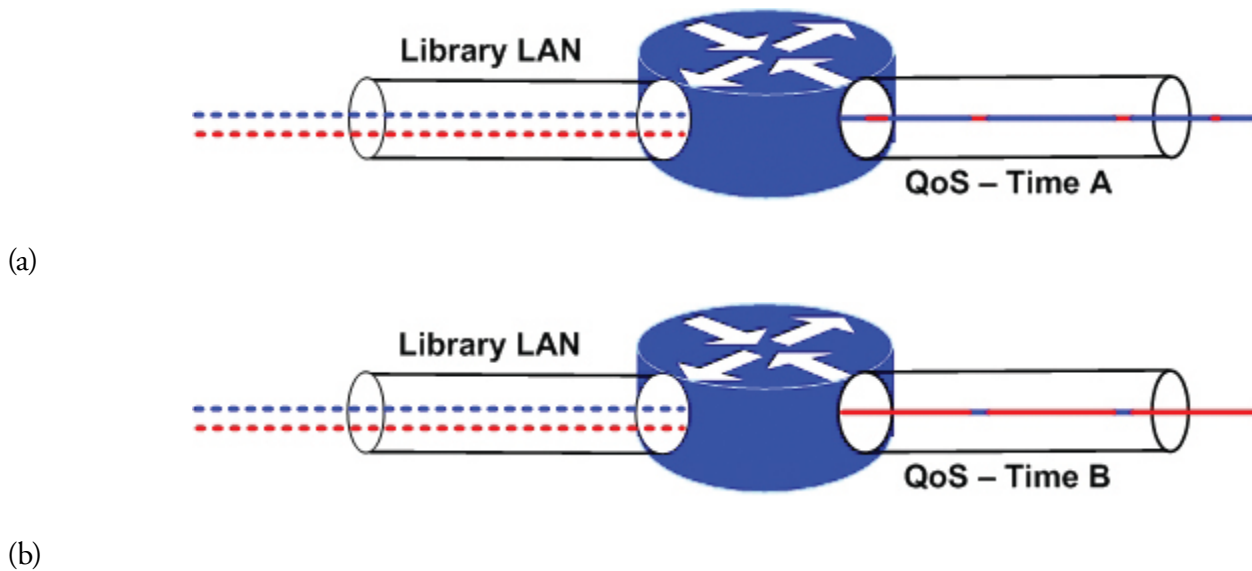


FIGURE 8. Using quality of service (QoS) to prioritize administrative and patron traffic.  
NOTE: Blue lines indicate administrative traffic; red lines indicate patron traffic; LAN = local area network.

With QoS, the higher-priority administrative traffic takes precedence over the traffic identified as lower-priority, ensuring that sufficient bandwidth is available for administrative traffic when needed. At such times (indicated by “Time A” in the figure), lower-priority traffic packets are buffered (placed on hold) or discarded until more bandwidth is available. A properly implemented QoS strategy will ensure that at least some of the low-priority traffic will be transmitted even in times of heavy use.

One advantage of QoS is that the library’s administrative operations can function at an acceptable level even when there is high Internet use by the library’s patrons. A second advantage is the fluidity with which the same bandwidth can support lower-priority traffic when bandwidth is available. In Figure 8(b), few administrative applications are running at this moment in time (“Time B” in the figure). In this case, Internet traffic (shown in red) uses virtually all the available bandwidth. When designed and implemented properly, QoS will allow low-priority traffic to consume most or all of the bandwidth if higher-priority traffic does not need it. Most QoS implementations guarantee a minimum percentage of bandwidth for each priority queue to ensure that some traffic can always be transmitted.

To implement QoS, a library needs to have equipment that can support it and the expertise to configure it. Ideally, QoS is implemented at every aggregation point—in the branch library, in the main library hub, and in the service provider’s network (although it can work successfully even if the service provider does not offer QoS functionality). The library’s wide area network (WAN) router or switch must be provisioned to differentiate data streams and give priority to some types of traffic over others. Not all WAN devices have QoS capability, however. The older the device, the less likely it is to have QoS capability or to be upgradable to a version of code that supports QoS. Almost all manufacturers offer QoS feature sets with their new equipment, but a library should ascertain this before making a purchase.

While QoS is becoming increasingly common, a fair amount of expertise is still required to implement it. If a library is fortunate enough to have access to IT staff, the manufacturer of the equipment can train them to implement the QoS feature set. If the library does not have IT staff available, it will have to seek outside experts.



## Advantages of Aggregation

As a library considers how to address its need for broadband connectivity, one of the first questions it must answer is whether it will join forces with other libraries in the area to form a network or deal with the issue on its own.

For a library that decides on the latter approach, obtaining broadband connectivity can conceptually be as simple as ordering a DSL circuit, a T1 circuit (1.5 megabits per second [Mbps]), or a higher-capacity circuit from a local broadband provider with the library at one end and any Internet service provider (ISP) at the other. With some basic routing or switching equipment, often provided by the ISP, a broadband connection can be achieved. In practice, however, managing a broadband connection is usually not quite so easy. For many libraries, barriers to achieving acceptable broadband connectivity range from cost to network expertise to the willingness to accept change. Given the continuing growth in broadband needs, moreover, maintaining adequate connectivity is a dynamic process that often requires frequent adjustments to equipment and bandwidth levels.

Each of the library networks reviewed in this publication achieved success in part because the libraries were organized into a consortium, ranging from as few as 9 sites in one Wisconsin consortium to more than 270 in Maine. Organizing into a consortium provides increased efficiency that cannot be achieved by any one library alone.

Business enterprise networks typically centralize commonly accessed applications at the head-end (main location) and lease or purchase circuits to connect them. Doing so provides economies in hardware, software, and technical support. Many libraries are already familiar with the benefits of collaboration in managing library resources. For instance, libraries often are able to buy more library materials by combining their purchasing dollars. They also are able to reduce the number of popular items purchased by sharing them through interlibrary loan. As another example, an ILS centralizes cataloging and tracking of library materials. When online public access catalog systems (and other applications, such as e-mail servers) are centralized, member libraries avoid the expense of owning and managing them individually. In many library systems, resources are consolidated at the system's main library, typically the largest in the system.

It is intuitive that one larger ILS is more cost-effective than 25 smaller ones at individual libraries. What may not initially be intuitive is the cost savings realized by centralizing technical support. Hiring technical support staff centrally is less expensive than each library's hiring part-time staff or executing its own service contract, and usually results in having staff who have more experience and better credentials as well.

Each of the library networks profiled here applied these concepts to its network design. For instance, each consolidated hardware (such as e-mail servers and domain controllers) and other network operations into a single building, usually the main library. In addition, these library networks aggregate network traffic, which lowers costs, improves efficiencies, and provides a single security perimeter.

Figures 9 and 10, respectively, illustrate the two broad strategies of individual libraries obtaining broadband connectivity on their own and libraries joining forces to obtain connectivity. In Figure 9, ten individual libraries connect directly to an ISP. Each such library usually incurs two monthly charges: one for the broadband circuit, typically provided by a local service provider (telephone or cable company), and the other for connection to a port provided by the ISP. When the telephone or cable company is also the library's ISP, those costs are usually combined on a single bill. The costs shown in the figure are an example of actual charges a library in Wisconsin would incur if

it were directly connected to the Internet.<sup>53</sup> As can be seen, each library that connects directly to the Internet at 1.5 Mbps incurs a \$600 circuit charge and an ISP charge of \$338 per month (for a total of \$3,380 for all ten libraries). Note also that each library requires its own equipment, which can be expensive to purchase and maintain.<sup>54</sup>

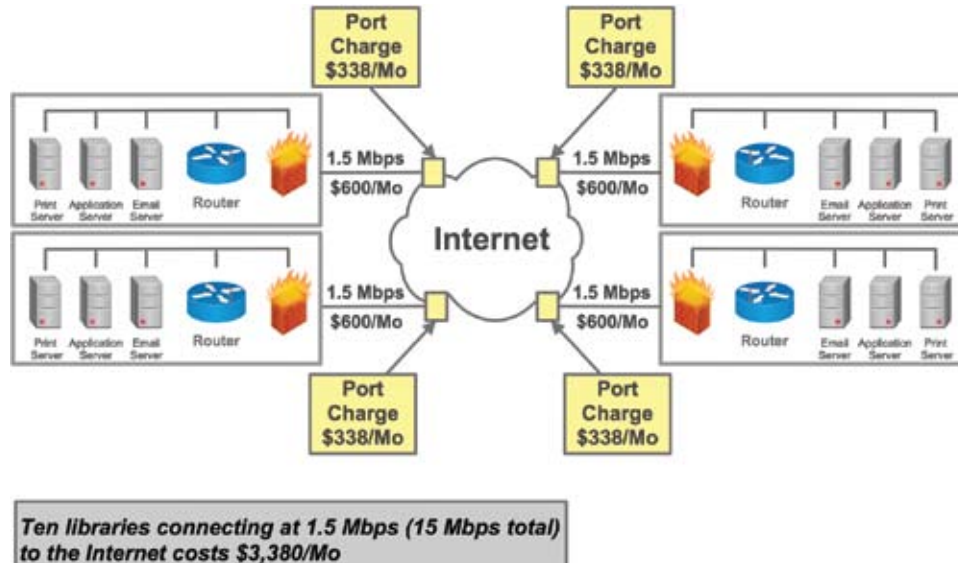


FIGURE 9. Individual libraries connected to the Internet.

In Figure 10, libraries 1 through 9 connect to the main library (also referred to as the hub or head-end). Network designers refer to this arrangement as a hub-and-spoke configuration. There are several advantages to this design.

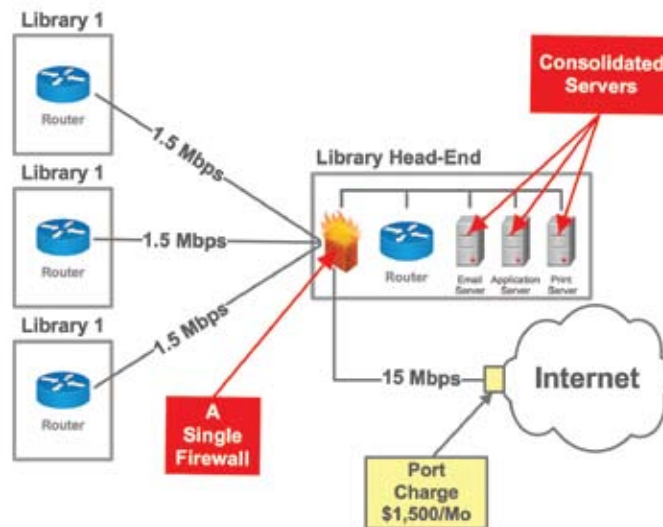


FIGURE 10. Bandwidth for individual libraries aggregated at the main library (hub or head-end).

<sup>53</sup> Fully 98 percent of Wisconsin's public libraries are connected to a regional library system WAN for their Internet connectivity. So while this is an accurate example, it is used by only a few libraries in the state. Also, the \$600/month circuit charge is the state contract rate. Libraries pay just \$100/month. See Section 6 for more information.

<sup>54</sup> Further, in some situations this equipment may be eligible for E-rate discounts only in the Priority 2 category, which very few libraries receive.

First, the ISP port charge is much lower. As the amount of bandwidth purchased from the ISP increases, the rate paid per megabit decreases. This general rule can be applied to all bandwidth service providers. In the scenario represented by Figure 9, each of the ten libraries is connected at 1.5 Mbps directly to the Internet, and the port charges total \$3,380/month. When the libraries aggregate their bandwidth to a single location before connecting to the Internet, the port charge is less than half that amount—\$1,500/month. This represents a monthly savings of \$1,880, or \$22,560 annually, just on the cost of the bandwidth connection to the Internet. More than 90 percent of Wisconsin's public libraries use this hub-and-spoke approach for connecting to the Internet.

A second advantage of the hub-and-spoke design is that equipment costs are lower. Note that in Figure 10, all the servers have been consolidated in the main library. As previously mentioned, this reduces the total number of devices that must be purchased and effectively lowers the overall cost of the connections. In this case, each library contributes only 10 percent of the expense it incurred by purchasing connectivity individually (Figure 9) because the 10 libraries divide the cost of the shared equipment. As the number of libraries in a network increases, the average contribution for equipment decreases.

A third advantage of the consortium approach is that network security can also be shared at a reduced cost. Failure to maintain security can result in a range of problems, from denial-of-service attacks to hackers within the library launching a virus or reformatting the disk drives of every computer on the library's local area network (LAN). In Figure 9, each library is responsible for its own security and for maintaining the requisite staff expertise to address this issue. In contrast, the hub-and-spoke design shown in Figure 10 requires one connection to the Internet that must be secured. In practice, two connections to the Internet (the second for redundancy, in case of a problem with one connection) are ideal. A single firewall allows for a common rule set among all participating libraries, providing centralized protection from external intrusion.



## ADSL or asymmetric digital subscriber line

Commonly called DSL, consists of technology and equipment that allow high-speed communication, including video signals, across standard copper telephone wires. ADSL can transmit at high rates of speed both upstream and downstream, depending on line distance. “Asymmetric” refers to the fact that ADSL is designed to deliver more speed downstream (from the central office to the customer) than upstream (the other way around).

## Aggregation node or aggregation point

A physical location that combines or aggregates access layer circuits in a hierarchical network, typically implemented via a larger router or switch. The aggregation node transitions circuits from the access layer of the network to the aggregation layer. Some traffic will continue through the aggregation layer to the core layer of the network.

## Backbone network

Connects smaller networks. Backbones exist at all levels, from local to national. They can be deployed across many buildings (such as in a campus setting or across cities or states) or within a single building.

## Bandwidth

Also called capacity, denotes the volume of data an Internet connection can handle over a given unit of time. The volume of data being transmitted is usually measured in bits per second (bps).

## Bit

The smallest possible unit of information, usually expressed as a simple binary choice: yes or no, on or off, one or zero. In a digital system, all information is expressed simply as very large strings of ones and zeros.

## Bits per second or bps

A common measure of data transfer in data communications. It is used to denote how many bits of data are traveling through the transmission per second. (See also kilobits per second [Kbps] and megabits per second [Mbps].)

## Broadband

A general term referring to high-speed communication, regardless of which medium—fiber, wire, cable, or wireless—is used to provide it. Precisely what speed constitutes broadband is constantly changing as technological capability, applications, and user demands evolve.

## Bundled service

Multiple services provided by a single company. One advantage (or disadvantage, depending on one’s perspective) of bundled service is that there is usually only one bill and one place to go for customer service regardless of how many services are ordered.

## Cable modem

While serving the same purpose as a dial-up modem, a cable modem is different in many ways. The major differences are that a cable modem is much faster, and it does not use a telephone line to connect but instead uses a digital cable television line. Moreover, instead of connecting to a serial port as does a dial-up modem, a cable modem connects to a standard Ethernet port with a much faster rate of data transfer. Computers equipped with a cable modem have a continuous or “always on” connection to the Internet.

## Central office or CO

Refers to the physical location of the local telephone company’s building where home and business subscriber lines are connected to the rest of the network. For purposes of Internet access, the central office switching equipment receives data transmissions from a customer’s location and then sends those transmissions to the Internet over telephone company or third-party networks.

## Children’s Internet Protection Act or CIPA

A federal law that addresses concerns about access to offensive content over the Internet on school and library computers. CIPA imposes certain types of requirements on any school or library that receives funding for Internet access or internal connections from the E-rate program.

## Connection speed

The speed of a data communications circuit. Some circuits are symmetrical—they have the same bandwidth capacity going to and from the network. Asymmetrical systems differ in the bandwidth provisioned; more bandwidth is typically available from the network to the end user than from the end user to the network.

## Dial-up access

Access to the Internet using conventional voice telephone service. It requires the use of a modem to connect a computer to the telephone line. Dial-up speeds are up to 56 kilobits per second (Kbps).

## DSL or digital subscriber line

A technology developed to send high-speed transmissions over standard copper telephone wires. See also ADSL or asymmetric digital subscriber line.

## E-rate

The commonly used name for the Schools and Libraries Program of the Universal Service Fund, administered by the Universal Service Administrative Company under the direction of the Federal Communications Commission. The program provides discounts to assist schools and libraries in the United States and its territories in obtaining affordable telecommunications and information services.

## Ethernet

A common method for connecting computers and equipment in a single location. Ethernet connects computers, printers, workstations, servers, etc. within a building to a hub or router that allows the devices to communicate.

## Fiber

A glass-based transmission medium (as opposed to copper). The electronics, which use lasers to transmit optical signals, are placed at opposite ends of the path. Fiber optics can provide significantly larger capacity over longer distances relative to copper-based electrical signals, thus yielding much higher bandwidth.

## Fiber ring

A circular pattern of localized fiber optic cables used to transmit data and information at very high speeds over a short distance within a specific region.

## Frame relay

A technique used to send digital information, which in data packets (called frames) is passed from one or many start points to one or many destinations through a series of intermediate node points. This technique commonly sends data between local area networks (LANs) over a wide area network (WAN).

## Head-end

See Hub.

## Hub

A central location on a network that links remote workstations or locations. At the center of a local area network (LAN), the hub connects network devices, including computers, printers, and servers. In a wide area network (WAN), a hub can also refer to a central location.

## Hub and spoke

A network arrangement in which one or more servers is the hub (see above), and other servers or other devices, called spokes, are connected to the hub.

## Innerduct

A specific type of conduit designed to hold fiber optic or other types of cable.

## Internet service provider or ISP

A vendor providing access to the Internet.

## Intranet

A private network accessible only by an organization's members or employees or others with authorization.

## ISDN or Integrated Services Digital Network

A set of international standards designed as an enhancement to the analog public switched telephone network (PSTN). ISDN connections consist of ISDN modems that dial up other ISDN modems across ISDN lines.

## Kilobits per second or Kbps

A unit expressing the speed of data transfer through a network in terms of thousands of bits per second.

## Last mile

The telecommunications technology that links the end user to the local point of presence (POP) of the area telecommunications provider (such as the telephone company, cable provider, or Internet service provider). This section of the connection is usually the most expensive because it is not shared with other users that would also share the costs. Last-mile technologies include fiber optics, copper cable, and satellite transmission.

## Local area network or LAN

A computer network that spans a relatively small area, connecting computers, workstations, servers, printers, and other peripherals. Most LANs are confined to a single building or group of buildings. However, one LAN can be connected to other LANs over any distance, creating a wide area network (WAN).

## Megabits per second or Mbps

A unit expressing the speed of data transfer through a network in terms of millions of bits per second.

## Megabyte or MB

A unit expressing the amount of physical storage on a storage device—a hard disk, for example.

## Microwave

The radio frequency used for communicating to and from satellites. Microwaves can also be used to transmit telephone, facsimile, video, and data signals in terrestrial systems.

## Middle mile

Telecommunication facilities in the access layer of the network connecting the local loop (last mile) to the aggregation point.

## Modem

Short for modulator/demodulator, a device that connects a computer to a network. Modems work at different speeds; the faster the speed, the faster the information flows to (and from) the computer. A modem's speed is measured in bits per second, or bps.

## Network

Links devices, such as computers and telephones. LANs and WANs are examples of networks.



## Plain old telephone service or POTS

Standard analog telephone service generally associated with making and receiving voice calls. The term is sometimes used in discussing new telephone technologies with respect to whether and how existing voice transmission for ordinary phone communication can be accommodated. For example, asymmetric digital subscriber line (ADSL) and Integrated Services Digital Network (ISDN) connections allocate some portion of their channels for POTS while providing most of their bandwidth for digital data transmission.

## Point of presence or POP

A physical location where an Internet service provider aggregates the Internet packets from its customers before forwarding them to another location. Internet packets can pass through many POPs at various levels of the Internet (e.g., local, regional, or national) before reaching a final destination, such as a server or someone's laptop computer. A local Internet service provider (ISP) may have just one POP, but national ISPs may have thousands.

## Postalized pricing

Circuit pricing that is held constant regardless of the distance from the end-user site to the aggregation point. That is, all users pay the same rate regardless of how far they are from the aggregation point.

## Public switched telephone network or PSTN

Refers to the local and long distance telephone system. It can denote only one company or a collection of local, long distance, and international telephone companies.

## Real Simple Syndication or RSS

A subscription protocol used to aggregate frequently updated websites (such as blogs and news sources). Users subscribe to an RSS feed of a website they want to monitor. The RSS feeds are aggregated and viewed through a web-based (Google Reader) or client-side (Netnewswire) application, commonly called a "reader." The reader receives updates from the subscribed websites and displays the updated content in the reader interface. RSS is useful for users who wish to aggregate website updates in one place. A user can click on a headline and be directed to the full article on the original website.

## Router

A hardware device that separates network segments, allowing only certain Internet Protocol (IP) addresses to cross boundaries. Routers are typically used to connect local area network (LAN) segments to a wide area network (WAN).

## Satellite transmission

A type of transmission that sends a signal to a satellite in orbit. When the orbiting satellite receives a transmission, it amplifies the transmission and sends it back to earth. Satellite transmission can be used for high-speed Internet access.

## T1

Sometimes written as T-1, a common name for a DS1 transmission rate of 1.544 megabits per second (Mbps).

## Telecom transmission rates

Traditional transmission rates build in the following order:

- DS0 is 64 kilobits per second (Kbps)
- DS1 is 1.544 megabits per second (Mbps) (one DS1 can have 24 DS0s)
- DS3 is 45 Mbps (one DS3 can have 28 DS1s)
- OC3 is 155 Mbps (one OC3 can have 3 DS3s)
- OC12 is 655 Mbps (one OC12 can have 12 DS3s)
- OC48 is 2,400 Mbps (one OC48 can have 48 DS3s)

## Throughput or transfer rate

The amount of data moved successfully from one place to another in a given time period. Throughput is usually measured in number of bits per second (bps) that are transmitted, which is typically expressed as kilobits per second (Kbps) or megabits per second (Mbps).

## Transmission Control Protocol/Internet Protocol or TCP/IP

Protocols that provide communications between connected networks and between diverse hardware architectures and different operating systems. These protocols allow communication among users on the Internet or World Wide Web.

## Upstream/downstream

Two directions involved in delivering information over a single circuit. In a symmetrical connection, both upstream and downstream transmission speeds are the same. In an asymmetrical connection, the speed of one direction can be greater than that of the other. Typically, the speed of the downstream side of the connection (from the network to the end user) is greater than that of the connection from the user to the network. (See also ADSL or asymmetric digital subscriber line.)

## Virtual local area network or VLAN

A network of computers that appear to be connected to the same network even if they are physically located on different segments of a local area network (LAN).

## Web 2.0

Generally attributed to Tim O'Reilly, O'Reilly Media, in 2004, Web 2.0 websites allow users to do more than retrieve information. Traditional websites limit users to viewing, and the content can be modified only by the site's owner. Web 2.0 applications and websites are interactive, encouraging users to create and add content to them. With Web 2.0 websites, users can own and exercise control over the data. Software applications are run entirely through

the Internet browser. As these interactive applications increase in popularity, they also increase in complexity, requiring more and more bandwidth to run the added features. One advantage of successful Web 2.0 applications is their ability to improve as users add their own content.

### Web application mashup

A Web-based application created by combining parts of two or more existing applications into a new application that has components of each original. A mashup can add value by displaying information in new or unusual ways not apparent in the originals. An example is adding the geographic coordinates from Google Earth to a photo stored on Flickr.

### Wide area network or WAN

A network that connects two or more remote locations. Any media connection type, including plain old telephone service (POTS) lines, ISDN, DS1, DSL, satellite, microwave, or fiber, can be used in a WAN.

### Widget

A generic term for a graphical interface and its corresponding code that allow a user to interact with the application on a website without requiring any additional coding on the part of the user. Widgets are commonly used to enhance websites by adding graphic icons such as clocks, weather badges, and word-of-the-day. Widgets also allow users to link to other websites, frequently social networking sites such as Del.icio.us, Digg, RSS feeds, and Facebook. A primary purpose of adding a widget to a website is to encourage user interaction with the website's content.

### Wireless

Any communications service utilizing electromagnetic waves to transmit signals. In this type of system, the most notable feature is the lack of wires connecting devices. Wireless systems can be used over long and short distances; the type of wireless system used will determine the speed and distance possible. Wireless operations permit services, such as long-range communications, that are impossible or impractical to implement with the use of wires.

### Wi-fi

Short for wireless fidelity, a wireless local area network (LAN) technology that enables a laptop, personal digital assistant, or other mobile device to connect to another device.

#### Additional Resources:

These definitions were derived from the following sources. Please refer to these sources for additional information.

#### **Tech Term Glossary**

[http://www.dsl-experts.com/broadband\\_glossary\\_a.htm](http://www.dsl-experts.com/broadband_glossary_a.htm)

#### **TechSoup**

<http://techsoup.org/tools/glossary.cfm>

#### **Webopedia**

<http://webopedia.com>

**Harry Newton, *Newton's Telecom Dictionary* (22<sup>nd</sup> ed.) (San Francisco: CMP Books, 2006)**

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## Related Work from OITP

### ***Fiber to the Library: How Public Libraries Can Benefit from Using Fiber Optics*** **by John Windhausen, Jr. and Marijke Visser**

Broadband access is enormously important if libraries are to fulfill their mission of serving the American public with necessary information services. Unfortunately, the ability of libraries to meet these community needs is in jeopardy because of inadequate broadband capacity. This policy brief explains how and why fiber-based solutions are desirable for most libraries in the long run.

### ***Rethinking the E-Rate by Carrie Lowe***

The federal Education-rate (E-rate) program provides libraries with discounts on telecommunications services. Lowe describes the complexity of the current program rules and application process, but quickly shatters some common myths about the program. Overall, libraries should take greater advantage of the E-rate program to support their ongoing broadband expenses.

### ***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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1615 New Hampshire Avenue, N.W.  
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Washington, D.C. 20009  
Telephone 202-628-8410  
Fax 202-628-8419  
[www.ala.org/oitp](http://www.ala.org/oitp)

The Office for Information Technology Policy advocates for public policy that supports and encourages the efforts of libraries to ensure access to electronic information resources as a means of upholding the public's right to a free and open information society.





## About the Authors

This publication is the product of a team of researchers, authors and reviewers. This team includes consultants Karen Strege, John Windhausen, Chris Alberts, Robert Bocher, and Kristen Batch. From the OITP staff, team members include Carrie McGuire, Alan Inouye and Marijke Visser.

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The Office for Information Technology Policy advocates for public policy that supports and encourages the efforts of libraries to ensure access to electronic information resources as a means of upholding the public's right to a free and open information society.

