The Wisconsin State Network: BadgerNet

June 2009

What follows is a case study of a successful library broadband network – in this case, Wisconsin collaborates with regional library cooperatives to provide service. This document is in pre-publication, draft format; it will be published later this year in a longer document that will include other case studies and supplementary materials.

These case studies are being created to assist libraries in their development of connectivity and sustainability plans under the Opportunity Online Broadband Grant Program of the Bill & Melinda Gates Foundation – and hopefully, they will be useful for other purposes.

Summary

Wisconsin has a very comprehensive and successful statewide program for library broadband connectivity. The state's public libraries are highly connected; 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.[1]

Perhaps the biggest reason for Wisconsin's success is the creation of "BadgerNet," which is one of the largest state networks in the country.[2] BadgerNet extends to every one of the state's 72 counties, providing next generation voice, data, and video services to state agencies, local governments, schools, and libraries. BadgerNet provides a statewide backbone network, middle mile and last mile connectivity. BadgerNet's comprehensive end-to-end service is one of the reasons that a very high percentage of schools and libraries in the state connect to it.

Other key factors that have contributed to Wisconsin's success include:

1. The State's Department of Public Instruction (DPI) provided strong leadership and advocated for library needs when then-Governor Thompson established a Blue Ribbon Commission to investigate the establishment of a statewide network in 1993 (the State Library Agency is a division within DPI);
2. Wisconsin's 17 regional library systems are statutorily obligated to provide technology assistance and support to their members as a condition of receiving state funding; and

[1] http://www.wla.lib.wi.us/legis/USF.htm.
[2] See Access Wisconsin's web site at http://www.accesswis.com/about.

3. Wisconsin has a state Universal Service Fund that subsidizes the cost of K-12 schools and libraries' local broadband connections and provides additional state aid to regional library systems.

BadgerNet

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 library sites. AT&T serves as the prime contractor, and the services are provided by a consortium of telecommunications providers that includes other local telephone companies.[3] There is 24x7x365 network support and help desk services available.

In March 2005, the Wisconsin Department of Administration (DOA) entered into a new $116.7 million, five-year agreement with the consortium for a new converged, higher-capacity data and video network renamed called the BadgerNet Converged Network (BCN).[4] The transition to the new network was completed on September 1, 2006. The State Library Agency helped coordinate this transition. At that time the BCN was the largest network of its type that AT&T, the prime vendor, had under contract.

Origins of BadgerNet

From as early as the 1970's, Wisconsin has been one of the nation's leaders in creating long-haul video networks to provide distance learning to schools. To build on this success, the 1993 Blue Ribbon 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 their network plans.

Libraries played an active role in this 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 creation of BadgerNet in 1993, and the legislature largely adopted 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 (the Technology for Educational ACHievement) program.[5] TEACH uses state Universal Service Funds to subsidize local

[3] Additional information concerning BCN the BadgerNet network can be found under "BadgerNet Network Design and Usage" below.
[4] Though 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.
[5] The TEACH program is unrelated to the federal TeachforAmerica program.

access connections to BadgerNet for K-12 schools, public libraries, and regional library systems.[6]

Economic Climate When Network Was Established

BadgerNet was created at a time when the economy was stable and growing. This economic stability allowed the state sufficient time to undertake the three-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 1990's 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.

BadgerNet Governance

BadgerNet is a program administered by the network office in the state's Department of Administration (DOA). The BadgerNet Advisory Council (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 to services provided under the network contract. The Council 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.

BadgerNet Finance

BadgerNet and its service vender operate under a five-year contract and prices are stable for libraries within this contract period. Libraries pay a subsidized rate of $100 monthly for a connection up to 3 Mbps, and $250 per month for up to a 20Mbps circuit. The BCN contract ends in 2011 and the Council is actively planning for the network's future contract service requirements.

Users of BadgerNet

All state agencies are required to use BadgerNet, but it is also available to universities, technical colleges, private colleges, K-12 institutions, public libraries and other authorized users. In total, the network exceeds 2,400 end-points spread across each of the 72 counties within the state. Nine hundred state agency remote locations use the data network capability of the system to connect to their agency headquarters in Madison.

Though library participation was (and remains) voluntary, about 97 percent of Wisconsin's public libraries have connected to the Internet via BadgerNet since the mid-1990's. The libraries generally use a BadgerNet Wide Area Network (WAN) topology where individual library circuits then 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 ISP.

[6] Additional information about TEACH is available in the "TEACH and the Wisconsin State Universal Service Fund" section below.

The network also offers high-resolution, real-time interactive video to approximately 350 K-12 schools. Included in the video services is a network scheduling function and a network-provided video bridge. Classes are held over the network as an integral part of instruction with as many as 32 separate conferences tying over 100 classrooms together during a single hour.

Library Systems Within Wisconsin

Libraries and Library Systems

Within the state of Wisconsin, there are 388 public libraries organized into seventeen regional library systems, or consortia.[7] The smallest of the regional systems have as few as six libraries networked together and the largest two systems contain over fifty libraries each. These seventeen systems cover the entire state of Wisconsin and all 388 public libraries belong to one of these regional systems. The systems were established in the 1970s to increase access to library materials and service for Wisconsin residents and promote resource sharing among public libraries. By statute, the systems are required to provide services such as interlibrary loan, reference assistance, consulting services to their member libraries and assistance in the area of technology.

Libraries in Wisconsin receive approximately 80 percent of their funding from municipal and county taxes. State aid contributes 7 percent and the remaining 13 percent comes from other funding sources.

Library System Obligations

Library systems are required to assist their member libraries in the area of technology in return for the receipt of state funding. In this regard, they play an important role in addressing the local public library broadband and Internet connectivity needs. Among the services they provide:

A. All seventeen 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.

B. All seventeen systems provide consulting for the purchase of computer software and hardware.

C. Many systems also offer centralized purchasing for software and hardware, which allows member libraries to obtain a lower price than they could obtain individually.

D. Some systems make information technology staff available as the first point of contact to assist with troubleshooting and installing new software and hardware,

[7] See system map at http://dpi.wi.gov/pld/wisysdir.html#public

while others provide such staffing at lower fees than member libraries would be charged by private contractors.

WiscNet

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.[8] 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.

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 and a represent from the regional library systems are on the board. For public libraries in the state, the average annual membership in WiscNet is about $450. Over 90% of the libraries have this fee paid for by their regional library system.

TEACH and the Wisconsin State Universal Service Fund

Another factor contributing to the success of networking for Wisconsin's libraries is the availability of funding through the TEACH program.[9] In October of 1997, the Wisconsin Legislature created the TEACH program to help schools and libraries obtain and sustain their use of technology. TEACH pays for equipment, the installation costs for the local data lines and video links to BadgerNet, and a portion of these monthly service costs.

Under the TEACH program, the schools, libraries and other eligible institutions pay a reduced rate (usually $100 or $250 per month) for their broadband connections; the remainder is paid by the TEACH program.

TEACH receives its funding from the state's Universal Service Fund[10] and from the Federal E-rate program.[11] On an annual basis, TEACH spends approximately $17 million to subsidize network expense for the schools and libraries. The subsidy for public libraries and regional public library systems is approximately $3.5 million annually. TEACH received additional spending authority in the 2007-09 budget. This enabled over 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 Wisconsin state 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 governor's draft 2009-11 budget proposes to fund regional library consortia

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[8] See, www.wiscnet.net.
[9] See, http://www.teachwi.state.wi.us/. Much of the information about TEACH program and the state's Universal Service Fund can be found in an Audit of the state's Universal Service Fund conducted by the Wisconsin Public Service Commission, Report 07-11, August, 2007, available at http://www.legis.state.wi.us/LAB/reports/07-11full.pdf.
[10] 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.
[11] TEACH files one consolidated E-rate application on behalf of over 800 K-12 schools and libraries on BadgerNet.

(RLCs) totally out of the state's Universal Service Fund, increasing the contribution to $17 million annually.

BadgerNet Network Design and Usage

Unique Features of the BCN

There are two aspects of the Badgernet Converged Network (BCN) that are somewhat unusual and particularly beneficial to Wisconsin's library connectivity:

First, the BCN contract covers all three network layers (Core, Aggregation and Access).[12] 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. BCN's comprehensive end-to-end service is one of the reasons that almost every library system 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 a 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 Mbps, 5 Mbps, 10 Mbps, 15 Mbps, 20 Mbps, et cetera (traditional telephone company offerings are limited to either 1.5 Mbps or 45 Mbps).

Geographic Coverage of BCN

BadgerNet covers the entire state with circuits in each of the 72 counties. The network includes four core routers in Madison, Milwaukee, Green Bay and Eau Claire. BadgerNet includes seventeen aggregation nodes around the state to minimize the distance between the library and the aggregation node (the distance of an access circuit).

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.

All the core, aggregation and internal library networking premise based equipment is manufactured by Cisco, which allows the system to operate seamlessly and reduces the complexity of maintaining the network. The core routers are linked by very high capacity OC48 trunks (approximately 2.4 Gigabits worth of capacity) and the aggregation layer

[12] As described in the chapter on Broadband Networks, 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.

routers are connected by OC24 (1.2 Gbps), OC12 (655 Mbps) and OC3 (155 Mbps) trunks.[13]

Topology

AT&T is the prime contractor for BCN, but there are 48 different telecommunications carriers (telephone companies or other service providers) who provision various components of service under the BCN contract. Fortunately for the regional public library systems, the BCN contract allows the local provider to provision service in a variety of ways while ensuring the library's interface is always the same 10/100 Ethernet port. Routing traffic through the aggregation and core layers of the network is always the same regardless of the access layer technology.

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 Lines (DSL), microwave and satellite technology alternatives because it was too difficult to include every technology available and keep the service consistent. Some of these alternatives services also do not have the reliability of a dedicated circuit. 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.

In the access layer of the network, circuits can be purchased in increments as low as 256 kilobits per second (kbps) and as high as 1 Gigabit per second (Gbps). Libraries can purchase increments of 1, 2, 3, 5, 10, 20, 30, 40, 50, and 100 Mbps at a standard fixed rate anywhere in the state. A library may request a bandwidth amount between 100 Mbps and 1 Gbps and receive an Individual Case Based (ICB) price. All libraries in Wisconsin have at least a 1.5 Mbps local access connection, and most will increase to at least 3 Mbps before the end of 2009.

Without exception, the regional library systems within Wisconsin have adopted the hub and spoke wide area network design. Choosing one library, often the regional library system headquarters, to act as the hub provides equipment consolidation advantages as well as bandwidth and port access to the Internet. The hub and spoke design does present a different set of problems regarding bandwidth utilization.

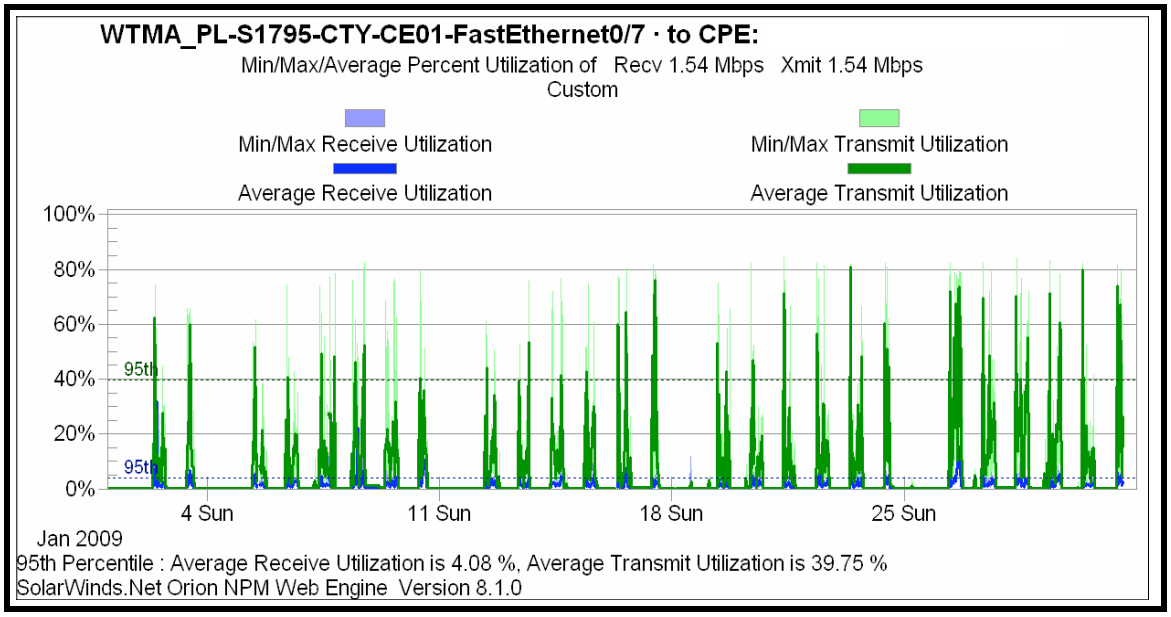
Network Management

BadgerNet WAN service allows the library to put a Quality of Service mark on every packet introduced to the network. The libraries mark Internet traffic as low priority and the integrated library system and other administrative traffic as high priority.

[13] "OC" stands for optical carrier. It generally refers to the use of fiber optic cable as the underlying transmission technology. The higher the number that succeeds "OC," the faster the transmission speed.

In addition, Wisconsin libraries have access to a network management tool that graphs usage at any BadgerNet site (DSL lines excluded). The graph below shows traffic usage over 30 days during the January 2009.[14] A graph like this makes it easier to manage traffic in the network and, more importantly, makes the case that a library needs additional bandwidth. While anecdotal information of slow Internet usage can be helpful, producing a graph showing actual usage can provide persuasive evidence that additional bandwidth is needed.

On most days, this library's usage peaks at around 80 percent of circuit capacity. As a general rule, if peak utilization exceeds 80 percent of a circuit's capacity more than twice in one week, it is a candidate for an upgrade. This particular library requested and was granted an increase from 1.5 Mbps to 3 Mbps.



Pricing

From its inception, BadgerNet required its vendors to build in rural areas as well as urban and was required 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 the standard BCN prices.[15]

Of the services offered under the BCN contract, the libraries most frequently use Wide Area Network service, which allows them to tie remote libraries to the system's main library or library system in the hub and spoke network design referenced on the previous page.

[14] Source: BadgerNet Network Management Center
[15] See Note 5, *supra*.