Capacity Planning for Broadband in Public Libraries: Issues and Strategies

by John Carlo Bertot

Introduction

The current context of public library public access technology provision is paradoxical. On the one hand, libraries continue to offer a substantial number of public access services—workstations, licensed resources, training programs, digital reference, and wireless access, to name a few. On the other hand, public libraries are clearly compromised in their ability to continue enhancing the services they offer. Librarians face budget cuts in a tough economy, building issues like space availability, adequate power, and cabling, resource availability, staff skills and access to broadband connectivity. In spite of these obstacles, the content, services, and resources of the network-based environment are evolving rapidly. Though it is difficult to predict the exact development of the Internet in the coming years, it is clear these new technologies are essential to public library services, in terms of both business functions and user resources. Today, these services are more interactive, more complex, and more bandwidth-intensive. Thus librarians find themselves with strained resources, but the need to continually implement and update increasingly complex and demanding network-based services. This chapter focuses on issues associated with building broadband capacity within public libraries to meet the connectivity needs of public access services.

The traditional view of building broadband capacity for one-way traffic into the library is outdated. With oft-accessed Internet-based resources like YouTube, Second Life, Facebook, Hulu, and a host of others, the broadband needs of today's libraries should encompass a robust bidirectional network. But the pressure is not just from library users, as users and libraries alike generate their own content and engage in these interactive, real time services and resources. Rather, there are multiple pressure points that must be addressed in order to ensure adequate broadband capacity in libraries.

Background

Public libraries adopted the Internet in its early stages, and continue to provide network-based services and resources. The most recent 2007–2008 *Public Library Funding and Technology Access* survey found:[1]

- 98.9% of public library branches offer public Internet access.
- 73% of public libraries report connection speeds greater than 769 kbps, up from 62.1% in 2006–2007. Of all libraries, 38.9% have a 1.5 Mbps connection. The disparity, however, is quite large between urban libraries, 51.6% of which have a 1.5 Mbps connection and their rural counterparts, 32.1% of which offer a 1.5 Mbps connection.

  - 57.5% (up from nearly 52% in 2006–2007) of respondents report that their connectivity speed is insufficient some or all of the time.
  - 75.1% of libraries indicate that they will not be increasing their bandwidth in the coming year, primarily due to cost and availability factors.

- 65.2% of public library branches offer wireless Internet access, up from 54.2% in 2006–2007.
- Nearly 75% of public libraries report that their wireless connections share the same bandwidth as their

public desktop computers, which places additional pressure on bandwidth.

This technology infrastructure includes an array of services like licensed databases; homework resources; audio content, such as podcasts and audiobooks; digital reference; gaming; e-books; integrated library systems; as well as dozens of other services and resources. In a general sense, the more interactive Web 2.0 environment is placing increasing pressure on the library's limited bandwidth.

Two recent reports by the U.S. Internet Industry Association and Scarborough Research indicate that broadband adoption by U.S. consumers is up substantially and available to 99% of households in the nation (defined as available to at least one person in a particular zip code).[2]

These reports were based on the historical definition of broadband (200 kbps in either direction, upload or download) adopted by the Federal Communications Commission (FCC) and reflect the type of data the FCC requires ISPs to report.

On March 19, 2008, the FCC adopted a five-tiered definition of broadband:[3] 200 kbps to 768 kbps ("first generation data"); 768 kbps to 1.5 Mbps ("basic broadband"); 1.5 Mbps to 3 Mbps; 3 Mbps to 6 Mbps; and 6 Mbps and above. The FCC will also require that broadband be measured in both directions (upload and download), not just one direction as it had been in the past. The new guidelines also implement new reporting requirements for ISPs. The new definitions are still based on residential access and fail to consider the broadband needs of a public access venue like a public library. Moreover, the United States suffers from a lack of a national broadband vision and policy that encompasses clear goals and a timeline towards promoting ubiquitous broadband.[4]

Closely tied to the bandwidth issue is the federal E-rate program. The E-rate program was established as part of the federal Telecommunications Act of 1996. It provides an important source of revenue (in the form of discounts on bills of 20 to 90 percent) to support K–12 school and public library Internet access and telecommunication services. The latter includes discounts on broadband circuits that support Internet access and other services and applications, including shared integrated library systems. The program is funded at $2.25 billion annually and is part of the broader universal service fund collected from the telephone companies.

Taken together, these reports, studies, and the E-rate program provide a complex and competing picture of broadband issues within the context of public library public access. The telecommunications industry, and to some extent the FCC, indicate that broadband is available throughout the United States at affordable rates. On the other hand, the library community indicates that broadband is not accessible, not affordable, does not meet the needs of their public access services, and requires substantial planning and management—regardless of E-rate. Both call into question the quality of public access Internet services that public libraries can offer their communities.[5]

Building Capacity

Given the current context of public library broadband deployment, capacity barriers, services offered, and increasing demands of Internet-based applications, we must ask how libraries should plan, build, and implement robust networks that meet today's broadband demands—but also grow to meet the demands of applications yet to come.

There are a number of factors that can impact a library's bandwidth. These include:

- **The technology infrastructure and architecture currently in place in the library.** Bandwidth is only part of the issue that determines the actual user experience. For example, routers, hubs, workstations, video memory and capabilities, RAM, and a host of other factors can have a dramatic impact on the overall service quality and user experience. It may be the case that current bandwidth subscription is not what is creating a speed bottleneck, but rather other factors—or all these factors in combination.

- **Network load.** It is not uncommon in some libraries to have staff and public access workstations share the same connection. Increasingly, wireless access is overlaid on this network as are many other services (ILS, VoIP, and streaming content). This in turn can create a range of congestion points. Knowing a network's load is critical.

- **Traffic routing and management.** There are a number of tools, discussed in more detail below, that can substantially increase the user experience without increasing actual bandwidth. These include packet shaping, packet prioritization, and compression approaches that can greatly enhance speed. With this, however, Figure 21 offers a brief and admittedly simplified planning guide for libraries to use as they plan their broadband capacity:

- **Services and resources.** A first critical step is for libraries to ascertain the services and resources that they make or wish to make available to their users and staff. This helps the library review its current networked services and resources, and also allows for the identification of future services and resources. But perhaps more important, this allows the library to review its networked services portfolio and begin

Service/Resource	Factors in Determining Bandwidth Needs (e.g., numbers of workstations; numbers of simultaneous connections; specific resources, services or protocols being used, such as viewing static Web pages, peer-to-peer file sharing; streaming content)	Priority/Desired Quality of Service	Bandwidth Management Approaches (e.g., packet shaping, compression)	Estimated Bandwidth Calculation Formula (e.g., given the number of workstations and use patterns, how much bandwidth is needed for public access workstations? Given the availability of wireless access number of wireless users, how much bandwidth does wireless service need?)	Estimated Bandwidth Need
Integrated Library System					
Licensed Resources					
Website					
Wireless (wi-fi)					
Gaming					
Social Networking					
Number of Computers					
VoIP					
Backups					
Software Updates					
Other					
					Total Bandwidth Need

Figure 21
Capacity planning worksheet.

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assessing the relationship between services and bandwidth needs.

- **Determining service priority and desired quality of service levels.** Not all services are of equal importance in terms of their quality of service. For example, libraries may consider that ILS and staff e-mail traffic is a higher priority than user access to social networking sites. It is essential that libraries review all of their network services and make priority determinations. In technical terms, prioritization often happens through port number or protocols. But the idea is to determine which network traffic matters more or less.

  - It is important to note that some services may require a higher priority simply because of their technology. For example, a key issue with VoIP is latency—that is the time it takes for packets to travel to their destination (and back if the transmission is two way). The more latency (or delay) in certain transmissions such as Internet-based phone calls, the more ineffective the service. Thus certain services may automatically require a higher prioritization.

  - "Back office" services such as backups and software updates must be included. These can run during off library hours, but they do also require bandwidth considerations.

  - Also, what library staff and management consider high priority may differ from what users consider high priority. Thus, there is a need to review the quality of service issues holistically.

- **Bandwidth management approaches.** There are a number of approaches that libraries can implement to better manage traffic flow over their networks—and thus make more effective use of their bandwidth. These include:

  - Packet shaping. Based on the quality of service determinations, libraries can prioritize the transmission of data packets. For instance ILS packets would be priority one and get transmitted immediately versus social network traffic which may be a secondary priority and thus may be delayed in transmission to allow for the immediate transmission of ILS searches. This is a form of congestion management.

  - Compression. It is also possible to compress packets so that they consume less bandwidth during transmission. This process involves compression on the transmission end and decompression on the receiving end, but can greatly increase bandwidth efficiency.

  - Queue management. Given the burst nature of voice, video, and data traffic, it is likely that the amount of traffic will exceed the speed of the connection at some point. Queuing establishes the priority for routers as they buffer data—for example, the first packet is the first out, or other rules that sort packets into different queues and govern the servicing of those queues.

- **Estimated bandwidth calculation.** Though it is not possible to calculate bandwidth needs for each service due to the wide range of services that make use of the same protocols (e.g., streaming video can range from 56 kbps to 384 kbps for low-definition video versus 2.5 Mbps for high-definition video), one can ascertain the bandwidth requirements for some services. For example, the average size of an e-mail is 2 to 5 k, and the average VoIP call (with compression) is roughly 30 k (though the latency issue identified above is a factor). Based on network traffic monitoring and estimated load measures (e.g., 10 e-mail accounts, 100 e-mails per user per day, and roughly 30,000 e-mails per month), libraries can calculate some rough measures of bandwidth need—but these can and do vary, and thus precise measures are difficult to ascertain.

The above planning considerations are not definitive and serve as a beginning point for libraries to consider their bandwidth needs. Moreover, libraries should not view their networks as static since:

- Broadband usage can differ and grow over time, thus it is important to continually monitor usage and build capacity for growth

- It may be possible to arrange additional capacity at the most congested network times. For example, if a library has a T1 connection (1.5 Mbps, leased line), libraries can arrange with their telecommunications providers to have temporary increases in bandwidth. These temporary increases in speed may serve the library's needs rather than permanent additional procurements.

Given this fluid and dynamic broadband environment, libraries need to continually assess their broadband needs and consider approaches that can help to meet demand.

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Developing a Capacity Plan

The planning considerations presented above, though simplified, may be beyond many libraries that do not have the technical expertise to engage in successful capacity-planning efforts. And yet these planning efforts are critical to library networked services. Libraries that do not have the expertise to develop capacity plans or have difficulty in understanding telecommunications issues may find assistance from their telecommunications providers, network/telecommunications consultants, city or county technology and telecommunications staff, state library agencies, regional library consortia, ILS vendors, and others. Increasingly, it is through networks that information flows in and out of the library. Indeed there is almost no service in a library now that does not rely on network transmission, whether its circulation systems, e-mail, and interlibrary loan, or public access services such as wireless access, workstations, licensed databases, or digital libraries. Without sufficiently planned and managed bandwidth, a host of library services will at best slow to access and use or at worst impossible to access and use.

Notes

1. *Libraries Connect Communities: Public Library Funding and Technology Access Study 2007–2008* (Chicago, IL: American Library Association, 2008).
2. U.S. Internet Industry Association, *Deployment of Broadband to Rural America* (Alexandria, VA: U.S. Internet Industry Association, 2008), www.usiia.org/pubs/Rural.pdf (accessed October 20, 2008); Scarborough Research, The Need for Internet Speed: Broadband Penetration Increased More Than 300% Since 2002. (New York: Scarborough Research, 2008), www.scarborough.com/press_releases/Broadband%20FINAL%204%2015%2008.pdf (accessed October 20, 2008).
3. Anne Broache, FCC Approves New Method for Tracking Broadband's Reach, *CNET News* (2008), www.news.com/8301-10784_3-98981s18-7.html (accessed October 20, 2008).
4. John Windhausen, *A Blueprint for Big Broadband* (Washington, DC: Educause, 2008), http://connect.educause.edu/Library/Abstract/ABlueprintforBigBroadband/45996 (accessed October 20, 2008).
5. John Carlo Bertot, and Charles R. McClure, "Assessing Sufficiency and Quality of Bandwidth for Public Libraries," *Information Technology and Libraries* 26, no. 1 (2007): 14–22.