

## *Benchmark 9: How much bandwidth does my library need?*

By Samantha Becker, Sofia Leung, and Robert Bocher

### **What is Bandwidth and why is it important?**

Edge Benchmark 9 measures a library's ability to accommodate user demand for public access technology. This article addresses Benchmark 9.2, which looks at whether a "library meets or exceeds the minimum bandwidth capacity necessary to support public user [Internet] demand." Why is bandwidth so important to providing patrons with access to Internet related services and applications?

In brief, bandwidth is a measure of how much information can be transmitted over an Internet connection. For example, it determines how quickly a website loads and the quality of a video a patron is watching. It is helpful to think of bandwidth like a straw. The larger the diameter of the straw – or the more bandwidth you have – the faster you can drink, or the faster you can receive information from the web.

Bandwidth is measured in bits per second, which is how many units of data (bits) can be transmitted in one second. Because a bit is a very small unit (smaller than a single character), most people are more familiar seeing bandwidth expressed in kilobits per second (kbps), or as megabits per second (mbps). A kilobit is 1,024 bits, and a megabit is 1,024 kilobits. The total available bandwidth that comes into a library building, or the amount the Internet Service Provider (ISP) has agreed to supply, will most likely be measured in mbps, unless the library has already upgraded to gigabit (gbps) service—which very few libraries have.

### **How much bandwidth do I need?**

The issue of how much bandwidth a library needs has been debated in the library community for over a decade—and this debate will likely continue well into the future. The answer of course is: as much as you need. But this superficial response does not help library staff who need practical guidance in addressing this issue. With this in mind, Benchmark 9.2 is intended to help provide guidance, while at the same time acknowledging that the current bandwidth needs of each library can vary considerably and will continue to grow.

For public Internet access, the amount of bandwidth available needs to be high enough to allow simultaneous users to use online applications that are bandwidth intensive, like streaming videos, cloud computing, or conference calling. These days, websites are also often very bandwidth intensive with many sites having multiple photos and other elements that take a lot of bandwidth to load quickly.

If the amount of bandwidth is too low, much of the public access technology users' time will be spent waiting for websites to load and many videos may play so poorly that they are essentially unviewable.

Ultimately, low bandwidth has a negative impact on patrons—it can be very frustrating and prevent them from accomplishing their goals. To be certain this does not happen, a library will need a fairly high bandwidth—both to ensure continuous adequate connections during high traffic periods, as well as to continue to meet ever increasing demand as bandwidth-intensive applications continue to grow.

Inadequate bandwidth also constrains the types of technology services you may offer to your community in the future—including interactive online tutoring, digital learning labs that allow teens to upload their creative content, and videoconferencing. In this context, the bandwidth guidelines in Benchmark 9.2 can be used to start a conversation at your library about what your library and your users could do if you added more bandwidth than what they need today.

### Calculating minimum bandwidth needs

Benchmark 9.2 helps libraries decide how much bandwidth is necessary to meet user demand by defining three levels of bandwidth capacity. The bandwidth capacity for the indicator is expressed as how many bits per second should be available to *each Internet user* for uploading or downloading data. It is expressed in terms of *each Internet user* because the amount of bandwidth a library building needs depends on how many desktop computers, laptops, and tablets can be connected to the library's Internet service. The higher the number of possible simultaneous users, the greater the total amount of bandwidth the library needs to have delivered by the ISP. (In this respect bandwidth is like electricity because you need to plan for peak use not just "average" use.)

The Edge indicator for bandwidth defines three levels of capacity that libraries can strive to provide to their patrons. The Level 1 capacity is 512 kbps download and 128 kbps upload per Internet user. This level is considered the floor, or the minimum recommended allocation of bandwidth that is available to each user during the library's busiest use times. This amount of bandwidth will allow many users to be simultaneously engaged in bandwidth intensive activities like watching videos from popular sites before all users begin to experience lags in their connections.<sup>1</sup> Libraries that experience extended periods of maximum use of their computers, or have users that frequently engage in bandwidth intensive activities, may want to strive to meet one of the higher level goals:

- Level 1: Each public Internet user is allocated at least 128 kbps upload and **512 kbps** download of network bandwidth capacity
- Level 2: Each public Internet user is allocated at least 256 kbps upload and **768 kbps** download of network bandwidth capacity
- Level 3: Each public Internet user is allocated at least 500 kbps upload and **1 mbps** download of network bandwidth capacity

Bandwidth capacity per user is all well and good as a measure of service to the patron and as a reliable indicator, but it isn't all that useful in helping libraries determine how much bandwidth they need to have delivered to the library from the ISP—they need to know how big of a straw to buy!

Calculating the bandwidth requirements for a library location requires determining the maximum number of simultaneous users and multiplying that number by the desired level of bandwidth capacity

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<sup>1</sup> While bandwidth requirements for streaming video varies considerably depending on the host and the quality of the video, 512 kbps would usually allow a user to stream a standard definition YouTube video. You can see the bandwidth requirements for other applications here: <http://www.crtc.gc.ca/eng/publications/reports/PolicyMonitoring/2012/cmr4.htm#t452>

the library wants to provide. Each desktop computer, laptop, or tablet provided by the library for patron use within the library counts as *one user*. This does not include mobile lab computers, computers in classrooms that aren't regularly available to patrons, or laptops that are loaned for use outside the library. For libraries with wireless networks for patrons, the number of wireless users is estimated at one wireless user per three public computer users.<sup>2</sup> Many libraries have found that demand for their wireless networks is growing—if this is the case, the Level 2 or Level 3 targets for bandwidth per user might be more appropriate than the Level 1 minimum recommendation.

To calculate the minimum bandwidth you will need delivered to a particular library location to provide quality Internet-based services, you will need to know the following:

- The total number of computers, laptops, and tablets available for patrons to access the Internet *within the library*
- Whether or not the library provides a public wireless Internet connection
- The target level the library wishes to achieve for this indicator

If the library location has a wireless connection, you can take the above information and plug it into this formula:

$$\frac{(\# \text{ of devices} \times 1.3) \times (\text{target kbps download})}{1024} = \text{mbps needed per building}$$

In the formula, the number of terminals is multiplied by 1.3 to take into account the one wireless user per three public computer users. The second half of the equation, target kbps x 1024, converts the download bandwidth target level in kbps (kilobits per second) to mbps (megabits per second), which standardizes the amount of bandwidth you need to achieve your desired level of service per user into the units usually used in a service contract with your ISP.

If you don't have a wireless connection, the formula looks like this:

$$\frac{(\# \text{ of terminals}) \times (\text{target kbps download})}{1024} = \text{mbps needed per building}$$

Here's an example from the "**Anytown Public Library**":

Number of library computers = 11

Number of library laptops = 6

Wireless = Yes

Traffic = Heavy, continuous use all or almost all of the time

$$\frac{((11 + 6) \times 1.3) \times (768)}{1024} = 16.6 \text{ mbps needed to the building}$$

Here, Anytown Public Library decided that the Level 2 bandwidth (768 kbps download per user) was the minimum needed because their computers are almost always in use and their patrons watch a lot of

<sup>2</sup> This measurement comes from the ratio of wireless users to library computer users in the 2010 *Opportunity for All* study available at Available at: <http://www.gatesfoundation.org/Learning/Documents/OpportunityForAll.pdf>

videos. To support all their users at the Level 2 bandwidth level, Anytown Public Library will need to have at least 16.6 mbps of download bandwidth coming to the library.

What about the reverse? A library can also figure out what level they are currently providing by inverting the formula to figure out the bandwidth allocation per user in kbps:

$$\frac{(\text{current contracted bandwidth in mbps} \times 1024)}{(\# \text{ of terminals} \times 1.3)} = \text{current level of kbps per user}$$

The number to use for “current bandwidth” should be the bandwidth your ISP is currently contracted to provide. If the library does not have wireless, the number of terminals should not be multiplied by 1.3.

In our example, Anytown Public Library checked their ISP agreement and found they were paying for 11 mbps download bandwidth for their building. After doing the bandwidth calculation, they found they were very nearly hitting the Level 1 bandwidth recommendation, but would need to increase their bandwidth subscription to provide better access for their patrons:

$$\frac{(11 \times 1024)}{((11 + 6) \times 1.3)} = 510 \text{ kbps per user}$$

Since most ISPs do not provide much information about the upload speeds they provide to customers, for now Edge is only calculating bandwidth recommendations based on the download speed. Also, since the advertised or contracted bandwidth provided by your ISP may be less than the actual bandwidth you receive in your library location, Edge also recommends doing a speed test to determine the actual bandwidth.<sup>3</sup> Once you have conducted the speed test, you can use the results in place of the bandwidth your ISP is contracted to provide in the above calculation and figure out how much bandwidth is actually available to each user.

The best time to conduct the speed test is when there are no patrons using the public Internet computers or wireless network so you can see how much bandwidth is available to the library before patrons start drawing bandwidth off your connection. If your library shares a network connection between patron users and staff users (which is not recommended), you should conduct the speed test while library staff are actively using the network, but before patrons are using it—that way you can see how much bandwidth is left over for use by patrons.

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<sup>3</sup> You can do a speed test at your library location on the following site: [www.speedtest.net](http://www.speedtest.net)

### **Managing your bandwidth**

Unfortunately, a high level of bandwidth does not guarantee that the library's Internet connection will be speedy and glitch-free for patrons. Libraries need to manage the bandwidth they have in order to minimize congestion, which can lead to poor performance. Benchmark 10.1, which evaluates how well a library manages its Internet connectivity, provides the following suggestions to help manage your library's bandwidth:

- Know the maximum available bandwidth speed available at each location
- Perform speed tests on public computers to compare advertised and actual bandwidth speed
- Get alerts about connectivity problems in real time
- Continuously monitor connectivity (up/down/ping) at the network level
- Monitor Internet traffic by packet type and volume
- Allocate bandwidth for library staff functions and public Internet access through separate data circuits or through hardware/software mechanisms to prioritize network traffic
- Shape network bandwidth for quality of service

Additional information on how to manage the Benchmarks and other related topics can be found at [www.libraryedge.org](http://www.libraryedge.org).