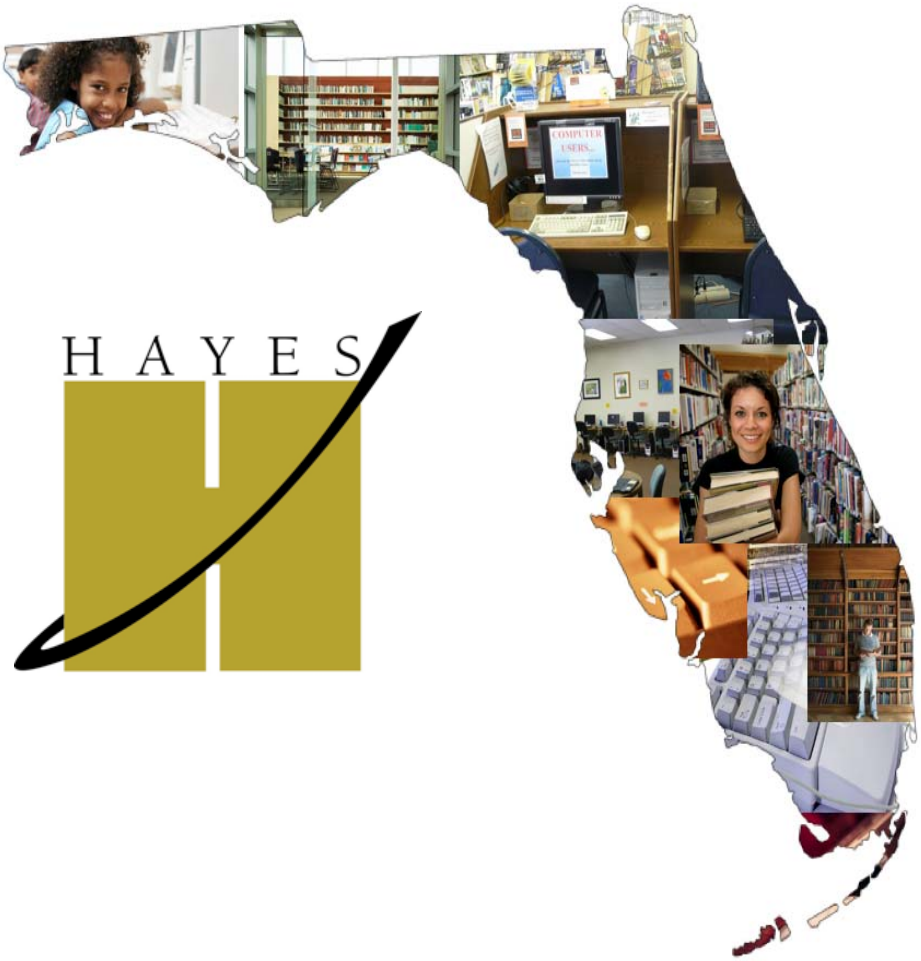
HAYES, IT Consulting

Technology Assessment Report

Florida Broadband Capacity Planning Project

State Library and Archives of Florida

August 2010



Hayes E-Government Resources, Inc. 2473 Care Drive, Suite 201, Tallahassee, FL 32308 (850) 297-0551

Table of Contents

Florida Broadband Capacity Planning Project

Preface

The State Library and Archives of Florida contracted with Hayes e-Government Resources, Inc. (Hayes) to perform IT consulting services, which included network assessments of network inventories and bandwidth for Florida's public library outlets and to make recommendations for improving broadband capacity within each facility as part of the Florida Broadband Capacity Planning Project. This report for the State Library and Archives of Florida provides a record of technology and services found in individual libraries or systems at the time Hayes visited. The project began May 7, 2010, and ended August 31, 2010.

Introduction

Florida's public libraries provide access to free resources such as print, audio, and video media, technology, and Internet access. With the decline in Florida's economy, the collapse of the housing market, and high unemployment, more individuals in the communities are turning to the library for their access to online resources to perform tasks. These tasks include filling out and submitting government forms and job applications, as well as other recreational, educational, and personal pursuits. According to recent data posted on the State Library and Archives of Florida website, 84 million Floridians visited libraries in 2007-2008. The following report provides information for the state and the individual sites to use in planning and implementing increased broadband access to improve and modernize computing capacity, and to sustain broadband-based services by increasing Florida public library participation in the Federal E-rate program. The E-rate program makes funding subsidies available to public libraries for telecommunications infrastructure and Internet connectivity.

Project Methodology

The State Library and Archives of Florida retained Hayes in early May to provide IT Consulting Services for the Florida Broadband Capacity Planning Project. During the design phase of the project, the State Library and Archives notified public libraries about the project, held webinars to explain the project to the libraries, and developed pre-assessment surveys for those interested libraries to complete. Originally, the number of public libraries who would be able to participate, given time constraints associated with the funding, was estimated at 150 public libraries; however, 172 sites applied to take part. Hayes agreed to include the extra sites as part of the original agreement. Interested libraries completed the pre-assessment survey for the State Library, which in turn supplied the documents to Hayes.

Engineers and technology specialists at Hayes analyzed and reviewed the library documents. After this initial review, Project Managers and engineering team leaders developed a plan for engineers to visit each of the selected local public library sites in Florida. At each of the sites, engineers informally inventoried the network hardware and computers, observed processes and procedures, reviewed the performance of the systems at each site, and interviewed the librarians and staff. After completing each site visit, they recorded their observations, estimations, and created network diagrams based on the information provided to them during the assessment. Once all of the results were collected, the Project Managers, team leaders, field engineers, and E-rate specialists reviewed the findings and collaborated on a summary report for each site. In addition to the summary reports, Tier 3, the advanced engineering group, finalized network diagrams based on what the field engineers had observed at the public library sites and based on library documents and information.

Library Technology Landscape

Interviews and meetings with library administration, staff, and the Hayes team revealed common factors influencing the ability of Florida's public libraries to provide an optimal technology environment for delivering library services. Most of these can be traced back to the amount of bandwidth available, the number and age of computers using the connection including the wireless guest patron machines, and the network equipment in place at the public libraries. Each of the library system and site reports in the appendix of this document provides this information along with Hayes' suggestions.

- *Bandwidth:* The majority of public libraries would benefit from controlling per user bandwidth. With controls in place, the library can measure actual bandwidth needs to determine if an increase in the amount of bandwidth is required. Bandwidth for library systems must support the amount aggregated from all local sites.

- *Connection Speeds:* Approximately 70% of the connection speeds at public library sites are described as slow or slow at times.

- *Public Workstations:* The majority of public libraries expressed a need for additional workstations. They described waiting lists and patrons queued up for their turn to use a computer or the Internet.

- *Age of Workstations:* Approximately 56% of the public workstations in the selected libraries are over four years old. Outdated workstations presented problems, a few of which include: connecting to the Internet, slowing down network throughput, software incompatibility, not meeting minimum specifications to run software, and accessing newer media.

- *Networking Equipment:* Old equipment and consumer grade equipment was evident at many sites. Most of it is still functional, but replacing it with commercial grade equipment that has newer features for management and security will increase the efficiency of the network, maximize available bandwidth, and provide information to find and correct network problems.

- *Wireless Access:* Most libraries have open access for wireless and no restraints on its use, which affects the network throughput. At many sites, wireless access is available with no acceptable terms of use agreement or rate limiting of the amount of bandwidth used.

- *Funding*: While the public use of library services has increased, library funding and budgets have been cut. E-rate is a source of funding that public libraries can use for discounts on Internet access, telecommunications services, or internal connections if they meet program requirements. Many of the public libraries file E-rate applications for some services, but they are not taking advantage of all of the opportunities available in the E-rate program.

Capacity Planning

The Internet has great potential for supplying and electronically maintaining information for patrons and staff in the library. Not only is Internet access used for the research on a specific topic, but also it is used for getting up-to-the-minute news, watching videos, downloading audio books, listening to music, storing personal files, etc. The computers are also being used by staff to conduct library business.

Most of the library systems that were reviewed are part of a wide area network (WAN) of services connecting member libraries or branch libraries for sharing resources and services. Cloud Computing is the new phrase that is being used to describe the massive amounts of computing power available on the Internet. For libraries offering free Internet access to people in the community, maintaining enough bandwidth in support of the free service that can be used in so many different ways by patrons and staff is a challenge.

The focus in this section is mainly on bandwidth consumed by patrons using library equipment to access the Internet. However, there are more computers being used in the library than just library-owned computers. In a majority of the libraries that were reviewed, wireless patron-owned laptops are being used in the local libraries on a regular basis and that number is growing each day. During an informal exercise to calculate the amount of bandwidth needed for a computer to explore the Internet, the Hayes team used a local library system's reports and correlated the bandwidth with the number of wired patron machines, to calculate the amount of bandwidth needed.

Hayes' engineers performed informal testing to determine the amount of bandwidth that one patron's computer needs to have optimal performance for using the Internet. Engineers use the term "informal" testing because there is no logical way to have a controlled test. To have a usable correlation between bandwidth and computers, patrons and staff should be conducting normal tasks on the Internet. Capturing the normal traffic pattern is more realistic than trying to work through a controlled test that can produce added disclaimers related to the final results. The team wanted to observe and monitor actual bandwidth utilization in a normal day and work from those findings.

Leon County libraries were selected for the informal testing. The engineers used library locations that had a sufficient amount of network resources to provide adequate bandwidth to complete a sampling for calculating the correlation between bandwidth and computers. This calculation would be meaningful only if Internet users were not being constrained.

Engineers studied the Multi Router Traffic Grapher (MRTG) graphs of the libraries' actual bandwidth utilization over a defined period of time with the known number of computers that were in use at the time. MRTG gathers the count of packets and bits traversing a link, as counted by the router or the switch hardware. MRTG computed a 5-minute average of bits-per-second every five minutes and displayed in graphical form. This implies that there are some moments when usage is higher and some when it is lower, but a 5-minute average is not trivial. The MRTG daily graph provides statistics on the graph that indicate the daily average, including the daily 5-minute peak, and the current 5-minute average bits per second. The daily average includes hours when the library is closed, and therefore is not reflective of actual use. The peak 5-minute average bandwidth was used to represent what an unconstrained environment would consume. Less than that amount of bandwidth would constrain the users.

Engineers looked at several library branches where the patron computer count was known and the peak 5-minute average could be determined. By knowing the number of patron computers in a couple of representative libraries and reading the peak bandwidth in those libraries, the engineers were able to calculate bandwidth per computer by dividing total peak bandwidth by the number of computers in operation. The result was the average bandwidth used by an unconstrained computer.

Most network applications can be characterized as bursty, such as a web browser session where the user cycles between downloading web pages and idle time while reading the pages. These peaks and valleys are more pronounced with just a few users; however, with hundreds of users, the peaks fill in between each other and the result appears as a smoother consumption of bandwidth on the charts. For that reason, the calculations of average bandwidth apply best to a large number of patrons. The engineers concluded that

with larger numbers of computers, less bandwidth per computer is needed than with smaller numbers of computers, where more bandwidth is needed for the same tasks. By making this determination, the engineers were able to calculate a point at which the consumption of bandwidth smoothed out, versus a number where the consumption was not smoothed out on the graphs.

It would be optimal to state that the results are without disclaimers, but that is not the case. The informal test did not take into consideration all the variables that could impact the network throughput. Those variables, just to name a few, include misconfiguration of network equipment, varying types of network traffic, congested or poorly configured computers, and routing of traffic once it leaves the facility. In addition, it does not take into consideration that libraries may not be using bandwidth shaping to use bandwidth more efficiently. However, Hayes' engineers believe that with all issues considered, our findings are very valid and useful.

The National Broadband Initiative posted speeds that are considered to be the minimum speeds for broadband services in libraries. Those speeds are 256 Kbps upstream and 768 Kbps downstream per computer. Although these speeds will probably be needed in the future with the onset of more bandwidth-intensive applications used on the Internet, based on the observations made by the Hayes engineers, we do not believe that it is necessary to have that much bandwidth per computer sitting idle to achieve adequate Internet bandwidth for today's information user. According to our calculations, a library with less than 25 computers should have an allocation of 384 Kbps per computer; and for those with more than 25 computers the bandwidth allocation should be 300 Kbps per computer. As the number of computers accessing the Internet increases, the amount of bandwidth per machine can decrease. When the number of computers exceeds 150, bandwidth per computer can decrease to 250 Kbps. Hayes' engineers did not have the opportunity to test larger numbers, and few of the public libraries we reviewed singularly have more than 150 computers in one location. However, when dealing with a large number of computers in big library systems, 250 Kbps per computer is the speed that can be used to determine the amount of bandwidth that is needed for the Internet.

Standard Technology Practices

Internal and External Connections

Most libraries have a requirement to support both wired and wireless connections. IEEE wireless standard 802.11n is backwards compatible with 802.11g, which in turn is backwards compatible with 802.11b. Because IEEE 802.11b/802.11g/802.11n are all compatible with Ethernet technology, the wired and wireless networks can be combined into a single virtual local area network (VLAN) or Layer 2 broadcast domain; however, performance may suffer depending on the particular router/switch/access point hardware and how much broadcast and multicast traffic is present. For sites with slower 1.5 Mbps Internet wide area network (WAN) connections, the WAN tends to be the congestion point, and the local LANs and wireless LANs (WLANs) are usually not an issue. The WLAN can become the bottleneck when using higher speed Internet WAN connections.

Wireless access points support several bit rates, but higher bit rates are only possible under optimal conditions of minimal noise and high signal strength. Noise is interference caused by other devices transmitting at the same 2.4GHz frequency, including other WLANs, cordless telephones, microwave ovens, wireless mice, etc. Signal strength is diminished as distance between the client and the access point is increased and as the signal penetrates obstacles such as walls, furniture, etc. Materials that contain water such as books, people, and concrete walls tend to dampen 2.4GHz signals because water molecules absorb the signals. Wireless devices are usually configured to automatically use the fastest possible data rate given noise and signal strength conditions. As a wireless user's distance from the access point increases, their associated connection speed will decrease down to 1 Mbps and then cease.

As a first step to improve throughput, implementing a premise router with multiple Ethernet LAN interfaces is recommended to allow the wired and wireless networks to be separated. A degraded wireless connection can be as slow as 1 Mbps. Assuming wired workstations use full-duplex 100 Mbps fast Ethernet technology, there can be more than 100:1 speed disparity. Of particular interest to libraries with open wireless access is that a patron using the wireless network from the parking lot near the edge of the coverage cell at

1 Mbps can significantly decrease throughput for all computers on the same LAN.

As a second step to improve throughput, it may make sense to subdivide the wireless network into multiple wireless LANs. Wireless access points use the same signaling to talk to all associated wireless computers, and an access point will serve the slowest PC for broadcast and multicast traffic. In the United States, under FCC rules, the 2.4GHz spectrum has 11 channels used by 802.11b/g; however, these 22 MHz wide channels overlap each other. Using channels 1, 6, and 11, which are the only non-overlapping channels, works best. One strategy to consider is to program one access point to associate only at higher data rates using a unique VLAN and wireless channel, while programming a second access point to only associate at lower data rates using a different unique VLAN and non-overlapping wireless channel. This will prevent users who are close to an access point, who associate at 54 Mbps, from degraded performance caused by a user near the edge of the coverage cell, who associates at 1 Mbps. Unfortunately, some of these access point-provisioning options are only available on more expensive professional grade units and not present on many consumer grade units.

According to one major wireless vendor, the average throughput for an 802.11g access point is greatly diminished to about 1/3 when serving both 802.11g and legacy 802.11b clients, compared to only serving 802.11g clients. Segregating these patrons with separate access points and VLANs allows for support for patrons with older legacy laptops without severely degrading performance for patrons with modern laptops.

Wireless equipment vendors often quote the performance of their devices with a raw bit rate, but because of encoding overhead, the more important payload throughput rate is much smaller. For example, 802.11g vendors often advertise 54 Mbps, but the user data that can traverse such a connection can only reach a maximum of 22 Mbps under the most optimal conditions. The following table illustrates the difference between raw bit rate and actual payload throughput, and the effect of how the support of legacy wireless clients severely degrades performance in a mixed 802.11b/g environment.

	Approximate maximum payload throughput	Raw maximum rate (not throughput rate)	Raw minimum rate (not throughput rate)
802.11b access point	6 Mbps	11 Mbps	1 Mbps
802.11g access point with both 802.11g and legacy 802.11b clients	8 Mbps	54 Mbps	1 Mbps
802.11g access point with only 802.11g clients	22 Mbps	54 Mbps	1 Mbps

Reference: http://www.cisco.com/application/pdf/en/us/guest/products/ps430/c1244/ccmigration_09186a00801d61a3.pdf

When surveying a wireless network, it is important to consider the location of the resources accessed by patrons and the Internet bandwidth. If patrons primarily access the Internet, and the Internet bandwidth is constrained to a lower speed such as less than or equal to 1.5 Mbps, the Internet bandwidth will be the bottleneck, and improving the wireless throughput will not help the overall patron experience. If the Internet bandwidth is faster or the patrons are accessing local servers, then improvement to wireless throughput can make a large improvement to the patron's experience.

As a rule of thumb, the engineers believe that Internet bandwidth should be sized so that each patron can receive an average minimum of about 300 Kbps of bandwidth. Unfortunately, power users sometimes run applications on computers with fast connections that will consume an excessive amount of bandwidth and "starve" the other patrons. Most patrons will use a web browser to download a web page and then sit while reading the page, an inherently bursty data pattern. Other patrons may attempt to stream high-resolution video or download large data files that can continuously consume a large amount of bandwidth. Packet shaping technology should be considered to allocate patron bandwidth fairly when the demand exceeds the supply.

Bandwidth Shaping

Controlling bandwidth utilization is one aspect of technology implementation that libraries should improve. Hayes' engineers discovered that a misconception exists among library staff about the functions that bandwidth shaping offers the end-user. As the engineering

teams talked with staff during the onsite visits, they discovered that some staff mistakenly considers bandwidth shaping as controlling "where" patrons go on the Internet and censoring the locations that they visit as a content filter would do. Library staff acknowledged that most libraries support a patron's use of the Internet to download games, or to watch videos, or to participate in other bandwidth intensive projects of a patron's choosing. For the staff person who has misconceptions, they do not know the benefits of rate limiting or shaping bandwidth to maximize resources and to mitigate congestion in a network.

Bandwidth shaping does not prevent an Internet user from visiting preferred sites that contain bandwidth intensive applications; it only shapes or limits how much bandwidth is given to a user at any given time. The constant high utilization of network bandwidth by heavy bandwidth users reduces the communication speed available to the rest of the general users. To prevent this situation and to ensure equal access of network throughput by all users, the library should implement bandwidth shaping on the network. Bandwidth shaping could benefit those libraries that report that they have adequate bandwidth, but find Internet access speeds slow at times. Some libraries reported that at certain times of the day the Internet completely slows down with patrons visibly noticing the degrading of the network's performance. To some degree, bandwidth shaping could help in these situations. If there is no noticeable change in throughput, after the implementation of bandwidth shaping, chances are the available bandwidth is saturated and needs to be upgraded.

Typically, the solution for bandwidth shaping is to use an appliance that is in-line with the connection to the Internet. The Internet can provide sources for many different bandwidth-shaping solutions. In most cases the solution involves an appliance, which can be expensive; but implementing the appliance into the network will save money that would be spent on WAN speed upgrades and will provide a better experience for the user accessing the World Wide Web. This would especially make sense for library systems with several branches that connect to a central location and share a single Internet connection because Internet traffic could be shaped for the whole system with a single device.

Standard Network Practices

Often networks do not perform ideally due to poor configurations, link errors, electrical interference, broken hardware and numerous other causes. There is no one answer to making a network perform flawlessly, but rather there are procedures to find and correct problems. Consumer grade network equipment usually does not have the ability to display interface statistics or to log errors, so it is difficult to find and correct problems when using consumer grade equipment on a network. Professional grade equipment will maintain several error counters for each interface and can both store and forward error log messages to a central SYSLOG server for later analysis. This information empowers one to correct errors.

Often it is not possible to employ knowledgeable network engineers to work on a small network, but the library consortiums can usually bring in resources to review and correct networks. This section assumes that the network is large enough to afford technical resources necessary for optimum performance.

The most common LAN throughput problem is caused by Ethernet duplex mismatch that occurs when two directly connected devices automatically negotiate parameters. Sometimes auto negotiation between different vendor equipment does not work properly. One can look at the interface statistics and notice "collision errors." One should start by clearing all statistics, then after some hours, check the interface again for errors. This can be corrected by manually configuring the duplex of either the switch port or the connected device port to match each other. It is preferred that both devices are full-duplex for maximum throughput, but if that is not possible, then both should be half-duplex. When both devices match, then collision errors should cease. If collision errors continue, then one of the devices is probably broken. In particular with fast Ethernet devices, both devices should be either configured for auto negotiation or both configured for 100 Mbps full-duplex, as one side configured for auto and the other for manual will always result in the auto device to run in half-duplex mode.

There are other causes of interface errors, but these errors are much less likely and are beyond the scope of this article. The point is that link errors result in slower throughput

and they can be corrected to achieve optimum performance.

The ISP usually manages the link to the Internet and the associated router. ISPs usually deploy routers that maintain interface statistics and can see track errors on the WAN link. Since the WAN link is often exposed to weather and electrical surges, it is not uncommon to have errors in the WAN link, which will result in slower than normal performance. If you monitor the WAN traffic level and observe network slowness when the WAN link is not congested, then WAN link errors may be the cause. A call to the ISP asking them to look for problems can result in the ISP dispatching a Telco person to fix the WAN link and restore optimum throughput. Therefore, it is important to monitor the WAN link usage. Although you may not be able to monitor the ISP router directly, you can achieve the same by monitoring the port of the device that connects to the ISP.

There are numerous network interface-monitoring solutions. Some are free and fairly simple, and others are expensive and require a full-time person to make them work correctly. The correct monitoring solution depends on the size of the network, the budget, and the availability of trained personnel. Looking at the graph of the WAN link usage can tell much about the health of the network.

Interface bandwidth graphs that have flat-tops indicate high traffic saturation, which could be normal and indicate the need for more bandwidth or, if not normal, could indicate that an abusive user is consuming excessive bandwidth at that time.

It is good practice to have all network routers, switches, and wireless access points log messages to a centralized SYSLOG server. Then when problems happen, a search through the logs can lead to information on the cause and the fix for a problem. Also one should review the logs periodically to look for network ailments that may not be obvious to the users so that proactive corrective action can maintain the network in optimum condition.

It is good network practice to segment a network into different virtual local area networks (VLANS). This can isolate trusted staff computers from untrusted public computers, especially the potentially infected laptops that patrons bring into the library. It would be good practice to separate patron laptops, patron desktops, staff desktops, and servers, each

on its own VLAN, and to connect them using a firewall that has meaningful rules for allowable traffic. Segmentation of a network is good for security, but it also helps with throughput by reducing the broadcast domain, so that as each computer constantly broadcasts data in the background, the broadcasts will not travel to other VLANs. Also, it is common for wireless links to operate at speeds well below the published rate when any of the wireless clients have a poor signal and thereby cause all traffic on that VLAN to slow down as well. Putting wireless traffic on a separate VLAN prevents the slower wireless computers from interfering with the wired computers on the LAN. Note that separating devices onto different VLANs does not prevent all devices from competing for the WAN bandwidth.

One of the critical elements of a network is DNS. Domain Name System (DNS) servers are used to translate Internet names to IP addresses, so that packets of information can be addressed and sent across the network. Every web page usually has multiple references to other web resources and each name must be translated with DNS before communicating to that source. If DNS response is slow, then it will appear that the Internet is slow. It is important to use a DNS server with fast response and this can best be accomplished by operating a local DNS server that can cache recently accessed web sites and their IP addresses. In many situations an organization will just use the DNS server that the ISP offers as part of its network connectivity. It is meaningful to traceroute and ping to the DNS server to be sure that it is close and has quick response times. Avoid using a DNS server that is many hops away.

Since it is common for a few individuals to consume excessive amounts of bandwidth and thereby deprive other users of their fair share of Internet bandwidth, it is good practice to rate-limit the average usage of each user's computer on the network. There are numerous commercial solutions for limiting per-user bandwidth consumption. Note that limiting the bandwidth is not censoring access to any site on the Internet. Filtering web pages is a different solution that is necessary for Children's Internet Protection Act (CIPA) compliance.

E-rate

After talking with library personnel at various libraries participating in the assessment project and examining several years of library E-rate applications, it is apparent that a majority of the libraries in Florida are not taking full advantage of the E-rate program. Library personnel provided several common rationales as to why libraries do not take full advantage of the discounts available to them through the E-rate program. With the downturn in the economy, communities more than ever before are utilizing local library resources, and library personnel are noting that the number of patrons coming into the library has continued to increase. Patrons are using Internet resources in the library to find jobs, fill out job applications, and to look for government information related to unemployment. Patrons also use online local and state resources to apply for food stamps or other government assistance programs. More than ever, libraries need to take advantage of funding opportunities that are almost guaranteed for their Internet access and telecommunications services to maintain a high level of online resources for the communities being served.

Throughout the assessment process, a variety of interpretations of E-rate program rules were shared with the Hayes team. The libraries need to have an unambiguous understanding of how the rules of the program affect specific situations and administrative decision-making for participation in the E-rate program and the application process. From our conversations with the libraries, three major stumbling blocks emerged as reasons that libraries are not applying for E-rate discounts on eligible services. These are as follows:

> The Children's Internet Protection Act (CIPA) guidelines are widely interpreted. This prevents libraries from following a procedure or having a complete understanding of what criteria are sufficient to meet the rules of the program.
>
> Libraries are not applying for the portion of the Internet connection that directly supports Internet access for the system libraries when Internet bandwidth is provided by a county's IT department. Cost allocation can be performed to determine the share of the cost that can be discounted, which is only the library's share.

When counties go out to bid for telecommunications services or Internet services, the purchasing departments are not filing appropriate E-rate forms, Form 470, for competitive bidding as required by the rules of the program. Therefore libraries are unable to use the resulting county contracts in the E-rate program.

The State Library may be able to provide leadership in assisting libraries to understand the rules of the program and to help library personnel work with county purchasing offices to follow E-rate procurement processes to take advantage of discounts on eligible services. As of August 2010, Florida libraries have been awarded approximately $2.3 million dollars in all categories of funding for Year 2010. Applications are still being reviewed and funded at this time and the total funding commitments to date are a good indicator that the level of funding for 2010 is in line with the funding for 2009. If libraries addressed the three main reasons for not capitalizing on discounts in the E-rate program, the libraries would be able to claim more Internet and telecommunications services, and the total funding commitments could increase by at least 20%.

The table below is a sampling of the past ten years of Florida library applications, commitments and disbursements for each of the E-rate service categories. Taking into consideration Florida's growth in population, inflation over time, new contracts, and the growth of the Internet in libraries during the period of time captured on the chart, it would seem reasonable that libraries should be receiving more funding in all three-service categories.

Year	Internet Access		Telecommunications		Internal Connections	
	Committed	Disbursed	Committed	Disbursed	Committed	Disbursed
2000	$360,795	$235,813	$2,662,334	$1,769,157	$0	$0
2003	$493,632	$169,407	$2,328,129	$1,648,528	$82,947	$47,864
2005	$212,436	$155,983	$1,998,844	$1,518,740	$55,221	$0
2007	$337,868	$232,752	$1,940,868	$1,578,730	$0	$0
2009	$681,943	$143,840	$2,117,162	$768,851	$137,365	$73,952
2010	$986,089	$0	$2,238,101	$0	$411	$0

NOTE: for 2009 and 2010 awards and disbursement are ongoing over a two year period

The E-rate application process is solely the responsibility of the individual library and library systems in the state. However, by providing guidance and information regarding the three areas of concern discussed earlier, the state will ensure that libraries understand the E-rate program rules, which will allow them to reap the benefits of the E-rate program. Additional funding will increase the ability of the libraries to provide more resources to the citizens of Florida.

The funding chart reveals another interesting bit of information in relation to the application process of Florida libraries. The lack of funding for internal connections over the past ten years is unmistakable. This situation is attributable to the fact that there are only one or two counties in the state that had a 90% E-rate discount in the course of the past ten years. In addition, funding for internal connections in the E-rate program has not been as low as 80% except for the past two years. We believe that the libraries have been at a disadvantage for applying for internal connections in the past.

National School Lunch Program Free and Reduced Lunch numbers have increased as more families are qualifying for assistance as a result of higher poverty rates. There is the opportunity for some libraries to benefit from higher free and reduced lunch numbers. These numbers will increase the E-rate discount percentages available for library applicants in the 2011 funding year. It is possible that more of Florida's counties may qualify for a 90% discount for the 2011 application window, and "Priority 2" funding could go down to 80% again. Any library that has an 80% or greater E-rate discount percentage should consider filing for internal connections in the fall of 2010 while the E-rate 2011 window is open (December 2010 through February 2011).

Conclusion

At many libraries, more people are using online resources, computers, and Internet services than are using print materials. Today, public libraries are facing the challenge of a society who depends more on technology and online resources, and whose expectations and demands of the library are for those digital and virtual resources. In light of this, Florida's public libraries have done an outstanding job keeping up with the changes that transform the existing practices and services that are delivered through technology. Conducting a network assessment and developing recommendations and guidance can be truly effective in both the short and long term improvement of current technology services for public libraries.

Hayes gratefully acknowledges the support of the State Library and Archives of Florida and the participating public libraries that provided the data on the library technology upon which this document is based. The pre-assessment survey, engineering reports, and interviews provided information for the network conclusions and recommendations offered. Although it is difficult to get information that is exact and fixed within an evolving and dynamic context of public access, use, and infrastructure, we believe that technology assessment is an ongoing process, and libraries will need to continually assess their needs and consider courses of action that will help them to meet the public demand.

Appendix A

CD ROM Disk contains the network assessments for the following sites:

Alachua County Library System	Headquarters
	Alachua Branch Library
	Archer Branch Library
	Hawthorne Branch Library
	High Springs Branch Library
	Micanopy Branch Library
	Millhopper Branch Library
	Newberry Branch Library
	The Library Partnership
	Tower Rd. Branch Library
	Waldo Branch Library
Citrus County Library System	Central Ridge Library
	Coastal Region Library
	Floral City Public Library
	Homosassa Public Library
	Lakes Region Library
Collier County Public Library	East Naples Branch Library
	Estates Branch Library
	Everglades City Branch Library
	Golden Gate Branch Library
	Headquarters Library
	Immokalee Branch Library
	Marco Island Branch Library
	Naples Regional Library
	River Park Community Center
	South Regional Library
	Vanderbilt Beach Branch Library
Gadsden County Public Library System	Cowen Public Library
	Havana Public Library
	William A. "Bill" McGill Library
Jackson County Public Library	Graceville Branch
	Marianna Branch
Jacksonville Public Library	Argyle Branch
	Beaches Regional
	Branham Brooks Northwest Branch
	Brentwood Branch
	Brown Eastside Branch
	Charles Webb Wesconnett Regional
	Dallas Graham Branch
	Highlands Regional
	Main Library

	Mandarin Regional
	Maxville Branch
	Murray Hill Branch
	Pablo Creek Regional
	Regency Square Regional
	San Marco Branch
	South Mandarin Regional
	Southeast Regional
	University Park Branch and Support Services Department
	West Regional
	Westbrook Branch
	Willowbranch Branch
Lake County Library System	Astor County Library
	Cagan Crossings Community Library
	Cooper Memorial Library
	East Lake County Library
	Fruitland Park Library
	Helen Lehmann Memorial Library
	Lady Lake Public Library
	Lake County Library System
	Leesburg Public Library
	Marianne Beck Memorial Library
	Marion Baysinger Memorial Library
	Minneola Schoolhouse Library
	Paisley County Library
	Tavares Public Library
	Umatilla Public Library
	W. T. Bland Public Library
Leon County Library	Dr. B. L. Perry, Jr. Branch
	Fort Braden Branch
	Lake Jackson Branch
	Main Branch, LeRoy Collins
	Northeast Branch
	Parkway Branch
Martin County Library System	Blake - Main
	Courthouse Law Library
	Hobe Sound Library
	Indiantown Elisabeth Lahti Library
	Jensen Beach Hoke Library
	Mid County Robert Morgrade Library
	Palm City Cummings Library
Monroe County Public Library	Big Pine Key Branch Library
	Islamorada Branch Library (Helen Wadley Branch Library)
	Key Largo Branch Library

	Key West Library (May Hill Russell Library)
	Marathon Branch Library (George Dolezal Branch)
Nassau County Public Library System	Bryceville Branch Library
	Callahan Branch Library
	Fernandina Beach Branch Library
	Hilliard Branch Library
New River Public Library Cooperative	Bradford County Public Library
	Emily Taber Public Library
	New River Public Library Cooperative
	Union County Public Library
Pasco County Library Cooperative	Centennial Park Branch Library
	Hudson Regional Branch Library
	Hugh Embry Branch Library
	Land O' Lakes Branch Library
	New River Library
	Regency Park Branch
	South Holiday Branch
	Support Services
	Zephyrhills Branch
Polk County Library Cooperative	Auburndale Public Library
	Bartow Public Library
	Dundee Public Library
	Eagle Lake Public Library
	Fort Meade Public Library
	Haines City Public Library
	Justice Stephen H. Grimes Law Library
	Lake Alfred Public Library
	Lake Wales Public Library
	Lakeland Public Library
	Lakeland Public Library, E-Library South Lakeland
	Lakeland Public Library, Larry R. Jackson Branch
	Latt Maxcy Memorial Library
	Mulberry Public Library
	Polk City Community Library
	Polk County Library Cooperative
	Winter Haven Public Library
Santa Rosa Library System	Gulf Breeze Branch
	Jay Branch
	Milton Branch
	Navarre Branch
	Pace Branch
St. Johns County Public Library System	Anastasia Island Branch Library
	Bartram Trail Branch Library

	Hastings Branch Library
	Main Branch Library
	Ponte Vedra Beach Branch Library
	Southeast Branch Library
St. Lucie Library System	Fort Pierce Branch Library
	Lakewood Park Branch Library
	Morningside Branch Library
	Port St. Lucie Branch Library
	St. Lucie West Library (Joint-Use Facility with IRSC and FAU)
	Zora Neale Hurston Branch Library
Suwannee River Regional Library	Branford Public Library
	Greenville Public Library
	Jasper Public Library
	Jennings Public Library
	Lee Public Library
	Live Oak Public Library
	Madison Public Library
	White Springs Public Library
Volusia Library System	Daytona Beach Regional Library (City Island) formerly Volusia County Library Center
	DeBary Library
	DeLand Area Public Library
	Deltona Regional Library
	Edgewater Library
	Holly Hill Library
	John H. Dickerson Heritage Library
	Lake Helen Library
	Library Support Center
	New Smyrna Beach Regional Library
	Oak Hill Library
	Orange City Library
	Ormond Beach Regional Library
	Pierson Library
	Port Orange Regional Library
Walton County Public Library	Coastal Branch
	Defuniak Branch
	Freeport Branch
	Milton Branch
Single Branch Libraries	Apalachicola Municipal Library
	Boynton Beach City Library
	Lighthouse Point Library
	Riviera Beach Public Library
	Safety Harbor Public Library
	Winter Park Public Library