Inclusive Gigabit Libraries: Learn, Discuss and Brainstorm

Grant Report to the Institute of Museum and Library Services

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Executive Summary

Through a grant from the Institute of Museum and Library Services, we provided a series of continuing education forums to examine how public libraries can play a role in shaping the future of the Internet through the development of next generation broadband networks. We partnered formally with the Office of Information Technology Policy at the American Library Association and US Ignite. These events helped library leaders and their stakeholders to develop ideas and strategies to implement applications based on case studies focused on a growing number of library systems that are early adopters of next generation networks. These libraries are participants in US Ignite, an initiative of the White House Office of Science and Technology Policy and the National Science Foundation. US Ignite's ongoing goal is to "drive new business opportunities and accelerating U.S. leadership in the adoption of ultra-fast broadband and software-defined networks in communities nationwide"[i]. US Ignite also aims to open opportunities for industry, government academia, and the general public to discover innovative software applications designed to run on smart, high-speed computer networks to improve how to manufacture products, protect the environment, produce and consume energy, educate and train the workforce, enhance civic engagement and participation, and advance healthcare. IMLS supports US Ignite by "helping libraries and museums use high-speed broadband to improve education, workforce, and health outcomes for millions of Americans… to spur innovation in the creation of tools that enhance access, use, and management of digital assets". [ii]

We asked, how can libraries, as anchor institutions, leverage high-speed, next generation networks and applications to benefit communities? How do public libraries that serve almost the entire American population transform themselves into 21st century institutions of the future to provide critical, relevant services incorporating state of the art technologies and digital services to create better communities? Library leaders participating in the *Inclusive Gigabit Libraries* project examined what the US Ignite initiative means for libraries and how libraries can utilize next-generation networks and new applications to serve the public. Throughout the course of the project, we provided 10 continuing education forums across the US on this topic and reached approximately 1,500 library leaders. We learned from our forums and research interviews that libraries are critical stakeholders in the future of the Internet for several reasons.

Libraries have been and remain among the most central information institutions in the United States. They are situated at a crucial intersection of people, technology and information, capable of leadership in new high-speed information ecosystems. Increasingly,

libraries rely on broadband connectivity coupled with redesigned organizational processes to provide Internet-enabled services to meet the individual human development needs of its communities.

Libraries are highly dependent on the Internet and are expanding access to the Internet. According to results of the 2011 Digital Inclusion Survey, public libraries across the U.S. are making a big impact in their communities. During 2011, public libraries provided services to 299.9 million people, about 95 percent of the U.S. population.[iii] Approximately 91% of libraries offer wireless Internet, and over 60 percent of public libraries are the only provider of free public Internet in their communities.[iv] Most importantly, 76 percent help customers apply for employment using the Internet.

Since 2009, The US is experiencing a wave of new investment in broadband networks to expand connections to cities to deliver high-speed, high-capacity Internet service to community anchor institutions. With the deployment of high-speed broadband networks to libraries and community anchor institutions through the American Recovery and Restoration Act and a growing number of ISPs making investments, many library leaders are developing new strategies to explore Internet-enabled options to deliver services and library experiences.

Libraries with a high-speed network create opportunities for 21st Century learning, discovery, and co-invention. Libraries of the future will serve a critical role in advancing information and communications technology in providing communities with the knowledge, tools, and skills to promote educational advancement, economic development, and civic engagement. Hwang and Horowitt describe "keystone institutions" such as public libraries, as an environment that "encourages disconnected people to self-organize into greater form", and that "support the social and cultural fabric essential to innovation. These keystone institutions "play the role of nurturing the social interactions that turn basic ingredients of capital, labor and ideas, into vibrant, sustainable innovation systems that can enable entrepreneurs, as well as cities and regions, to attain new heights of innovation and productivity[v]."

Through this initiative, technological breakthroughs will provide an Internet infrastructure that will grow in concert with the evolving information demands of the public. The next-generation applications enabled by gigabit networks enable opportunities for libraries to create more digitally inclusive communities. From Makerspaces to 3D printers, ultra-high speed networks allow libraries to interact with their communities like never before[vi].

In this report, we share with you the details of the continuing education forums. We provide detailed case studies that we compiled from site visits to leading examples, including the CENIC Network in California, Cuyahoga County Public Library, and Chattanooga Public Library.

The case studies highlight the successes and challenges libraries incur when implementing innovative services and how they overcome them in order to transition into a 21st Century organization – a library of the future to remain relevant, provide services to advance their communities, and sustain and increase their customer base. We identified a common thread among each case study relating to organizational innovation and transformation and the steep learning curve experienced by each library is discussed throughout the report. Key themes surrounding change and reorganization in organizational processes, staff skill and training, technology development, and forward-thinking leadership embedded in cultural change are also discussed.

I. Introduction

With funding from IMLS, we conducted a series of continuing education forums to share information with library leaders about the future of the Internet. We partnered formally with the Office of Information Technology Policy at the American Library Association and US Ignite. The focus of each forum was to examine how public libraries can play a role in shaping the future of the Internet through the development of next generation broadband networks. With the deployment of high-speed broadband network to libraries and community anchor institutions through the American Recovery and Reinvestment Act of 2009 (ARRA) and other recent broadband infrastructure investments, many library leaders are developing new and innovating strategies to explore Internet-enabled options to deliver the next-generation of services and library experiences. Our national forums helped library leaders to share and develop ideas and strategies to implement applications to meet the real-world needs of the public.

The national forums focused on national efforts to build the next generation of the Internet. On June 13 2012, the White House and National Science Foundation launched the U.S. Ignite initiative to continue research and development on the next generation of the Internet. The initiative's goal is to open opportunities for industry, government academia, and the general public to discover innovative software applications designed to run on smart, high-speed computer networks to improve how to manufacture products, protect the environment, produce and consume energy, educate and train the workforce, enhance civic engagement and participation, and advance healthcare. Through this initiative, technological breakthroughs will provide an Internet infrastructure that will grow in concert with the evolving information demands of the public.

US Ignite focuses on next generation Internet networks. Next-generation networks are smart, high-speed, high-capacity networks aimed at improving the user experience. These networks utilize:

- Software defined networks;
- GENI technologies;
- Open Flow;
- Connection to Internet 2;
- Gigabit-speed networks of at least 100 Mbps to 10 Gbps.

US Ignite is facilitating the development of applications to run on these types of networks through its collaboration with the National Science Foundation and its member organizations. Currently, 25 cities and 15 commercial entities are US Ignite members. The member cities are required to seek at least 250 users to participate in using applications developed for the GENI network. US Ignite is also organizing developers to use software defined networks and a large scale virtual laboratory, known as the GENI network, to develop applications and advance networking management networks to improve the quality of the online experience for users.

As the launch event unfolded, a group of participants representing different stakeholder groups for public libraries enthusiastically saw many possibilities for public libraries to play a critical role with the initiative. As part of US Ignite, IMLS is promoting best practices in high-speed innovation. IMLS noted that it is "helping libraries and museums use high-speed broadband to improve education, workforce, and health outcomes for millions of Americans. Its grants spur innovation in the creation of tools that enhance access, use, and management of digital assets.[vii]"

In a breakout meeting focused on workforce development and community needs, Joanne Hovis, President of CTC Technology and Energy, facilitated a robust discussion sharing stories from local leaders who were at the forefront of building gigabit speed broadband networks. This included local leaders from Chattanooga, Champaign, IL, Lafayette, LA, and the Cleveland region. In a defining moment in the meeting, John Windhausen, Executive Director of the Schools, Health, and Libraries Broadband Coalition asked, "What does the mean for schools and libraries?" Others raised an additional key question: "How can libraries, as community anchor institutions, leverage these networks and applications to benefit the communities they serve?"

We also heard messages from IMLS about its work to identify best practices among library partnerships with US Ignite. This included:

- Sari Feldman presenting how the Cuyahoga County Public Library system is partnering with Case Western Reserve University and One Community to bring one-gigabit broadband connection to its Warrensville Height library branch.
- Chattanooga, TN, one of the first gigabit cities that connected the Chattanooga Public Library, shared how Corinne Hill and local leaders were leveraging high-speed connections to transform the library into spaces where citizens can discover and learn how to produce knowledge in new digitally-enabled ways.
- We heard from Grace Agnew from the Rutgers University Library on how her research team developed the first library-focused application, the Video Mosaic Collaborative, to support collaboration for using a NSF funded video library of 20 years of math education.

We discussed how various communities are building new ultra high-speed broadband networks and connecting libraries to them.

To keep momentum from the White House event moving forward, an idea to provide a continuing education forum to examine opportunities for libraries emerged.

Over the past two years, US Ignite has helped to foster the development of applications to run on next generation networks.

Some examples of US Ignite applications include[viiiix]:

- Video Mosaic Collaborative
- Cizzle, a browser-based simulation environment
- Kansas City Public Library software lending library
- Engage 3D, a browser-based 3D video conferencing application
- A distributed, virtual community supercomputer
- Medical and public health analysis of big data
- Remote radiology
- Remote surgery
- Personal sensor networks
- Reliable process control for manufacturing
- Collaborative design for manufacturing
- The CASA radar network for weather forecasting
- The SimCenter, a center for research into next-generation technologies in computational modeling, simulation and design
- PlanIT Impact, an interactive application that helps designers, planners and constituents visualize future development scenarios;

An important goal of *Inclusive Gigabit Libraries* was to convene library and broadband leaders in a series of national continuing education forums about the U.S. Ignite initiative to address how libraries can leverage high-speed networks to benefit communities. We provided 10 leadership forums and reached approximately 1,500 library leaders. The forums consisted of presentations of compelling case studies and strategies for libraries to deliver services and generate knowledge using high-speed connectivity.

The forums helped library leaders and other stakeholders learn and strategize about how to leverage high-speed broadband networks to create public value in a fast-changing globally networked environment. In addition, library leaders need to understand how best to implement and manage high-speed broadband networks. Library leaders face uncertainty and these new developments raise many questions about the future of libraries. What are the most effective approaches for libraries to provide virtual and public spaces that engage with and transform a sustainable high-speed network infrastructure[x]? How should library leaders

educate their staff, boards, and legislative bodies about the next generation of networks and what the high-speed broadband means to service models with greater use of digital resources? How should library leaders develop strategic plans to leverage high-speed broadband networks as the infrastructure for Internet-enabled service delivery plans? How should library leaders address the challenges to develop digital applications and services that are adopted and used regularly by the public?

The continuing education forums:

- Convened an audience of public library stakeholders representing all types of libraries, federal, state and local government, ISPs, technology sector, technology leaders, software developers, community anchor institutions, specialists in sustainable broadband adoption strategies, academia, consultants, and managers of public computer centers;

- Featured case studies presented by library leaders who provided first-hand insight from their experiences with adopting and using next generation Internet networks currently under deployment in various cities across the US. The "live" case studies included:
    - *Overview of US Ignite* – Nicole Levine, Manager
    - *Strategies for Connecting Public Libraries to Statewide Next Generation Middle-mile Networks* - CENIC with Louis Fox, CEO;
    - *Leadership Imperatives to Transform a Traditional Library to a Hub of Innovation* – Chattanooga Public Library, Corinne Hill, Executive Director; and Nate Hill;
    - *Organizational Change and New Service Models* – Cuyahoga Public Library System, Sari Feldman, Executive Director; and Rebecca Ranallo;
    - *The Video Mosaic Collaborative* –Rutgers University Library, Grace Agnew.

- Engaged the audience of library leaders from around the country with interactive sessions to generate new ideas and knowledge sharing. The interactive questions focused on understand what does it take to make a library "ready" to use a gigabit connection. What are the organizational, technological capabilities, governance, and user acceptance factors that shape when a library will be ready to use a gigabit connection? We facilitated the sessions to invite audience participation allowing local libraries to share their stories of expanding Internet connectivity and developing new programs and services;

- Maximized reach by offering the forums in different time and delivery formats to maximize our reach. This included holding in-person meetings with simultaneous

virtual sessions using Blackboard Collaborate, virtual only sessions, small group format, and conference sessions.

The participants of the forums identified a number of impacts that a gigabit network may have on libraries:

1. Library users can more quickly accomplish online tasks.
2. Increase the value of online learning through individual and group access of bandwidth intense online education.
3. Increase hands on learning opportunities through bandwidth intense maker space activities. (3D files can be over 20 MB.)
4. Creation of programs that encourage the community to create digital content.
5. Scheduling of library programs can occur based upon needs of the community, not upon availability of bandwidth.
6. Increased value to technology organizations holding bandwidth intense trainings and events at the library.
7. Increased value to businesses, particularly those who need to upload large amounts of data.
8. Reduce administrative costs including switching phone communications to Voice Over IP, reducing management of bandwidth traffic, and reducing staff maintenance of public access computers (since the software and even the operating system can reside in the cloud).
9. The library can serve as a test bed for new applications being run on next generation networks.

This report highlights how public and academic libraries across the U.S. are transforming themselves by developing and implementing digital services over gigabit networks.

The first case study shows how the Peninsula Library System, a consortium of thirty-two city, county, and community colleges in San Mateo County, California, is partnering with the Corporation for Education Networks Initiatives (CENIC) to become a sixth segment of the CalREN research and education network. CENIC operates the network that provides high-bandwidth Internet to five charter associates that include K-12 institutions, community colleges, state universities, private universities, and non-charter research and education institutions in California. Membership in the network is enabling all PLS libraries to become connected to the gigabit network.

The second is the Chattanooga Public Library case study that shows how leadership and organizational change can transform traditional services into state-of-the-art workspaces and technologies. The case study features Corinne Hill, the Executive Director of Chattanooga Public Library.

The third case study is the Cuyahoga County Public Library in Cleveland, OH that demonstrates how leadership strategies and risk-taking serve as the catalyst for development of diverse digital services at multiple branches.

At each forum, we organized the case studies around a framework to understand the challenges of adopting technological innovations. We used research from the strategic management and innovation literature to provide library leaders with a framework to guide the development of strategic plans and decision-making to support using high-speed networks. We introduced library leaders to the broadband strategic innovation model for libraries. This model is based on many of the lessons from C.K. Prahalad and M.S. Krishnan's 2008 book, *The New Age of Innovation*, and other related research in the strategic management field as a framework for understanding how the best performing organizations leverage information and communication technologies and organizational processes to meet the specific individual needs of customers. We also introduced library leaders to the latest research on broadband adoption to explain what factors lead an individual to try out and use a new technology based on the individual's expectations for the performance of the technology, ease of use, social influences, and level of understanding of the technology (digital literacy).

II. Overview of Libraries Leading the Way to Implement Next Generation Networks

Access to the Internet is vital for public libraries to serve its mission. Knowing that information is fundamental to democracy, the public library's daily mission to serve the information needs of the public is situated at a crucial intersection of people, technology and organizations. Public libraries rely heavily on the Internet, digital technologies and digital content to contribute to the social and economic vitality of the community it serves through life long learning, information literacy and as an information center[xi]. In spite of libraries lagging in average access speeds to their buildings, its becoming commonplace for libraries to use the Internet to leverage itself as a community-based digital platform outfitted to support physical visits and in-person services, administrative functions, back-office operations, and public-facing access to digital content and other virtual services and resources. Libraries are consistently increasing access points for the public to interact with and produce digital content.

As a steward of information and provider of public access to the Internet, the public library must balance two objectives to meet its day-to-day needs and its future direction. First, libraries need to stay at pace with the technological changes that are redefining the form, structure and function of information and the way in which its delivered through the Internet to its patrons. Second, the Internet is disrupting the traditional idea of libraries by reimagining libraries as important stakeholders for the future of the Internet. As the information age matures, public library leaders are imagining how their library's informative, educational, recreational and cultural functions will evolve if it has access to the Internet through high-bandwidth, high-capacity networks[xii][xiii].

Libraries are important stakeholders for next generation networks. Next Generation Internet refers to research and development in large-scale computer networks to improve the performance of the Internet to "help ensure the continued leadership of the United States in high-performance computing and its applications"[xiv]. This includes providing sustained access by the research community throughout the US, providing dispersed efforts to increase software availability, productivity, capability security, portability, and reliability; and provide high-performance networks, including experimental test bed networks, to enable research and development on, and demonstration of, advanced applications enabled by these networks[xv]. The U.S. vision of the next generation of the Internet is to advance capabilities in three areas:

- "WeCompute—Expanded human-computer partnerships, including more capable, available, and affordable systems; more powerful digital tools for people; and new forms of collaboration between the two.
- Trust and Confidence—The ability to design and build systems with levels of security, safety, privacy, reliability, predictability, and dependability that "you can bet your life on."
- Cyber Capable—Transformed education and training to ensure that current generations benefit fully from cyber capabilities and to inspire a diverse, prepared, and highly productive next-generation workforce of cyber innovators."[xvi]

US Ignite is facilitating the development of applications to run on these types of networks through its collaboration with the National Science Foundation and its member organizations. Currently, 25 cities and 15 commercial entities are US Ignite members. The member cities are required to seek at least 250 users to participate in using applications developed for the GENI network.

US Ignite is also organizing developers to use software defined networks and a large scale virtual laboratory, known as the GENI network, to develop applications and advance networking management networks to improve the quality of the online experience for users. GENI is the Global Environment for Network Innovations. GENI was proposed in 2005 as a next-generation Internet with "built-in security and functionality that connects all kinds of devices." GENI allows researchers to explore networks of the future and is a unique virtual research laboratory for at scale experimentation of applications and services. It is supported by the National Science Foundation, and available without charge for research and classroom use[xvii]. "GENI planning efforts are organized around several focus areas, including facility architecture, the backbone network, distributed services, wireless/mobile/sensor sub networks, and research coordination amongst these."[xviii]

Libraries with a high-speed network create opportunities for 21st Century learning, discovery, and co-invention. Libraries of the future will serve a critical role in advancing information and communications technology in providing communities with the knowledge, tools, and skills to promote educational advancement, economic development, and civic engagement. Hwang and Horowitt[xix] describe "keystone institutions" such as public libraries, as an environment that "encourages disconnected people to self-organize into greater form", and that "support the social and cultural fabric essential to innovation. These keystone institutions "play the role of nurturing the social interactions that turn basic ingredients of capital, labor and ideas, into vibrant, sustainable innovation systems that can enable entrepreneurs, as well as cities and regions, to attain new heights of innovation and productivity."

Through this initiative, technological breakthroughs will provide an Internet infrastructure that will grow in concert with the evolving information demands of the public. The next-generation applications enabled by gigabit networks enable opportunities for libraries to create more digitally inclusive communities.

As libraries develop strategies to leverage Internet-enabled services, libraries and stakeholders need to be able to test and evaluate options and access possible applications easily. Developing applications is expensive and risky and libraries have very limited budgets and resources. Application developers need a place to test the applications with real users in real-world conditions. The U.S. Ignite fills this need by providing a national test bed for applications. As Rob Kling observes, all IT systems require interdisciplinary study that takes into account their interactions with institutional and cultural contexts. The ultra-high speed networks and the applications running on them do not exist in social or technological isolation. Their "cultural and institutional contexts" influence the ways in which they are developed, the kinds of workable configurations that are proposed, how they are implemented and used, and the range of consequences that occur for organizations and other social groupings[xx]. The U.S. Ignite GENI networks will permit developing and evaluating applications through full consideration of the real-life context of the users.

For example, a local library could develop and test applications using not only users on their local broadband network, but also users from other member cities. Additionally, libraries on the GENI network can provide access to their applications to all library patrons to test and evaluate them. This not only broadens the number of people using applications under development, but also broadens the diversity of users. The GENI network opens a door to a broader range of people who are able to participate in the design and development of new library services.

Here are some examples of how public libraries are playing a role in developing next generation networks to align with IMLS goal for US Ignite to spur "innovation in the creation of tools that enhance access, use, and management of digital assets".

- The Chattanooga Public Library (CPL) is on a mission to transform the public library space. Through Executive Director Corinne Hill's leadership and strategic vision, the library has developed a number of high-tech initiatives to engage the public. The strategy features the 4th Floor, which is a combination of a hacker space, maker space, and event space. The 4th Floor was previously used as a storage space for equipment and old furniture. A large section of the 4th Floor is dedicated to open

space with comfortable large chairs, couches, and tables where people can meet to work together and use state-of-the-art technology such as 3D printers and laser cutters. The open space creates the environment for learning, engagement, innovation, and development. In one of its newest ventures, CPL is collaborating with the City of Chattanooga to develop an open data portal known as the Open Chattanooga Data Portal. CPL collaborated with Engage 3D, AIGA, developers, and designers to put on its first ever youth coding camp, Dev Dev, the summer of 2013. Fifty youth learned HTML, CSS, Python, and robotics programming. In another collaboration the summer of 2013, the 4th Floor was used to host CO.LAB's GIGTANK Demo Day. GIGTANK is the world's only accelerator connected to a metro-wide fiber network enabling business entrepreneurs to test and launch ideas on the Chattanooga gigabit network.

- The Cuyahoga County Public Library (CCPL) Warrensville Heights branch, which opened in Spring 2012, has a 2-gigabit connection. Located strategically next to the YMCA, the new branch serves as an anchor institution for the economically disadvantaged community. This is one part of an effort to redevelop and revitalize the government complex and services in the area. Other ways CCPL is increasing the acceptance and use of broadband in the library is by offering digital literacy and computer competency training; unlimited use of devices over the network; and accessibility to industry standard audio/visual equipment for its customers to record original music, upload music to a library-searchable playlist, and even film videos. CCPL reorganized the summer of 2013 and created the Literacy Learning Division focusing on literacy and learning for youth and adults by combining the Adult Programming, Youth Programming, and Literacy and Outreach programs. CCPL provides a College Prep Academy that helps adults prepare for college entrance exams through distance learning and provides locations for non-credit continuing education courses in collaboration with Case Western Reserve. Technology trainers are also on-site to provide customers and staff assistance with learning to use tech tools and software.

- The Santa Monica Public Library (SMPL) has five branches located in a growing community that includes tech companies such as incubators and accelerators. One of the goals of SMPL has been to expand services outside of the walls into the public. The library is connected to the city's gigabit network and is connected to a 100-gigabit backbone that was recently upgraded from 10 Gbps with communications to the Internet on a 1-gig pipe, enabling the library to provide high-speed broadband and wireless Internet connectivity to the public[xxi]. The library will soon introduce a

new service supported by the gigabit network, Hoopla, which will enable customers to download streaming content. The library delivers service to the Pico Branch, located in a park. The staff provide services with a mobile service model using digital tools including tablets, either iPads or Android devices equipped with a web-based application to register customers and access account information, and hand-held radio frequency identification (RFID) check-in and check-out devices that can print. During the day, staff members are present in the park to engage the public with materials for circulation or market services, enabling patrons to download content and register them on the spot. The City of Santa Monica continues to make significant broadband investments and is becoming known as the "Silicon Beach". As Jory Wolf, CIO of Santa Monica, describes: "We are considered a leader in social tech and have leveraged our fiber optic network to advance free Wi-Fi in public parks and major bus routes, provide internet to our libraries, and connect our schools and college locations. These efforts have contributed to education, economic development, and provide impressive Internet speeds for large conferences and events. We are proud to be the 1st, 100 Gigabit municipal network in the U.S.[xxii]"

- Rutgers University Libraries is the lead partner in the development a Video Mosaic Collaborative (VMC), which runs on a node on the GENI network, hosted by the university with broadband speed at one gigabit per second. More than twenty years of math learning experiences of school-aged children in grades 4-12, including transcripts and student work, is accessible via the Learning Video Collection of VMC. The environment boasts an online collaboration platform enabling teachers and educators to use the tool for classroom activities to enhance educational experiences for students. In addition, researchers can use the VMC to conduct research about student learning and access data for analysis and publishing, using larger segments of videos. The VMC Analytic tool enables a person who is registered on the site to annotate videos, create virtual clips, and create playlists of multiple, virtual clips. For example, teachers can access the site to use and edit video clips and annotations to use in in class instruction. Teachers can learn different strategies for teaching in the classroom in a group or one-on-one format for student learning.

- As the rollout of Google Fiber continues in Kansas City, the Kansas City Public Library (KCPL) will be connected to a gigabit network encompassing most of the city. KCPL is piloting a software lending library (built on the open source Ruby on Rails) that will be deployed over the gigabit network once the library is connected. The software lending library will allow customers who have a KCPL library card to check out software applications for a scheduled time period such as Adobe

Photoshop, Adobe Premier, Microsoft Office, and the Rosetta Stone hosted on the site using a remote desktop solution. Customer will also be able to access business software applications to support entrepreneurial and businesses development.

- The Google Fiber service in Kansas City is a widely known strategy to build a gigabit speed broadband network. As the rollout of Google Fiber continues in Kansas City, the Kansas City Public Library (KCPL) in Missouri and the Kansas City Kansas Public Library (KCKPL) are eagerly awaiting gigabit Internet connections in all their branches located within their respective municipalities. In April 2014 the Kansas City Public Library's main library received a 1 Gbps connection from Google Fiber and is determining how best to deploy administrative and public access. The branches are expected to receive the service from Google Fiber in the fall of 2014.

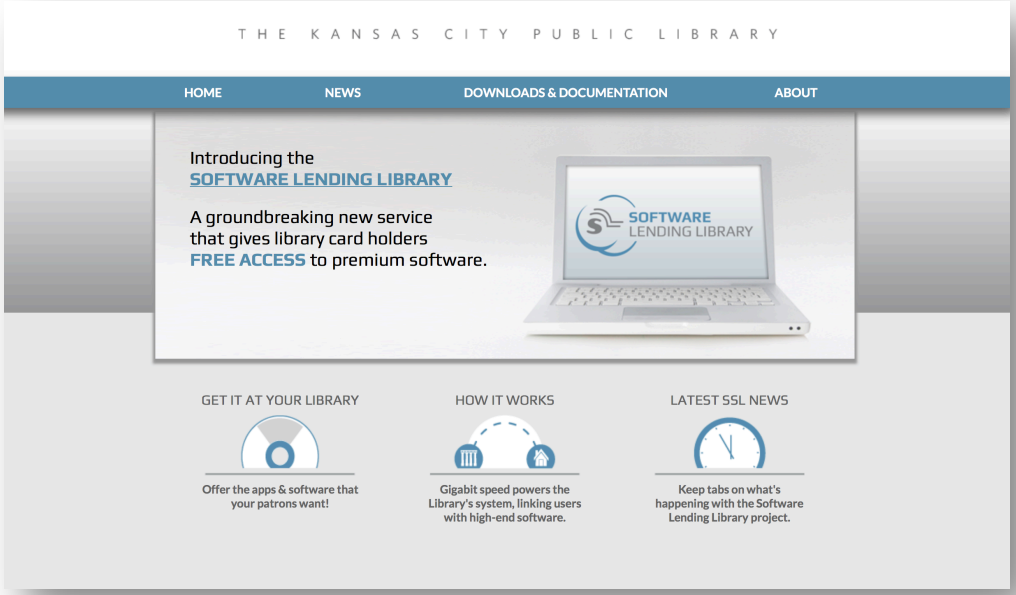


Figure 1 - Kansas City Public Library Software Lending Library

- KCPL's plans include expansion of their Small Business Center, creation of a Software Lending Library, increased digitized content and changes to their Mobile Digital Media Lab for Youth. Supported by Mozilla and the National Science Foundation, the Mozilla Ignite Challenge invited developers, network engineers and community catalysts to submit ideas for applications designed to run on next generation networks with speeds up to 1 Gbps. The winning applications received funding and support to build their ideas. KCPL's Software Lending Library was one of the

winners. According to David LaCrone, Digital Branch Manager at Kansas City Public Library,

"Being a Mozilla Ignite grantee had a lot of benefits. For starters we were awarded $17,500 which funded travel to the US Ignite Summit and Gigtank Demo Day in Chattanooga where we presented publicly on the project. It also enabled us to pay a contract developer to build the web application and to buy software licenses. Perhaps more importantly, the folks at Mozilla and US Ignite provided a lot of advice, encouragement and support as we went from concept to pilot."

- Australia's National Broadband Network (NBN) will provide gigabit speed connectivity to all Australians, enabling them to access and share information and digital technologies in many areas, including health, education, business, entertainment, and teleworking. Most homes, schools, and businesses will be connected to fiber to the premise, while a small segment will be connected by satellite or fixed-wireless. The Aitkenvale branch is the first library in Australia to become connected to the NBN. Our team met with Warren Cheetham. Warren is the Coordinator for Information & Digital Services at the City of Townsville (Queensland) Public Library. Warren received a national fellowship to study libraries connected to gigabit networks in the US. We met via Skype and during his visit to the US, including Urbana-Champaign, IL. The Aitkenvale branch is providing a government related program to assist organizations working with children with sight disabilities using video-conferencing. This branch has also hosted community information sessions to residents to promote broadband and library services. Video conferencing presents additional opportunities for CityLibraries to provide services outside of the community over the NBN. The State Library of Queensland plans to stream programs from the State Library's Indigenous Centre to Townsville. Programs include story time sessions that can potentially be accessed by residents through videoconferencing at the CityLibrary branches. The CityLibrary plans to collaborate with the State Library's digital media center to develop its own digital media program.

III. Broadband Networking Challenges for Public Libraries

During the forums we asked the participants to discuss the challenges that libraries face currently.

The public library serves the public through four functions: informative, educational, recreational, and cultural[xxiii]. As the information age matures, public library are reimagining how these functions are delivered as it uses the Internet and digital technologies and content to contribute to the social and economic vitality of the community it serves through life long learning, information literacy and as an information center[xxiv]. Professor Mandel and her colleagues observe that public libraries are taking on new roles through Internet-enabled services as a place for public access to the Internet, E-government provider, emergency and disaster relief provider, Internet and technology trainer and youth education support provider[xxv].

Increasingly, libraries, like most of the U.S. economy, depend on the Internet as much as they depend on basic utilities such as electricity and water. Libraries rely on broadband connectivity coupled with redesigned organizational processes to provide Internet-enabled services to meet the individual human development needs of the communities they serve[xxvi]. The digital age brings many exciting opportunities, but the participants of the forums noted that libraries also face many challenges.

- Libraries have to figure out ways to provide access and support the use of digital technologies and content by everyone. As an essential democratic, public libraries are established by public law, maintained with public funds to offer everyone equal privileges for free and equal access to knowledge, information and ideas.[xxvii] Public libraries help to meet the information needs of our communities by serving as the place that provides information to help a community build its capacity for action, solve problems, explore and discover new knowledge, engage in its civic affairs, and create a sense of connectedness socially.[xxviii]

- Additionally, libraries play a critical role in helping to bridge the broadband digital divide across communities. When considering where people go to access the Internet, public libraries, schools, and community centers are more likely to be used by minority groups. African Americans were more likely to access the Internet at their public library (51%) as compared to Hispanics (43%) and White Americans

(27%). [xxix]

- The extent to which public libraries use the Internet varies considerably across the United States. At the same time that efforts are underway to bring more bandwidth to libraries, the demand for bandwidth in libraries is growing beyond the supply. Public libraries report that they are making more computers available for public access, continue to increase access to such digital resources as databases, e-books and devices, and offer a variety of formal and informal strategies to improve digital literacy.[xxx]

- To address costs and service quality, library leaders also are exploring whether cloud-based services are suitable to deliver services for library catalogs, administrative applications, and communications. Cloud-based services depend on a reliable, high-speed connection to the Internet.

- However with these demands for broadband capacity, "though libraries reported increases in public access computers and bandwidth, 41.7 percent of libraries (down from 44.9 percent in 2010-2011 and 45.1 percent in 2009-2010) reported that their connection speeds are insufficient some or all of the time and 65.4 percent of libraries (down from 76.2 percent in 2010-2011 and 73.5 percent in 2009-2010) reported that they had fewer public access computers to meet demand some or all of the time".[xxxi]

Its growing commonplace for libraries to use the Internet to power itself as a community-based digital platform set-up to support physical visits and in-person services, administrative functions, back-office operations, and public-facing access to digital content and other virtual services and resources. Libraries are growing in how they are providing access points for the public to use the library for producing digital content.

As these trends continue, the public library has a vested interest in how its network is configured within the walls of the library and along the way from its building to the Internet. Libraries face many challenges in being able to provide adequate access to high speed broadband Internet.[xxxii] Bertot and McClure observe that one challenge is the question of bandwidth sufficiency and quality, which can be attributed to various factors including: [xxxiii]

- Number of workstations (public access and staff) that simultaneously access the Internet;
- Provision of wireless access that shares the same connection;
- The connectivity path to the Internet;
- Type of connection and bandwidth that the telecommunication company is able to supply the library;

- Operations being performed by the users of the Internet connection;
- Switching technologies;
- Latency effects that affect packet loss, jitter, and other forms of noise throughout a network;
- Local settings and parameters;
- Range of networked services that the network links to;
- The speed of the network;
- General application resource needs, protocol priority, and other general factors.

Libraries also have a vested interest in how its network is configured to access and run Internet applications. As libraries increase the amount of digital content and services available to the public, library leaders are growing concerned that streaming video may be choppy or books and articles may be slow to download. Even more challenging, with the growth of library programs and services to help patrons create, produce and share content, libraries need network capabilities to permit patrons to upload content as fast as they download content. With a high-speed network, libraries create opportunities for 21st century learning, discovery and co-invention. The next-generation applications enabled by gigabit networks have created new opportunities for libraries to create more inclusive communities. From software-lending libraries to Makerspaces to 3D printing, ultra-high speed networks allow libraries to serve their communities like never before.

IV. Expanding Research and Education Networks to Public Libraries

We are seeing strategies to connect public libraries to statewide Research and Education (R&E) networks. With federal funding through the Recovery Act's Broadband Technology Opportunity Program from the National Telecommunication and Information Agency, several Research and Education Networks expanded high-speed broadband access for public libraries. Additional ISPs, such as Google Fiber, AT&T, Century Link and Verizon are making investments to build gigabit speed networks.

The Gates Foundation forecasted that libraries would increase access to R&E networks in their 2011 report *Connections, Capacity, Community: Exploring Potential Benefits of Research and Education Networks for Public Libraries*. Research and Education networks are regional computer networks that provide Internet service to educational, research, government and community anchor institutions, including public libraries. The R&E network operators are investing into their network infrastructure meet the ever-growing network demands of these institutions within each state. These networks provide a range of such shared services as cloud services, virtual private networks, e-mail hosting, domain name services, and many other related services to connect these institutions to the Internet, advanced research networks such as Internet2 and National Lambda Rail, and trans-global networks. Many of these networks started in the late 1960's and 1970's to connect mainframe computers at universities and government institutions together and later formed the network making up critical parts of the Internet in the mid 1980's. The R&E networks evolved into serving the commercial Internet in 1994. Now R&E networks offer network facilities services on fiber-based networks.

Internet2 is a critical organization and network for R&E networks. This network delivers network services for research and education, and provides a secure network testing and research environment. Internet2's mission is to "accelerate research discovery, advance national and global education, and improve the delivery of public services".[xxxiv] The Internet2 Network, through its regional network and connector members, connects over 60,000 U.S. educational, research, government and "community anchor" institutions, from primary and secondary schools to community colleges and universities, public libraries and museums to health care organizations. Internet2 provides member benefits that include access to software services through its NET+ Services, a portfolio of cloud services and solutions.

Here are three examples of R&E networks that are expanding access to public libraries on gigabit networks – MCNC, OPLIN and an in-depth case study of CENIC.

- MCNC operates NCREN, the R&E network that provides broadband Internet service to all K-12 school districts, higher education campuses and academic research institutions across North Carolina. MCNC expanded its network from connecting colleges and universities to adding K-12 schools, health care systems, public safety and public libraries () at various points in its history[xxxv]. With funding the Broadband Technology Opportunity Programs, MCNC received nearly $105 million in funding through two awards to expand high-speed broadband connectivity to public libraries, along with other community anchor institutions. MCNC constructed almost 1,800 new miles of broadband network to extend NCREN from North Carolina's urbanized areas to reach underserved areas, mostly in economically disadvantaged rural areas of the state. MCNC connected 52 of the states 77 public library systems to NCREN. The network increases broadband capacity at public libraries by at least 10 to 20 times faster than previous ISP services.[xxxvi] At this point MCNC has 10 connections to libraries using MCNC-owned fiber. MCNC welcomes additional library connections as the necessary funding becomes available.

- As a state program, OPLIN (Ohio Public Library Information Network) provides Ohio's public libraries with broadband Internet connections. In 2013 OPLIN began utilizing OARnet (Ohio Academic Resources Network) to provide Ohio's public library systems with gigabit connections. Currently, OARnet is the originating high-speed access point for 54 public library systems in Ohio. Another 54 libraries are in process of gaining access to OARnet. The cost of adding the library systems to OARnet is already partially covered by OPLIN. The Ohio Public Library Information Network (OPLIN) automatically upgrades a library's connection when their usage hits 70 percent saturation at peak times (mid afternoon, middle of the week). CCPL's situation was unusual in that CCPL requested an increase before hitting the 70% saturation because they believed there was a bottleneck between the administration building and the branches.

CENIC: A Research and Education Network Connecting Public Libraries

As this grant started, CENIC announced its plans to extend its R&E network to public libraries in California. The Corporation for Education Network Initiatives in California

(CENIC) operates California's R&E network. CENIC is a non-profit organization created to serve California's K-20 research & education institutions with cost-effective, high-bandwidth networking. CENIC has five charter associates: California Community Colleges, California K-12 System, California State University System, Private Universities, and the University of California System.

CENIC designs, implements, and operates CalREN, the California Research and Education Network, a high-bandwidth, high-capacity Internet network specially designed to meet the unique requirements of these communities, and to which the vast majority of the state's educational institutions are connected. The network has over 3,000 miles of fiber-optic cabling that connects over 10,000 sites. Over *ten million Californians* use CalREN every day[xxxvii]. CalREN consists of a CENIC-owned and operated backbone to which schools and other institutions in all 58 of California's counties connect via leased circuits obtained from telecom carriers or fiber-optic cable.

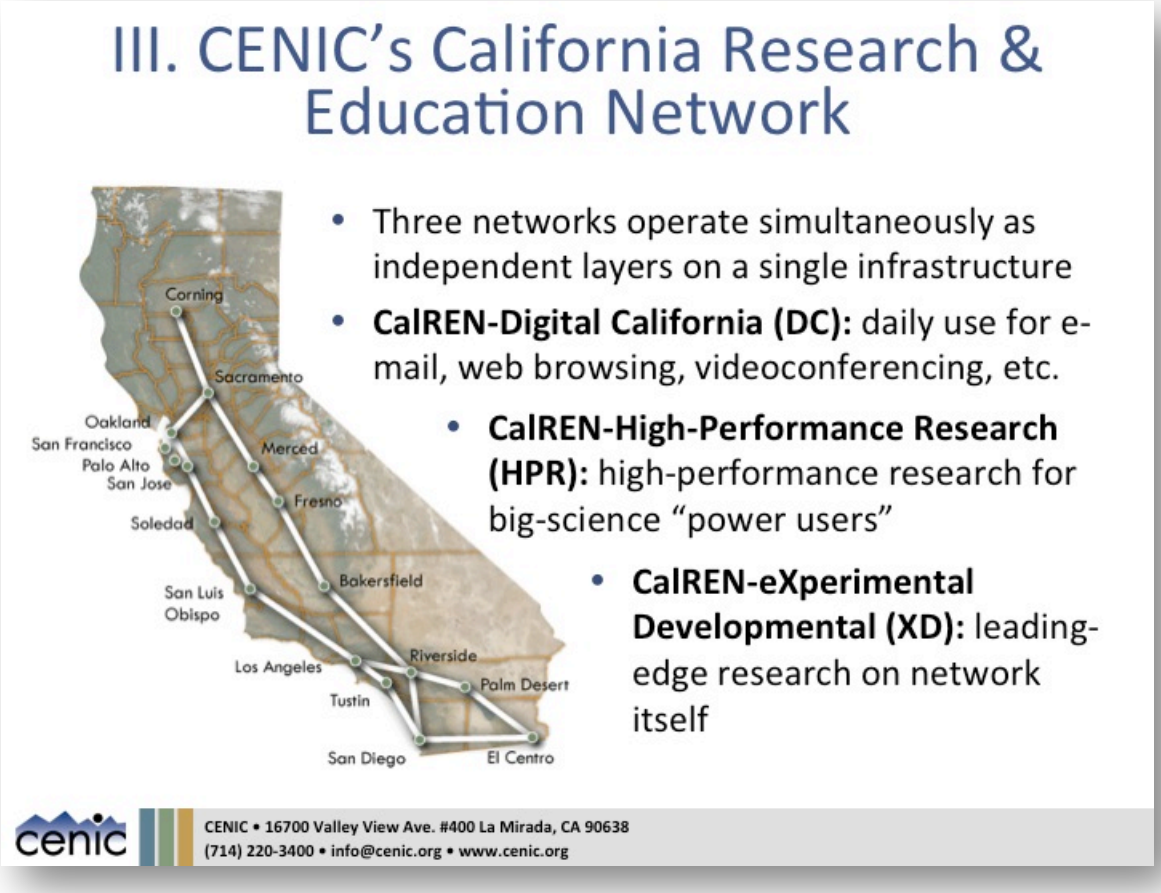
CENIC operates three network tiers that offer opportunities for public libraries in California to connect to the Internet for a range of services as described in Figure #.

- The CalREN-Digital California network provides commodity level broadband Internet services. It is ideal to provide public libraries with such everyday uses as e-mail, web browsing, video-conferencing, and access to cloud services. Two public library systems are now connected to this network. The Peninsula Library System connects to this network tier through the Sunnyvale Regional Interconnection Network. The San Francisco Public Library System connects to this network tier through the San Francisco Regional Interconnection Network. Plans underway to connect additional public libraries to this network.

- The CalREN-High Performance Research Network provides leading edge network services for research for science and power users. This network tier offers high-speed access to Internet 2.
- The CalREN-eXperimental Development Network provides a network environment to conduct basic research on network infrastructure and applications. It also supports research on very large-scale data with high levels of computation and supercomputing. The network serves the San Diego Supercomputer Center, the University of California Institutes for Science and Innovation, the Center for Advanced Computing Research at Caltech and its Jet Propulsion Laboratory, the University of Southern California and its Information Sciences Institute, Stanford University and the Stanford Linear Accelerator Center, national laboratories and

other major network research entities that collaborate with these researchers in California.

Figure 2 - CENIC's Network Layers



CENIC has initiated a plan to connect public libraries to the CENIC network. At the first Inclusive Gigabit Library continuing education session at the California Library Association conference in November 2012, Louis Fox, CEO of CENIC, announced that CENIC began plans to expand CalREN to connect to public library systems across California. Louis also provided an update during his May 2014 SHLB keynote presentation. CENIC has now proposed LibraryNet to bring together California's public libraries as CENIC members.

To accomplish this, CENIC is addressing several challenges.

First, CENIC is working on organizational changes to add public libraries as a Charter Associate. CENIC's vision is that the public will benefit greatly by adding public libraries to the R&E networks with the other educational institutions. This will ensure that "libraries [have] the capability to collaborate more seamlessly with one another as well as draw on content, expertise, and opportunities from schools, colleges, and universities, extending these capabilities to individual libraries and library patrons statewide and thereby enhancing access to information, research, and credit/non-credit distance learning".

Second, CENIC worked with the California State Library and statewide stakeholders to determine the broadband needs and availability to public libraries through a comprehensive research study. The report is entitled, "High-Speed Broadband in California Public Libraries: An Initiative of the California State Library."[xxxviii] The State Librarian conducted a needs assessment and spending plan to connect local public libraries to a statewide high-speed Internet network. The report evaluated the current level of Internet connectivity and expenditures, identified the network with requirements of public libraries to connect to the Internet and estimated the costs of connectivity options.[xxxix]

Third, CENIC connected 4 library systems using different strategies to demonstrate the feasibility of its initiative. CENIC reports that "current efforts have concentrated on the Peninsula Library System, the San Joaquin Valley Library System, and the San Francisco Public Library, as well as libraries in California's Central Valley as part of the Central Valley Next Generation Broadband Infrastructure Project. However, the ultimate aim of the California State Library and CENIC is broadband connectivity for all libraries within the state of California".[xl]

- Peninsula Library System:
    - The Peninsula Library System (PLS) is a consortium of 35 public and community college libraries working together to provide innovative and cost-effective service to their users and is partnering with CENIC. Founded in 1971, the system is funded primarily by member libraries. PLS also receives support from the state California Library Services Act funds, federal Library

Services and Technology Act and local contracts for special services. PLS operates a reference backup service for member libraries. Currently, ten libraries are serving as demonstration projects and developing state-of-the-art services over the gigabit network. Thanks to PLS leadership and the cooperation of its members, residents of San Mateo County can borrow and return books at any local library. They can search a joint catalog of member library holdings and use other library services by logging on to www.plsinfo.org. One pilot site is the San Mateo County Public Library (SMCPL) Belmont branch. The library offers wireless Internet that enables customers to use devices such as iPads and laptops, and download e-books. The staff is migrating to cloud services using Google Sites, which will help with storage and archiving documents. In Summer 2014, SMCPL will use funds to expand its STEM initiative using technology such as 3D printers that can now be supported with the gigabit connection. A Community Information Project (CIP) works closely with county human service agencies to collect and organize information about their work. A directory of community services compiled by CIP can be found on the Web site." Now that they are on CENIC, Peninsula Library System is *paying less for 1 Gbps than they were for 5Mbps*

- Central Valley Next Generation Broadband Infrastructure Project
    - The Broadband Technology Opportunities Program awarded the Central Valley Independent Network (CVIN) and its partner, CENIC, $46.6 million to build a 1,129-mile fiber backbone network through 18 counties in California's Central Valley. Through this project, CVIN/CENIC connected 158 public libraries among 6,293 community anchor institutions. Through this network, the public libraries increased its broadband speeds from an average of 10 Mbps to 1 Gbps. [xli]

Fourth, CENIC, worked with policy makers who established budget and policy mandates to support expanding broadband access at public libraries statewide. California passed budget legislation through the Budget Act of 2014, SB 852 to provide new funding to enact Governor Brown's plan to connect public libraries to the CENIC network and to provide funding for the California Library Services Act and the state literacy program. The legislation provides:

> "High-Speed Internet Access – the Budget includes $3.3 million General Fund to provide public libraries access to high-speed Internet to better meet the demands of today's library patrons. This includes $2.3 million to allow California's public library branches to access a statewide, high-speed Internet network, and $1 million General

Fund on a one-time basis for grants to public libraries that require equipment upgrades to connect to a high-speed network."[xlii]

V. Chattanooga Public Library

"Our mission is to be the community's catalyst for lifelong learning."
–Chattanooga Public Library

Photo Credit: CPL Flickr

The story of Chattanooga Public Library reads like a novel:

A community, equipped with a budding confidence in its own fortitude, takes on the daunting task of transforming its "fixer-upper" library. Armed with high speed broadband as a game changer, with a solidified commitment to civic support, Chattanooga not only transforms its "space for the curious", but also inspires an international imprint for libraries and beyond.

A new gigabit network and a new executive director have enabled the Chattanooga Public Library (CPL) to transform into a community hub for learning, technology and creation. Chattanooga, known as the "Gig City", was the first city in the U.S. to provide Internet at 1 gigabit per second. The fiber network provides speeds that are 200 times faster than the current national average, and 10 times faster than the FCC's National Broadband Plan. The municipal broadband network has become invaluable for the library and other community anchor institutions to serve the public. Private industry is also contributing to economic growth in Chattanooga, with Volkswagen and Amazon building divisions in the city.

While the advances associated by the network has transformed the library into a national and internationally recognized institution of reinvention, Executive Director Corinne Hill concedes that, "transition is really messy and it's really hard and it doesn't feel good all the time. It's really easy, when you're in the throes of it and people start to push back, to say, "Oh, we're on the wrong track," and you back out and you never transition. To me that's worse. I think you have to push through, you have to lean into it, you've got to go with it." "My job here as the director, has been to take this neglected library and turn it into a 21st-century facility", shares Hill. "Having the access to high-speed broadband is, to me, a

complete game-changer. It's a complete game-changer for libraries, it's a complete game-changer for communities."

When Corinne Hill became executive director of the Chattanooga Public Library, one of her first initiatives was getting fiber built to the library and connecting the facility to the gigabit network. The city paid for building fiber to the building and setting up the connection at a cost of approximately $26,000. The library receives Internet access through a contract with EPB Fiber Optics. Through this arrangement, the library pays approximately half the cost of its previous Internet service. The Chattanooga Public Library has used these cost savings to invest in up-to-date devices and computers for patrons to access the gigabit network.

Chattanooga's gigabit fiber network is a municipal utility network operated by EPB. EPB has been distributing electric power to customers through the Chattanooga-Hamilton County area for 80 years. Although EPB was constrained by rules as a publicly financed institution, it decided to attach fiber to every meter in an effort to develop a smart-grid to improve and provide increased, more efficient services to customers. The smart-grid is a next-generation energy distribution system enabling EP to provide two-way communication with its customers resulting in data that is received in real time resulting in shorter electricity outages. The smart-grid has resulted in greater quality customer service and improved reliability. A gigabit connection became available in August 2010, although more businesses rather than residences subscribe to a 1 gigabit connection. The fiber network covers 600 square miles and provides access to over 150,000 homes and businesses.

> *"The way we see this, this whole project, we see it as a springboard for this community. We wanted to give this community really a tool, a platform for doing things that other communities might not have the platform to do. In the very beginning, before we borrowed the money, before we went out and started building anything, we had dozens if not hundreds of community meetings, and what we did in those community meetings is we told people what we were planning to do, and we asked them to let us know if they thought it was a good idea and let us know if they thought it was a bad idea. We almost wanted to know if they thought it was a bad idea more than if they thought it was a good idea, because we certainly didn't want to do all this and then have our community not be happy with it. And so what we did is we asked these folks that we spoke with to call city council, to call our board and to let them know what they thought. And it's not scientific, but if you look at some newspaper polls and things like that, you can say about 80% of the folks said, "Yeah, yeah, yeah, go do it."*
>
> –Danna Bailey, Vice President of Corporate Communications, EPB

In her two years in Chattanooga, Corinne Hill has received national and international recognition for the reinvention of CPL. In 2014 Hill received the Librarian of the Year award from Library Journal for leading the high-tech transformation of the library. She has also been elected to serve on the Governing Board's Standing Committee for the International Federation of Library Associations (IFLA) and travels internationally on their behalf as a representative for the promotion and development of libraries.

Hill and her staff have implemented strategies for developing digital services over CPL's gigabit network that focuses on beta testing, experimentation, and input from the public that drive customer visits.

Figure 3 - Application Hackday Event at the Chattanooga Public Library

Photo Credit: CPL Flickr

One example is the transformation of the library's internationally recognized 4th Floor of innovation. A key focus for transformation at CPL has been to identify what customer services should be stopped, which ones should be upgraded, and what new services should be added. CPL promotes beta testing on its 4th Floor to identify what new digital services are working. Corinne believes that the beta testing model provides time for adequate transition to new services from the old so that all services are not changed at once. The staff is critical for providing suggestions for services, such as offering 3D printing and laser cutters, that are tested in a public space to determine its feasibility as a service the library should provide. This model also enables the public to participate by using the technology that is being tested and discussing ways of improvement with the staff, whether it is the technology itself or where it is physically located on the 4th Floor that influences how the public uses it. This strategy provides continuity and balance for service provision and for the staff who are responsible for implementing new ideas.

Hill works with staff to identify diverse ways to experiment with the newest technology offered, and being connected to the gig network makes this possible. Experimentation is important and does not have to be conducted on a grand scale. Hill promotes a "fail fast, fail cheap" philosophy among staff. If projects that are

minimally funded do not work within a designated time established by administration, the library does not implement the service because it is a sign that it will not achieve sustainable services, serve customers well, or be cost-effective. Hill recommends that services should be implemented as a result of adequate research, testing, and customer input.

In addition, Corinne suggests that libraries implement services that are value driven**.** Services that are adopted must be larger rather than adopting the newest hyped technology for library services that may potentially die because of a lack of customer use. For example, the 4th Floor was not created to be used solely as a maker space; it accommodates this service in addition to 3D printers, laser cutters, lounge space for customers to collaborate, and event space for technology demonstrations and workshops. The space on the 4th Floor is multi-purposed and can continue to evolve according to what the public needs to promote testing and innovations that target economic development in manufacturing, product development using 3D computers, and training. This dual-pronged strategy is what makes the 4th Floor successful.

> *"The point of the 4th floor is to really disengage from some of the traditional transactional things that happen in libraries, and offer access to bandwidth and offer access to tools so that a lot of the knowledge exchange is happening person-to-person, and sometimes it's people connecting to other people via machines. Just providing the sort of open learning experience for folks so that they can self-guide their way through, but so that they also can feel safe and feel like somebody else might help them if they come up with an interesting problem that they want to try to solve."*
>
> *"It's a space for the curious, right? Which the library has always been, but we're in a time now that, thanks to the Internet, which we're all lovers of, we can really focus on people producing content, sharing content and remixing content and working with things in just a different way than we ever did before."*
>
> –Nate Hill, Assistant Director, Chattanooga Public Library

The value of the gigabit network connection to CPL lies in the development of innovative services and digital applications that serve Chattanooga citizens. The library has reinvented itself by transforming a traditional customer service model into a space for collaboration. Librarians aren't stationed behind a reference desk, but are interacting with users at multiple points of service. The space and technology available for customers to collaborate in on the 4th Floor is a key example of this

model. The overhaul included a change in internal processes to generate greater efficiency and investment in technology.

CPL assistant director Nate Hill has led the vision for the 4th Floor, a public laboratory and educational facility with a focus on information, design, technology, and the applied arts. The 4th Floor is a combination of a hacker space, maker space, and event space. The 4th Floor it is also noted for being a civic laboratory where people meet to share new ideas, develop and co-invent new innovations, and be free to produce knowledge.

The 4th Floor was opened to the public after a Maker Day event hosted with The Company Lab (CO.LAB) in March 2013 that focused on showcasing 3D printing that drew approximately 1,200 people, the largest crowd the library has ever experienced. The event was the turning point for the Library's 4th Floor. After the success of Maker Day, library administration and staff decided to hold public hours on the 4th Floor.

Before its reinvention, the space was a 14,000-square-foot attic that was a storage facility for archives, art, and furniture that was not being used in the library. A large section of the 4th Floor is dedicated to open space with comfortable large chairs, couches, and tables where people can meet to work together and use state-of-the-art technology such as 3D printers and laser cutters. The open space creates the environment for learning, engagement, and development and customers utilizing the 4th Floor create entrepreneurial opportunities with access to equipment and resources.

Change on the 4th Floor is evolutionary. A key driver for the success of CPL's 4th Floor is its treatment as an ecosystem, a philosophy promoted by Nate and Corinne to effect continual change of services, space, and technology made available to the public.

An ecosystem is a community of living and non-living elements in the environment. In this context, the library is interconnected with community organizations, resources, and technology in which it lives, produces, and survives. What is most important about the 4th Floor is that technology innovations are predicated on the strength of relationships and resources shared between organizations. Consensus is built around innovation and understanding the ways in which practices, creativity, and knowledge sharing are developed between connected organizations. For example, technology organizations in the community such as CO.LAB handle the library's 4th Floor as a tech start–up often providing resources such as training and sharing ideas at no cost.

The systematic evaluation of the 4th Floor is a strategy used by library administration and staff led by Nate that enables the space and technology to evolve in sync with new technologies released by corporations and vendors, collaborative projects with community organizations, and evaluation of digital services used by other libraries. The 4th Floor's success is a network of customers, entrepreneurs, collaborators, and stakeholders can come to create synergies around ideas, test ideas, and learn through co-creation using technologies on the 4th Floor.

Figure 4 - 4th Floor at Chattanooga Public Library

"Libraries in transition, especially, are sort of making the place. It's not collaboration in the traditional sense. It's about tearing down siloes and people from different backgrounds to start working together. It's where citizenry engage with knowledge and information, [and] sometimes with social services too. It's a place where someone can get online and learn about something they need. Someone that is at a disadvantage and doesn't have access to not only broadband [or] a computer in general. Anytime you're making those connection points, that's a place that magic can happen."
-Jeff Cannon, Chief Operating Officer & Innovation Officer, City of Chattanooga

Collaboration between CPL and its partners have been important for developing digital services and creating interest about new technologies and the area of information science to the community. CPL's collaborators include incubators, associations, businesses, foundations, the mayor's office, technology developers and designers, computer programmers, entrepreneurs, and investors.

Partners such as the City of Chattanooga, The Company Lab (CO.LAB), and Engage 3D, a unit of the Lamp Post Group, work with the library to develop digital solutions and services. Communication, resources, and knowledge sharing comprise the collaborative relationships between the Chattanooga Public Library and its partners. Innovations are often dependent upon co-invention that takes place in networks in Chattanooga where CPL and its partners connect to other organizations, share resources such as teaching technology classes, and create knowledge. The influence, construction, and redesign of ideas and technologies take place within these networks.

In one of its newest ventures, CPL is collaborating with the City of Chattanooga under the leadership of Mayor Andy Berke and the Benwood Foundation to develop an open data portal known as the Open Chattanooga Data Portal that will serve as a model for other cities. The library also received a Knight Foundation Community Information Grant to help develop the application. The project is the creation of an open data portal to be hosted by the library that will reform data across government in Chattanooga and decrease the need for creating PDFs and documents that are often in file cabinets.

The development of the project was based on participation from community residents who provided recommendations on the types of data that needed to be opened up and composition of the open data policy. The library's data specialists are working on this project in collaboration with Code for America Fellows that are interning in the Mayor's Office. The applications that result from this project will ping the library. The library was a place in the past where customers could access government documents in different formats, and now customers can access government documents as a development platform. Customers will have access to large amounts of data outside of the library made available on a large data server.

Led by the youth services librarian on the 2nd Floor, CPL collaborated with Engage 3D, AIGA, developers, and designers to put on its first ever youth coding camp, Dev Dev, the summer of 2013. Fifty youth learned HTML, CSS, Python, and robotics programming. In another collaboration the summer of 2013, the 4th Floor was used to host CO.LAB's GIGTANK Demo Day. GIGTANK is the world's only accelerator connected to a metro-wide fiber network enabling business entrepreneurs to test and launch ideas on the Chattanooga gigabit network. During Demo Day, startups presented next-generation ideas to an audience of businesses, angel investors, partners, and community leaders. Engage 3D took part in the event by hosting a transcontinental duet between two musicians that incorporated visual art, dance, and technology by the Theater Center in Chattanooga and the Annenberg Innovation Lab at the University of Southern California in Los Angeles, California. A connection from the library to these organizations was made possible by EPB.

A gigabit connection has provided a platform to use next-generation technology, open source, and donated applications that increase the services and digital tools available to the public. Library staff conducts as much open source work as possible to provide a platform for customers to co-invent. In addition, providing a platform that is developed with the same technologies used by CPL partners and collaborators is important and increases use of the system. CPL does not manage the gigabit network; however, staff manages the application layer and works with the City of Chattanooga's IT department concerning any other technical issues with the network. Managing the application layer of the network is a benefit for the library as it enables staff to fine-tune and develop other next generation applications.

Partnering with vendors is another important aspect of reinventing CPL. The library is working with Aerohive, a vendor that provided a demo to set up wireless connectivity at all four library locations, which was beta tested on the 4th Floor. Vendors are an important source of resources through which the library obtains technology donations to save money. The library will be testing new access points that use the new standard that was developed by staff in collaboration with the vendor to provide higher levels of wireless bandwidth that can accommodate multiple devices. The wireless is state-of-the art, and the access points adjust to the movement of people from one space to another on the 4th Floor. The wireless load balances, which are convenient when larger numbers of customers, are using the system. The wireless system includes a console that enables staff to customize the wireless service. After the beta testing was completed, library administration made decision to purchase and implement the service at all of its locations.

The hiring of staff with expertise and adequate skills and reclassification of existing staff positions has been important for accomplishing not only the goals of the 4th Floor but for reinventing the library, implementing customer-driven services, and transforming library services. Corinne's vision included recruiting library staff with cutting edge experience with innovative library services. She hired people who were knowledgeable and experts in their area. For example, Corinne recruited Nate Hill from the San Jose Public Library. Nate's background and experience includes web development and the arts. This background was essential in the redevelopment of the space on the 4th Floor. His expertise has been conducive for developing relationships with tech organizations because he can speak the common language and expertise.

New job positions titled "Smart People" were created for additional staff hired to work twenty hours per week. Smart People assist the digital services team on the 4th Floor. The staff on the 1st floor of the library by helping customers when staff are working on other tasks.

A digital services team of tech and data specialists with computer science and GIS backgrounds was also created. This team consists of a web developer, a social media strategist, a statistics person, and an ILS/maker. This creates a cohesive unit of members with different areas of specializations who can provide assistance to customers across diverse services.

> *"I really spend a lot of time making sure the staff gets what they need to do what they want to do. For me it's been a lot about giving up control so that they can make decisions and be accountable for what does and doesn't happen."* –Corinne Hill

Employees' skills and assets are valued at CPL. The library management structure is not characterized by a top-down model, but rather a dual model that reflects input from the bottom-up with important contributions and suggestions from staff. Corinne's role is to facilitate transformation while allowing library staff to recommend and lead change in departments across the organization, which aligns with their areas of expertise, competencies, and specializations. The staff are responsible for solving problems in their departments, and are given the flexibility and autonomy to get work done while maintaining ownership over their work.

To allow staff to have full control over their jobs takes trust, which is an element Corinne has instituted in the organization. For example, the digital services staff approached Corinne with a staffing model to relocate their offices to the 4th Floor to be physically available to assist customers. The recommendation worked and the staff helps customers from answering simple questions to showing them how to use the technology such as the 3D computers. In addition, Corinne developed a mobile service-delivery model similar to the Apple store retail market concept that she had implemented in the Dallas Public Library and also wanted to implement at CPL. She believes that the point of service is the best method for assisting customers. The staff is now mobile and do not have desk schedules but they work seamlessly on the 4th Floor as a team providing services to assist customers. However, when the staff needs to work on special projects and need the quiet space, they have the flexibility to work in their offices.

VI. Cuyahoga County Public Library

"At Cuyahoga County Public Library we are committed to our mission of being at the center of community life by creating an environment where reading, lifelong learning and civic engagement thrive."

Photo Source: Cuyahoga County Public Library

In 2013, the Cuyahoga County Public Library (CCPL) upgraded their broadband connection. One branch, Warrensville Heights, has a full gigabit through OneCommunity. All CCPL branches larger than 10,000 square feet will have a full synchronous gigabit late summer of 2014 from AT&T via OARnet. They currently have 600Mbps.

Prior to the 2013 upgrade, CCPL had a 10Mbps connection into their Administration Building, which served all 28 branches. In 2012, CCPL completed a new building for the Warrensville Heights Branch. The Warrensville Heights Branch was the first construction project of CCPL's capital campaign. The new construction created an opportunity to ensure the branch building's network infrastructure could sufficiently handle the increased bandwidth. CCPL knew the following factors would require additional bandwidth in the new building:

- Increased size of the building from 14,215 to 27,500 square feet.
- Increased public access computers 18 to 59.
- The branch is located in a low-income neighborhood (median income of $35,926) resulting in substantial use of the public access computers and the wireless Internet access.

The construction of the new Warrensville Heights branch coincided with OneCommunity's infrastructure grant from the Broadband Technology Opportunity Program. The grant helped cover the cost of deploying fiber to the Warrensville Heights branch. The one-gigabit

connection ensures no blackouts, no restrictions on the network and the potential to innovate to meet the needs of the community. As a nonprofit open broadband network provider OneCommunity is rare.

CCPL is responsible for the broadband service cost to their branches. The cost for one gigabit from OneCommunity to Warrensville Heights is $1375 per month.

The next step was to get a gigabit connection into the other branches. They needed a gigabit connection into the Administration Building, internal infrastructure to manage the connection and redistribute to the branches, and the network connections to the branches that could handle the redistribution. With their e-rate contract ending in 2013, they knew the timing was right. OPLIN (Ohio Public Library Information Network) secured a gigabit connection from AT&T to CCPL's Administration Building. AT&T was chosen because they were able to provide the connection for the lowest cost. OPLIN's mission is to provide broadband connections and related information services to Ohio's public libraries. As a state funded agency, OPLIN can utilize the state of Ohio's contracts with telecommunications providers.

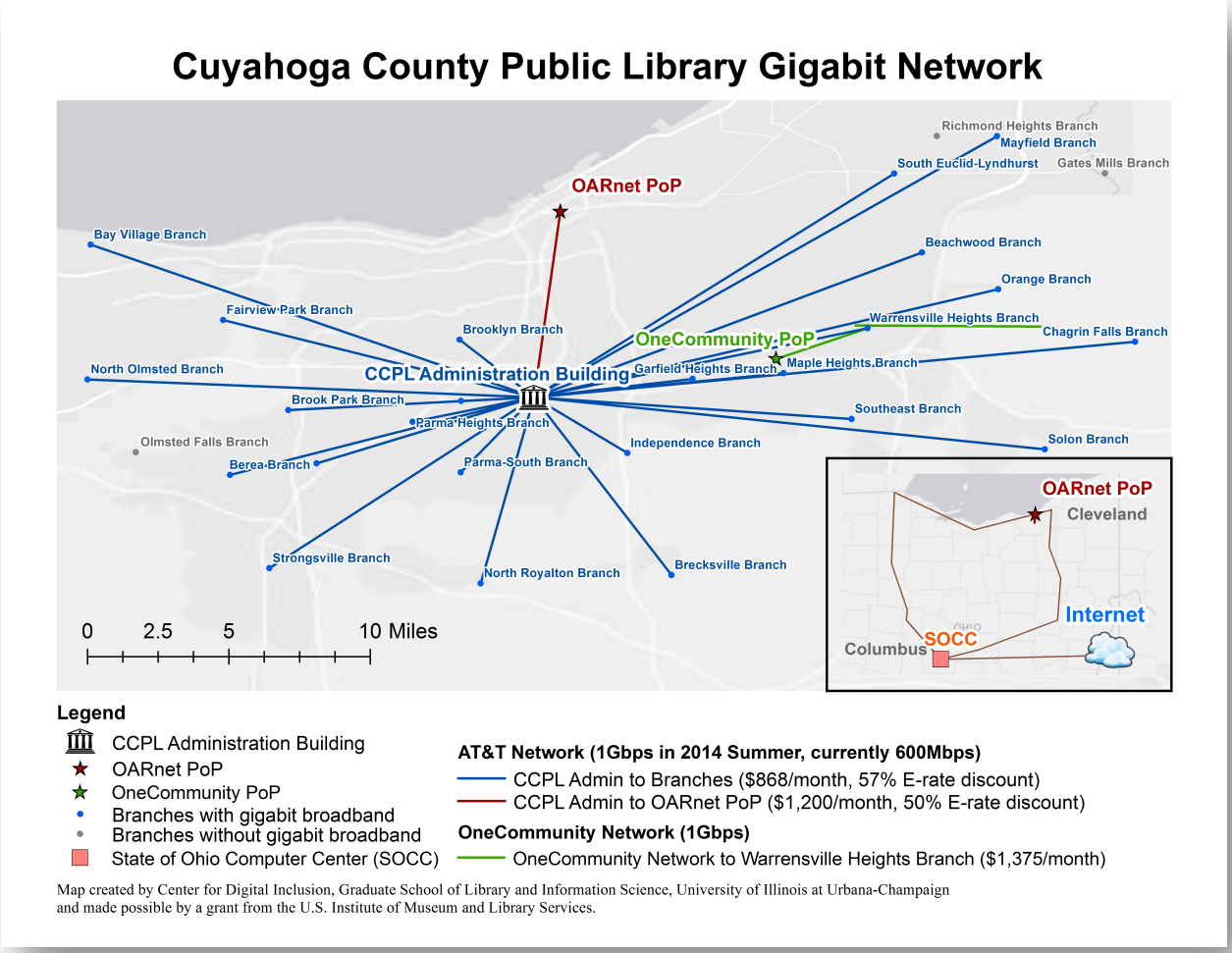
The State of Ohio covers the cost of the service between CCPL and the State of Ohio Computer Center (SOCC) at $1200 per month. This includes a 50% E-rate discount. The State also covers the cost of the service between the SOCC and the Internet at approximately $271.50 per month. This service is not E-rate eligible.

For the connections between the Administration Building and the branches, CCPL created an RFP, received proposals from OneCommunity and AT&T, and chose AT&T because their proposed cost was significantly lower. The AT&T bid was lower due to AT&T's existing local infrastructure. The library also made an investment in a 10 Gbps interface for the Administration Building and data center, which allows them to push connectivity at 1 Gbps to the branches.

New network switches at each branch are included in the monthly contract with AT&T. CCPL averages a system-wide e-rate discount of 57 percent, which amounted to $140,000 in 2012. CCPL staff worked with a consultant to complete their e-rate application. While they found the process cumbersome, they believe that by using the e-rate process, the library was able to negotiate a better rate for connectivity.

CCPL pays AT&T $868 per month per branch for the service between the Administration Building and the branches. They are receiving a 57% E-rate discount.

Figure 5 - Map of Cuyahoga County Public Library Network



Prior to their increased bandwidth, the Internet usage at multiple branches was so high that CCPL had to manage access, including targeting ideal times for programming to take place and reducing public bandwidth access during high usage. Now, network slowdowns are a headache of the past. Most of CCPL's 509 public access computers are in continual use, the library is looking to its gigabit connection to reduce costs by switching its phone service to Voice over IP (VoIP) and they are experimenting with new services. CCPL also has begun to promote access to the gigabit as a service itself.

Rebecca Ranallo, CCPL Information and Technology Literacy Manager has strategically chosen to focus on what she calls their foundation services, that is meeting the information

and technology access needs of their customers. CCPL recognizes many of their "customers" (their terminology) come to the library for the Internet access.

According to Ranallo, "I'm not sure that our customers recognize that there are a lot more people bringing in their devices and the bandwidth is still good. Our gig is what makes that possible." The high speed broadband is necessary to keep up with the increasing bandwidth needs of CCPL's customers. Prior to the upgrade, library staff had to stagger classes and programs to avoid maxing out the connections.

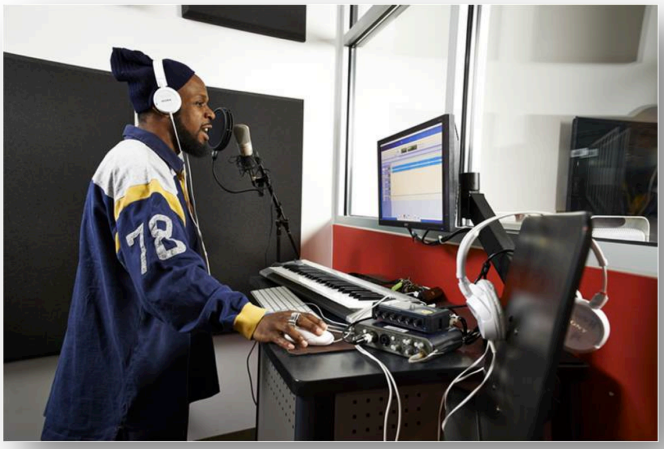


Figure 6 - Digital Music Production Studio at Warrensville Branch Library

New service offerings include the Warrensville Branch recording studio where users of the booth can easily download, upload and edit video and audio files. Multiple branches offer robotics and game design programs for youth. CCPL is experimenting with using video conferencing for informal and formal education between branches and with community partners.

CCPL Director Sari Feldman sees high-speed broadband and a skilled staff as the essential resources necessary to accomplish the library's mission. CCPL's mission is to be at the center of community life by providing an environment where reading, life-long learning and civic engagement thrive. In practical terms, this means being able to meet the continually increasing public access bandwidth needs while also creating new informal learning services and spaces. According to Feldman, the new services could only be implemented with increased broadband, internal infrastructure and staff buy-in.

The staff is encouraged to suggest new programming and form new partnerships. Branch directors attend city council meetings, school board meetings and Chamber of Commerce events. Matching this culture of local engagement with a hefty dose of bandwidth is bringing technology innovation aligned to community needs.

In 2006 Sari Feldman created the position of Internet and Media Services Manager and recruited Ranallo to fill the position. Ranallo had been the Technology & Information Literacy Initiative Librarian at Cuyahoga Community College. In 2013, Ranallo's title was changed to Information and Technology Literacy Manager. Her responsibilities include:

- Developing a continuum of library technology programming that serves our customers from birth through seniors.
- Managing a team of trainers and specialists who work with staff and customers to promote technology.
- Overseeing the rollout and evaluation of new pilot technology programs.
- Facilitating and implementing piloted technology programs system-wide.
- Developing partnerships with local organizations to utilize our gigabit connection.
- Engaging community expertise in the STEAM fields and partnering for library programming.
- Representing Cuyahoga County Public Library and promoting the system's role as a regional technology innovator.

VII. Conclusion

Libraries remain fundamental information institutions in the United States. More and more, libraries depend on robust broadband connectivity paired with innovative organizational processes to provide the essential services that meet the needs of diverse communities. Unfortunately, these increased expectations are often not paired with increased resources. Library leaders must keep up with fast-paced technological change while constantly reimagining the library as a 21st Century institution with cutting-edge services and resources. Simultaneously, a majority of libraries report insufficient bandwidth to meet the needs of citizens and the need for higher speeds will only continue to grow.

As libraries develop strategies to leverage Internet-enabled services, libraries and its stakeholders need to be able to test and evaluate the options and also to access possible applications easily. Developing applications is expensive and risky and libraries have very limited budgets and resources. Application developers need a place to test the applications with real users in real-world conditions.

Thankfully, national initiatives such as US Ignite have been established around the research and development of next-generation networks and applications. Twenty-five cities and 15 commercial entities are US Ignite members. It is crucial that libraries are included as leaders and recognized as stakeholders in this discussion.

To address this need, we offered a series of 10 nation-wide continuing education forums with more than 1,500 library leaders to discuss the future of the Internet. We partnered formally with the Office of Information Technology Policy at the American Library Association and US Ignite. The goal of these forums was to develop ideas and strategies to implement next-generation applications to meet the real-world, daily needs of the public. In addition, library leaders need to understand how best to implement and manage high-speed broadband networks. Our discussions focused on a central question: "How can libraries, as community anchor institutions, leverage these networks and applications to benefit the communities they serve?"

Forums also highlighted the case studies included in this report from libraries currently engaged in innovative partnerships to offer patrons the latest and greatest next-generation resources. For example, the Cuyahoga County Public Library system is partnering with Case Western Reserve University and One Community to bring one-gigabit broadband connection to its Warrensville Height library branch. The Chattanooga Public Library is leveraging high-speed connections to transform the library into spaces where citizens can discover and learn how to produce knowledge in new ways. The Rutgers University

Library has developed the first library-focused application, the Video Mosaic Collaborative.

At each forum, library leaders also recognized a need to understand how to best to implement and manage high-speed broadband networks. Another key "behind the scenes" best practice identified in the forums and case study involves organizational culture and change. Library leaders involved with next-generation networks share a common trait of welcoming and easily adapting to change. This leadership style has resulted in a transformation of services and state-of-the art facilities in Chattanooga and elsewhere.

The knowledge, discussions, case studies, and reports gathered throughout the *Inclusive Gigabit Libraries* project have the potential to serve as a guide for any library with next-generation goals. As more library leaders express desire to offer innovative services and partnerships, the work documented in this report becomes increasingly valuable. This report serves as a first-step in documenting current collaborations and best practices, as technology and library systems advances.

Appendix I – Advisory Team

We assembled an outstanding team of advisors:

- Will Barkis, Mozilla Foundation
- Larra Clark, American Library Association (ALA)
- Corinne Hill, Chattanooga Public Library
- Joanne Hovis, CTC
- Nicole Levine, U.S. Ignite
- John Windhausen, SHLB
- Gwenn Weaver, Department of Commerce, NTIA
- Fen Zhao, AAAS Science and Technology Policy Fellow

Appendix II – Project Team Staff and Research Assistants

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Helen Jentzen	Aiko Takazawa
Abraham McClurg	LaTesha Velez
LaEisha Meaderds	Melissa Villa-Nicholas
Kinyetta Nance	Martin Wolske
Colin Rhinesmith	

Appendix III – Summary of Forums

We held 10 forums across the United States. From our registration log and attendance counts, we estimated that 1468 library leaders and stakeholders participated in the forums. For each forum, we invited local library leaders and community stakeholders from the region to participate in the forum. Some of the forums were held as pre-conference workshops at conference meetings. This strategy enhanced the relevance of the forum for the local and regional issues facing libraries. For example, the forum at the California Library Association Conference drew an audience that our partners helped to invite that included CENIC launching its initiative to connect libraries to the California Research and Education Network. Other invited guests were state library officials, governor office representatives, along with local government leaders and library leaders. We customized the forum to talk about the issues in California. Based on this experience we replicated this in the forum in Seattle at the ALISE conference, and in Dallas/Ft. Worth at the iConference. The Washington DC forum at SHLB focused on bringing together local leaders from around the country to interact in the forum with national leaders.

Date	Location	Event
11/2/12	San Jose, CA	California ALA
1/20/13	Seattle	ALISE
2/12/13	Ft. Worth	iSchools Conference
3/26/13	Virtual	COSLA
4/16/13	Dallas	Broadband Communities
5/1/13	Washington DC	SHLB
6/25/13	Chicago	US Ignite Conference
6/30/13	Chicago	ALA Conference
7/27/13	Champaign	Champaign Public Library/Mortenson Center
10/3/13	Champaign	Carnegie Exchange with University of Pretoria

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