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Building the Broadband Future: The Communications Needs of Kansas Schools, Libraries, and Hospitals

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TABLE OF CONTENTS

1 EXECUTIVE SUMMARY 1

1.1 Background 2

1.2 Findings 3

2 RESEARCH PROCESS 6

3 RESEARCH FINDINGS 8

4 KAN-ED ACHIEVED IMPORTANT RESULTS FOR KANSAS SCHOOLS, LIBRARIES, AND HOSPITALS 22

4.1 Kan-ed Provided a Basic Level of Broadband to Schools, Libraries, and Hospitals Statewide, Regardless of Size or Remoteness 22

4.2 Kan-ed Provided High-Quality Services, Optimized for Schools, Libraries, and Hospitals 23

4.3 Kan-ed Aggregated Public Buying Power to Reduce Costs and Normalize Rates Across the State for Rural, Suburban, and Urban Institutions 24

4.4 Kan-ed Circuit Pricing Was Reasonable Relative to Alternatives 25

4.5 The Kan-ed Model Did Not Keep Pace with Technological Change; Migration to Higher Bandwidth Options Is Necessary to Meet the Needs of Kansas Schools, Libraries, and Hospitals 27

5 EMERGING MODELS IN OTHER STATES FOCUS ON FIBER OPTICS AND VERY HIGH BANDWIDTH TO SCHOOLS, LIBRARIES, AND HOSPITALS, IN PARTNERSHIP WITH PRIVATE COMPANIES 29

5.1 Utah 29

5.2 Ohio 30

5.3 North Carolina 31

5.4 Colorado 33

5.5 Georgia 34

5.6 Nebraska 34

5.7 Oklahoma 35

5.8 Missouri 36

6 THE NEED FOR BANDWIDTH BY SCHOOLS, LIBRARIES, AND HOSPITALS IS GROWING DRAMATICALLY NATIONWIDE 38

6.1 Kansas Schools, Libraries, and Hospitals Indicate Fast-Growing Needs for High-Bandwidth Services........ 39

6.2 High Bandwidth Needs in Education 44

6.3 High Bandwidth Needs Among Libraries 55

6.4 High Bandwidth Needs Among Hospitals 58

7 KANSAS SCHOOLS, LIBRARIES, AND HOSPITALS NEED BROADBAND PROCUREMENT SUPPORT 67

7.1 Kan-ed Provided a Range of Broadband Support 67

7.2 Kansas Schools, Libraries, and Hospitals Indicate an Interest in Receiving Broadband Support 67

7.3 Kansas Can Support Broadband Procurement for Schools, Libraries, and Hospitals 69

8 KANSAS CAN ENABLE MIGRATION TO WORLD-CLASS INTERNET SERVICE BY FACILITATING DIGITAL ROADS 74

8.1 Digital State Highways in the “Middle Mile” Stimulate Private Investment 74

8.2 Constructing Digital State Highways Is Efficient 76

8.3 Coordinating Digital State Highway Construction with Other Utility Projects Reduces Costs 79

8.4 Case Study: Arizona Builds Digital State Highways to Stimulate Private Investment 80

9 SURVEY DATA SUMMARY 82

9.1 Survey Methodology 82

9.2 Respondents Range in Size and Complexity of Communications Needs 84

9.3 Respondents Connected to, and Indicated Satisfaction with, Kan-ed’s Network 85

9.4 Respondents Have a Range of Existing Internet Services 90

9.5 Respondents Use the Internet for Specific Applications 94

9.6 Respondents Report Concerns About Internet Costs and Connection Speeds 96

9.7 Respondents Are Widely Engaged in Providing Internet Access to Clients, Staff, and the General Public . 103

9.8 Survey Results for the K–12 Education Sector 104

9.9 Survey Results for the Health Care Sector 111

9.10 Survey Results for the Libraries Sector 116

TABLE OF FIGURES

Figure 1: Geographic Location of Survey Respondents 7
Figure 2: Comparative Speeds of Various Technologies....10
Figure 3: Download Speeds for Libraries....17
Figure 4: FCC Comparison of Monthly Cost for Rural Health Care Providers 26
Figure 5: Kan-ed Members That Have Determined Alternative for Replacing Service....39
Figure 6: Alternate Connection to Replace Kan-ed 40
Figure 7: Respondents' Kan-ed Connection Speeds 41
Figure 8: Respondents' Replacement Connection Speeds 42
Figure 9: Sufficiency of Current Internet Connection Speed 43
Figure 10: Networking Upgrades Needed for Online Assessments....46
Figure 11: Broadband Needs for Digital Assessments....47
Figure 12: Public Library Internet Connectivity Speeds (2011–2012) 57
Figure 13: Percentage of Office-Based Physicians with Electronic Medical Records/ Electronic Health Records (2001–2010)....63
Figure 14: Schools' Interest in Broadband Program Support 68
Figure 15: Libraries' Interest in Broadband Program Support....68
Figure 16: Health Care Sector's Interest in Broadband Program Support....69
Figure 17: Schools' Participation in E-Rate Program 70
Figure 18: Libraries' Participation in E-Rate Program....70
Figure 19: Health Care Sector's Participation in FCC Broadband Funding Program....71
Figure 20: Health Care Sector's Participation in Department of Agriculture Broadband Funding Program 72
Figure 21: Middle-Mile and Last-Mile Fiber 74
Figure 22: Underground Conduit Bank for Multiple Users....78
Figure 23: Example Coordinated Conduit Bank and Gas Main Installation 79
Figure 24: Survey Responses by Organization Type 83
Figure 25: Average Number of Employees by Sector 84
Figure 26: Average Number of Computers by Sector....85
Figure 27: Connected to Kan-Ed by Sector 85
Figure 28: Type of Connection to Kan-ed by Sector 86
Figure 29: Kan-ed Connection by Number of Employees....86
Figure 30: Uses of Kan-ed Connection....87
Figure 31: Use of Kan-ed Network Operations Center by Sector 88
Figure 32: Kan-ed Members That Have Determined Alternative for Replacing Service....88
Figure 33: Alternate Connection to Replace Kan-ed 89
Figure 34: Alternate Connection to Replace Kan-ed by Connection Type....89
Figure 35: Price of Replacement Service by Sector 90
Figure 36: Broadband Internet Connections Available....91
Figure 37: Average Monthly Internet Service Cost by Sector....91
Figure 38: Average Monthly Internet Service Cost by Type 92
Figure 39: Organizations with Wide Area Intranet by Sector....92
Figure 40: Location of Internet Purchase Decisions by Sector 93
Figure 41: Frequency of Internet Downtime by Sector 93
Figure 42: Use of the Internet 94
Figure 43: Use of the Internet by Sector 95
Figure 44: Adequacy of Internet Connection Speed by Sector....96
Figure 45: Importance of/Satisfaction with Aspects of Internet Service (Mean) 97
Figure 46: Importance of/ Satisfaction with Aspects of Internet Service (Chart)....98
Figure 47: Gap Between Importance of/ Satisfaction with Aspects of Internet Service 98
Figure 48: Importance of Internet-Based Activities....99

Figure 49: Importance of Internet-Based Activities by Sector....100
Figure 50: Willingness to Pay More for Service....101
Figure 51: Willingness to Pay More for Service (Average)....101
Figure 52: Agreement with Statements About Internet Access....102
Figure 53: Provide Internet Access to Employees, Guests, or General Public by Sector....103
Figure 54: Sufficiency of Internet Connection by Sector....104
Figure 55: Number of Students in School District....104
Figure 56: Schools' Use of Internet Access....105
Figure 57: Schools' Internet Uses by District Size....106
Figure 58: Schools' Participation in E-Rate Program....106
Figure 59: Schools' Interest in Broadband Program Support....107
Figure 60: Adequacy of Schools' Broadband Service....108
Figure 61: Schools' Use of Laptops, Tablets, and Smart Phones....109
Figure 62: Type of School Institution....109
Figure 63: Schools Connected to KanREN....110
Figure 64: Schools' Willingness to Use Tool to Match Distance Learning Instructors with Users....110
Figure 65: Number of Beds in Health Care Facility....111
Figure 66: Type of Health Care Facility....112
Figure 67: Health Care Facility's Participation in Electronic Health Systems....112
Figure 68: Health Care Facility's Use of Internet Connection....113
Figure 69: Health Care Facility's Limitations Due to Internet Service....113
Figure 70: Health Care Sector's Participation in FCC Broadband Funding Program....114
Figure 71: Health Care Sector's Participation in Department of Agriculture Broadband Funding Program....115
Figure 72: Health Care Sector's Interest in Broadband Program Support....116
Figure 73: Number of Library Locations....116
Figure 74: Library Use of Internet Connection....117
Figure 75: Libraries' Most Important Internet Uses....118
Figure 76: Number of Daily Library Patrons Accessing Internet....118
Figure 77: Number of Computer Terminals on Local Library Network....119
Figure 78: Libraries' Participation in E-Rate Program....119
Figure 79: Libraries' Interest in Broadband Program Support....120

TABLE OF TABLES

Table 1: Survey Respondents by Sector....7
Table 2: Bandwidth Requirements to Achieve Full Functionality of Health IT Applications....15
Table 3: Kan-ed Pricing Structure....25
Table 4: Bandwidth Requirements to Achieve Full Functionality of Health IT Applications....38
Table 5: Network Characteristics of Telehealth Applications....65
Table 6: Survey Respondents by Sector....82
Table 7: Uses of Kan-ed Connection by Sector....87
Table 8: Importance of/ Satisfaction with Aspects of Internet Service....97

1 Executive Summary

High-quality, high-bandwidth broadband is essential to the operations of schools, libraries, and hospitals. Libraries use broadband to serve their vital role of providing information access, supporting job searches, and fostering citizen participation. Schools require broadband to enable world-class distance learning, individualized use of computers by students, and centralized, cost-effective administration. And hospitals increasingly rely on broadband to exchange medical records, to communicate to and among rural areas that lack medical personnel, and to share over videoconference—in real time—the expertise of specialized physicians all over the State.

Pursuant to the direction of Kansas House Bill 2390, this report analyzes the broadband needs of Kansas schools, libraries, and hospitals. This report offers survey data and analysis to assess the current needs of schools, libraries, and hospitals across Kansas and to identify ways in which the State may be able to support improvements in those services to better meet the needs of its community anchor institutions in the education, health care, and library sectors.

Through Kan-ed and other programs, Kansas has demonstrated significant leadership among the states in enabling a basic level of broadband for its key community anchor institutions. As technology has changed, however, many other states have adopted new strategies that catalyze or incentivize construction of world-class, future-proof broadband networks to serve schools, libraries, and hospitals. This report provides a range of recommendations for steps Kansas can take to enable Kansas schools, libraries, and hospitals to keep par with their counterparts nationally, as well as to enable private sector companies to provide world class services.

This analysis and the other work underway within Kansas represent important steps in planning to maximize the benefits of broadband. Both near- and long-term planning is required, with respect to schools, libraries, and hospitals—but also businesses and citizens—so that Kansas is well positioned to realize the full economic and educational potential of broadband.

This report was prepared by Columbia Telecommunications Corporation (CTC)[1] in late 2012 and early 2013.

[1] CTC is a 30-year old communications technology consultancy with experience across a full range of technologies. CTC has planned, designed, or evaluated hundreds of fiber optic and wireless networks since 1983. In recent years, CTC has provided evaluative, strategic, planning, and engineering services for the statewide fiber network in Maryland (which serves schools, libraries, public safety, public health, and government institutions) and for the three-state regional fiber network in the National Capital Region; has provided strategic and business planning services for the statewide fiber network in Pennsylvania (which serves education and health care users); and developed the reference architecture for the national fiber-to-the-home network currently being built in New Zealand. CTC has consulted to the cities of San Francisco, Seattle, Los Angeles, and Washington, D.C. regarding broadband needs, as well as to the states of Maryland, Delaware, and New Mexico.

1.1 Background

Per the terms of House Bill 2390, the Kansas Department of Commerce tasked CTC to conduct a needs assessment of the broadband communications requirements of Kansas schools, libraries, and hospitals. This needs assessment and a range of related broadband analyses are the project of the Kansas Statewide Broadband Initiative (KSBI).[2] This assessment under HB 2390 was undertaken by KSBI as part of a broader research project to determine how broadband can enhance economic activity and opportunity for businesses, consumers, and community anchor institutions across the State of Kansas.

Under the terms of the legislation, CTC was tasked to conduct analysis of five issues:

1. Compare the utilization, efficiency, and effectiveness of the Kan-ed communications network[3] to programs in other states for schools, libraries, and hospitals

2. Determine if the Kan-ed network, as of the effective date of HB 2390, was worth its cost in terms of price, service, quality, needed network upgrades, and increased utilization of broadband by schools, libraries, and hospitals

3. Determine if there exist alternative models or opportunities for broadband procurement by schools, libraries, and hospitals in Kansas

4. Determine if the network services and applications offered by Kan-ed led to full utilization of broadband technology by schools, libraries, hospitals and their surrounding communities

5. Recommend cost-effective alternative broadband strategies[4]

During late 2012 and early 2013, CTC conducted independent research and analysis of the schools,[5] libraries, and hospitals that form Kan-ed's membership, as well as of other,

[2] KSBI is a partnership of the Kansas Department of Commerce, Kansas communities, government officials, the private sector, and the National Telecommunications and Information Administration. KSBI's mission is to analyze the changing nature of broadband needs in Kansas and to encourage economic growth in Kansas through use of the Internet and advanced communications networks. www.kansascommerce.com/index.aspx?NID=360.

[3] Kan-ed is a program created by the Kansas Legislature and administered through the Kansas Board of Regents to expand the collaboration capabilities of Kan-ed's member institutions, specifically K–12 schools, higher education institutions, libraries, and hospitals. *See:* http://www.kan-ed.org/. The larger Kan-ed program has included over the years a range of programmatic components, including shared software and applications, video-conference scheduling, database access, and online learning support services. This report does not address those programs. Rather, per the direction of HB 2390, this report evaluates the communications network element of Kan-ed and the services associated with providing that network to schools, libraries, and hospitals.

[4] Conference Committee Report Brief Senate Substitute for House Bill No. 2390, As Agreed to May 14, 2012, http://www.kslegislature.org/klrd.

comparable programs in other states. CTC also drew on its own experience with planning, designing, or evaluating large public communications networks, including in Colorado, Delaware, Illinois, Maryland, California, Washington, New Mexico, Louisiana, North Carolina, Pennsylvania, and Virginia.

1.2 Findings

Based on the research we conducted and on our own experience, CTC came to a series of conclusions. Our findings, relative to the issues we were tasked with analyzing, are as follows:

1. *Compare the utilization, efficiency, and effectiveness of Kan-ed to programs in other states for schools, libraries, and hospitals*

    - With respect to baseline utilization, efficiency, and effectiveness, Kan-ed's network accomplished similar goals to programs designed to serve schools, libraries, and hospitals in other states.

    - With respect to technology and capacity, in the past few years, Kan-ed did not keep pace with other states that lead in developing new strategies to stimulate world-class services to schools, libraries, and hospitals.

2. *Determine if the Kan-ed program, as of the effective date of HB 2390, was worth its cost in terms of price, service, quality, needed network upgrades, and increased utilization of broadband by schools, libraries, and hospitals*

    - Utilization. Kan-ed led to increased utilization of broadband by schools, libraries, and hospitals by enabling rural schools, libraries, and hospitals to use broadband services that may otherwise have been too costly or inaccessible for them.

    - Price. Kan-ed contracted for and provided services whose cost was below market in previous years and that, even now, are reasonable given market options (consumer-grade products may appear cheaper but are not comparable to business-class products).

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[5] The "schools" category generally includes the needs of community colleges and vocational and technical facilities, which in many cases face the same kind of bandwidth needs and concerns as do K–12 schools. With respect to our survey data, the confidence interval was too large for us to be able to analyze the needs of this community with statistical relevance. However, our analysis is that their needs are substantially similar to those of the K-12 sector. As a result, unless otherwise noted, the term "schools" throughout this report applies to community colleges and vocational and technical schools as well as K–12 schools. The large research universities have a different set of broadband resources and face very different bandwidth needs, and are thus in a separate category this is not evaluated here.

- Service and Quality. Kan-ed provided high-quality, reliable network services that enabled schools, libraries, and hospitals to effectively communicate and share resources over the dedicated Kan-ed network.

- Needed network upgrades. At the time it was decommissioned, the Kan-ed network required upgrade to faster, more capable broadband speeds in order to meet the needs of Kansas schools, libraries, and hospitals.

3. *Determine if there exist alternative models or opportunities for broadband procurement by schools, libraries, and hospitals in Kansas*

    - Alternative models for broadband procurement would benefit Kansas schools, libraries, and hospitals as they migrate off the Kan-ed network. In particular, we recommend that the State support these institutions with services such as:

        a. Technical support to understand and select commercial communications services

        b. Procurement support in the form of consolidation of needs and aggregated bidding and purchasing

        c. Planning support to help navigate and maximize the federal broadband subsidy programs for schools, libraries, and hospitals

4. *Determine if the services and applications offered by Kan-ed led to full utilization of broadband technology by schools, libraries, hospitals and their surrounding communities*

    - The services and applications offered by Kan-ed enabled extensive utilization by schools, libraries, and hospitals, but ultimately required technology upgrades because broadband needs are growing exponentially.

    - National data and trends demonstrate that schools, libraries, and hospitals have enormous needs for high quality, high bandwidth Internet services.

    - Kansas schools and hospitals will shortly require 1 gigabit service per facility and libraries should target 100 megabit to 1 gigabit service, depending on number of users.

    - The services and applications offered by Kan-ed do not lead to full utilization by the surrounding communities because the technology and funding model did not incentivize private service providers to build new facilities to schools, libraries, and hospitals that might then also benefit surrounding communities.

5. *Recommend cost-effective alternative broadband strategies*

   - The State can enable private sector provision of cost-effective broadband by building future-proof middle-mile infrastructure in the form of Digital State Highways—by placing inexpensive conduit and fiber optics for private use during highway and road construction projects.

   - The State can provide broadband funding to schools, libraries, and hospitals to enable them to purchase better, more costly services. The demand for better services will incent private service providers to build new, world class facilities to those locations. In addition, the State funding will provide leverage to increase the amount of federal funding available to the schools, libraries, and hospitals for broadband services.

Each of these findings is explained in more detail in Section 3, and supported by the in-depth analysis described in Section 4 through Section 9.

2 Research Process

CTC met extensively with public and private sector stakeholders in Kansas, as well as with representatives of the schools, libraries, and hospitals. In addition, CTC designed an online survey to capture substantial information about Kan-ed members' use of their Internet services, their connections and speeds, and other information about broadband Internet, including:

- Current communications services, connection types, and costs
- Alternatives for replacement of their Kan-ed connections, including costs
- Internet use, importance, satisfaction, and opinions about service
- Use of the Internet and communications services for key operational functions
- Specific information regarding communications use for libraries, educational organizations, and health care facilities

The survey was developed with the input of representatives of the Department of Commerce, Kan-ed, KanREN,[6] the Office of the State Library, the Kansas Hospitals Association, and the Kansas Board of Education.[7]

The survey was sent to all members of Kan-ed, including in the education, health care, and library sectors. More than 60 percent of the Kan-ed members responded to the survey.[8] The responses came from all over the State.

Table 1 lists the respondents by sector. Figure 1 illustrates the geographic location of the survey respondents.

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[6] The Kansas Research and Education Network (KanREN) "is is a non-profit consortium of colleges, universities, school districts and other organizations in Kansas, organized for the purpose of facilitating communication among them, and providing themselves with connectivity to the Internet via a statewide network." *See:* "What is KanREN?", KanREN website, http://www.kanren.net/index.php/about.html.

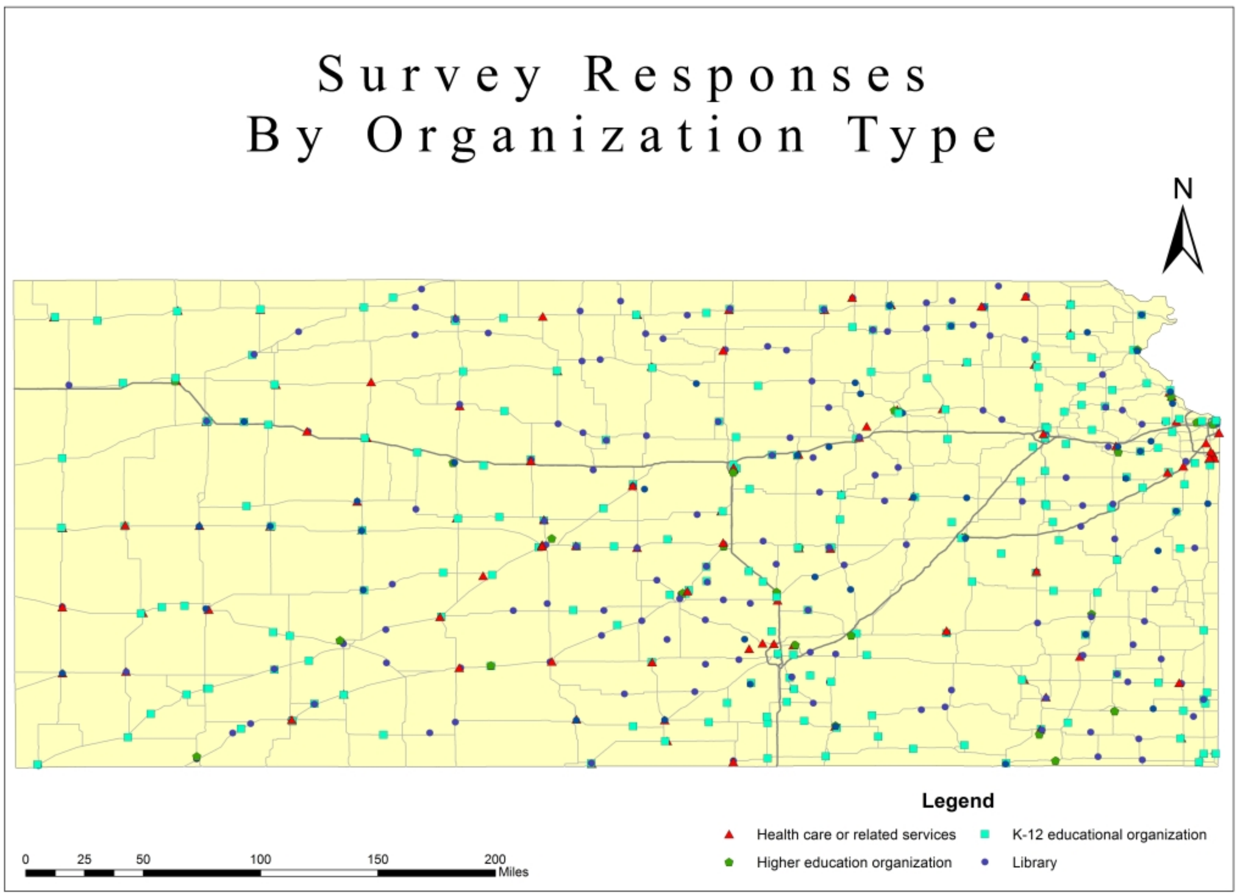
[7] CTC extends its thanks, for time and feedback offered during design of the survey instrument, to Mr. Jerry Huff, Director of Kan-ed, Kansas Board of Regents; Mr. Jeff Hixon, Director, Statewide Resource Sharing, State Library of Kansas; Ms. Melinda A. Stanley, State Education Technology Coordinator, Kansas State Department of Education; Ms. Jennifer Findley, Vice President, Education and Special Projects, Kansas Hospital Association; and Mr. Cort Buffington, Executive Director, KanREN, Inc.

[8] The survey evaluated the needs of K–12 schools, libraries, hospitals, and institutions of higher learning. Unfortunately, we cannot reliably utilize the higher education responses because the relatively small number of respondents resulted in a broad confidence interval. As a result, we do not present specific higher education sector data here but responses for higher education institutions are included in all aggregate results.

Table 1: Survey Respondents by Sector

	Members	Responses	Response Rate	Confidence Interval
Libraries	336	239	71.1%	±3.4%
K–12 Education	335	187	55.8%	±4.8%
Higher Education	52	21	40.4%	±16.7%
Health Care	240	92	38.3%	±8.0%
Total (All)	963	619	64.3%	±2.4%

Figure 1: Geographic Location of Survey Respondents



The survey objectives, process, and results are described in detail below.

3 Research Findings

Based on the research we conducted and on our own experience, CTC came to a series of conclusions. Each of our findings is briefly summarized here, under the specific HB 2390 issue to which it responds. Detailed analysis is provided in the other sections of this report.

Issue 1: Compare the utilization, efficiency, and effectiveness of Kan-ed to programs in other states for schools, libraries, and hospitals

Finding 1.1: With respect to utilization, efficiency, and effectiveness, Kan-ed's network accomplished similar goals to programs designed to serve schools, libraries, and hospitals in other states

In ways comparable to those in other states, Kan-ed has delivered consistent, high-quality, cost-effective services to a large membership over a significant period of time.

Utilization. Kan-ed utilization was extensive; stakeholders made full use of the services provided them over the Kan-ed network, as measured by the stakeholders' own reporting of their uses of Kan-ed bandwidth as well as by the volume of video conferencing events managed by Kan-ed.

Efficiency. Given the markets in which it operated, Kan-ed secured for itself and its members cost-effective services based on competitively bid contracts that offered rural areas normalized pricing identical to that offered to metropolitan area schools, libraries, and hospitals. Pricing was consistent with or below prices for similar circuits in rural markets nationally. As another important measure of efficiency, Kan-ed used its State funding as leverage to maximize the amount of the federal Universal Service funds flowing into Kansas.

Effectiveness. Kan-ed was very effective as measured by the key metric of enabling all schools, libraries, and hospitals, no matter how rural or remote, to realize the benefits of a minimum level of broadband connectivity. In part as a result of Kan-ed's efforts, to our knowledge there are no schools, libraries, or hospitals in its membership that still use dial-up (pre-broadband) Internet. And Kan-ed delivered to its connected members not only a basic broadband product but also the support and services to enable them to make use (such as through video conferencing) of this reliable connection to their counterparts around the State.

Finding 1.2: With respect to technology and capacity, in the past few years, Kansas has not kept pace with other states that lead in developing new strategies to stimulate world-class services to schools, libraries, and hospitals

We find, however, that Kan-ed's technology platform and service offerings had grown stale in recent years. Over the past few years, most states have migrated their Kan-ed-type networks to new platforms and infrastructures that offer far greater bandwidth. These new offerings tend to require the most robust possible infrastructure, usually in the form of fiber optics, the "holy grail" of communications infrastructure. As a result, statewide networks have worked to deploy backbones over fiber and to extend offerings over fiber to schools, libraries, and hospitals wherever possible. This trend is apparent in the case studies presented below: Whether the fiber is owned by the statewide network or leased, the best of the statewide networks utilize fiber optics in order to deliver the tremendous speeds and services that are their hallmark.

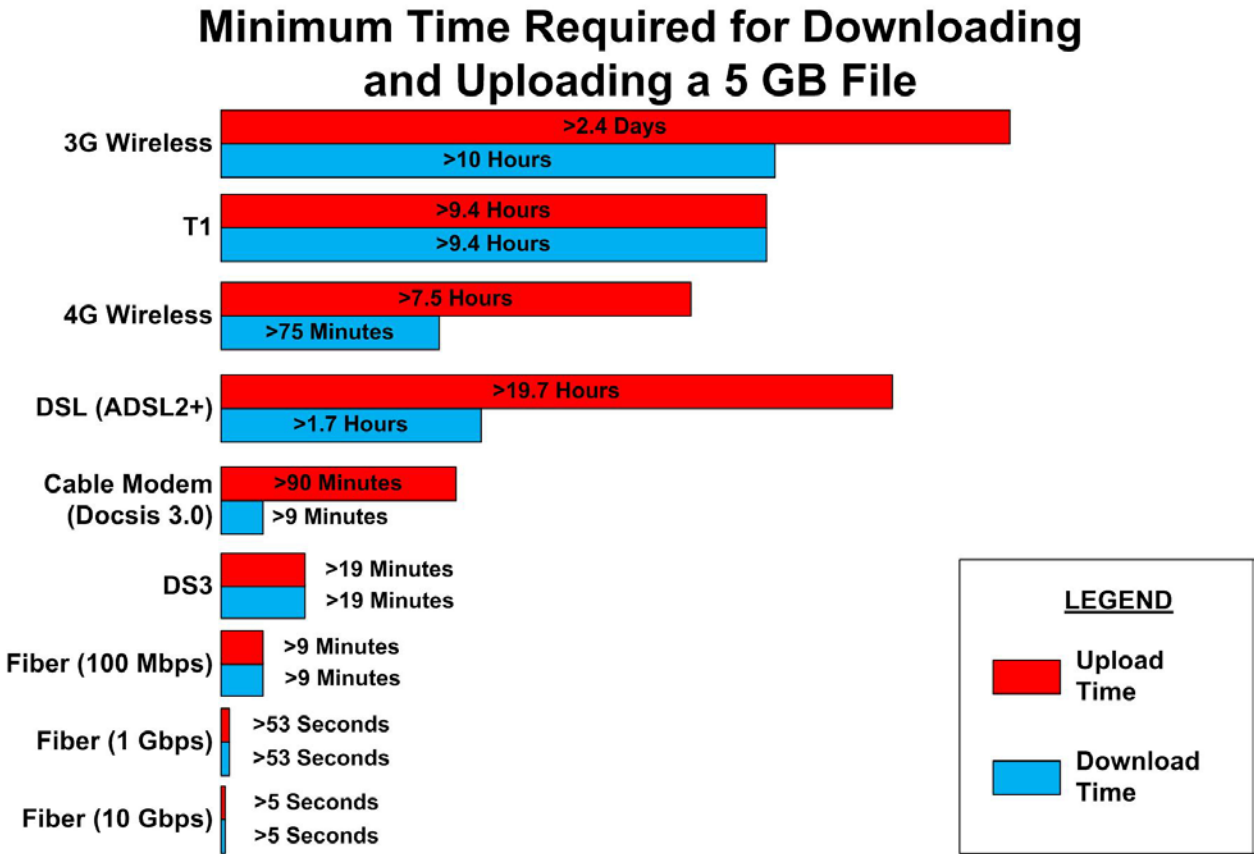
In contrast to Kansas, most states have migrated from first-generation broadband networks like the one operated by Kan-ed to state-of-the-art broadband technology. Just weeks ago, Gov. John Kasich of Ohio presided over the launch of a similar effort in that state—one that is designed to deliver very high bandwidth services to Ohio educations institutions over fiber optics.[9]

Our review of services provided by the Kan-ed network at the time it was decommissioned in 2012 suggest they were not comparable to the prevailing level of technology and capacity in networks that are considered to be keeping pace with the emerging needs of their memberships. The networks in states such as Ohio, Oklahoma, Colorado, North Carolina, and Utah are increasingly viewed as the standard, rather than the exception, for educational and health care networking. Among Kan-ed's members that connected to the network, most chose a basic T-1 connection, which delivers 1.54 megabits per second (Mbps) of throughput (this choice was driven in part by the fact that a T-1 was offered for free). In contrast, in states such as North Carolina and Utah, every school district building is connected over fiber, and broadband offerings start at 1 gigabit per second (Gbps)—*600 times* the speed of the basic Kan-ed T-1 offering. Notably, Google's fiber deployment will deliver gigabit speeds to the schools, libraries, and hospitals in Kansas City.

Figure 2, below, illustrates the comparative upload (sending data up, to the Internet) and download (pulling data down, from the Internet) speeds of various technologies. Note that the faster speeds all require fiber optics, the technology that is the basis for the programs in Oklahoma, Colorado, North Carolina, Utah, Pennsylvania, and Ohio, as well as many other states. Kan-ed's core offering is the T-1, which was offered for free and taken by 70 percent of Kan-ed connected members. (The balance chose to pay for higher bandwidth at preferred pricing negotiated by Kan-ed with its private sector vendor.)

[9] See, for example: [http://www.govtech.com/wireless/Ohio-Launches-States-New-Ultra-Fast-Broadband-Network.html.](http://www.govtech.com/wireless/Ohio-Launches-States-New-Ultra-Fast-Broadband-Network.html)

Figure 2: Comparative Speeds of Various Technologies



Issue 2: Determine if the Kan-ed program, as of the effective date of HB 2390, was worth its cost in terms of price, service, quality, needed network upgrades, and increased utilization of broadband by schools, libraries, and hospitals

In summary, Kan-ed was "worth its cost" with respect to meeting the basic needs of its membership and offering a basic level of connectivity to even the most remote, least-resourced institutions. Absent Kan-ed, many schools, libraries, and hospitals would have had lesser, more costly options in terms of price, service, and quality of broadband connection. In this way, Kan-ed enabled utilization by some schools, libraries, and hospitals that would otherwise not have emerged.

Finding 2.1: <u>Utilization</u>. Kan-ed enabled rural schools, libraries, and hospitals to use broadband services that may otherwise have been too costly or inaccessible for them, and has thus increased utilization of broadband

Kan-ed realized an important accomplishment by ensuring the availability of broadband for its members in remote areas of the State. Kan-ed enabled and delivered a basic level of broadband to institutions across the State. Particularly in the early years of Kan-ed, many of these institutions would not have been able to afford, or access, such services absent Kan-ed.

Based on the survey data we collected, Kan-ed's members are generally satisfied with the services they have received from Kan-ed; utilize the network extensively for a wide range of tasks—particularly video conferencing, providing Internet access to stakeholders, "cloud-based" applications, and online data storage; and are concerned about how to meet their connectivity needs in the absence of Kan-ed.

Kan-ed's network enabled members to increase their online activities, and to achieve operational efficiencies and programmatic benefits (such as sharing of resources among distant and remote schools) that would otherwise not have been possible in the early years of Kan-ed's network operations. In the K-12 area, for example, Kan-ed has enabled reliable video conferencing for sharing of data, teaching resources, and training for a decade; given the limitations of video conferencing over the public Internet a decade ago, this sharing and efficiency would not have occurred in that timeframe absent Kan-ed. Across all sectors we surveyed, Kan-ed members report extensive use of Kan-ed's network for distance learning and video-sharing of resources.

Finding 2.2: Price. Kan-ed contracted for and provided services whose cost was below market in previous years and that, even now, are reasonable given market options

Kan-ed's members are generally satisfied with the pricing they have received from Kan-ed and many of them are deeply concerned about how to meet their needs in the absence of Kan-ed's funding.

Based on our experience, Kan-ed's pricing for its services was quite low, relative to market price, at the time Kan-ed entered into its current contract in 2007; even today, six years later, its pricing is competitive relative to national pricing for comparable products.

Kan-ed network pricing was also reasonable relative to the costs of replacing service for the schools, libraries, and hospitals that used to be on Kan-ed's network. According to KanREN, which has helped Kan-ed members to identify and get pricing for alternative solutions, the average cost quoted in the past few months by private sector companies for T-1 services was $599 per month (compared to the $653 per month that Kan-ed was paying for the T-1, a cost that included use of a router and round-the-clock monitoring of the circuit by KanREN, Kan-ed's Network Operations Center contractor.

One significant benefit of Kan-ed's centralized bidding is that it normalized pricing statewide, thus enabling rural and remote facilities to benefit from the greater negotiating leverage of their urban and suburban counterparts. In order to benefit rural Kansas schools, libraries, and hospitals, Kan-ed entered into a competitively bid contract with AT&T that normalized pricing across the State. This enabled Kan-ed to provide T-1 circuits at no charge, or facilitate the leasing of enhanced circuits, to even the most remote and inaccessible parts of Kansas at pricing that was comparable to more populous parts of the State. For some of the least financially able schools, libraries, and hospitals, this mechanism enabled broadband connectivity that otherwise would not have occurred.

Finding 2.3: Quality and Service. Kan-ed provided high-quality, reliable network services that enabled schools, libraries, and hospitals to effectively communicate and share resources over the dedicated Kan-ed network

Kan-ed's members indicate high satisfaction with the level of service they received over their Kan-ed connections, and the related support Kan-ed provided. Among other things, Kan-ed provided technical and planning support; help navigating the federal schools and libraries broadband funding program known as e-Rate; and round-the-clock monitoring and troubleshooting of the broadband connection to maintain quality. These services are not included with mass market consumer-grade services, such as DSL and commercial wireless, which may appear cheaper but are not truly comparable.

Finding 2.4: Needed network upgrades. At the time it was decommissioned, the Kan-ed network required upgrade to faster, more capable broadband speeds in order to meet the needs of Kansas schools, libraries, and hospitals

As is discussed above, the circuits provided by Kan-ed as of 2012 to the majority of its connected members were insufficient to meet bandwidth needs and required upgrade. It is our understanding that Kan-ed was evaluating its options for rebidding or renegotiating its vendor contract as of the time the network was defunded, but that multi-year commitments to the vendor (given in return for preferred pricing, in a practice that is typical around the country) limited its flexibility in this regard.

Issue 3: Determine if there exist alternative models or opportunities for broadband procurement by schools, libraries, and hospitals

Finding 3.1: Alternative models for broadband procurement (and support for that procurement) would benefit Kansas schools, libraries, and hospitals as they migrate off the Kan-ed network

Understanding, planning, and negotiating communications services can be challenging for smaller institutions, such as remote libraries with small staffs and limited technical resources. One of the benefits Kan-ed provided these institutions was access to services that were centrally planned and procured—and that had the benefits of bulk purchasing and aggregated demand. Kan-ed also provided some limited support for its members in navigating the federal broadband funding for schools and libraries known as e-Rate.

With the decommissioning of the Kan-ed network, many of these benefits are no longer available to the schools, libraries, and hospitals of Kansas. Yet even without the Kan-ed network, these services could be provided to Kan-ed members so as to enable them to more effectively and successfully plan and negotiate for private sector services—and in order to enable them to maximize the benefits to Kansas institutions of the federal broadband funding programs. Considering the highly rural landscape in Kansas, an aggregated procurement model can enable rural schools, libraries, and hospitals to benefit from the collective buying power of these sectors statewide.

These strategies are used extensively by the best of the statewide networks in other states. In North Carolina and Utah, for example, state entities provide technical guidance and support to schools to support their selection of, and use of, broadband. Aggregated demand is used in Ohio, Colorado, and Nebraska to secure optimal pricing of services from vendors and pass those savings to schools, libraries, and hospitals. And all of these statewide networks (or other state agencies) either manage the entirety of the federal funding program or provide support to the local anchors to do so, with the successful outcome of maximizing the aggregate amount of federal funding that supports that state's schools, libraries, and hospitals.

The majority of respondents to the CTC survey indicate that they would take advantage of State programs to help them maximize federal subsidies, help evaluate communications service offerings, or participate in a "buying pool" for communications services.

We therefore recommend that the State provide for support to schools, libraries, and hospitals in the form of:

a. Technical support to understand and select commercial communications services

b. Procurement support in the form of consolidation of needs and aggregated bidding and purchasing

c. Planning support to help navigate and maximize the federal broadband subsidy programs for schools, libraries, and hospitals

Issue 4: Determine if the services and applications offered by Kan-ed led to full utilization of broadband technology by schools, libraries, hospitals and their surrounding communities

Finding 4.1: The services and applications offered by Kan-ed enabled extensive utilization by schools, libraries, and hospitals, but ultimately required technology upgrades because broadband needs are growing exponentially

Based on our research, we found that more than 50 percent of eligible institutions in Kanas took advantage of the Kan-ed network to connect to each other and to the public Internet. For more than 70 percent of those institutions, Kan-ed was the sole connection they used. Approximately 28 percent used both Kan-ed and another connection, most of them saving the Kan-ed connection, which was highly reliable, for video-conferencing and resource sharing with their counterparts around the State.

As is discussed above, Kan-ed enabled a baseline, minimum level of broadband (the T-1) for all schools, libraries, and hospitals, no matter how remote, and afforded to all its member institutions the opportunity to realize the benefits of the technologies it offered.

With the passage of time, however, a technology upgrade was required to enable full realization of the promise of broadband. (Based on the information we received, Kan-ed was evaluating such upgrades at the time it was decommissioned).

Schools, libraries, and hospitals in Kansas agree that their needs for broadband are growing, as we discovered in our interviews of individual institutions as well as of their representatives among State agencies and associations. Health information exchanges, for example, require significant increases in bandwidth for hospitals; one-to-one computing programs in Kansas schools require that each student now have access to the amount of bandwidth that might have sufficed for an entire school a decade ago; and Kansas libraries report extensive, constant use of bandwidth by members of the public who rely on the library's Internet connection for such essential activities as job searches and homework. As a result, Kan-ed members report extensive, critical needs for high quality, high bandwidth Internet services—and anticipate that those needs will grow with time.

In addition, KanREN, the research and education network operated by the Board of Regents, reports that it has worked to assist Kan-ed members to secure alternative forms of broadband in light of Kan-ed's decommissioning; of the hundreds of requests from Kan-ed members, all but three requested speeds in excess of that available over a T-1.[10]

[10] Interview with Cortney Buffington, Executive Director of KanREN, Inc., January 25, 2013.

Finding 4.2: National data and trends demonstrate that schools, libraries, and hospitals have enormous needs for high quality, high bandwidth Internet services—needs far in excess of the services that can be delivered over Kan-ed-type circuits

In the past decade, community anchor institutions such as schools, libraries, and hospitals have seen their broadband needs grow enormously; the emerging standard is for 1 gigabit per second (Gbps), which is 600 times the speed of a T-1, the basic level offered by Kan-ed. The FCC's National Broadband Plan establishes as one of the nation's key goals that "[e]very community should have affordable access to at least 1 gigabit per second broadband service to anchor institutions such as schools, hospitals, and government buildings."[11]

According to the FCC, health care facilities' broadband needs exceed 100 Mbps on a regular basis. The FCC notes that a "typical rural health clinic with five practitioners should have at least 10 Mbps, while hospitals should have at least 100 Mbps."[12] As the FCC's graphic demonstrates, medical applications such as image transfer (PACS) require 100 Mbps; that number will multiply by the number of simultaneous users of that application.

Table 2: Bandwidth Requirements to Achieve Full Functionality of Health IT Applications

Text-Only HER	Remote Monitoring	Basic e-mail + Web browsing	SD Video Conferencing	HD Video Conferencing	Image Transfer (PACS)
.025 Mbps	.5 Mbps	1.0 Mbps	2.0 Mbps	>10 Mbps	100 Mbps

Source: Federal Communications Commission[13]

The U.S. Department of Commerce has found that schools require connections of 50 to 100 Mbps per 1,000 students.[14] Education technologists recommend even greater capacity; in an environment where students are bringing up to three devices each to school, some recommend that schools provide 300 to 600 Mbps *per classroom,* which delivers a few megabits per student to support video learning.[15]

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[11] Federal Communications Commission, *National Broadband Plan: Connecting America*, 2010, Goal 4, http://www.broadband.gov/plan/goals-action-items.html.

[12] Federal Communications Commission, *Health Care Broadband in America: Early Analysis and a Path Forward*, FCC Omnibus Broadband Initiative, August 2010, at 6, http://download.broadband.gov/plan/fcc-omnibus-broadband-initiative-%28obi%29-working-reports-series-technical-paper-health-care-broadband-in-america.pdf.

[13] *Ibid.*

[14] Federal Communications Commission, Eighth Broadband Progress Report, In the Matter of Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of the Telecommunications Act of 1996, as Amended by the Broadband Data Improvement Act, August 14, 2012, GN Docket No. 11-121, at 133.

[15] Tanya Roscorla, "5 Ways to Prepare Schools for Bring Your Own Device," Center for Digital Education, December 10, 2012, http://www.centerdigitaled.com/news/5-Ways-to-Prepare-Schools-for-Bring-Your-Own-Device.html.

The State Educational Technology Directors Association (SETDA) recommends that by the 2014–15 school year, each school have at least 100 Mbps Internet per 1,000 students and staff (service to the public *Internet*) and at least 1 Gbps for each 1,000 students and staff connecting the schools to each other and to their district building (*intranet* service). SETDA recommends that by the 2017–18 school year, each school have at least 1 Gbps per 1,000 students and staff (service to the public *Internet*) and at least 10 Gbps per 1,000 students and staff connecting the schools to each other and to their district building (*intranet* service):[16]

Broadband Access for Teaching, Learning and School Operations	2014-2015	2017-2018
An external Internet connection to the Internet Service Provider (ISP)	At least 100 Mbps per 100 students/ staff	At least 1 Gbps per 100 students/ staff
Internal wide area network (WAN) connections from the district to each school and among schools within the district	At least 1 Gbps per 1,000 students/ staff	At least 10 Gbps per 1,000 students/ staff

Source: State Educational Technology Directors Association

Community colleges and vocational and technical facilities face many of the same kind of bandwidth needs and concerns as do K–12 schools, including the impact of bring-your-own-device (BYOD) policies (which are discussed in greater detail in Section 6.2). A "bandwidth calculator" sponsored by the U.S. Department of Education illustrates the fact that the capacity that once sufficed for community colleges is no longer sufficient. For example, assuming that each student requires a 1 Mbps to 1.5 Mbps connection to support an adequate video stream, then a college with 300 simultaneous users would need up to 450 Mbps just for that application.[17]

In the libraries sector, TechSoup, a non-profit that provides technical assistance to libraries with the support of the Gates Foundation, notes that the amount of bandwidth required depends on the number of users and computers at a library facility.[18] As a TechSoup/Colorado State Library graphic illustrates (see below), a T-1 used by three library patrons simultaneously will enable website loading in five seconds and a book download in 15 seconds.[19] While not optimal, these

[16] Christine Fox, John Waters, Geoff Fletcher, Douglas Levin, *The Broadband Imperative: Recommendations to Address K–12 Education Infrastructure Needs*, State Educational Technology Directors Association, 2012, at 2.
[17] "Bandwidth Calculator," School 2.0 eToolkit, Center for Technology in Learning at SRI International. http://etoolkit.org/etoolkit/bandwidth_calculator/about.
[18] "Bandwidth Management," TechSoup for Libraries. http://www.techsoupforlibraries.org/planning-for-success/networking-and-security/bandwidth-management; see also Kieran Hixon, "Broadband Basics for Public Libraries," TechSoup and Colorado State Library, Presentation, January 15, 2013, http://www.techsoupforlibraries.org/blog/broadband-basics-webinar-follow-up; http://ipac.umd.edu/survey/analysis/broadband-public-libaries; http://plinternetsurvey.org/sites/default/files/publications/BroadbandBrief2012.pdf; http://www.webjunction.org/documents/illinois/Broadband_Calculator.html (a broadband bandwidth calculator for libraries that uses speed of website loading as a guide to bandwidth needs).
[19] "Bandwidth Management," TechSoup for Libraries. http://www.techsoupforlibraries.org/planning-for-success/networking-and-security/bandwidth-management.

speeds may be acceptable. Times will multiply, however, as the number of simultaneous users multiply. As a result, a library serving 30 simultaneous users would require at least 45 Mbps to enable website loading in five seconds and a book download in 15 seconds. Video applications will require three times that bandwidth.

Figure 3: Download Speeds for Libraries[20]

Download Speeds

Internet Connection Speed by Mbps based on 1 computer connected

	www Website (320 KB)	Book (1 MB)	Song (4 MB)	Movie (6 GB)
>50	.003 seconds	.01 seconds	.03 seconds	8 minutes
25-50	.06 seconds	.2 seconds	.6 seconds	16 minutes
10-24	.09 seconds	.3 seconds	1.3 seconds	33 minutes
6-9	.3 seconds	.8 seconds	3.2 seconds	1.5 hours
3-5	.4 seconds	1.3 seconds	5.3 seconds	2.25 hours
1.5-2	.8 seconds	2.7 seconds	10.7 seconds	4.5 hours
<1.5	3.2 seconds	10.4 seconds	41.7 seconds	9 hours

However
The more computers per connection, the slower that connection becomes:

	www Website (320 KB)	Book (1 MB)	Song (4 MB)	Movie (6 GB)
3 computers* on one T1 (1.544 Mbps) = 512 Kbps	5 seconds	15 seconds	1 minute	26 hours
12 computers* on one T1 (1.544 Mbps) = 128 Kbps	20 seconds	1 minute	4 minutes & 10 seconds	106 hours
30 computers* on one T1 (1.544 Mbps) = 56 Kbps	45 seconds	2 minutes & 22 seconds	9 minutes & 31 seconds	244 hours

*For connection purposes, a computer includes desktops, laptops, tablets, and all devices on the connection via wired or wireless access.

For more information: www.broadbandmap.gov

Source: TechSoup / Colorado State Library

[20] Kieran Hixon, "Broadband Basics for Public Libraries," TechSoup and Colorado State Library, Presentation, January 15, 2013. http://www.techsoupforlibraries.org/blog/broadband-basics-webinar-follow-up

Finding 4.3: Kansas schools and hospitals will shortly require 1 gigabit service per facility and libraries should target 100 megabit to 1 gigabit service, depending on number of users

Based on all the expert sources cited above and on our survey of the applications that are enabling schools, libraries, and hospitals,[21] we recommend that most Kansas schools and hospitals target 1 gigabit per second service if possible. For larger libraries that serve more than 50 to 100 users at a time, a gigabit is also merited. Smaller libraries that serve five to 30 users at a time should aim for 50 to 100 megabit per second service, which would allow for use that is not limited or restrained by bandwidth.

We note that all of these speeds require fiber optics as the transmission infrastructure and that once that fiber is in place, upgrades to higher speeds can be both simple and cost-effective. For this reason, our recommendations focus on enabling private sector use of fiber optics as the optimal infrastructure over which to deliver communications services.

Finding 4.4: The services and applications offered by Kan-ed do not lead to full utilization by the surrounding communities because the model did not incentivize carriers to build new facilities

Kan-ed did not lead to full utilization by the surrounding communities because the Kan-ed model was not designed to enable that effect. As noted here, the model effectively enabled schools, libraries, and hospitals across the State to secure a basic level of broadband (i.e., a T-1) at no charge. Those community anchor institutions could choose to pay for more higher-speed service if they wanted to—but they were incentivized to take the lower bandwidth, no-cost service, especially given the typical budget constraints faced by institutions in these sectors.

Had Kan-ed been structured differently, the community anchors may have opted to pay for higher-speed service—which in turn would have led to the private sector building more fiber infrastructure to reach those facilities because of the projected revenues over time. And, the fiber built to the community anchors might gradually have led to more broadband availability and utilization in the surrounding communities. In this way, the community anchor institutions would also have served as anchor customers for providers to incentivize construction of fiber facilities that would also, over time, be extended to the local community.

Issue 5: Recommend cost-effective alternative broadband strategies

The following recommendations are designed to meet the needs of all Kansas hospitals, schools and libraries, especially in rural communities, for access to a broadband network sufficient to

[21] A detailed analysis of those applications, by sector, is presented in Section 6 below.

meet expected demands in bandwidth. The recommendations are based on best practices emerging nationwide, with respect to cost-effectiveness, economic benefit, and optimal public-private partnership models.

Finding 5.1: The State can enable private sector provision of cost-effective broadband by building future-proof middle-mile infrastructure

To meet the needs not only of Kansas institutions but also of private service providers who serve the institutions, this recommendation focuses on the infrastructure that enables broadband. Our recommendation is that the State can support the availability of broadband for its schools, libraries, and hospitals (as well as businesses and citizens) by building the infrastructure over which private companies compete—the Digital State Highways that would lower barriers to entry and enable private companies to provide world-class services. Efforts such as this have been undertaken in Arizona, Oklahoma, North Carolina, and Colorado, among other states, utilizing a range of models.

The construction of Digital State Highways would enable private carriers and entrepreneurs to cost-effectively:

1. Connect from the Internet backbone (the digital equivalent of federal highways)
2. Bridge the "middle-mile" (the digital equivalent of state highways and roads)
3. Concentrate their investment in last-mile deployment (the digital equivalent of local roads and driveways)

This strategy reduces the burden on private service provider to build the digital highways into neighborhoods and communities ("middle-mile" infrastructure)—thus enabling the carriers to invest locally in neighborhood streets and driveways ("last-mile" infrastructure) for high-speed Internet service to schools, libraries, hospitals, homes, and businesses.

The cost of building Digital State Highways (the "middle mile") directly impacts the cost of providing "last-mile" broadband in unserved areas.[22] If the State dedicates resources to building the highways, the private sector can concentrate its resources on the neighborhood streets. The public investment would thus reduce a sizeable expense for last-mile developers by opening up middle-mile access and removing a key barrier to building and operating broadband networks.

[22] Federal Communications Commission, "National Broadband Plan: Connecting America," Chapter 8 http://www.broadband.gov/plan/8-availability/#r8-8 (accessed Oct. 1, 2012).

Finding 5.2: The State can build Digital State Highways by placing inexpensive conduit and fiber optics for private use during highway and road construction projects

The construction of fiber optic communications cables is a costly, complex, and time-consuming process. Simultaneous construction and co-location of facilities reduces the long-term cost of building communications facilities. This is because there are significant economies of scale through:

1. Coordination of broadband infrastructure construction with road construction and other disruptive activities in the public right-of-way

2. Construction of spare conduit capacity where multiple service providers or entities may require infrastructure

The reason that these economies are available is primarily because fiber optic cables and installation materials are relatively inexpensive, often contributing a fraction of the total cost of new construction.[23]

The State of Arizona, which has a pioneering program to place conduits for private sector use in the state's rights-of-way, estimates that the incremental cost of placing the conduits is comparable to the cost of painting stripes on the highway.[24]

Finding 5.3: The State can provide broadband service funding to schools, libraries, and hospitals

Through public funding, the State can enable schools, libraries, and hospitals to buy better communications services, and thereby incentivize the private sector to build better infrastructure.

Schools, libraries, and hospitals have available to them a range of generous federal funding programs. For schools and libraries, there is e-Rate. For hospitals, the FCC announced in

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[23] Columbia Telecommunications Corporation, *Brief Engineering Assessment: Efficiencies Available through simultaneous construction and co-location of communications conduit and fiber*, Prepared for the National Association of Telecommunications Officers and Advisors and the City and County of San Francisco, August 2009, http://ctcnet.us/CoordinatedConduitConstruction.pdf (accessed January 17, 2013); see also, Columbia Telecommunications Corporation, *Brief Engineering Assessment: Cost estimate for building fiber optics to key anchor institutions*, Prepared for the National Association of Telecommunications Officers and Advisors and the Schools, Health, and Libraries Coalition, September 2009, http://ctcnet.us/CTCCostsForAnchorInstitutions.pdf (accessed January 17, 2013).

[24] "The Two Highways Proposition: Combined infrastructure projects save both time and money," *Digital Arizona Program,* Arizona Strategic Enterprise Technology. http://www.digitalarizona.gov/About/The_Two_Highways_Proposition.html.

December a new program called the Healthcare Connect Fund;[25] modeled on e-Rate, it will provide broadband subsidies to rural hospitals, as well as some urban hospitals. On average, the funding amount for both of these federal programs as applied to Kansas will be about 65 percent.

That still leaves approximately 35 percent of the cost of broadband service to be borne by the schools, libraries, and hospitals. That is not an insignificant amount. In a time of tough budgets, it is quite likely that many schools, libraries, and hospitals will opt for less expensive, lower-speed connectivity. If the State were to subsidize some portion of the institutions' 35 percent cost, the schools, libraries, and hospitals would be able to choose to purchase more costly, more capable services from the private sector—which in many cases would lead the private sector to build better infrastructure to those anchor institutions within a community. And once that infrastructure is in place, it will serve as a core infrastructure that will hopefully lead to additional private sector infrastructure investment to reach area homes and businesses. (Once you build a highway into an area, it is much easier to build the local roads.) So the State's funding would serve not just the schools, libraries, and hospitals—it will have a spillover effect on the surrounding communities, an impact that can be measured and tracked through the Kansas broadband map.[26]

Summary of Recommendations

Based on the findings above, the following is a summary of a range of strategies for consideration to support the broadband needs of Kansas schools, libraries, and hospitals, while incentivizing private sector investment and supporting private sector provision of services. These recommendations are based on national best practices.

Recommendation 1: Provide technical support and assistance to schools, libraries, and hospitals in planning, negotiations, procurement, and use of the federal broadband funding programs

Recommendation 2: Provide financial support to schools, libraries, and hospitals that would enable them to contract for better, higher-bandwidth services to be provided by the private sector

Recommendation 3: Develop a Digital State Highways Plan that constructs communications infrastructure at low cost that can then be utilized by the private sector, to lower private sector fees and costs

[25] http://www.fcc.gov/document/new-healthcare-connect-fund-expands-access-broadband-healthcare

[26] The Kansas broadband map, which is a project of the Department of Commerce, enables tracking of broadband service availability and progress, based on baseline and frequently updated data. The State thus already has in place the mechanism for gauging the impact of new broadband programs undertaken since the map was first made available in the past two years. The map can be accessed at http://broadband.kansasgis.org/map/.

4 Kan-ed Achieved Important Results for Kansas Schools, Libraries, and Hospitals

Based on our observations of the broadband provided to schools, libraries, and hospitals nationwide in the past decade, Kan-ed realized accomplishments on behalf of Kansas schools, libraries, and hospitals.

4.1 Kan-ed Provided a Basic Level of Broadband to Schools, Libraries, and Hospitals Statewide, Regardless of Size or Remoteness

A decade ago, many schools, libraries, and hospitals in Kansas either could not access or could not afford broadband communications services—particularly in rural areas. In some cases, institutions did not understand broadband sufficiently to prioritize it within always-tight budgets. In this environment, which was common in rural areas nationwide, Kan-ed made available a basic level of connectivity services (via the T-1 circuit) to the most remote and expensive-to-connect locations in the state, thus enabling schools, libraries, and hospitals to benefit from online services and activities.

For some of the least financially able schools, libraries, and hospitals, Kan-ed removed the cost of that circuit entirely and enabled broadband connectivity that otherwise would not have occurred, particularly in the early years of Kan-ed's existence, when the benefits of broadband were not as well recognized as they are now.

At the same time as removing the cost constraints for rural institutions, Kan-ed also removed many of the transaction costs and burdens of obtaining broadband. For example, Kan-ed's centralized purchasing model alleviated the need for individual institutions to research, understand, negotiate, and procure services themselves—tasks that are not only time-consuming but that also require technical expertise that may not be available in every institution, particularly those that are smaller, such as Kansas' rural libraries.

Absent Kan-ed, these tasks and processes may have served as barriers to broadband adoption by some schools, libraries, and hospitals.

The net result of Kan-ed's aggregated planning and procurement is that rural Kan-ed members gained access to baseline broadband options that were comparable to those in metropolitan areas. This was a considerable accomplishment in a national environment in which rural institutions face far fewer broadband choices and exponentially higher prices than do their urban and suburban counterparts.

4.2 Kan-ed Provided High-Quality Services, Optimized for Schools, Libraries, and Hospitals

Kan-ed provided not just a basic level of broadband, but also technical assurances that the broadband connection would be more robust, reliable, and consistent than a consumer-grade connection—able, in other words, to support the type of institutional applications essential to schools, libraries, and hospitals. Kan-ed accomplished this outcome by operating a dedicated network over leased circuits, with management of the network from the Network Operations Center operated by KanREN at the University of Kansas in Lawrence.

The fact that the Kan-ed connection was offered over a dedicated, managed network is significant. From a technical standpoint, a managed network can provide significant benefits relative to a collection of independent circuits and connections, even if those independent connections are individually fast and reliable. Further, a managed T-1 circuit, even if it appears to be lower bandwidth than a consumer-grade connection, would be better able to meet an anchor institution's needs.

A consumer-grade connection is simply insufficient to meet the needs of a school, library, or hospital. Just as an institution needs institutional-grade flooring rather than residential-grade carpeting to handle the facility's constantly high level of use, those entities need institutional-grade circuits to meet their connectivity needs. (Businesses that depend on their network connections pay for business-grade services, too.)

The main benefits of a single managed network are for:

- Interactive, media-rich applications that have the most rigorous requirements for end-to-end smoothness
- Applications with the highest security and privacy requirements
- Applications that benefit from centralized management, where central authentication/credentialing and content filtering are important

Ten years ago, for example, reliable video over the Internet was relatively unheard of—but Kan-ed, because it was a managed network, made that happen.

Managed networks are able to bypass public Internet connections. As a result, traffic (such as video conferencing or voice calls) crossing the networks can do so in a significantly more predictable way. The network managers (in this case, KanREN) can ensure there will be no sudden surges in other traffic that will cut off or interfere with a video session. Users and locations can be virtually "hard-wired" to each other over the network, and institutions can have predictable, steady access to backup data or servers located across the network, even if the network covers an entire state.

When a network is designed as a single managed entity, it is significantly easier to set up gateways that control access on and off the network. This is useful if content needs to be filtered, as in some educational or government networks, or if acceptable usage rules need to be strictly enforced. Managed networks can also be insulated from the Internet, providing greater protection from intrusion and viruses.

Like bandwidth, these differentiating factors are critically important to schools, libraries, hospitals, and other community anchor institutions; as the Schools, Health & Libraries Broadband (SHLB) Coalition noted in comments recently filed with the FCC on a wireless broadband matter, "Community anchor institutions—K–12 schools, colleges, libraries, health clinics… and others—often need bandwidth in excess of 25 Mbps and sometimes 100 Mbps to 1 Gbps… Furthermore, the quality of broadband service demanded by anchor institutions is much different… Anchor institutions often need firewalls, separation of public and administrative channels, filters and security protections…."[27]

In all these ways, Kan-ed provided reliability, security, and value to its connected members.

4.3 Kan-ed Aggregated Public Buying Power to Reduce Costs and Normalize Rates Across the State for Rural, Suburban, and Urban Institutions

Anchor institutions in rural areas often pay more for broadband services,[28] because of the distance to be traversed between the institution's location and the carrier network and because of the "small number of potential customers that can share the costs in rural areas."[29]

In order to benefit rural Kansas schools, libraries, and hospitals, Kan-ed entered into a competitively bid contract with AT&T that normalized pricing across the State. This enabled Kan-ed to provide T-1 circuits at no charge, or facilitate the leasing of higher-bandwidth circuits, to even the most remote schools, libraries, and hospitals at pricing that was comparable to more populous parts of the State. Within the community of research and education networks nationally, this practice is known as "postalization"—a term that refers to the fact that the U.S. Postal Service offers the same rates for delivery of regular mail regardless of the origination and destination within the country. This postalization allowed Kan-ed to bring service to organizations that might otherwise have faced exponentially higher costs.

[27] Comments of the SHLB Coalition in the Matter of AT&T and NCTA Petition on Transition from Legacy Transmission Platforms to Services Based on Internet Protocol, GN Docket 12-353.

[28] See, e.g., Federal Communications Commission, In the Matter of Rural Health Care Support Mechanism Report and Order, December 12, 2012, Appendix B; OBI Health Care Technical Paper at 10.

[29] See, Federal Communications Commission, In the Matter of Rural Health Care Support Mechanism Report and Order, December 12, 2012, Appendix B.

In addition, Kan-ed used its authority as a central purchasing agent and supplier of services to schools and libraries to maximize the benefits of the federal e-Rate program, under which school and library communication services are subsidized by the federal Universal Service Fund. The specific amount of each school district or library's funding is determined by both (1) the rural nature of the community and (2) the community's degree of poverty, as measured by participation in the federal free and reduced-price school lunch program. The e-Rate program is notoriously high in bureaucracy; applications and compliance efforts are very paperwork-intensive and a challenge for any small, under-resourced entity. Kan-ed, through central e-Rate planning and execution, enabled smaller institutions to participate in the program while relieving them of at least part of a considerable administrative burden.

4.4 Kan-ed Circuit Pricing Was Reasonable Relative to Alternatives

At the time that Kan-ed entered into a competitively bid contract with AT&T in 2007, the pricing it secured for its members was extremely competitive relative to the usual cost of T-1 circuits nationally. Even by today's standards, the pricing secured by Kan-ed was competitive and respectable.

In our experience, it was not unusual for a school or library to pay $1,500 per month for a T-1 in 2007, and very remote institutions might have faced costs many times that amount. The cost per month for a T-1 under the Kan-ed contract was $653. That cost included the use of a router and round-the-clock monitoring of the circuit by KanREN, Kan-ed's Network Operations Center contractor. For larger circuits, the cost rose, but still represented a discount from AT&T's usual pricing and was not in excess of what we have seen in other states.

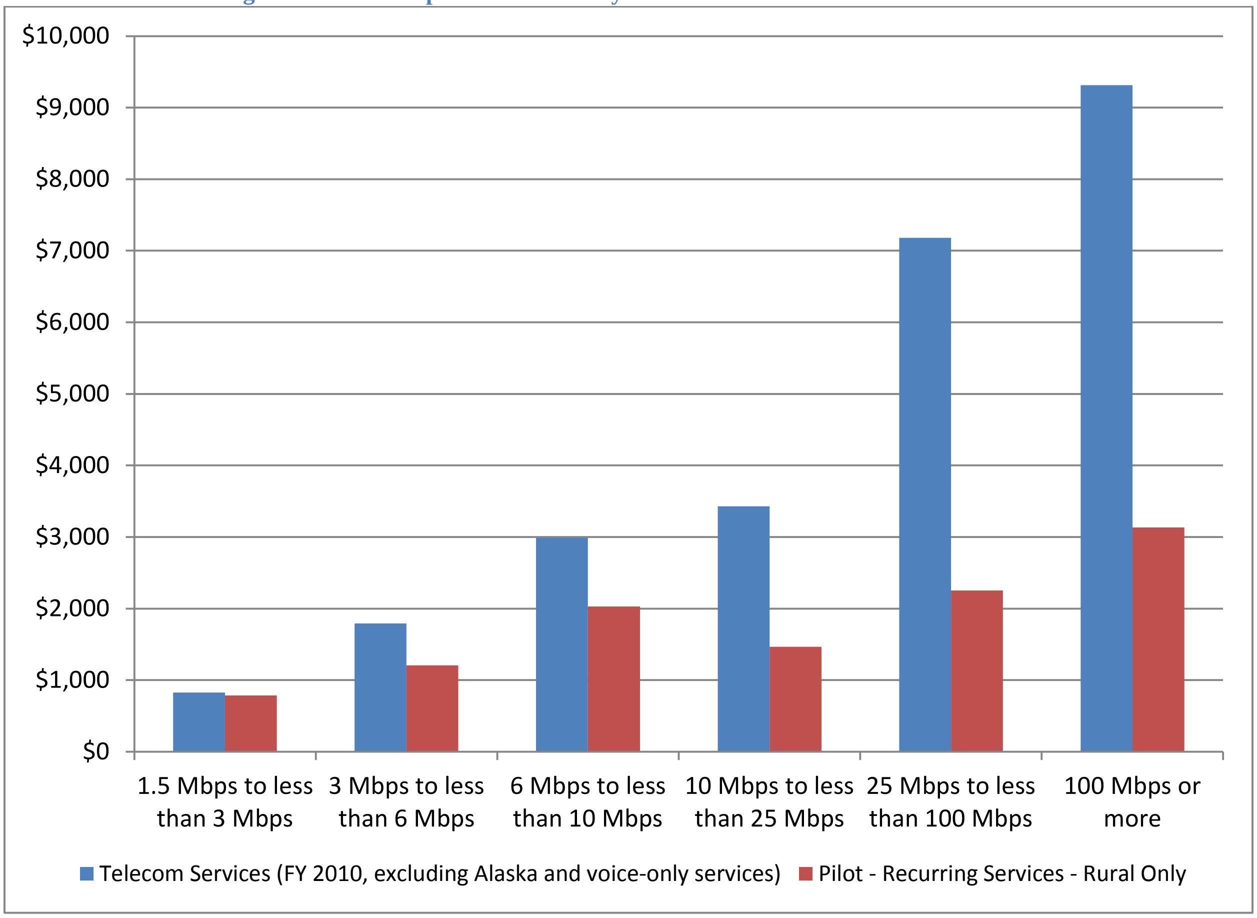
The Kan-ed pricing structure is summarized in Table 3. (MRC is the "monthly recurring cost.")

Table 3: Kan-ed Pricing Structure

Bandwidth	Port	QOS	Access	Availability	Router	Total MRC	Kan-ed MRC	End-User MRC
1.5 MB	$229.90	$45.98	$250.00	SW	$128.03	$653.91	$653.91	$0.00
3.0 MB	$334.40	$66.88	$500.00	SW	$128.03	$1,029.31	$529.31	$500.00
4.5 MB	$438.90	$87.78	$750.00	SW	$144.79	$1,421.47	$0.00	$1,421.47
6.0 MB	$504.90	$100.98	$1,000.00	SW	$144.79	$1,750.67	$0.00	$1,750.67
7.5 MB	$570.90	$114.18	$1,250.00	SW	$161.54	$2,096.62	$0.00	$2,096.62
9.0 MB	$631.40	$126.28	$1,500.00	SW	$161.54	$2,419.22	$0.00	$2,419.22
10.5 MB	$687.61	$137.50	$1,750.00	SW	$226.11	$2,801.22	$0.00	$2,801.22
10 MB DS3	$659.56	$131.89	$995.00	*	$380.99	$2,167.44	$0.00	$2,167.44
20 MB DS3	$975.75	$195.14	$995.00	*	$380.99	$2,546.88	$0.00	$2,546.88
30 MB DS3	$1,404.15	$280.83	$995.00	*	$380.99	$3,060.97	$0.00	$3,060.97
40 MB DS3	$1,694.00	$338.80	$995.00	*	$380.99	$3,408.79	$0.00	$3,408.79
45 MB DS3	$1,769.90	$353.98	$995.00	*	$380.99	$3,499.87	$0.00	$3,499.87

As one basis for comparison, the Federal Communications Commission recently released a summary of average pricing for rural health care facilities under its Telecommunications Program. The summary shows average costs for bandwidth equivalent to a T-1 of approximately $800[30] as compared to the $653 paid by Kan-ed members. Similarly, the FCC's analysis shows average costs for 3 to 6 Mbps of approximately $1,800, as compared to Kan-ed's pricing of $1,029 to $1,750.

Figure 4: FCC Comparison of Monthly Cost for Rural Health Care Providers[31]



Source: FCC

[30] The analysis compared rural health care providers in the FCC's health care funding pilot program to rural providers receiving funding from the FCC's long-standing Telecommunications Program. *See:* FCC Report and Order in the Matter of Rural Health Care Support Mechanism, Dec. 21, 2012, WC Docket No. 02-60. http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-12-150A1.pdf

[31] *Ibid.* at 44.

4.5 The Kan-ed Model Did Not Keep Pace with Technological Change; Migration to Higher Bandwidth Options Is Necessary to Meet the Needs of Kansas Schools, Libraries, and Hospitals

For all these accomplishments, over time, Kan-ed's pricing and technical structure unfortunately had unintended consequences that tended to slow migration to higher bandwidth options by Kansas schools, libraries, and hospitals.

First, Kan-ed's choice of the T-1 circuit, a reliable but low-bandwidth circuit, as the basic circuit over which to serve schools, libraries, and hospitals may have been adequate in Kan-ed's early years, but is inadequate at the current time, given the bandwidth needs of these organizations.

Second, Kan-ed's policy of providing free access to T-1s but charging for higher-bandwidth circuits had the unintended effect of incentivizing schools, libraries, and hospitals to utilize these inadequate T-1 circuits rather than upgrading at their own cost.

Kansas schools, libraries, and hospitals are, relative to their counterparts in much of the country, at a disadvantage in the year 2013 if they receive their communication services over a T-1 circuit. The T-1 represented the state of the art in connectivity for schools, libraries, and hospitals in the 1990s, but is universally considered inadequate as of recent years.[32] As is discussed in detail in Section 6 of this report, existing online applications require exponentially higher bandwidth for such key community anchor institutions such as schools, libraries, and hospitals. As the Schools, Health & Libraries Broadband (SHLB) Coalition has noted, "anchor institutions need significantly more capacity than residential locations, given the number of users utilizing the network at a given time and the types of transmissions those users are likely to need to complete."[33]

Furthermore, the associations that represent these anchor institutions in matters of technology and telecommunications have strongly recommended that schools, libraries, and hospitals have a minimum of a gigabit of network capacity. (The term "gigabit" is shorthand for 1 gigabit per second—equivalent to 1,000 Mbps—and describes a connection that offers hundreds of times the speed of a T-1 line).[34]

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[32] *See*, for example: Fox, C., Waters, J., Fletcher, G., & Levin, D. (2012). The Broadband Imperative: Recommendations to Address K–12 Education Infrastructure Needs." Washington, D.C. State Education Technology Directors Association (SETDA). http://www.shlb.org/ckfinder/userfiles/files/The_Broadband_Imperative%20-%20SETDA%20-%20May%202012.pdf.

[33] Comments of the SHLB Coalition in the Matter of AT&T and NCTA Petition on Transition from Legacy Transmission Platforms to Services Based on Internet Protocol, GN Docket 12-353.

[34] *See*, for example: "Gbps," TechTerms.com. http://www.techterms.com/definition/gbps.

The T-1, in other words, represented a viable and useful means of connectivity in past years, but has grown obsolete for major institutional needs. Unfortunately, the fact that even until 2012 the default offering for Kan-ed connectivity was a T-1 had the effect of reinforcing the idea that this size circuit was sufficient. Kansas schools, libraries, and hospitals would ideally have migrated to higher-capacity circuits by now.

The T-1 problem was compounded by Kan-ed's pricing structure, which unfortunately had the effect of disincentivizing upgrades of network circuits among the member organizations. The pricing structure was extremely well-intentioned; it sought to make a basic level of connectivity affordable for all schools, libraries, and hospitals. However, the allocations had some unintended consequences.

Kan-ed provided access to a T-1 circuit at no charge, but required the school, library, or hospital to pay for some or all of the circuits if they chose to upgrade to a higher capacity. To get a service above 4 Mbps, the school, library, or hospital was responsible for 100 percent of the cost. Kan-ed did facilitate communications between its member organizations and AT&T, and the aggregate buying power of Kan-ed almost certainly enabled the members to receive better pricing from AT&T than they would have received independently. And as an intermediate step, a school, library, or hospital could choose a 3 Mbps connection (two T-1 connections) and pay 50 percent of the cost, (effectively paying for one T-1 line while Kan-ed paid for the other).

But for some schools, libraries, and hospitals with limited resources, this pricing structure created the incentive to stick with the insufficient T-1 circuit, especially since the Kan-ed funding disappeared at 4 Mbps and above. As a result, Kan-ed's generous funding for the T-1 served to incentivize the continued use of the T-1, rather than migration to more capable circuits.

In part as a result of this structure, 70 percent of Kan-ed's members who chose to connect to the Kan-ed network did so over a T-1. The remaining 30 percent chose to connect over higher speeds, even though those connections entailed costs to the institution.[35]

[35] Based on the data provided to CTC by Kan-ed, the following summarizes the number of members and their selected connection speeds as of early 2012:

Connection Speed	Number
T-1 (1.54 Mbps)	285
3.088 Mbps	76
4.632 Mbps	7
6 Mbps	18
7.72 Mbps	2
9 Mbps	8
10 Mbps	3
12 Mbps	3
15 Mbps	2
20 Mbps	3
30 Mbps	2
45 Mbps	3

5 Emerging Models in Other States Focus on Fiber Optics and Very High Bandwidth to Schools, Libraries, and Hospitals, in Partnership with Private Companies

This section of the report presents case studies of statewide networks in other states, as a benchmark by which to evaluate how Kansas schools, libraries, and hospitals' broadband needs are met. We looked in particular at Kansas' neighboring states (Colorado, Oklahoma, Missouri, and Nebraska) and other states with large rural areas that face comparable challenges to Kansas (Utah and North Carolina).

We find that, over the past decade, most states have migrated their Kan-ed-type networks to new platforms and infrastructures that offer far greater bandwidth. These new offerings tend to require the most robust possible infrastructure, usually in the form of fiber optics. As a result, statewide networks have worked to deploy backbones over fiber and to extend offerings over fiber to schools, libraries, and hospitals wherever possible. This trend is apparent in the case studies presented below: whether the fiber is owned by the statewide network or leased, all of the networks described here require fiber in order to deliver the tremendous speeds and services that are their hallmark.

Another trend among these networks is that most of them seek to use state and local funds as leverage to maximize the amount of the federal Universal Service funds flowing into their state. In a minority of cases including Missouri, state funds have been reduced or eliminated in the recent economic crisis, but in most of the states, including Oklahoma, North Carolina, Georgia, and Utah, the state is still an active funding partner to the statewide network.

The case study networks vary in their structures and governance models. Like Kan-ed, many are public networks, housed in the state Board of Regents or another agency of state government. These include the Utah Education Network, Ohio Academic Resources Network, and Network Nebraska. Some are private non-profit corporations that receive public funds to serve public institutions but are independent with respect to governance. These include MCNC in North Carolina and MOREnet in Missouri.

5.1 Utah

Utah Education Network[36] is a state agency, funded by the state legislature for 50 percent of total operating costs ($17 million per year). An additional 35 to 40 percent of its operating budget comes from maximizing the e-Rate program, and the balance comes from grants.

[36] This case study is based on CTCs interview of Mr. Jim Stewart, Director of the Utah Education Network, January 28, 2013. CTC extends its thanks to Mr. Stewart for his time and consideration.

UEN does not charge its stakeholders for services, which receive services for free and thus avoid having to navigate the e-Rate program, which is cumbersome and complex—a great challenge in particular for less-resourced and smaller school districts. Indeed, the centralization of the e-Rate process (such that UEN applies for all its stakeholders) has increased the funding level for higher-income areas by enabling application under the statewide average and has maximized e-Rate for the state.

Scale also enables them to get better pricing for individual stakeholders. UEN serves public education, higher education, most state agencies, most libraries, and Head Start centers.

UEN operates a main backbone of 10 gigabits, with 1 gigabit spurs off the backbone to some remote areas of the state. The network has 1,400 endpoints and 1,200 miles of fiber optic infrastructure, the great majority of which is owned by the telephone company, CenturyLink. UEN leases circuits from CenturyLink and other providers, and has the benefit of having developed a competitive environment; for example, CenturyLink recently dropped its prices dramatically in response to competition from other carriers.

A decade ago, as it migrated from T-1s to Gigabit Ethernet services (600 times the speed of a T-1), UEN paid its private carrier approximately $1,500 to $3,000 per line. On average, UEN now pays CenturyLink $800 to $1,200 per circuit (its most costly circuits, which are outliers, are $2,500—still $300 less per circuit than the cost of a tariffed T-1).

UEN has found that its stakeholders can quickly learn new applications and devise new ways to utilize huge amounts of bandwidth. UEN's Director, Jim Stewart, strongly rejects that idea that schools do not need gigabit services and more. To the contrary, he notes, the big bandwidth gives them the opportunity to learn, experiment, and never ration their use. For major events, such as a presidential inauguration or other key civic event, every student in every classroom in the state can stream the event without risk to the quality or reliability of the service. And as one-to-one computing and bring-your-own-device (BYOD) initiatives expand throughout educational settings, the higher bandwidth will be essential, not optional.

5.2 Ohio

The State of Ohio has invested approximately $13 million to upgrade its existing academic network to operate at 100 Gbps speeds.[37] The Ohio Academic Resources Network (OARnet) is a state owned and operated fiber network that primarily serves research and academic

[37] This case study is based on the following sources: Mulholland, Jessica. Ohio Launches State's New Ultra-Fast Broadband Network," December 11, 2012, *Government Technology,* http://www.govtech.com/wireless/Ohio-Launches-States-New-Ultra-Fast-Broadband-Network.html; Nelson, George. "Kasich Lights Upgraded Broadband Network," December 12, 2012, *The Business Journal,* http://businessjournaldaily.com/economic-development/kasich-lights-upgraded-broadband-network-2012-12-12; Ohio OARnet, https://www.oar.net/.

institutions. It also provides connectivity for community and university hospitals, K-12 schools in some urban areas, state and local government agencies, and public broadcasting stations.

OARnet fiber is a state owned network governed by the Ohio Board of Regents. It connects Ohio's colleges and universities and their associated research institutions and hospitals. By expanding OARnet's capacity to 100 Gbps, the state seeks to accommodate the need for transferring enormous datasets among research institutions, university hospitals, and other institutions and private partners engaged in high level research. The OARnet backbone connects the cities of Akron, Athens, Cincinnati, Cleveland, Columbus, Dayton, Portsmouth, Toledo, Wooster, and Youngstown.

Significantly, OARnet provides the state's access points for Internet2, the expanding network for non-profit, academic, and government collaboration. Internet2 is itself 100 Gbps; therefore, OARnet's upgrade to 100 Gbps capacity gives Ohio researchers the ability to harness the full potential of Internet2, and ensures that they will not be the limiting factor when it comes to the speed of collaboration with other institutions across the country.

On the private industry side, OARnet provides service to companies collaborating with the academic and research community in Ohio. The service is provided on a cost-recovery basis, which serves as an incentive for companies to partner with Ohio institutions over other potential locations. With the increase to speeds of 100 Gbps, companies and researchers can collaborate on a much broader range of emerging technologies and applications.

OARnet users, connected across 1,850 miles of fiber, will be linked in to a new Network and Innovation Center located at the Ohio State University. This $2.3 million project, developed as a public-private partnership, will focus specifically on developing technologies for 100 Gbps capacity and working in collaboration with the Ohio Supercomputer Center.

5.3 North Carolina

In North Carolina, the state funds participation by schools statewide in a program operated by MCNC.[38] MCNC is an independent non-profit that operates the North Carolina Research and Education Network (NCREN). NCREN connects all K-12 school districts, community colleges, universities, and some non-profit health care sites throughout North Carolina "to each other, the Internet, and global research networks at very high speeds."[39]

NCREN has built its own fiber optic network (funded in part with federal grants and in part with local contributions from the public and private sectors) to all Internet Points of Presence in the state and also to many of the school district buildings throughout the state. Where it has not

[38] Unless otherwise noted, this case study is based on CTC's interview with Mark Johnson, MCNC Chief Technology Officer, in December, 2012. CTC extends its thanks to Mr. Johnson for the information and time.
[39] MCNC.org.

built its own fiber, MCNC has leased dark fiber from the private sector (and in turn makes available to the private sector dark fiber within its owned footprint).

The state funds the participation of K–12 at the level of $20 million per year to fund the portion of the schools' costs that are not covered by the federal e-Rate program. Among other benefits, this strategy maximizes the benefit of the e-Rate program for North Carolina schools by increasing the level of services delivered to the schools; by eliminating the burdens of navigating the e-Rate program by individual schools because it is all centrally managed (by the North Carolina Department of Public Instruction); and by centralizing planning in expert hands to address e-Rate. In turn, the schools are obligated to utilize their savings on technology projects, such as providing devices and services to students and faculty, that are not covered by the e-Rate program.

This program resulted from a study commissioned by the state that sought new strategies for realizing the potential of broadband for North Carolina schools. What the study determined was that (as is the case in Kansas now) each school district was contracting independently for its services. As a result, there was no economy of scale and a very low quality of communications between and among the schools.

The study recommended connecting all the school districts to NCREN so they could communicate among each other, as well as to the outside through the public Internet. The study led to a detailed planning project and eventually to the very successful initiative to connect school district buildings.

The funding includes engineering services by MCNC staff to provide assistance to the school districts; to do network assessments; to support technology migration; and to plan how to realize the benefits of the broadband networks. There is no cost to the school districts, and the program ensures they get centralized, trustworthy third-party support on which they can rely.

Among other accomplishments, the program has resulted in:

- Dramatic increase in the amount of federal e-Rate money flowing into North Carolina
- A seven-fold increase in utilization of Internet by schools in North Carolina
- The impressive milestone reached that 100 percent of school districts have at least 100 megabits per second Internet bandwidth (for an average of four schools per district)
- 75 of 125 districts have elected to take more than the base offering of 100 Mbps

The K–12 initiative has been so successful that the community college system (representing 58 colleges) elected also to move to NCREN and specifically asked for the same engineering support. The state's libraries are eligible to connect, but they are currently not funded by the state to participate, and receive no centralized support.

The system has also created new business and new revenues for local phone companies, who are partners in the program. MCNC's connection is only to the school district location, and then the local company provides the connectivity from the district building to the schools themselves. With the increase in use by the schools, these companies have seen the volume of business they are doing with schools increase dramatically, resulting in an outcome in which all parties benefit.

In the health care area, MCNC also operates the North Carolina telehealth network, which is funded through FCC discounts, and enables high bandwidth services to non-profit health care facilities.

5.4 Colorado

In Colorado, schools and libraries are anticipating service from EAGLE-Net, a public middle-mile fiber optic network currently under construction throughout Colorado. It was funded partially through a federal BTOP grant[40] and partially through local "match" obligations. In keeping with the funding parameters of the federal BTOP program, EAGLE-Net's fiber is designed to bridge gaps and deliver high-bandwidth connectivity all the way from the Internet backbone to rural communities, schools, libraries, hospitals, and government buildings,[41] enabling middle-mile access (backhaul) for local providers throughout the state and bringing some measure of parity to rural areas and rural anchor institutions relative to those in metropolitan areas.

The EAGLE-Net grant was awarded for middle-mile communications facilities to connect regions and neighborhoods to each other and to the Internet backbone—at the same time as connecting community anchor institutions over the new, enhanced communications facilities.[42] EAGLE-Net was required to commit to interconnection and non-discrimination obligations that would enable many, competing providers to use the new federally-funded infrastructure—and to ensure that monopolies would not be created or perpetuated in the middle-mile.[43]

[40] The term "BTOP" refers to the Broadband Technology Opportunities Program. BTOP is one of the two broadband funding programs created by the passage of the American Recovery and Reinvestment Act of 2009 (ARRA). It is administered by the National Telecommunications and Information Administration (NTIA) of the U.S. Department of Commerce.

[41] The term community anchor institution refers to "schools, libraries, medical and healthcare providers, public-safety entities, community colleges and other institutions of higher education, and other community support organizations and agencies that provide outreach, access, equipment and support services to facilitate greater use of broadband service by vulnerable populations, including low-income, unemployed, and the aged." Dep't of Agriculture, Rural Utilities Service, 74 Fed. Reg. 33104, 33107, July 9, 2009, "Broadband Initiatives Program; Broadband Technology Opportunities Program; Notice" (http://www.ntia.doc.gov/files/ntia/publications/fr_bbnofa_090709.pdf) (accessed Nov. 2, 2012).

[42] *Notice of Funds Availability.* Federal Register/Vol. 74, No. 130, p. 33108. July 9, 2009, http://www.ntia.doc.gov/files/ntia/publications/fr_bbnofa_090709.pdf (accessed Nov. 2, 2012).

[43] *Id*.

EAGLE-Net is an intergovernmental entity that developed from the efforts of the Centennial Board of Cooperative Educational Services (CBOCES) to expand broadband in Colorado.[44] The program has the support of the governor of Colorado, as well as the state's congressional delegation.

The CBOCES had previously served as an aggregator and broadband service provider for Colorado school districts and, in that capacity, identified that Colorado school children, on average, had less access to bandwidth than their counterparts in other states and that Colorado ranked 42nd among US states in broadband.[45] BOCES staff developed EAGLE-Net to meet that need and expanded to include other anchor institutions and broadband users (such as health care) in keeping with the requirements of BTOP's enabling legislation and related grant requirements.

As in North Carolina, the program is intended to benefit the private sector as well as the community anchors that will be served over EAGLE-Net. Ideally, the program will create new business and new revenues for local phone companies, will partner with EAGLE-Net to distribute the connectivity from the district building to the schools themselves (while EAGLE-Net delivers the services to the district building).

5.5 Georgia

The Georgia Statewide K–12 Network provides bandwidth to every public school district in the state. This network does not serve other types of institutions or end-users. The Georgia Department of Education planned and built the network, but the service itself is provided by a private company (AT&T).[46] The network offers a minimum connection speed of 3 Mbps per school, which is a very limited amount of bandwidth for large institutional use. However, the network does not exclude any part of the state, including state and charter schools.[47] So, while limited in speed and scope, the network achieves close to universal service for its target institutions. The state budgets $3.3 million for the K12 network which supplements the schools' $7.5 million in federal e-Rate funds, according to the State Education Policy Center.[48]

5.6 Nebraska

Network Nebraska[49] was authorized by the Nebraska state legislature in 2006, and is operated by the state's Chief Information Officer in partnership with the University of Nebraska. The network is "a statewide, multipurpose, high capacity, scalable telecommunications network"

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[44] See http://www.co-eaglenet.net/about-us/history/.
[45] *Id*.
[46] Statewide K12 Network, Georgia Department of Education, (http://www.gadoe.org/Technology-Services/Infrastructure/Pages/Statewide-K12-Network.aspx).
[47] Id.
[48] State Education Policy Center, (http://sepc.setda.org/state/GA/broadband/state-network/).
[49] All material in this case study is based on the information provided online by Network Nebraska. www.networknebraska.net.

under which the state government contracts with private providers for capacity and then provides services to state and local government agencies and educational entities.[50]

Access is mandated, by statute, to “each school district, each educational service unit, each community college, each state college, and the University of Nebraska” though participation is not mandated for educational entities.

Network Nebraska access begins at 30 Mbps.

The program was funded initially by the state, and users are also charged based on actual costs, which are reviewed by the state annually.

The Nebraska legislature provided for a mix of funding sources to support Network Nebraska users, including:

- Equipment reimbursements
- Hardware and software (and installation) purchases
- Distance education scheduling and training, an event clearinghouse, and administration of a learning management system
- Incentives for qualified distance education courses
- A technology allowance for school district access and transport charges equal to 85 percent of the difference between local system costs and the e-Rate funding amount

5.7 Oklahoma

Oklahoma’s statewide broadband network, OneNet, is a collaborative project of the Oklahoma State Regents for Higher Education and the Oklahoma Office of State Finance. OneNet operates as a public-private partnership between the state and private telecommunications providers. The network provides broadband service to “public and vocational-technical schools; colleges and universities; public libraries; local, tribal, state and federal governments; court systems; rural health care delivery systems; and programs engaged in research.”[51] It utilizes both fiber and wireless broadband technologies to deliver service.

In collaboration with other state agencies, OneNet and the State Regents received $74 million in federal grants in 2010 to expand broadband through underserved communities. The money is being used for a 1,000 mile build-out of fiber backbone. OneNet provides managed network services for older technologies types, including T-1 circuits; for dedicated Ethernet service of 10

[50] Neb.Rev.Stat. 86-5,100 [As amended by LB1071, § 43 (2010)].
[51] OneNet History, http://www.onenet.net/about-us/onenet-history/.

Mbps and up, however, users must contract with a telecom provider with a OneNet interconnection. Through these partnerships with private companies, OneNet provides its users with reduced rates over existing middle-mile and last-mile private networks.[52]

According to the State Education Policy Center, OneNet funds itself entirely through service charges to its institutional users. Schools receive support from the federal e-Rate program and the Oklahoma Universal Service Fund, but not from the state's general fund.[53]

OneNet's pricing schedule suggests that one of the benefits of its public-private model is an ability to hold rates at a consistent level across its membership organizations and across the state. Most of its service options list specific monthly or yearly rates, as well as installation fees, despite offering many of these services through a private telecommunications provider. Without the participation of a state-owned network backbone, these rates would almost certainly be higher, particularly for more rural and inaccessible sites.[54]

5.8 Missouri

The Missouri Research and Education Network (MOREnet) provides network services to Missouri's, universities, libraries, schools, and state and local agencies. Though MOREnet emerged as a state-funded program, it recently transitioned to an entirely member-funded model. MOREnet is a part of the University of Missouri, and in addition to providing Internet access and related support services also provides the state access to the Internet2 network, and offers e-Rate and other support services.

MOREnet was the country's first statewide education network.[55] It began with twelve colleges and university charter members, and grew rapidly with significant state funding. In the late 2000s, MOREnet migrated its members to a fiber optic network, which today provides 10 Gbps speeds.

While initially MOREnet was focused on its primary goal of providing Internet access and application sharing among its members, it continued to add new services, such as video conferencing support and managed networking.

MOREnet remained almost 50 percent state funded up until 2009, but the onset of the financial crisis led to a dramatic change in the network's funding model. The Missouri governor had the authority to withhold state appropriations from MOREnet, and in 2010, the MOREnet lost its entire allocation in this way. MOREnet went from receiving $12 million in state support to nothing at all in the course of just two years.[56] In order to continue serving its members,

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[52] Id.
[53] State Education Policy Center, (http://sepc.setda.org/state/OK/broadband/state-network/).
[54] OneNet Rates/Pricing, http://www.onenet.net/services/rates-and-pricing/.
[55] "MOREnet 20 Years and Beyond," The Quilt, (http://www.thequilt.net/index.php/member-spotlight/214-morenet-20-years-and-beyond).
[56] MOREnet FY2010 Annual Report, (http://www.more.net/pdfs/FY10_annualreport-110404.pdf).

MOREnet had to become entirely member-funded, requiring significant hikes in service and membership fees. Some members saw their costs go up by more than 400 percent.[57] The cuts had a particularly high impact on K-12 schools.

Impressively, MOREnet retained about 97 percent of its members through this transition.[58] MOREnet continued to add additional services, such as disaster recovery, cloud computing, and network backup. Offering e-Rate consulting services helps its K-12 and library members maximize federal subsidies, making MOREnet membership financially worthwhile for organizations in need of resources. MOREnet continues to operate on this member-funded model without taxpayer support, and served over 700 member institutions in FY2012.[59]

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[57] "MOREnet 20 Years and Beyond," The Quilt, (http://www.thequilt.net/index.php/member-spotlight/214-morenet-20-years-and-beyond).
[58] Id.
[59] MOREnet FY2012 Annual Report, (http://www.more.net/sites/default/files/fy12ar_121029.pdf).

6 The Need for Bandwidth by Schools, Libraries, and Hospitals Is Growing Dramatically Nationwide

Nationally, the need for bandwidth by schools, libraries, and hospitals is growing dramatically and is fundamental to state and local interests. The Federal Communications Commission's (FCC) National Broadband Plan establishes as one of the nation's key goals that "[e]very community should have affordable access to at least 1 gigabit per second broadband service to anchor institutions such as schools, hospitals, and government buildings."[60] Such speeds are increasingly needed to support the growing demand for high-speed Internet access in education, public libraries, and medicine. Networks around the United States are taking steps to realize—and surpass—this goal. For instance, in December 2012, Ohio Governor John Kasich announced the completion of a 100 Gbps broadband network—a tenfold increase in speed and capacity from the existing (10 Gbps) infrastructure. The expanded network is expected to unleash "unlimited potential for the state of Ohio."[61]

As the FCC has concluded, "smaller providers generally can achieve satisfactory health IT adoption with mass-market packages of at least 4 Mbps for single physician practices and 10 Mbps for two-to-four physician practices."[62]

For larger locations, however, the FCC found that a "typical rural health clinic with five practitioners should have at least 10 Mbps, while hospitals should have at least 100 Mbps."[63]

Table 4: Bandwidth Requirements to Achieve Full Functionality of Health IT Applications[64]

Text-Only HER	Remote Monitoring	Basic e-mail + Web browsing	SD Video Conferencing	HD Video Conferencing	Image Transfer (PACS)
.025 Mbps	.5 Mbps	1.0 Mbps	2.0 Mbps	>10 Mbps	101 Mbps

NTIA has found that "based on studies by state education technology directors, most schools need a connection of 50 to 100 Mbps per 1,000 students. The FCC has found that only 63 percent of schools have available to them download speeds of at least 25 Mbps.[65]

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[60] National Broadband Plan: Connecting America, Goal 4. http://www.broadband.gov/plan/goals-action-items.html

[61] Jessica Mulholland, "Ohio Launches State's New Ultra-Fast Broadband Network," *Government Technology,* December 11, 2012. http://www.govtech.com/wireless/Ohio-Launches-States-New-Ultra-Fast-Broadband-Network.html

[62] National Broadband Plan at 211.

[63] OBI Health Care Technical Paper at 6.

[64] *Ibid.*, at 5.

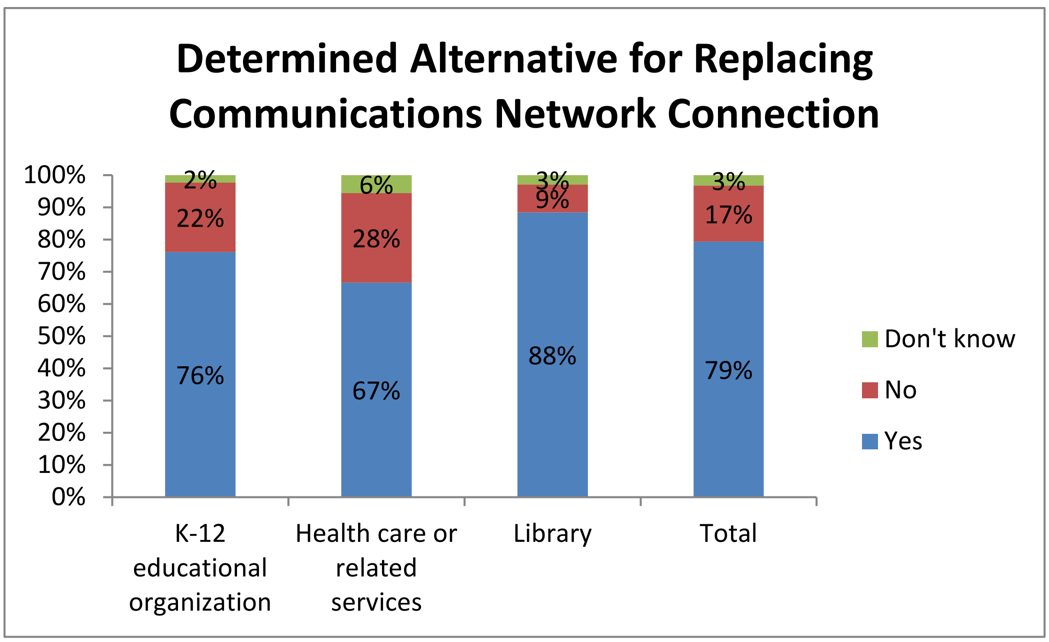
[65] Federal Communications Commission, Eighth Broadband Progress Report, In the Matter of Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of the Telecommunications Act of 1996, as Amended by the Broadband Data Improvement Act, August 14, 2012, GN Docket No. 11-121, at 133.

6.1 Kansas Schools, Libraries, and Hospitals Indicate Fast-Growing Needs for High-Bandwidth Services

The sections below demonstrate the many applications that schools, libraries, and hospitals use (and will use in the future) that require higher bandwidth. Kansas schools, libraries, and hospitals have indicated that they understand this in the interviews we conducted with individual stakeholders and the entities that represent them, including the Kansas Hospital Association, the State Library of Kansas, the Kansas State Board of Education, and the Kansas Board of Regents.

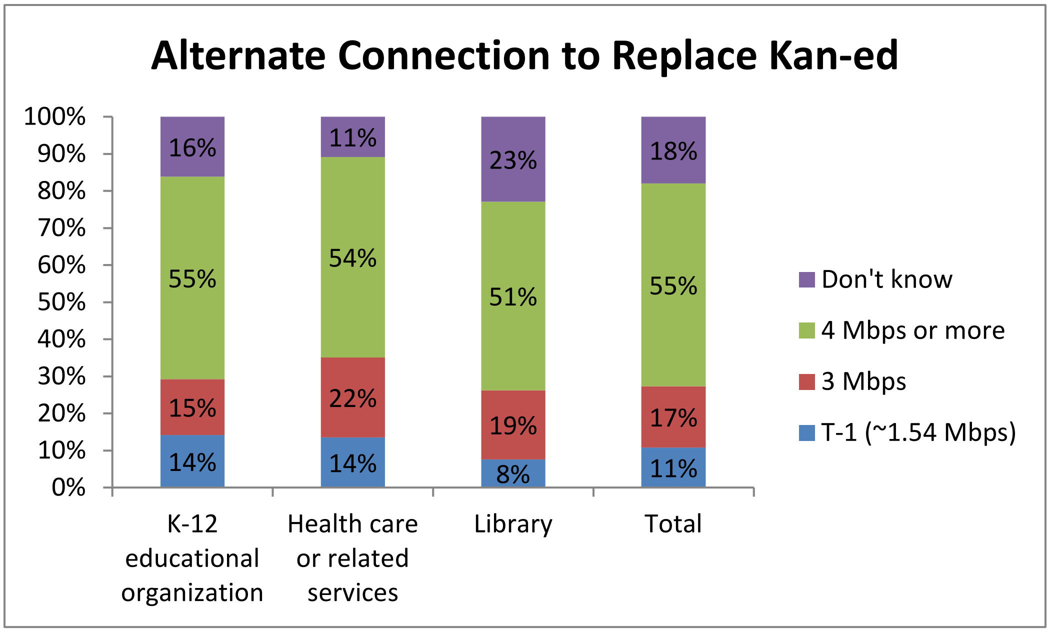
We also see this understanding in the survey data. From 67 percent to 88 percent of the schools, libraries, and hospitals that were previously connected to Kan-ed have determined an alternative to that service (Figure 5).

Figure 5: Kan-ed Members That Have Determined Alternative for Replacing Service



The majority of those entities have selected products with speeds in excess of a T-1, which was the speed to which 70 percent of Kan-ed providers subscribed—in part because it was provided at no cost. (See Figure 6.)

Figure 6: Alternate Connection to Replace Kan-ed



This move toward higher bandwidth after the decommissioning of the Kan-ed network appears to be occurring across the State, and is not geographically isolated. The following two maps demonstrate this change. The first map (Figure 7) illustrates the survey respondents that were connected to Kan-ed, and the speed at which they indicated they were connected. The second map (Figure 8) shows the speed at which they indicate they are replacing their Kan-ed service. The replacement speeds are higher, and are geographically dispersed throughout the State.

Figure 7: Respondents' Kan-ed Connection Speeds

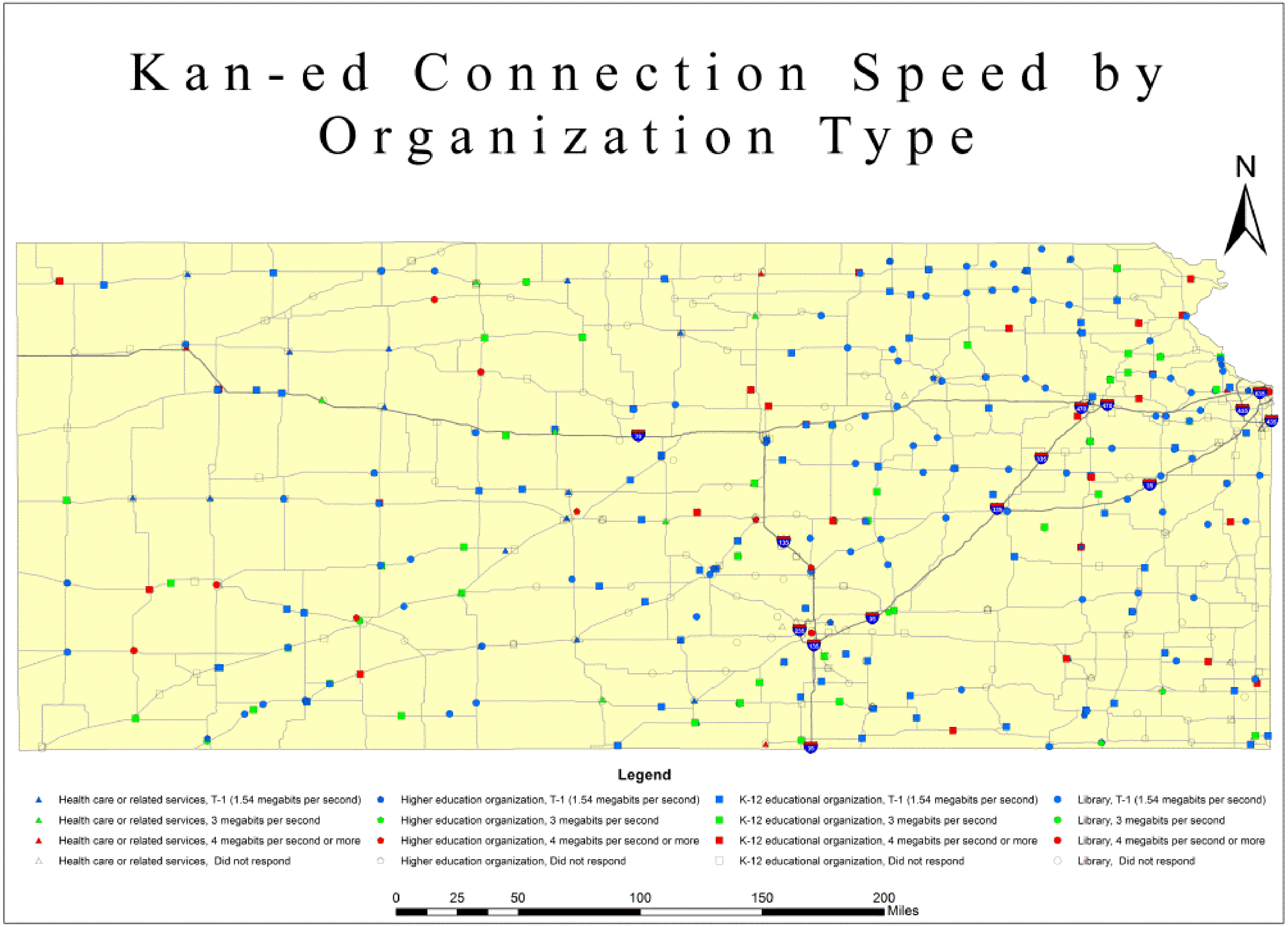
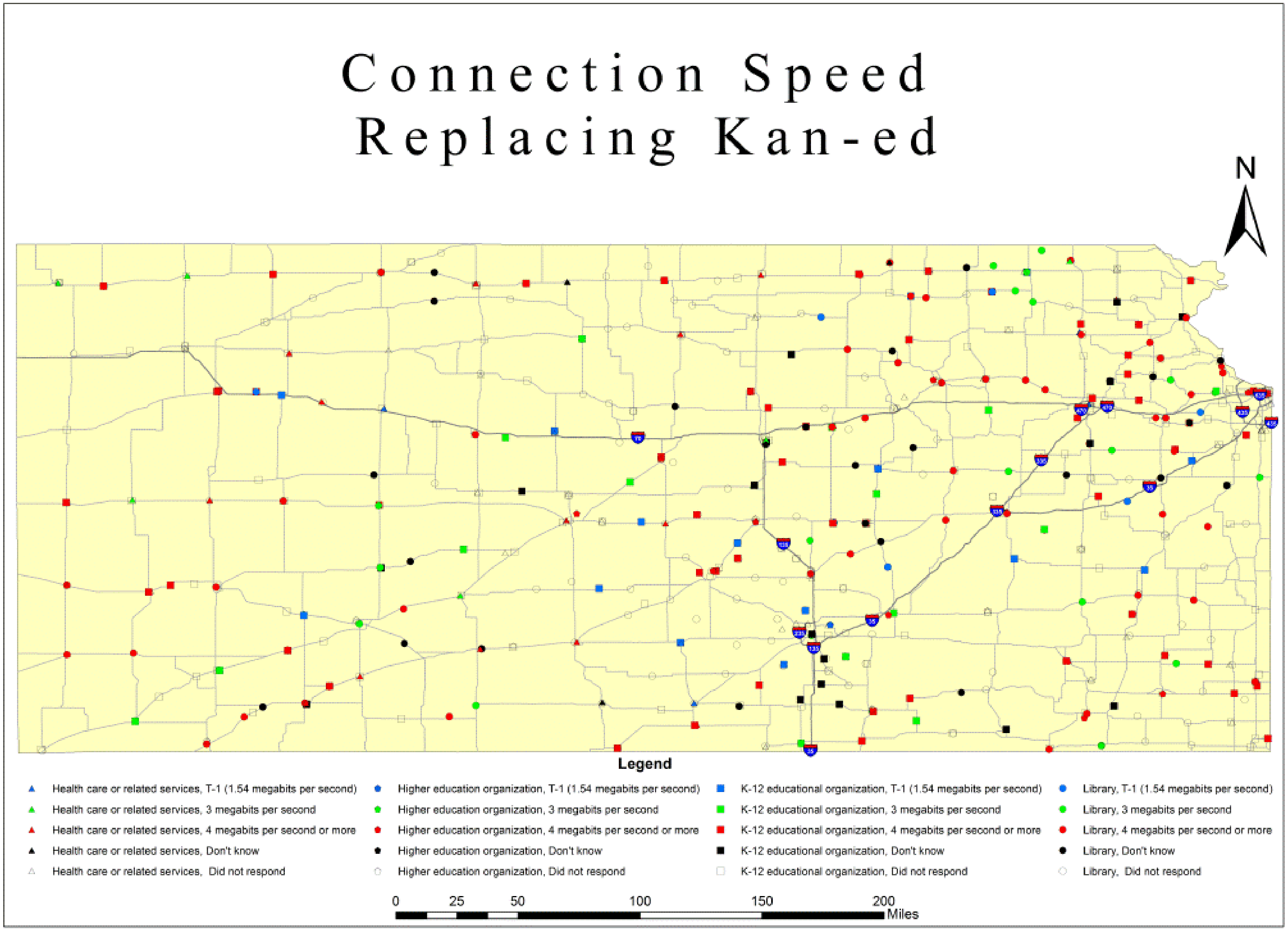


Figure 8: Respondents' Replacement Connection Speeds

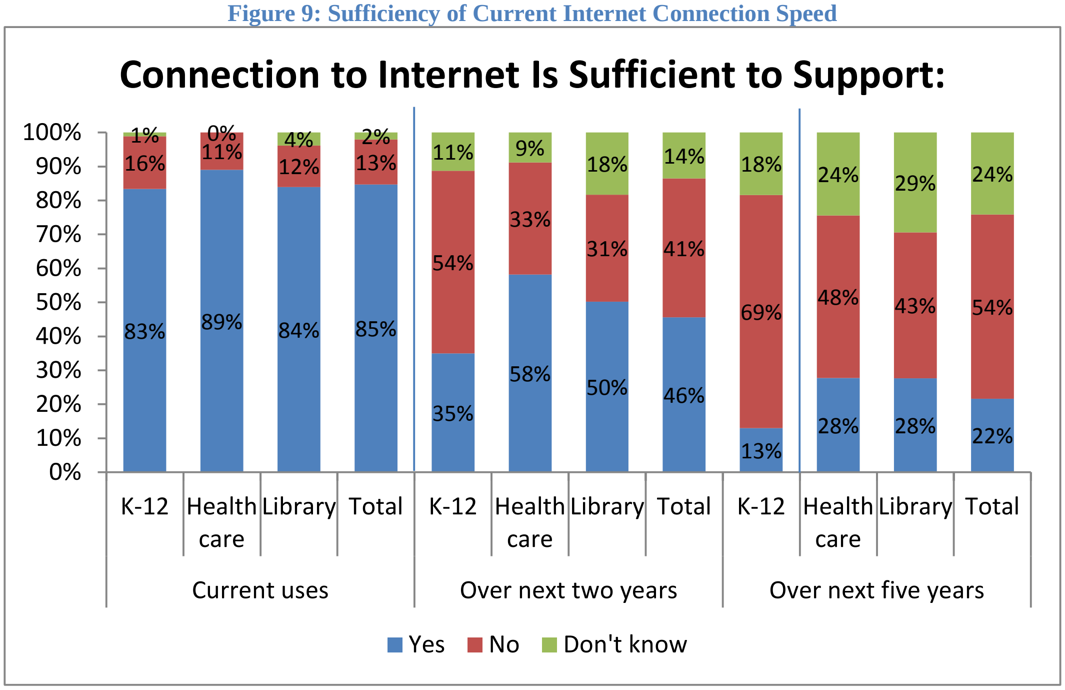


This conclusion is reinforced by reporting from KanREN, which has worked with a large number of Kan-ed members in recent months to attempt to secure alternative connectivity after the decommissioning of Kan-ed. According to KanREN's executive director, Cort Buffington, of the many hundreds of institutions, only three requested pricing for a T-1 circuit.[66]

While it is important to note, as we have elsewhere in this report, that higher bandwidth products may, if they are mass-market, consumer-grade products, hold certain deficiencies relative to the reliability and symmetrical speed of a Kan-ed T-1 circuit, there is nonetheless a clear pattern here of Kan-ed members seeking higher bandwidth than the majority of them received from Kan-ed.

In other words, mass market, consumer-grade products are insufficient to meet the needs of schools, libraries, and hospitals. In our survey, nearly one-half of respondents indicated that their Internet connection speed was insufficient to meet their current needs, while the balance (55 percent) indicated that it was adequate. (See Figure 9.)

Figure 9: Sufficiency of Current Internet Connection Speed



[66] Interview with Cortney Buffington, Executive Director of KanREN, Inc., January 25, 2013.

6.2 High Bandwidth Needs in Education

A significant number of the nation's schools suffer from inadequate Internet access. Insufficient bandwidth precludes creative and expansive online learning, such as video conferencing or collaborative work. Such schools are restricting classroom use of broadband applications like streaming video to preserve bandwidth. As the Benton Foundation explains:

> Distance learning over broadband is a distant dream. Online curricula is offline. Teachers are insufficiently trained to use technology in their classrooms, so that whatever technology is available to them languishes. Students are taught the basic 3 Rs, as required by the No Child Left Behind Act, but not the digital skills that will enable them to translate those 3 Rs into success in today's Information Age.[67]

"The content-rich world in which we live requires bandwidth to view it."[68] Yet, according to the 2008 America's Digital Schools report, 37 percent of school districts anticipate a problem obtaining sufficient bandwidth and the majority have already implemented policies to conserve bandwidth by limiting student Internet use.[69] Although a 2010 FCC survey of e-Rate funded schools found the majority of respondents had some level of Internet access, nearly 80 percent of respondents reported insufficient bandwidth for educational needs.[70] Despite these problems, Internet proficiency is assumed at the college level, leaving many children at an educational disadvantage. These problems will only grow as more schools adopt more bandwidth-intensive practices.

In no more than a few years more, hard-copy text books will cease to be printed in favor of electronic textbooks. This process is underway in Korea with a fixed deadline. The U.S. Federal Communications Commission (FCC) has challenged the private sector to enable this process by 2015.[71] At a recent conference, FCC Chairman Julius Genachowski urged the nation to "step up [its] efforts to realize the promise of this new technology in the U.S."[72] States around the

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[67] Jonathan Rintels, "An Action Plan for America: Using Technology and Innovation to Address Our Nation's Critical Challenges," The Benton Foundation, 2008, at 20. http://www.benton.org/initiatives/broadband_benefits/action_plan.

[68] Edwin Wargo, "2008 Digital Schools Report and Bandwidth," *The Brute Thing*, May 16, 2008. http://edtecheconomics.blogspot.com/2008/05/ed-tech-trends-report.html.

[69] Meris Stansbury, "Researchers Identify Key Ed-Tech Trends," *eSchoolNews*, May 15, 2008. http://www.eschoolnews.com/2008/05/15/researchers-identify-key-ed-tech-trends/. (Summarizing Thomas W. Greaves and Jeanne Hayes, "America's Digital Schools Report 2008: The Six Trends to Watch.")

[70] Fox, *et al.,* 2012, "The Broadband Imperative: Recommendations to Address K–12 Education Infrastructure Needs," Washington D.C.: State Educational Technology Directors Association (SETDA), at 2. http://www.setda.org/c/document_library/get_file?folderId=353&name=DLFE-1515.pdf.

[71] "FCC Chairman Genachowski Joins Secretary of Education Duncan to Unveil New 'Digital Textbook Playbook,' A Roadmap for Educators to Accelerate the Transition to Digital Textbooks," News Release, Federal Communications Commission. http://transition.fcc.gov/Daily_Releases/Daily_Business/2012/db0201/DOC-312244A1.pdf.

[72] Katie Ash, March 29, 2012, "U.S. Officials Tackle National Adoption of Digital Textbooks," *Education Week* (Blog), March 29, 2012. http://blogs.edweek.org/edweek/DigitalEducation/2012/03/fcc_lead_and_doe_discuss_digit.html.

country are seizing this challenge. In September 2012, the California state Senate approved SB 1052 and SB 1053, requiring the University of California, the California State University, the California Community Colleges, and other private institutions to find or develop open education resources for students. The legislation is intended to reduce textbook costs for students, saving students at participating universities as much as $1,500 annually. The bills are currently awaiting consideration by the California State Assembly.[73] Such initiatives would not be possible without sufficient bandwidth to support online viewing.

A growing number of states are beginning to administer tests to their students online. The State Educational Technology Directors Association (SETDA) reports that at least 33 states are already delivering at least one test via technology. Moreover, the Department of Education is advocating for a greater use of online testing through the Common Core State Standards initiative, which requires schools in 46 states and the District of Columbia to "administer 'next generation' assessments almost exclusively online."[74] The new assessments for the "Smarter Balanced" and "Partnership for the Assessment of College and Career Readiness" (PARCC) consortia will be conducted electronically by 2014. Moreover, national guidelines require that once such online assessments are implemented, all students in a grade must take the tests (which will include high-definition videos and sound files) simultaneously,[75] leading to greater network traffic during testing. In fact, the Center for Digital Education explains, "adherence to Common Core guidelines will force school districts across the nation to rethink the way they handle networking and computing in a number of mission-critical areas."[76] (See Figure 10.)

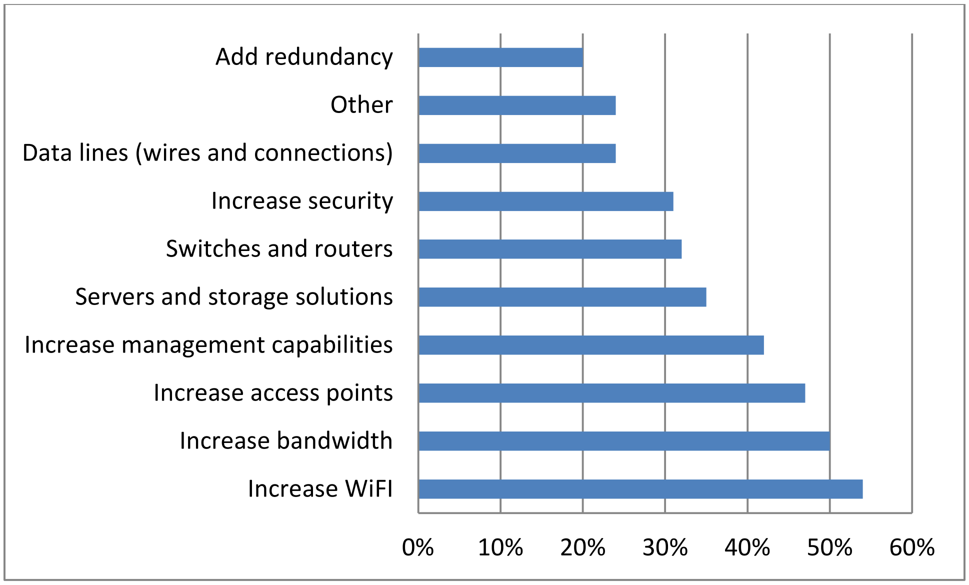
[73] Levon Massian, June 3, 2012, "State Senate Advances Bills that would Create Free Online Textbook Library," *The Daily Californian,* June 1, 2012. http://www.dailycal.org/2012/06/01/state-senate-advances-bills-that-would-create-free-online-textbook-library/.

[74] Ian Quillen, "Bandwidth Demands Rise as Schools Move to Common Core," Education Week: Digital Directions, October 17, 2012, Vol. 6. at 19-20. http://www.edweek.org/dd/articles/2012/10/17/01bandwidth.h06.html.

[75] Center for Digital Education, "Preparing for the Common Core State Standards: School districts face an opportunity to reinvest in network infrastructure," at 2 (http://images.erepublic.com/documents/CDE12+STRATEGY+Comcast_V.pdf)

[76] *Id.*

Figure 10: Networking Upgrades Needed for Online Assessments[77]



In anticipation of this transition, SETDA recommends that schools have external Internet connections to an Internet service provider of 100 Mbps for every 1,000 students and staff.[78]

These recommendations increase in the 2017–18 school year to 1 Gbps for every 1,000 students and teachers for an external connections and 10 Gbps for internal network connections, "in anticipation of future technologies not yet conceived."[79] Indeed, digital testing entails large numbers of students working online simultaneously—a function that simply cannot be accommodated, even in a small school, over copper-based Internet access.

[77] Center for Digital Education, "Preparing for the Common Core State Standards: School districts face an opportunity to reinvest in network infrastructure," at 4 (http://images.erepublic.com/documents/CDE12+STRATEGY+Comcast_V.pdf)

[78] Tanya Roscorla, "How Many States Deliver Tests with Technology," Center for Digital Education, Dec. 6, 2012. http://www.centerdigitaled.com/news/How-Many-States-Deliver-Tests-with-Technology.html.

[79] Ian Quillen, "Bandwidth Demands Rise as Schools Move to Common Core," Education Week: Digital Directions, October 17, 2012, October 17, 2012, Vol. 6. at 19-20. http://www.edweek.org/dd/articles/2012/10/17/01bandwidth.h06.html.
Fox, *et al.,* 2012, "The Broadband Imperative: Recommendations to Address K–12 Education Infrastructure Needs," Washington D.C.: State Educational Technology Directors Association (SETDA). http://www.setda.org/c/document_library/get_file?folderId=353&name=DLFE-1515.pdf. *See also* Center for Digital Education, "Preparing for the Common Core State Standards: School districts face an opportunity to reinvest in network infrastructure," at 5. http://images.erepublic.com/documents/CDE12+STRATEGY+Comcast_V.pdf.

Figure 11: Broadband Needs for Digital Assessments[80]

Broadband Access for Teaching, Learning and School Operations	2014–2015	2017–2018
An external Internet connection to the Internet Service Provider (ISP)	At least 100 Mbps per 100 students/ staff	At least 1 Gbps per 100 students/ staff
Internal wide area network (WAN) connections from the district to each school and among schools within the district	At least 1 Gbps per 1,000 students/ staff	At least 10 Gbps per 1,000 students/ staff

Source: State Educational Technology Directors Association

American schools are migrating to one-to-one computer programs (also known as "ubiquitous computing"), whereby each student and teacher has one Internet-connected wireless computing device for use both in the classroom and at home. A 2006 survey found that 31 percent of superintendents are implementing ubiquitous computing in at least one grade, up from an historical average of 4 percent. Moreover, over 75 percent of superintendents recognized the potential benefits of one-to-one computing, agreeing with the statement that "ubiquitous technology can reduce the time, distance, and cost of delivering information directly to students and that teachers can spend substantially more one-on-one time with each student and personalize the education experience to each student's needs."[81]

By 2007, 78.7 percent of U.S. school districts reported moderate to significant improvement in one-to-one computing programs,[82] with potentially significant benefits for student learning. A 2006 report by America's Digital Schools found that one-to-one computing programs correlated with increased student retention and attendance, improved writing skills, and reduced disciplinary problems.[83] As Michael Davino, Superintendent of Schools in Springfield, New Jersey explains, "[a] wireless laptop program provides up-to-date information, access to virtual experiences, instant feedback, individualized attention for all learning styles, student independence, and constant practice. And it's highly adaptable to individual, small group, or whole class instruction."[84] To accommodate such programs, SETDA recommends that a school upgrade its network to a 50 Kbps/ student/staff broadband connection.[85]

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[80] Fox, *et al.,* 2012, "The Broadband Imperative: Recommendations to Address K–12 Education Infrastructure Needs," Washington D.C.: State Educational Technology Directors Association (SETDA), at 3. http://www.setda.org/c/document_library/get_file?folderId=353&name=DLFE-1515.pdf.

[81] "America's Digital Schools 2006: A Five-Year Forecast," The Greaves Group and The Hayes Connection, at 15, 18. http://www.ads2006.net/ads2006/pdf/ADS2006KF.pdf.

[82] Meris Stansbury, "Researchers Identify Key Ed-Tech Trends," eSchoolNews, May 15, 2008. http://www.eschoolnews.com/2008/05/15/researchers-identify-key-ed-tech-trends/.

[83] "America's Digital Schools 2006: A Five-Year Forecast," The Greaves Group and The Hayes Connection, at 15. http://www.ads2006.net/ads2006/pdf/ADS2006KF.pdf.

[84] *Id.* at 18.

[85] Fox, *et al.,* 2012, "The Broadband Imperative: Recommendations to Address K–12 Education Infrastructure Needs," Washington D.C.: State Educational Technology Directors Association (SETDA), at 4. http://www.setda.org/c/document_library/get_file?folderId=353&name=DLFE-1515.pdf.

Schools are also launching "bring your own device" (BYOD) initiatives. While this leverages limited school infrastructure (by requiring students to provide their own), it raises a number of information technology challenges, including "information security and privacy, support costs, network capacity and bandwidth."[86] Of particular concern, BYOD initiatives are very bandwidth intensive. A recent mobile learning report found that about half of high school students and 40 percent of middle school students have a smartphone or tablet. This represents a 400 percent increase from 2007.[87] Assuming similar growth over the next five years, student use of mobile devices will increase the demand on K–12 networks.

Bailey Mitchell, chief technology and information officer of Georgia's Forsyth County Schools, witnessed the impact of such growth on the school's network, explaining that the County did "not have adequate infrastructure to enable an environment where potentially every other or every student has a device." There, the number of devices increased from 10,000 to 19,000 in a single year. The growth exceeded network capacity and "student instruction was interrupted." This failure led to a three-fold expansion of network capacity (1.3 Gbps to the Internet and 2 Gbps to wide area networks). Mitchell explains, "We've been able to justify that expense because when the network blips, it's such an impact on instruction that it's absolutely unacceptable." He cautions that IT directors will need to anticipate such needs when students are allowed to use their devices throughout the day.[88]

Jefferson County Public Schools in Louisville, Kentucky has expanded its network to accommodate the growing use of technology, including mobile devices being used by teachers and students. Over a five-year period, the district expanded from a 12-megabit wide area network to a 1 gigabit network. The district also built up its wireless system, which now includes 2,000 access points.[89]

Growth in the use of mobile devices is also evident at community colleges. As Martin Gang, assistant director of strategic information technologies for Maricopa Community Colleges explains, "Each year, bandwidth usage goes up farther and faster, and with mobile devices, the bandwidth is continually tasked."[90]

[86] Bob Violino, Aug. 21, 2012, Community College Times, "BYOD: Bring your own devices to campus" (http://www.communitycollegetimes.com/Pages/Technology/BYOD-Bring-your-own-devices-to-campus.aspx).
[87] Tanya Roscorla, Dec. 10, 2012, "5 Ways to Prepare Schools for Bring Your Own Device," Center for Digital Education, December 10, 2012. http://www.centerdigitaled.com/news/5-Ways-to-Prepare-Schools-for-Bring-Your-Own-Device.html.
[88] Tanya Roscorla, "Bring Your Own Device Prompts School Infrastructure Investments," Center for Digital Education, March 13, 2012. http://www.centerdigitaled.com/classtech/BYOD-Forsyth-Infrastructure.html.
[89] Tanya Roscorla, "School Districts Lay Foundation for Mobile Devices," Center for Digital Education, March 4, 2010. http://www.centerdigitaled.com/edtech/School-Districts-Lay-Foundation-for-Mobile-Devices.html.
[90] Tanya Roscorla, "Community Colleges Handle Increased Mobile Device Load," Center for Digital Education, April 1, 2011. http://www.centerdigitaled.com/infrastructure/Community-Colleges-Handle-Increased-Mobile-Device-Load.html.

The BYOD movement is viewed as a way to facilitate access to textbooks and educational services and to "increase[ ] productivity and enhance[ ] collaboration among faculty and staff."[91] Despite these benefits, BYOD creates both unique challenges and opportunities for community colleges. On the one hand, community colleges often lack the robust wireless infrastructure of four-year institutions. Four-year institutions are more likely to invest in such infrastructure because they need to support 24-7 bandwidth requirements for their students. In contrast, community colleges only anticipate the technological needs of commuter students. On the other hand, four-year institutions are also more likely to have resources to provide "standard-issue hardware" to their students. The absence of such resources makes BYOD more appealing in the community college context.[92]

Dodge City Community College (DCCC) in Kansas launched a variation of BYOD in fall 2012, requiring all full-time students to purchase an iPad. The requirement has helped create "a more collaborative experience in the classroom," while allowing faculty to prepare lessons "knowing exactly what students have." The uniform technology requirement also streamlined demands for technical support staff. By requiring the same technology from each student, DCCC has leveled the playing field between students from different backgrounds and with different learning styles.[93]

Teachers have been able to use the students' iPads to "explor[e] new ways of teaching and learning." For instance, sociology teachers are using the students' iPads to take students on a virtual tour of a foreign county and automotive students are using the devices as they work on cars. Math teachers are using an application that transforms the iPads into a white board, whereby the instructors can draw a math problem on the device while recording an explanation about how it is done. Students can observe the lesson on their individual devices or projected on a wall. They can also perform calculations on their iPad and submit the solution to the teacher, who can respond individually or to the whole class. Other instructors are using an application that not only enables them to send a presentation to every student's iPad, but provides access for the teacher to determine if individual students are logged in and paying attention.[94] DCCC President Don Woodburn explains the iPad initiative has allowed students to "explore the material deeper, get more repetitions and ask questions privately outside class immediately when it pops into their minds."[95]

The Mid-State Technical College (MSTC) in Wisconsin has also embraced wireless devices in the school's nursing program. The college has issued iPods replete with reference materials to all fourth-semester nursing students. This allows students to access technical information during

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[91] Bob Violino, Aug. 21, 2012, Community College Times, "BYOD: Bring your own devices to campus" (http://www.communitycollegetimes.com/Pages/Technology/BYOD-Bring-your-own-devices-to-campus.aspx).
[92] Ellie Ashford, Dec. 18, 2012, Community College Times, "Personal Devices Promote Student Engagement" (http://www.communitycollegetimes.com/Pages/Technology/Personal-devices-promote-student-engagement.aspx).
[93] *Id.*
[94] *Id.*
[95] *Id.*

clinical rounds, without "cart[ing] around 'suitcases full of books.'" The college also issued iPads to nursing faculty with a variety of learning and medical information applications, allowing faculty to display questions during class and students to respond using their iPods. Lea Ann Turner, the college's learning technology manager reports that the devices have become "almost indispensable now after only a semester," leading the dean to issue iPads to faculty for first-year students.[96]

By issuing digital devices, community colleges can increase digital literacy and educational opportunities for their students. In California, for instance, 33 community colleges in an 18-county region are undertaking a federally funded effort ("California Connects") to distribute laptops to nearly 6,000 socioeconomically disadvantaged students in the schools' Mathematics, Engineering, Science Achievement (MESA) programs. Students receive the laptops after completing twelve hours of community service. Specifically, "the MESA students teach others who lack access to or knowledge of navigating the Internet how to utilize it for essential tasks such as securing gainful employment, exploring higher education opportunities, accessing health and finance resources, engaging with social networks and advancing their general quality of life." In this way, the "program is helping those who can't afford to buy computers and also helping to expand people's awareness of how to use them."[97] Ultimately, the program is intended to educate an additional 61,000 broadband Internet users in the state.[98]

These programs benefit students, but increase bandwidth demands at community college campuses. Even absent a formal BYOD program, Northern Virginia Community College is observing a significant increase in student-owned mobile devices on campus. As a consequence, "one of the biggest challenges NVCC faces is availability of access points across campus to support the bandwidth capacity." NVCC is investing its technology funds to address the shortfall, and wireless access points and charging stations are now part of the college's budget planning and new building projects.[99]

Internet use is not necessarily limited to classroom demands. For instance, on university campuses, classrooms must share the network with recreational users in residential dorms, where peer-to-peer file sharing and video streaming also demand significant bandwidth.[100] And such bandwidth-hungry recreational use is not limited to four-year universities. In fact, in 2006,

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[96] *Id*.

[97] "California Connects Provides New Group of LMC's MESA students with Laptops, Software and Internet Access to Train Others in their Communities," Nov. 17, 2011 (http://www.losmedanos.edu/news/comp2011.asp).

[98] *See* Broadband USA, Connecting America's Communities, Project Fact Sheet: "California Connects" (http://www2.ntia.doc.gov/files/grantees/foundation_for_community_colleges.pdf); "California Connects Provides New Group of LMC's MESA students with Laptops, Software and Internet Access to Train Others in their Communities," Nov. 17, 2011 (http://www.losmedanos.edu/news/comp2011.asp); "California Connects Teams Up with Community Colleges to Help PCC Students Succeed," Aug. 31, 2011, page 20 (http://www.pasadenanow.com/main/2011/page/20).

[99] Bob Violino, Aug. 21, 2012, Community College Times, "BYOD: Bring Your Own Devices to Campus" (http://www.communitycollegetimes.com/Pages/Technology/BYOD-Bring-your-own-devices-to-campus.aspx).

[100] Collette Boothe, "The Need for Data," Center for Digital Education, Jan. 8, 2009. http://www.centerdigitaled.com/edtech/The-Need-for-Data.html.

a community college in Texas blocked students from accessing MySpace.com to preserve limited bandwidth at the college. At the time, campus officials reported that nearly 40 percent of the school's daily Internet traffic involved visits to the social network.[101]

Many schools are using the Internet to expand course offerings. For instance, in Greenville, South Carolina, students are enrolling in an online Latin course taught by a teacher at another school in the district. Elsewhere, students can use the Internet to take higher level or better-quality courses than those available at their home schools.[102] The Greaves Group has found that many schools are even offering core courses over the Internet, with vocational technology (91 percent) leading, followed by science (78 percent) and social studies (76 percent). Online learning is often used for advanced-placement courses, including art and music (38 percent), math (35 percent), and science (31 percent), which may not have sufficient student enrollment to support a live course.[103] Online education enrollment has grown exponentially. In fact, the Innosight Institute reports that in 2000, roughly 45,000 K–12 students had taken an online course. By 2009, more than 3 million K–12 students had done so. Innosight predicts that 50 percent of high school courses will be delivered partially online by 2019.[104] Beyond K–12, online learning is growing in favor because it saves students time and money.[105]

The Internet helps break down the walls of the classroom, allowing students to participate in virtual fieldtrips and better visualize their lessons. Students are going online and "touring the Smithsonian National Air and Space Museum, experiencing a tribal dance in Africa, or scouring the depths of the Pacific Ocean in a submarine." Users are exploring the digital archives at the Library of Congress and collaborating with students, professors and government officials in other states and around the world.[106] The State Educational Technology Directors Association envisions a classroom environment where "Internet-based educational technologies and practices" are fully "integrated into the curriculum." In such a scenario, students "access rich, multimedia-enhanced educational content from the Internet" on personal laptops, post both audio and video content to school learning management systems, access e-textbooks and assignments online, collaborate with other students both at their own school and around the world, participate in fieldtrips to distant locations, and complete online assessments. Such

[101] Graeme Moore, April 23, 2006, "Texas Community College Bans MySpace.com to Free up Bandwidth" (http://www.wistv.com/story/4806901/texas-community-college-bans-myspacecom-to-free-up-bandwidth?clienttype=printable).

[102] Jonathan Rintels, "An Action Plan for America: Using Technology and Innovation to Address Our Nation's Critical Challenges," The Benton Foundation, 2008, at 21. http://www.benton.org/initiatives/broadband_benefits/action_plan.

[103] "America's Digital Schools 2006: A Five-Year Forecast," The Greaves Group and The Hayes Connection, at 19. http://www.ads2006.net/ads2006/pdf/ADS2006KF.pdf.

[104] Michael Horn and Heather Staker, Jan. 2011, "The Rise of K–12 Blended Learning," Innosight Institute, January 27, 2011. http://www.innosightinstitute.org/education-blog/the-rise-of-k-12-blended-learning/

[105] Collette Boothe, "The Need for Data," Center for Digital Education, Jan. 8, 2009. http://www.centerdigitaled.com/edtech/The-Need-for-Data.html.

[106] Jonathan Rintels, "An Action Plan for America: Using Technology and Innovation to Address Our Nation's Critical Challenges," The Benton Foundation, 2008, at 21. http://www.benton.org/initiatives/broadband_benefits/action_plan.

technology-rich experiences require greater bandwidth in the classrooms. In fact, SETDA asserts that this whole-curricula approach requires schools to provide a 100 Kbps per student/staff broadband connection.[107]

This digital classroom is possible in North Carolina, thanks to the North Carolina Research and Education Network (NCREN). North Carolina has one of the three largest community college networks in the nation, with 1 out of 8 citizens aged 18 or above utilizing the Community College System's resources in some manner. This use has led to a need for substantial improvements in broadband connectivity. In 2010, the Office of Information Technology Services selected NCREN as the high-speed broadband network for all 58 of the state's community colleges, connecting the colleges to all other public education institutions in the state, to the Internet, and to advanced research networks around the country. This $144-million investment has led to an overall increase of 34 percent in bandwidth in a single year, with even greater improvements at some institutions. The network now provides the community colleges with Internet services ranging from 100 Mbps to 1 Gbps, in addition to other managed video services, such as live streaming and recorded archived sessions. As a consequence, students at Nash Community College can enroll in a "classroomless class," whereby students can log in and attend classes in real time with the professors using streaming video.[108]

Unfortunately, North Carolina's robust community college network is not universal. Pulaski Technical College (PTC) in North Little Rock, Arkansas has a 40-MB broadband connection. While this network can satisfy some of the college's demands, it limits online opportunities. The connection must support 4,000 students that are enrolled in online classes and 11,000 students at six different locations. As a consequence, distance education is limited to "static content stored in a learning management system" and cannot "support more interactive, media-rich technologies on a large scale." David Durr, dean of information technology at the college, bemoans the existing network: "We're … limited in our ability to provide students with remote access to facilities and equipment on our campuses. If we had more capacity, we could offer students much better educational experiences."[109]

The University of Arkansas Community College at Hope has an even more limited network. The college relies on broadband service based on increments of T-1 lines. This limited bandwidth is proving inadequate as student enrollment increases, distance education grows in popularity, and professors begin to place additional course materials online. As Dave Phillips, director of

[107] Fox, *et al.,* 2012, "The Broadband Imperative: Recommendations to Address K–12 Education Infrastructure Needs," Washington D.C.: State Educational Technology Directors Association (SETDA), at 4. http://www.setda.org/c/document_library/get_file?folderId=353&name=DLFE-1515.pdf.
[108] MCNC, Jan. 14, 2013, "Community Colleges Using Video to Extend Modern Classrooms" (https://www.mcnc.org/print/news/community-colleges-using-video-to-extend-modern-classrooms).
[109] Bob Violino, Oct. 2010, Community College Times, "Broadband Key to Expanding Learning Opportunities at Rural Colleges" (http://www.communitycollegetimes.com/Pages/Technology/Broadband-key-to-expanding-learning-opportunities-at-rural-colleges.aspx).

telecommunications at the college remarks, these growing demands "start[ ] affecting network performance at that point.… We're getting a lot of interruptions of traffic."[110]

Broadband is needed to enable students and faculty to communicate with one another at different campuses. Academic research is no longer limited to a single university. Rather experts are sharing information across campuses—and internationally. Examples of these high-bandwidth applications abound:

> At the November 2011 Supercomputing Conference in Seattle, a group of industry partners worked with the California Institute of Technology and the University of Victoria to showcase a high-speed link between Seattle and Victoria. An international team transferred data at a combined rate of 186 gigabits per second. Another example of global collaboration is the Atacama Large Millimeter/submillimeter Array in Chile. A single telescope that's being built in Chile is expected to put out upwards of 100 gigabits per second of data in a few years, [Rob] Vietzke [of Internet2] said. Through AMPATH, an international research connection point in Miami that Florida International University developed, university researchers link remotely to the telescope in Chile with an Internet2 connection. Instead of going to the instrument in Chile or the one it connects to in Hawaii, they can see the telescope and take pictures from Florida. Along with this telescope, 10 universities work together in the Southeastern Association for Research in Astronomy consortium and operate two telescopes in Arizona and Chile.[111]

Access to this research is critical. Indeed, our universities will be "severely limited in their potential success if they're not able to use the next generation or the latest generation of research networks."[112]

Educational networks will also need to expand to accommodate growing amounts of data. Market research analysts report global data production increased nine-fold between 2006 and 2011. They project data production to increase to 8 trillion gigabytes—or 40 times 2006 levels—by 2015. Indeed, global data production is more than doubling annually.[113] Robust data storage solutions, which may include virtualization, are needed to accommodate this growing information—and to ensure that it is accessible to our students.

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[110] *Id.*

[111] Tanya Roscorla, "Fast Research Networks Make Global Collaboration Possible," Center for Digital Education, December 21, 2011. http://www.centerdigitaled.com/infrastructure/Fast-Research-Networks-Make-Global-Collaboration-Possible.html.

[112] Tanya Roscorla, "Fast Research Networks Make Global Collaboration Possible," Center for Digital Education, December 21, 2011. http://www.centerdigitaled.com/infrastructure/Fast-Research-Networks-Make-Global-Collaboration-Possible.html. (quoting Rodney G. Wilson, senior director of external research at Ciena).

[113] "Discovering the Data Opportunity: How Strategic Storage Solutions Save Dollars, Increase Efficiency, and Enhance Learning," Converge, October 2012. (http://images.erepublic.com/documents/CDE12_NetApp_handbook_V.pdf).

Research by the International Society for Technology in Education and the Consortium for School Networking confirms that broadband applications in the schools have many benefits. In particular, technology has:

- Led to measurable improvements in school performance (as measured on the Adequate Yearly Progress Tests under the No Child Left Behind Act of 2001).
- Improved attendance, decreased dropout rates, increased graduation rates, and allowed increased parental involvement.
- Improved school efficiency and productivity.
- Helped teachers satisfy professional requirements by helping develop lesson plans and providing continuing education opportunities.
- Enhanced students' problem-solving and independent-thinking skills.
- Enabled schools to meet the needs of special education children.
- Increased equity and access in education by creating learning opportunities for geographically isolated students.
- Improved workforce skills.[114]

Case studies bear out these benefits. For instance, elementary school students in the "Enhancing Missouri's Instructional Networked Teaching Strategies" (eMINTS) program consistently scored higher on standardized achievement tests than students who did not have access to the same technology. Participants' classrooms are equipped with a teacher's desktop computer and laptop computer, a scanner, a color printer, a digital camera, an interactive white board, a digital projector, and one computer for every two students. In New York, middle and high school students enrolled in the "Points of View media project" used broadband to access museums and historical collections, streaming video and video conferencing, and primary documents to explore the Theodore Roosevelt era. Seventy-five percent of program participants reported that they learned more than they would have from a traditional class.[115]

Bandwidth must expand to allow students to realize these benefits. A fiber network provides the most scalable solution. Bandwidth calculators are available to estimate bandwidth requirements at an individual school.[116] Such last-mile needs can only be met with a sufficiently

[114] "Why Technology in Schools?" Ed Tech Action Network. http://www.edtechactionnetwork.org/why-technology-in-schools.

[115] "Ed Tech and Student Achievement," Ed Tech Action Network. http://www.edtechactionnetwork.org/student_achieve.html.

[116] *See, e.g.,* http://etoolkit.org/etoolkit/bandwidth_calculator/index (listing an array of online activities that a school could engage in and estimating needed bandwidth per student).

robust middle mile.[117] As Denise Atkinson-Shorey, an educational technology consultant in Colorado explains, "If the capacity for data transmission is too low at any step along the way, the connection speed (like water pressure) suffers no matter how much a single user invests in making bandwidth available at the network gateway end…. And in the case of many rural schools, it's the middle-mile connections, or the cables that run from hubs on the national Internet backbone, that are inferior."[118]

6.3 High Bandwidth Needs Among Libraries

Libraries have long served as "a premier Internet access provider in the continually evolving online culture."[119] In fact, a 2008 study found public libraries provided the only free Internet access in 72.5 percent of U.S. communities nationwide. This number rose to 82 percent in rural communities.[120] A 2012 study reaffirms the role of libraries as the sole public provider of free Internet access in the majority (64.5 percent) of American communities.[121]

Public libraries serve a variety of functions. They offer desktop workstations for Internet use, technical training, and access to locally relevant content. Public library Internet access is used for an array of reasons—job seeking, educational research, travelers looking to keep in touch with their families, and emergency information. Libraries play a key role in providing access, assistance and training through e-government sites and services. Public libraries also provide a safety net during disasters when Internet access may be limited elsewhere.[122] In light of this wide array of services, "the role of the public library as a stable Internet provider cannot be overestimated."[123]

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[117] The term "middle-mile" refers to facilities used for backhaul between the Internet service provider and the Internet backbone. The "last-mile" refers to the portion of the network that connects the middle-mile directly to the home, business, or mobile device of the user. In one commonly-used analogy, communications networks are compared to traditional infrastructure: the "Internet backbone" is comparable to the Interstate Highway System; the "middle-mile" is like the network of smaller highways that reach rural communities and roads that reach neighborhoods and key facilities; the "last-mile" is the neighborhood street and driveway that leads directly to the user.

[118] Ian Quillen, "Bandwidth Demands Rise as Schools Move to Common Core: School technology needs grow faster in preparation for common-core," Education Week: Digital Directions, October 17, 2012. http://www.edweek.org/dd/articles/2012/10/17/01bandwidth.h06.html.

[119] Marijke Visser and Mary Alice Ball, Dec. 2010, "The Middle-mile: The Role of the Public Library in Ensuring Access to Broadband," Information Technology and Libraries, at 193. http://www.ala.org/lita/ital/sites/ala.org.lita.ital/files/content/29/4/visser.pdf.

[120] *Id.* at 191.

[121] Information Policy and Access Center (IPAC), 2012, "Public Libraries and Broadband." http://www.plinternetsurvey.org/analysis/public-libraries-and-broadband.

[122] John Carlo Bertot, Charles R. McClure, and Paul T. Jaeger, 2008, "The Impacts of Free Public Internet Access on Public Library Patrons and Communities," *Library Quarterly* 78, no. 3, at 286. http://mcclure.ii.fsu.edu/publications/2008/The%20impacts%20of%20free%20public%20Internet%20access%20on%20public%20library%20patrons%20and%20communities.pdf

[123] Marijke Visser and Mary Alice Ball, Dec. 2010, "The Middle-mile: The Role of the Public Library in Ensuring Access to Broadband," Information Technology and Libraries, at 192.

Public libraries, however, are facing significant capacity constraints. Bandwidth requirements are growing as public use expands and matures, but libraries are unable to keep up. As Bertot, McClure, and Jaeger report:

> Libraries may be struggling to meet demands as a result of a combination of factors such as the limits on physical space in libraries, the increasing complexity of Internet content, the continual costs of Internet access and computer maintenance, the inherent limitations of the telecommunications grid, and the rising demands for bandwidth, processing speed, and numbers of workstations, among other factors.[124]

In recent years, libraries have expanded wireless access to allow for a larger number of users at limited workstations. While this allows more users to get online, it also creates additional traffic on limited bandwidth.[125]

Libraries are seeking ways to add bandwidth as applications become more intensive (e.g., streaming video, online communications, social networking tools), yet this growing need is seldom accompanied by a corresponding increase in budget or capacity. The Information Policy and Access Center (iPAC) reports that libraries have steadily increased their bandwidth capacity in recent years. While only 12.3 percent of public libraries reported speeds greater than 10 mbps in 2008-2009, 31.7 percent of public libraries have reported speeds at this level in 2011-2012 (see Figure 12).[126] While bandwidth has increased in recent years, however, this growth has been outpaced by the increase in bandwidth-requiring applications. Consequently, despite supposed high-speed connections, users may experience "slow connectivity and near dial-up speeds."[127]

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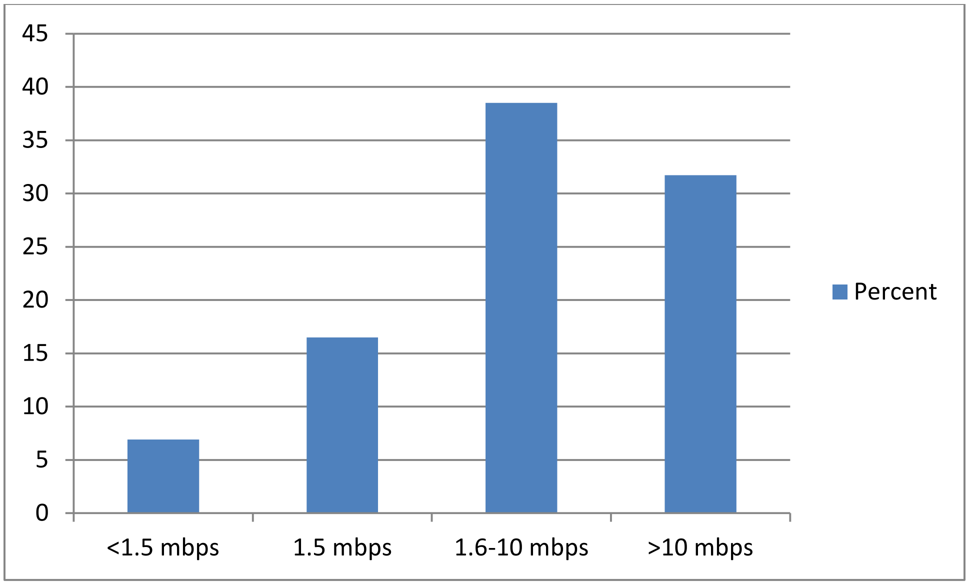
[124] John Carlo Bertot, Charles R. McClure, and Paul T. Jaeger, 2008, "The Impacts of Free Public Internet Access on Public Library Patrons and Communities," *Library Quarterly* 78, no. 3, at 297.
[125] *Id.* at 292.
[126] "Public Libraries and Broadband," *Public Library Funding and Technology Survey,* Information Policy and Access Center, 2012. http://ipac.umd.edu/sites/default/files/publications/BroadbandBrief2012_0.pdf.
[127] "Broadband and Public Libraries," Information Policy and Access Center (IPAC), 2012. http://www.plinternetsurvey.org/analysis/public-libraries-and-broadband.

Figure 12: Public Library Internet Connectivity Speeds (2011–2012)[128]



Data from the Public Libraries and the Internet studies reveal a "'disconnect' between what their communities expect and the levels of Internet access that they are able to provide to their communities."[129] In fact, a 2012 study found that 41.1 percent of public libraries report that their connection speeds are insufficient to meet patron needs some or all of the time.[130] While this is an improvement from nearly 58 percent reporting inadequate speeds in a similar 2007 survey,[131] it reveals that additional bandwidth is needed. The data suggests that libraries have reached an "infrastructure plateau for provision of and access to Internet services."[132] This problem is only compounded by the economic downturn, as more people depend on libraries for free Internet access. As a consequence, infrastructure limits are being hit precisely at a time when consumer demand for library services is increasing.

While libraries have long served the role of "community guarantor of free public Internet access,"[133] they cannot meet these needs without public support. As Visser and Ball acknowledge, "[o]vercoming the challenges successfully will require support on the local, state, and federal level."[134] Indeed, "[w]hat else can the federal government fund that simultaneously

[128] "Public Libraries and Broadband," *Public Library Funding and Technology Survey,* Information Policy and Access Center, 2012. http://ipac.umd.edu/sites/default/files/publications/BroadbandBrief2012_0.pdf.
[129] John Carlo Bertot, Charles R. McClure, and Paul T. Jaeger, 2008, "The Impacts of Free Public Internet Access on Public Library Patrons and Communities," *Library Quarterly* 78, no. 3, at 287.
[130] "Broadband and Public Libraries," Information Policy and Access Center (IPAC), 2012. http://www.plinternetsurvey.org/analysis/public-libraries-and-broadband.
[131] Marijke Visser and Mary Alice Ball, Dec. 2010, "The Middle-mile: The Role of the Public Library in Ensuring Access to Broadband," Information Technology and Libraries, at 191.
[132] John Carlo Bertot, Charles R. McClure, and Paul T. Jaeger, 2008, "The Impacts of Free Public Internet Access on Public Library Patrons and Communities," *Library Quarterly* 78, no. 3, at 297.
[133] *Id.* at 299.
[134] Marijke Visser and Mary Alice Ball, Dec. 2010, "The Middle-mile: The Role of the Public Library in Ensuring Access to Broadband," Information Technology and Libraries, at 191-92.

serves so many educational, economic, employment, communication, government, and emergency preparedness functions?"[135]

While slightly more than half (58.3 percent) of public libraries reported in 2010-2011 that their broadband connection meets patron needs, more libraries are expected to report insufficient connections in coming years unless funding to improve broadband infrastructure is increased. Indeed, "[a]s more people rely on public libraries for Internet access, and as more of these people use a greater range of high bandwidth education, government, and entertainment content, the bandwidth capacity of libraries becomes an increasingly significant issue."[136]

Many libraries are seeking to expand their use and meet access demands by establishing Wi-Fi networks. However, the Information Policy and Access Center (iPAC) reports that in the vast majority of libraries with wireless access (82.3 percent), wireless users are sharing the same bandwidth and connection with existing workstations. As a consequence, libraries are increasing "connection capacity at the expense of connection quality." This growth results in more users drawing on limited bandwidth. iPAC explains:

> As an example, take a common scenario: a public library has 15 public access workstations in constant use; it offers Wi-Fi that supports another 10–15 simultaneous connections, typically in use; the library has a T-1 connection (1.5 Mbps or megabits per second leased line broadband service); and the Wi-Fi and public access workstations share the same connection. With up to 30 devices sharing the same 1.5 Mbps connection, the connection speed at the device level is the equivalent of dial-up service, severely affecting the quality of the user experience.[137]

It is unsustainable for libraries to increase the number of workstations and use of their Wi-Fi networks without a concomitant increase in connection speed. Yet, this is precisely what is occurring. In fact, though 74.3 percent of libraries reported that they did not increase their connection speed from 2011–2012, 60.1 percent reported an increase in the use of their public access workstations and 74.9 percent reported an increase in the use of their Wi-Fi network. "If these trends continue, we can expect the demands on public library networks to exceed capacity in the near future, especially at urban public libraries."[138]

6.4 High Bandwidth Needs Among Hospitals

The U.S. healthcare system is expensive, overburdened, and inefficient.[139] In 2006, national health care costs grew 6.7 percent to $2.1 trillion, or $7,026 per person, and accounted for 16

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[135] John Carlo Bertot, Charles R. McClure, and Paul T. Jaeger, 2008, "The Impacts of Free Public Internet Access on Public Library Patrons and Communities," *Library Quarterly* 78, no. 3, at 300.
[136] "Survey: Broadband and Public Libraries," Information Policy and Access Center (IPAC), 2012. http://ipac.umd.edu/survey/analysis/broadband-public-libaries.
[137] Ibid.
[138] Ibid.

percent of gross domestic product (GDP). Similar growth is projected to continue until 2017, at which point it will account for nearly 20 percent of GDP.[140] Some of this expense can be attributed to the inappropriate reliance on costly hospital emergency rooms, which are often sought after traditional office hours or in communities with a shortage of physicians. In fact, over half (55 percent) of the 114 million emergency room visits each year are for non-emergencies, accounting for $31 billion annually, or $300 per American household.[141]

Broadband technology can dramatically reduce these expenses by providing the tools to remotely monitor patients, allow collaboration between medical professionals, facilitate the transfer of medical data and images, and increase access to emergency services in remote areas.[142] By one estimate, these services can lead to savings of $165 billion per year.[143] "Always-on broadband" is "essential" for many of these applications and greatly improves others that "depend on uninterrupted real-time transmission."[144] While the economic benefits of telemedicine are undeniable, these applications require significant bandwidth, particularly for those that require streaming video and high-resolution diagnostic imaging. As the Healthcare Information and Management Systems Society explains, "[h]igh bandwidth is crucial in supporting the ever-expanding technical infrastructures prevalent throughout many of the nation's hospitals, clinics and doctor's offices." For instance, a T-1 internet connection could take as much as an hour to upload an image study to the network, whereas the same image can be moved in seconds using Internet2.[145]

Broadband allows users to access medical information online, avoiding costly trips to medical professionals. Approximately 20,000 health-related websites provide information to more than

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[139] Many individuals are using emergency facilities for general care, increasing the burden on those facilities and compromising service for others.

[140] Jonathan Rintels, "An Action Plan for America: Using Technology and Innovation to Address Our Nation's Critical Challenges," The Benton Foundation, 2008, at 15.
http://www.benton.org/initiatives/broadband_benefits/action_plan. *See also* Centers for Medicare and Medicaid Services, "National Health Expenditure Projections 2008-2008" (projecting annual public health-care expenditures to reach $2.9 trillion by 2012 and continuing to grow at an average annual rate of 7.2 percent, reaching $4.4 trillion, or 20.3 percent of GDP, in 2018).
http://www.cms.hhs.gov/NationalHealthExpendData/downloads/proj2008.pdf.

[141] Devon Herrick, Convenient Care and Telemedicine, National Center for Policy Analysis, NCPA Policy Report No. 305 (ISBN #1-56808-179-0), Nov. 2007, at 3-5.

[142] Jonathan Rintels, "An Action Plan for America: Using Technology and Innovation to Address Our Nation's Critical Challenges," The Benton Foundation, 2008, at 15 (broadband can "revolutionize medical treatment").
http://www.benton.org/initiatives/broadband_benefits/action_plan. *See also* Carlton Doty, "Delivering Care Anytime, Anywhere; Telehealth Alters the Medical Ecosystem." Forrester Research for the California Healthcare Foundation, Nov. 2008; Telemedicine Association of Oregon, "Benefits of Telemedicine," Jan 16, 2004.
http://www.ortcc.org/PDF/BenefitsofTelemedicine.pdf.

[143] Jonathan Rintels, "An Action Plan for America: Using Technology and Innovation to Address Our Nation's Critical Challenges," The Benton Foundation, 2008, at 15.
http://www.benton.org/initiatives/broadband_benefits/action_plan.

[144] Alexander H. Vo, "The Telehealth Promise: Better Health Care and Cost Savings for the 21st Century," University of Texas Medical Branch, May 2008, at 13.

[145] Healthcare Information and Management Systems Society, Sept. 17, 2009, FCC Broadband Workshop on Healthcare. http://www.himss.org/policy/d/broadbandSummary.pdf.

three-quarters of online Americans who access medical information over the Internet.[146] More than ten percent of broadband users use the Internet for this purpose on a given day.[147]

Broadband users also avoid scheduling (and driving) to multiple appointments by using the Internet to get a second opinion based on their medical records or by exchanging e-mails with their doctors. Notably, Kaiser Permanente reduced appointments with primary care physicians by 7 percent to 10 percent by allowing its enrollees to e-mail questions to their doctor through a secure messaging system.[148] Thirty-seven percent of Kentucky broadband users report that access to online information has saved them an average of 4.2 unnecessary trips for medical care in a single year.[149]

Telehealth holds particular promise for remote monitoring of chronic conditions. Nearly half of Americans (45 percent or 130 million people) suffer from at least one chronic condition, such as arthritis, asthma, Cancer, depression, diabetes, heart disease, and obesity. Combined, treatment of these conditions accounts for seventy five percent of healthcare spending—$1.5 trillion annually.[150] Despite this enormous expense, most Americans with chronic conditions suffer from inadequate treatment. According to the National Center for Policy Analysis, less than one fourth of patients with high blood pressure control it adequately. Twenty percent of patients with Type-1 diabetes fail to see a doctor annually, with forty percent of diabetics failing to regularly monitor their blood sugar level or receive recommended annual retinal exams.[151]

Through remote monitoring, tens of millions of Americans can manage and address their chronic illness at dramatically lower cost. In fact, both the Benton Foundation and the University of Texas estimate that remote monitoring could lower hospital, drug and out-patient costs by 30 percent, reducing the length of hospital stays from 14.8 days to 10.9 days, office visits by 10 percent, home visits by 65 percent, emergency room visits by 40 percent, and hospital admissions by 63 percent.[152]

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[146] Devon Herrick, Convenient Care and Telemedicine, National Center for Policy Analysis, NCPA Policy Report No. 305 (ISBN #1-56808-179-0), Nov. 2007, at 14; Jonathan Rintels, "An Action Plan for America: Using Technology and Innovation to Address Our Nation's Critical Challenges," The Benton Foundation, 2008, at 15-16. http://www.benton.org/initiatives/broadband_benefits/action_plan.

[147] Jonathan Rintels, "An Action Plan for America: Using Technology and Innovation to Address Our Nation's Critical Challenges," The Benton Foundation, 2008, at 16. ("On an average day, one in nine of those with a broadband connection uses it to research online medical information"). http://www.benton.org/initiatives/broadband_benefits/action_plan

[148] Devon Herrick, Convenient Care and Telemedicine, National Center for Policy Analysis, NCPA Policy Report No. 305 (ISBN #1-56808-179-0), Nov. 2007, at 14.

[149] Steven S. Ross and Masha Zager, "Fiber to the Home Is Green Technology," Broadband Properties, Jan/ Feb 2009, at 31. http://www.bbpmag.com/2009issues/jan09/BBP_JanFeb09_CoverStory.pdf.

[150] Partnership to Fight Chronic Disease, 2008 Almanac of Chronic Disease, at 7 (Foreword by Richard Carmona, 17th U.S. Surgeon General). http://www.fightchronicdisease.org/pdfs/PFCD_FINAL_PRINT.pdf.

[151] Devon Herrick, Convenient Care and Telemedicine, National Center for Policy Analysis, NCPA Policy Report No. 305 (ISBN #1-56808-179-0), Nov. 2007, at 8.

[152] Jonathan Rintels, "An Action Plan for America: Using Technology and Innovation to Address Our Nation's Critical Challenges," The Benton Foundation, Nov. 2008, at 16. http://www.benton.org/initiatives/broadband_benefits/action_plan.

Remote monitoring applications are incredibly varied. Patients with chronic obstructive pulmonary disease can improve lung function with the use an inhaler and monitor airflow to and from their lungs with a spirometer, lowering hospital readmissions to 49 percent as compared to 67 percent for patients lacking home monitoring. Similarly, remote monitoring of congestive heart failure patients cut re-hospitalizations in half.[153] Glucose Meter Cell Phones allow diabetics to remotely monitor blood-sugar levels.[154] Diabetics in Pennsylvania using such home-monitoring systems were able to reduce hospitalization costs by more than 60 percent from a control group with traditional in-person nurse visits.[155] The Veterans Administration reports similar savings from its home-monitoring system, which has reduced emergency room visits by 40 percent and hospital admissions by 63 percent.[156] Remote monitoring holds particular promise for the elderly, by allowing them to defer or avoid institutionalization, thereby enhancing quality of life and reducing medical costs.

Broadband can also reduce transportation costs between medical facilities by allowing doctors to monitor patients and collaborate remotely. The potential savings are dramatic. The Benton Foundation estimates that telehealth technologies can prevent:

- Thirty-nine percent (850,000) of transports between emergency departments, with an annual savings of $537 million;
- Forty-three percent (40,000) of transports from correctional facilities to emergency departments and 79 percent (543,000) of transports from correctional facilities to physician office visits, with an annual savings of $280 million;
- Fourteen percent (387,000) of transports from nursing facilities to emergency departments and 68 percent (6.87 million) of transports from nursing facilities to physician office visits, with an annual savings of $806 million.[157]

[153] Devon Herrick, Convenient Care and Telemedicine, National Center for Policy Analysis, NCPA Policy Report No. 305 (ISBN #1-56808-179-0), Nov. 2007, at 16. *See also* Jonathan Rintels, "An Action Plan for America: Using Technology and Innovation to Address Our Nation's Critical Challenges," The Benton Foundation, Nov. 2008, at 16 (discussing a New York case study that reduced health care costs for home-bound patients with congestive heart failure to cut overall health care costs by 41 percent).
http://www.benton.org/initiatives/broadband_benefits/action_plan.

[154] Kathy Brown, Senior Vice President for Public Policy Development and Corporate Responsibility Verizon Communications, "Using Broadband to Promote Energy Efficiency."
http://www.uschamber.com/bclc/resources/newsletter/2008/0804_verizon.

[155] Jonathan Rintels, "An Action Plan for America: Using Technology and Innovation to Address Our Nation's Critical Challenges," The Benton Foundation, Nov. 2008, at 15.
http://www.benton.org/initiatives/broadband_benefits/action_plan.

[156] *Id.*

[157] Jonathan Rintels, "An Action Plan for America: Using Technology and Innovation to Address Our Nation's Critical Challenges," The Benton Foundation, Nov. 2008, at 16.

Much research has been done about the potential benefits of broadband for rural medical care. Notably, the FCC has already authorized over $400 million to 25 states to use telemedicine networks to provide medical care to rural areas.[158] This allows rural doctors to provide timely medical care while avoiding costly—and potentially risky—transfers to urban hospitals. In Georgia, for instance, telemedicine allows doctors at academic centers to participate remotely in the examination of patients at rural hospitals, cutting transports by 60 to 80 percent.[159] This program enables doctors at the Medical College of Georgia's neurology department to use video conferencing to examine, diagnose and treat stroke patients at 10 rural hospitals.[160]

Broadband also improves the quality of medical care in rural areas by providing access to in-service training without requiring costly participation in distant conferences.[161]

The adoption of Electronic Medical Records will make healthcare more efficient. Because the current medical system is fragmented, doctors seldom have comprehensive information about a patient's medical history, leading to costly and invasive duplicate procedures. This disjointed system means that "[p]atients may be treated at multiple locations by multiple doctors who keep multiple paper records and fill out multiple paper forms seeking reimbursement from multiple insurance carriers."[162] By creating a universal repository for medical records, caregivers can coordinate treatment, easily provide second opinions, streamline billing, and avoid duplicative procedures. Online access to medical records could help doctors avoid such inefficiencies, with savings totaling $81 billion annually—or $670 per household.[163] Of course, these savings requires a significant up-front investment from medical professionals who have to upload medical histories and transition to electronic record keeping.

The use of Electronic Medical Record (EMR) systems is expected to grow dramatically in the next two years. While such systems have existed in some form for more than 30 years, as of

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http://www.benton.org/initiatives/broadband_benefits/action_plan; Alexander H. Vo, "The Telehealth Promise: Better Health Care and Cost Savings for the 21st Century," University of Texas Medical Branch, May 2008, at 2.

[158] Robert LaRose et. al., "Closing the Rural Broadband Gap," Department of Telecommunication, Information Studies, and Media, Michigan State University. November 30, 2008.

[159] Dr. Jay Sanders, President and CEO, the Global Telemedicine Group and Professor of Medicine (Adjunct) at Johns Hopkins School of Medicine.

[160] Jonathan Rintels, "An Action Plan for America: Using Technology and Innovation to Address Our Nation's Critical Challenges," The Benton Foundation, Nov. 2008, at 16. http://www.benton.org/initiatives/broadband_benefits/action_plan.

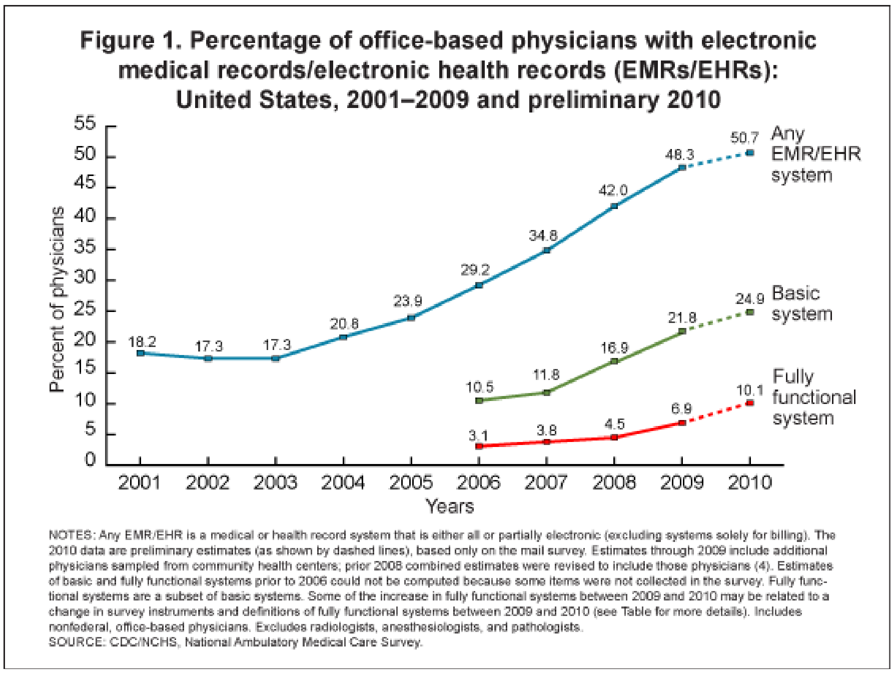
[161] Joseph Fuhr and Stephen Pociask, "Broadband Services: Economic and Environmental Benefits," The American Consumer Institute, Oct. 31, 2007, at 39.

[162] Jonathan Rintels, "An Action Plan for America: Using Technology and Innovation to Address Our Nation's Critical Challenges," The Benton Foundation, Nov. 2008, at 17. http://www.benton.org/initiatives/broadband_benefits/action_plan.

[163] Jonathan Rintels, "An Action Plan for America: Using Technology and Innovation to Address Our Nation's Critical Challenges," The Benton Foundation, Nov. 2008, at 18 (citing Rand Health, "Extrapolating Evidence of Health Information Technology Savings," 2005 Public Medical Research data from the National Health Expenditure Data, HHS and "Upgrade America's Health Care System: Pass Health IT Legislation Now," Business Roundtable, April 2, 2008). http://www.benton.org/initiatives/broadband_benefits/action_plan.

2006, only 10 percent of U.S. hospitals had a fully integrated system.[164] By 2007, the Center for Disease control reports that 34.8 percent of office-based physicians reported some EMR use. By 2009, EMR adoption had increased to 48.3 percent of office-based practices.[165] This growth is anticipated to continue. In fact, the Administration has announced a goal of 100 percent utilization of electronic records by 2014. To that end, the American Recovery and Reinvestment Act (ARRA) formalized a national "Office of the National Coordinator for Health Information Technology (ONCHIT or ONC) within the U.S. Department of Health and Human Services (HHS). ARRA further established a system of incentives and penalties to facilitate the transition.[166]

Figure 13: Percentage of Office-Based Physicians with Electronic Medical Records/ Electronic Health Records (2001–2010)[167]



A robust, high-speed network is required to realize many of these benefits. Some telehealth activities are "asynchronous" and can be realized without real-time services. These include a variety of "store and forward" activities – including medical monitoring, e-mailing between patients and providers, and sharing of medical images. Other activities require real-time or "synchronous" communications. These include physician office visits conducted via videoconference, specialist visits that require high-definition video (e.g., dermatologist), and

[164] Smaltz, Detlev and Eta Berner. "The Executive's Guide to Electronic Health Records." (2007, Health Administration Press), at 3.
[165] CDC, Chun-Ju Hsiao, *et al.*, Dec. 2010, NCHS Health E-State: Electronic Medical Record/Electronic Health Record Systems of Office-based Physicians: United States, 2009 and Preliminary 2010 State Estimates, at 1 (http://www.cdc.gov/nchs/data/hestat/emr_ehr_09/emr_ehr_09.pdf)
[166] U.S. Department of Health and Human Services Centers for Medicare & Medicaid Services 42 CFR Parts 412, 413, 422 et al. Medicare and Medicaid Programs; Electronic Health Record Incentive Program; Final Rule
[167] Figure from: CDC, Chun-Ju Hsiao, *et al.*, Dec. 2010, NCHS Health E-State: Electronic Medical Record/Electronic Health Record Systems of Office-based Physicians: United States, 2009 and Preliminary 2010 State Estimates. http://www.cdc.gov/nchs/data/hestat/emr_ehr_09/emr_ehr_09.pdf.

real-time medical imaging in time-sensitive cases. The latter category are significantly more bandwidth-intensive.

Even store-and-forward telehealth applications, such as sharing medical images with medical providers, can impose significant bandwidth demands. Medical images—such as X-rays—often are digitally stored in huge files (an MRI scan may consume many gigabytes of data, and files up to a terabyte have been seen with some medical studies). Uploading such files can be "quite bandwidth-intensive." A provider may use a local digital medical-imaging device (like a CT scanner, or a digital X-ray machine in an orthopedist's office, or an ultrasound device in an obstetrician's office) to create files and upload them to a web-hosting store so that medical providers elsewhere can view and assess them. Medical centers may also wish to retain their own digital images, and simply allow viewer access by external electronic health records through a local linkage.[168] Bandwidth requirements will vary dependent upon the preferred practice and a network must be robust enough to accommodate different applications by thousands of medical professionals.

Sujansky and Associates explore the range of bandwidth needs in their assessment of the California Telehealth Network. (See Table 5, below.) Bandwidth requirements for video conferencing vary dependent on screen resolution. While standard-definition video conferencing can operate at 300 Kbps, high-definition video conferencing requires at least 1 Mbps. Store-and-forward operations also requires a range of bandwidth. While single image can be transferred at 500 Kbps, significantly more bandwidth (e.g., 10 Mbps) is needed to transfer large files. Absent adequate bandwidth, such transfers must be scheduled for low-usage times, such as overnight.

Other telehealth applications (e.g., audio-conferencing, clinical messaging and telemetry) do not necessarily demand a lot of bandwidth, though requirements will increase to accommodate growing numbers of telehealth users. Real-time telehealth applications, such as video- and audio-conferencing, may require greater network capacity because they are particularly sensitive to latency (delay in delivery of data packets), jitter (variations in latency over time) and packet-loss. For instance, a typical conversation cannot be transmitted with latencies greater than 300 milliseconds. Greater delays would "disrupt natural verbal and visual communication patterns." Conferencing applications also require stable rates of latency. Data buffers cannot function with excessive jitter, which compromises the quality of a video or audio-feed. High levels of packet loss or packets arriving out of order can also cause visible disruptions in an audio or video feed. Store-and-forward telehealth applications, in contrast, are not sensitive to latency, packet loss or jitter, reducing network requirements for these uses.

Emergency telehealth applications (e.g., remote video conferencing during crises) are extremely sensitive to network downtimes. Such emergency applications cannot be scheduled around network availability. Consequently, the network must be designed to accommodate the

[168] Robert Rowley, June 3, 2010, EHR Bloggers, "Internet Connectivity and the Future of EMRs" (http://www.practicefusion.com/ehrbloggers/2010/06/internet-connectivity-and-future-of.html).

greatest level of potential use. Continuous telemetry of critically ill patients likewise demands a reliable network.[169]

Globally, networks have been developed to accommodate an array of telehealth applications. For example, the Virtual Critical Care Unit in Australia allows for telepresence support in the emergency, high dependency and obstetric departments between two distant Australian hospitals. To function, the network requires a 100 Mbps connection at each site. A telesurgical system in Korea likewise requires a 100 Mbps connection to facilitate data transport between sites. A Canadian telehealth study found that telesurgery is impractical with bandwidth below 4 Mbps, though it can be performed at 6 Mbps.[170] Of course, such applications are overlaid atop a network with a wide array of other uses, which demand additional bandwidth.

Table 5: Network Characteristics of Telehealth Applications[171]

Category	Application	Acceptable Latency Level	Acceptable Packet Loss	Downtime Sensitivity	Minimum Bandwidth
Conferencing	High definition video-conferencing	Low (<150 ms). Can not tolerate any recognizable delay.	Minimal. Recognizable gaps in video and audio feed are unacceptable.	Medium. Typically, tele-consultations do not involve emergency care, thus some downtime can be tolerated	1 Mbps (symmetrical) for single video channel; 2 Mbps (symmetrical for two video channels)
Conferencing	Standard definition video-conferencing	Low (<150 ms). Can not tolerate any recognizable delay.	Minimal. Recognizable gaps in video and audio feed are unacceptable.	Medium. Typically, tele-consultations do not involve emergency care, thus some downtime can be tolerated	300 Kbps (symmetrical) for single video channel; 600 Kbps (symmetrical) for two video channels
Conferencing	Audio conferencing	Low (<150 ms). Can not tolerate any recognizable delay.	Minimal. Recognizable gaps in video and audio feed are unacceptable.	Medium. Typically, tele-consultations do not involve emergency care, thus some downtime can be tolerated	18 Kbps

[169] Sujansky & Associates, LLC, Applicability of the California Telehealth Network as the Network Infrastructure for Statewide Health Information Exchange: An Assessment of the Optimal Roles for the CTN in California's HIE, Oct. 8, 2009. http://www.sujansky.com/docs/CTN_for_HIE_Assessment_SujanskyAndAssociates_2009-10-08_FINAL.pdf.
[170] R. Steele and A. Lo, "*Telehealth and Ubiquitous Computing for Bandwidth-constrained Rural and Remote Areas*", Personal and Ubiquitous Computing, doi:10.1007/s00779-012-0506-5, 2012.
[171] Sujansky & Associates, at 11.

Category	Application	Acceptable Latency Level	Acceptable Packet Loss	Downtime Sensitivity	Minimum Bandwidth
Store-and-Forward	e.g., diabetic retinal examination, diagnostic image review, etc.	High.	High. Lost packets can be resent.	Low	.5 Mbps (except for full radiological studies, which require high bandwidths, e.g., > 10 Mbps
Telemetry	Continuous telemetry (e.g., ECG, ICU monitors)	High. Reviewing providers does not need to get data at exact moment of recording (i.e., 1-5-second delay acceptable).	Medium. Lost packets can be resent. Applications can utilize buffers to handle packet loss.	High. Important clinical events can be missed if the network is down even temporarily.	.5 Mbps (possibly less, depending on number of data channels required)
Telemetry	Periodic telemetry (e.g., BP, blood glucose)	High.	High. Lost packets can be resent.	Medium. Data may be resent after network is back up	56 Kbps per data channel
Clinical Messaging	I.e., provider-patient exchange of email, instant messages, text messages, etc.	High.	High. Lost packets can be resent.	Medium. Data may be resent after network is back up	56 Kbps
Education/ Research	E.g., continuing medical education, grand rounds, population health research, etc.	High.	High. Lost packets can be resent.	Low	Asynchronous activities require .5 Mbps, synchronous require 1 Mbps

7 Kansas Schools, Libraries, and Hospitals Need Broadband Procurement Support

House Bill 2390 asked us to evaluate alternative forms of broadband procurement. As the legislation assumes, we agree that there are other forms of procurement and procurement support that can be provided to Kansas schools, libraries, and hospitals, even in the absence of the Kan-ed network.

7.1 Kan-ed Provided a Range of Broadband Support

It is important to note that a school, library, or hospital that received service from Kan-ed was getting not just a circuit, but essentially a bundle of services and benefits that came with that circuit, including:

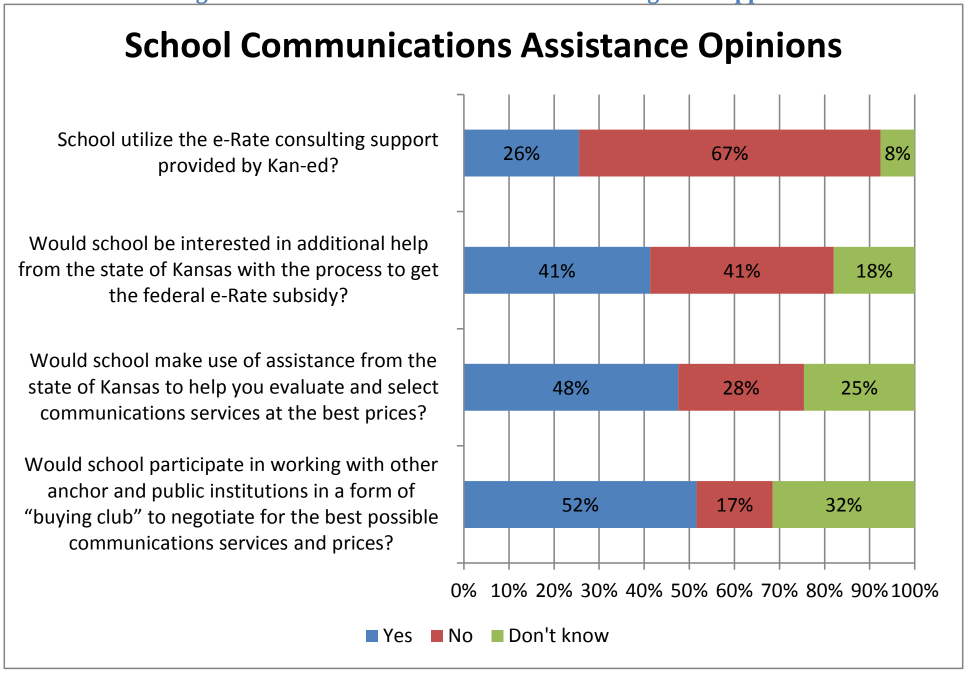
- Pricing based on the aggregated need of Kan-ed members throughout the state, which enabled greater leverage in negotiating price
- Assistance with the local e-Rate application process, as well as direct support from Kan-ed in the form of modest e-Rate consulting
- Expert technical assistance, in the form of round-the-clock monitoring from the KanREN network operation center and access to KanREN staff when technical issues arose

As a result, the elimination of Kan-ed's communications network also eliminates additional procurement and support benefits that came with the connections and creates new costs and needs for these entities—gaps that they will now have to fill. That said, many of these additional benefits can be provided by another public or private entity, even in the absence of the Kan-ed communications network.

7.2 Kansas Schools, Libraries, and Hospitals Indicate an Interest in Receiving Broadband Support

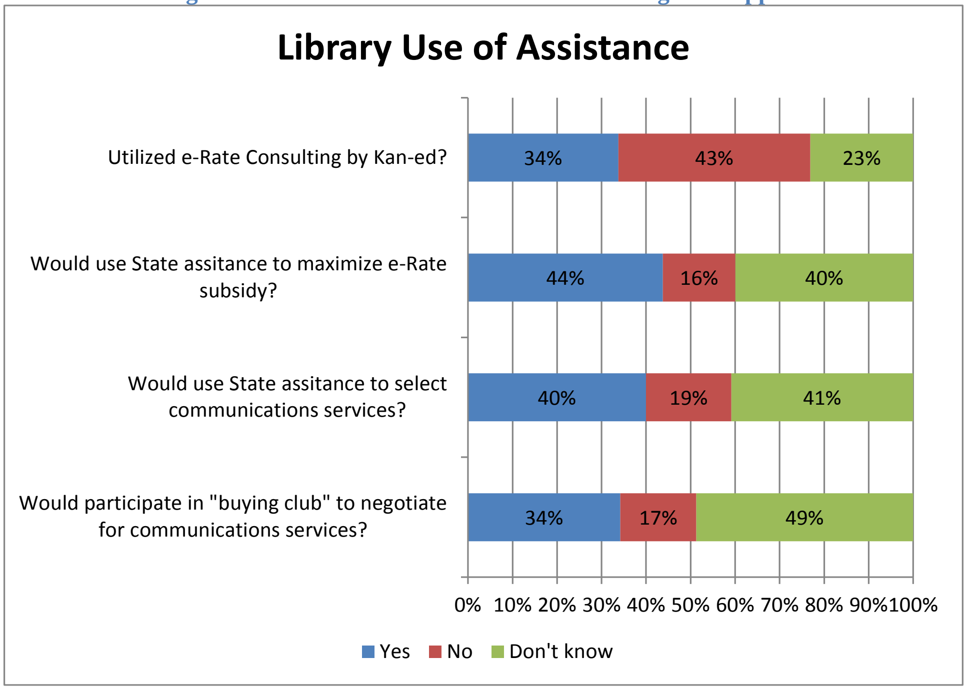
We believe that the survey data and interviews we conducted demonstrate a very strong need for these kinds of support services on the part of schools, libraries, and hospitals. For example, while 26 percent of schools utilized the e-Rate consulting support provided by Kan-ed, 41 percent indicated interest in receiving additional help from the State. An even greater percentage would like help evaluating and selecting communications services, and in forming a "buying club" to and negotiate prices based on aggregated demand. (See Figure 14.)

Figure 14: Schools' Interest in Broadband Program Support



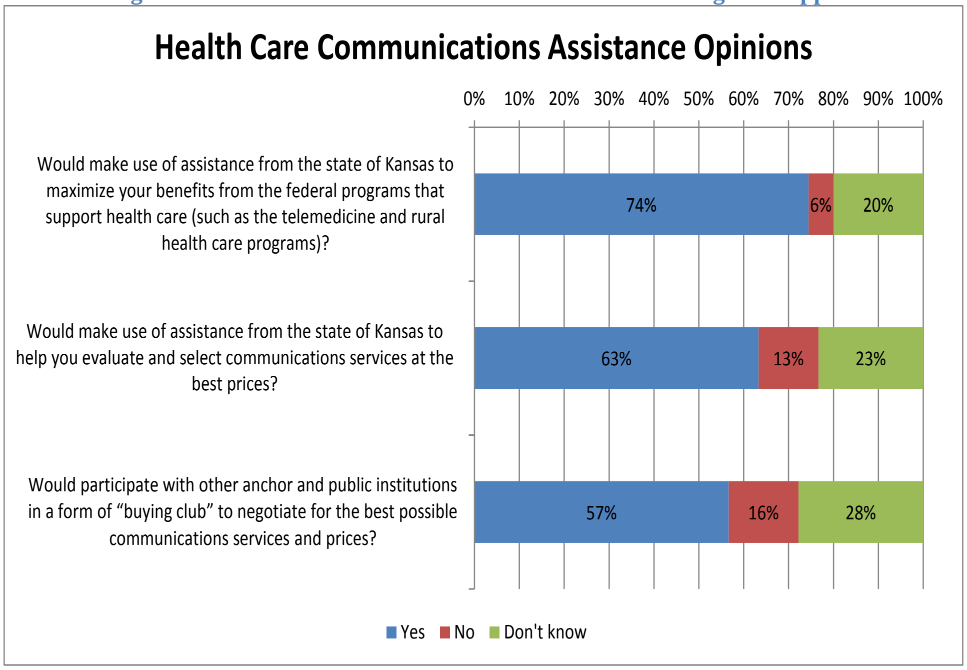
Similarly, 34 percent of libraries utilized the e-Rate consulting support provided by Kan-ed, but 44 percent indicated interest in receiving additional help from the State. Many libraries would also use State assistance in evaluating and selecting communications services, and would participate in a buying club to negotiate prices based on aggregated demand. (See Figure 15.)

Figure 15: Libraries' Interest in Broadband Program Support



The majority of the health care sector also indicated a strong interest in receiving additional help from the State (74 percent), using State assistance in evaluating and selecting communications services (63 percent), and participating in a buying club to negotiate prices based on aggregated demand (57 percent). (See Figure 16.)

Figure 16: Health Care Sector's Interest in Broadband Program Support



7.3 Kansas Can Support Broadband Procurement for Schools, Libraries, and Hospitals

We conclude, based on the survey data, that there is significant room for Kansas to support broadband procurement by schools, libraries, and hospitals through aggregated bidding and purchasing, centralized planning and procurement, and consolidation of needs.

The data collected during the surveys also demonstrate that Kansas schools, libraries, and hospitals have not yet maximized their opportunity to utilize the federal funding programs.

While most schools are using the e-Rate program, a considerable number of libraries are not. (See Figure 17 and Figure 18.) In some cases, libraries elect not to utilize e-Rate because the funding includes a mandatory condition that libraries filter certain kinds of content; however, in many cases the reasons the libraries are not using the e-Rate program are that most Kansas library systems are small and under-resourced, and the program may simply be too burdensome for them to navigate.

Figure 17: Schools' Participation in E-Rate Program

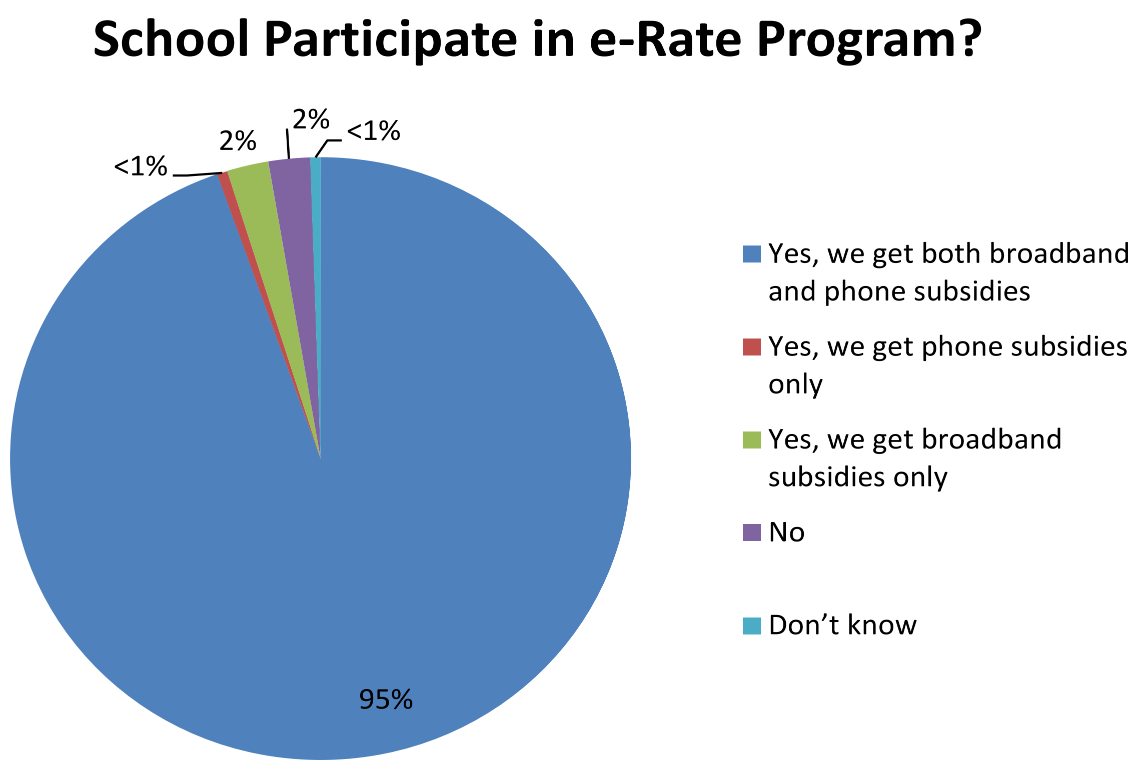
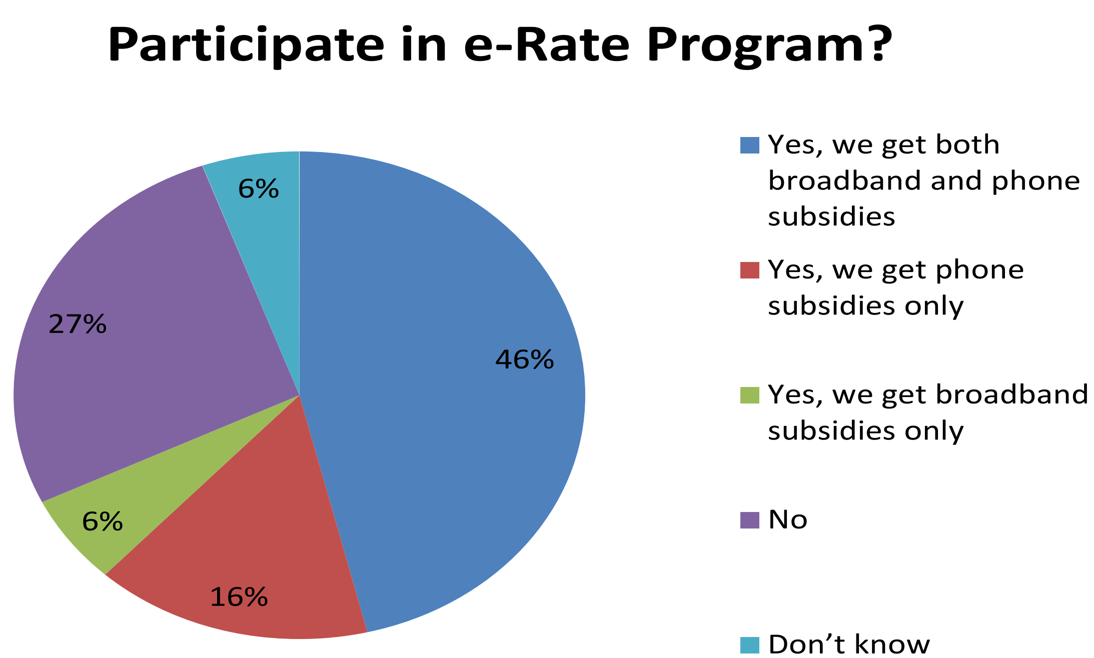


Figure 18: Libraries' Participation in E-Rate Program



The survey data indicate that the health care sector has also not maximized its use of applicable federal funding programs. A majority of hospitals do not currently participate in the FCC's rural health care communications funding program (see Figure 19) or the Rural Utilities Service's broadband grant program (see Figure 20).

Figure 19: Health Care Sector's Participation in FCC Broadband Funding Program

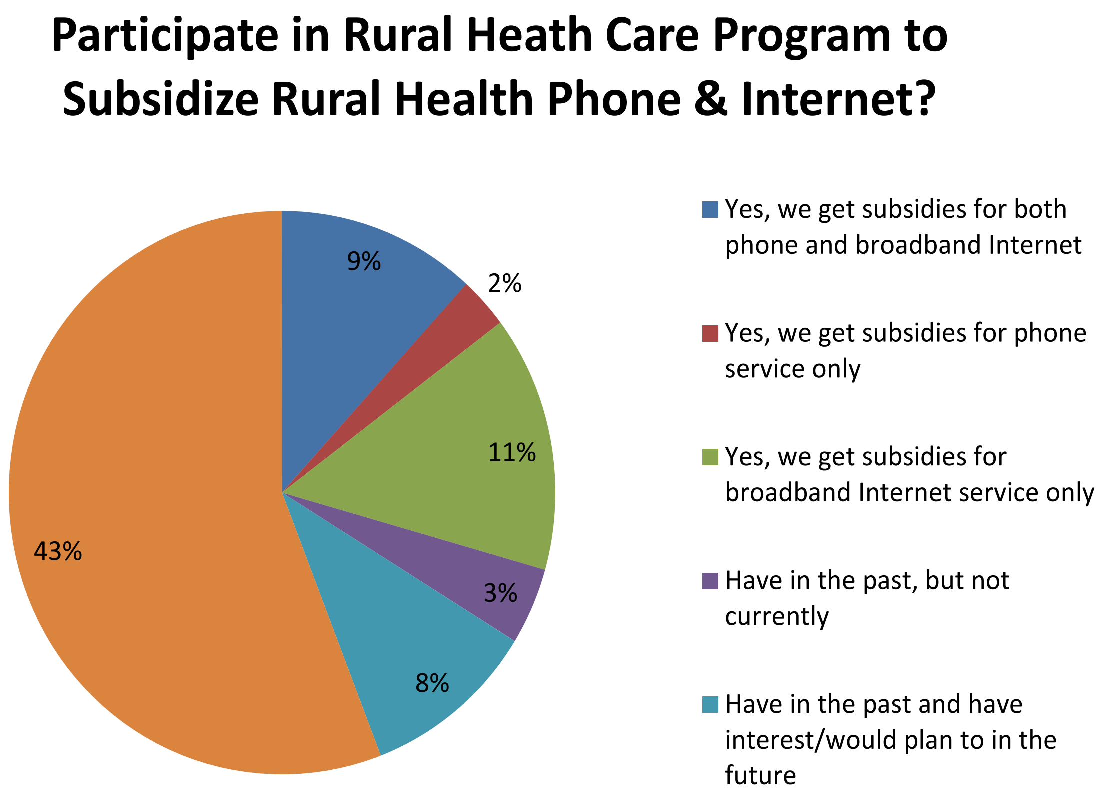
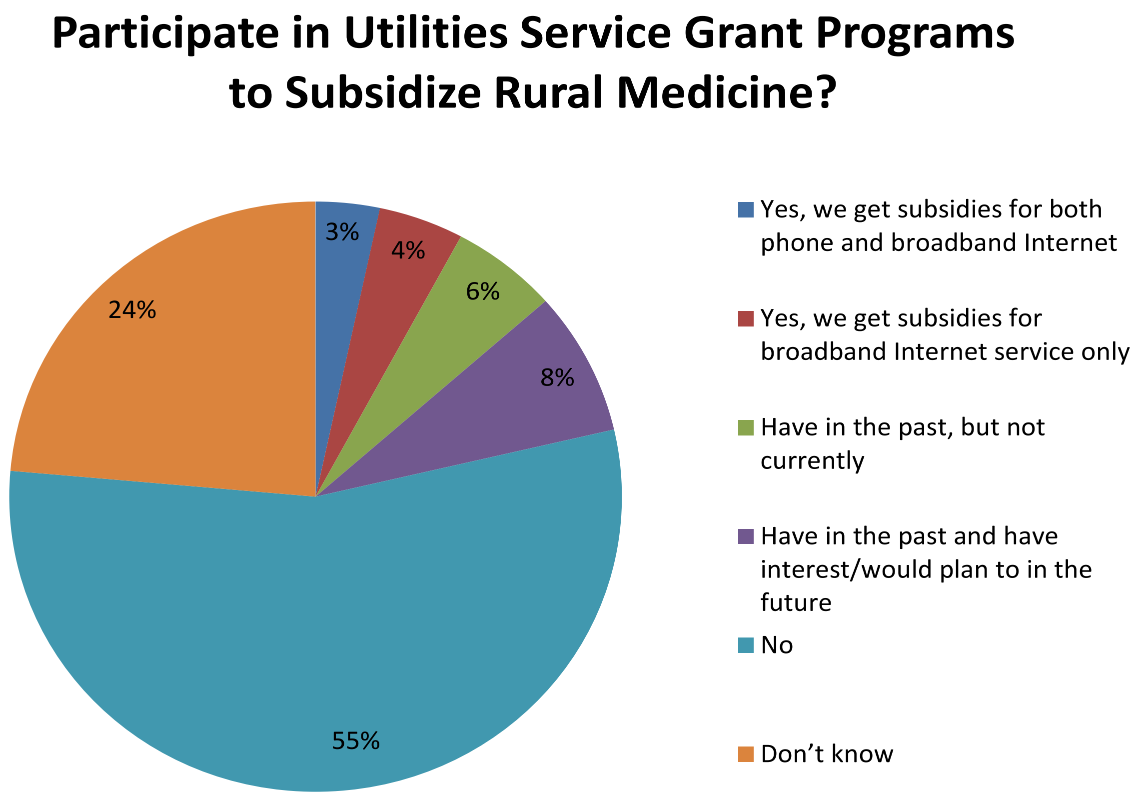


Figure 20: Health Care Sector's Participation in Department of Agriculture Broadband Funding Program



We therefore believe that there is opportunity for the State to help schools, libraries, and hospitals make better use of federal funding programs. We also believe that in doing so, the State can, in the aggregate, increase the number of dollars flowing into the State from sector-specific federal broadband funding programs.

One model we suggest for consideration is the one implemented in North Carolina. (A detailed case study is included below.) When the State of North Carolina decided to fund K–12 broadband services through the state's non-profit higher education network (North Carolina Research and Education Network, or NCREN), NCREN undertook to centralize all e-Rate applications so that schools were entirely relieved of this burden. Since then, the net amount of e-Rate funds flowing in to the state has increased dramatically—while the schools have increased their Internet utilization seven-fold.

The State should also consider providing targeted subsidies directly to schools, libraries, and hospitals to defray their broadband costs. On average, Kansas schools, libraries, and hospitals are eligible for an approximately 65 percent federal funding—which leaves a 35 percent funding that is required locally.[172] Many of these schools, libraries, and hospitals, particularly those

[172] The federal government, through the FCC's Universal Service Fund, provides funding support to schools and libraries in the form of the e-Rate program, and to healthcare facilities through a number of programs—most

where the local community has less resources available for broadband, would benefit from financial support from the State to cover the costs of the local match and enable them to purchase better, higher-bandwidth services. (As a point of reference, the State of Nebraska covers 85 percent of the difference between its educational entities' local broadband costs and their e-Rate reimbursement.[173])

In addition, the State funding, if combined with federal program planning and consulting support, could enable Kansas to increase the amount of federal funds flowing into the State. The percentages of the subsidies will not vary, but if the institutions are able to buy more costly, higher-bandwidth services, the absolute dollar figure flowing into the State will increase.

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significant of which is the newly created Healthcare Connect Fund. Other programs fund equipment and services, both through the FCC and the Department of Agriculture's Rural Utilities Service. The Healthcare Connect program will require a one-third local match from the healthcare facility applying for the funding. While the funding level will vary by school district (it ranges from 50 to 90 percent, based on a combination of the rural nature and level of poverty in the local community), Kan-ed staff inform us that the average statewide funding is approximately 65 percent.

[173] Neb.Rev.Stat. 79-1003(13).

8 Kansas Can Enable Migration to World-Class Internet Service by Facilitating Digital Roads

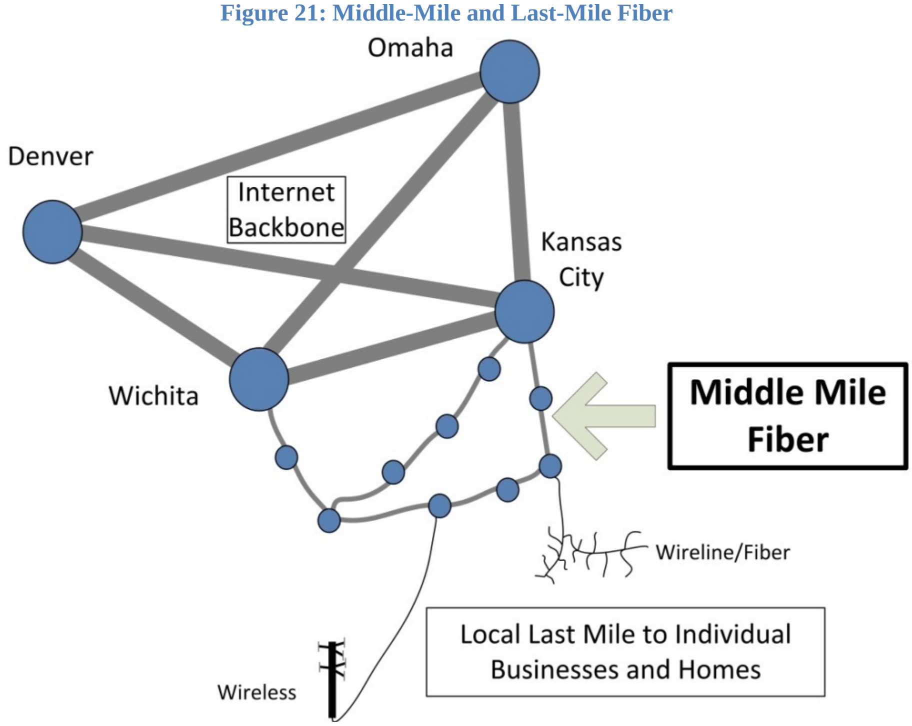
Construction of Digital State Highways—in the form of communications conduit and fiber optics installed in conjunction with the State's highway construction programs—is one way for Kansas to address the need for better infrastructure and services to schools, libraries, and hospitals—as well as to Kansas businesses and homes.

8.1 Digital State Highways in the "Middle Mile" Stimulate Private Investment

It is widely accepted that such conduit and fiber optics enable private carriers and entrepreneurs to cost-effectively bridge the gap between the Internet backbone (the equivalent of the federal interstate highway system) and the "last mile" (the equivalent of neighborhood streets and driveways). That gap is known as the "middle mile" and, in the apt analogy of the highway system, it is the equivalent of state highways that reach from federal interstates into communities, where localities build local streets and roads.

Where the State builds these middle-mile Digital Highways, the private carriers need not build their own middle-mile facilities and can concentrate their investment in last-mile deployment—thus increasing last-mile investment in high-speed Internet service to homes and businesses. Figure 21 illustrates the relationship of (1) Internet backbone; (2) middle-mile fiber; and (3) last-mile wireline and wireless infrastructure:

Figure 21: Middle-Mile and Last-Mile Fiber



Digital State Highways can deliver substantial economic benefit through middle-mile availability and stimulation of investment in the last-mile. The National Broadband Plan, for example, recognizes that middle-mile costs directly impact the cost of providing last-mile broadband in unserved areas.[174]

Additionally, one of the most critical metrics for broadband availability and adoption is the wholesale cost of commodity Internet service in a community. Such costs determine whether or not it is feasible for a service provider to enter or sustain its business. The cost of middle-mile service from the Internet backbone to a rural area can be hundreds of dollars per megabit per second (i.e., hundreds of times the cost in metropolitan areas for the same megabit), making it infeasible for a rural carrier or entrepreneur to sell cost-effective services.

The public investment in Digital State Highways would thus reduce a sizeable expense for last-mile developers by opening up competitive middle-mile access and removing a key barrier to building and operating broadband networks. Kansas companies would thus be able to obtain high-speed, cost-effective services in any community connected over the Digital State Highways.

It is widely understood that the middle-mile serves as a "critical enabler of 'last-mile' broadband service to homes and local businesses."[175] Lack of affordable, available middle-mile transport creates enormous costs to competitive carriers and entrepreneurs and to local and broader economic activity.[176] The high cost of traditional middle-mile facilities creates a costly barrier to last-mile broadband investment because the carrier cannot access the market it wishes to serve, thus resulting in an "utter lack of meaningful competition,"[177] and limiting investment and innovation in areas like rural Kansas.

As the FCC explains:

> In many cases, the rural broadband provider will need to obtain backhaul transport from more than one provider, often over facilities that were designed for voice telephone or cable television services…. Some of these 'middle-mile' facilities may have insufficient capacity, causing the transmission speed on otherwise adequate last-mile broadband

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[174] Federal Communications Commission, "National Broadband Plan: Connecting America," Chapter 8 (http://www.broadband.gov/plan/8-availability/#r8-8) (accessed Oct. 1, 2012).

[175] Testimony of The Honorable Lawrence E. Strickling, Assistant Secretary for Communications and Information National Telecommunications and Information Administration, United States Department of Commerce, July 18 2012, before the Committee on Small Business United States House of Representatives, "Digital Divide: Expanding Broadband Access to Small Businesses**."** http://www.ntia.doc.gov/speechtestimony/2012/testimony-assistant-secretary-strickling-digital-divide-expanding-broadband-acc

[176] See Jim Baller and Casey Lide, June 2008, "Bigger Vision, Bolder Action, Brighter Future: Capturing the Promise of Broadband for North Carolina and America," at 123-24 (http://s.ftthcouncil.org/files/final_bhlg_white_paper__5-27-08__jim_baller.pdf) (accessed Sept. 30, 2012).

[177] Economics and Technology, Inc., "Special Access Overpricing and the U.S. Economy," prepared for the Ad HocTelecommunications users Committee, August 2007 at 19.

> facilities to come to a crawl or stall before the data reach the Internet backbone. Overcoming this may require the construction of a dedicated facility, which drives up costs and can deter last-mile broadband investments. *Moreover, even when the last-mile provider acquires access to adequate middle-mile facilities, that access may be prohibitively expensive*.[178]

In sum, lack of access to the middle mile inhibits investment in the last mile.

As a result, new conduit or fiber can fill an important gap, providing a cost-effective middle-mile alternative in markets where none has otherwise developed. Its presence encourages competition and offers access to all qualified providers. By lowering barriers to entry, it enables entrepreneurs and rural providers to connect—and offers far-reaching economic benefits economy-wide.

As a recent World Bank report explains, "[c]ompetitive and well-functioning wholesale markets for backhaul capacity [middle-mile] are a critical component of broadband diffusion and adoption."[179] Governments focus on developing the middle mile because they recognize that the "availability of adequate fib[er] backhaul networks in each region is a fundamental prerequisite for any broadband development."[180]

Such public infrastructure projects are viewed as "stimulat[ing] infrastructure-based competition"—a process by which public funding enables private innovation and investment.[181] Moreover, since backhaul networks are not limited to particular technology platforms, last-mile providers can offer end users whatever access technology they prefer or can afford (such as fiber, DSL, mobile, or wireless).

8.2 Constructing Digital State Highways Is Efficient

The construction of fiber optic communications cables is a costly, complex, and time-consuming process. The high cost of construction is a barrier to entry for potential broadband communications providers. In addition, available space is diminishing in the public rights-of-way (ROW). And cutting roads and sidewalks substantially reduces the lifetime and performance of those surfaces.

[178] FCC, May 22, 2009 "Bringing Broadband to Rural America: Report on a Rural Broadband Strategy" (italics added) http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-291012A1.pdf (accessed Sept. 30, 2012).
[179] The World Bank, Tim Kelly and Carlo Maria Rossotto, eds., 2012, Broadband Strategies Toolkit, at 115 (http://broadbandtoolkit.org/Custom/Core/Documents/Broadband%20Strategies%20Handbook.pdf)
[180] Filomena Chirico and Norbert Gaál, 2011, Competition Policy Newsletter, "State Aid to Broadband: Primer and Best Practices," at 57, http://ec.europa.eu/competition/publications/cpn/2011_1_10_en.pdf (accessed Oct. 3, 2012).
[181] *Id.* at 53.

Accordingly, encouraging or requiring simultaneous construction and co-location of facilities in the public ROW will reduce the long-term cost of building communications facilities. This is because there are significant economies of scale through:

1. Coordination of construction with road construction and other disruptive activities in the public ROW.

2. Construction of spare conduit capacity where multiple service providers or entities may require infrastructure.

The reason that these economies are available is primarily because *fiber optic cables and installation materials alone are relatively inexpensive, often contributing to less than one quarter of the total cost of new construction.* While material costs typically fall well below $40,000 per mile (even for large cables containing hundreds of fiber strands), labor, permitting, and engineering costs commonly drive the total price toward $200,000 per mile.

Moreover, as the ROW becomes more crowded with communications infrastructure and other utilities, the cost of new construction can grow exponentially. In general, however, it is in the best interests of both public and private entities for the public sector to identify construction collaboration opportunities that share the burden of expensive and duplicative labor-related costs and efficiently utilize physical space in the ROW.

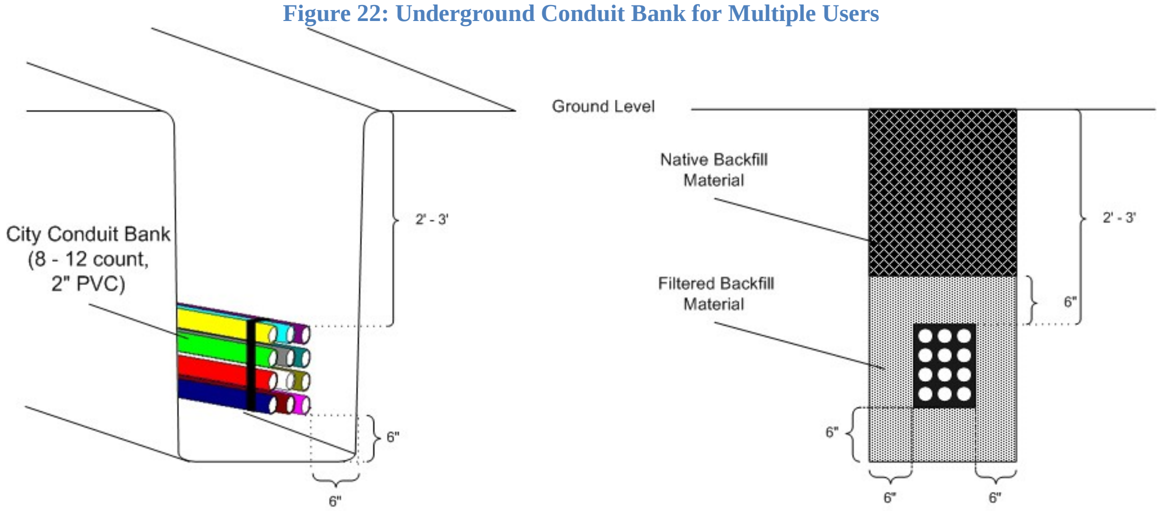
If fiber construction is coordinated with a major road or utility project that is already disrupting the ROW in a rural area, the cost of constructing the fiber, communications conduit, and other materials can range from $30,000 per mile up. However, if fiber construction is completed as part of a separate standalone project, the cost of constructing fiber and communications conduit can range from $95,000 to $200,000 per mile.

There are numerous methods for constructing fiber optic infrastructure. In particular, underground construction using protective conduits generally provides the most scalable, flexible, and durable method for developing long-term communications infrastructure, but is also typically more expensive than aerial construction methods requiring attachments to utility poles. This is because of the limit in the quantity of cables and attachments that can be placed on existing utility poles in more crowded areas, and because aerial construction is more exposed and vulnerable to outside conditions.

Banks of conduits constructed *simultaneously* (Figure 22), or large conduits segmented with inner duct, provide multiple pathways for the installation of multiple fiber optic cables located in close proximity, with the ability to remove, add, or replace fiber optic cables without disturbing neighboring cables.

Conversely, multiple conduits installed at different times must be physically spaced, often by several feet, to prevent damage to one while installing the next. Once the ROW becomes crowded, often the choices of construction methods are reduced, leaving only less desirable methods and more costly locations for construction of additional infrastructure.

Figure 22: Underground Conduit Bank for Multiple Users



Some of the key cost components that can be avoided or reduced through coordinated construction efforts include:

- Incremental labor and material costs, through reduced crew mobilization expenses and through larger bulk material purchases
- Trenching or boring costs, particularly when coordination enables lower-cost methods (e.g., trenching as opposed to boring) or allows multiple entities to share a common trench or bore for their independent purposes
- Traffic control and safety personnel costs, particularly when constructing along roadways requiring lane closures
- Engineering and survey costs associated with locating existing utilities and specifying the placement of new facilities
- Engineering and survey costs associated with environmental impact studies and approvals
- Lease fees for access to private easements, such as those owned by electric utilities
- Railroad crossing permit fees and engineering

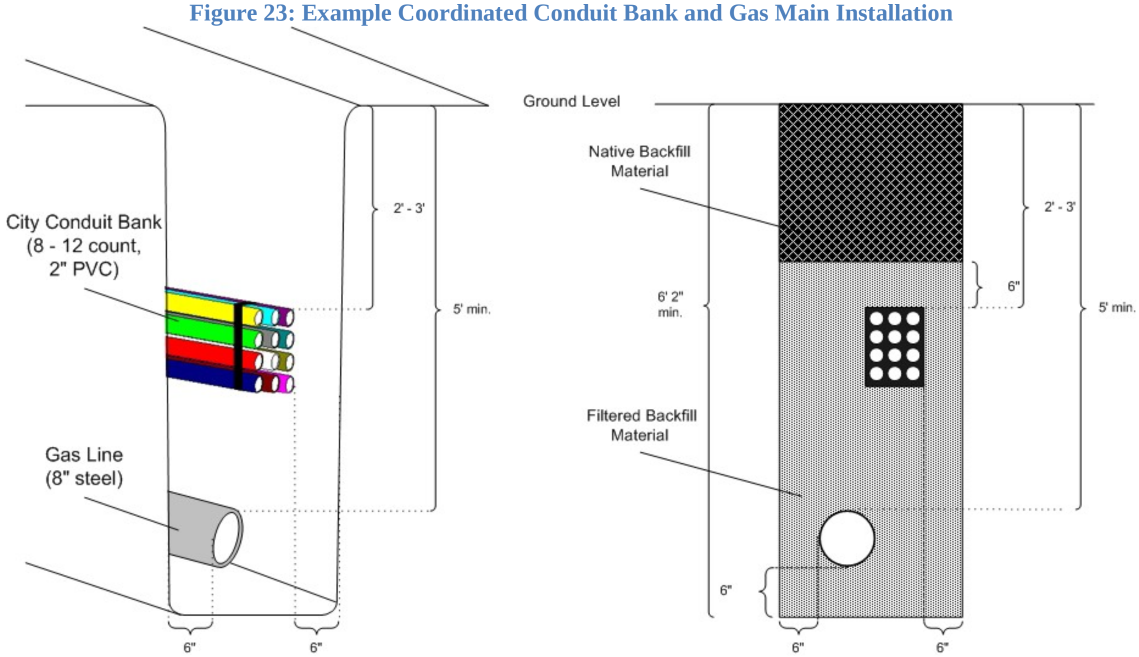
- Restoration to the ROW or roadway, particularly in conjunction with roadway improvements
- Bridge crossing permit fees and engineering

8.3 Coordinating Digital State Highway Construction with Other Utility Projects Reduces Costs

Where other types of construction are occurring within or along the ROW, such as highway construction or resurfacing, roadway widening, sidewalk repairs, bridge construction, and water or gas main installation, there is an opportunity to place telecommunications infrastructure at an overall reduced cost and with reduced disruption to public ROW.

Figure 23 illustrates how a multi-user conduit bank might be installed with a gas main, water main, power line, or other large utility installation requiring trenching. We note that in a case like this, it is important to ensure proper backfill of trench material and facilitate future access to both the conduit and the other utility for repair by offsetting the two utilities horizontally and requiring a somewhat wider trench. This offsets somewhat the potential cost savings by requiring a larger trench and multistep backfill process. Nonetheless, cost savings are still substantial.

Figure 23: Example Coordinated Conduit Bank and Gas Main Installation



8.4 Case Study: Arizona Builds Digital State Highways to Stimulate Private Investment

In 2012, the Arizona legislature passed the "Digital Arizona Highways Act of 2012" (SB 1402) on the recommendation of the Digital Arizona Program.[182] This law allows the state to install fiber conduit in state rights-of-way whenever other maintenance work is being performed in the same location.[183]

According to Arizona officials, the deployment of fiber infrastructure under the old system was a costly endeavor, and in many cases, deployment was stopped as a result. Especially because of the prevalence of land grant areas in Arizona, fiber construction often had to go across a strictly regulated property with requirements that the state seek the best use of the land, thus making it very costly to build there.

At the same time, state planners recognized that across the state, the highways go where the rural populations live, and provide routes to bring fiber conduit to those areas. The new law thus provides that wherever there is open maintenance or construction in a state roadway, it is state policy to install conduit for fiber at the same time. The state recognized that this was incredibly cost effective—*the cost of installing conduit when other work is underway is about the same as the cost to add paint stripes to the road for the equivalent distance*.

Under this model, the state owns the conduit but gives the private sector the opportunity to pull fiber through it. As a result, Arizona has effectively made its physical highways into information highways; the state owns the conduit as it owns the roads, and the private sector owns and operates the fiber placed in the state's conduit. The state hopes to free up long stretches of middle-mile routes through long diverse stretches of the state where it has been difficult and costly to build fiber. By providing the rights-of-way and conduit to investors and service providers who want to expand long-distance network capacity into rural areas, the state believes it will incentivize new projects that would not have happened otherwise.

The private companies will pay for access to the conduit so as to recover the state's costs up front.

This law thus reflects a significant policy shift. It recognizes that the cost savings and economic benefits of making broadband available justify the state's up-front investment to build conduit

[182] The State of Arizona administers a statewide broadband strategic plan through the Arizona Strategic Enterprise Technology (ASET) office, which in turn created the Digital Arizona Program. This program actively advocates for broadband expansion throughout rural Arizona and serves as the Arizona counterpart to the Kansas Statewide Broadband Initiative (KSBI).

[183] This case study is based on the following sources: CTC interview with Mr. Mike Golden and Mr. Jeffrey Crane, Digital Arizona Program, September 2012; CTC interview with Mr. Galen Updike, Digital Arizona Program, May 2012; "The Two Highways Proposition," *Digital Arizona Program*, http://www.digitalarizona.gov/About/The_Two_Highways_Proposition.html (accessed 24 January 2013). CTC wishes to thank Mr. Golden, Mr. Crane, and Mr. Updike for their time and consideration.

in public rights-of-way. This process streamlines the fiber construction process by making the conduit available to all comers and eliminating many of the requirements for construction permits, environmental and historical studies, and other one-time processes that were previously repeat costs for every provider for every new project in a state right-of-way. Under the new program, the state has addressed all of these in advance while building the conduit. Making fiber conduit readily available through the rights-of-way is a significant step in enabling a new generation of public-private partnerships for broadband expansion throughout the state. The new program reflects that the state recognizes access to high-speed information infrastructure is in the same category as power, water, and transportation—an essential public need.

9 Survey Data Summary

To develop the appropriate data for this needs assessment, in late 2012 CTC conducted a survey of the members of Kan-ed, which include schools (including institutions of higher education), libraries, and hospitals.

9.1 Survey Methodology

In late November 2012, e-mails were sent on behalf of the Kansas Department of Commerce by CTC to all 963 members of Kan-ed with a link to an online survey about their use of the Internet and their Kan-ed connection. An online survey mechanism enabled completion of survey questionnaires over the Internet. A total of 619 completed responses were received by December 15, 2012, including approximately 530 that were completed in their entirety and 89 that were partially completed (including some with only one or two skipped questions).

Given the total of 963 Kan-ed members and 619 responses, the response rate was 64.3 percent (55.0 percent including only those 530 that were entirely completed). Aggregate results across all Kan-ed members are thus available with a confidence interval of ±2.4 percent at the 95 percent probability level. That is, 19 times out of 20, the survey results would capture the actual values for the entire population of Kan-ed members within ±2.4 percent.[184]

A breakdown of response rates within each sub-category of organizational types, and the corresponding confidence intervals, is summarized as follows:

Table 6: Survey Respondents by Sector

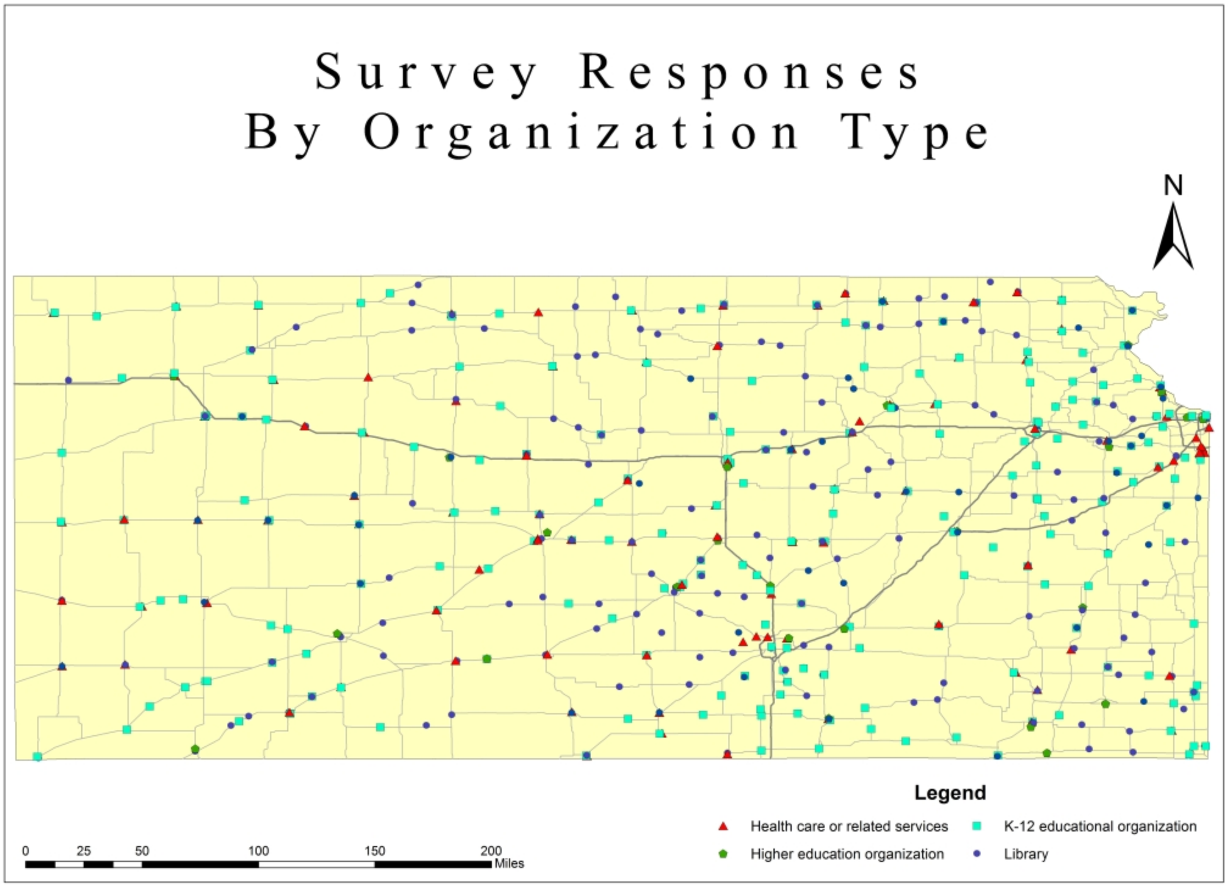
	Members	Responses	Response Rate	Confidence Interval
Libraries	336	239	71.1%	±3.4%
K–12 Education	335	187	55.8%	±4.8%
Higher Education	52	21	40.4%	±16.7%
Health Care	240	92	38.3%	±8.0%
Total (All)	963	619	64.3%	±2.4%

[184] While it is possible that a small number of survey responses were completed by a participating organization within a larger Kan-ed member, such as an individual library within a regional library network, the statistical analysis presented in this report assumes a total population of 963 Kan-ed members and 619 unique responses.

Many of the results summaries presented in this report include a breakout of libraries, K–12 schools, and health care respondents for comparative purposes. Results within each subcategory should be evaluated using the confidence intervals noted in the previous table. Due to the relatively small number of higher education members and the resulting broad confidence interval, results for the higher education sector are not presented separately in this report. However, responses for higher education institutions are included in all aggregate results.

Respondents are located all over the State. Figure 24 shows their locations:

Figure 24: Survey Responses by Organization Type



The survey results are summarized and discussed in the following sections. Please note that the results often refer to “Kan-ed members” which should be interpreted as the subset of survey respondents whose aggregate responses are valid within the statistical criteria and uncertainties discussed previously.

Results for many aspects are subdivided into the health care, libraries, and K–12 sectors. Due to the small number of higher educational organizations in the sample and the subsequent broad confidence intervals, results for the higher education group are not presented separately, but are included in aggregate totals.

9.2 Respondents Range in Size and Complexity of Communications Needs

All respondents were asked about the size of their facility and their broader organization, both in terms of the number of employees and the number of computers. This information is useful as it can drive Internet purchasing decisions, both in terms of the connection type and the cost that the organization is willing to pay for Internet service.

The average respondent had 117 employees and 226 computers at the location surveyed. Across the State of Kansas, respondents averaged 154 employees and 296 computers. On average, libraries were much smaller than other responding facilities.

Figure 25: Average Number of Employees by Sector

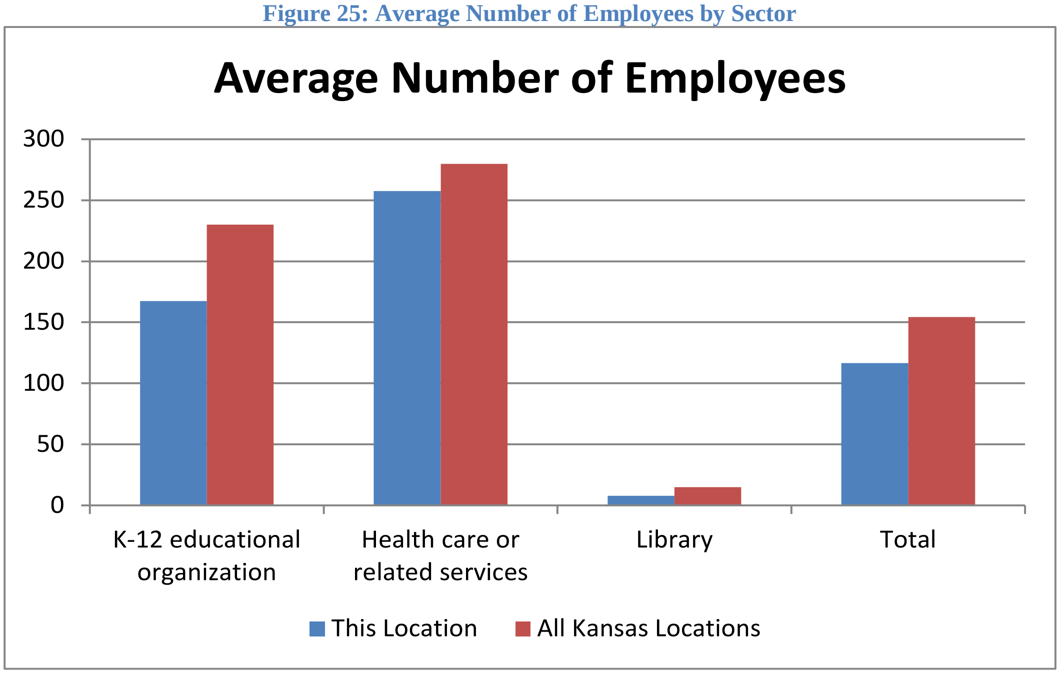
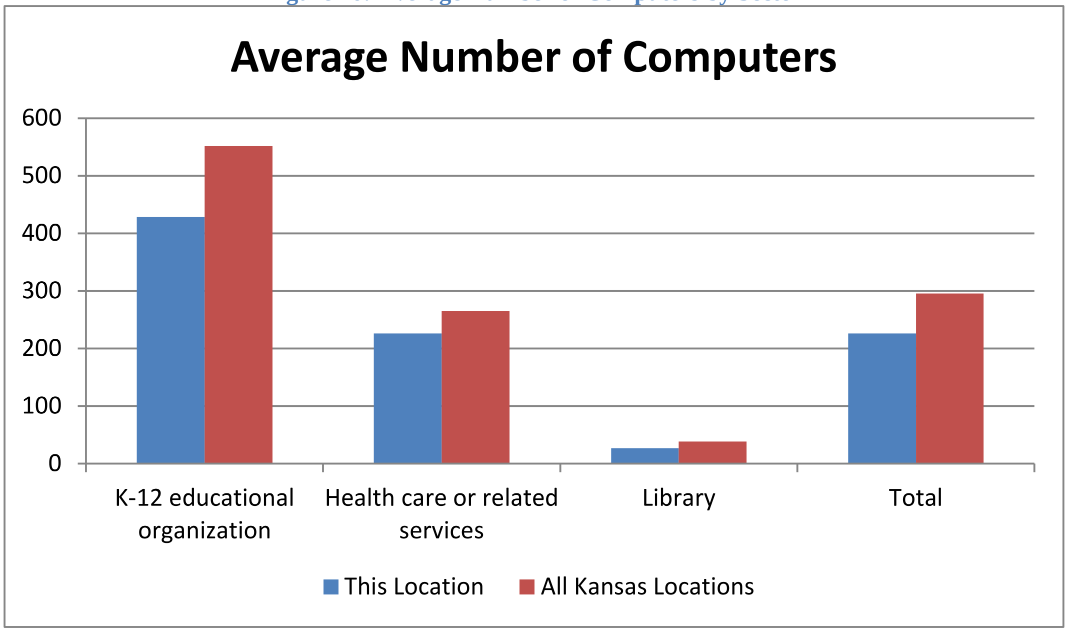


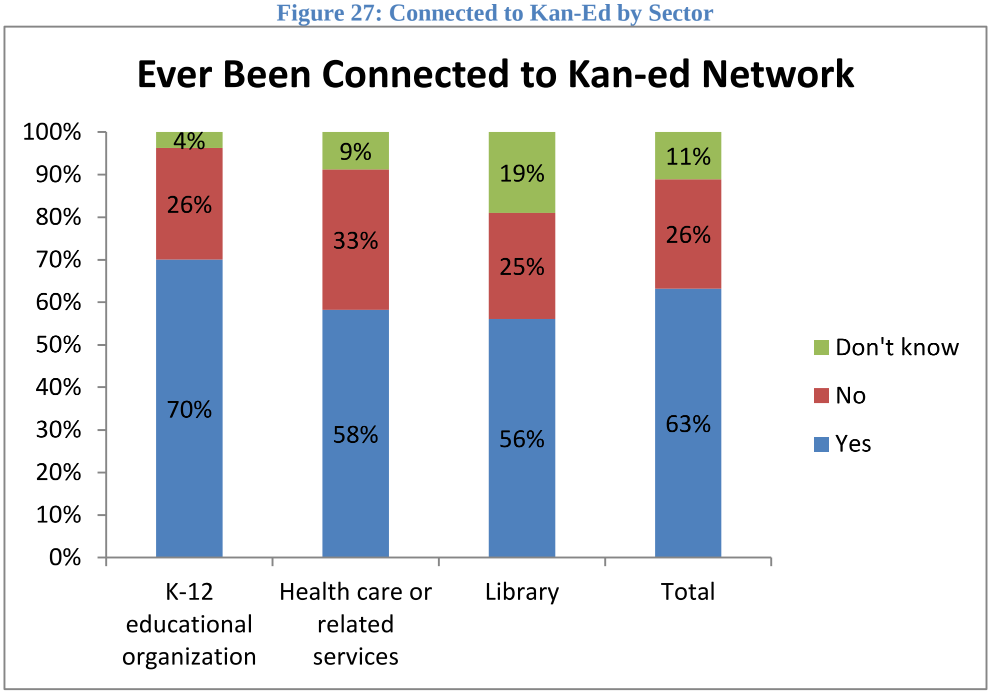
Figure 26: Average Number of Computers by Sector



9.3 Respondents Connected to, and Indicated Satisfaction with, Kan-ed's Network

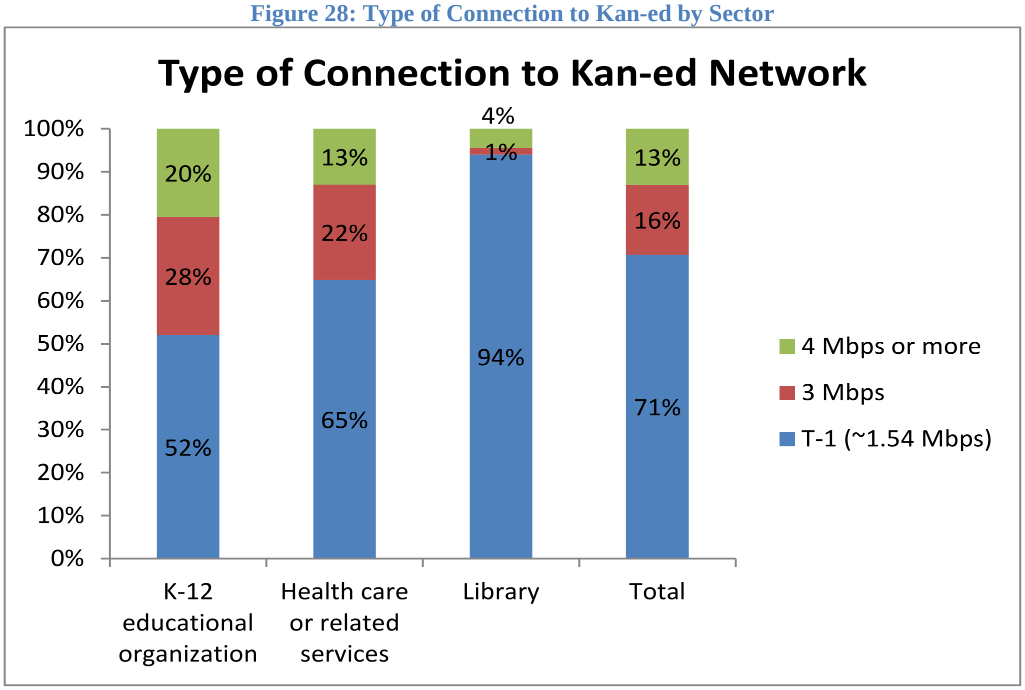
Nearly two-thirds of respondents indicated that they were, or had been, connected to the Kan-ed network and an additional 11 percent were not sure if they had been connected. K–12 respondents were the most likely to have been connected to the Kan-ed network.

Figure 27: Connected to Kan-Ed by Sector



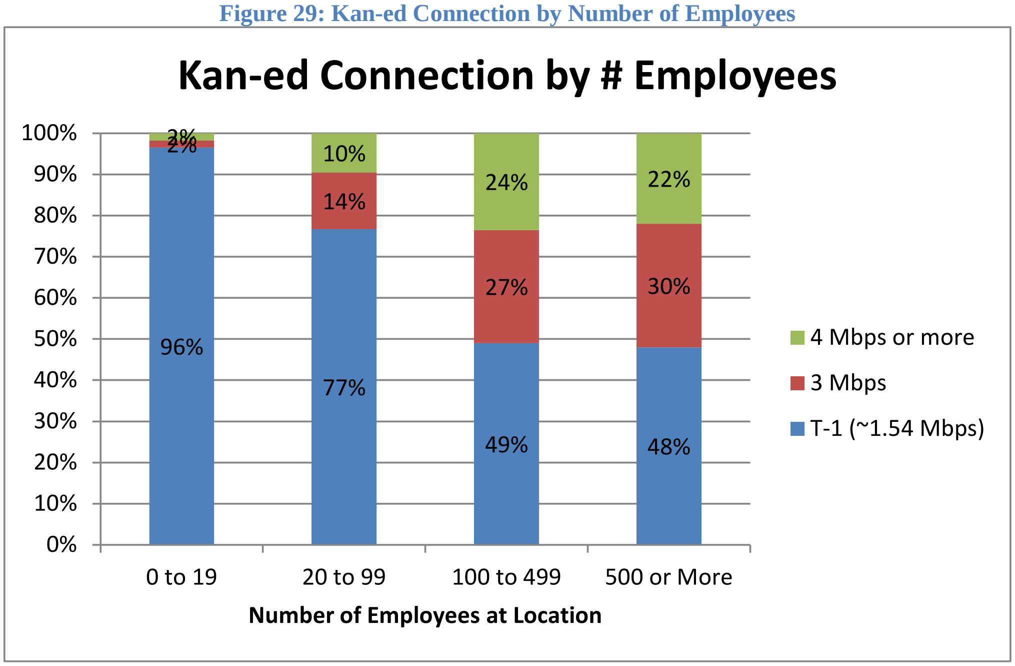
Most Kan-ed connections were over a T-1 connection, with approximate speeds of 1.5 Mbps. Faster connections were more prevalent for educational organizations and less common for libraries.

Figure 28: Type of Connection to Kan-ed by Sector



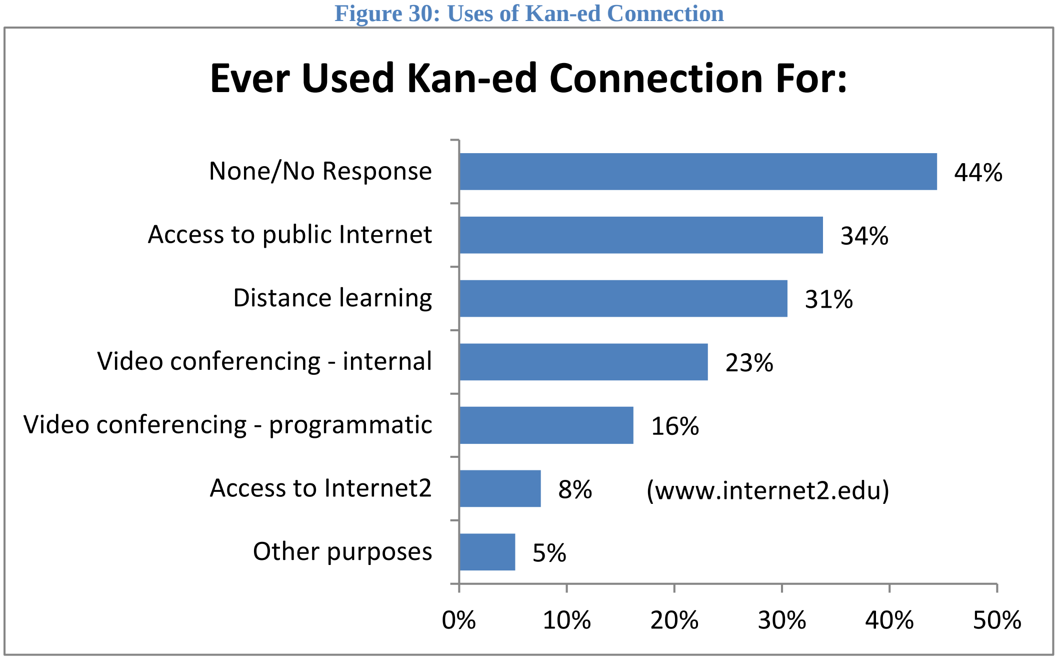
The type of connection to Kan-ed varies by size of the organization. Smaller organizations are most likely to have T-1 connections. Over one-half of organizations with 100 or more employees had connections of 3 Mbps or faster.

Figure 29: Kan-ed Connection by Number of Employees



Of the key Internet uses provided, over one-third of respondents had used their Kan-ed connection to provide Internet access to the public and nearly one-third used their Kan-ed connection for distance learning. A moderate proportion of respondents also used their connection for video conferencing.

Figure 30: Uses of Kan-ed Connection



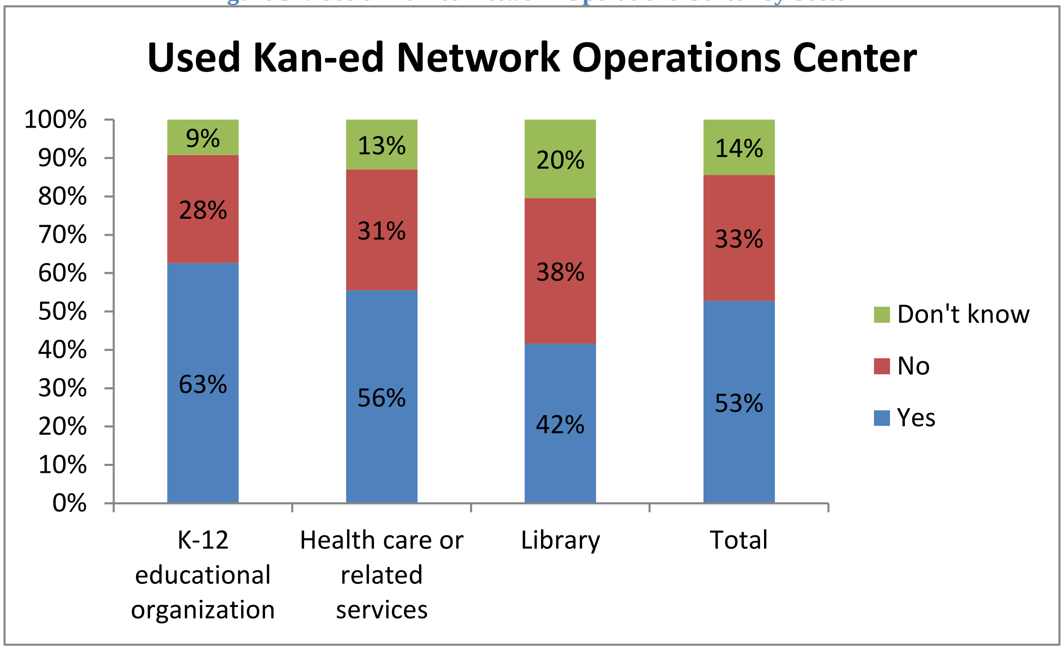
As one might expect, K–12 educational organizations are the most likely to use their Kan-ed connection for distance learning, while libraries are the most likely to provide public Internet access via their Kan-ed connection. The uses of the Kan-ed connection among the three primary sectors are summarized in the following table.

Table 7: Uses of Kan-ed Connection by Sector

		Which best describes your organization?			
		K-12 educational organization	Health care or related services	Library	Total
		Column N %	Column N %	Column N %	Column N %
Uses of Kan-ed Connection	Video conferencing - internal	32%	37%	12%	23%
	Video conferencing - programmatic	22%	22%	10%	16%
	Distance learning	45%	38%	18%	31%
	Access to Internet2	11%	10%	4%	8%
	Access to public Internet	34%	17%	48%	34%
	Other purposes	2%	11%	7%	5%
	None/No Response	34%	43%	44%	44%

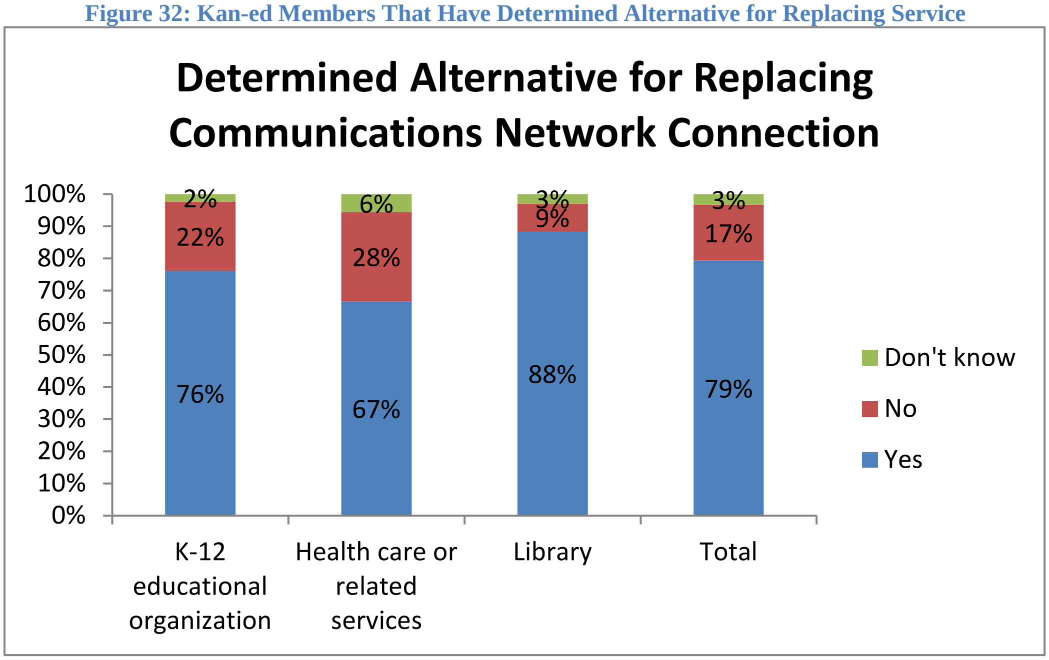
More than one-half of respondents had used the Kan-ed Network Operations Center. It was most heavily used by K–12 educational organizations and least frequently used by libraries.

Figure 31: Use of Kan-ed Network Operations Center by Sector



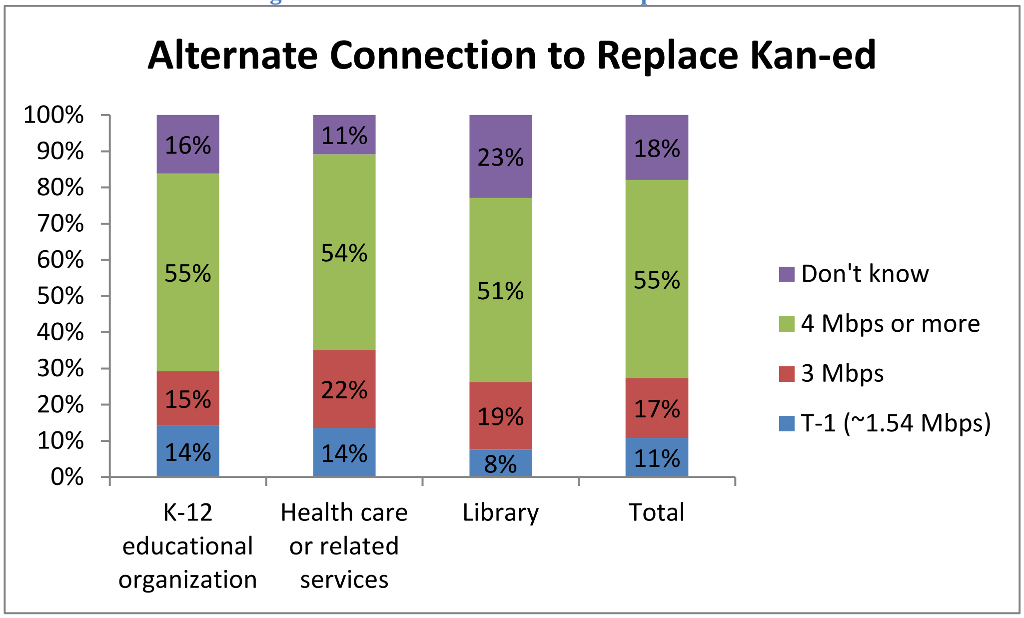
Nearly all respondents were aware that the Kansas legislature had eliminated Kan-ed communications network connections. Nearly 80 percent of respondents have investigated and determined an alternate for replacing the connection received from Kan-ed, if that need were to arise.

Figure 32: Kan-ed Members That Have Determined Alternative for Replacing Service



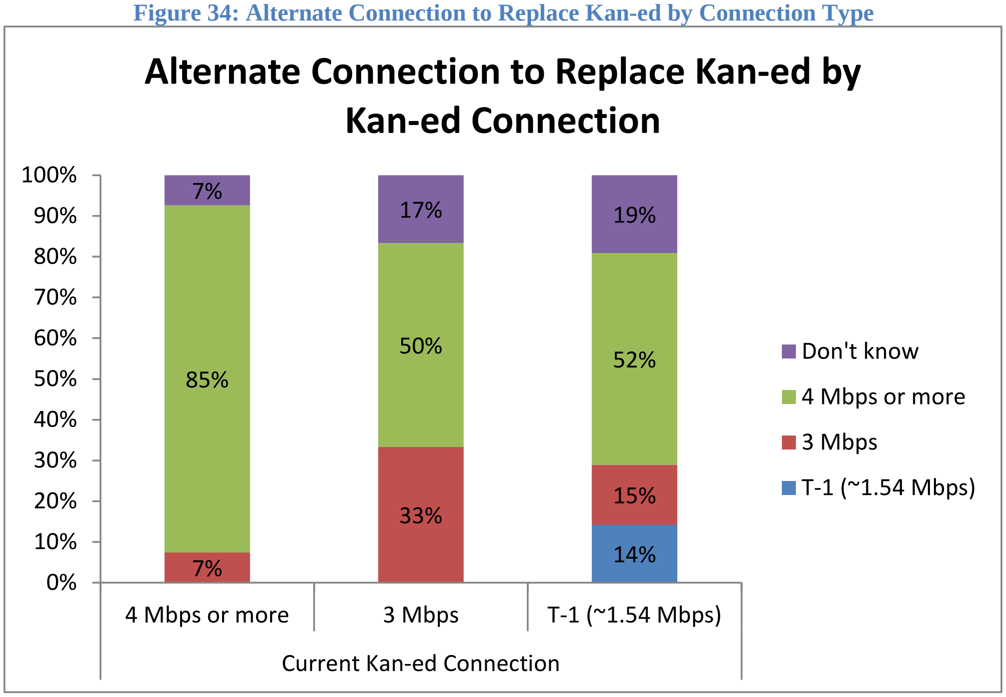
More than one-half responded that they would replace their Kan-ed connection with a service offering speeds of 4 Mbps or greater. Approximately 17 percent would replace their Kan-ed connection with a 3 Mbps service and 11 percent would replace it with a T-1 service. There are 18 percent of respondents that did not know what replacement speed was available.

Figure 33: Alternate Connection to Replace Kan-ed



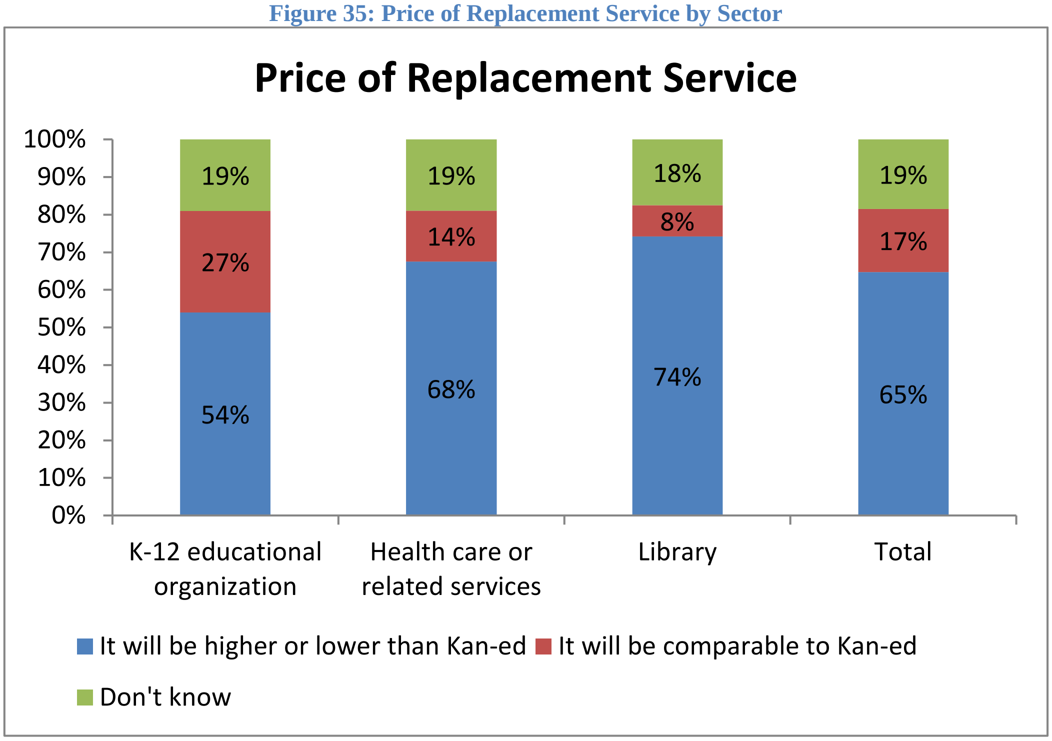
Of those members who currently have 4Mbps or faster Kan-ed service, 85 percent would be able to replace the Kan-ed service with a 4Mbps or faster service. No respondents with Kan-ed speeds of 3Mbps or greater would replace with T-1 service.

Figure 34: Alternate Connection to Replace Kan-ed by Connection Type



Most replacement Internet services will have different costs than the Kan-ed service, with only 17 percent having comparable costs.

Figure 35: Price of Replacement Service by Sector



A write-in box was provided for additional details from the respondent. Of the 159 write-in responses with discernible higher or lower write-in responses, 112 (70 percent) indicated that their cost would be higher and 47 (30 percent) indicated that their cost would be lower. Several of those commenting that prices would increase also noted that their current Kan-ed connections were free or subsidized.

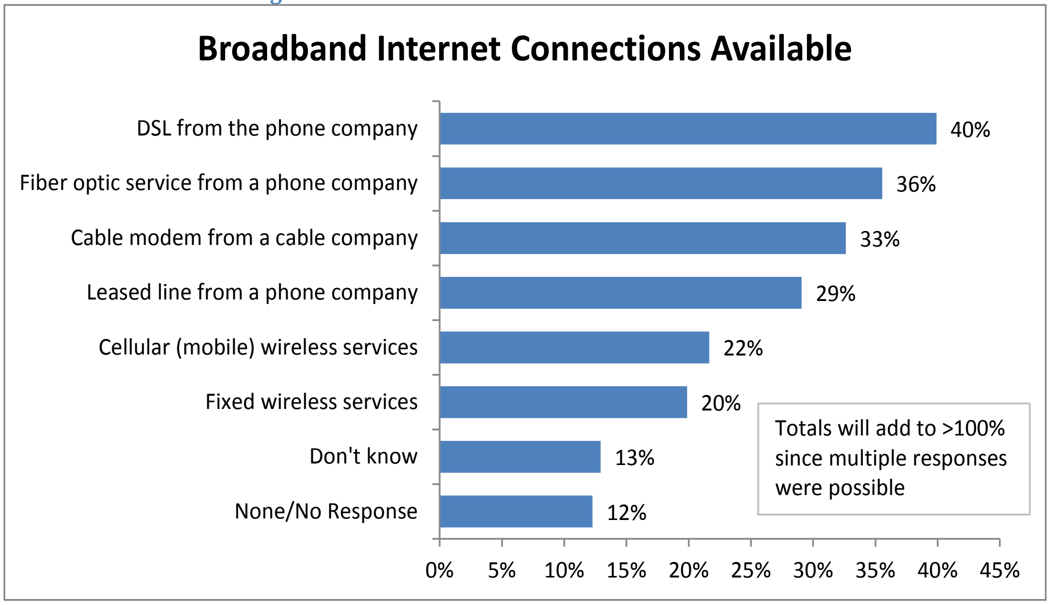
9.4 Respondents Have a Range of Existing Internet Services

All respondents were asked about their current Internet service and various aspects and opinions about that service.

Approximately 28 percent of respondents maintain at least two Internet connections to their building, including more than one-half of health care facilities

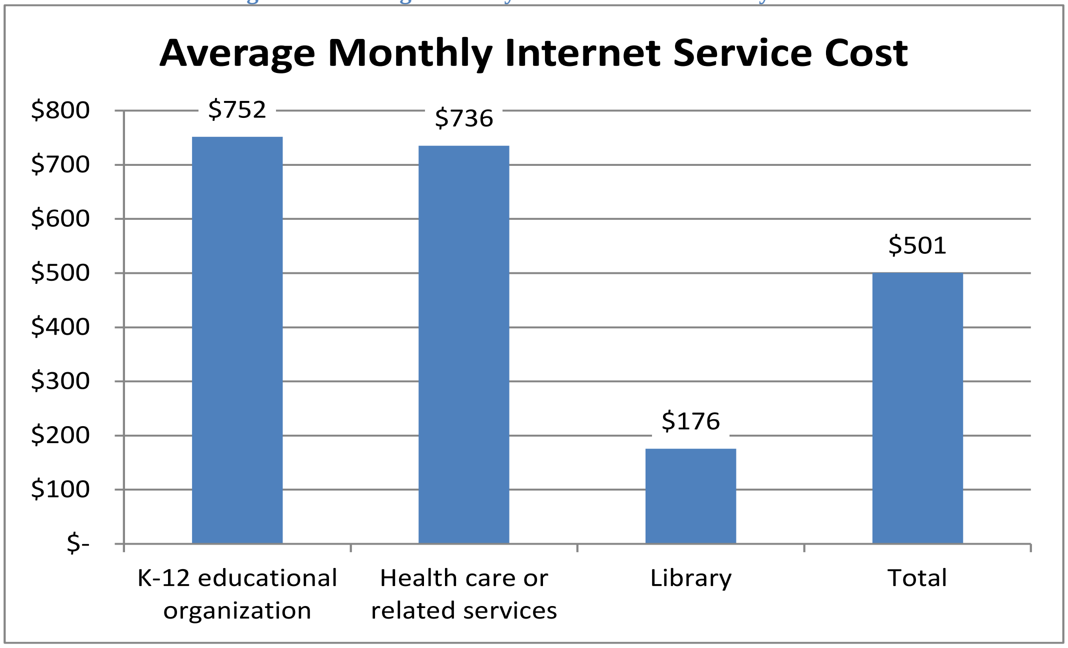
Respondents were also asked to indicate what types of broadband Internet connections were available at their facility. The most common broadband connection available was DSL, followed by fiber-optic service, cable service, and leased lines. One-fourth of respondents either did not know what was available or did not respond to this question.

Figure 36: Broadband Internet Connections Available



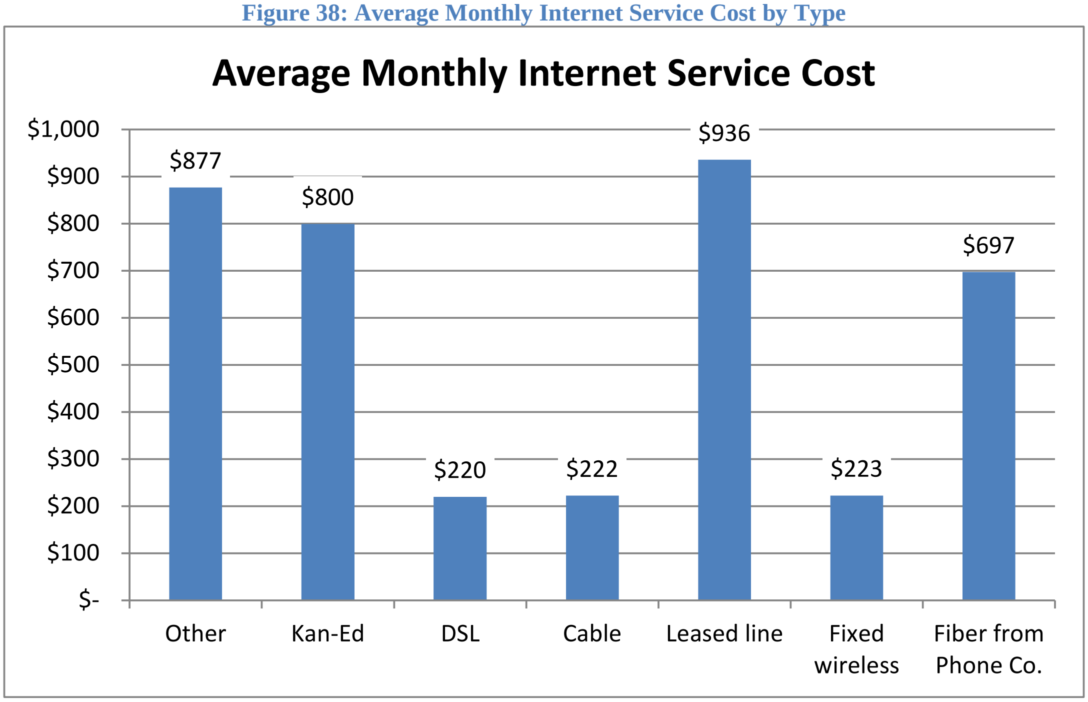
The typical Kan-ed member pays approximately $500 per month for Internet service. This varies widely among the key sectors, with health care facilities paying substantially more than libraries. This is impacted by the respondent's type of connection, service, and size.

Figure 37: Average Monthly Internet Service Cost by Sector



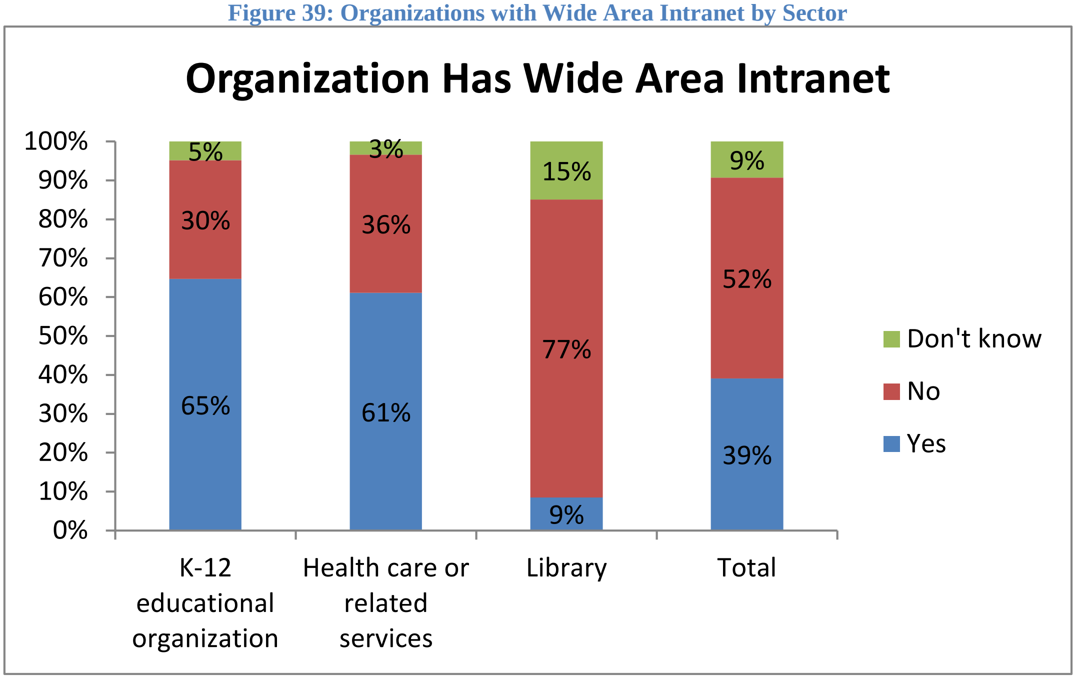
Leased line service and other (miscellaneous) services were generally the most expensive Internet services, as reported by respondents. DSL, cable, and fixed wireless services tended to be the least expensive services. Although the Kan-ed service ranked relatively high, this may be a factor of the sizes of the organizations served and the number of users served.

Figure 38: Average Monthly Internet Service Cost by Type



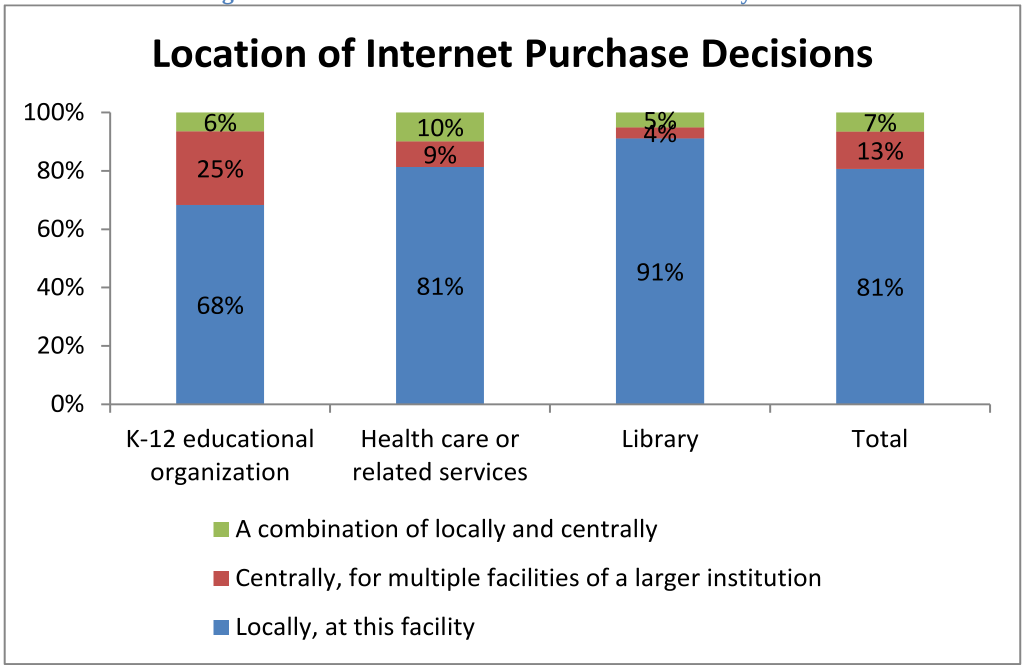
Most health care facilities and educational organizations have a wide-area Intranet in place. This is much less common with libraries. This may be related to the physical size of the facilities and the number of users.

Figure 39: Organizations with Wide Area Intranet by Sector



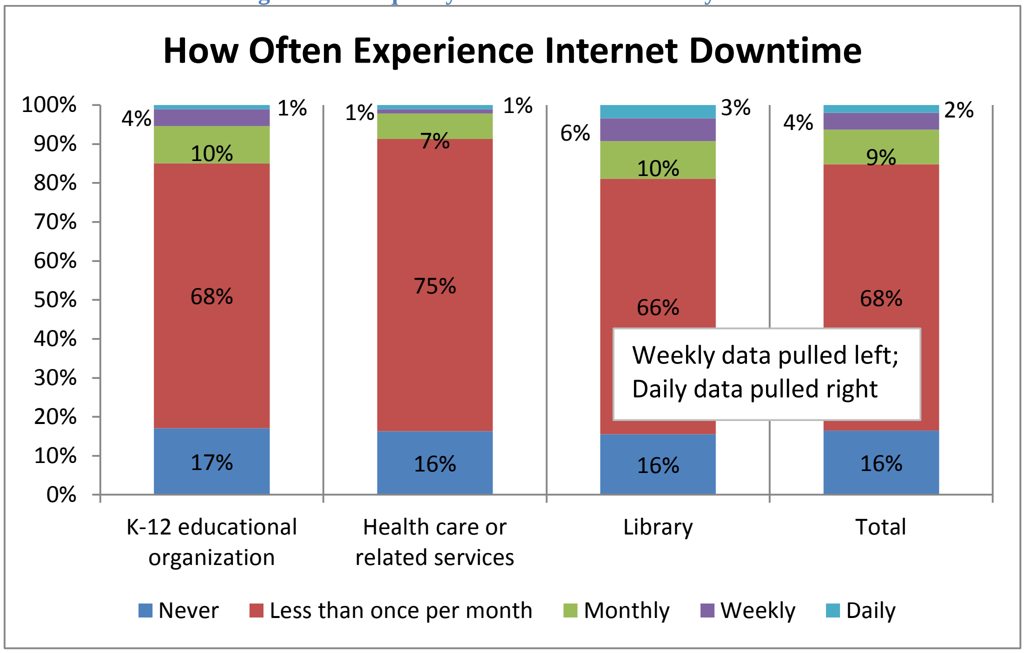
The majority of Internet purchase decisions are made locally at the facility surveyed. K–12 educational organizations were the most likely to make Internet purchase decisions centrally, across multiple facilities.

Figure 40: Location of Internet Purchase Decisions by Sector



Approximately 85 percent of respondents indicated that their Internet connection went "down" either never or less than once per month. Only two percent of respondents indicated that their Internet service was interrupted on a daily basis.

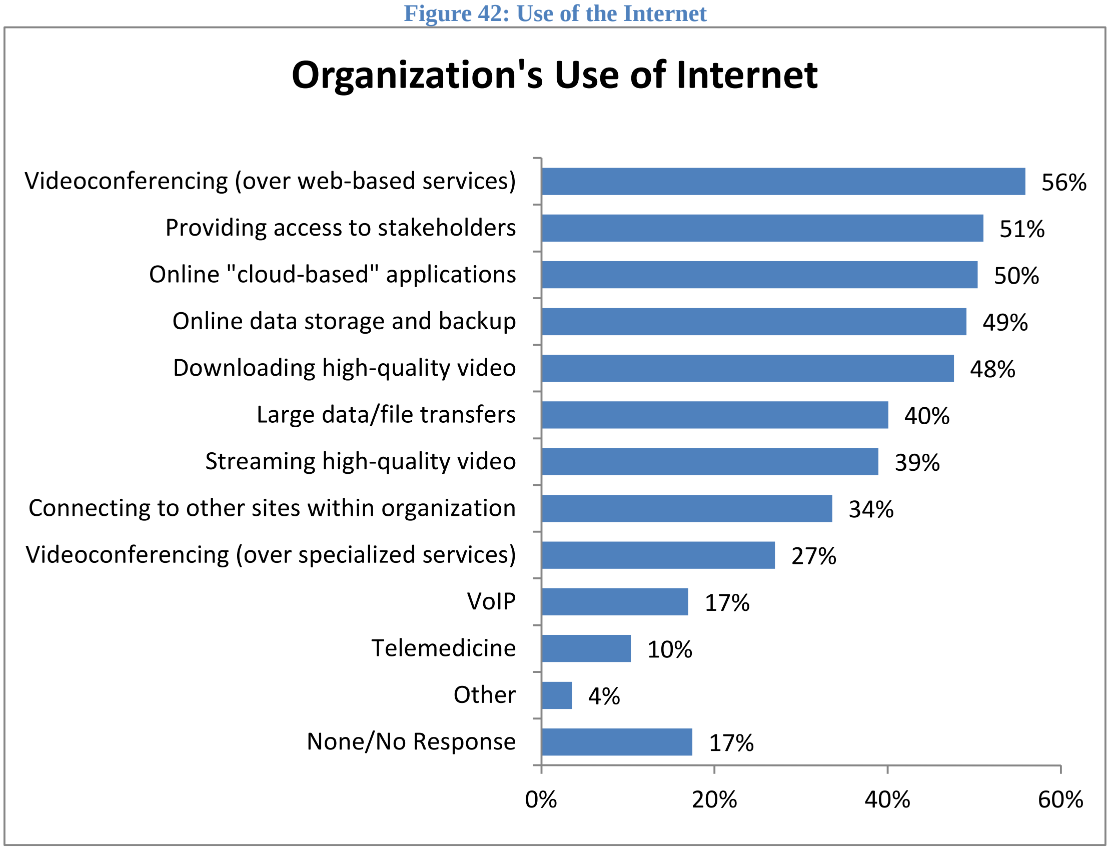
Figure 41: Frequency of Internet Downtime by Sector



9.5 Respondents Use the Internet for Specific Applications

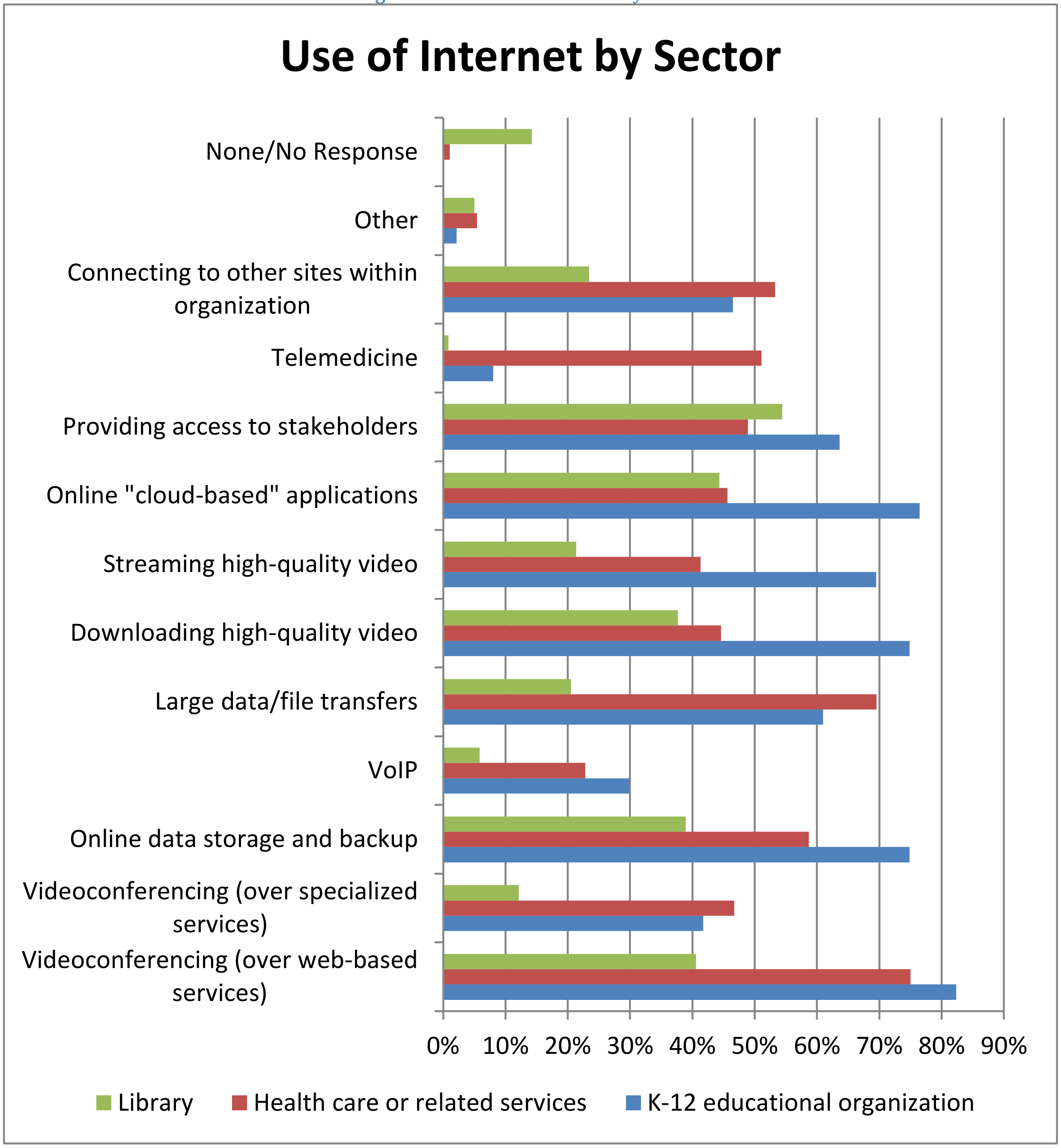
Respondents were asked about their use of their Internet service for various tasks and activities. Of the activities solicited, more than one-half of respondents used the Internet for video conferencing, providing Internet access to stakeholders, and using on-line "cloud-based" applications. Other popular activities include online storage and backup, downloading or streaming high-quality video, and transferring large data files.

Figure 42: Use of the Internet



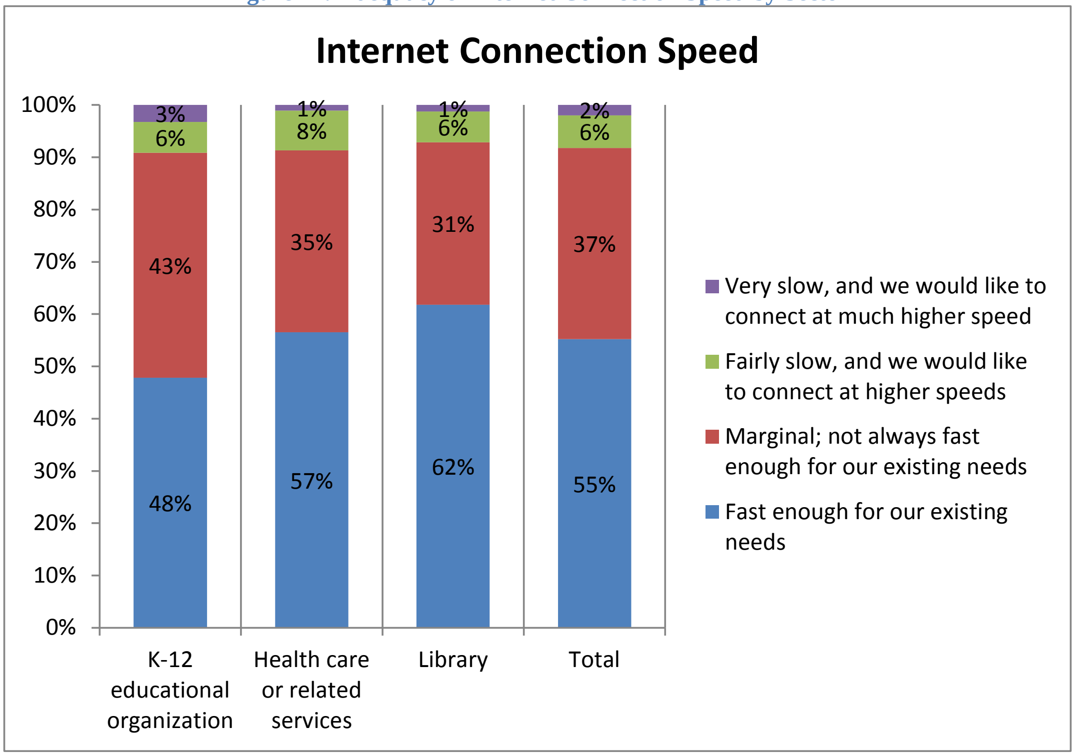
The organization's use of the Internet for activities varies by sector. K–12 educational organizations were much more likely than other sectors to use the Internet for high-quality video streaming or downloading, data storage, and online "cloud-based" applications. Libraries were less likely than other sectors to use most of the Internet activities available in this question's response options.

Figure 43: Use of the Internet by Sector



Nearly one-half of respondents indicated that their Internet connection speed was insufficient to meet their needs, while the balance (55 percent) indicated that it was adequate.

Figure 44: Adequacy of Internet Connection Speed by Sector



9.6 Respondents Report Concerns About Internet Costs and Connection Speeds

Respondents were asked about the importance of, and their satisfaction with, various aspects of their Internet service. The means of responses for both importance and satisfaction across all respondents are summarized in the following graph. The subsequent table provides detailed means across each Internet aspect across the major Kan-ed sectors.

Figure 45: Importance of/Satisfaction with Aspects of Internet Service (Mean)

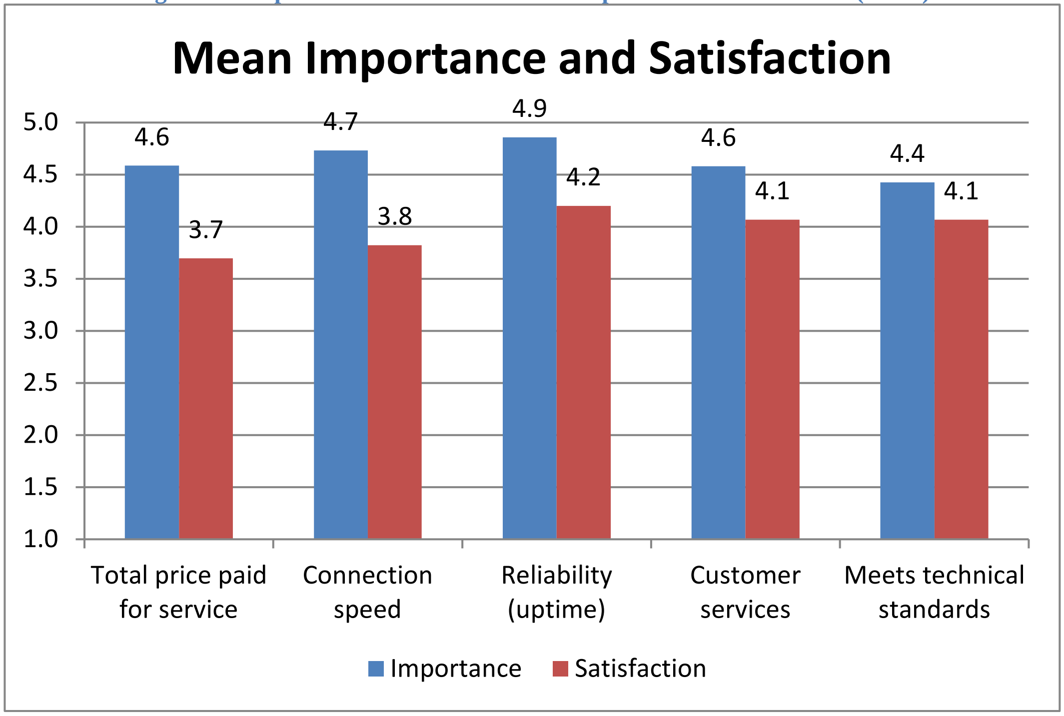


Table 8: Importance of/ Satisfaction with Aspects of Internet Service

Importance and Satisfaction with Internet Service					
		Q32 Which best describes your organization?			
		K-12 educational organization	Health care or related services	Library	Total
		Mean	Mean	Mean	Mean
Importance	Total price paid for service	4.6	4.5	4.6	4.6
	Connection speed	4.8	4.7	4.7	4.7
	Reliability (uptime)	4.9	4.9	4.8	4.9
	Customer services	4.6	4.4	4.6	4.6
	Meets technical standards	4.5	4.4	4.4	4.4
(1=Not at All Important and 5=Very Important)					
Satisfaction	Total price paid for service	3.7	3.4	3.9	3.7
	Connection speed	3.8	3.8	3.9	3.8
	Reliability (uptime)	4.3	4.2	4.1	4.2
	Customer services	4.1	4.0	4.1	4.1
	Meets technical standards	4.1	4.0	4.0	4.1

(1=Very Dissatisfied and 5=Very Satisfied)

The gap between importance and satisfaction helps identify aspects with which Internet services are meeting or not meeting the expectations and desires of customers. That is, if the importance placed on a specific aspect is greater than their satisfaction with that service aspect, providers are not fully meeting the needs of customers. The largest gaps are for the Internet connection speed and the price paid for service. The gaps between importance and satisfaction are summarized in the following graph and table.

Figure 46: Importance of/ Satisfaction with Aspects of Internet Service (Chart)

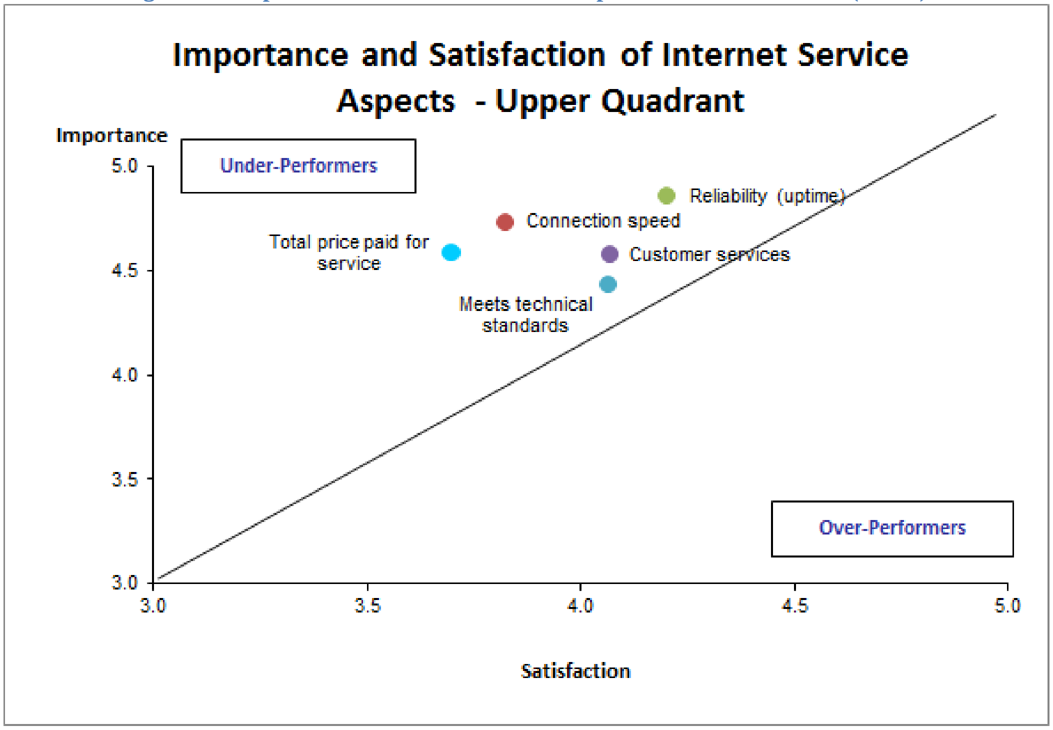
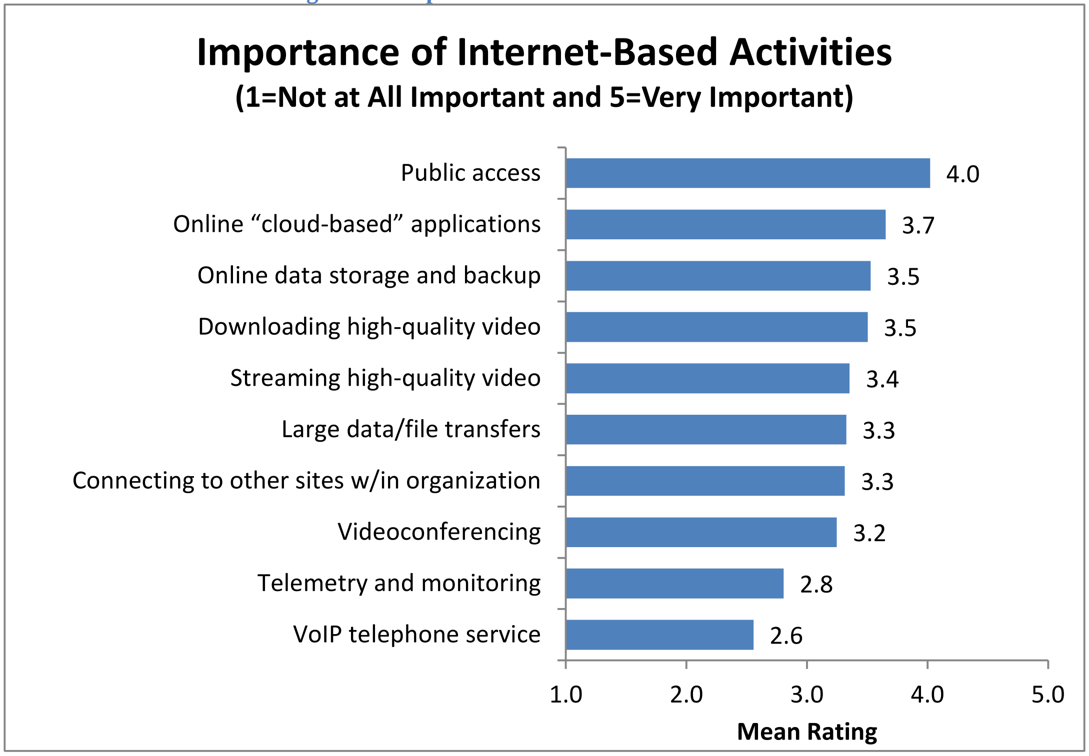


Figure 47: Gap Between Importance of/ Satisfaction with Aspects of Internet Service

Gap Between Satisfaction and Importance Ratings				
	Mean Satisfaction	Mean Importance	GAP < = >	Significance
Total price paid for service	3.7	4.6	-0.9	Expectations not met
Connection speed	3.8	4.7	-0.9	Expectations not met
Reliability (uptime)	4.2	4.9	-0.7	Expectations not met
Customer services	4.1	4.6	-0.5	Expectations not met
Meets technical standards	4.1	4.4	-0.4	Expectations not met

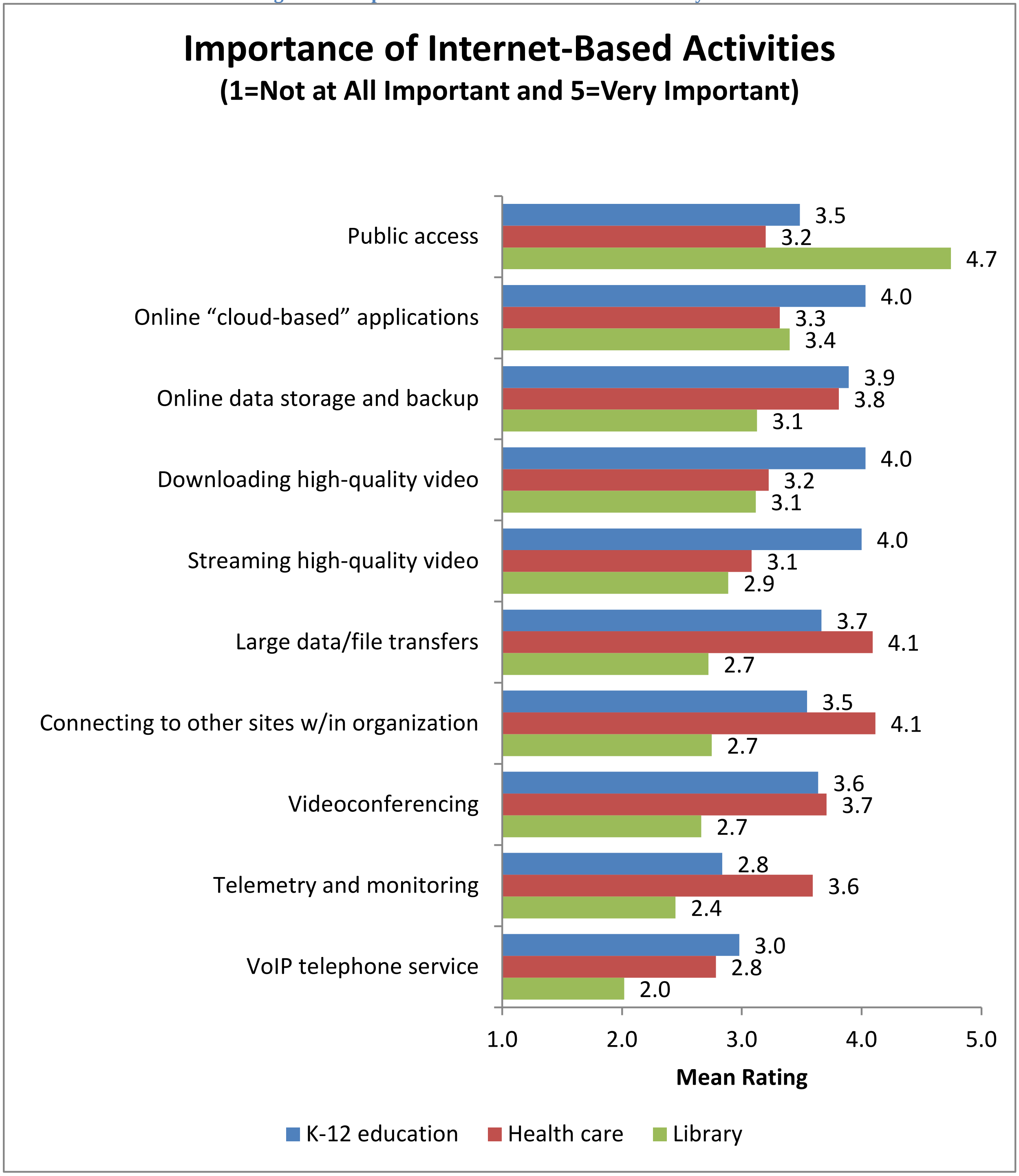
Respondents were also asked about the importance of various Internet-based activities for their organization. Providing public access to the Internet ranked as the highest importance among the activities listed. The least important Internet-based activities were Voice over Internet Protocol (VoIP, or Internet-based telephone service) and telemetry and monitoring.

Figure 48: Importance of Internet-Based Activities



The importance placed on Internet activities by different types of organizations varied significantly. The most important aspect for libraries was providing public Internet access. Health care and related organizations viewed large data transfers and connecting with other sites in the organization as the most important. K–12 schools ranked high-quality video streaming and downloads, along with “cloud-based” applications as the most important activities.

Figure 49: Importance of Internet-Based Activities by Sector



Respondents were asked about their willingness to pay a higher cost for very high speed Internet service. Over 40 percent of respondents indicated that they were willing or very willing to pay 20 percent more than their current Internet cost for very high speed Internet service. This decreased to 16 percent who were willing to pay 40 percent more and only four percent who were willing to pay 60 percent more. Respondents' willingness to pay for very high speed Internet service is illustrated in the following two graphs.

Figure 50: Willingness to Pay More for Service

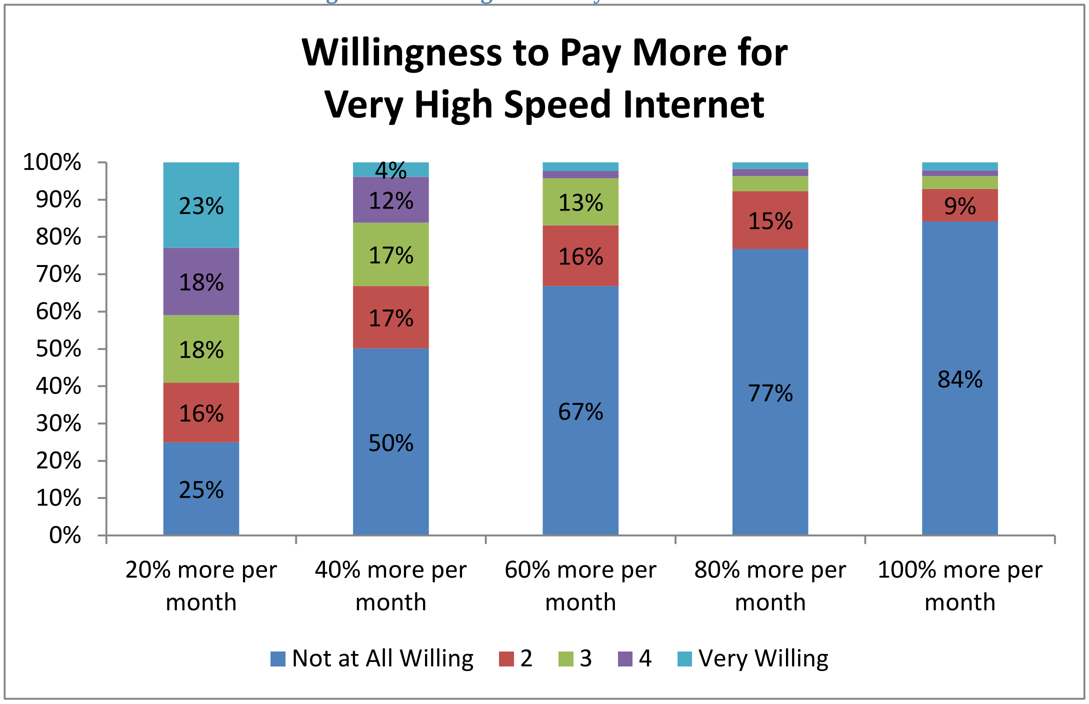
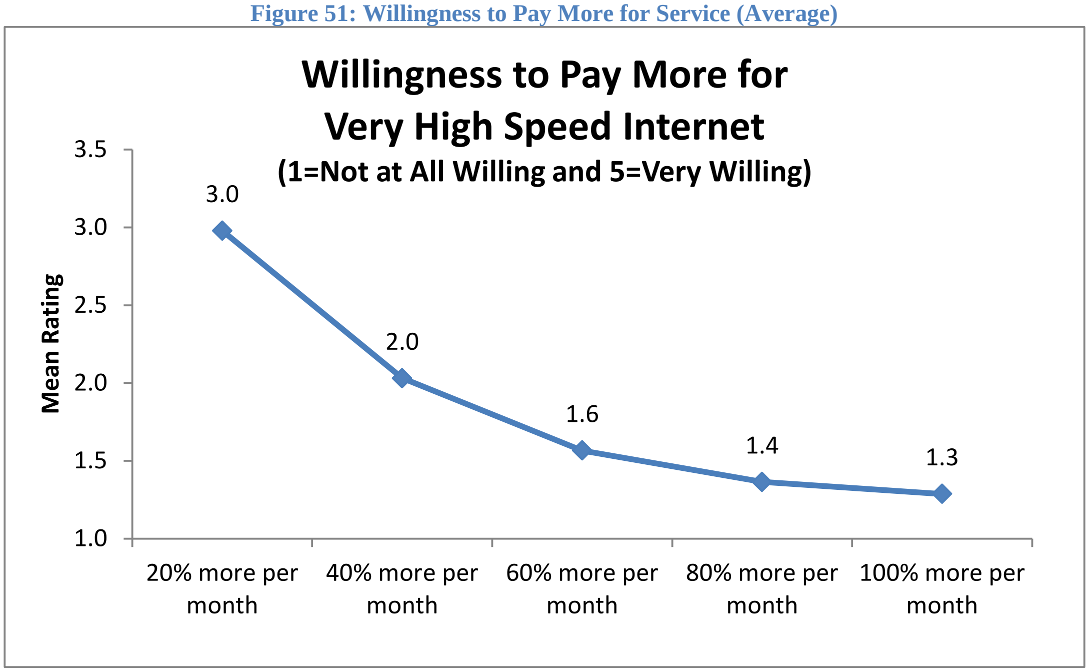


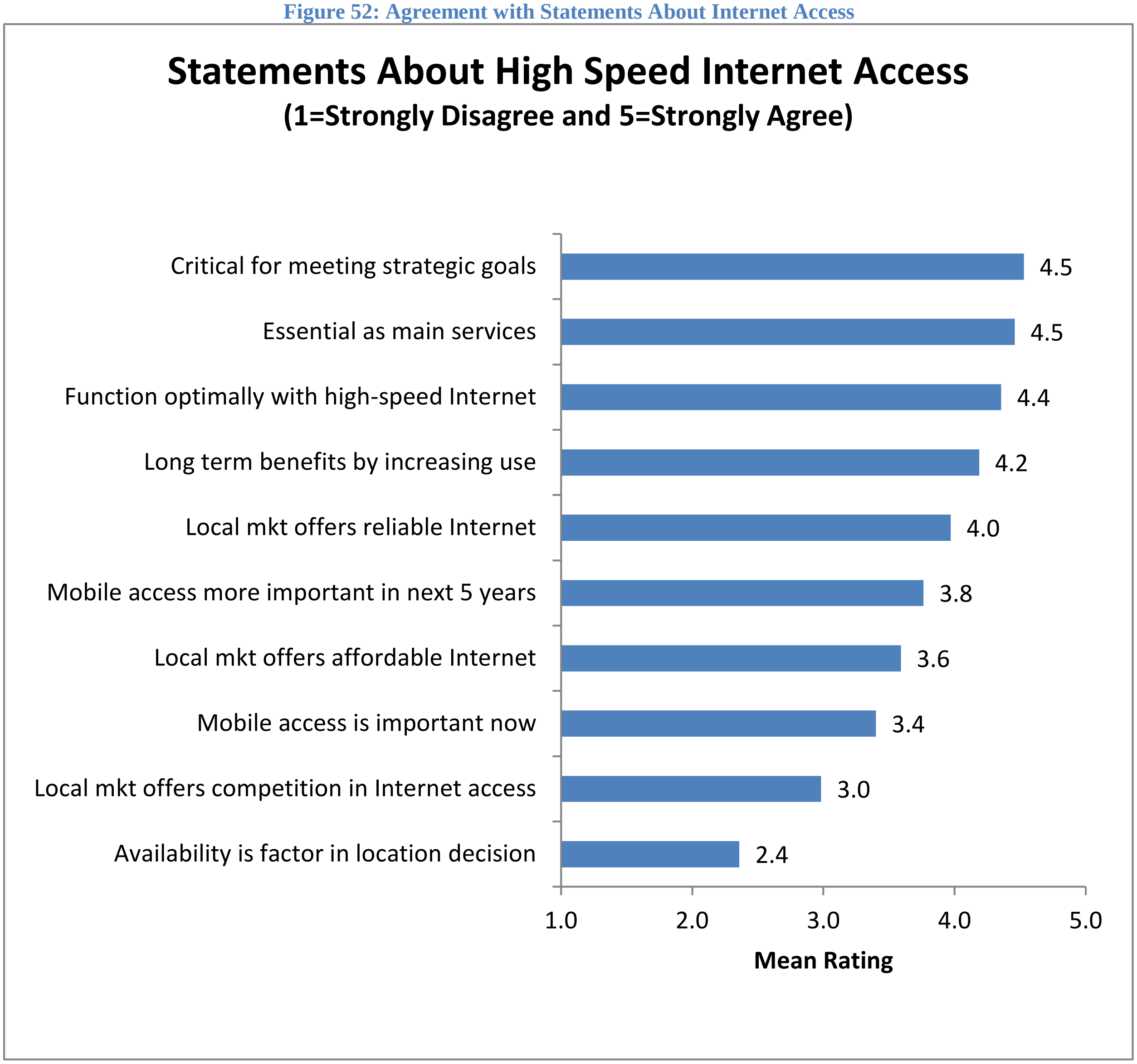
Figure 51: Willingness to Pay More for Service (Average)



Respondents were asked their opinions about several statements regarding broadband Internet service costs, availability, and importance. Respondents strongly agreed that high-speed Internet service was critical for meeting their organization's strategic goals, was as essential as other main services such as utilities, and they are only able to function optimally with high-speed Internet service.

Respondents were neutral, on average, about whether their local market offers competition for Internet access, and were slightly positive about whether their local market offers affordable Internet services. The only response that was in slight disagreement was that the availability of high-speed Internet was a factor they used in deciding where to locate facilities.

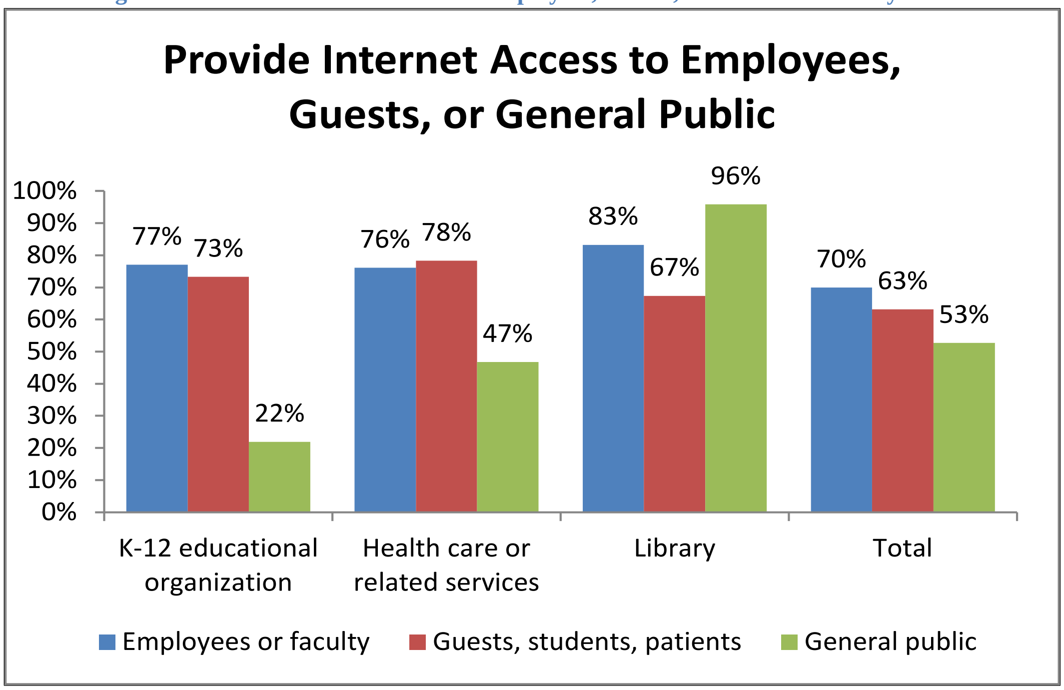
Figure 52: Agreement with Statements About Internet Access



9.7 Respondents Are Widely Engaged in Providing Internet Access to Clients, Staff, and the General Public

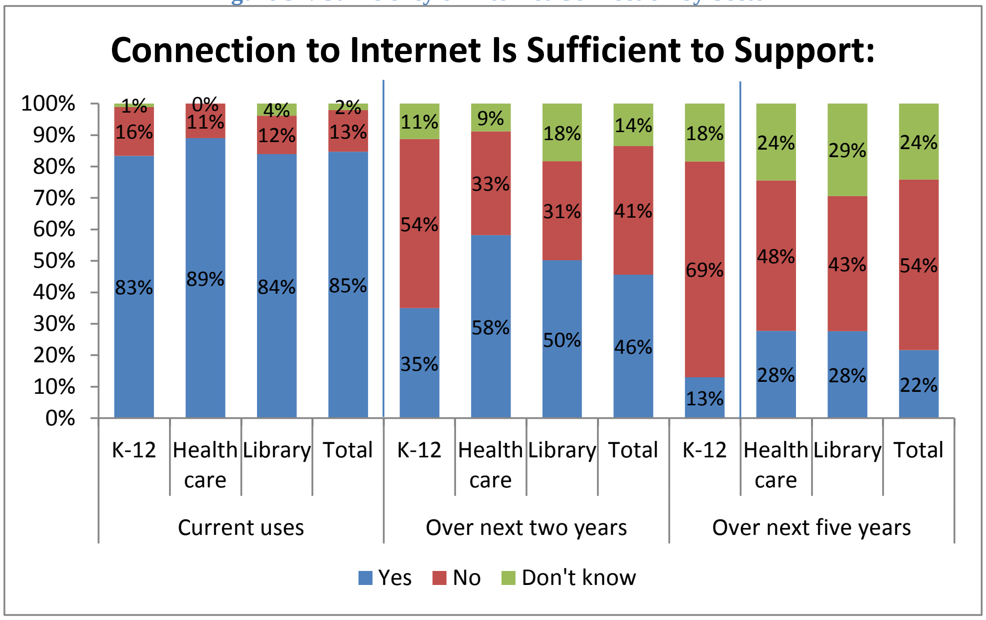
Over one-half of responding organizations provide Internet access to the general public, and 70 percent provide access to employees or faculty. Most libraries provide Internet access to the general public, while only 22 percent of K–12 schools provide public Internet access.

Figure 53: Provide Internet Access to Employees, Guests, or General Public by Sector



Most feel that their current Internet connection is sufficient to support current uses, but less than one-half believe it will be sufficient in two years and less than one-fourth believe it will be sufficient in five years. This indicates the increasing importance of high-speed Internet access, and the need for increased service speeds to meet the future needs of these organizations.

Figure 54: Sufficiency of Internet Connection by Sector

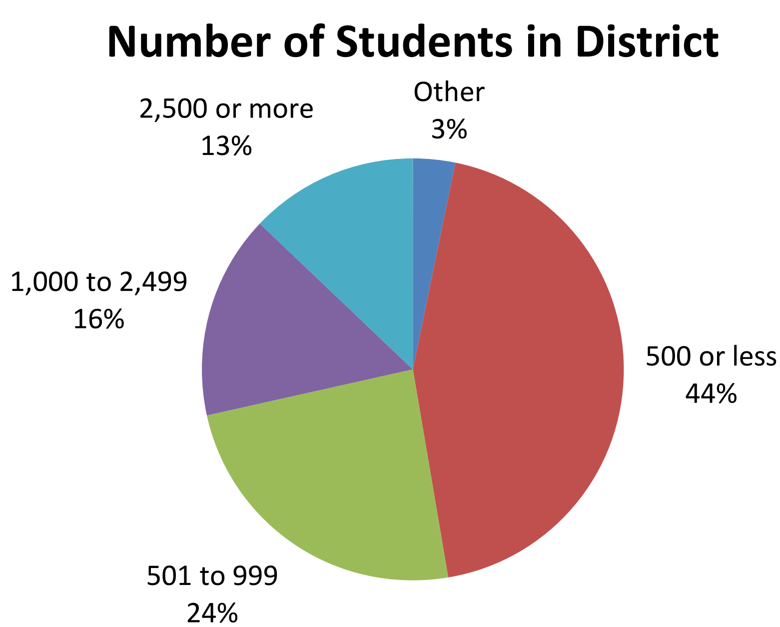


9.8 Survey Results for the K–12 Education Sector

A total of 187 K–12 educational organizations responded to the survey. Results within this sector are available with a confidence interval of ±4.8 percent.

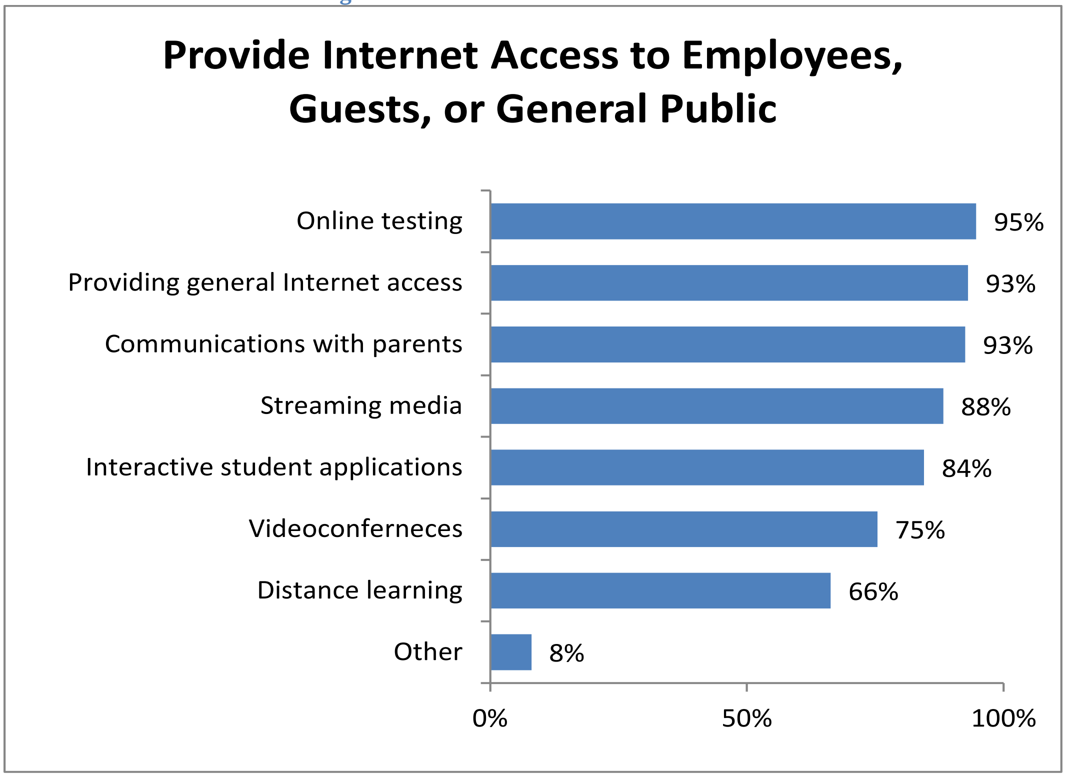
Nearly half of the K–12 schools responding were in districts with 500 students or less. Comparisons of the district size and other data are provided in subsequent portions of this section.

Figure 55: Number of Students in School District



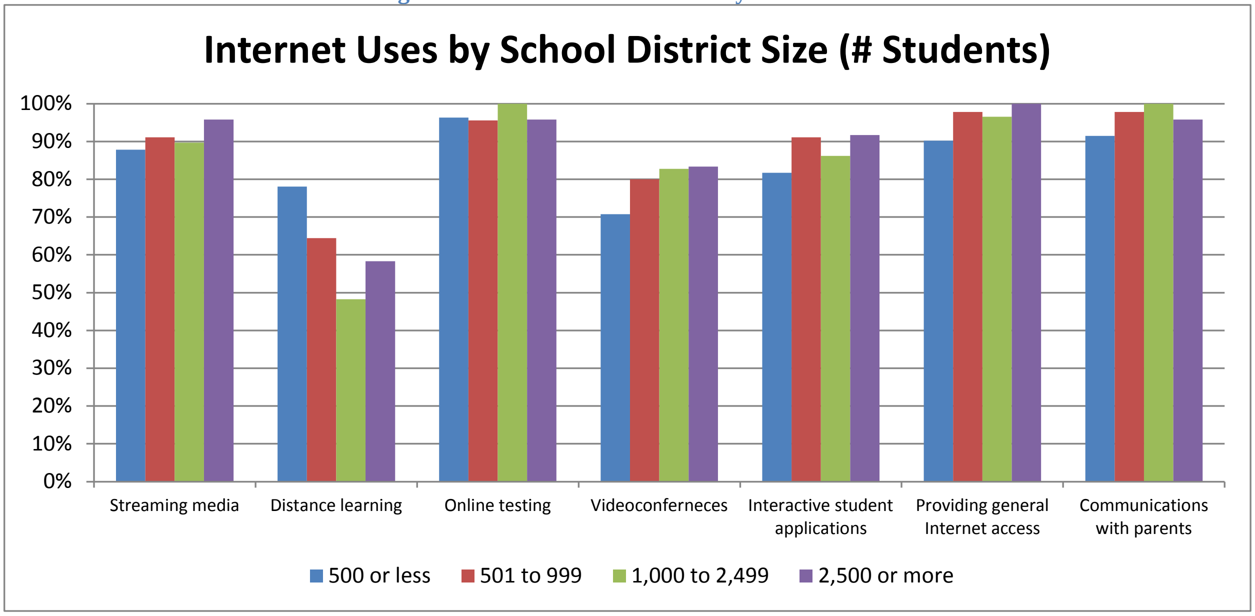
K–12 schools use the Internet for a wide variety of tasks. Nearly all use the Internet for online testing, providing general Internet access, and communicating with parents. More than two-thirds of responding schools use the Internet for distance learning.

Figure 56: Schools' Use of Internet Access



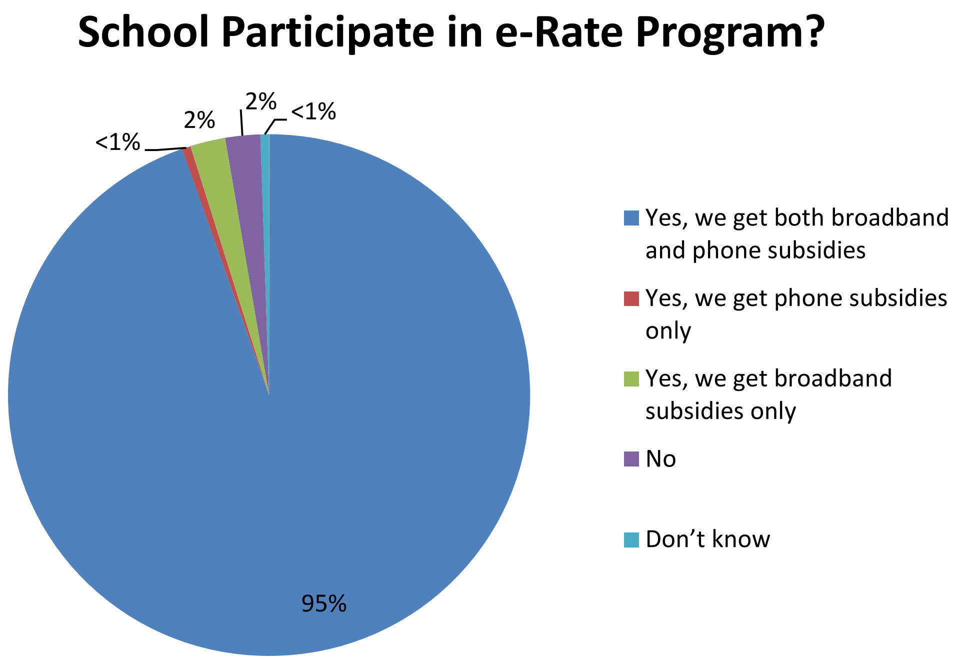
Smaller school districts are slightly less likely to use the Internet for general Internet access, communication with parents, or videoconferences, but are more likely to use the Internet for distance learning.

Figure 57: Schools' Internet Uses by District Size



The vast majority of responding K–12 schools participate in the e-Rate program which subsidizes phone and broadband services for schools and libraries.

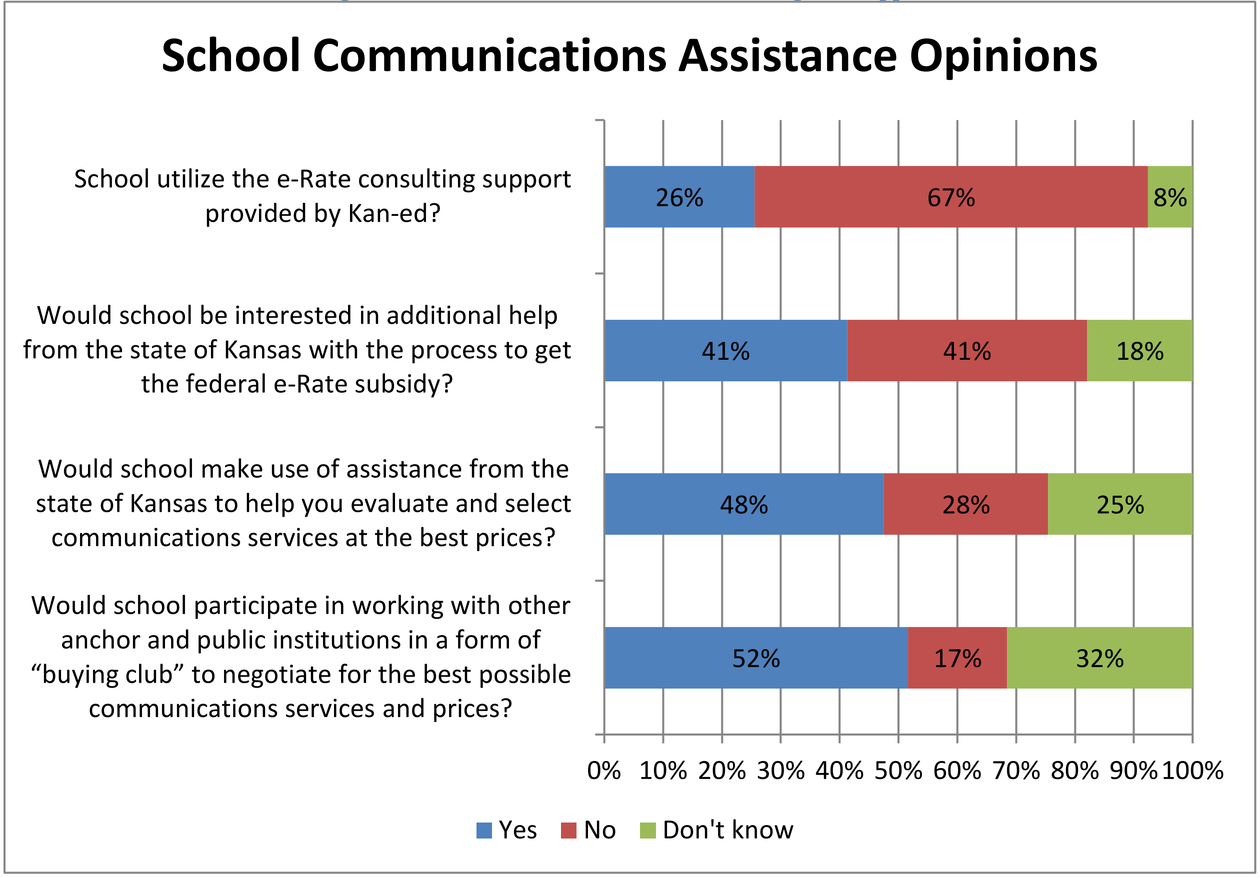
Figure 58: Schools' Participation in E-Rate Program



K–12 educational organizations were asked a series of questions regarding whether they would welcome support in addressing e-Rate subsidies and purchasing of communications services. The responses are summarized in the following illustration.

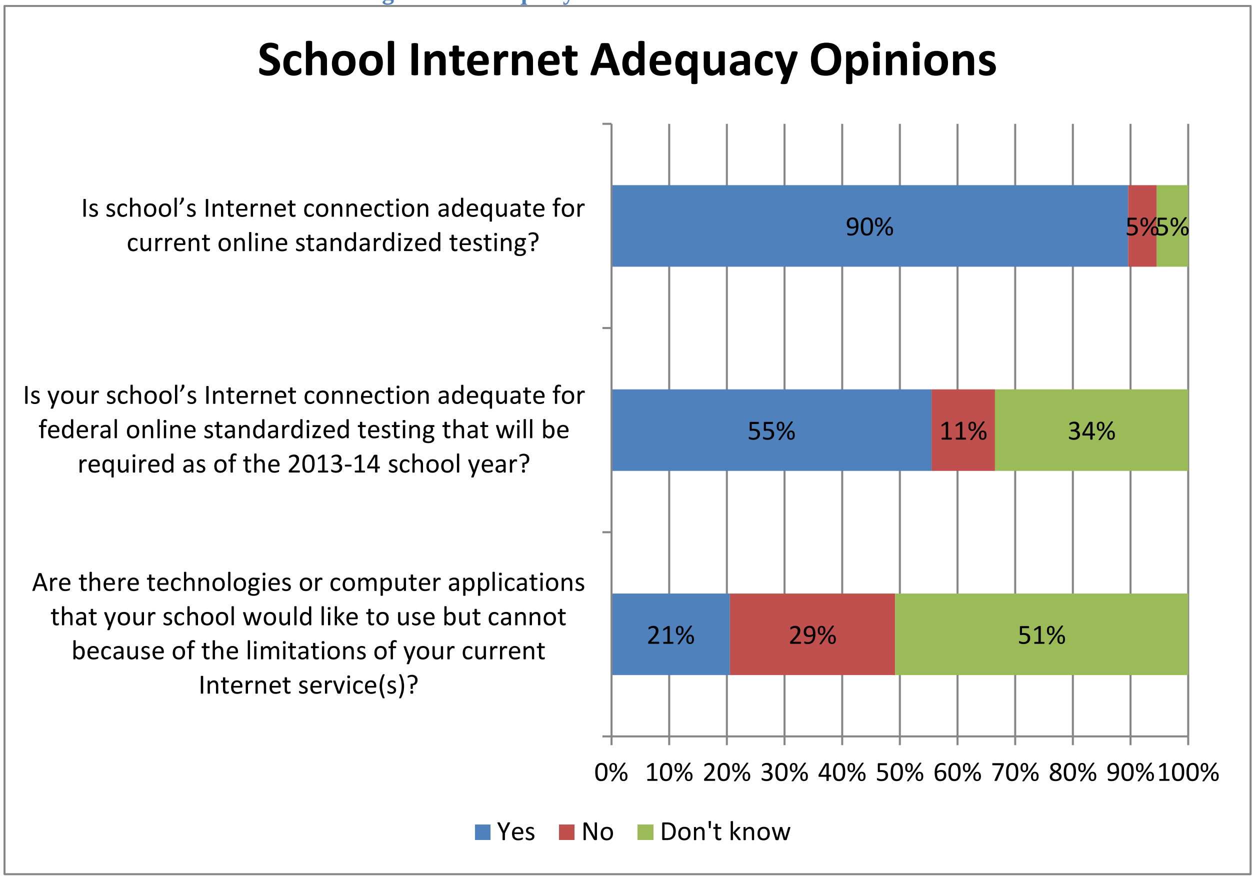
Approximately one-fourth of schools utilize the e-Rate consulting support provided by Kan-ed, although two-thirds did not take advantage of this support. Over 40 percent of responding K–12 schools would be interested in help from the State to get the e-Rate funding, roughly the same percentage as those who would not be interested. Approximately one-half of respondents would use assistance from the State to evaluate bids for communications services. Approximately one-half of respondents would participate in a buying club to negotiate prices for communications services. Only 17 percent stated that they would not participate in a buying club, while approximately one-third of respondents were unsure.

Figure 59: Schools' Interest in Broadband Program Support



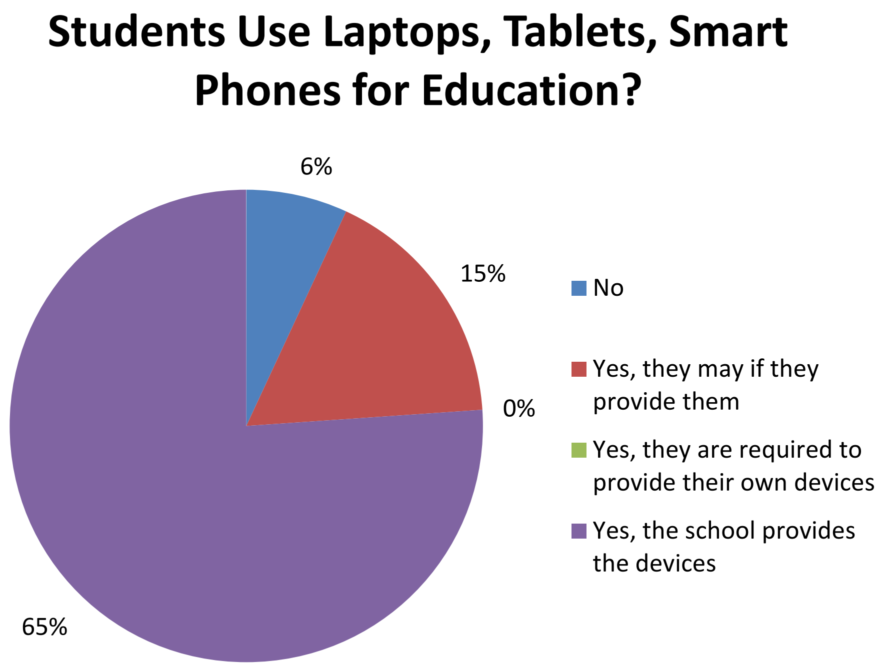
The vast majority of respondents believe their Internet connection is adequate for current online standardized testing, while only five percent stated that it was not adequate. However, only 55 percent stated that their connection was adequate to meet the 2013–14 testing requirements and one-third were unsure.

Figure 60: Adequacy of Schools' Broadband Service



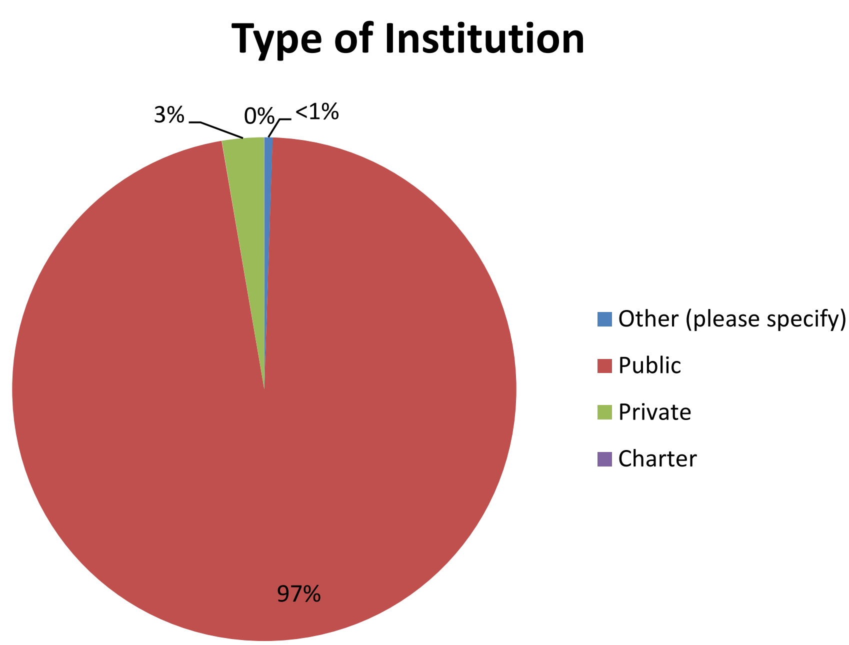
Over 90 percent of K–12 school respondents indicated that students used laptops, tablets, or smart phones for educational purposes while at school. Most schools provided the devices for student use, while a small portion of students provided their own.

Figure 61: Schools' Use of Laptops, Tablets, and Smart Phones



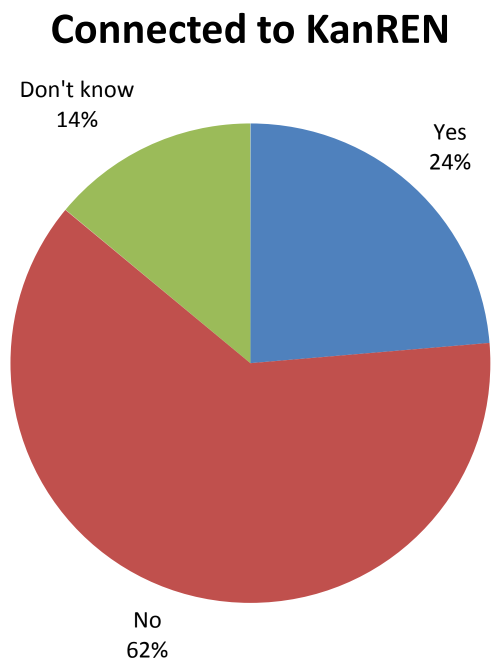
Nearly all K–12 school respondents were public institutions, while a small percentage were private or other types of institutions.

Figure 62: Type of School Institution



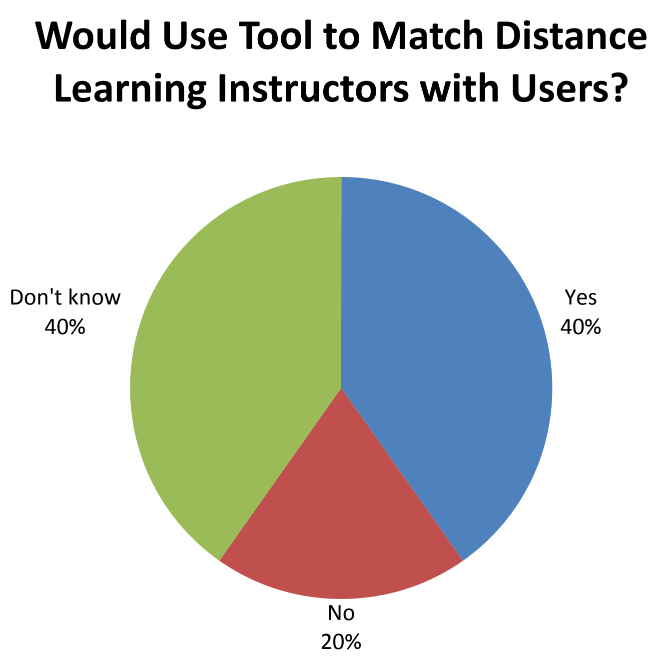
Roughly one-fourth of responding K–12 educational organizations were connected to KanREN while 14 percent were unsure.

Figure 63: Schools Connected to KanREN



Forty percent of K–12 respondents indicated that they would use a Kansas-based organizing tool or clearing house to match distance learning instructors with potential users. Twenty percent indicated that they would not use this too, while 40 percent were unsure.

Figure 64: Schools' Willingness to Use Tool to Match Distance Learning Instructors with Users



9.9 Survey Results for the Health Care Sector

Results for specific questions asked of organizations in the health care industry are summarized in this section. As noted previously, 90 health care organizations responded to the survey. Results within this sector are available with a confidence interval of ±8.0 percent.

Three-fourths of health care respondents had 25 or fewer beds in their facility. Over one-half were community hospitals, over one-fourth were hospital systems, and smaller shares were other types of health care facilities.

Figure 65: Number of Beds in Health Care Facility

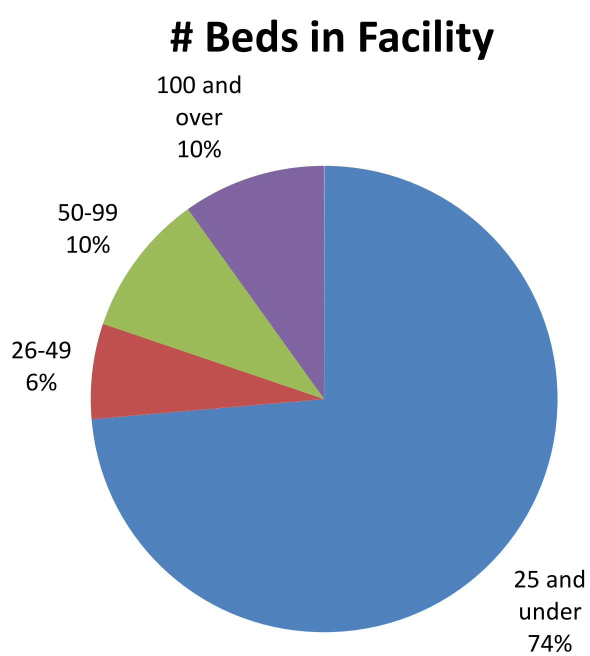
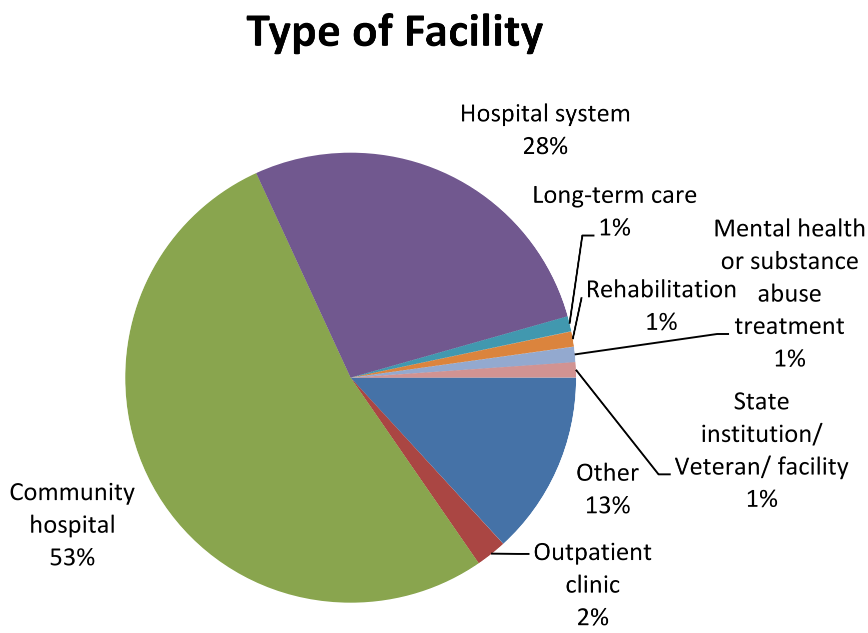
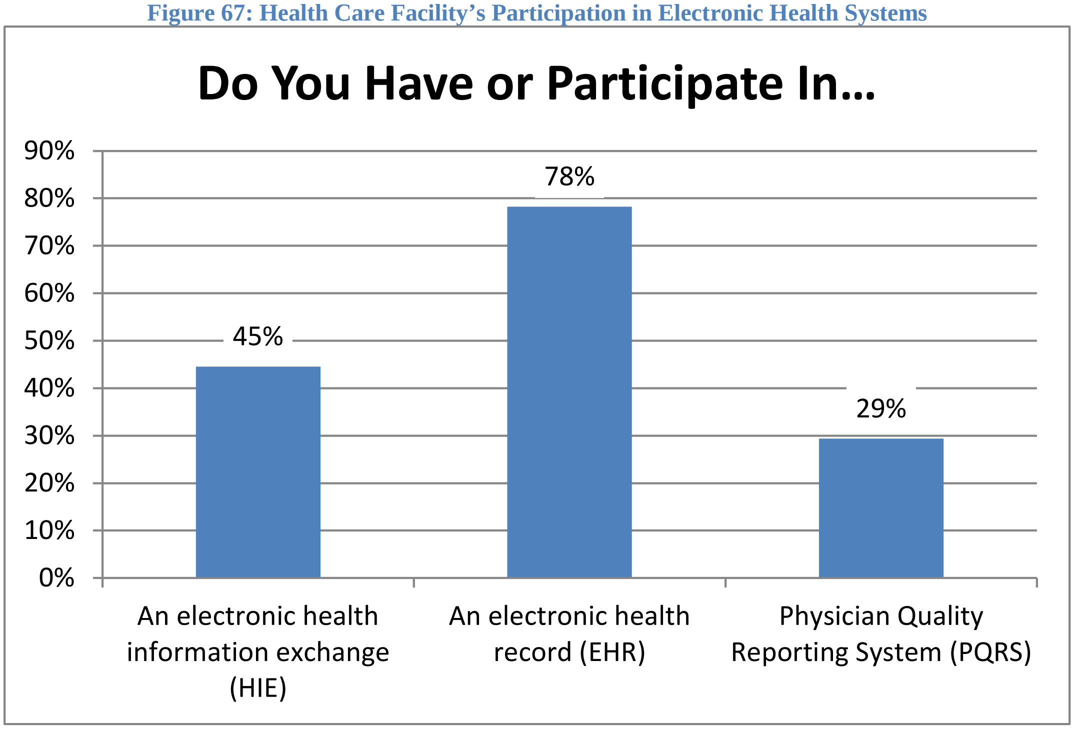


Figure 66: Type of Health Care Facility



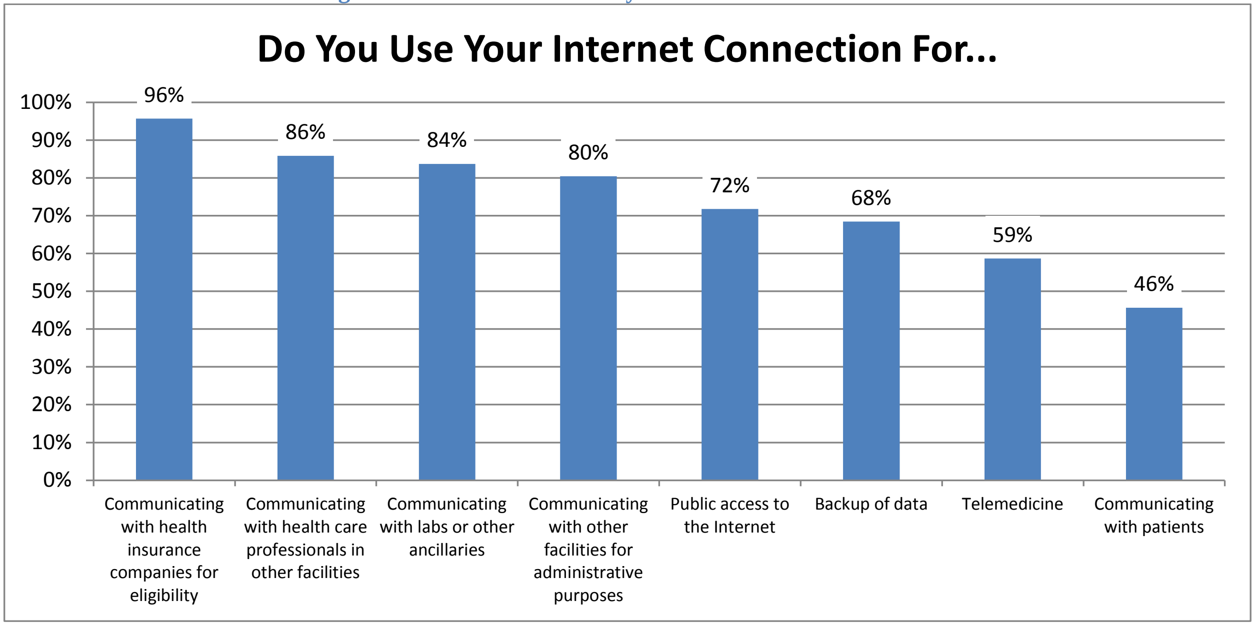
Most health care facilities participate in an electronic health record (EHR) system, nearly one-half participate in an electronic health information exchange (HIE), and 29 percent have a physician quality reporting system (PQRS).

Figure 67: Health Care Facility's Participation in Electronic Health Systems



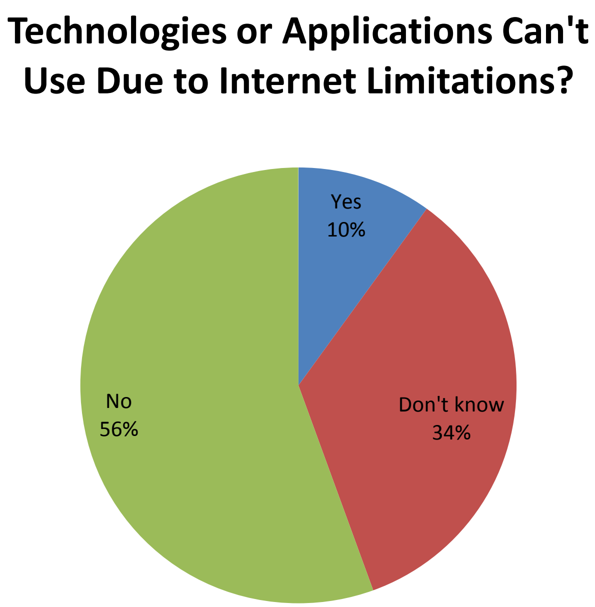
Health care organizations use their Internet connection for a variety of activities. The most common is communicating with insurance companies, communicating with staff in other facilities, and communicating with labs or other ancillaries.

Figure 68: Health Care Facility's Use of Internet Connection



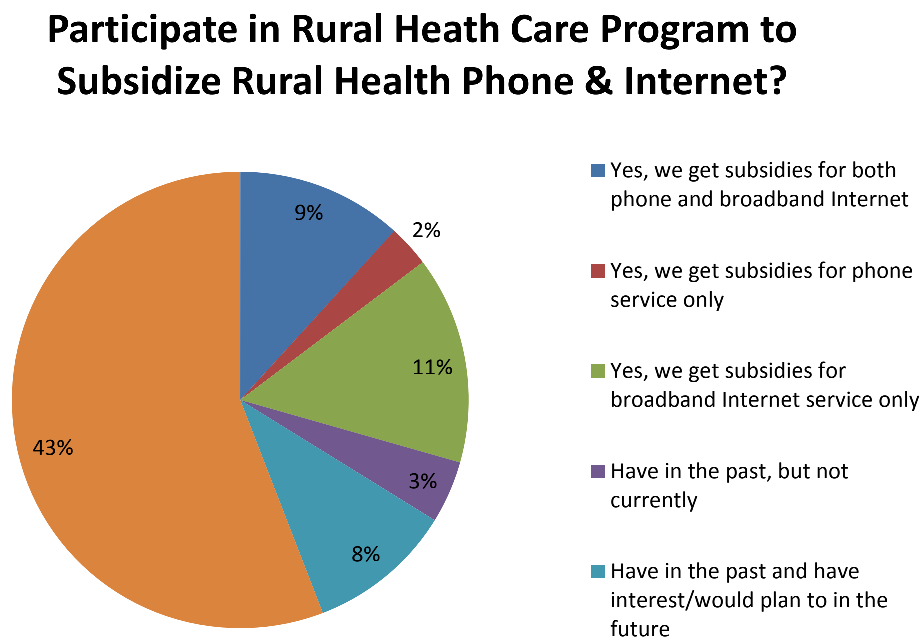
Only 10 percent of health care respondents indicated that there were technologies or other computer applications that they would like to use but cannot due to Internet service limitations.

Figure 69: Health Care Facility's Limitations Due to Internet Service



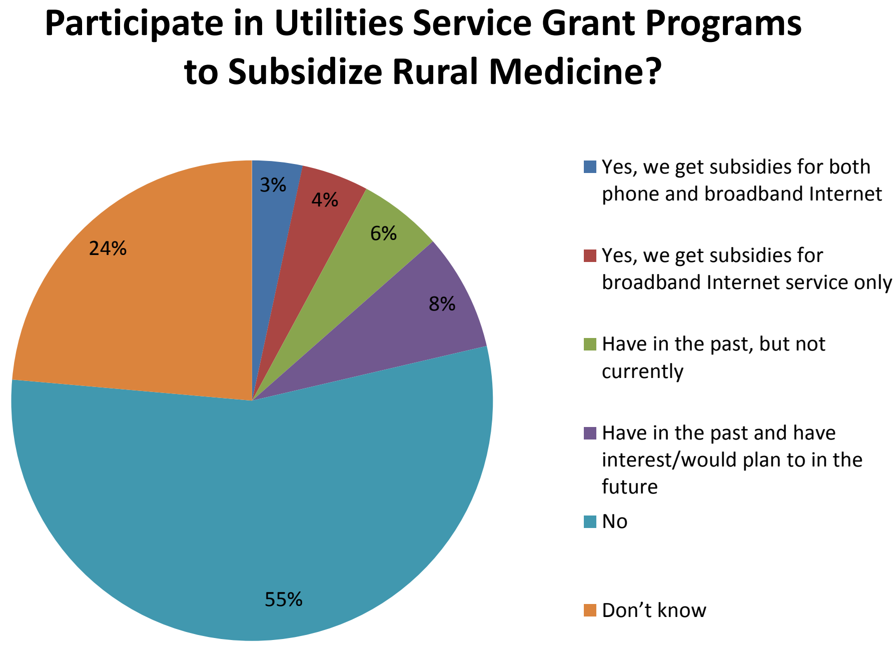
Over one-half of health care respondents participate in the federal rural health care program, administered by the Federal Communications Commission, and receive subsidized phone and broadband Internet services.

Figure 70: Health Care Sector's Participation in FCC Broadband Funding Program



At least 7 percent of responding health care facilities receive grants from the USDA Rural Utilities Service for phone or broadband Internet services. An additional 14 percent have received those grants in the past and 24 percent are unsure.

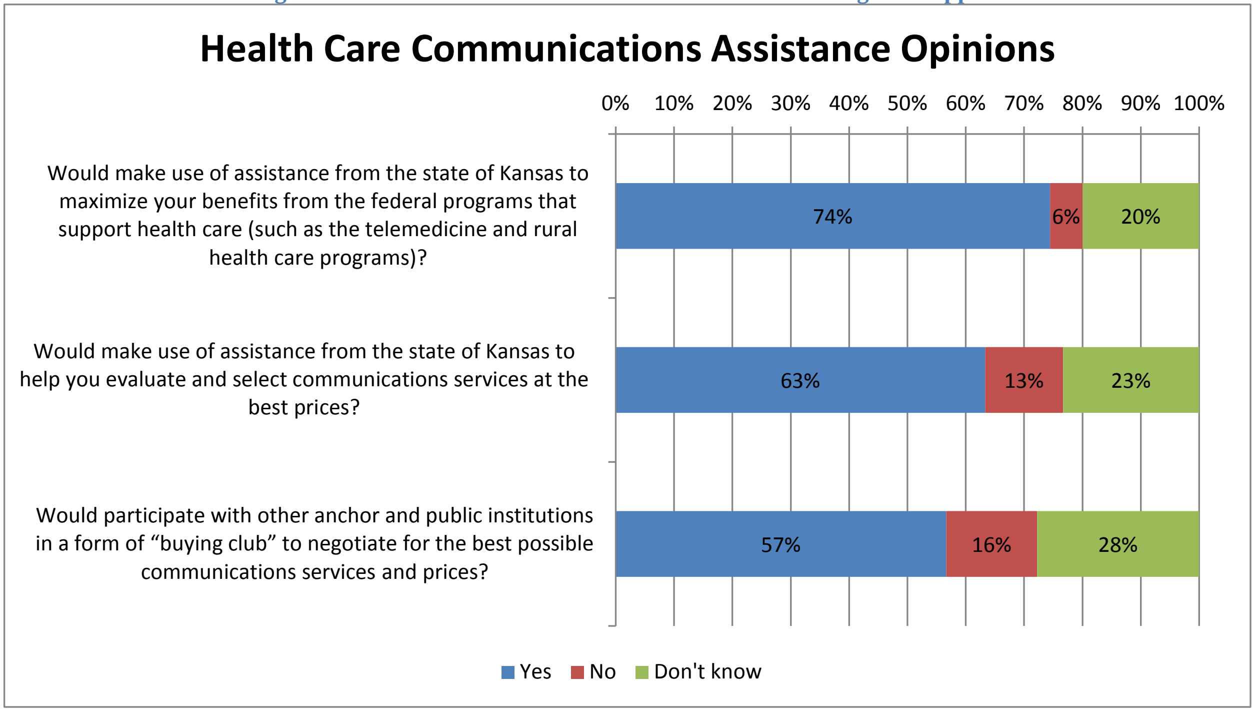
Figure 71: Health Care Sector's Participation in Department of Agriculture Broadband Funding Program



Respondents were asked several questions soliciting their opinions about using assistance related to communications services purchases.

More than one-half indicated that they would participate in a "buying club" to negotiate prices for communications services. Nearly two-thirds would use assistance from the State of Kansas to help select their communications services. Nearly three-fourths would use assistance from the State to maximize benefits from federal programs to support health care.

Figure 72: Health Care Sector's Interest in Broadband Program Support

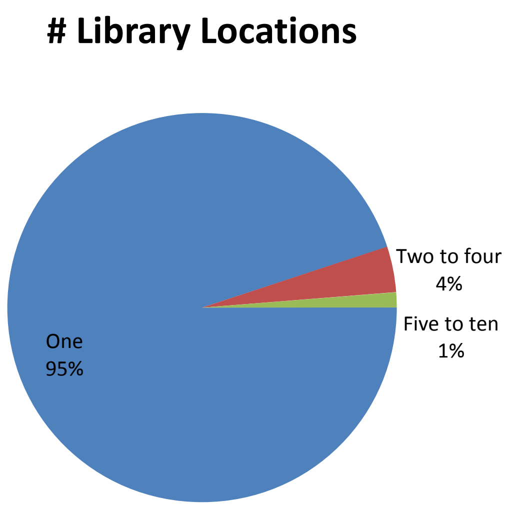


9.10 Survey Results for the Libraries Sector

Results for specific questions asked of libraries are summarized in this section. As noted previously, 239 libraries responded to the survey. Results within this sector are available with a confidence interval of ±3.4 percent.

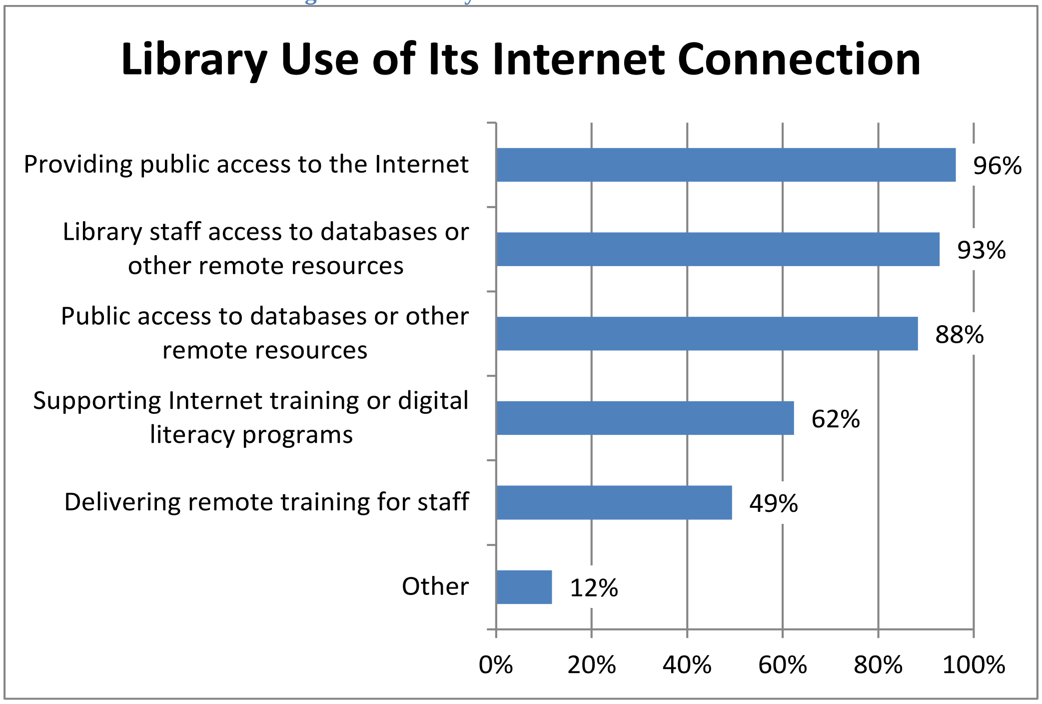
The vast majority of responding libraries are single-location entities. Only 5 percent were part of a broader library network.

Figure 73: Number of Library Locations



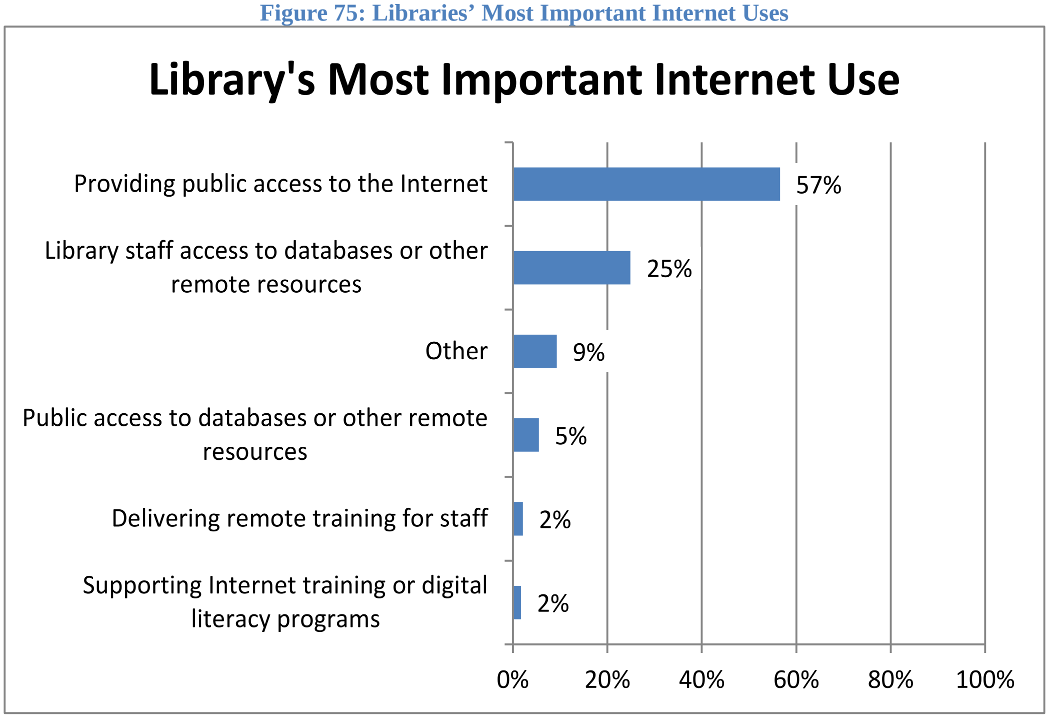
Over 90 percent of libraries use their Internet connection to provide Internet access to the public and provide staff access to databases or other resources. Nearly one-half use the Internet for training or digital literacy programs.

Figure 74: Library Use of Internet Connection



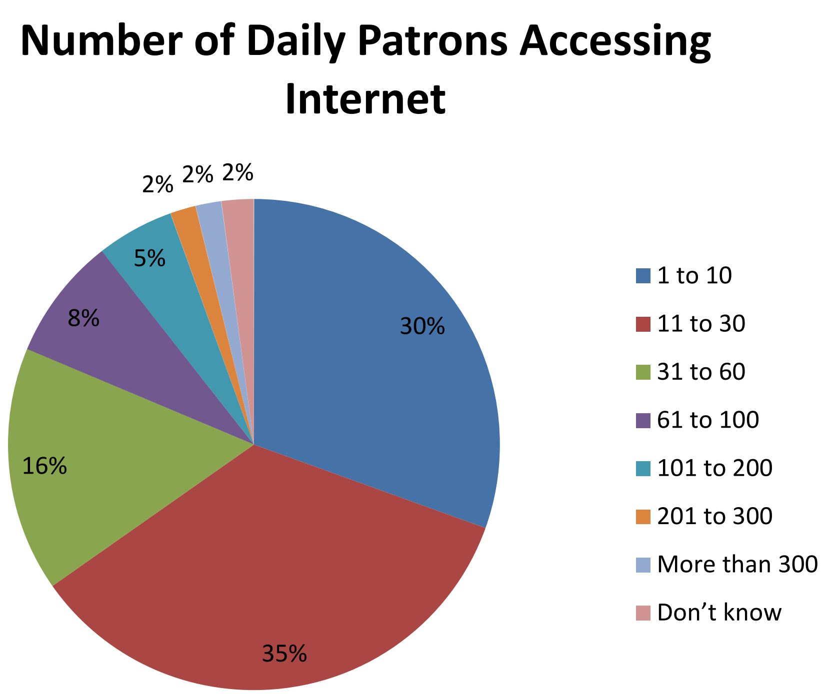
Libraries ranked the provision of public Internet access as the most important use of its Internet connection, followed by providing staff access to databases or other resources.

Figure 75: Libraries' Most Important Internet Uses



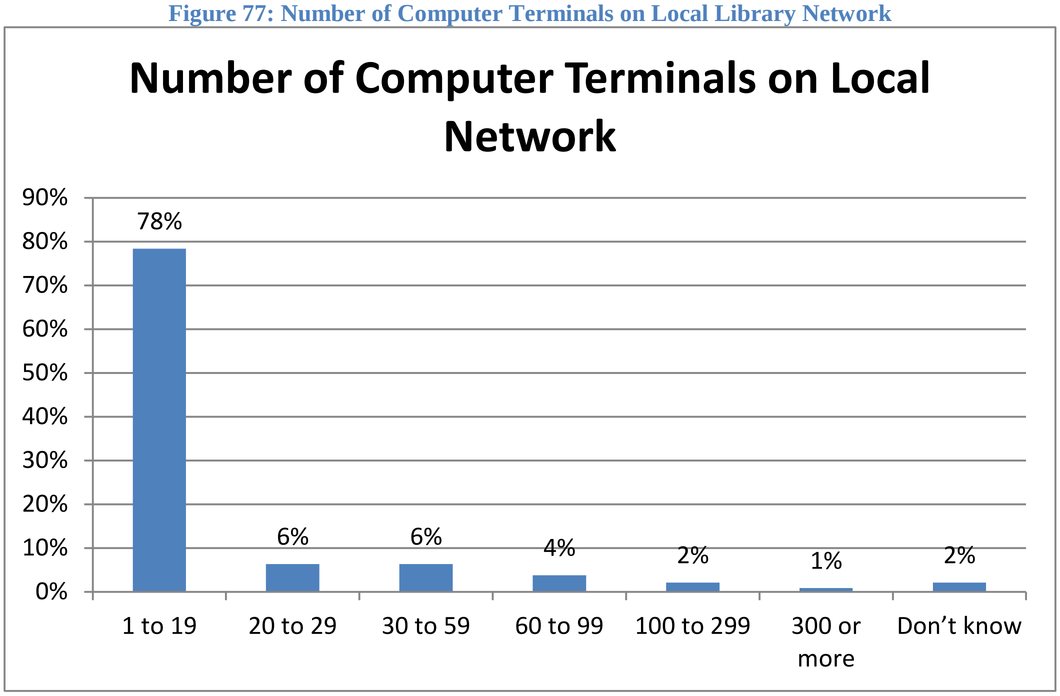
Two-thirds of libraries have 30 or fewer patrons accessing the Internet daily. Less than 10 percent of libraries have in excess of 100 patrons accessing the Internet on a daily basis.

Figure 76: Number of Daily Library Patrons Accessing Internet



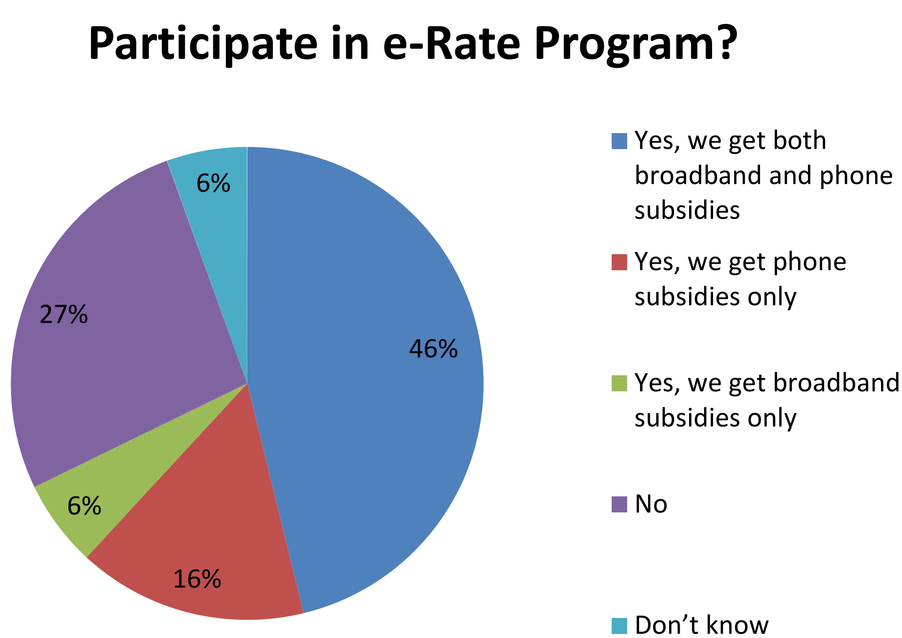
Most libraries have fewer than 20 computer terminals or devices supported by their local area network. Ninety-four percent of libraries provide wireless Internet access to patrons.

Figure 77: Number of Computer Terminals on Local Library Network



Over two-thirds of libraries participate in the federal e-Rate program, which subsidizes phone and broadband services.

Figure 78: Libraries' Participation in E-Rate Program



Libraries were asked about their use of, and desire for, assistance regarding communications services. Approximately one-third of libraries had used e-Rate consulting support provided by Kan-ed. Nearly one-half would make use of assistance from the state of Kansas to maximize their funding from the federal e-Rate program. An additional 40 percent were unsure.

Approximately 40 percent of libraries would use assistance from the state of Kansas to help evaluate and select communications services at the best prices. An additional 41 percent were unsure.

Approximately one-third of libraries would participate with other anchor and public institutions in a form of “buying club” for the best possible communications services and prices. Nearly one-half were unsure.

Figure 79: Libraries’ Interest in Broadband Program Support