Arkansas Digital Learning Study
Overview

Background

The Quality Digital Learning Study Committee was established by the Arkansas Department of Education at the direction of the Arkansas General Assembly (Act 1280 of 2013). Act 1280 was sponsored by Rep. Dan Douglas (R) of Bentonville.

The Committee sought to develop a plan to establish and maintain a scalable, equitable, affordable, high-speed broadband infrastructure solution for all K-12 schools that balances the competing interests of all stakeholders, utilizes all available public/private telecommunications resources, builds on national promising practices and preserves local control of district network infrastructure.

Consideration was given to a variety of connectivity solutions, cost, commodity Internet vs. research and education special-purpose networks, speed to market, as well as Governor Mike Beebe's preference for a public/private partnership. The Quality Digital Learning Study Committee Report to the Arkansas General Assembly was published on May 6, 2014.

Report Highlights:

- National indicators show Arkansas currently ranks near the bottom in high-speed Internet access and digital learning.
- Arkansas Act 1280 requires public school students graduating in 2018-19 and beyond to take at least one digital learning course but the state K-12 education network (APSCN/CIV) does not provide enough high-speed Internet to meet instructional and administrative needs.
- Schools should have a minimum of 100 kilobits per student/staff for 2013-14 and 1 megabit per student/staff in 2017-18 to facilitate digital learning. Few Arkansas schools have this capacity.
- Many Arkansas schools do not have equal access to affordable and adequate broadband forcing them to supplement state-provided connectivity with separate provider contracts at exorbitant wide-ranging costs of $1.20 per megabit to $280 per megabit. Many districts find these prices unaffordable.
- Arkansas maintains two separate statewide networks for education – one for K-12 schools (APSCN/CIV) and one for higher education, healthcare and law enforcement entities (ARE-ON).
- While ARE-ON provides ample capacity and high-quality service at affordable prices, the State's K-12 (APSCN/CIV) network does not.
- K-12 students are strictly prohibited from using the state's more robust network (ARE-ON) due to Act 1050– a change in telecommunication laws enacted in 2011.
- Digital learning is important for education but it is also a critical economic development issue. For every job lost due to the Internet, 2.6 jobs are created; and for every one percent increase in broadband saturation, employment increases 0.2 to 0.3 percent annually.

Arkansas Digital Learning Study

State of Arkansas

Quality Digital Learning Study Committee Report to the Arkansas General Assembly Pursuant to Act 1280 of 2013

May 2014

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Arkansas Educational Administrators Association
Arkansas Public School Resource Center
Arkansas Research and Education Optical Network
Arkansas Rural Education Association
Arkansas Science and Technology Authority
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EAST Initiative
FASTER Arkansas
Federal Communications Commission
Internet2
Southern Regional Education Board
State Educational Technology Directors Association
State E-Rate Coordinators Alliance
The Quilt
Tyson Foods
University of Arkansas System
University of Arkansas for Medical Sciences
Wireless Internet Service Providers Association

Legislation directing this study (Arkansas Act 1280 of 2013) was sponsored by State Representative Dan Douglas.

May 6, 2014

To Governor Mike Beebe, the Arkansas General Assembly, and friends of Arkansas children:

The world is changing, especially when we consider this new "digital age." We rely on computers and the Internet more than ever before. Even those of us who are older and are digital immigrants have adapted. We carry cell phones that are actually tiny computers, capable of accessing limitless information anytime, day or night.

Our children are growing up as digital natives, never knowing a world without the Web, personal devices like iPads, and multifunctional phones. Yet our educational system has been slow to adopt these technologies as part of the teaching and learning pedagogy. National reports indicate part of the reason is a lack of access to consistent, high-speed Internet connectivity.

This report is the beginning of improving Arkansas's capacity to provide high-speed connectivity for K-12 schools. It is a blueprint from which we can build a robust infrastructure for all 460,000 students in public schools. This report is a conceptual framework. As more information becomes available, tactics will have to adjust and change.

That we need to act is not debatable. How we act to provide connectivity to all schools is complex and evolving. We could debate forever the details but, for the sake of our children and meeting the needs of our future workforce, we must start now. This report is the blueprint we need to provide the infrastructure for a 21st century Arkansas education.

I want to thank all of the business leaders, legislators, Internet providers, educators and others that have participated in the development of this report. We have developed the blueprint. Now, let the building begin.

Dr. Ed Franklin, Chair
Quality Digital Learning Study Committee

Where Arkansas Needs to Be

” Affordable high-speed Internet is the difference between providing the great equalizer for rural and low-income students or increasing the great divide.”

–Dr. Richard Abernathy
Vice-Chair, Quality Digital Learning Study Committee
Executive Director, Arkansas Association of Educational Administrators (AAEA)

” If we’ve learned nothing else, this is about all of our kids and not about a handful of schools. This is a statewide issue. Other states have managed to create a network that is robust, transparent, equalized and efficient.”

–Dr. Tom Kimbrell
Commissioner of Education

”Arkansas already has a network in place that will allow us to reduce the size of government, increase competition, and provide the content essential for a globally competitive workforce if K-12 schools can use it.”

–Jerry Jones
Chair, FASTER Arkansas
Executive Vice President, Acxiom

Where is Arkansas Today?

- “D” for digital learning opportunities, according to the 2013 “Digital Learning Now” report from the Foundation for Excellence in Education.
- 50th for broadband access, according to TechNet’s 2012 Broadband Index.

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Executive Summary

> *"The vision of the Arkansas State Board of Education is that all public schools are connected to a robust broadband infrastructure necessary for instructional Internet access and student participation in a world-class online learning experience."*
>
> — Arkansas State Board of Education, October 14, 2013

Legislative Directive

Arkansas was among the first states to recognize the importance of high-speed Internet, providing all schools administrative connections for their data systems in 1992 (Act 4 of 1992). With the Digital Learning Act of 2013 (Act 1280 of 2013), Arkansas affirmed the importance of digital learning for students and directed the Department of Education to develop a plan to establish and maintain "the necessary infrastructure and bandwidth to sufficiently facilitate and deliver a quality digital learning environment in each school district and public charter school" in Arkansas.

Process

In June 2013, the Arkansas Department of Education convened the Quality Digital Learning Study (QDLS) Committee with individuals representing higher education and K-12, telecommunications service providers, legislators and other stakeholders. Governor Mike Beebe also asked business leaders to form the Fast Access for Students, Teachers and Economic Results (FASTER) Arkansas Committee to examine, from a business perspective, the Internet needs of Arkansas public schools and how best to meet those needs. A subgroup of the FASTER Arkansas Committee, the Engineering/Infrastructure Task Force was also created to provide network engineering expertise and guidance for the QDLS and FASTER Arkansas Committees.

The Quality Digital Learning Study Committee met monthly from July through December 2013 and heard testimony from a variety of experts in digital learning and network engineering. The committee reviewed articles and national reports on broadband connectivity and educational technology trends. Extensive data gathering took place on multiple levels with documentation and information assembled by the Arkansas Department of Education, Department of Information Systems, FASTER Engineering/ Infrastructure Task Force, and committee staff.

In the end, four strategic approaches were considered by the Quality Digital Learning Study Committee to provide a robust K-12 digital learning environment: a) maintain the status quo, b) build/expand the state's K-12 network using primarily public resources and infrastructure, c) build/expand the state's K-12 network using primarily private resources and infrastructure and d) develop a new vision for a K-12 network using shared public and private resources and infrastructure.

In December 2013, the Quality Digital Learning Study (QDLS) adopted the FASTER Arkansas Engineering/Infrastructure Task Force recommendation to develop a new, collaborative vision for K-12

networking using public and private resources and infrastructure. There were no votes against the recommendation and one abstention.

Broadband access for Arkansas students is a complex issue and building a system today that will meet the changing needs of tomorrow is a challenging task. This conceptual report outlines the challenges that exist in Arkansas today but, more importantly, provides a path forward.

With the submission of this report, the Quality Digital Learning Study (QDLS) Committee addressed its obligation under Act 1280 of 2013. Hereafter, State leaders will work to advance the Committee's findings and recommendations, and to implement a sustainable statewide networking solution for all Arkansas public schools.

> "The factors that will drive our national future—educational achievement, a healthy population, broad political participation and economic opportunity for all—depend in significant ways on how we structure and manage our spreading digital frontier."
>
> **Luis A. Ubiñas, Former President, Ford Foundation**

SOURCE: NY Times Op-Ed., "Our Schools, Cut Off From the Web" June 16, 2013.

A. Findings and Data Overview

1. **Digital learning is more than online courses, computers and e-books—**Arkansas code defines *digital learning* as any educational delivery model that uses technology to strengthen the student learning experience and does not rely exclusively on compressed interactive video (CIV). It includes online and blended learning such as flipped classrooms, and is transforming how students learn. *Online learning*, which uses technology to connect instructors and students in different locations, is a type of digital learning. It allows highly-qualified teachers to reach students in every corner of the state via e-mail, online forums, videoconferencing, chat rooms, bulletin boards or instant messaging (Act 1280 and Ark. Code Ann. §§ 6-11-105 and 25-15-201 et seq.).

2. **Digital learning is important for education, health care, public safety, business and government operations, but it is also a critical economic development issue**. Digital learning allows small, rural schools to offer the same high-level courses as larger, urban districts. It levels the playing field for today's students and tomorrow's leaders, who will not only consume digital media and use technology at unprecedented levels but envision and create new content and devices. Broadband deployment also increases business efficiency, lowers consumer costs and creates jobs. For every job lost due to the Internet, 2.6 jobs are created; and for every one percent increase in broadband saturation, employment increases 0.2 to 0.3 percent annually.

3. **Arkansas public schools, as anchor tenants, can play a critical role in increasing digital literacy and consumer broadband adoption.** Community anchor institutions such as schools, libraries, community health centers and government offices hold the key to rural consumer broadband expansion and adoption. Rural consumers are as likely as their urban peers to subscribe to high-speed Internet services when they a) know the benefits of high speed access, b) experience those benefits first hand, and c) feel confident using the Internet. Few groups are better positioned to develop these prerequisites than students, and few organizations are better able to offer exposure and training than schools and libraries.

4. **There is an emerging national consensus regarding minimum bandwidth targets for K-12 schools**. By 2014-15, the State Educational Technology Directors Association (SETDA) recommends schools have a minimum of 100Kbps/students and staff and by 2017-18, SETDA recommends that schools have a minimum 1Gbps external Internet connection per 1,000 students and staff and 10Gbps internal local area network connection per 1,000 students and staff.

5. **Current high-speed Internet on the K-12 education network (APSCN/CIV) are inadequate to meet instructional and administrative needs at some schools.** A 2010 Federal Communications Commission Survey of E-Rate-funded schools indicates most have some form of broadband service, but nearly 80 percent said their broadband connections were inadequate to meet current instructional and administrative needs. This finding was echoed by a 2011 Arkansas Association of Educational Administrators survey. The State provides some K-12 connectivity through the Arkansas Public School Computer Network (APSCN) but that connectivity is not sufficient to meet 21st century digital learning needs.

6. **Existing state network resources are not providing equal access to affordable, adequate broadband connectivity for Arkansas K-12 schools**. Each of Arkansas's 258 public school districts and charter schools can purchase broadband connections and Internet access separately. Seventy-one percent of school bandwidth statewide is purchased directly by districts from local providers, leading to significant variances in bandwidth capacity, contract terms and service availability. The Arkansas Department of Education conducted a survey of all school districts in 2013 which showed broadband costs, from $1.20 per Mb to $280 per Mb.

7. **Arkansas public schools differ in access to digital learning infrastructure and network support services; flexibility is required**. Some school districts have developed working relationships with their local telecommunications service providers and have been able to meet the digital learning needs of their students while others need additional expertise. National best practices in K-12 connectivity offer rural, isolated or underserved school districts a menu of technical and professional development services on an as-needed basis, with smaller schools needing more bandwidth per student than their urban peers due to concurrent usage and distance learning. Beyond infrastructure, clear instructional and technical plans, educator professional development, local facility

Batesville School District: Below Basic Connectivity

"A teacher monitors a lab of students working in online Credit Recovery software. Halfway through a placement assessment, the Internet grinds to a halt. The tests start timing out. The entire lab is kicked from the program and forced to start the test over from the beginning. Students who are getting a second chance to earn credit hours are now required to do the work over and over again, sometimes multiple times…"

"In years past, a school would often be told their bandwidth wasn't being managed properly if things were creepy-crawly slow. There's a lot of truth in that--bandwidth management is critical, but our need for bandwidth has outgrown our ability to provide it. We have reached critical mass. The current culture of education is demanding more from our administrators, teachers, and students that involve online services."

Clint Lucy, Director of Information Technology, May 2013

upgrades, devices and affordability are also noteworthy elements of successful digital learning environments.

8. **Successful state education networks create public/private partnerships that leverage all existing resources** to aggregate statewide demand, lower network costs, standardize user fees, centralize managed services, strategically use federal funds and extend research and education optical networks to serve K-12 schools. Of the 42 public, state/regional research and education dense wave fiber-optic networks in the U.S. connecting to Internet2, the Arkansas Research and Education Optical Network (ARE-ON) is the only one that does not serve K-12 schools and is prohibited by state law (Act 1050 of 2011) from doing so.

B. Recommendations

The Arkansas Constitution requires the State to "maintain a general, suitable and efficient system of free public schools and shall adopt all suitable means to secure to the people the advantages and opportunities of education."

The challenge laid before the Quality Digital Learning Study Committee by the Arkansas General Assembly and Governor Mike Beebe was to establish and maintain a scalable, equitable, affordable, high-speed broadband infrastructure solution for all K-12 schools that balances the competing interests of all stakeholders, utilizes all available public/private telecommunications resources, builds on national promising practices and preserves local control of district network infrastructure.

Consideration was given to a variety of connectivity solutions, cost, commodity Internet vs. research and education special-purpose networks, speed to market, as well as the Governor's preference for a public/private partnership.

The Quality Digital Learning Study Committee developed a conceptual framework that shows a clear path forward for the State if we work together. It is not only about where schools are today but where all Arkansas schools need to be in the future. As more information becomes available, plans will adjust and evolve.

The Arkansas Digital Learning Study analyzes the current capacity and cost of the State's K-12 network, explores a variety of models used in other states, and proposes solutions that build on technical recommendations from the FASTER Arkansas Engineering/Infrastructure Task Force, a group of public and private sector technology professionals. Its conceptual framework explains how the state can re-allocate existing education network expenditures to establish a robust digital learning infrastructure in every public school district and charter school.

A New Vision for K-12 Networking
Public/Private Partnership Re-imagined

1. **Connect school districts with a robust fiber-optic network**. This applies to any solution and will require significant investments in personnel as well as network services and, where possible, regional telecommunications service provider resources.
2. **Adopt the State Educational Technology Directors Association (SETDA) recommendations for K12 bandwidth as minimum targets.** Arkansas's network must have the capacity to provide concurrent access to world-class educational content for all students and staff with the ability to grow and adapt to meet future demands. For 2014-15, the minimum recommended bandwidth is 100 kbps/student and staff and for 2017-18 the minimum recommended bandwidth is 1Mb per student and staff.

3. **Centralize management for statewide network support services** such as billing, E-Rate applications, network recommendations/implementation/construction, network monitoring, vendor management, and problem resolution while preserving the responsibility of school districts to manage local area networks that interconnect school buildings.
4. **Efficiently aggregate statewide demand** to achieve greater economies of scale, reduce costs, improve access, and deliver high-quality content. Reducing the number of networks serving education from three +: DIS (CIV and APSCN), ARE-ON, and numerous telecommunications service providers (TSPs) to one: with private TSP transport from an ARE-ON backbone to a single district metropolitan area network, accomplishes this goal.
5. **Optimize the use of E-Rate and other federal funding programs** to build and sustain the network.
6. **Provide comprehensive value-added services** such as teacher professional development and network technical support to help districts create, maintain and effectively utilize local area networks.

Anticipated Benefits

A review of national best practices shows a number of anticipated benefits flow from the six recommendations outlined above, primarily in three areas: cost, capacity and content.

Lower Costs

1. **Aggregating statewide demand** maximizes the State's buying power and offers more leverage in purchasing negotiations (circuits, content and software).
2. **Maximizing the use of existing state resources and reducing the number of district access points** requires less construction, equipment, maintenance and overhead.
3. **Cost-sharing and equalized rate structures** level the playing field for rural and underserved public school districts and charter schools.
4. **Centralizing network functions and purchasing** streamlines the process districts use to access telecommunications services.

Higher Capacity

1. **Scalability** allows districts to burst up to higher speeds during peak periods, such as statewide testing periods, and allows simultaneous use of devices.
2. **Enhanced reliability and reduced latency** (the time it takes for content to get from point A to point B) means high-quality video and real-time interactions can happen without delays.
3. **Centralized IT support** for districts with limited access to highly-qualified technology professionals helps districts effectively maintain local network infrastructure and equipment.

Secure, Specialized Content

1. **Access to superior education content such as Internet2** protects student privacy and reduces the risk of exposure to questionable Internet content.
2. **Special-purpose education networks allow master teachers and content experts to share their knowledge and skills** with rural and underserved communities.
3. **Accelerated feedback on assessments for students and parents** facilitates just-in-time remediation and intervention for struggling students.

Preface

What follows is a conceptual report that provides a clear path forward for the State of Arkansas, if we work together. Much has been discussed about individual Arkansas schools and districts that have or lack affordable high-speed Internet access but the *Arkansas Digital Learning Study* takes a broader view. It is not only about where schools are today but where *all* Arkansas schools need to be in the future.

This report analyzes the current capacity and cost of the State's K-12 education network, explores a variety of models used in other states, and proposes solutions that build on technical recommendations from the FASTER Arkansas Engineering/Infrastructure Task Force, a group of public and private sector technology professionals. Consideration was given to a variety of connectivity solutions, cost, commodity Internet vs. research and education special-purpose networks, speed to market, as well as the Governor's preference for a public/private partnership.

Developing a plan for digital learning infrastructure today that will meet the long-term needs of tomorrow is a complex task that requires flexibility. As more information becomes available, tactics will have to adjust and evolve. In-depth efforts have been made to thoroughly analyze broadband access in Arkansas K-12 schools and obtain accurate data on available network and provider capacity (see Appendix A).[1] Additional information and supporting documentation for this report was gathered from Arkansas telecommunications companies, state agencies, procurement documents, school districts, and others to validate or clarify the recommendations.

I. Defining the Problem (Data and Analysis)

A. Teaching and Learning in a Digital Age

Governor Mike Beebe released a Strategic Plan for Economic Development in 2009 that declared "Arkansas is at an economic crossroads." The report noted Pulitzer Prize-winning author Thomas L. Friedman's observations about the Internet, saying:

> *"This platform now operates without regard to geography, distance, time, and, in the near future, even language…Wealth and power will increasingly accrue to those companies, individuals, universities, and groups who get three basic things right: the infrastructure to connect with this flat-world platform, the education to get more of their people innovating on, working off of, and tapping into this platform, and finally, the governance to get the best out of this platform and cushion its worst side effects."* [2]

Friedman's words about the prerequisites for quality education, workforce and economic development in the 21st century are as true today as they were five years ago, and the imperative for Arkansas to ensure their presence is even more pressing. The State of Arkansas has a constitutional obligation to maintain a general, suitable and efficient system of free public schools and shall adopt all suitable means to secure to the people the advantages and opportunities of education and yet, where K-12 digital learning infrastructure and opportunities are concerned, Arkansas trails the nation.

Arkansas ranks at or near the bottom in national rankings of K-12 digital learning and high-speed Internet access. The 2013 "Digital Learning Now" report from the Foundation for Excellence in Education gave Arkansas a 'D' for digital learning opportunities, an improvement over the 'F' the state received in 2012.[3] TechNet's 2012 Broadband Index also listed Arkansas as 50th among all states for broadband access.[4]

Our students are growing up in a digital era, one where 74 percent of 12-17 year olds are "mobile Internet users," often using cell phones to take pictures or record video of in-class assignments.[5] They are digital natives, seamlessly integrating technology into their daily lives. Education policy makers and school leaders, however, are often digital immigrants, trying to make the best use of technologies that young people take for granted, in schools designed for the pre-digital era.[6]

21st Century Paradigm Shift

Twenty-first century learning is very different from the traditional, teacher-as-expert lecture model most adults experienced. It includes flipped classrooms where teachers serve as facilitators; project-based assignments requiring teamwork and collaboration; problem-based learning to address community concerns; more emphasis on data integration and manipulation vs. memorization; and on-demand delivery models that allow students to learn anytime, day or night.

Cabot School District: Emerging Technology Leader

Cabot High School is known for its high-tech digital learning environment and forward-thinking approach to K-12 networking. With two gigabits (Gb) of bandwidth for students and staff, and a 1 to 1 device initiative that features Google Chrome books, Cabot teachers can deliver aligned curriculum via a wiki, or any other online resource they choose.

These methods and tools reflect the need for students to become digitally literate citizens who can harness the power of technology to not only consume content, but develop completely new applications. This paradigm shift affects more than students, teachers, and administrators. Policy-makers need to consider the implications for school funding mechanisms and information technology investments.

Table 1: Evolving Teaching and Learning Methods

	20th Century Paradigm	21st Century Paradigm
Student Interaction	Mainly individual, some collaborative	Mainly collaborative, some individual
Assessment	Mainly summative (at the end) with some formative (in process)	Primarily formative with some summative
Learning focus	Predominantly content with some process	Predominantly process with seamlessly embedded content
Teaching approach	Just in case you need to know learning	Just in time for you to use it learning
Learning relevance	Low relevance to the learner; lacks context. Insignificant to me, my group, community or world	Relevant to learner; current and topical. Significant to me, my group, community or world
Thinking Skills	Predominantly lower order: remember, understand & apply with repetition and multiple choice	Predominantly higher order: analyze, evaluate & create using relational & extended responses
Technology use	Literacy (learning about technology) & augmentative (learning w/technology)	Transformative (learning through technology)
Timing of learning	Traditional school schedule with learning from 9am-3pm and homework after school	Anytime, anywhere learning facilitated by technology. Flexible schedules based on neurological research

SOURCE: http://edorigami.edublogs.org/2010/10/02/comparing-20th-and-21st-century-educational-paradigms/

Beyond K-12: Higher Education and the Economic Development Imperative

High-speed Internet access has fundamentally changed how people get, share and create information but it's especially critical for economic development in rural states like Arkansas.[7] Where high-speed Internet resources exist, consumers follow, and where high-speed Internet is deployed, jobs are created.[8]

For every one percent increase in broadband saturation, employment increases 0.2 to 0.3 percent annually.[9] And for every job lost to the Internet, 2.6 are created in its place.[10] Broadband deployment increases business efficiency. It allows access to new markets for goods and services and it lowers consumer costs.[11] High-speed Internet also gives Arkansans access to academic and employment options like the University of Arkansas eVersity, an online university dedicated to serving adult students.[12]

Research shows that K-12 public schools, as anchor tenants, can play a critical role in increasing digital literacy and consumer broadband adoption.[13] Rural consumers are as likely as their urban peers to subscribe to high-speed Internet services when they a) know the benefits of high speed access, b) experience those benefits first hand, and c) feel confident using the Internet. Few groups are better positioned to develop these skills than digital native students, and few organizations are better able to offer exposure and training than public schools.[14]

Arkansas is fortunate to have a clear vision for 21st century digital learning and an economic development effort that's focused on high-tech industries. In 2011, Governor Mike Beebe and his Workforce Cabinet announced a voluntary pilot program - STEM Works - focused on Science, Technology, Engineering, and Math (STEM) education. The effort recognized that future educational and workforce demands will be driven by the 21st century economy and require higher-level skills for all workers.

> *"The STEM fields offer stable, well-paying careers for the 21st century, and the demand continues to grow at a rapid pace. These are positions that companies are struggling to fill, even in tough economic times. If we are to continue to attract these types of companies to Arkansas, we must prepare our young people with high-tech skills and build a workforce that will help our state prosper."*
>
> **– Governor Mike Beebe, August 17, 2011**

Today, 57 secondary schools participate in STEM Works, and there are three UTeach programs at the University of Arkansas, Fayetteville, University of Arkansas at Little Rock and University of Central Arkansas.

B. Dynamic Schools, Static K-12 Network

1. Arkansas Public School Computer Network (APSCN)

Arkansas was one of the first states to recognize the importance of high-speed Internet for schools.[15] In 1989, the General Assembly directed the State to automate school district financial and educational reporting and in 1992, the Arkansas Public School Computer Network (APSCN) was funded to provide all public schools with Internet connections for data reporting.[16] At a time when few states funded any school or district connectivity, Arkansas led the nation.

Figure 1: K-12 Education Network (APSCN/CIV) Points of Presence (PoPs)

The Arkansas Department of Information Systems (DIS) currently leases a K-12 education network (APSCN/CIV) from private service providers. DIS is legislatively mandated to conceptualize, design, develop, build and maintain common

information technology infrastructure elements used by state agencies and governmental entities (Arkansas Code Annotated §25-4-105). DIS maintains five points of presence in Fayetteville, Little Rock and Pine Bluff and connects more than 2,100 governmental sites to the Internet and the State's data infrastructure.

2. Compressed Interactive Video (CIV) Network

In 2005, a Compressed Interactive Video (CIV) component was added to APSCN.[17] Through CIV, dedicated bandwidth was reserved for distance learning with the goal of alleviating teacher shortages, offering additional course-scheduling opportunities for students, providing access to an enriched curriculum, and allowing educators to participate in online professional development.

CIV network courses served 8,971 students in 2012-13 but CIV courses will be phased out beginning in 2014-15.[18] High-quality digital and online learning opportunities are now readily available through the Internet and dedicated bandwidth for compressed video transmissions is not necessary.[19] Similarly, the compression technique used for CIV causes transmission delays and reduced audio and visual quality. Students and teachers notice this most when up to two seconds of delay separate a question from its response. Arkansas's Compressed Interactive Video (CIV) network is, like the state K-12 education network (APSCN) as a whole, outdated.

Since 1992, Arkansas has invested more than $150 million (see Vendor Cost Only, Appendix H) to deploy and maintain the K-12 education network (APSCN/CIV) while the services and bandwidth available to school districts through the network remained virtually unchanged.[20] In 1992-93, for example, the State provided 1.5 kbps/student. Twenty years later, it provided 5 kbps/student, a 6 percent annualized growth rate. During that same 20-year period, demand for bandwidth among high-end users increased 50 percent each year.[21]

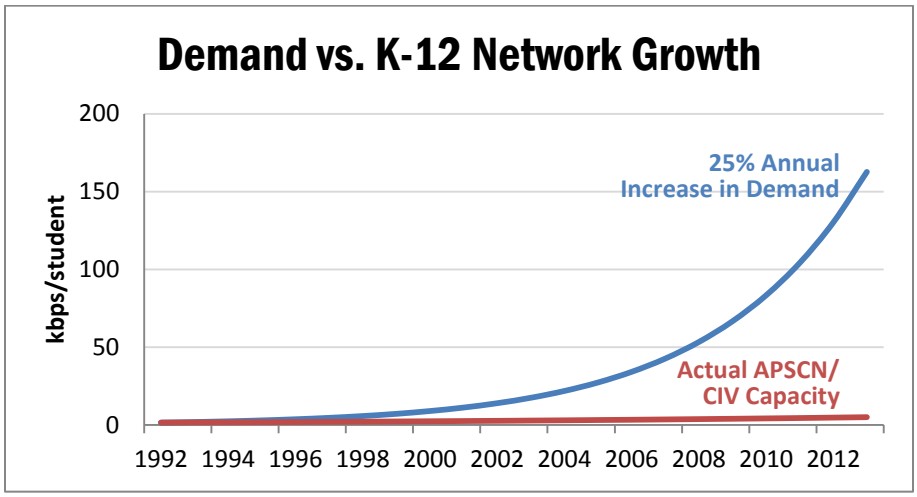


Figure 2: Comparing National Bandwidth Demand to Arkansas K-12 Education Network Capacity

- **If the State's K-12 education network (APSCN/CIV) had grown at just half the rate of high-end user demand, Arkansas schools would receive 162 kbps/student in 2013-14.**

Predictably, the lack of state-support for bandwidth and Internet connectivity is negatively impacting public schools. A 2010 Federal Communications Commission Survey of E-Rate-funded schools indicates most have some form of broadband service, but nearly 80 percent said their broadband connections were inadequate to meet current instructional and administrative needs.[22] In Arkansas, a 2011 Arkansas Association of Education Administrators survey revealed 80 percent of respondents experienced problems

with bandwidth in the previous year, 78 percent wanted to implement technology initiatives but couldn't due to bandwidth limitations, and 84.5 percent had to restrict access to educationally relevant or useful sites because of bandwidth concerns.[23]

A recent comment from White County Central School District illustrates the gap between state supplied-bandwidth and growing demand beginning in 2001:

> *"There was a time (1996-2001) when one T1 (1.5Mbps of bandwidth) line that the State of Arkansas provided was enough for our needs. This was when we hosted our own email server, one computer lab and before audio and video streaming. During this time our computer-to-student ratio was about one computer to six students. Our maintenance, transportation and cafeteria departments did not require computer use.*
>
> *Fast forward to 2013—our email is with 'Google apps' for education, we have seven computer labs including our COWs (Computers on Wheels), and an assorted number of mobile devices in our special education rooms and libraries. We have a state mandated distance learning classroom that streams video six periods out of the day, and every department on campus is required to communicate via email. There are many other cloud based applications that are not mentioned like our year book and teacher/student assessment programs.*
>
> *We struggle while trying to accomplish all of this and everything our community and state expects with just 10 Mbps of bandwidth."*
>
> **– Shayne Wallis, Technology Coordinator**
> **White County Central School District, May 2013**

Meanwhile, the educational demand for bandwidth and digital learning continues to increase. All school personnel communicate via email. School transportation departments use global positioning systems (GPS) to monitor traffic and road conditions. Teachers use online tools to provide real-time updates on student behavior and learning progress. Students watch YouTube science demonstrations and National Geographic movies for research projects. There are countless applications and resources for which Arkansas schools need bandwidth:

- ACSIP (School Improvement)
- ADE Data Center
- AELS (Educator Licensure)
- AETN (Prof. Development)
- Arkansas iTunes U
- Arkansas Student GPS
- Assessments
- Assessments (NWEA, Formative)
- ATLAS (Mentoring)
- Bring Your Own Device (BYOD) Initiatives
- Child Nutrition Claims Software
- Digital Books
- District Report Cards
- eFinance
- Email
- eSchool
- Learning Management Software (Blackboard, Moodle, etc.)
- Master Plan Tool
- Online Lessons (Odyssey, Compass Learning, etc.)
- School Dude
- Search Engines (Google)
- Skype/FaceTime/Oovoo
- Streaming Media (Natl. Geographic, Kahn Academy, YouTube)
- TESS (Teacher Evaluations)
- Triand
- Virtual Arkansas (Distance Learning)

Global technology leader Cisco estimates networked devices per capita will increase from 4.8 to 7.8 between 2012 and 2017.[24] Beginning 2014-15, the State Educational Technology Director's Association (SETDA) recommends a minimum of 100 kbps/student for high-tech digital learning environments with one-to-one device initiatives.[25] For 2017-18, SETDA recommends 1 Mbps/student for high-need schools.

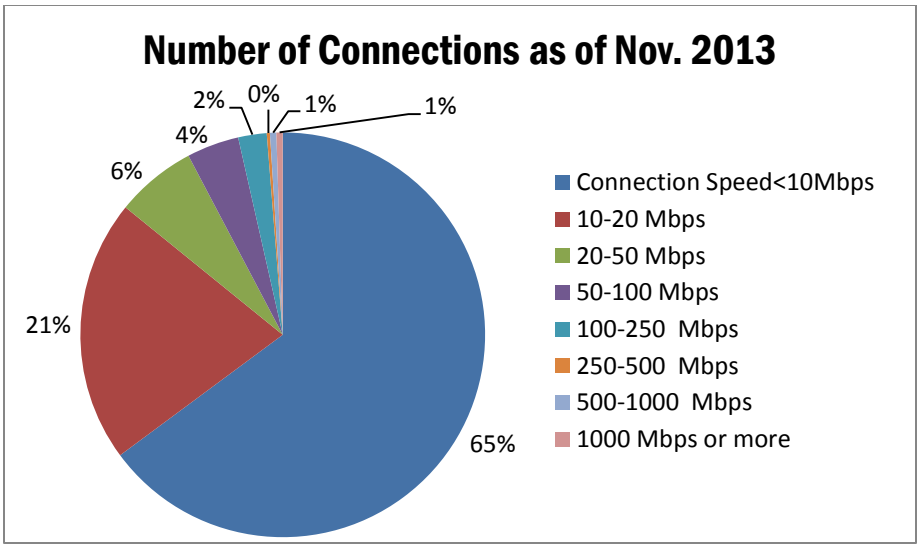


Figure 3: K-12 Education Network Connections by Capacity

– **65 percent of Arkansas's K-12 education network connections (APSCN/CIV) provide less than 10 megabits per second (Mbps) of connectivity and 86 percent of connections provide less than 20 Mbps. For perspective, 15 Mbps is the minimum recommended by the Federal Communications Commission for an American family with four networked devices.**[26]

Patchwork Solutions

Public school districts have found a variety of ways to supplement state-funded connectivity and provide students the 21st century digital learning opportunities citizens expect. Some purchase additional business or consumer grade bandwidth from the Department of Information Systems (DIS). Others negotiate separate agreements with local telecommunications service providers. To effectively combine all services, districts must purchase additional routers, content filters and aggregation equipment. The Arkansas Department of Education's recent bandwidth survey revealed 71 percent of the bandwidth purchased by schools comes directly from private providers, bypassing the state K-12 education network (APSCN/CIV).

> *"In addition to the bandwidth provided by the state, the Piggott School District currently pays for an additional 10 Mb of DSL bandwidth. This extra bandwidth is only at our high school campus and, for our purposes so far, has been sufficient. It appears, however, that it will not be sufficient...The cost of this bandwidth is around $150.00 per month including the per month cost of an additional line from our ISP carrier. On top of these monthly charges, we also had to purchase approximately $6,000.00 worth of equipment to allocate or aggregate bandwidth and provide state-mandated content filtering. In order to repeat this process for our elementary campus we will have to buy or lease the required equipment a second time."*
>
> **– Joseph Crittenden**
> **Piggott School District, May 2013**

Nationally, cost and local infrastructure are the most commonly cited barriers to deploying mobile technology.[27] In Arkansas, districts report paying $1.20/Mb to $280/Mb for bandwidth depending on the geographic location of the district or school, service requested, construction costs and provider. Rural or geographically isolated districts that require construction of new fiber-optic lines through rocky terrain or over great distances often pay the highest prices since there is no risk-pooling mechanism in place to

equalize or postalize the rates statewide. Eighty-eight percent of bandwidth costs, including the high cost of upgrading legacy copper wire to modern fiber-optic cable, are shouldered by individual school districts with support from the federal E-Rate program (see Appendix I).[28]

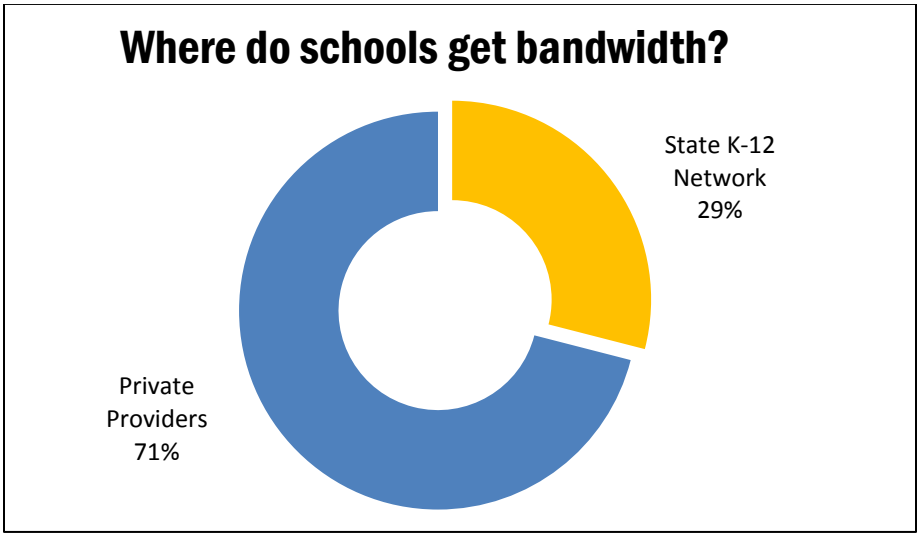


Figure 4: Percentage of School District Bandwidth by Source

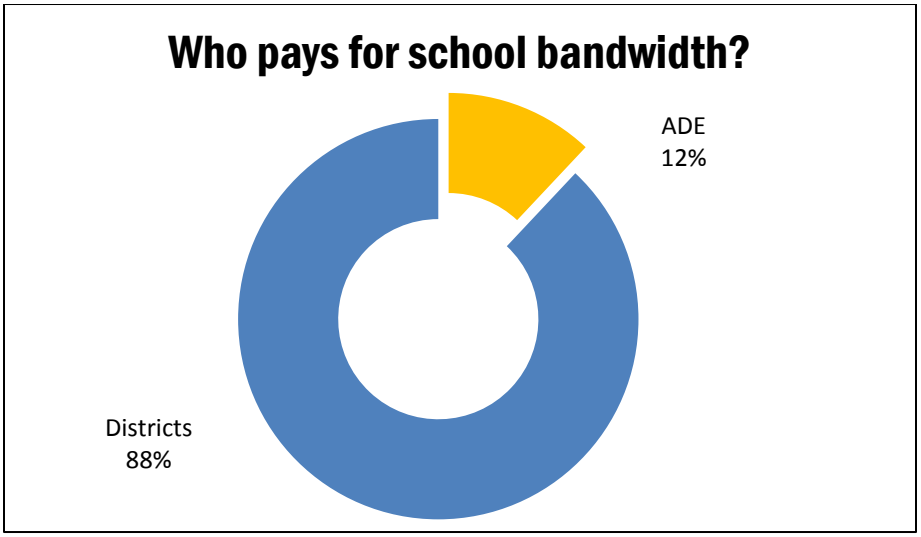
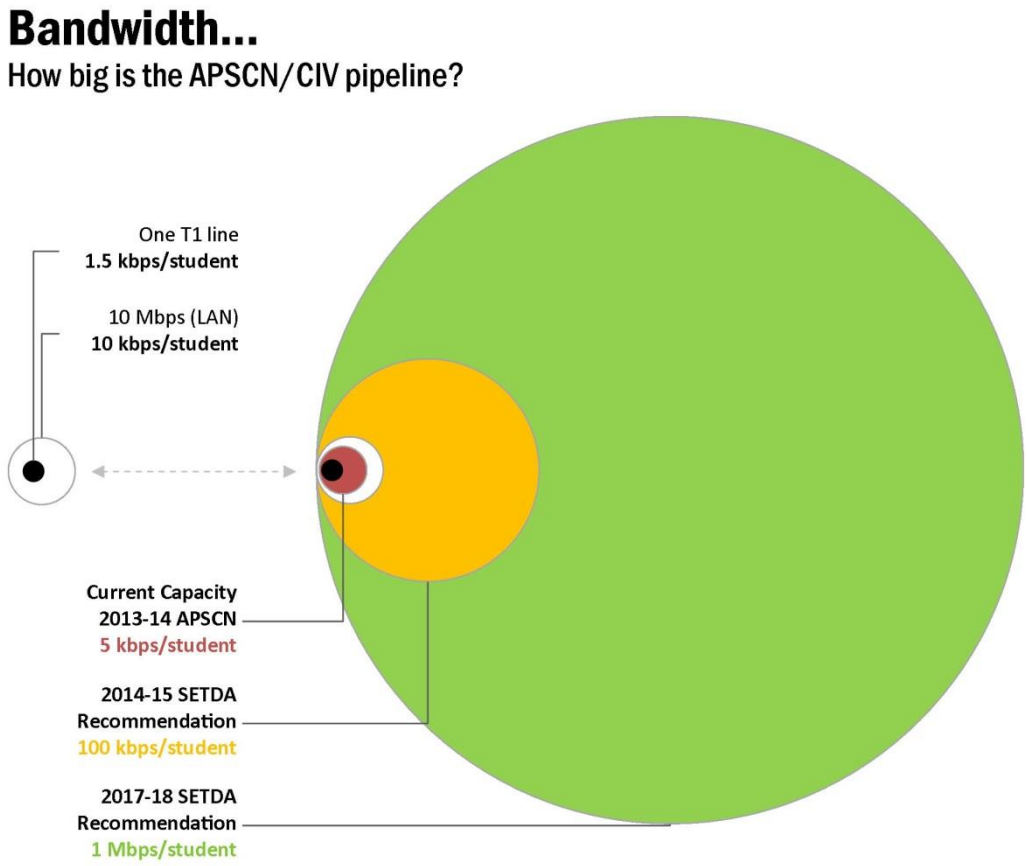


Figure 5: Percentage of School District Bandwidth by Purchasing Entity

NOTE: The State of Arkansas, local school districts, public charter schools and Education Service Cooperatives receive federal E-Rate reimbursements of 20-90 percent to help defray the cost of eligible telecommunication services.

Uneven Results

Today, the State K-12 education network (APSCN/CIV) is comprised of more than 500 separate connections to 258 school districts, charter schools and 15 education service cooperatives. In fiscal year 2013, the Arkansas Department of Education paid approximately $19 million to the Department of Information Systems for services inclusive of software/hardware, licenses, lines, filters, connectivity and project management activities. Schools with 250 to 500 students receive 1.2 Mbps to 2.5 Mbps of state-funded bandwidth, an amount less than the Federal Communications Commission recommends for a typical family with four devices.



NOTE: 1024 kilobits per second (kbps) = 1 megabit per second (Mbps)

Figure 6: Relative Bandwidth Size/Capacity

School districts have taken steps to bridge the gap between the State's support for digital learning infrastructure and their actual needs. They recognize the need to fulfill the digital learning requirements of Arkansas Act 1280 and meet community expectations for a 21st century learning environment. The piecemeal effort of 258 separate school districts, however, has resulted in disparate costs, service inequities, and inefficient statewide network operations.

C. Other State Network Resources

Arkansas currently has two taxpayer-funded education networks. The Arkansas K-12 education network (APSCN/CIV) and the Arkansas Research and Education Optical Network (ARE-ON) for postsecondary schools, healthcare and law enforcement institutions.

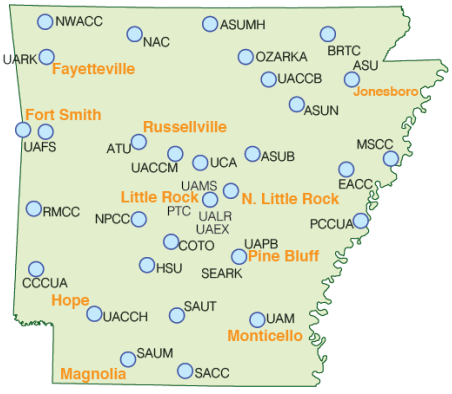


Figure 7: Arkansas Research and Education Optical Network Points of Presence (PoPs)

1. ARE-ON

The Arkansas Research and Education Optical Network (ARE-ON) is a separate, leased education network affiliated with The Quilt, an advanced regional networking group. ARE-ON is operated by a not-for-profit consortium that includes all public degree-granting institutions in Arkansas and selected higher education institutions. ARE-ON provides a high-speed fiber-optic

backbone network throughout the state with 1 gigabit (Gb) and 10 Gb Ethernet connections to its members, affiliates, national research and education networks, regional optical networks and commercial service providers. Since 2005, the total state and federal investment in ARE-ON is $57 million.[29]

The network consists of approximately 2,200 miles of long-haul and metro fiber, secured mostly through 10- and 20-year indefeasible right of use (IRU) agreements with private service providers. ARE-ON's fiber-optic backbone supports 40 wavelengths of 10 gigabits per second (Gbps) but just two of the 40 wavelengths are used to meet the day-to-day and peak networking needs of Arkansas colleges and universities. ARE-ON's 31 points of presence and potential for 3,000 Gbps of bandwidth are currently unavailable to K-12 schools due to Act 1050 of 2011.

2. e-Link Extension

In 2011, the University of Arkansas for Medical Sciences (UAMS) Center for Distance Health received $61 million to expand, integrate and enhance the Arkansas Telehealth Network. Prior to partnering with ARE-ON, Arkansas Telehealth Oversight and Management (ATOM) members had limited bandwidth and lacked the equipment necessary to participate in electronic medical record exchange, remote clinical consultations, and virtual research collaboration.

Today, e-Link uses the ARE-ON backbone to provide 454 locations substantial bandwidth, interactive video capability, and distance learning opportunities for health, education, research and public safety. The special-purpose network offers access to education-rich content such as Internet2 and the National Lambda Rail, and has successfully enhanced first responder and other emergency services by providing broadband connectivity to ambulance dispatchers, the Arkansas Trauma Communications Center, and the Arkansas Bioterrorism Network.

3. Act 1050 of 2011

House Bill (HB) 2033, later known as Act 1050, was introduced during the 88th Arkansas General Assembly.[30] The Act amended the Telecommunications Regulatory Reform Act of 1997 to prohibit state and municipal entities from offering voice, data, broadband, video and wireless services. Specific exceptions were included for 911, E911, emergency services, higher education, healthcare, and law enforcement. A broader exception for "educational" entities, such as K-12 schools, was removed.

The legislative history for HB 2033 states the bill was filed and referred to the Insurance and Commerce Committee on March 7, 2011. It was passed by both the House and Senate and transmitted to the Governor's Office for signature on March 31, 2011. The Arkansas Department of Education has no record of written testimony or advice requested by the General Assembly or Office of the Governor. Education leaders were not asked to weigh the impact of the law on Arkansas K-12 students.

Before Act 1050, the Telecommunications Regulatory Reform Act prohibited government agencies from offering telephone services to Arkansans. This prohibition encouraged existing service providers to build lines in rural communities and ensured the profitability and advancement of those who invested in low-density areas.[31] In return for market protection and low-interest government loans, however, rural providers had to provide universal service at a reasonable, affordable cost. Indeed, the "goal of universal service was – and remains today – to ensure that all Americans, regardless of where they live, receive quality telephone service at reasonable rates."[32]

With Act 1050, however, the rules of the game were changed. Act 1050 prohibits the state and municipalities, except those owning an electric utility or television distribution system, from offering high-speed Internet services without any offsetting universal service requirement or protection for captive audience broadband consumers like K-12 schools.

Act 1050 states:

> "(3) Any restriction contained in this subsection shall not be applicable to the provision of telecommunications services or facilities to the extent used solely for 911, E911, other emergency and law enforcement services, ~~educational or medical purposes,~~ or for the provision of data, broadband, or non-entertainment video telecommunications services or facilities by ~~an educational~~ or to a medical institution or institution of higher education to its students, faculty, staff, or patients, as the provision relates to academic, research, and healthcare information technology applications under the Arkansas Information Systems Act of 1997, § 25-4-101 et seq."[33]

In other words, Act 1050 allows the State to use one of its existing education networks (ARE-ON) for academic research, and healthcare needs at colleges, universities, medical and law enforcement facilities while making it unlawful for K-12 students to access the network. Arkansas is the only state where it is unlawful for a public (state or regional) research and education network to serve K-12 schools. K-12 students were, literally, struck out.

II. Meeting the Challenge (Study and Recommendations)

A. Legislative and Executive Leadership

In 2013, Governor Mike Beebe called upon Arkansas telecommunications service providers to partner with the state in providing broadband for all Arkansas students. The Arkansas General Assembly confirmed its commitment to digital learning with the Arkansas Digital Learning Act (Act 1280 and Ark. Code Ann. §§ 6-11-105 and 25-15-201 et seq.), and the State Board of Education adopted a vision for digital learning, saying:

> "*The vision of the Arkansas State Board of Education is that all public schools are connected to a robust broadband infrastructure necessary for instructional Internet access and student participation in a world-class online learning experience."*

The Arkansas Department of Education (ADE) was asked to lead a study of K-12 broadband and "the necessary infrastructure and bandwidth to sufficiently facilitate and deliver a quality digital learning environment in each school district and public charter school" in Arkansas. In response, the Quality Digital Learning Study (QDLS) Committee was formed.

From June to December 2013, Quality Digital Learning Study (QDLS) Committee members representing higher education and K-12, telecommunications service providers, legislators and other stakeholders (see Appendix B) met monthly and heard testimony from a variety of experts in digital learning and network engineering.[34] The committee reviewed articles and national reports on broadband connectivity and educational technology trends. The Department of Education, Department of Information Systems, and private service providers presented relevant information. The State commissioned surveys and gathered supporting documentation to assess Arkansas K-12 education network and identify best-practices from other states (see Appendix F).

Concurrently, Governor Mike Beebe asked business leaders to form the Fast Access for Students, Teachers and Economic Results (FASTER) Arkansas committee (see Appendix C) to examine, from a business perspective, the broadband needs of Arkansas public schools and how best to meet those needs. A subgroup of the FASTER Arkansas committee, the Engineering/Infrastructure Task Force (see Appendix D), was also created to provide network engineering expertise and guidance for the QDLS and FASTER Arkansas committees.

B. Committee Consensus Achieved

Four strategic approaches were considered by the Quality Digital Learning Study Committee to provide a robust K-12 digital learning environment, incorporating recommendations from the FASTER Arkansas Engineering/Infrastructure Task Force: a) maintain the status quo, b) build/expand the State's K-12 network using primarily public resources and infrastructure, c) build/expand the State's K-12 network using primarily private resources and infrastructure and d) develop a new vision for a K-12 network using shared public and private resources and infrastructure.

Guiding Principles

- High-speed, affordable connectivity
- Access for all public school students
- Equity for public school districts
- Leverage public/private resources
- Incorporate national best practices

Committee members recognized the State's constitutional obligation to provide Arkansas students with an adequate education as well as the legislative directive to determine how to establish and maintain a scalable, equitable, affordable, high-speed broadband infrastructure solution for K-12 schools. The committee sought to balance the competing interests of all stakeholders, use all available public/private telecommunications resources, build on national promising practices and preserve local control of inter-district network infrastructure.

Ultimately, the committee was convinced by the private-sector expertise and network recommendations provided by the FASTER Engineering/Infrastructure Task Force which prioritized quality (efficiency and capacity), cost and speed to market (see Appendix E). In December 2013, the Quality Digital Learning Study Committee voted to recommend a new, collaborative vision for K-12 networking. There were no votes against the recommendation. There was one abstention.

Ongoing Data Collection

The Arkansas Department of Education led an effort to collect statewide, district, or school level information about technology infrastructure and devices. Act 1280 of 2013 was the primary impetus for data collection at the state level regarding school bandwidth and Internet connectivity. This effort is ongoing. The Arkansas Department of Information Systems (DIS) maintains the current K-12 education network and was able to supply information about the level of connectivity it provides Arkansas school districts. However, information about the total school bandwidth purchased outside of existing DIS contracts, directly from private providers, is more difficult to acquire. Despite the use of public funds and state procurement procedures, there is a lack of transparency regarding pricing and service availability.

C. A New Vision for K-12 Networking

The Quality Digital Learning Committee's recommendation that the state embrace a new vision for K-12 networking—one that unifies public and private networking efforts, restores the ability of K-12 school districts and private providers to use ARE-ON, and provides affordable, high-speed broadband service for all Arkansas students, has six components:

Recommendation 1: **Connect school districts with a robust fiber-optic network.** This applies to any solution and will require significant investments in personnel, network services and, where possible, regional telecommunications service provider resources.

Copper cabling, the technology used for basic telephone service and much of the State's existing K-12 network, was designed to provide enough bandwidth for voice transmissions, not the data and video-streaming applications schools use today. Despite capacity improvements in copper wiring that make it a cost-effective option for residential connectivity, fiber-optic cabling remains the preferred

solution for high-density, multi-user environments such as K-12 schools. Fiber offers more bandwidth over longer distances with less interference and signal degradation and allows schools to scale up, rapidly, over time.[35] This higher capacity does come at a cost, but the benefit outweighs the cost when compared to the long-term needs of schools and anticipated demand growth statewide.

Table 2: Copper vs. Fiber Comparison

	Distance	Bandwidth	Voice Channels
Copper	2.5 km	1.5 Mb/s	24
Fiber	200 km	2.5+ Gb/s	32,000 +

SOURCE: http://www.thefoa.org/tech/fo-or-cu.htm

Recommendation 2: **Adopt the State Educational Technology Directors Association (SETDA) recommendations for K-12 bandwidth as minimum targets.** Arkansas's network must have the capacity to provide concurrent access to world-class educational content for all students and staff with the ability to grow and adapt to meet future demands. For 2014-15, the minimum recommended bandwidth is 100Kbps/student and staff and for 2017-18, the minimum recommended bandwidth is 1Mb per student and staff. This recommendation provides a capacity target that is unlikely to be met in the near term, but allows for growth over time.

Recommendation 3: **Centralize management for statewide network support services** such as billing, E-Rate applications, network recommendations/implementation/construction, network monitoring, vendor management, and problem resolution while preserving the responsibility of school districts to manage local area networks that interconnect school buildings.

Recommendation 4: **Efficiently aggregate statewide demand** to achieve greater economies of scale, reduce costs, improve access, and deliver high-quality content. Reducing the number of networks serving education from three +: DIS (CIV and APSCN), ARE-ON, and numerous telecommunications service provider (TSPs) to one: with private TSP transport from an ARE-ON backbone to a single district metropolitan area network, accomplishes this goal.

Arkansas has a robust fiber-optic backbone network that provides secure access to the Internet for higher education, health and public safety institutions. This existing State resource should be extended to school district hubs (middle-mile connectivity) using leased private provider, fiber-optic lines. This preserves provider revenue streams and minimizes the need for each of the State's 258 school districts, public charter schools and Education Service Cooperatives to lease, purchase or maintain redundant filtering and firewall equipment. It also maximizes access to rich educational curriculum and content.

Private telecommunications service providers have invested more than $800 million by some accounts in regional network upgrades, bringing fiber to many previously-underserved school districts.[36] These investments should be leveraged to provide last-mile fiber-optic connectivity to individual schools and establish or upgrade fiber-optic local area networks (connections between school buildings). This reduces the cost and number of connections from the state network to school districts, reduces possible points of failure/security breach (further improving student safety), and allows more efficient bandwidth management at the state and local level.

Recommendation 5: **Optimize the use of E-Rate and other federal funding programs** to build and sustain the network. The Federal E-Rate Program (also known as the Schools and Libraries Program) provides money to states, Education Service Cooperatives and local school districts for school and

library Internet connectivity. Schools and libraries receive discounts of between 20 and 90 percent on eligible telecommunications services depending on the location of the school (urban or rural) and the percent of students enrolled in the National School Lunch Program. Arkansas typically receives less E-Rate money per student than neighbor states with comparable demographics. Arkansas should increase its E-Rate funding requests at the state and local level to pay for additional K-12 broadband and leverage E-Rate to offset the cost of adding K-12 data traffic to the ARE-ON backbone.

Recommendation 6: **Provide comprehensive value-added services** such as teacher professional development and network technical support to help districts create, maintain and effectively utilize local area networks. The Committee strongly recommends that the Arkansas Department of Education provide ongoing professional development and network support for teachers and technology personnel, particularly in rural or remote areas where districts may have difficulty attracting and retaining qualified technology personnel and tech-savvy teachers. Existing State activities and funds may be re-allocated or re-aligned for this purpose.

Anticipated Benefits

Arkansas currently leases its state K-12 education network (APSCN/CIV) exclusively from private providers, aggregating less than one third of K-12 demand in just three cities. The State also leases a separate network for higher education, health and law enforcement purposes.

On the State K-12 education network, traffic traverses multiple service provider networks before reaching either the Internet or the Arkansas Department of Education for data reporting purposes. Smaller providers have to purchase the right to cross larger carrier networks, and high-speed coverage gaps persist where construction costs are high or the consumer base is small. In sum, costs are high, capacity is low, and access to educational content is often restricted due to limited capacity. On the other State network, higher education, law enforcement and healthcare facilities benefit from high quality, high capacity, and secure access with low monthly costs.

With a unified, public/private partnership approach, however, many of the current barriers to affordable, equitable high-speed Internet access for K-12 students would be eliminated. Data and analysis suggest significant benefits flow from these six recommendations, primarily in three areas: *cost*, *capacity* and *content*.

Lower Costs

Aggregating statewide demand on a single, unified education network will give the State more leverage in purchasing negotiations (Ethernet circuits, Internet pricing, and software). Presently, 258 individual school districts, public charter schools and Education Service Cooperatives are purchasing bandwidth, software and equipment as individual entities, rather than bulk-buying at the state

Arkansas Benefits from a Unified Education Network

Lower Costs	• Efficient aggregation of statewide demand • Centralized management • Connectivity purchased wholesale vs. retail • Spread out, pooled construction costs • Less equipment • Fewer connections
Higher Capacity	• Dense-wave fiber-optic lines=more bandwidth • Low latency (delays) • High reliability • Cached software upgrades • Scalability for peak usage periods
Secure, Specialized Content	• Global experts and research via Internet2 • Enhanced safety, security features • Real-time data for teachers • Rapid-response, remediation for students • Net neutrality

level. This inefficiency is driving up costs for school districts and reducing efficiency. Unifying public and private network resources means districts will no longer have to purchase different pieces of equipment to make their various connections work together.

The Quality Digital Learning Study Committee recommendations also encourage districts to install or upgrade fiber-optic local area networks/metropolitan area networks (LANs/MANs). Where today, many districts have multiple connections to the state network, going forward most districts would have one, with all other school buildings being connected in a loop. This reduces the possible points of failure on the state network and reduces the amount of construction, equipment, maintenance and overhead required to operate and upgrade the network. The State's leasing obligation would end at each district hub, with local school districts maintaining responsibility for local loops/Wide Area Network (WANs), internal building infrastructure (such as wireless access points), and devices.

The unification of public and private network resources would also allow the State to develop a regionalized cost-sharing model with more equitable prices for school districts. If the State assumes responsibility for middle-mile connectivity as recommended, regional or statewide bulk-buying becomes feasible and the cost of construction projects can be spread out over larger service areas. This reduces both non-recurring and monthly recurring costs for geographically isolated communities, leveling the statewide playing field.

The study's recommendation for centralized, managed backbone services will also help school districts that have difficulty hiring or retaining qualified network support staff. The State can monitor and anticipate growing network demand as well as plan long-term statewide network upgrades in a way that many school districts cannot. Rural and/or low-income communities with limited capacity to perform technology planning and procurement will no longer be at a competitive disadvantage.

Higher Capacity

Private provider network resources, while substantial, do not provide the level of dedicated dense-wave, fiber-optic capacity available through the Arkansas Research and Education Optical Network (ARE-ON).

Research and education networks are designed to anticipate and accommodate the high-bandwidth applications that students, teachers and researchers need. ARE-ON offers, for example, the ability to cache common software and upgrades (such as Apple iOS updates or statewide assessments) on its network, limiting disruptions or slow network operations. ARE-ON is also highly scalable, allowing districts to 'burst up' to higher speeds during peak usage periods, such as statewide testing windows, without additional costs.

The existing K-12 education network (APSCN/CIV), which requires K-12 data traffic to cross multiple for-profit networks, virtually guarantees reduced reliability and increased latency (the time it takes for content to get from point A to point B). High-quality video and real-time interactions may be delayed due to network congestion and interfere with classroom instruction. Using ARE-ON's ample capacity ensures students have access to 3D videos and high-definition images without excessive buffering or frequent time-outs that can discourage teachers from using digital content and disrupt student learning.

Finally, the recommendation to centralize information technology support for districts allows those with limited access to highly-qualified technology staff to have the same level of network infrastructure and equipment as districts with more resources. Standardized network capacity and equipment recommendations will improve efficiency, reduce the number and type of challenges network support staff face, and allow the State to support more school districts with short- and long-term technology plans. The state may, or may not be the most effective provider of these services. Regional Education Service Cooperatives could meet this need.

Secure, Specialized Content

The Arkansas Research and Education Optical Network (ARE-ON) gives Arkansas students access to Internet2–a rich source of secure educational content and data. Member institutions and innovators from primary and secondary schools, colleges and universities, libraries, and museums use Internet2 to connect with each other, develop new technologies and applications, and explore primary content and resources, such as high-definition and 3D images of Smithsonian library artifacts.

Third graders can use Internet2 to explore kelp forests surrounding Channel Islands National Park and use live webcams to predict and observe. Teachers can 'take a class underwater' to see, hear and speak with divers (park rangers). High school students can 'attend concerts' by noted musicians, engage in virtual town-hall meetings with former presidents or use remote laboratory equipment to conduct science experiments.[37]

Merging the State's network resources also helps ensure K-12 students are surfing the Web safely. Children's Internet Protection Act (CIPA) content filters can be strategically placed on the backbone to handle all K-12 Internet traffic, with settings and permissions customized at the local level. Internet2 offers tools to verify the identity and legitimacy of users, facilitate single sign-on access to educational applications, and improve network security using multifactor authentication services.

Beyond the content and security available through the Arkansas Research and Education Optical Network (ARE-ON), high-speed networking facilitates the digital learning mandated by Act 1280. Master teachers and content experts will be able to develop and share courses and curriculum using iTunes U, Blackboard, etc. without service interruptions. Teachers can provide rapid feedback for parents, just-in-time interventions for struggling students, and use real-time classroom management applications like Arkansas Student GPS. And critical educational content will not be throttled to maximize revenue from content providers.[38]

ARE-ON maintains Internet neutrality, securing equal access for all educational Web sites and Internet-based applications.

E-Rate Optimization

The Schools and Libraries Program, commonly known as E-Rate, helps public and private K-12 schools, school districts, public charter schools, educational cooperatives and libraries obtain affordable Internet access and telecommunications services. Eligible entities can either receive discounts or reimbursements ranging from 20 to 90 percent.[39] The E-Rate program is administered by the Schools and Libraries Division of the Universal Service Administrative Company on behalf of the Federal Communications Commission.

The State of Arkansas has achieved 100 percent participation in the E-Rate Program by Arkansas public schools (not including public charter schools) for the last five years through the collaborative efforts of the Arkansas Legislature, Arkansas Department of Education, Department of Information Systems, and Educational Service Cooperatives technology coordinators. Arkansas schools and libraries have received more than $204.9 million in E-Rate discounts over 15 years with the average Arkansas E-Rate discount being 79 percent for 2012-13.[40] This is a remarkable achievement given the

K-12 Unplugged in Kansas?

In 2012, Kansas eliminated its state K-12 network. Districts now negotiate separate contracts with Internet service providers.

"A report released by the Kansas Department of Education found that 53 of Kansas's 208 districts say Internet providers limited the amount of broadband they could purchase and 69 districts indicated they had difficulty finding secure, efficient and affordable Internet Access."

SOURCE: "School Districts Seek Faster Internet Connections" Education Week Online. March 11, 2013

complexity of the E-Rate program and the fact that eligible services and program rules frequently change.

E-Rate Central, a partner in Arkansas's 2013-14 E-Rate application cycle, compared Arkansas's E-Rate funding levels to neighbor states with similar public and private enrollment figures and poverty rates (Mississippi, Louisiana and Oklahoma) and comparable states with strong statewide K-12 networks (Nebraska, North Carolina and Utah).

Table 6: E-Rate Funding for Selected States, 2008-12

	Total Public and Private Enrollment	Total E-Rate Funding	Per Student Funding	Poverty by Household Income	Adjusted Per Student Average
Oklahoma	693,911	$332,665,002	$479.41	15.6%	$89.30
Utah	607,542	$132,486,674	$218.07	14.5%	$68.87
Louisiana	843,598	$289,247,669	$342.87	18.3%	$54.44
North Carolina	1,601,345	$390,187,418	$243.66	13.1%	$54.05
Arkansas	511,014	$138,662,351	$271.35	15.9%	$49.59
Nebraska	337,540	$54,364,312	$161.06	9.5%	$49.26
Mississippi	545,176	$177,668,267	$325.89	20.1%	$47.11

SOURCES:

1. Student count: NCES Digest of Education Statistics (http://nces.ed.gov/programs/digest/2012menu_tables.asp)
   a. Table 37: Public elementary and secondary schools, Fall 2010
   b. Table 74: Private elementary and secondary schools, Fall 2009
2. E-Rate funding: E-Rate Central state funding totals (http://www.E-Ratecentral.com/us/default.asp) as of April 9, 2014 — see other workbook tabs
3. Household poverty: 2009 Census data (http://en.wikipedia.org/wiki/List_of_U.S._states_by_poverty_rate)

The reasons for the variation in total and per-student funding among the selected states are unknown, but it appears that Arkansas may not be making the best use of the federal E-Rate program. Despite fluctuations in the total E-Rate funds available for distribution each year, Arkansas's share of the national total remained relatively flat while, Utah, Oklahoma, North Carolina and Louisiana seemed to capitalize on the periodic availability of additional funds.

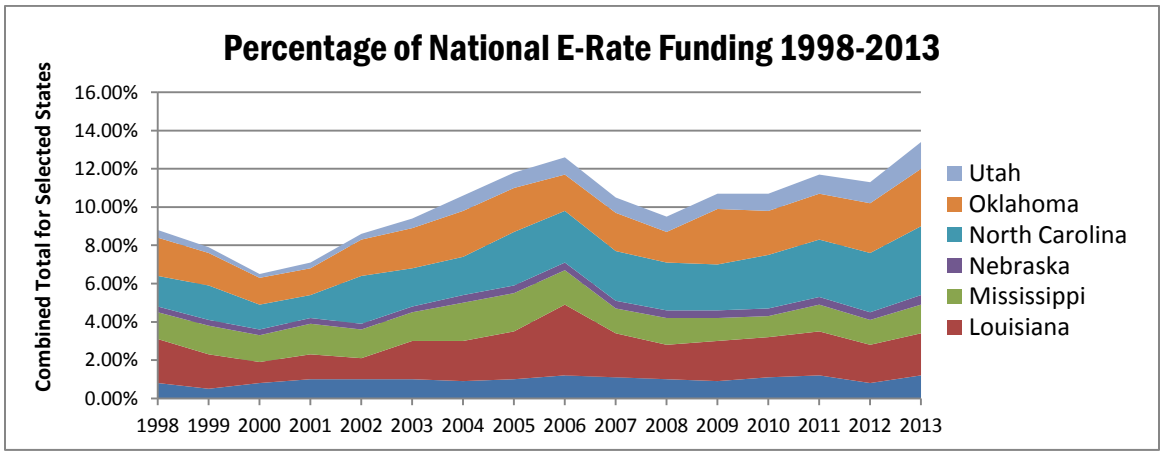


Figure 8: Percent of National E-Rate Funding for Selected States, 1998-2013

SOURCE: E-Rate Central state funding totals as of April 9, 2014 — see other workbook tabs (http://www.E-Ratecentral.com/us/default.asp)

NOTE: The layers above represent the percent of national E-Rate funding selected states received from1998 to 2013. The width of the bands/layers indicates a greater proportion of the national total.

III. Conclusion, Next Steps

The Internet has fundamentally changed how teaching and learning is done around the world. From Mountain Home to Bangalore, educators are embracing technology as a means to make learning more relevant and engaging for students. Arkansas continues to strive for excellence in education so our children can successfully compete for 21st century jobs. The use of technology and digital learning, in all its various forms, is vital to the success of students and provides a vehicle to deliver more opportunities and a brighter future for our children and our state.

It is tempting to focus on the connectivity needs of the few historically underserved schools and districts that desperately need more bandwidth. However, Act 1280 directs the State to study how to provide a robust K-12 broadband infrastructure statewide, for all schools. No Arkansas child should be disadvantaged due to his or her geographic location. Act 1280 also requires the Class of 2019 to take at least one digital learning course to graduate from high school and, unfortunately, our current K-12 education network is ill-equipped to provide ubiquitous, affordable, high-speed Internet access for all students.

Other states have increased E-Rate revenue, dedicated their high-cost funds to education, and reduced statewide networking costs by eliminating redundant taxpayer-funded networks. Network unification using ARE-ON is currently unlawful, but it is within the purview of the Arkansas General Assembly to keep or remove any statutory barriers to this approach.

The path forward is based on all of the information available to the Quality Digital Learning Study Committee. Questions about costs, feasibility, and school district readiness remain. K-12 connectivity is primarily purchased directly from telecommunications providers and, without provider information or participation in data validation, a more accurate analysis of broadband is difficult to produce.

How much fiber-optic connectivity is available to schools? Which schools lack access to high-speed Internet? What type of infrastructure do providers have in place, and how much would it cost to implement the proposed public/private partnership model? The State made the following efforts to answer these questions:

1. Governor Mike Beebe reached out to the Internet service provider community in July 2013 to request data on school district bandwidth capacity (see Appendix A). A secure environment was provided to ensure the confidentiality of proprietary information but information was not received.

2. In August 2013, the Arkansas Department of Information Systems (DIS) followed up on the Governor's request, asking for "information outlining the level of connectivity currently available, projected to be available and the mechanism in which it would be delivered to schools…to determine areas that are unserved or underserved through existing broadband services."[41] Again, information was not received.

3. Finally, in late August and September 2013, the Arkansas Department of Education (ADE) contacted K-12 technology coordinators to gather data on district bandwidth and cost. A Web-based portal was established for district self-reporting and Internet service providers were encouraged to authenticate the data ADE received. Providers notified ADE of just two erroneous figures.

The State remains committed to working with the Arkansas telecommunications industry to help preserve competition and fairness in the marketplace, but cannot wait indefinitely to address an issue with far-

reaching educational and economic development consequences. The needs of Arkansas students are pressing and the State's obligation is clear.

Going forward, Arkansas leaders can advance these recommendations by:

1. **Developing a plan to aggregate K-12 demand via existing infrastructure, pool all available resources, and provide greater price transparency and equity**. Earlier efforts to obtain pricing for a unified network were sidelined by E-Rate timelines and competing legislative priorities.[42]

2. **Restoring statutory parity with neighbor states**. Of the 42 public, state/regional research and education dense wave fiber-optic networks in the U.S. connecting to Internet2, the Arkansas Research and Education Optical Network (ARE-ON) is the only one that cannot serve K-12 schools, directly or indirectly, because of State law (Act 1050 of 2011).

3. **Providing the professional development, common software application and local network support services necessary to support a quality digital learning environment**. This should include educator professional development as well as assistance for local network support staff with training and long-term planning for student device initiatives and other technology efforts.

To sum up, Arkansas has a fundamental choice to make. Do we maintain the status quo until external forces demand action or initiate a quality digital learning solution that equitably serves all children, reducing government waste by saving the state and schools money, unifying redundant networks, and uses state and federal funds more effectively? Arkansas education, policy and business leaders have said that educational technology and digital learning is vital to the success of our students and our state. Across the country leaders are moving aggressively to provide digital learning resources for K-12 students because they know the need is urgent.

Appendix A: Governor's Request for Data from the Internet Service Provider Community

July 15, 2013

Dear Internet Service Provider,

On behalf of Governor Mike Beebe, thank you for participating in the broadband discussion on July 10. The Internet service provider industry has a key role to play in educating our students, and your interest in expanding broadband access in Arkansas's public schools was inspiring. Your feedback will be invaluable as we move forward.

In the meeting, several providers requested information on the broadband needs in public schools. The State Educational Technology Directors Association recommends 100 Kbps per student, but as Commissioner of Education Dr. Tom Kimbrell mentioned, much more will be needed to serve the needs of students and teachers today and in the future.

Attached is a list of demarcation points, building addresses, and student enrollment for each Arkansas public school, which will serve as a starting point for identifying service gaps. **Please provide your company's current capacity information for each location in the yellow columns and return it to Brittany Kincaid at brittany.kincaid@arkansas.gov by close of business on Wednesday, July 24.** The Arkansas Department of Education will make additional requests for information if the need arises.

Julie Mullenix of Mullenix and Associates will serve as the liaison between the Quality Digital Learning Study (QDLS) committee and all Internet service providers. Please contact Julie with any questions, ideas, or concerns you may have, and look for regular communications from her about specific topics from the QDLS group as well. She can be reached at (501) 844-7071 or juliemullenix@arkansas.net.

Other contacts include Ed Franklin, a consultant and education advocate who is the Chair of the Quality Digital Learning Study committee. He can be reached at eorcfranklin@att.net or (501) 912-5912. Jerry Jones, Executive Vice President of Acxiom, is leading Fast Access for Students, Teachers, and Economic Results. FASTER is a group of business representatives concerned about broadband. Jerry can be reached at jerry.jones@acxiom.com or (501) 342-1350.

Strengthening our broadband infrastructure for our public schools is essential to making our state an educational and economic leader. Working together, we will be successful. Thank you again for your time and efforts.

Sincerely,
Emily Jordan-Cox
Director of Policy, Office of Governor Mike Beebe

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Appendix E: FASTER Engineering/Infrastructure Task Force Report

Adopted by FASTER Dec. 2, 2013 and by QDLS on Dec. 3, 2013

Fast Access for Students, Teachers and Economic Results (FASTER Arkansas)

Engineering/Infrastructure Task Force Report

Background-

Act 1280, passed by the 89th General Assembly, requires the Arkansas Department of Education to explore ways to establish and maintain the infrastructure and bandwidth necessary to deliver a quality digital learning experience for all Arkansas public school students. The Arkansas Department of Education formed the *Quality Digital Learning Study Group* to complete this task, with Dr. Ed Franklin of the Arkansas Association of Two-Year Colleges serving as the committee chairperson.

Governor Mike Beebe also asked Jerry Jones of Acxiom to convene the Fast Access for Students, Teachers and Economic Results (FASTER Arkansas) committee to examine, from a business perspective, the broadband needs of Arkansas public schools and how best to meet those needs. FASTER will also consider the implications of expanded broadband access for economic development and make state and federal policy recommendations regarding broadband expansion.

A subgroup of the Faster Arkansas committee, the engineering/infrastructure task force was formed to provide network engineering expertise and recommendations for the FASTER Arkansas Committee.

Mission-

The mission of the engineering /infrastructure task force was to review technology solutions for broadband expansion and recommend one or more network engineering solutions for Arkansas public schools.

Scope-

1. Review bandwidth specifications- provided by leading experts, research reports, and the *Quality Digital Learning Study Group*.
2. Review bandwidth growth projections- consideration will be given to future, expanding bandwidth needs as defined by leading experts, research, and the *Quality Digital Learning Study Group*.
3. Develop network standards and operational framework- final recommendation must include a standardized plan including a blueprint for network hardware, configurations, troubleshooting, repair escalation, etc.
    a. Provide for school district/Coop interconnectivity- Review and plan school district demarc location and interconnectivity to and interconnectivity within the individual school and administration buildings within that district.
    b. Build in adequate oversight - The network must have ongoing management of the standards and insure that standards are met by the school districts. Consider a "user group" mentality where the technology coordinators are in a collaborative environment

with group communications, annual meetings, and site reviews to promote quality implementations.

c. Ensure security- Content filtering is required for public school networks to prevent underage access to inappropriate Internet content. Filtering components must be standardized and centrally managed.

Considerations-

1. Type of connectivity solutions- Nothing is pre-determined; objective consideration must be to all solutions that provide quality infrastructure with an eye toward long-term stability. The work is vendor agnostic.
2. Cost- While cost is always of concern in making network engineering recommendations; it is only one of many factors. In selecting a network design, cost is weighted behind the quality and long term performance of the network and ability to leverage existing assets such as dark and lit public/private fiber-optic capacity.
3. Commodity Internet vs. research and education networks- It is important to understand the difference between commodity TSP services vs. special purpose networks (e.g. ARE-ON) and the advantages and disadvantages of each, including ease of access to educationally relevant content such as Internet2.
4. Speed to market- Act 1280 requires schools to offer a digital learning course beginning 2014-15 and the 2014-15 E-Rate application deadlines are approaching. Neighbor states have made substantial upgrades to their K12 networks and Arkansas must act quickly to remain academically and economically competitive.
5. The Governor has expressed a preference for collaborative, partnership solutions that optimize the use of all available public/private resources.

Policy Options-

Four broad policy approaches were considered for Arkansas's broadband challenge: A) maintain the status quo, B) build/expand the K12 network using public infrastructure, C) build/ expand the K12 network using existing private infrastructure and D) develop a new public/private partnership for K12 using shared public and private infrastructure.

Recommendations-

1. **Connect school districts with a robust fiber-optic network**. This applies to any solution and will require significant investments in personnel as well as network services and, where possible, regional telecommunications service provider resources.
2. **Adopt the State Educational Technology Directors Association (SETDA) recommendations for K12 bandwidth as minimum targets.** Arkansas's network must have the capacity to provide concurrent access to world-class educational content for all students and staff with the ability to grow and adapt to meet future demands. For 2014-15, the minimum recommended bandwidth is 100Kbps/student and staff and for 2017-18 the minimum recommended bandwidth is 1Mb per student and staff.
3. **Centralize management for statewide network support services** such as billing, E-Rate applications, network recommendations/implementation/construction, network monitoring, vendor management, and problem resolution while preserving the responsibility of school districts to manage local area networks that interconnect school buildings.
4. **Efficiently aggregate statewide demand** to achieve greater economies of scale, reduce costs, improve access, and deliver high-quality content. Reducing the number of networks serving education from three: DIS (CIV and APSCN), ARE-ON, and telecommunications service provider

(TSPs) to one: an ARE-ON backbone with private TSP transport from ARE ON to a single district metropolitan area network, accomplishes this goal.

Rationale/Discussion-

1. Critical factors in successful networking are quality implementation, technical support, network monitoring/problem resolution and vendor management.
    - A large portion of the state's school districts are not adequately networked or connected in a local or metropolitan area network (LAN/MAN). The large number of K12 network demarcs (520+) reduces network efficiency.
    - School districts are not consistently able to budget for, attract and use technical support staff.
    - The varying levels of technical support at the local level make it extremely difficult to accurately assess equipment age, condition, or capacity.
2. The federal E-Rate program's complex regulations and limited funds results in under-utilization of the program.
    - Centralizing E-Rate applications at the regional or state level improves program utilization and network cost-recovery.
    - E-Rate could cover up to 80% of K-12 statewide networking, fiber construction, and network services when properly utilized.
    - Arkansas may not have the expertise necessary to develop a statewide networking plan that fully utilizes the E-Rate program; the state did not increase its planned bandwidth targets for the 2013-14 E-Rate application cycle.
3. Many states with well-developed research and education networks use them to provide K-20 "middle mile" connectivity (North Carolina/NCREN model), strengthen government network connectivity, and improve public safety and healthcare delivery systems.
    - Of the 42 research and education optical networks in the U.S., ARE-ON is the only one that does not serve K12.
    - The ARE-ON network is an unmatched, publically-funded optical network designed to provide high speed broadband and connectivity for research and education institutions.
    - The numerous ARE-ON access points make it more economical to connect to districts, reducing transport costs.
    - Higher education institutions and hospitals in Arkansas are "anchor tenants" of the ARE-ON backbone, facilitating regional telecommunication service providers (TSPs) efforts to build out re-usable fiber infrastructure to ARE-ON hub facilities.
    - Adding K12 to ARE-ON can improve the ARE-ON network by providing the funds necessary to bring ARE-ON's fiber-optic capacity to remote and underserved areas of the state.
    - Internet2 access in the state must go through an ARE-ON sponsored connection.
4. In states where research and optical networks are less established or non-existent, telecommunications service providers were tapped to develop a K12 networking solution (Idaho/Qwest model and Mississippi/AT&T).

Unresolved/Outstanding Challenges-

1. Precise cost estimates, existing private provider fiber resources and pricing models. Others states provide examples of potential cost savings but precise figures for Arkansas models are not yet available. ADE is gathering this information for other states' costs and from the ongoing Invitation for Bids (IFB) process.
    - Pricing and fiber routes are proprietary for telecommunications service providers and could only be obtained through the IFB process.

2. Well-defined network designs. Without accurate cost information for Arkansas network routes, it is difficult to model and holistically estimate cost (capital and ongoing) or any cost savings achieved through economies of scale.
    - ARE-ON is, however, developing a network design using their backbone as the middle mile solution similar to the approach used in other states.
    - The technology subcommittee has not proposed or requested a sole-source, telecommunications service provider-designed network solution due to the inability of that solution to provide K12 schools access to Internet2 content.
    - E-Rate expertise has to be considered in any network design. It may be necessary for the state to bring in additional expertise to ensure the proposed network designs optimize potential E-Rate reimbursement.

Appendix F: Supplemental Data and Analysis

National Best Practices, Models

Providing adequate, affordable access to broadband for K-12 schools is a national challenge that each state approaches differently. The Quality Digital Learning Study (QDLS) Committee spoke with or profiled a number of states with high-capacity networks to discover best practices. Pursuant to the recommendation of the FASTER Engineering/Infrastructure Task Force, a national survey was also conducted to identify additional features, network design and cost structures common to statewide K-12 networks.

The Arkansas Department of Education received 15 responses to its Research and Education Network/Quilt Member Survey, 17 responses to the State Education Network Survey and 11 responses to its Survey of state E-Rate Coordinators. Every state that responded had one or more research and education optical networks.

The results of Arkansas's nationwide survey of state E-Rate coordinators, Quilt members (research and education networks), and state K-12 education networks are available online:

- State Education Network Survey (https://www.surveymonkey.com/results/SM-96Y8638/)
- Quilt Member Survey (https://www.surveymonkey.com/results/SM-JMFR638/)
- E-Rate Member Survey (https://www.surveymonkey.com/results/SM-GB7F638/)

Pooled K-20 Networks

- Of the 42 public, state/regional research and education dense wave fiber-optic networks in the U.S. connecting to Internet2, the Arkansas Research and Education Optical Network (ARE-ON) is the only one that does not serve K-12 schools and is prohibited by state law (Act 1050 of 2011) from doing so.
- Most research and education networks serve higher education, K-12 education, government agencies, libraries, and healthcare facilities. Some extend services to museums, cultural and economic development organizations, non-profits and law enforcement entities.
- Of the seven responses to E-Rate Coordinator Survey question #4, six states pay for Internet as well as backbone and middle-mile connectivity. Only one state pays for school connections (last-mile).
- The level of integration between K-12 and research and education networks varies. Some networks report 80-100 percent of district bandwidth and commodity Internet is purchased through the research and education network. Others indicate near zero participation as they are "not doing K-12 bandwidth in a large way yet."
- Neither research and education networks nor state K-12 network respondents require school districts to purchase transport circuits or Internet access through their networks.

Public-Private Partnerships

States typically describe their network as a public/private partnership or hybrid model but that could mean any number of things.

- In Mississippi, state network services (backbone, middle-mile, last-mile and Internet access) are procured from a single service provider, with strategic direction and contractual oversight provided by the State.

- In North Carolina, MCNC (a private, non-profit provider) won the state's bid to provide high-speed Internet, backbone and middle-mile connectivity, and works with the state and eligible member organizations to obtain last-mile connectivity from local service providers.
- In Vermont, a variety of local Internet service providers connect eligible customers to Internet2 via settlement-free peering. The minimal costs of that service are absorbed by the University of Vermont with all other bandwidth and commodity Internet being purchased by school districts from private service providers.

Bandwidth Demand Models

States use a variety of metrics to gauge K-12 district bandwidth requirements and project demand over time. Initial estimates may use federal or State Educational Technology Director's Association (SETDA) recommendations in combination with student/staff counts and district requests, while more established networks rely on network trend data and bandwidth management applications. Testimony received at Quality Digital Learning Study Committee meetings suggests that, whatever the starting point a state uses for initial bandwidth offerings, total demand will generally double each year thereafter.[43]

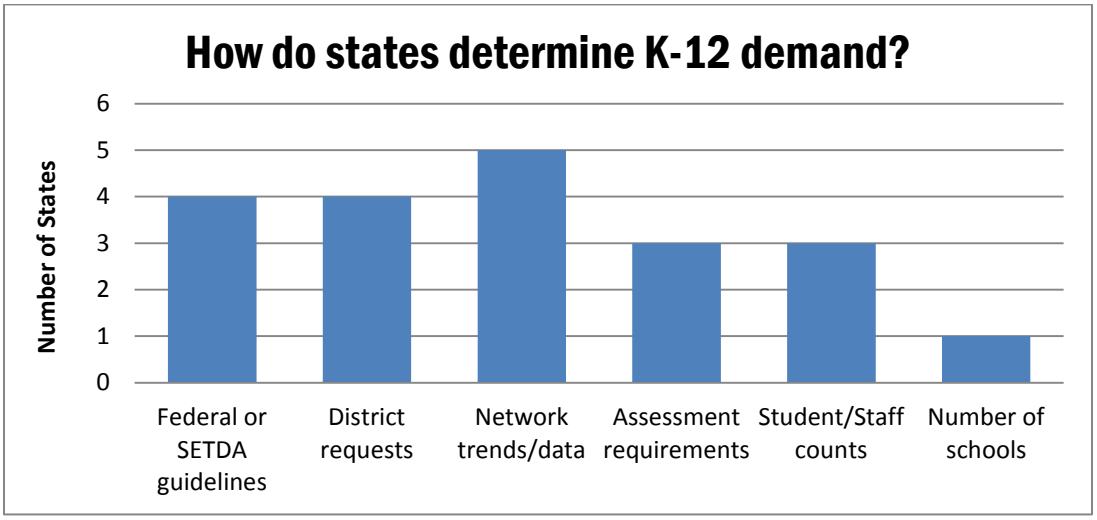


Figure 9: State Methods for Projecting Bandwidth Demand

In its seminal report, *The Broadband Imperative*, the State Educational Technology Director's Association (SETDA) provided a national framework for assessing school bandwidth needs. The SETDA model groups schools according to their use of technology. The report recognizes that schools that use technology for supplemental enrichment, limited one-to-one device initiatives, and whole school transformation, where digital resources are integrated into all aspects of teaching and learning, will have different bandwidth needs.[44] The Quality Digital Learning Stud recommendation to adopt SETDA's model allows flexibility and room for growth.

Table 3: SETDA Model for Bandwidth Demand

	Basic	Emerging	Advanced
All schools	10 kbps per student/staff	50 kbps per student/staff	100 kbps per student/staff

The State may also consider an alternative matrix, developed in California and used by North Carolina, which determine bandwidth need based on the school's use of technology and the grade level of

students being served.[45] This method acknowledges that there may be differences in need or demand between primary and secondary schools.

Table 4: California/North Carolina Model for Bandwidth Demand

	Basic	Emerging	Advanced
Elementary	X kbps per student	X kbps per student	X kbps per student
Middle/Junior high	XX kbps per student	XX kbps per student	XX kbps per student
High School	XXX kbps per student	XXX kbps per student	XXX kbps per student

A third model was offered by Idaho representatives who found students in small, rural schools were more likely to be online simultaneously (and use proportionately more bandwidth per student) than students in larger, more urban schools.

Table 5: Idaho Model for Bandwidth Demand

	Basic	Emerging	Advanced
Urban	X kbps per student	X kbps per student	X kbps per student
Rural	XX kbps per student	XX kbps per student	XX kbps per student

Centralized Network Management

The centralized network management contemplated in this report has two components: 1) management of the build-out (construction and project management) from the state leased backbone to proposed district hub locations and 2) management of a unified statewide K-12 education network.

A single entity would be tasked with providing statewide network management services to include: capacity management, network management (including maintaining equipment standards) configurations, specifications and router protocols, proactive network monitoring and monthly reports, centralized service desk support and staff/personnel, utilization trend monitoring, proactive tracking and coordination of regional trouble tickets, corrective action response and resolution, real-time access to network performance statistics, and annual projections/reviews of network costs for state budgetary purposes. The Arkansas Department of Information Systems and Arkansas Research and Education Optical Network currently provide these services for the state's separate education networks.

Local Staff Support

During Quality Digital Learning Study meetings, the need to support local technology and instructional staff with technology was often discussed. Members acknowledged that many Arkansas school districts have highly skilled and knowledgeable technology staff while others are unable to attract or retain qualified technical support staff either because of location or compensation.

The Arkansas Department of Education's surveys of peer states found a roughly even split among respondents as to whether the state provides this type of local support. Just over half of research and education network and E-Rate Coordinator respondents say their state provides local area network and application support, although most maintain a telephone help-desk. Of those that provide more robust support, available assistance covers: DNS, email, Internet access, content filtering, firewalls, security monitoring and security assessments with 3-10 personnel devoted to the task.

The State may wish to consider whether these services could be provided regionally, through Education Service Cooperatives or via some other, locally-defined means.

Selected State Profiles

The following states were selected for their similarity to Arkansas in terms of total student enrollment and poverty rates, regional proximity, and differing approaches to K-12 statewide networking.

Louisiana

The Louisiana Network Optical Initiative (LONI) began in 2004 with funding now approaching $50 million in investment from the State of Louisiana. It is a public, non-profit network under the authority of the Louisiana Board of Regents designed to enhance education, research and economic development in Louisiana through its four higher education system boards and participating institutions. Louisiana also has pending legislation (Senate Bill No. 622) to "develop and implement a statewide educational technology plan that ensures that every public elementary school and secondary school classroom has the infrastructure and capacity necessary to provide a high quality, digital instructional environment that maximizes the integration of technology into the classroom and enhances and improves student engagement and learning."

Mississippi

The Mississippi Department of Information Technology Services (ITS) is the state agency tasked with providing cost-effective information technology and telecommunication solutions statewide. ITS works to minimize duplication, reduce costs and improve the efficiency of common technology services. Mississippi leases their state government, education, and research networks from a telecommunications provider. ITS procures these statewide network services from a single vendor. In 2011, the Mississippi Optical Network (MissiON), the state's research and education optical network component, was added to provide the State's research institutions additional broadband capacity. The MissiON contract was established as an eight year lease at $2 million per year for a total contract value of $16 million. ITS network services are provided to public universities, community colleges, public libraries, schools, school districts, hospitals, law enforcement and state agencies statewide.

Nebraska

Network Nebraska began its collaborative effort of government, educational institutions, and the private sector in 2006 to ensure that Nebraska has an efficient, affordable, reliable and scalable telecommunications infrastructure, widespread communications networks, and sufficient network support functions. The network provides shared telecommunications backbone resources, network services, and applications under the authority of the State of Nebraska Office of the CIO, and assisted by the University of Nebraska. Network Nebraska uses a "hybrid" public/private partnership model that takes advantage of the relative strengths of its stakeholders. Nebraska centralizes network design, management and administrative functions, and the State contracts with private communications providers for Wide Area Network, backbone circuits, and Internet access. The Office of the CIO also applies for E-Rate as a statewide consortium applicant for the statewide backbone and statewide Internet. District support services, including a clearinghouse for distance education courses (http://nvis.esucc.org/), and E-Rate filing assistance for WAN circuits and telephone, are offered by educational service units and distance education consortia.

North Carolina

MCNC is a private, non-profit network that builds, owns and operates leading-edge middle-mile broadband infrastructure for North Carolina's research, education (higher education and K-12) and healthcare institutions. MCNC won a competitively bid contract that to serve North Carolina Research and Education Network (NCREN) users and received a $28 million Broadband Technology Opportunities Program (BTOP) grant in 2010 to add community colleges, independent colleges and universities, rural health facilities and charter schools to its network. MCNC collaborates with the State Information

Technology Services department to procure last mile transport services for districts and provides data center services like hosting, interactive video conferencing and engineering services.

Oklahoma

OneNet was created with $14 million from a $350 million statewide bond measure approved by voters in 1992. It is dedicated to leveling the playing field for Oklahoma's rural communities by increasing broadband access across the state. It provides high-speed Internet options for rural communities to ensure rural citizens have the same opportunities as those in metropolitan areas. OneNet serves Oklahoma colleges and universities; K-12 and career technology schools; public libraries; local, tribal, state and federal governments; court systems; rural health care delivery systems; nonprofit organizations; and programs engaged in research with an equitable rate structure. On July 31, 2013, the Oklahoma Community Anchor Network (OCAN) became fully operational. OCAN is an optical ring of 1,005 miles of fiber. The network's 10 gigabit connection will serve 35 Oklahoma counties and connect 33 community anchor institutions.

Utah

In 1989, The Utah Legislature formally established the public Utah Education Network (UEN) as a statewide education network consortium to coordinate the technology initiatives of public and higher education and provide cost-effective Internet access for all public schools and school systems in Utah. UEN currently serves over 1,100 public schools, colleges, Head Start programs, and libraries. UEN provides a robust, reliable fiber-optic backbone network connecting every public school, college, university and Applied Technology campus in the state. The Network provides Internet access, storage and filtering, applications and content, professional development and technical support. In February 2010, UEN received a $13.5 million Broadband Technology Opportunities Program (BTOP) grant and now has upgraded 144 community anchor sites including Gigabit (Gb) Ethernet fiber-optic connections to 74 Elementary Schools, 100 Mb broadband to 20 charter schools and 18 public libraries, and broadband Ethernet to 20 Head Start programs, research network infrastructure to 8 higher education campuses and 4 governmental facilities/agencies.

Appendix G: Telecommunications Industry Position Statement

December 19, 2013

The Arkansas wireline telecommunications provider community participated in the Quality Digital Learning Study Committee and each of its 6 meetings. We are disappointed with the recommendation. Private providers abstained from voting on this issue at a QDLS meeting on Dec. 3, 2013. During the meeting, our industry provided the following three reasons we did not, and cannot, support the recommendation in its current form:

The committee has moved forward with this recommendation without doing a thorough analysis of the issue. Since the first meeting of the committee, industry representatives have asked for information identifying Arkansas school districts with no broadband access. The report we were provided identified seven schools without broadband access. Through our exhaustive research, we found only one school in Arkansas on the list of the seven provided that does not have adequate access to broadband today. Without accurate information regarding broadband needs, it is premature to make specific recommendations. The Arkansas broadband provider community recognizes there are schools in Arkansas in need of assistance, likely more than one, and we stand willing to address these needs. The recommendation offered here, however, is based on incomplete and incorrect data.

The telecommunications industry also expresses concerns that no cost or funding mechanism has been associated with the recommendation.

Finally, we are concerned with the recommendation's conflict with state law. Although the technical subcommittee did acknowledge that this recommendation is inconsistent with state law, the issue is not addressed here.

The private wireline telecommunications community continues to request an accurate assessment of the state's broadband infrastructure. We are concerned that the recommendation would create a redundant network - at taxpayer's expense - in an effort to address a problem that has yet to be fully defined.

Appendix H: Arkansas Public School Computer Network Costs and Appropriations 1992-2013

Vendor Costs Only

Fiscal Year	Cost
1992-93[1]	$20,000,000.00
1993-94[1]	$5,500,000.00
1994-95[1]	$10,500,000.00
1996-97[1]	$6,000,000.00
1998-99[1]	$6,500,000.00
1999-2000	$3,040,188.68
2000-01	$3,245,259.78
2001-02	$5,666,557.13
2002-03	$6,288,739.80
2003-04	$8,376,032.04
2004-05	$7,056,069.48
2005-06	$8,564,016.00
2006-07	$10,056,756.00
2007-08	$9,620,100.00
2008-09	$9,407,388.00
2009-10	$8,826,372.00
2010-11	$10,082,658.00
2011-12	$10,450,920.00
2012-13[2]	$10,404,969.35
TOTAL	**$159,586,026.26**

[1] The Arkansas Department of Information Systems (DIS) is still researching and restoring data files from the state accounting system, AFGM, which was used prior to AASIS. DIS was able to identify a $20 million loan and contract authorization for APSCN in Act 1034 of 1991 and Act 4 of 1992. For 1993-94 there was an appropriation for $5.5 million. In 1994-95 there was an appropriation for $6 million and one in 1998-99 for $6.5 million. These figures do not reflect actual expenditures, only appropriation.

[2] Pending final E-Rate funding approval

Appendix I: Understanding the Federal E-Rate Program[41]

E-Rate Basics

The Schools and Libraries Program, commonly known as "E-Rate", is administered by the Schools and Libraries Division (SLD) of the Universal Service Administrative Company (USAC) on behalf of the FCC. The program helps public and private K-12 schools, school districts, educational cooperatives, and libraries obtain affordable telecommunications and Internet access services. Each year E-Rate provides approximately $2.9 billion in funding across four service categories: telecommunications services, Internet access, internal connections, and internal connections basic maintenance. E-Rate discount percentages are based upon the federal school location designation (urban or rural) and criteria related to the National School Lunch Program. Service discounts range from 20 percent to 90 percent.

Applying for E-Rate Funds

Applications for E-Rate funding are submitted on an annual basis. All eligible entities are encouraged to apply for E-Rate discounts for eligible services and equipment. Unlike grant funding, whereby funds are commonly received in advance of expenditures being incurred, the E-Rate program is a reimbursement program comprised of two major processes. Schools may apply for funds based upon projected expenditures but they are reimbursed based upon actual expenditures.

Working Together to Make E-Rate a Success in Arkansas

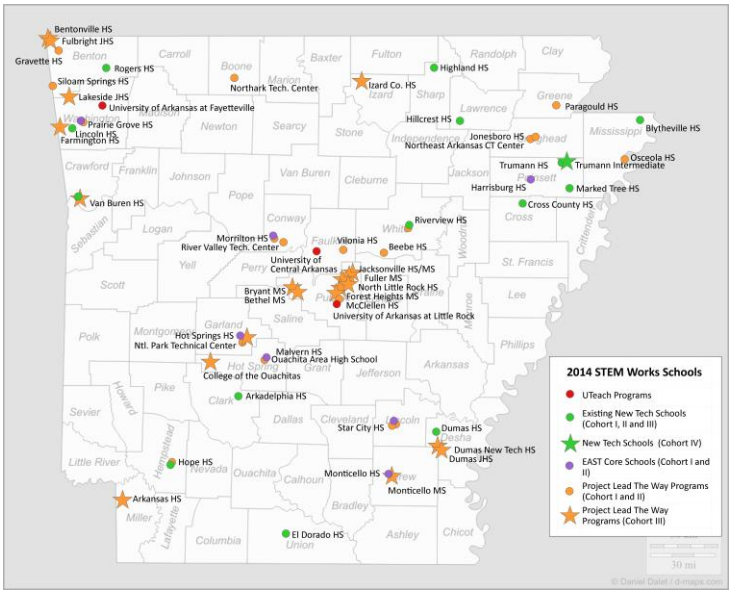
Several entities collaborate to help schools, libraries, and educational cooperatives successfully obtain E-Rate funds for technology services: Arkansas Department of Education (ADE), Arkansas State Library (ASL), Department of Information Systems (DIS), and Educational Service Cooperatives (COOP) technology coordinators. Each plays a significant role in assisting Arkansas applicants with the E-Rate process. The assistance provided includes training, application filing assistance and deadline notification. Each of these organizations has diligently worked to increase the amount of E-Rate funding received by Arkansas entities. E-Rate program communications were enhanced through the development and distribution of ADE and ASL informational newsletters, brochures and emails. In addition, ADE increased hands-on-training and focused special attention on schools with little or no E-Rate experience.

The State of Arkansas Achieves 100 Percent E-Rate Program Participation by Public Schools

Through the collaborative efforts of the Arkansas Legislature, ADE, DIS, and the Educational Service Cooperatives technology coordinators, Arkansas has achieved 100 percent public K-12 school participation for five (5) consecutive years, 2007/2008 through 2012/2013. At the end of the application filing period it appeared the state had 100 percent participation for funding year 2011/2012. After all the deadlines and extensions, there were two districts that did not complete the full application process: Ashdown School District did not certify the application before the deadline and Hazen School District did not submit the Item 21 Attachment.

The participation level in recent E-Rate training events and the number of Form 470's submitted to-date indicate that Arkansas will again achieve 100 percent participation for program year 2013-2014. (The 100 percent figure does not include Charter schools.) Full participation in the E-Rate program by Arkansas K-12 public schools is due in part to improvements in training materials and presentations; and the provision of additional E-Rate labs and one-on-one filing assistance to school districts. Throughout the final days of the filing window, enhanced communications (to school districts that have either no application on file or an incomplete application) helps ensure full participation. Educational Service Cooperative technology coordinators and neighboring school district personnel contact districts in their areas and provide program and deadline information. District superintendents are also informed regarding schools that have not submitted a complete application.

Appendix J: Arkansas STEM Works



Arkansas is fortunate to have both a clear vision for 21st century digital learning and strong leadership for K-12 public education. In 2011 Governor Mike Beebe and his Workforce Cabinet announced a voluntary pilot program - STEM Works - focused on Science, Technology, Engineering, and Math (STEM) education in Arkansas public high schools and universities. The effort recognized that future educational and workforce demands will be driven by the 21st century digital economy which requires higher level skills for workers.

> *"The STEM fields offer stable, well-paying careers for the 21st century, and the demand continues to grow at a rapid pace. These are positions that companies are struggling to fill, even in tough economic times. If we are to continue to attract these types of companies to Arkansas, we must prepare our young people with high-tech skills and build a workforce that will help our state prosper."*
>
> **– Governor Mike Beebe**

By design, STEM Works provided seed money for proven, scalable, affordable, and research-based STEM initiatives and began with the modest goal of 10 secondary schools in 2011, 16 schools in 2012, 32 in 2013 and two universities by 2012. Since then, Arkansas STEM Works has grown to include 57 secondary schools and three UTeach programs at the University of Arkansas, Fayetteville, University of Arkansas at Little Rock and University of Central Arkansas. The interest in and adoption of the STEM Works initiative has surpassed all expectations.

Today, state, federal and philanthropic contributions for STEM Works exceed $12 million, excluding in-kind contributions of staff, space, and equipment from districts and universities. Arkansas public school districts are embracing STEM education and digital learning as a way to level the playing field for youth in rural and remote areas and prepare students to participate in the 21st century global economy.

More information about STEM Works is available on line at:
http://www.arkansased.org/divisions/policy/stem-works.

Appendix K: Multi-state Technology Director/K-12 Network Survey

The following questions are in multiple choice, yes/no, or short answer format to minimize the time required to respond. The questionnaire is being provided electronically, but if you prefer to have a hard copy to review and complete please respond to nikki.moore@arkansas.gov with that request and a hard copy will be emailed to you.

General Information

1. Name of State
2. Contact
    a. Name
    b. Title
    c. Phone
    d. Email
    e. Preferred contact method

Network Policy & Approach

3. Does your state have a Research and Education Network and does K12 utilize it? Yes/No
4. Are school districts required to purchase transport and/or Internet access from your state's network? Yes/No
5. Which general description best describes your K12 network design?
    a. Standalone private network for K12
    b. Integrated private network for K12 and state government
    c. Integrated private network for K12, state government and higher education
    d. Integrated private network for K12, state government, higher education and other
    e. Single commercial network provider with VPN for K12
    f. Regional commercial network providers with VPN for K12
6. Are school/district rates publicly available? Yes/No
7. Are school/district rates leveled or equalized in some way? Yes/No
8. Does your state outsource state network management? Yes/No
9. Does your state outsource E-Rate support for schools, districts and/or regional education service districts/cooperatives? Yes/No
10. How do you determine/forecast K12 district connectivity requirements?
    g. Based on Federal guidelines
    h. Based on what is requested by the district
    i. Based on network trends and capacity management
    j. Based on student count
    k. Based on number of schools
    l. Other _____

Network Cost and Usage

11. If known, what percent of total school district bandwidth comes from the state network?
12. What are the current per Mb costs for Internet access for school districts?
13. What are the current per Mb cost for transport to school districts?
14. What is your state's total E-Rate reimbursement (in whole dollars)?
15. What percent of the state network is eligible for E-Rate reimbursement?
16. How many vendors or providers are currently supporting the state network?

Appendix L: Multi-state Research and Education Network (REN) Survey

The Arkansas Department of Education, as part of a statewide legislative effort, is requesting information on state research and education networks (RENs) policy, users and costs and needs your help. This email survey should take around 15 and no more than 30 minutes to read and respond to. So sorry for the inconvenience, but thank you in advance for making this possible.

The survey is available online at: https://www.surveymonkey.com/s/quiltmember. If you prefer working from a hard copy, please complete the attached survey and 'scan it back' to nikki.moore@arkansas.gov.

State: _____
Contact person: _____
Title: _____
Email: _____

Network Policy & Approach

1. Does your state have a Research and Education Network (REN) or REN interconnection points (GPN or FRGPs)?
2. Does K12 utilize or interconnect with the REN?
3. What other entities are authorized users of the REN?
4. Are school districts required to purchase transport and Internet from the REN?
5. Describe the business model of the REN

Network Cost and Usage

6. Describe how costs are recovered by the REN, such as an annual membership fee plus cost per Mbps? Other?
7. What are the K12 membership fees and rates per Mbps
8. Are the K12 rates publicly available?
9. Are K12 rates level, postalized or equalized?
10. If not, what is the range of the rates?
11. If known, what percent of total school district bandwidth is purchased from the state's REN?
12. Does the state outsource the network management of the REN?
13. Does the REN apply for E-Rate reimbursement for K12 services?
14. What percent of the REN is eligible for E-Rate reimbursement?
15. Name the vendors/providers currently supporting the REN

Appendix M: Multi-state E-Rate Coordinator Survey

The Arkansas Department of Education, as part of a statewide legislative effort, is requesting information on state E-Rate and district support services provided by other states and needs your help. This email survey should take around 15 and no more than 30 minutes to read and respond to. So sorry for the inconvenience, but thank you in advance for making this possible.

The survey is available online at: https://www.surveymonkey.com/s/eratecoordinator.

If you prefer working from a hard copy, please complete the attached survey and 'scan it back' to nikki.moore@arkansas.gov.

State: _____
Contact person: _____
Title: _____
Email: _____

General Questions

1) What percentage of funding of the K12 network annually comes from the sources below:
   a. State funds _____
   b. Local funds_____
   c. E-Rate funds_____
   d. State grant(s) _____
   e. Federal grant(s) _____
   f. Other _____
2) Does the state DOE have a dedicated annual K12 network budget? Yes/No
3) What is the total annual state budget for connectivity, staff, video conferencing, online courses (including transport, Internet, filtering and firewalls, etc.) for the K12 network? _____
4) Circle all services that the state DOE funds on an annual basis.
   a. Network backbone (core network)
   b. District connections (middle mile, backbone to district hub)
   c. Internet access
   d. School connections (WAN, connecting school sites within a district)
   e. WAN equipment
   f. LAN equipment
   g. Routers
   h. Fiber build out/construction
   i. Education Service Centers/Cooperatives
   j. State Department of Education/Agency

Management Services for Network Implementation (upgrade/new build out)

5) Describe the scenario that lead to the state implementing the most recent K12 network upgrade.
   _____
6) What year was the most recent K12 network upgrade? _____
7) Was the upgrade managed by the state, outsourced or both? _____
8) If both, please describe. _____
9) Name the provider(s) if outsourced. _____
10) List the major management tasks associated with the implementation._____

11) Describe the network upgrade elements and/or new build out. _____
12) Estimate the number of K12 sites involved in the implementation. _____
13) Estimate the annual cost of the implementation. _____

Ongoing Network Management Services

14) Does the state provide technical assistance/WAN support to districts? Yes/No
15) Does the state provide network management services for K12 that are over and above those provided by the vendor(s)? Yes/No
16) If yes, please describe. _____
17) If yes, name the provider(s)._____
18) List the services that are provided in-house related to network management? _____
19) Estimate the total annual cost of network management resources?_____

District Support Services

20) Do you provide technical assistance/LAN support to your districts? Yes/No
21) Which of the services listed below to you provide to your districts? (circle all that apply)
    a. DNS
    b. E-mail
    c. Internet Access
    d. Content Filtering
    e. Firewall
    f. Security Monitoring
    g. Security Assessment
    h. Other _____
22) How many people (staff or contractors) are dedicated to district support? _____
23) Do you maintain a help desk dedicated to technical support? Yes/No
24) Do you maintain a listserv dedicated to technical support? Yes/No
25) Do you offer technical training sessions to district technology staff? Yes/No
26) How many training sessions do you offer per year? _____
27) Do you sponsor technology conferences to introduce new technologies to the school districts? Yes/No
28) How are costs determined for district support services?_____
29) What is the estimated total cost? _____

E-Rate Coordination Services

30) Does your state provide statewide E-Rate coordination? Yes/No
31) Is the coordination provided through the State Department of Education (SDOE) or through another state entity? _____
32) Is E-Rate coordination outsourced to a company/consultant? Yes/No
33) If yes, name the company/consultant._____
34) What software application doe the state use for document retention? _____
35) What system is in place for documentation in the event of disaster recovery? _____
36) Does your state host a list serve specifically dedicated to E-Rate? Yes/No
37) Does your state provide outreach and training for your E-Rate applicants? Yes/No
38) How are training sessions delivered? (circle all that apply)
    a. Face-to-face
    b. Webinars
    c. Combination
    d. Other _____

39) How many training sessions does your state provide each year? _____
40) Does your state provide help-desk services specifically for E-Rate applicants and service providers? Yes/No
41) Does your state file 470s and establish state master contracts? Yes/No
42) Does your state file a 471 for consortium/statewide services? Yes/No
43) Does your state file 471s for district applications? Yes/No
44) If yes, does the state or district pay for this service? Yes/No
45) Is your state a member of SECA? Yes/No
46) Is your state a member of the state consortia group? Yes/No
47) Please estimate the cost of annual E-Rate state coordination. _____
48) What software or system does your state use for document retention? _____
49) What software or system does your state use for document disaster recovery? _____

Appendix N: Key Terms and Acronyms

Acronyms

ADE – Arkansas Department of Education
APSCN – Arkansas Public School Computer Network
AREON – Arkansas Research and Education Optical Network
AWIN – Arkansas Wireless Information Network
CIV – Compressed Interactive Video
COS – Class of Service
DIS – Department of Information Systems
DSL – Digital Subscriber Line
ESL - Eligible Services List
ETP - Eligible Telecommunications Provider
FASTER Arkansas – Faster Access for Students, Teachers and Economic Results
FCC – Federal Communications Commission
Gbps – Gigabits per second
IPv4 – Internet Protocol Version 4
IPv6 – Internet Protocol Version 6
kbps – Kilobits per second
LAN – Local Area Network
LCP – Lowest Corresponding Price
MAN – Metropolitan Area Network
Mbps – Megabits per second
MPLS – Multi-Protocol Label Switching
OSP – Office of Procurement
POP – Point of Presence
P2P – Point to Point
QDLS – Quality Digital Learning Study
QOS – Quality of Service
RFP – Request for Proposal
SETDA – State Education Technology Directors Association
SLD – Schools and Libraries Division
USAC – Universal Service Administrative Company
USF – Universal Service Fund
VLAN – Virtual Local Area Network
VOIP – Voice Over Internet Protocol
VPN – Virtual Private Network
WAN – Wide Area Network

Terms

APSCN – Arkansas Public School Computer Network (APSCN) is managed by the Arkansas Department of Information Systems and links all Arkansas public schools with the Arkansas Department of Education (ADE) as required by Act 4 of 1992. APSCN ensures public schools can file electronic reports that provide state and local decision makers accurate, timely and comprehensive information.

AREON – The Arkansas Research and Education Optical Network (AREON) is a not-for-profit consortium that includes all public degree-granting institutions in Arkansas and other selected higher education organizations. AREON provides a high-speed fiber-optic backbone network throughout the state with 1Gb and 10Gb Ethernet connections to its members, affiliates, national research and education networks, regional optical networks, and commercial service providers.

AWIN - The Arkansas Wireless Information Network serves the State of Arkansas and her people by providing a reliable, statewide means of communication for the state's first responders. The AWIN System consists of over 100 tower sites scattered throughout the state.

CIV - The Compressed Interactive Video network is managed by the Arkansas Department of Education Distance Learning Center (ADE DLC) and allows teachers and students to see and speak to each other in real time.

Co-location or Peering Point (Demarc) – The co-location or peering point is the point at which the provider telecommunications transport and/or equipment ends and a customer's on-premises wiring can be used to connect the provider service to the customer facilities. It is typically considered the point where the provider's responsibility ends.

Digital Learning – Digital learning is any instructional practice that effectively uses technology to strengthen the student learning experience. Digital learning encompasses a wide spectrum of tools and practices, including online and formative assessments, increased focus and quality of teaching resources, online content and courses, applications of technology in classrooms and school buildings, adaptive software for students with special needs, etc.

Distance Learning – Education that takes place via electronic media linking instructors and students who are not together in a classroom. Students can work on their own in any off-campus location and communicate with faculty and other students via e-mail, electronic forums, videoconferencing, chat rooms, bulletin boards, instant messaging or other form of computer-based communication.

District Hub – A physical building that houses plant equipment including: routers, regeneration amplification, and other important networking hardware for group of school buildings. Districts hubs service one or more school buildings.

Education Service Cooperatives (Co-ops) – Offer regional administrative support and training for Arkansas public school districts as well as direct services to students including speech therapy, video instruction and gifted and talented programming. There are 15 educational co-ops in Arkansas.

LAN– A Local Area Network (LAN) is connects network devices over a relatively short distance. A networked office building, school, or home usually contains a single LAN, though sometimes one building will contain a few small LANs (perhaps one per room), and occasionally a LAN will span a group of nearby buildings. In addition to operating in a limited space, LANs are also typically owned, controlled, and managed by a single person or organization. They also tend to use certain connectivity technologies, primarily Ethernet and Token Ring.

MAN– A Metropolitan Area Network (MAN) is a network spanning a physical area larger than a LAN but smaller than a WAN, such as a city. A MAN is typically owned and operated by a single entity such as a school district, government body or large corporation.

Network Access Points (aka Carrier Hotel) – Places where large network providers meet to exchange network traffic. Typically, an ISP or network provider will access Tier 1 global providers and their networks via hubs, though they also serve as meet points for like networks.

Net Neutrality - "Net neutrality" refers to the concept of keeping the Internet open to all lawful content, information, applications and equipment; the principle that basic Internet protocols should be non-discriminatory, with content providers receiving equal treatment from Internet service providers.

Point of Presence (PoP) – An Internet point of presence is an access point to a carrier's network or the Tier 1 Internet. It is a physical location that houses servers, routers and other technical equipment. It may be housed in either part of the facilities of a telecommunications provider that the ISP rents or a location separate from the telecommunications provider. ISPs typically have multiple POPs, sometimes numbering in the thousands. POPs are also located at NAPs, IXPs and collocation centers.

The Quilt – The Quilt is the national coalition of advanced regional networks for research and education, representing 31 networks across the country. Participants in The Quilt provide advanced network services and applications to over 200 universities and thousands of other educational institutions. With the goal of promoting consistent, reliable, interoperable and efficient advanced networking services that extend to the broadest possible community; and to represent common interests in the development and delivery of advanced network services, The Quilt:

- Facilitates collaboration among regional networks
- Advocates on behalf of regional networks, and
- Helps regional networks leverage their collective experience and buying power.

Throttling - The intentional slowing of Internet service by an Internet service provider. It can be used to regulate network traffic and minimize bandwidth congestion. Bandwidth throttling can occur at different locations on the network. On a local area network (LAN), an administrator may employ bandwidth throttling to limit network congestion and server crashes. On a broader level, Internet service providers may use bandwidth throttling to reduce the bandwidth used by or supplied to the local network or to actively limit the speed of upload/download activities like video streaming. Bandwidth throttling is also often used in Internet applications, to spread a load over a wider network. It is also used to gain additional revenue by encouraging users to access more expensive content where bandwidth is not throttled.

SETDA – The State Education Technology Director's Association (SETDA) was formed in 2001 as a non-profit organization representing U.S. state and territorial educational technology leaders. SETDA increases the capacity of state and national leaders to improve education through technology policy and practice recommendations.

WAN – A Wide Area Network (WAN), as the term implies, spans a large physical distance. It is a geographically- dispersed collection of LANs. Routers connect LANs to a WAN. A WAN differs from a LAN in several important ways. Most WANs (like the Internet) are not owned by any one organization but rather exist under collective or distributed ownership and management. WANs tend to use technology like ATM, Frame Relay and X.25 for connectivity over the longer distances.

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