The Broadband Imperative II: Equitable Access for Learning

SETDA

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September 2016

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CREDITS & ACKNOWLEDGMENTS

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EXECUTIVE SUMMARY

The bar has moved. Access to high-speed broadband in K-12 education is no longer an afterthought; instead it is fundamental for implementing the student-centered learning models critical in preparing all students for college and careers in the digital age. Schools and districts are moving towards student-centered, personalized learning approaches to increase student success — utilizing digital applications to support these deeper learning experiences. High-speed broadband access enables schools to expand learning options, allowing students to create content, participate in virtual courses that may not be available on their campuses, and to collaborate with experts or other students remotely. Bandwidth capacity is required to support these digital age learning opportunities, and determines which digital instructional materials and educational applications students and educators can effectively leverage in the classroom.

Recommendations

In May 2012, SETDA's groundbreaking report, *The Broadband Imperative: Recommendations to Address K-12 Education Infrastructure Needs* pushed educators and policy makers around the country to increase high-speed broadband access in schools—with specific recommendations regarding access, funding, and policies to support teaching and learning. In April 2016, SETDA and Common Sense Kids Action released the *State K-12 Broadband Leadership: Driving Connectivity and Access* report highlighting the powerful impact of state leadership in driving critical policy decisions at the national and state level to support broadband networks, bandwidth capacity and home access for low-income families. In this companion report, *The Broadband Imperative II: Equitable Access for Learning* SETDA continues to advocate for increasing robust access both in and out of school to best prepare all students for college and careers. SETDA provides the following updated recommendations for policy makers and school leaders:

1. Increase Infrastructure to Support Student-Centered Learning
2. Design Infrastructure to Meet Capacity Targets
3. Ensure Equity of Access for All Students Outside of School
4. Leverage State Resources to Increase Broadband Access

Quick Facts

- **Cisco** predicts that global internet traffic will be over 50,000 Gbps by 2019, more than triple the current traffic rate.[1]
- **ENA**, based on its experience delivering connectivity to over 5,500 schools and libraries, continues to observe and projects into the future an internet growth rate of 65% per year.[2]
- **EducationSuperHighway** predicts that the typical school district will need to triple its bandwidth in the next three years.[3]
- **CoSN's Infrastructure Survey** states that 39% of districts report projected growth in the next 18 months between 50% and 499%.[4]

1 Increase Infrastructure to Support Student-Centered Learning

The following recommendations are goals for education leaders, policy makers, and network staff to support effective, seamless digital learning experiences. These recommendations are based on research and consultation with experts in the field. In addition to setting broadband targets for external connection to the internet service provider (ISP) and the wide area network (WAN), SETDA encourages districts and schools to be proactive in network capacity management—anticipating growth and setting benchmarks for initiation of bandwidth upgrades. SETDA discourages schools and districts from developing broadband expansion plans simply based on current usage. Usage data may be skewed to limited digital learning experiences for students or teachers and/or minimal usage of advanced tools and resources for school administration. In addition, if educators and IT specialists wait for users to maximize usage, typically expansion takes time, causing a bottleneck on the network, interrupting the teaching and learning experiences, and frustrating the users. SETDA also recommends that as a best practice, districts arrange with their providers to install underlying circuits that can support at least 25% more capacity than their purchased internet capacity levels so that they can seamlessly upgrade based on increased demands.

Internet Service Provider Recommendation

Updated in 2016, SETDA provides broadband capacity recommendations for connection to the internet service provider (ISP) based on the size of the district (number of students). This method allows education stakeholders to better understand some of the nuances between very small districts (under 1,000 students) compared to large districts (over 10,000 students). The ISP recommendations are based on research; analysis of data sets from districts across eight states regarding both capacity and usage; and consultation with experts in the field.

*Methodology Appendix A

INTERNET SERVICE PROVIDER RECOMMENDATIONS

School Year	2017-18 Targets	2020-21 Targets
Small School District (fewer than 1,000 students)	At least 1.5 Mbps per user (Minimum 100 Mbps for district)	At least 4.3 Mbps per user (Minimum 300 Mbps for district)
Medium School District Size (3,000 students)	At least 1.0 Gbps per 1,000 users^	At least 3.0 Gbps per 1,000 users
Large School District (more than 10,000 students)	At least 0.7 Gbps per 1,000 users	At least 2.0 Gbps per 1,000 users

^Published by SETDA 2012; Adopted by the FCC in 2014 https://www.fcc.gov/general/summary-e-rate-modernization-order
*User: students, teachers, administrators, staff, and guests
Methodology Appendix A

Wide Area Network (WAN) Recommendation

SETDA recommends that for the 2017-18 and 2020-21 school years, districts should have at least 10 Gbps per 1,000 users for wide area network (WAN) access. Based on recent trends, research and consultation with experts in the field, SETDA expects that WAN requirements will come closer in line to ISP connections as districts utilize cloud-based services, as well as the advent of virtualization—shifting the capacity requirements from the WAN to the ISP connection. Therefore, the WAN recommendations for 2017-18 remain the same for 2020-21.

WAN RECOMMENDATIONS		
School Year	**2017-18 Targets**	**2020-21 Targets**
Connections to each school to link to the internet via a district aggregation point and for in-house administrative functions	At least 10 Gbps per 1,000 users	At least 10 Gbps per 1,000 users
*User: students, teachers, administrators, staff, and guests		

2 Design Infrastructure to Meet Capacity Targets

State leaders should support districts in designing infrastructure to meet the recommended broadband capacity targets and the needs of digital learning environments. The focus of design should be on student learning, and not simply on the administrative functions that networks have traditionally provided for schools and districts. As districts and schools move to seamless digital learning environments, the importance of designing high-capacity and widely available networks, including the utilization of wireless networks is essential. Statewide broadband networks can provide significant benefits to districts, including cost savings and increased bandwidth. Statewide purchasing consortia, regional education networks, and district consortia are other options for providing effective and efficient broadband access to schools. However, not all districts have access to a statewide network or consortia options and instead purchase network services through a commercial or nonprofit provider. Alternatively, some districts may choose to build their own networks to maintain local control, especially if they can obtain affordable pricing options.

3 Ensure Equity of Access for All Students Outside of School

Digital equity is a topic of concern as inequities related to broadband access persist when some students, particularly low-income and rural students, do not have the same level of broadband and device access as other students outside of school. Gone is an era when students are automatically given textbooks to support their learning. Equity of access includes ensuring access to devices and sufficient high-speed broadband in school, at home, and everywhere else in the community to utilize digital instructional materials, complete homework assignments, and to connect with students, educators, and experts throughout the world anytime/anywhere. More states are enacting policies requiring digital instructional materials, as legislators are now recognizing the benefits of digital resources. These policy shifts have direct implications on issues related to device and internet access. As content shifts to digital, and typically some of that content is exclusively available online, students must have access to broadband and devices outside of school, particularly at home, to be successful. SETDA recommends states, districts and schools:

- Deliver outreach to families, particularly low income families, about the necessity for out-of-school access
- Leverage community partnerships for access
- Share out-of-school access options

4 Leverage State Resources to Increase Broadband Access

SETDA recommends that states leverage resources to increase broadband access in all schools. In the 2016 report, *State K-12 Broadband Leadership*, SETDA and Common Sense Kids Action focus on the role of state leadership in supporting districts and schools to increase high-speed connectivity and access for students and educators. Through a state broadband survey and independent data collection, SETDA gathered information for all 50 states, the District of Columbia, Guam, and the Commonwealth of Northern Mariana Islands (CNMI) regarding state policies and practices regarding broadband implementation. In this report, SETDA provides specific recommendations regarding state funding and policies to support broadband. Currently, one-third of states do not have any direct state funding for broadband. SETDA recommends that these states provide state funding for broadband to leverage grants and the expansion of the E-rate program. SETDA also recommends that states leverage policies, networks, and purchasing options to support increased broadband access in schools.

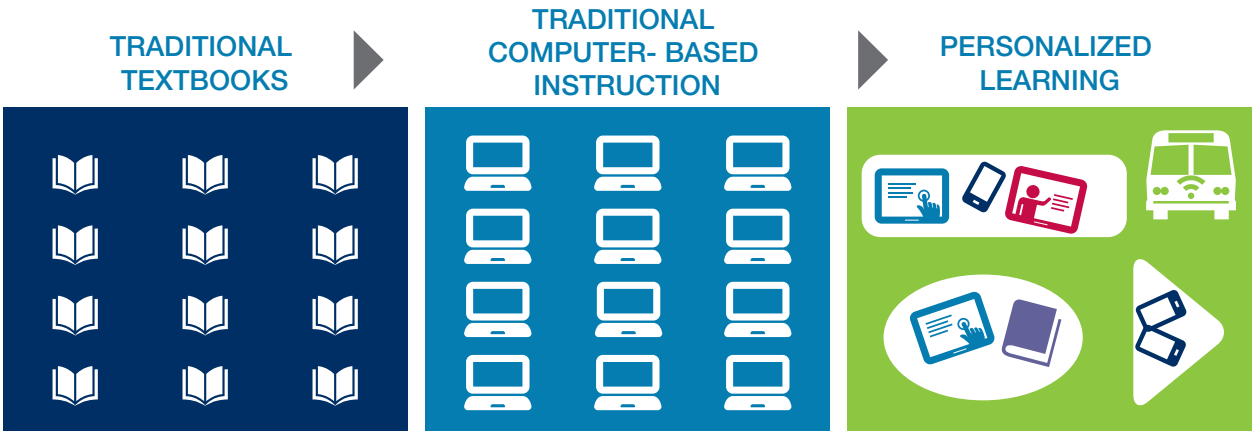
- Provide direct state funding for broadband services, including funding for the E-rate match
- Enact state policies to support deployment and adoption
- Create and/or expand state broadband networks for economies of scale
- Utilize innovative purchasing options for buying power

SHIFT IN LEARNING MODELS

Robust broadband is essential for equitable access in schools for all students, as bandwidth capacity determines which digital instructional materials and educational applications students and educators can effectively leverage in the classroom. With dependable, efficient access, students can participate in virtual and augmented activities, which engage students and promote self-discovery.[5] Students can also create content, interact with experts, collaborate with peers, learn to code and participate in simulation activities. Business demands for highly skilled technicians also impact digital instructional opportunities. In addition to academic needs, district and school leaders must consider the bandwidth requirements for administrative applications, such as student information systems, learning management systems, assessment tools, transportation resources, data collection,and human resource tools that require broadband access and in many cases via the cloud. Finally, students in low-income or rural areas must have the same digital learning opportunities as other students to be best prepared for college and careers.

The William and Flora Hewlett Foundation asserts that with deeper learning, "they [students] acquire and retain more academic knowledge when they are engaged, believe their studies are important, and are able to apply what they are learning in complex and meaningful ways."[6] Internet access supports personalized learning opportunities that lead to higher achievement and graduation rates. Business demands for highly skilled technicians also impact digital instructional opportunities as seen in the following exemplar.

Shift In Learning Models



Shift in Learning Models Exemplars

Utah – Business Demand for Skilled Employees Inspires Robotics STEM Academy

Bridgerland Applied Technology Center, in Cache County, Utah is an example of a Utah Education and Telehealth Network (UETN) connected institution that serves multiple districts and high schools in northern Utah. The recently established Robotics STEM Academy leverages UETN gigabit broadband connection, to access UETN's collaborative distance education technology, and provides face-to-face instruction. Students learn about drone technology, build their own small robots, and program the large industrial robots via eight different locations that connect through the Bridgerland Applied Technology Center. The industry demand for robotics technicians locally is high. Local businesses approached the district to establish a robotics class because they needed employees that could repair and program the robots on a day-to-day basis. Last year, the school met with industry leaders

and directors from all of the surrounding school districts to develop a robotics program and create degree opportunities for students. http://www.batc.edu/stem

Indiana – Wayne Township Leverages Infrastructure for Personalized Learning

Indiana's Metropolitan School District of Wayne Township (Wayne) is leveraging its infrastructure to ensure that all of its students have access to personalized learning opportunities that meet their specific educational needs. With a free and reduced lunch rate of 78%, the district prioritized engaging and effective digital content, boosting Wayne's infrastructure to deliver two Gbps of internet access through two points of access, with the ability to double that as needed. Providing every student with seamless and reliable access to accelerated learning opportunities—such as 1-to-1, asynchronous and synchronous online coursework—has enabled Wayne's students to cultivate their own learning pathways. In 2006, Wayne's graduation rate was 65%. Today, it has climbed to more than 94%. http://www.wayne.k12.in.us/itservices/.

Cornerstone Academy Uses Online Curriculum to Differentiate Instruction for ESL Students

Cornerstone Academy Preparatory School is a public charter elementary school in San Jose, California. The school was founded in August 2010 and has 453 students in kindergarten through sixth grade. Many of the school's students speak a language other than English at home and over three-fourths qualify for free or reduced lunch programs. Realizing the importance to its population of technology access, the school adopted a technology plan in 2014. Cornerstone partnered with the Franklin-McKinley School District to provide a 200 Mbps connection to the building, and installed industrial-grade wireless access points in all classrooms. Pursuant to the plan, during the 2014-2015 school year, Cornerstone hired a blended learning director and implemented a 1-to-1 rotational-blended learning model that allows teachers to provide differentiated, small group instruction to all scholars. During the school's morning Reading Power Hour, all students use Chromebooks to access the online English Language Arts curriculum to read and respond to texts, practice new vocabulary, and write collaboratively. Throughout the day in all subjects, teachers use Google Classroom, Google Apps for Education, online adaptive learning programs, and other technology resources to improve learning and to differentiate instruction. For professional development and coaching, teachers and coaches share videos.

> ***Broadband is like air—you can't see it, but you know when it's missing.***
>
> –Marion Dickel,
> Director of Academics and Technology
> Cornerstone Academy

Scenarios

Below are a series of scenarios that provide an overview of the necessity and value of access to high-speed broadband for teaching, learning, and operating a school. Although fictitious, these scenarios are based on real-life examples and should help to deepen the understanding of educators, administrators, and policy makers of how and why broadband access is not optional in or outside of the school.

Student Vignette

Malcolm lives in a rural area and has a 45-minute bus ride to school. Each day, he takes advantage of the school bus's wireless access and dives into projects. Since the beginning of the year, he has been following Under Armour® corporate financial statements for his Entrepreneurial Business class. Today, he clicks on an article from *The New York Times* that shares details about a new production facility in Vietnam. Then he checks his online Physics II class group chat to see if he needs to catch up on anything. Once at school, Malcolm switches to the campus Wi-Fi network. Throughout the school day, he accesses online tools and resources to complete his work, conduct research, and collaborate with students and teachers. During his blended learning Spanish class, he practices speaking with his teacher and other students via the microphone and headset. At lunch, he sets up an evening video conference with his history group. Thankfully, last year Malcolm's parents learned about discounted internet opportunities and now he has home internet access so he doesn't have to stay late at school or go to McDonald's to use the Wi-Fi. Apart from improved grades, this has helped Malcolm's parents to become much more engaged in Malcolm's learning, including the ability to check his grades, communicate with his teachers, and observe his work.

Teacher Vignette

After breakfast, Mr. Franklin logs-on to the school's learning management system to send a reminder message to his students about an upcoming project. When Mr. Franklin arrives at school, he schedules an evening meeting via instant messaging. Mr. Franklin creates a reminder notice on his laptop to update the online gradebook by end of the week and heads to his first class. He uses a flipped classroom method for instruction where students watch a video of his calculus lesson, prior to class and then participate in practice activities in class. Students use Sketchpad to work on calculus functions, creating unique functions by drawing a cartoon character—deepening the learning experience and reinforcing the properties of functions. In the next class period, students will work on calculus problems using interactive digital resources. Mr. Franklin answers questions and personalizes instruction based upon student online formative and summative assessments. At the end of the day, he meets with the principal to discuss options for the school's online community of practice where teachers are sharing lesson plans and coordinating peer-to-peer observations.

Administrator Vignette

Principal Clark leads a 1-to-1 school that has seamless wireless access throughout the building. As Ms. Clark walks through the halls of the school, students are using laptops to prepare a presentation. The bell rings and other students broadcast the morning announcements via streaming video. Ms. Clark has a full day of teacher observations to conduct, so she grabs her tablet and heads to the first classroom. On her tablet, she is able to access the district's educator effectiveness system and observation tools. The teacher has built lessons with resources from the district's learning object repository and posts them in the learning management system. Ms. Clark observes all students interacting via groups and posting notes online to share. On her way back to her office, Ms. Clark passes a classroom where several teachers are analyzing data from last week's formative assessments to determine if students have mastered the material. Ms. Clark arrives in her office in time to meet with a parent who has been accessing the parent portal and has noticed new behavior of not turning in assignments. After the parent meeting, Ms. Clark reviews the observation from this morning and recommends an online professional development course. She then attends a virtual meeting with other principals in the state who have a 1-to-1 school, to share best practices.

RECOMMENDATIONS

As schools continue to leverage digital tools and services, bandwidth needs are increasing exponentially. In May 2012, SETDA's groundbreaking report, *The Broadband Imperative: Recommendations to Address K-12 Education Infrastructure Needs* pushed educators and policy makers around the country to increase high-speed broadband access in schools—with specific recommendations regarding access, funding, and policies to support teaching and learning. In April 2016, SETDA and Common Sense Kids Action released the *State K-12 Broadband Leadership: Driving Connectivity and Access* report highlighting the powerful impact of state leadership in driving critical policy decisions at the national and state level to support broadband networks, bandwidth capacity and home access for low-income families. In this companion report, *The Broadband Imperative II: Equitable Access for Learning* SETDA continues to advocate for increasing robust access both in and out of school to best prepare all students for college and careers. SETDA provides the following updated recommendations for policy makers and school leaders:

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1 Increase Infrastructure to Support Student-Centered Learning

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Rationale for Infrastructure Recommendations

In determining recommendations for bandwidth targets, SETDA conducted research and solicited input from experts in the field to determine the projected bandwidth requirements necessary to fully realize the potential of digital learning that supports deeper learning experiences and best prepares students for college and careers. SETDA specifically considered the following:

- Projected bandwidth growth
- Educational applications for learning
- Administrative applications
- Upswing in the number of devices

Projected Bandwidth Growth

Most people cannot imagine life without the internet—from web surfing and checking email to engaging with social media and video chatting, technology is a part of everyday life, both for personal and professional engagement. The United Nations reports that more than three billion people are using the internet.[7] As the number of people who use the internet increases, so does the internet traffic. In a 2015 report, Cisco predicts that global internet traffic will be over 50,000 Gbps by 2019, more than triple current traffic.[8] As internet access booms across the globe, many districts and schools are still struggling to meet the minimum broadband needs to support high-quality, digital learning environments. Education SuperHighway reports that bandwidth demand is growing in K-12 public schools at a rate of over 50% per year and predicts that the typical school district will need to triple its bandwidth in the next three years. CoSN's *2015 Annual Infrastructure Survey* reveals that:

> ***… an infrastructure must be built to support exponential growth in the demand for internet capacity, ensure high reliability by avoiding key single points of failure, and provide ubiquitous access by students at anytime and from any place.***
>
> –U.S. Department of Education, Office of Education Technology, Building Robust Infrastructure as a Tool for Equity

- 68% of districts reported that they do not have sufficient internet bandwidth for the coming 18 months
- 56% reported that they do not have sufficient WAN bandwidth for the coming 18 months

Educational Applications for Learning

Similar to all instructional materials, the selection of digital tools and resources for instruction requires school leaders to first consider academic needs and then choose the most effective tool to meet those needs. The *Future Ready Schools: Building Technology Infrastructure for Learning* report recommends that when making decisions about digital tools and applications, district and school leaders should first determine *how students will use the technology for learning*. "Learning objectives should drive the technology implementation and not the other way around."[9] Based on curricular decisions, teachers and students must be able to plan for lessons and activities without concerns regarding bandwidth limitations. Based on the U.S. Departments of Commerce and Agriculture's report, *Broadband Opportunity Council Report and Recommendations*, broadband access should be considered a utility similar to water and electricity and be reliable for both homes and community institutions.

After determining the learning objectives, administrators and teachers need to determine the type of device and the application used, as bandwidth capacity needs vary significantly depending upon these choices. For example, Chrome devices recommend at least .2-.5 Mbps per user in a typical deployment and Wi-Fi of 802.11n, 5 GHz. Basic activities, such as checking email require minimum download speeds of .5 to 1 Mbps, whereas VoIP telephony software like Skype require minimum download speeds ranging from 30 Kbps for voice calls to recommended speeds of 8 Mbps for group videos with seven or more participants. Videoconferencing may include multiple video streams collaborating together, instead of a single stream where participants are only watching a video if there is robust bandwidth. Workforce50 reports that if you have bandwidth speeds of 50 Mbps, you can download HD video in minutes, instead of hours, without slowing down your other online activities. Cloud-based file sharing services are on the rise and require bandwidth to access multiple files from the cloud. Cloud-based activities are discussed in more detail later in this section.

In a school with a media rich learning environment where each student has a device, 80% of the users are concurrent and the school is leveraging cloud-based services, EducationSuperHighway predicts that a school with 99 students will need internet access of 149 Mbps by 2018.

The following table provides examples of broadband download speed requirements for various activities.

Table 1: Sample Broadband Requirements for Various Activities (Download Speeds)

Activity	Broadband Speeds
Searching the Web	1 Mbps
Checking email	.5 to 1 Mbps
Downloading digital instructional materials, including OER	1 Mbps
Engaging with social media	.03 Mbps
Completing multiple choice assessments	.06 Kbps
Sharing cloud-based documents (Office 365/Google Apps)	50 Mbps
Music streaming	2 Mbps
Video streaming—SD quality	3 Mbps
Video streaming—HD quality	5 Mbps
Video streaming—Ultra HD quality	25 Mbps
Streaming HD video or university lecture	4 Mbps
Watching a video conference	1 Mbps
Collaborating in HD videoconferencing	4 Mbps
Collaborating in a video conference	1 Mbps per user
Taking an online class	.25 Mbps
Engaging with simulation and gaming	1 Mbps
Engaging in two-way online gaming	4 Mbps

Resources: *Bandwidth Calculator*, *Google Apps Bandwidth Limits*, *SETDA Broadband Imperative*

This table is **not** intended to be used to calculate projected bandwidth for an entire school or district as there are many other factors to consider, such as administrative applications and cloud-based services, as well as aggregation strategies.

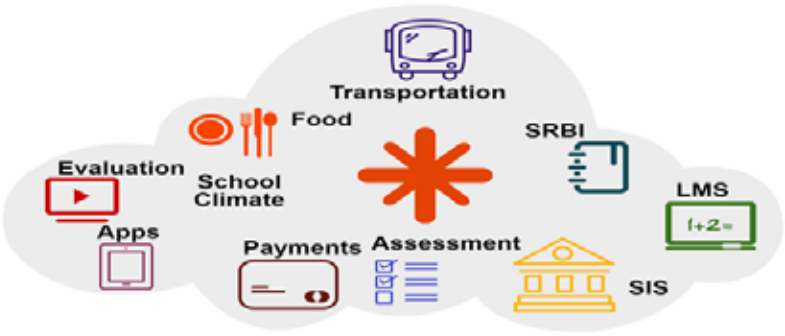
Administrative Applications

In addition to academic needs, district and school leaders must consider the bandwidth requirements for administrative applications. Administrative tools such as student information systems, learning management systems, assessment tools, transportation resources, data collection, and human resource tools each require broadband access. Districts are also beginning to move toward implementing modern applications that auto-connect utilities and tools for heating and cooling, security systems, and medical resources to increase efficiency and reduce costs—and these auto-connect tools require bandwidth, as well. Districts report that online video surveillance systems can increase bandwidth capacity needs approximately 30%. Finally, schools or districts that host 1-to-1 or other device initiatives must plan to manage online updates for these devices. For example, a 1-to-1 school with 1,000 device users performing an IOS update may require 1.5 Gbps for the update. The following image underscores district dependence on internet bandwidth. "Sharing the types of activity and internet traffic, and use of the state network is critical for helping leaders and policy makers to understand that resources are global, not local," said Doug Casey, Executive Director, Connecticut Commission for Education Technology.[10]

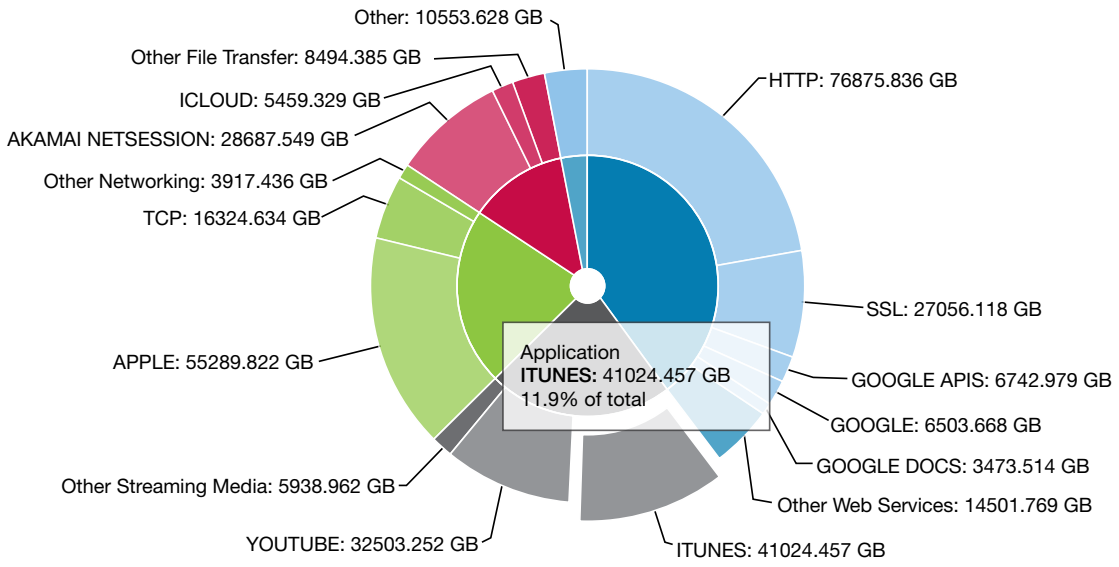
In order to estimate bandwidth required for the Schoology learning management system (i.e., exclusive of large media and data files that individual users might access), Schoology conservatively assumes a maximum of 50% of potential users in a school are active during the same time period, with about 10% of those actually issuing concurrent requests. So for a 1,000 user building experiencing those usage parameters, we calculate the bandwidth range as between 24 Mbps and 80 Mbps.

As shown in the following image, web service applications account for nearly half of all K-12 internet bandwidth activity. Streaming media, including video and music, are next, with file transfers utilizing the least amount of bandwidth.

Administrative Applications for Consideration



Source: Connecticut Commission for Education Technology



Source: Education Networks of America (ENA)

Upswing in the Number of Devices

As infrastructure leaders plan for broadband implementation, it is critical to also consider the fact that students and staff typically have access to more than one device and use both a school-issued and a personal device on the network. Some users may have three or more devices with the capability to access the network at the same time. However, most users will not use multiple devices concurrently for bandwidth-intensive activities such as video streaming or videoconferencing.

At the college level, Houston Community College, (TX) reports that the increase in the number of mobile devices used on campus is one of the most significant drivers of internet bandwidth utilization.

More Bandwidth Per User: Keeping Up with Student Demand

CoSN's 2015 Annual E-rate and Infrastructure Survey states that 46% of school systems currently report at least one device per student. Districts also projected a dramatic increase in the number of devices in three years—expecting that 91% of students will have at least one device, whether it is a school device or their own through a BYOD program. Interestingly, districts also project that in three years, 55% of students will have 2 or more devices.[11]

Internet Service Provider (ISP) Recommendation

Updated in 2016, SETDA provides broadband capacity recommendations for connection to the internet service provider (ISP) based on the size of the district (number of students). This method allows education stakeholders to better understand some of the nuances between very small districts (under 1,000 students) compared to large districts (over 10,000 students). The ISP recommendations are based on research; analysis of data sets from districts across eight states regarding both capacity and usage; and consultation with experts in the field.

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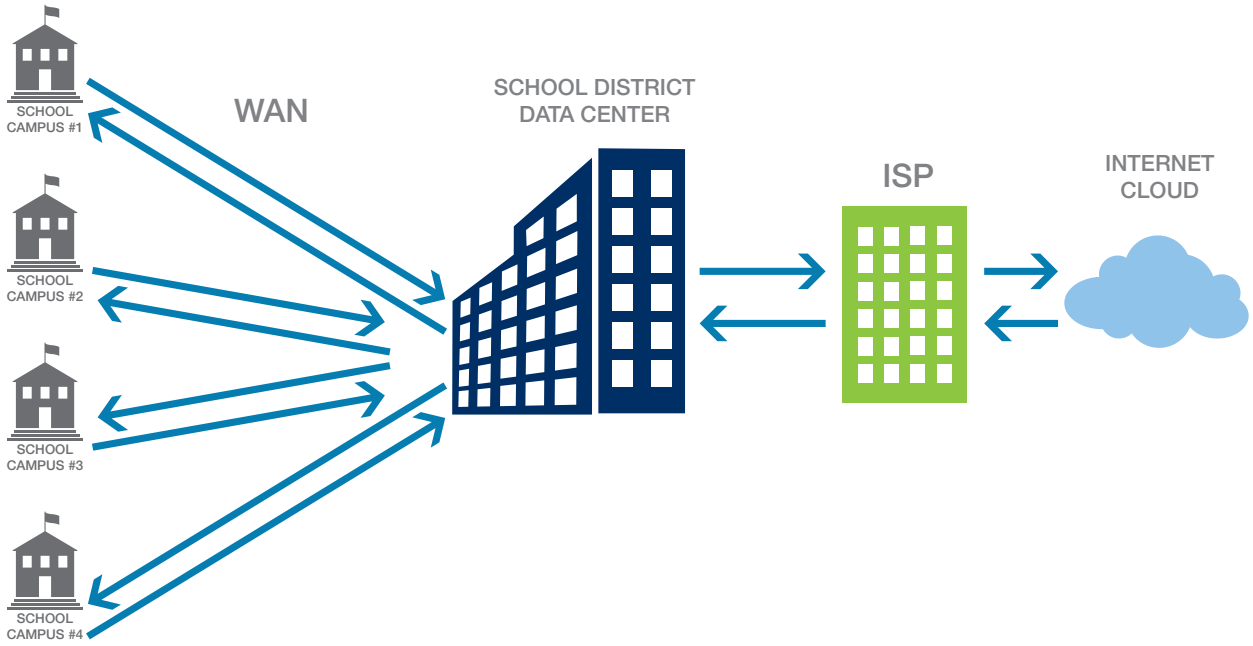
Connection to Internet Service Provider Considerations

These targets are minimum recommendations and should not be considered caps on usage. Rather, some districts will need more than the recommendations depending upon their digital learning environment. These recommendations also take into account the user experience—as utilization increases from 50% to 60% of bandwidth, all users will experience diminished performance.



Considerations for Small Districts (Fewer than 1,000 Students)

For small schools and districts, the minimum amount of bandwidth needed for basic administrative and automation functions makes up a substantially larger percentage of all network usage so the per user bandwidth required is substantially higher. For example, an extremely small school with 15 students and a 1.5 Mbps per user connection technically meets the current connectivity requirement, but they don't have enough bandwidth for more than a few intensive bandwidth activities at the same time. Additionally, this connection is also saturated with school overhead functions including state reporting, student information systems (SIS), and security. SETDA recommends the minimum bandwidth for

any district should be at least 100 Mbps for 2017-2018, and 300 Mbps for 2020-21. For example in 2017-18, if there are 50 students in a district, the table indicates that you need 75 Mbps (1.5 x 50) which is below the minimum threshold of 100 Mbps for the district;, therefore the district should acquire at least 100 Mbps.

Consideration for Medium Sized Districts (3,000 Students)

By 2020-21, for medium sized districts, 3 Gbps per 1,000 users should be used as a baseline with consideration given to individual building needs. Larger midrange districts with over 3,000 students should consider the 3 Gbps per 1,000 users as a reasonable starting point, realizing that many factors come into play, which may demand more bandwidth. Buildings of less than 3,000 students need to take into consideration a minimum to ensure enough bandwidth for video streaming, use of the cloud for storage, app use, and other district use cases.

Considerations for Large Districts (10,000 Students or More)

For large districts with dozens if not hundreds of school sites, it is common to design the district's network such that all sites ultimately lead back to a core location, and at that location, all inbound and outbound internet traffic flows through one aggregated connection. This works well at the 10,000 student level, but as district size increases, the aggregate bandwidth needs can decrease. The simplistic view of the size of this aggregated connection would be to determine each school's needs based on the recommendation of 2 Gbps/1,000 users and then aggregate those needs. For example, if a district with 50,000 users follows the recommendation of 2 Gbps/1,000 users, the calculated target would be 100 Gbps of bandwidth, which may be unavailable, unaffordable, and possibly unnecessary. Large districts usually have the technical capacity to determine appropriate bandwidths based on current and projected usage. However, digital learning opportunities should not be limited by the network size nor should the IT staff control the learning experiences. Large districts and some medium-sized districts may also use sophisticated aggregation and management strategies primarily applicable to very large networks and commercial carriers. Such strategies are beyond the scope of these recommendations, but determination of bandwidth and management strategies in these cases are the province of the district.

> At each school location, it is still important to ensure that the individual school site has a connection to the school from the core network that is *at least as large* as the recommended target.

Wide Area Network (WAN) Recommendation

SETDA recommends that for the 2017-18 and 2020-21 school years, districts should have at least 10 Gbps per 1,000 users for wide area network (WAN) access. Based on recent trends, research and consultation with experts in the field, SETDA expects that WAN requirements will come closer in line to ISP connections as districts utilize cloud-based services, as well as the advent of virtualization—shifting the capacity requirements from the WAN to the ISP connection. Virtualization, the next

generation network, emulates the functions of hardware with software. The network is powered by technologies that include software-defined networking (SDN) and network functions virtualization (NFV). With this approach, administrators can add capacity faster to meet demand. Cloud-based services refer to a model in which data, applications, and other digital resources are stored in *the cloud* and are available via the internet from any connected device. Devices may connect through a district network or through wireless access points. As district services such as learning management systems and student information systems move to the cloud, districts are not required to host as many applications in-house on the network. As a result, this practice has and will continue to bring the amount of WAN capacity required in line with the amount of ISP. As more services move to the cloud, the aggregate internet speed should approach the WAN speed as WANs will effectively become the internet. Districts may continue to use the WAN to enhance their in-district experience, e.g., tele- options between campuses, virtual face-to-face classes with ultra- high-definition video, and security videos. Therefore, the WAN recommendations for 2017-18 remain the same for 2020-21.

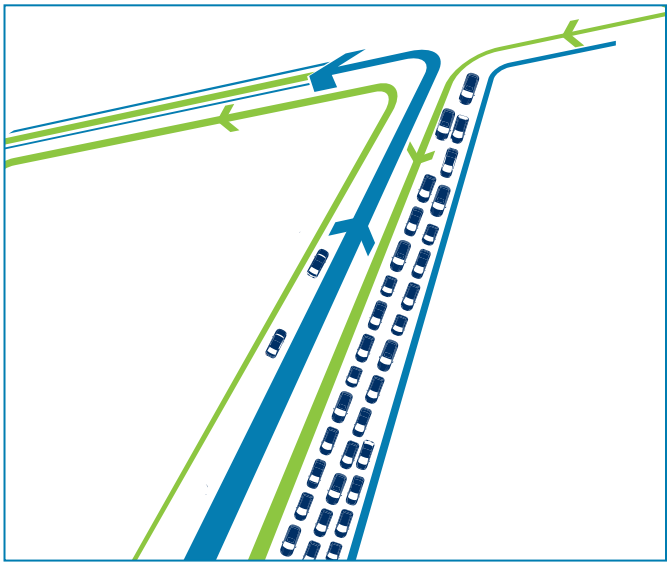
WAN RECOMMENDATIONS		
School Year	**2017-18 Targets**	**2020-21 Targets**
Connections to each school to link to the internet via a district aggregation point and for in-house administrative functions	At least 10 Gbps per 1,000 users	At least 10 Gbps per 1,000 users
*User: students, teachers, administrators, staff, and guests		

General Considerations for WANs

The bandwidth for a WAN depends on the maximum number of users on any one path, with the WAN for most facilities set to the maximum requirement for the largest facility, as the costs for purchasing for the entire facility often are the same as purchasing for only a portion of the facility. Schools should also consider the available technology compared to price when implementing WANs. For example, a 10 Gbps WAN may be less expensive than a 3 Gbps WAN because it may take three 1 Gbps connections to get to 3 Gbps, but only one 10 Gbps connection for 10 Gbps. An over-simplified way to think about this is to consider a suburban/urban transportation system. Many urban areas have rush hour, and often traffic is very slow. Ideally, most agree that more lanes on the big highways would ease the traffic, but consider each neighborhood that leads to the highway as a "school site" on a network. You often find that a one- or two-lane main artery road leading to the highway entrance is more than sufficient to allow traffic to flow smoothly, even at rush hour. However, it is not reasonable to build a highway that has as many lanes as the sum of all of the main artery roads' lanes. Certainly many highways need more lanes just as many large districts need more bandwidth, but just as with highways, there are other strategies that affect the aggregation of traffic. Unfortunately, in the

transportation world, it is very difficult and expensive to add lanes to a highway or build a new subway system. Fortunately, in the network world, it is easier to leverage strategies such as increasing bandwidth capacity (adding lanes), caching (mass transit), bandwidth shaping (commuter lanes), or peering (private roads).

WAN Considerations for Managing Increasing Internet Traffic Volumes at the Data Center



One consideration for schools adopting these recommendations is the effect of larger internet traffic volumes on devices located at the school's data center, including firewalls, routers, WAN accelerators, and other ancillary devices. These devices are needed to manage the security, availability, and performance of the school's network. These components may need to be upgraded to support the faster speeds contemplated in these recommendations. For instance, firewalls are designed to support specific network throughput speeds delivered by the internet access service (e.g., 1 Gbps, 10 Gbps). As internet access speeds are increased, the firewall in place at the school's premises will also need to be upgraded to support these faster speeds. Increasing the capacity of these ancillary devices offers an opportunity for the school to take advantage of innovative solutions offered by the networking equipment industry. In particular, Network Functions Virtualization (NFV) enables the school to consider cloud-based virtual customer premises equipment (CPE) option rather than a traditional hardware-based CPE option. With virtual CPE, most of the device's functionality is provided from the cloud, enabling faster installation, and upgrades to these components. Also, virtual CPE can typically be paid for with operating funds rather than capital outlays, which may offer more flexibility to the school.

2 Design Infrastructure to Meet Capacity Targets

State leaders should support districts in designing infrastructure to meet the recommended broadband capacity targets and the needs of digital learning environments. The focus of design should be on student learning, and not simply the administrative functions that networks have traditionally provided for schools and districts. As districts and schools move to seamless digital learning environments, the importance of designing high-capacity and widely available networks, including the utilization of wireless networks, is essential. Statewide broadband networks can provide significant benefits to districts, including cost savings and increased bandwidth options. Statewide purchasing consortia, regional education networks, and district consortia are other approaches for providing effective and efficient broadband access to schools. However, not all districts have access to a statewide network or consortia options and instead purchase network services through a commercial or nonprofit provider. Alternatively, some districts may choose to build their own networks to maintain local control, especially if they can obtain affordable pricing options. Regardless of the method, state leaders should support districts in designing infrastructure to meet the recommended broadband targets and capacity needs of a digital learning environment. Learn more about states providing leadership regarding broadband implementation and statewide networks in SETDA's *State K-12 Broadband Leadership* publication.

Research and Education Networks

Research and Education (R&E) networks are typically education-led, governmental, or nonprofit organizations that focus on a combination of research, education, medical, and economic development network services. Some R&E networks are part of universities or state government, where others are independent organizations. In addition to providing shared backbone and internet access services for its members, some R&E networks offer disaster recovery, email and web server hosting, high-definition (HD) videoconferencing, and cloud-based services. R&E networks are another option for districts and schools to meet their infrastructure needs. Learn more.

Design Flexible District Networks

Designing district networks for both the short and long-term that are open, filtered, flexible, and support multiple devices for teachers and students is critical. When designing networks, districts need to assure that the internet connections are used effectively. That means the school will need to have access to the resources necessary to use the internet, including school- or student-owned computers or devices, teacher professional development or training, software, an internal network, and technical support. For some schools, making full use of these connections may require that those schools modify their curriculum so that it effectively incorporates digital age learning. Districts and schools may need to modify their security policies to allow teachers and students to access rich digital resources on the internet or to engage in high-quality real-time collaboration or communication with experts, parents, and community members, or other schools. It is also important that networks are created by IT experts with input from all stakeholders, administrators, teachers, students and parents so that everyone has a voice in the needs of the network. Future Ready Schools: Building Technology Infrastructure for Learning is a resource to help district leaders consider a range of options when making decisions about infrastructure. Building Your Roadmap

> ***A clear vision for teaching and learning drives infrastructure planning.***
>
> –*Roadmap for 21st Century Learning Environments*

for 21st Century Learning Environments is a free planning tool that districts and schools can use to ensure a strategic approach to building infrastructure. Smart Education Networks by Design (SEND), a leadership initiative from CoSN, provides information on developing a ubiquitous, scalable, reliable network, identifying the following key drivers of network design:

- Capacity: Broadband targets (Mbps/student)
- Reliability: Unplanned internet downtime
- Mobility: Multiple devices per student and teacher
- Scalability & Flexibility: Ability to scale internet access, servers, and services
- Sustainability: Adequate funding sources
- Agility: Respond to changing needs of teachers and students quickly
- Maintainability: Networks are simpler and easier to maintain and to perform optimally.[12]

SETDA's *State K-12 Broadband Leadership: Driving Connectivity and Access* report identifies the following considerations when implementing or upgrading networks:

- Cost savings/pricing
- Economies of scale
- Bandwidth requirements
- Shared fiber-optic
- Integration of WAN and internet
- Technical support and expertise
- Security
- Shared technical services
- Educational support services

Additionally, SETDA recommends that districts consider:

- Network performance
- Latency
- Network availability
- Redundancy
- Self-provisioning
- Dark fiber

Kansas

In Kansas, KanREN provides a robust statewide network for research, education, and community anchor institutions in Kansas. KanRen members connect, collaborate, and share resources through the network and can leverage the consortium to secure services. KanREN's high network capacity enables members to improve data security by partnering with a peer organization to implement high-speed remote data backup over the KanREN network. These types of resource sharing opportunities allow members to leverage the robust network that exists to support the unique requirements of Kansas's institutions for disaster recovery and business continuity needs.

Building for Future Capacity: Districts should consider arranging with their service provider for underlying transport circuits that can easily be upgraded and accommodate at least 25% more internet capacity than their purchased capacity levels so that they can easily and dynamically upgrade as their usage demands. For example, a 1,500 student school district with a 5.4 Mbps/user recommendation in 2020-2021 would need to buy 8 Gbps. SETDA recommends purchasing or requesting circuit capacity of 10 Gbps to transport the 8 Gbps, just to provide some immediately available capacity should an upgrade be required.

Network Providers Privacy and Security Options: Districts should consider purchasing content filtering, firewalls, and Denial of Service (DDoS)/intrusion prevention tools as services and have them delivered from within the service provider's network. Often when districts increase capacity to the internet they have connectivity issues due to the inadequate capability to handle the upgraded bandwidth demand in their own content filtering, firewalling, and DDoS/intrusion prevention equipment.

Tips for Purchasing Internet Service: Committed information rate (CIR) and the physical port speed for the connection are typically the two factors to consider in the speed/capacity of internet service. The nature of network data is such that it is inherently sent in *bursts*; that is, large amounts of data are transmitted very quickly, with gaps of time between them. When purchasing internet service, the CIR defines the *average peak* amount of service that will to be provided while the physical port speed caps the maximum possible amount of service that may be used. Internet service providers can use both of these factors to produce an array of service options, with different performance levels and different price points. From a performance and financially prudent standpoint, paying for a CIR that most closely matches a school's typical peak use, while including a guaranteed ability to burst to the maximum port speed, provides a best-case scenario for K-12. CIR with burst charge options can minimize the cost, while accommodating peak usage demands, and provide use data that informs future usage needs. The measurement techniques used to determine the additional burst use (and associated cost) should be explicitly defined—and tend to be relatively lenient, with the industry standard based on measurements that average 5 minutes of use, discarding the top 5% of measurements, and using the remaining 5-minute sample as the measured use.

Flexible Network Exemplars

St. Vrain Utilizes Infrastructure as an On-Going Investment

The St. Vrain Valley School District is the seventh largest school district in Colorado and operates 55 schools with more than 32,000 students, spread over 411 square miles. St. Vrain is nationally recognized as a STEM leader, having won the Invest in Innovation Grant (i3) as well as receiving one of 16 Race to the Top grants. SVVSD is also known for its thoughtful use of video self-reflection as part of teacher professional development as well as a comprehensive and unique Learning Technology Plan, which leverages iPads, Chromebooks, Macs, and PCs. To accomplish this, SVVSD has a proactive infrastructure philosophy that views bandwidth, network gear, and state-of-the-art wireless infrastructure as ongoing investments with planned replacement cycles rather than periodic capital expenses. Staff and students experience pervasive Wi-Fi in 100% of school classrooms and benefit from a 10 Gbps fiber-optic network and over 3.5 Gbps of internet service across two internet service providers, which provides logical and physical redundancy for mission critical web access. All teachers have a MacBook Air as well as a mounted projection system, which enables 21st century learning opportunities.

Addison-Rutland Builds Own Fiber-Optic Network

Addison-Rutland Supervisory Union (Addison-Rutland), located in Fair Haven, Vermont, committed to building and sustaining a robust, commercial-grade fiber-optic network to enable effective 21st century learning. The district previously received internet access from a network of service providers, a system that required frequent cable modem reboots to establish connectivity. With a solid infrastructure now in place, Addison-Rutland deployed its 1-to-1 initiative in Grades 3–12. Teachers are using Google Classroom to create and organize assignments, provide timely feedback, and communicate with their students. Addison-Rutland's students are also getting hands-on technology experience with the district's 3D printers, by using online tools to design and print 3D models.

Shasta Elementary Network Upgrades Transform Teaching and Learning

In California, Governor Brown included $26.7 million (Senate Bill 852) in one-time funding to enhance broadband infrastructure for the schools with the most severe deficits. In 2014, Shasta Elementary was awarded BIIG grant funding to upgrade to a 1 Gbps fiber-optic circuit between the Redding School District and Shasta Elementary. Before the upgrade, Shasta could only run two or three browsers at the same time at their administrative offices. If the teacher needed to use the internet in the classroom, the teacher had to coordinate with the district administrative office. Now math and science teachers are utilizing digital resources that they couldn't imagine a year ago. After the network upgrade, Shasta Elementary experienced a 100 times increase in internet speed. Watch this video to see the changes in teaching and learning.

Maine's Cyberinfrastructure Enables All Students to Participate in Minecraft Programming

What better way is there to improve student engagement than to leverage something that already has a student's attention? A group of University of Maine researchers, in conjunction with a California startup company, are leveraging the broad appeal of Minecraft, to teach students the basics of computer programming using *Blockly*, a visually based programming language. This project will reach nearly 1,000 Maine youth and 72 STEM educators in primarily rural and economically disadvantaged communities. This program takes advantage of Maine's 4-H STEM Ambassador network across the state, as well as the computational network and infrastructure. By utilizing the Maine Learning Technology Initiative's 1-to-1 program, the necessary devices are in the hands of Maine's students and network in the schools, and the supercomputing facilities at the University of Maine students can be reached on an equal basis, anywhere in the state. This allows small, rural, and economically disadvantaged schools to play on a level playing field. Maine is unique in having all the pieces in place and is serving as a national model of the benefits of a strong statewide cyberinfrastructure for education.

Utilize Wireless Connectivity to Meet Infrastructure Needs

Most districts and schools are growing their wireless networks to help meet internet access needs. CoSN's *2015 Annual E-rate and Infrastructure Survey* reported that 56% of school districts do not have sufficient WAN bandwidth for the coming 18 months. With the advent of Chromebooks and BYOD programs, students and teachers often have multiple devices, further increasing internet access needs. The survey also states that 46% of school systems currently report at least one device per student. Districts projected a dramatic increase in the number of devices in three years—expecting that 91% of students will have at least one device, whether it is their own or through a school program.[13]

In fact, in an effort to ensure effective and efficient use of bandwidth delivery down to the classroom and student level, the FCC made additional funds available to provide discounts on local area network infrastructure and related services as part of E-rate Modernization in 2015. SETDA's *State K-12 Broadband Leadership: Driving Connectivity and Access* cites that 15 states reported that they have a master contract for Wi-Fi equipment that supports school and district purchasing options—helping districts increase capacity while reducing costs. In Rhode Island, a $20 million technology bond provided funds for the Wireless Classroom Initiative, to put wireless access in all classrooms. As schools and districts implement and expand their wireless networks there are multiple considerations—not only access in classrooms but also access in common areas. In Fairfax County, Virginia, a school system with 180,000 students, there are 12,000 wireless access points and most classrooms have 2 access points to handle density. There are 190,000 unique users (110,000 students/staff and 80,000 guests). Fairfax has wireless access points in classrooms, hallways, cafeteria, gym, athletic fields, and the playground. Wireless access allows staff to have instant access to emergency contacts if a student is sick or injured.[14]

The *School Wi-Fi Buyer's Guide*, developed by Education SuperHighway is a tool for districts and schools interested in making purchasing decisions for wireless equipment. The Guide describes wireless features and functionality, as well as feature tradeoffs and recommendations. The interactive website allows administrators and technology directors to build a requirement list based on the district's needs.

Wireless Access Exemplars

North Carolina Takes Advantage of New E-rate Funds for Wireless Access

The North Carolina Department of Public Instruction in partnership with The Friday Institute developed the state's Wireless Infrastructure plan, which urged the state to take advantage of new E-rate funds through a state consortium. The approach was optimized against the FCC $150-per-student allocation, and sought out a mix of providers who could deliver wireless equipment, Ethernet switches, wiring, configuration, and install and manage services eligible under the allocation. In 2015, the state provided Wi-Fi to over 375,000 students at an average cost of only $116 per student (pre-discount).

New Mexico Applies Lessons Learned from Other States for Wi-Fi

This program applied lessons learned from North Carolina and Alabama to aggregate buying power for Category 2 (Wi-Fi and networking equipment). The statewide master contract, accessed by all school districts and libraries has resulted in greater discounts than previous statewide contracts. Alabama has offered its *Mini-Quote* system to New Mexico, which functions like "eBay in reverse" as vendors compete with transparency on price in response to district requests against this contract. The 2016 funding year has seen more charter school participation in the E-rate program and an increase in pre-discount of about $15 million.

Prince George's County Provides Wireless Access in All High Schools

Prince George's County Public Schools (PGCPS) is the second largest K-12 school district in Maryland, serving over 129,000 students. PGCPS' Division of Information Technology plays an integral role in the support of the district's overall digital learning vision through the availability of infrastructure, devices, support, and training. PGCPS focused its attention on mobile devices—both personal and district-issued—supporting more than 100,000 devices with its robust infrastructure. The district installed wireless in its 210 schools and 20 administrative and maintenance buildings. Every elementary school currently has 100 Mbps of WAN access and every high school and middle school has 1 Gbps of internet access.

Kingsport City Schools Installs Wireless Network Covering the Entire District

Kingsport City Schools (KCS), located in northeast Kingsport, Tennessee, serves approximately 7,200 students and is comprised of 13 schools. KCS utilizes D-B EXCEL, a newly designed, virtual and blended learning program for high school students. Recognizing the power of digital learning, KCS' robust technology vision is designed to meet its students' individual instructional needs. Infrastructure and professional learning are two key areas where the district has focused its attention. To support its district-wide BYOD initiative and burgeoning 1-to-1 program, KCS installed a wireless network covering the entire district. KCS also installed a new web filter to provide content filtering on all student devices, and it upgraded its internet access to 1 Gbps. Additionally, KCS deployed Wi-Fi on five of its school buses, providing additional learning opportunities to its students who have longer bus routes. Technical support for the district's technology vision is provided through personnel at the district and school level, as well as via students who are trained and capable of providing such support. Visit the KCS website for more information.

Fraser Public Schools—Where Learning Drives Innovation Robust Wi-Fi Infrastructure

Fraser Public Schools, located in Fraser, Michigan, serving approximately 5,400 students, is a school district dedicated to blending traditional offerings with the best digital resources to customize each student's learning experience. Through advanced technology in all classrooms, personalized iPads for all students K-12, and hybrid course offerings, Fraser Public Schools continues to blend the traditional school model with the best digital resources. The district has deployed a robust Wi-Fi infrastructure while actively monitoring access point response times and proactively addressing bandwidth issues and Wi-Fi coverage. District internet access is 10 Gbps and district buildings are connected via a 10 Gbps WAN. Fraser's 1-to-1 iPad initiative enables teachers to create an environment that extends beyond the traditional classroom while allowing students to experience flexibility in learning, pacing, and demonstrating their understanding. With the strategic use of a learning management system, Fraser Public Schools teachers are able to leverage technology to allow students the ability to move at their own pace anytime, anywhere. Additionally, teachers are able to provide content and use high-impact teaching strategies to increase the rigor of student learning. Utilizing technology, students in Fraser are truly empowered and make choices about their learning on a daily basis.

3 Ensure Equity of Access Outside of School for All Students

Digital equity is a topic of concern as inequities related to broadband access persists when some students, particularly rural and low-income students, do not have the same level of broadband and device access as other students outside of school. Gone is an era when children are given a textbook to support their learning. Equity of access includes access to devices and sufficient high-speed broadband in the school building, the classroom, the home, and everywhere else in the community to utilize digital instructional materials and to connect students, educators, and experts throughout the world anytime/anywhere. As reported in SETDA's research paper *Navigating the Shift*, seven states (Arkansas, Florida, Georgia, Louisiana, North Carolina, West Virginia, and Wisconsin) have statutes requiring the implementation of digital instructional materials in the next five years. In 2015, Georgia passed Senate Bill 89, known as the *Digital Classroom Act,* which requires the implementation of digital instructional materials. The legislation also requires that local boards of education provide wireless electronic devices for students to access instructional materials and content. In Florida, beginning in the 2015-2016 academic year, all adopted instructional materials for students in K-12 must be provided in an electronic or digital format. This is a dramatic shift in state policy, as legislators are now recognizing the benefits of digital resources and these policies have direct implications on issues related to device access and internet access. If all content will be digital and typically some of that content is online, students must have access to broadband and devices outside of school to be successful.

The Aspen Institute's Task Force on Learning and the internet, *Learner at the Center of a Networked World* recommends that, "every student [has] adequate connectivity—including reliable broadband connections—as well as access to the hardware, applications, digital age literacy and high-quality content necessary to support their learning."[15] Learning doesn't end when the last bell rings, students need internet access outside of the school day, particularly at home to complete assignments; collaborate with their peers; participate in extracurricular activities; apply for higher education opportunities and even part time employment. The *2016 National Education Technology Plan (NETP)* recommends "students and educators have broadband access to the internet and adequate wireless connectivity, with a special focus on equity of access outside of school."[16]

Equity Challenges Persist

Unfortunately, the digital divide persists and not all students have access to the internet at home—often referred to as the "homework gap." The Pew Research Center reports that 5 million households with school-age children do not have broadband access at home. Low-income households—especially black and Hispanic ones—make up a disproportionate share of those households. The FCC's *2016 Broadband Progress Report* states that "broadband is not being deployed to all citizens in a reasonable and timely fashion." Additionally, only 2% of school systems report that ALL their students have access to devices outside of school.[17] In the 2015 report by the Bill & Melinda Gates foundation, 42% of teachers stated that student access to technology outside of the classroom continues to be problematic.

Even for those students who have access to the internet, *high-speed access* remains an obstacle to overcome as 10% of Americans nationwide lack access to speeds of at least 25 Mbps for downloads/3 Mbps for uploads and nearly 40% of citizens in rural areas and

Lack of available funding contributes to the home access issue. Although, the Federal Communications Commission recently voted to increase E-rate funding by 60% annually to improve broadband connectivity in schools and libraries, these E-rate funds cannot be used for home access.

tribal lands lack access to adequate broadband.[18] The Cooney Center reports that consistent quality connections are just as important as basic access, which is exacerbated for low and moderate-income families. In a recent survey of low and moderate-income families with school-aged children, 52% report that access is too slow and 26% report sharing a computer.[19] According to the recent Speak Up survey, two-thirds of students say that it is important for them to have safe and consistent access to the internet when they are outside of school for them to be successful in school.[20] More than three-fourths of students need to access the internet outside of the home to complete assignments—35% of students go to school early or stay late; 24% of students use the public library; and 19% of students go to fast food restaurants or cafes to use the internet.[21] According to a recent study from the Hispanic Heritage Foundation, Family Online Safety Institute, and My College Options, nearly 50% of students say they have been unable to complete a homework assignment because they didn't have access to the internet or a computer. Furthermore, 42% of students say they received a lower grade on an assignment due to lack of access.[22] Over 75% of school district technology leaders report they have no strategies to address off-campus internet access—an issue that prevents "anytime, anywhere" learning[23].

> ***Students' lack of access to online resources at home presented a major challenge to integrating technology into their teaching, reported more than half of teachers in low-income communities.***
>
> –Pew Research

Households with School-aged Children without Broadband Access

Among households with school-age children...

% Lacking a High Speed Connection at Home

	All	White	Black	Hispanic	Asian
Annual income under $50,000	31.4%	24.6%	38.6%	37.4%	15.5%
$50,000 or greater	8.4	6.7	13.0	12.8	4.0

% with a High-Speed Connection at Home

All households with school-age children	**82.5%**	**88.0%**	**71.5%**	**72.2%**	**92.3%**
Annual Income under $25,000	**60.3**	**67.9**	**53.6**	**54.8**	**79.0**
$25,000-$49,999	**75.7**	**80.6**	**71.2**	**69.2**	**88.6**
$50,000-$99,999	**88.2**	**90.5**	**84.1**	**82.1**	**94.0**
$100,000-$149,999	**94.3**	**95.1**	**91.7**	**90.6**	**96.5**
$150,000+	**96.7**	**97.0**	**93.5**	**93.9**	**97.9**

Source: Pew Research Center Analysis of 2013 American Community Survey (IPUMS).

Students Disadvantaged in Education and Job Market

Students who lack home access are also at a disadvantage as they look for part-time jobs and prepare for college and career. Online employment resources rival personal and professional networks as a top source of job information, according to the Pew Research Center's survey; *Lack of broadband can be a key obstacle, especially for job seekers*. Survey results indicate that 52% of Americans believe that those without access at home are at a "major disadvantage" for job opportunities or gaining new career skills. Without broadband access at home, 37% of respondents indicate that it would not be easy to create a professional resume; 30% would find it difficult to contact an employer via email, or fill out an online job application; and 27% would have a hard time finding online lists of available jobs in their area. The Pew Research Center *U.S. Smartphone Use in 2015* report states that low-income individuals are especially likely to use their phones for navigating job and employment resources and that 7% of Americans own a smartphone but have neither traditional broadband service at home, nor easily available alternatives for going online other than their cell phone.

Strategies and Exemplars

The following section presents several strategies and exemplars for ensuring equity of access outside of school for all students. SETDA encourages states and districts to consider any and all of these strategies to ensure that ALL students have device and internet access outside of school. Without access, students cannot realize the full potential of a digital learning environment.

- Distribute outreach to families about the necessity for out-of-school access
- Leverage community partnerships for access
- Share out-of-school access options

Distribute Outreach to Families About the Necessity for Out-of-School Access

Research shows that effective family-school partnerships support student achievement and school improvement according to the U.S. Department of Education's Partners in Education: A Dual Capacity-Building Framework for Family-School Partnerships. The framework focuses on building the capacity of educators and families to work collaboratively. Specific program goals are to build capacity in four areas:

- Capabilities (skills and knowledge)
- Connections (networks)
- Cognition (beliefs)
- Confidence (self-efficacy)

States are developing new approaches for family engagement programs and many states are employing family engagement strategies as a tool to promote educational equity. Connecticut adapted ED's framework for their state and hosted a family engagement conference. The conference focused on four key elements of the state framework:

> ***It's vital to understand that promoting educational equity necessitates family engagement. It is when families are authentically engaged and listened to as active partners that our students reach their full potential and graduate college and career ready.***
>
> –Dianna R. Wentzell, Connecticut Education Commissioner

- Opportunities for partnerships
- Conditions for success
- Strategies for building capacity
- Outcomes of successful family-school partnerships

Other national resources include the Family and Community Engagement Network, which connects states, districts, schools, community organizations, and families with each other to learn about best practices for engagement. The Family Engagement Resource Providers (FERP) project provides technical assistance by family engagement experts to states and 21st century community learning centers (CCLC).

Texas developed the Parent Empowerment Toolkit and framework. The toolkit states that "home-school partnerships need to be ongoing, comprehensive, purposeful, and relentless." The framework focuses on three areas:

- **School Culture/Climate:** Develop a family engagement system that cultivates and empowers adults to jointly support student achievement.
- **Building Capacity:** To ensure effective involvement of parents and to support a partnership among the school, involve parents and the community to improve student academic achievement.
- **Compliance:** Family engagement has always been a centerpiece of Title I, and includes specific statutory requirements pertaining to effective family engagement.

When conducting outreach to families through school meetings, flyers, or other methods, districts should include detailed information about the shift to digital learning and the use of digital instructional materials. Highlighting student success stories can be a powerful tool to illustrate the positive impact of a digital learning environment. Explaining to parents that learning doesn't end when the last bell rings and that students need internet access outside of the school day to complete assignments, collaborate with their peers, and participate in extracurricular activities is essential. It is also helpful for districts to understand the access challenges for students—who in their student population lack access to devices and the internet. One useful resource, developed by The Friday Institute for Educational Innovation and CoSN, is the student and parent surveys.[24] These surveys gather information about devices, internet access at home, connection speeds, community access options, as well as a student's ability to complete homework.

Specific outreach to families that lack robust access about discounted programs that support anytime, anywhere access for all students is another way that district and school leaders can help students obtain 24/7 access. Over the last two decades, the federal government has coordinated multiple programs to support community and home access. The FCC's Lifeline program provides millions of families with discounted monthly telephone service. On March 31, 2016, the FCC voted to modernize the program to include broadband access. For the first time, Lifeline will support stand-alone broadband service as well as bundled voice and data service packages to help low-income Americans with access. As part of the Lifeline modernization program, the FCC includes a Digital Inclusion Plan as a priority. The FCC's Consumer and Governmental Affairs Bureau (CGB) will develop a plan for the FCC to better understand the non-price barriers to digital inclusion and to propose how the FCC can facilitate efforts to address those barriers. This plan will address promoting digital inclusion generally and also as it particularly relates to the new Lifeline program.[25]Additionally, many nonprofit and corporate entities also have programs to help families access the internet at home. States and districts can share Table 2: Discounted Out-of-School Access Options with schools and families as part of their outreach activities.

Table 2. Discounted Out-of-School Access Options		
Provider	Description	Program Type
Access from AT&T	AT&T offers low-cost wired home internet service to qualifying one residents who participates in SNAP. Service options range from $5 - $10 per month.	Wired broadband at home
Comcast Internet Essentials	Comcast offers internet service for $9.95/month to households that have at least one child who qualifies for the National School Lunch Program.	Wired broadband to home
EveryoneOn: Connect2Compete (C2C)	EveryoneOn's C2C program provides affordable internet and devices to students and families that qualify for the National School Lunch Program. C2C is offered in partnership with local internet service providers, offering free or $9.95 home internet service in 48 states and the District of Columbia.	Wired broadband at home
CenturyLink internet Basics	Discounted Home internet service for $9.95/month.	Wired broadband at home
Kajeet	Kajeet SmartSpot allows educators to provide students CIPA-compliant, 4G-LTE internet access outside the classroom so they can complete their required assignments and homework. Kajeet also offers SmartBus, Wi-Fi internet access on the bus.	Mobile Education Broadband for students
Mobile Beacon	Mobile Beacon provides 4G LTE internet service to schools, libraries, and nonprofits. Mobile Beacon provides unlimited data plans for $10/month. Schools can offer families without internet access the ability to sign up for $10/month service by becoming an i3 internet inclusion enrollment partner with Mobile Beacon and PCs for People	Mobile broadband to schools/ nonprofits

Leverage Community Partnerships for Equity of Access

While recent federal initiatives are likely to improve bandwidth access, states and local school districts should also consider additional innovative options to offer adequate broadband access, including building public/private partnerships. Leveraging community partnerships with municipalities and libraries to provide internet access can give students who lack internet at home an alternative for accessing the internet. Pursuant to the July 2014 E-rate Modernization Order, libraries are eligible for up to $2.30 (pre-discount) per square foot over a five-year period. To ensure that E-rate funds are sufficient to meet the demands of schools with a small number of students and libraries in small buildings, the Order establishes a pre-discount funding floor of $9,200 in Category Two support available for each school or library over a five-year period.

> Fifty-two percent of administrators are working with public libraries to expand their hours or allow students to have priority access to the library's computers in the after school times.
>
> –Speak Up Survey

In rural areas, collaboration between schools and libraries can facilitate new fiber construction that can meet the needs of students after normal school hours. Students can sit in the parking lot to access

the internet through wireless connections at schools and libraries, even after hours. Some districts are putting wireless routers and solar panels on buses. Coachella Valley Unified School parks buses with wireless routers in underserved areas so that students can access the internet. Mobile hotspot lending programs are another way to give access to students who do not have internet at home. While some of these options may not be ideal for all students, education stakeholders are working towards finding innovative solutions for digital equity. The following exemplars highlight ways that districts and communities are working together to improve out-of-school access for students.

Last year, the largest carriers—known as *price cap* carriers—accepted $9 billion from the Connect America Fund to expand broadband in their rural service areas. In March, the FCC included $20 billion for the smallest carriers. Research shows that bringing broadband access to rural areas has the potential to benefit the entire community.[26]

Community Partnership Exemplars

Connected Nation Provides Broadband Planning Services for States and Communities

Connected Nation focuses on closing the digital divide and provides broadband planning services for states and communities. Specifically, Connected Nation promotes digital literacy by joining public and private partners in programs that help underserved populations overcome barriers to technology adoption. Connected Nation also provides research and analysis of broadband deployment and adoption across the nation.

Forsyth County Schools Partners with Chamber of Commerce to Host Wi-Fi Directory

Forsyth County Schools (FCS) in Georgia serves over 42,600 students and is the largest employer in the county with over 4,300 full-time employees and 1,300 substitutes. The majority of the district's secondary students had mobile devices. However, students were unable to use their devices once they left the school's wireless network and many did not have a home computer with broadband access for more complicated assignments. The district partnered with the Cumming-Forsyth County Chamber of Commerce to create a Free Wi-Fi Directory for students. This online directory posts a list and interactive map of free Wi-Fi hotspots, sponsored by organizations and businesses in Cumming-Forsyth County. The directory is both for the district's more than 39,000 students and all residents and visitors.

Kansas City Public Library Pilots Mobile Hotspot Lending Program

Nearly 70% of children in Kansas City School District do not have internet access at home. In response, the Kansas City Alliance for Digital Inclusion was formed as a joint community effort involving the school district, public library, and a variety of like-minded nonprofits, local businesses, and internet providers. The Alliance's mission is to maximize collaboration and impact among local organizations and initiatives to bridge the digital divide. The Alliance helps leverage existing digital service infrastructure/programs and work across organizations and traditional boundaries. One example of cross-boundary outreach occurred in the 2015-16 academic year. The Kansas City Public Library (KCPL) partnered with Kansas City Public Schools, Literacy Kansas City, and Connected for Good to pilot a mobile hotspot-lending program. Students in two urban high schools who have challenges in accessing digital content outside of the school day are able to check out laptops and 4G LTE mobile hotspots with free, unlimited 4G LTE data plans. Mobile Beacon awarded the grant to Kansas City Public Library for this pilot program.

Share Out-of-School Access Options

In some cases students without home access cannot utilize community options for internet access, such as the library, due to transportation, after school activities, or other commitments. States and districts should work to provide alternative access options so that *all* students can connect outside of school. The following exemplars highlight state- and district-provided wireless access, as well as the use of mobile hotspots on buses to meet student access needs.

Out-of-School Access Exemplars

Albemarle County Public Schools Provides Broadband to Students Living in Areas Without an internet Service Provider

Albemarle County Public Schools (ACPS) in Virginia repurposed the Educational Broadband Service (EBS) spectrum for home connectivity. ACPS is geographically diverse, encompassing urban and rural communities with areas of poverty and low levels of both broadband access and adoption. About two years ago, CTO Vincent Scheivert discovered that ACPS owned EBS licenses that they could use to bring community broadband to students living in remote areas without a current broadband provider. Over an eight-mile area, ACPS partnered with local police and fire agencies to successfully provide bandwidth to unserved families. The district is working to expand the program to public housing agencies and plans to extend this WiFi/spectrum usage to all students. ACPS hopes to use E-rate funds to address the out-of-school access problems, and has appealed to the FCC for a waiver.

District 87 Uses Curriculum Funds to Provide Internet Connections to Students at Home

In Bloomington, Illinois, District 87 equips every student in sixth, seventh, and eighth grades with a device for learning that they use at school and at home. However, more than one-half of the students are considered low-income and don't have internet access at home. The superintendent recognized that not all students have the ability to access community wireless connections and that this is an equity and social justice issue. The district decided to repurpose curriculum budget funds to provide internet connections for students who qualify for free or reduced lunch. Households are connected to the district's internet connection, enabling district filters to be in place.

South Carolina – Internet Home Access in Richland's District Two

Richland District Two is committed to integrating technology into the classroom and ensuring that technology is available to all of their students outside of the classroom. Most students have their own devices through BYOD or laptop loans from the school. The district used mapping data to determine which families lacked home internet access. After identifying the 25 families, mostly Hispanic, many of whom were first generation immigrants, Richland Two partnered with Kajeet to offer internet hot spot devices to the families with filtered internet broadband. When providing the devices to the family, the district explained that it was not only for students to complete homework, but also for the entire household to use to access community resources. http://www.kajeet.net/engage-parents-richland-two

Arizona – Mobile Hotspots Provide Access for Vail School District

Vail School District began their mobile hotspot deployment with 1 school bus at $60 per month. Today they have 10 buses with mobile hotspots at a zero cost to the district. They are paying for the service via corporate advertising. The mobile WiFi hotspot enables the district to extend the classroom to the bus for the students to use their 1-to-1 computing technology to its fullest advantage during travel time to and from school which can be up to 45 minutes each way. They maintain CIPA compliance

by having all traffic routed back to the district internet server. Since this is a cellular-based technology, it's not limited to the Tucson area. Even on extended trips, students and faculty have access to email and assignments while on the road making the learning area as mobile as the corporate workforce. http://www.vailschooldistrict.org/#1461700961781-65d1c994-5f2b

4 Leverage State Resources to Increase Broadband Access

SETDA recommends that states leverage resources to increase broadband access in all schools. In the 2016 report, *State K-12 Broadband Leadership: Driving Connectivity and Access*, SETDA and Common Sense Kids Action focus on the role of state leadership in supporting districts and schools to increase high-speed connectivity and access for students and educators. Through a state broadband survey and independent data collection, SETDA gathered information for all 50 states, the District of Columbia, Guam, and the Commonwealth of Northern Mariana Islands (CNMI) regarding state policies and practices regarding broadband implementation. In this report, SETDA provides specific recommendations regarding state funding and policies to support broadband. Currently, one-third of states do not have any direct state funding for broadband. SETDA recommends that these states provide state funding for broadband to leverage grants and the expansion of the E-rate program through 2018. States can learn more about E-rate modernization in SETDA's E-rate Modernization toolkit. SETDA also recommends that states leverage policies, networks, and purchasing options to support increased broadband access in schools. In this section, stakeholders can learn about some of the state strategies for increasing broadband access for all students:

- Provide direct state funding for broadband support and E-rate match
- Enact state policies to support deployment and adoption
- Create and/or expand state broadband networks for economies of scale
- Utilize innovative purchasing options for buying power

Provide Direct State Funding for Broadband Services, Including Funding for the E-rate Match

Nearly two-thirds of states reported that they provide direct state funding for broadband. This funding provides support to LEAs for broadband expenses not covered by E-rate and to support broadband construction for expansion and upgrades. Despite this, there are still issues of access in some states. In order to achieve SETDA's connectivity targets, the state executive office and legislators need to be leaders and partners in planning and implementing broadband expansion and upgrades.

The Schools, Health & Libraries Broadband Coalition's (SHLB) *Connecting Anchor Institutions: A Broadband Action Plan* outlines several approaches for improving broadband access, funding, and infrastructure for all communities. The report states that the biggest barrier to acquiring high-capacity broadband is often the up-front deployment costs. Funding can be provided directly to Community Anchor Institutions (CAIs), network providers, or nonprofit organizations that reallocate the funding to others.[5]

Alabama Leverages State Funds for E-rate Match

The governor, state legislature, Alabama Education Technology Association, and other state education technology stakeholders worked together to pass a bill, Alabama Ahead Act (AAA), that would leverage E-rate discounts. This legislation provided funding that prioritizes matching funds for E-rate, Wi-Fi, and wireless local area networks. Additionally, school systems can use the remainder of their allotted AAA funds to meet their identified needs within their approved technology plans. These needs may also include devices (student) and additional broadband connectivity. In 2016, the governor's budget proposed funding to cover the state match for the FCC's special construction-matching program in areas of broadband connectivity. That proposal was tabled for FY2016; however Alabama will

continue to look for new state funding sources. The ALSDE found lower pricing in Lit Fiber Services and hopes to take full advantage of these lower prices in conjunction with the statewide Mini-Quote process within the upcoming FY2017. Through the Alabama K-12 Joint (IT) Purchasing program, school systems have been able to use state master contract pricing combined with a Mini-Quote system for their E-rate applications for both Category 1 and Category 2 eligible services.

Maine Legislature Provides Grants to Support Unserved or Underserved Communities

The Maine legislature authorizes the Maine Public Utilities Commission to charge a universal services fee on certain telecommunications services, and to collect those funds to support *advanced* telecommunications services to schools and libraries for all that qualify. In addition, The ConnectME Authority is funded in a similar way and provides grants to providers and communities to improve infrastructure in order to provide service to unserved and underserved areas. High-quality internet connectivity for schools and libraries prompted the creation of the Maine Telecommunications Education Access Fund (MTEAF) and Networkmaine.

Minnesota Provides State Funding for Broadband Deployment in Unserved or Underserved Areas

Minnesota's Border-to-Border Broadband Development Grant Program provides funding for the expansion of broadband service to unserved or underserved areas. The program provides state funding for new and existing providers to invest in infrastructure. In 2016, within the $35 million fund, there is $500,000 for projects that include availability and adoption in low-income areas, and $5 million for underserved areas. Grants can provide up to 50% of project development costs, and the maximum grant amount is $5 million.

Enact State Policies to Support Deployment and Adoption

Nearly 60% of states have broadband policies, opening the door for expanding broadband access for all students. Policies may include recommendations for system architecture standards, bandwidth, and/or security standards.

Oregon Looks to the Future to Provide Robust Access to All Schools

Oregon is in the early stages of coordinating across state agencies to provide robust high-speed broadband access to all schools. Oregon is working with Education Superhighway to collect data to determine where each district stands in terms of access to high-speed broadband, level of service, and cost. The Oregon Broadband Advisory Council is using this data, along with information around networks that serve fire and safety, telehealth, and emergency management services for a conversation about building a network or system that meets the needs of all state agencies and the local communities. In 2015, the Oregon Department of Administrative Services coordinated a Request for Information (RFI) to identify options for broadband services to support 1,200 state agency office locations across Oregon, and included a secondary option for vendors to demonstrate how they might also support over 2,000 schools across the state with high-speed internet and broadband services.

Pennsylvania Statute Requires Universal Broadband Deployment in Public Schools

Pennsylvania statute requires universal deployment of broadband by all Incumbent Local Exchange Carriers (ILECs). As a result, every Pennsylvanian should have access to broadband services, even in the most rural areas. The law also requires universal broadband deployment in or adjacent to public rights-of-way abutting all public schools, including the administration offices supporting public schools, industrial parks, and health care facilities. Further, the law creates funding streams and programs to advance deployment, prioritize build-out to areas with the most demand, and foster adoption and utilization of broadband.

Create and/or Expand State Broadband Networks for Economies of Scale

More than one-half of states reported that they have centrally-coordinated statewide broadband networks for education.

Connecticut Education Network Meets Increasing Bandwidth Needs While Reducing Costs

Statewide broadband networks can provide significant benefits to districts, including cost savings and increased bandwidth, as well as consistent levels of safety and security to comply with federal and state requirements. The Connecticut Education Network (CEN) provides low-cost, high-speed access to K-12 schools serving more than 550,000 students and 40,000 teachers and staff. CEN also serves 36 colleges and universities, 161 libraries, and several government agencies. The CEN continues to meet increased demands of 1-to-1 learning environments and online testing while keeping operational costs level, resulting in a dramatic drop in bandwidth costs. CEN also provides its members cost-recovery model operations; free content filtering for all K-12 students; and proprietary peering agreements that keep paid circuit costs to approximately 10% of bandwidth usage.

Kentucky Education Network Provides Fiber-Base Connectivity to All School Districts

The Kentucky Education Network (KEN) is an education centric network that provides fiber-based connectivity to every K-12 school district via a Private Cloud for access to the internet, internet2, WiFi, and several statewide shared services, such as student information systems, financial management systems, and Windows server update services. Some of the other statewide, shared services offered to all K-12 school districts include voice, data, video, electronic mail, and educational resources for students, teachers, and administrators within a highly secure environment. KEN provides statewide anti-virus, DDoS protection firewall, internet content management and VPN access as well. The KEN private cloud also seamlessly connects to other statewide networks including public library, public healthcare, workforce development resource centers, all public universities and community colleges, and some Kentucky private colleges and universities. The $18 million network is funded through the state grant program, E-rate, and direct state aid. The Kentucky Department of Education manages the high-speed network in coordination with Commonwealth Office of Technology and serves 719,297 students.

Utah's Statewide Network Serves Education, Libraries, Government, and Health Entities

The Utah Education Telehealth Network (UETN) is a statewide consortium serving public education, higher education, applied technology, libraries, government, and other public entities in three main categories: networking services, application services, and support services. The state broadband network manages UETN and the primary funding sources are E-rate and direct state funding. UETN currently serves approximately 700,000 educators and students. Ninety-seven percent of LEAs use the network and 97% use it for internet. Utah reports that the network is used for: account administration, CIPA content filtering, internet access, and access to administrative software servers, internet 2, Network management, student management system, and telecommunication services.

Utilize Innovative Purchasing Options for Increased Buying Power

Several states utilize innovative purchasing options to increase capacity and reduce costs. Over time, costs have decreased dramatically even as capacity has increased tremendously.

New Jersey Statewide Purchasing Consortia Shows Significant Cost Savings

Launched in 2014, The Broadband Component of the Digital Readiness for Learning and Assessment Project (DRLAP) created a regional purchasing consortium for telecommunications services to help

schools collaborate in order to bring down the cost of high-speed broadband services; offer basic internet service (up to 100 Mbps) and high speed (over 100 Mbps); and help establish a statewide WAN through regional consortia for internet services as well as for other services. The initial consortia contracts resulted in $89 million in savings for participating schools while increasing bandwidth by 150%. New Jersey continues to provide support for the initiative, which is now in its second year. For more information see the full report.

Wyoming's Procurement Innovation Leads to an Increase in Capacity

The current major sources of funding for high-speed/broadband connectivity for districts are state funding through the school finance resources block grant, and the E-rate program. Through procurement innovation, new contracting vehicles were developed by Wyoming, enhancing the way the state engages ISPs and other vendors. A result of this innovation, there has been a 96% increase in capacity. In 2011, only two school districts had Ethernet capability; now all 23 counties and 48 school districts have Ethernet.

Summary and Next Steps

SETDA's recommendations concentrate on the need for improving K-12 infrastructure for learning in the digital age. Shifting the learning model to meet the needs of each individual student imagines new learning spaces both in and outside of school. As we prepare our students for both college and careers, education leaders and policy makers should not rest until each student is provided a personalized, equitable learning experience both in and outside of school. Education leaders should continue to collaborate with communities to ensure that all students have broadband access anytime, anywhere. Lastly, leaders must consider the ever changing ecosystem of technology tools and resources and how innovation impacts access at school, at home and in the community.

> ***States need to stay committed to seamless broadband access both in and out of school so that all students may have the opportunity to leverage the power of digital tools and resources.***
>
> –Candice Dodson, Director of eLearning, Indiana Department of Education

APPENDIX A: METHODOLOGY

SETDA asked multiple states to provide information regarding connectivity and utilization across the entire K-12 school base in order to build recommendations for ISP connectivity in this updated report. Eight states provided detailed, per district utilization data and a number of additional states also provided both aggregated statewide data and anecdotal feedback.

For the states where detailed per district utilization information was provided, we analyzed that data using a combination of 95th percentile traffic data on the downstream (towards the district) portion of the circuit as well as peak and average utilization data for March, April and May 2016. Peak, average and 95th percentile utilization data was then grouped by district enrollment and analyzed across states to understand the relative variances in actual utilization between various populations. While there were minor variances between states, a pattern showing roughly 45% more utilization per student at peak times for a district with 50 to 999 students as compared to a district with 2,000-2,999 students. Similarly, districts with 10,000 or more students utilized between 24% and 33% less utilization per student at peak than the same 2,000-2,999 student district.

Students (up to)	Observed Size Factor Peak
50	**5.62**
1,000	**1.45**
2,000	**1.09**
3,000	**1.00**
4,000	**0.73**
5,000	**0.70**
10,000	**0.76**
more	**0.67**

The team reviewed the actual peak utilization per student across the entire data set and found that the peak district currently utilizes about 500 Kbps at the end of the 2015-2016 school year. This observation fits with SETDA's previous recommendation of 1 Mbps per student or 1 Gbps per 1,000 students in the 2017-18 school year. Projecting utilization forward using a mix of annual growth projections ranging from 35% per annum to 65% per annum, we were able to come up with the recommendations we publish in this paper of 3 Gbps per 1,000 students at a district with 2,000-2,999 students. The recommendations for the lower and higher population districts were calculated using the observed size factor provided above.

Students (up to)	Size Factor (Peak)	2015-2016	2017-2018	2020-2021
1,000	**1.45**		1.49	4.35
3,000	**1.00**	0.50	1.02	2.99
more	**0.67**		0.68	2.00

APPENDIX B: FEDERAL PROGRAMS/INITIATIVES THAT SUPPORT SCHOOL ACCESS

As technology becomes more and more a part of daily life, policy makers are embracing digital learning opportunities. The 2016 Every Student Succeeds Act (ESSA) specifically addresses digital learning and the 2016 National Education Technology Plan identifies the essential components necessary to support learning: ubiquitous connectivity, powerful learning devices, high-quality digital learning content, and Responsible Use Policies (RUPs). Three specific resources are listed below:

ConnectED: In June 2013, President Obama unveiled the ConnectED initiative to "enrich K-12 education for every student in America." In February 2014, the President announced more than $750 million in commitments from seven private sector companies to deliver cutting-edge technologies to the classroom. Some of the offerings as part of that program include support for access to broadband and Wi-Fi access.

- AT&T: As part of the White House ConnectED Initiative, AT&T is providing 50,000 students and teachers in Title 1 schools with $100 million of free mobile broadband access, mobile device management, network filtering, and teacher professional development for three years for each selected school.
- Sprint Corporation: Through Sprint's in-kind support of ConnectED, up to 50,000 K-12 students across the US will be able to take advantage of their school's digital learning curriculum and resources outside the classroom.

Dear Colleague Letters: Richard Culatta, Director, Office of Educational Technology, Dept. of Education, Dear Colleague Letter: Examples of how funds from ESEA (Titles I, II, III) and IDEA may support the use of technology to improve instruction and student outcomes. Catherine E. Lhamon, Assistant Secretary for Civil Rights, Dept. of Education, Dear Colleague Letter: Ensuring that students of all races and national origin backgrounds have equal access to effective teaching, adequate facilities, and quality instructional programs and support, including off-campus internet connectivity.

E-rate: Since 1997, the Federal Communication Commission's (FCC) Universal Service for Schools and Libraries Program (often referred to as E-rate) provides most schools and libraries with discounted rates for specific services and products related to telecommunications services, telecommunications, internet access, internal connections, and basic maintenance. The amount of the discount depends on the level of poverty and location of each individual school or library. Schools and libraries can research their E-rate eligibility here. In 2014, after over a year of deliberation, the FCC commissioners updated the E-rate program by implementing programmatic changes to increase the efficiency and effectiveness of the program, ensuring E-rate funds are spent smartly, improving program administration, focusing on closing the Wi-Fi gap, and dramatically increasing funding for school broadband while transitioning support away from legacy technologies to 21st century broadband connectivity. The updating took place in two phases. On July 11, 2014, the FCC adopted the First E-rate Modernization Order (see order summary) and on December 11, 2014, the FCC adopted the Second E-rate Modernization Order (see order summary). SETDA and Common Sense Kids Action published an E--rate Modernization Toolkit in 2015 to support schools and districts in navigating the new program.

APPENDIX C: RESOURCES

Broadband and Wi-Fi Guide to Implementing Digital Learning (SETDA):

With the influx of new technology and increased connectivity, focused strategic planning is more important than ever to ensure digital learning opportunities for all students and educators. Most school districts have made investments in technology equipment, bandwidth and networking, training teachers, and supporting both the technology and those using it.

Broadband Progress Report 2016 (FCC)

The 2016 Broadband report reveals that there are significant improvements in broadband deployment, but the digital divide persists. Connectivity for schools has improved since the FCC modernized the E-rate program; however, 41% of schools still have not yet met the FCC's short-term goals of 100 Mbps/1,000 students for connectivity capable of supporting digital learning.

Broadband Technology Opportunity Program (BTOP)

Administered by the Department of Commerce's National Telecommunications and Information Administration (NTIA), the Broadband Technology Opportunities Program (BTOP) was a game-changing program for many states that had been lacking broadband connectivity. It provided $4.7 billion in grant funds to support the deployment of broadband infrastructure in unserved and underserved areas, to enhance broadband capacity at public computer centers, and to encourage "sustainable adoption of broadband service."

BroadbandUSA

Earlier this year, NTIA launched BroadbandUSA to provide communities with technical and strategic advice on how to expand broadband access and adoption. As part of this new initiative, NTIA developed the *Guide to Federal Broadband Funding*, a comprehensive manual of federal broadband funding opportunities and information about state and local funding sources. The guide details a wide range of opportunities. While the guide is not meant to provide an exhaustive list of all federal funding opportunities, it can serve as a starting point for communities to explore potential federal financing options.

ConnectALL

In 2016, President Obama launched the ConnectALL initiative to help Americans get online and have the tools to take full advantage of the internet. This program submitted recommendations to the FCC, encouraging that they reform a $1.5 billion per year phone subsidy program and turn it into a 21st century national broadband subsidy, to help low-income Americans get online. Alongside this FCC filing, the administration is releasing a new study on the economic importance of broadband.

ConnectED

In June 2013, President Obama unveiled the ConnectED initiative to "enrich K-12 education for every student in America." In February 2014, the President announced more than $750 million in commitments from seven private sector companies to deliver cutting-edge technologies to the classroom. Some of the offerings as part of that program include support for access to broadband and Wi-Fi access.

- AT&T: As part of the White House ConnectED Initiative, AT&T is providing 50,000 students and teachers in Title 1 schools with $100 million of free mobile broadband access, mobile device management, network filtering, and teacher professional development for three years for each selected school.
- Sprint Corporation: Through Sprint's in-kind support of ConnectED, up to 50,000 K-12 students across the US will be able to take advantage of their school's digital learning curriculum and resources outside the classroom.

ConnectHome

In 2015, to support increased broadband access at home, the White House launched the ConnectHome Initiative, a pilot initiative to help accelerate broadband adoption by children and families living in HUD-assisted housing. Collaboration between local governments, ISPs, nonprofit organizations, and other stakeholders offers broadband access, devices, technical training, and digital literacy programs for residents in assisted housing units. Twenty-seven cities and one tribal nation are participating in the pilot program. Connected Nation Provides Broadband Planning Services for States and Communities Connected Nation focuses on closing the digital divide and provides broadband planning services for states and communities. Specifically, Connected Nation promotes digital literacy by joining public and private partners in programs that help underserved populations overcome barriers to technology adoption. Connected Nation also provides research and analysis of broadband deployment and adoption across the nation.

Connecting Anchor Institutions: A Broadband Action Plan (SHLB)

This plan outlines several approaches for improving broadband access, funding, and infrastructure for all communities. In this series of 10 papers, the SHLB identifies the common themes of sharing, promoting competition, and funding strategies.

CoSN Digital Equity Toolkit

In 2016 CoSN launched the Digital Equity Action Agenda initiative. This effort highlights how some school districts are building meaningful community partnerships and creating tools to help district leaders get started in achieving digital equity. The free toolkit highlights major strategies by school systems to address digital equity/homework gap.

Digital Opportunity Center

Leading efforts to close the digital divide for digital equity, to alleviate poverty, and to address other vital social challenges.

Distance Learning and Telemedicine Loan and Grant Program (DLT)

DLT provides funding to meet the educational and health care needs of rural America. Through loans, grants and loan/grant combinations, advanced telecommunications technologies provide enhanced learning and healthcare opportunities for rural residents. Eligible purchases include: interactive video equipment, audio and video equipment, terminal equipment, data terminal equipment, inside wiring, computer hardware and software, computer network components, acquisition of instructional programming that is a capital asset, acquisition of technical assistance and instruction for using eligible equipment.

E-rate Modernization Resources (SETDA and Common Sense Kids)

SETDA and Common Sense Kids Action developed several resources to support state and local policy makers and digital leaders as they navigate the modernized E-rate program. Key highlights of the modernized program include: lit services special construction, dark fiber options, self-provisioning, state match, and Category Two Wi-Fi.

Every Student Succeeds Act

The ESSA reauthorizes the 50-year-old Elementary and Secondary Education Act (ESEA), the nation's national education law and longstanding commitment to equal opportunity for all students. The new law builds on key areas of progress in recent years, made possible by the efforts of educators, communities, parents, and students across the country.

Every Student Succeeds Act: A Progress Report on Elementary and Secondary Education, *Executive Office of the President, December 2015*

This report summarizes the progress the country's schools have made since 2008, including: adopting higher academic standards in nearly every state, increasing high school graduation rate to 81%, investing billions of dollars in high-quality early education, training 100,000 excellent STEM teachers, and expanding access to high-speed internet to 20 million more students.

FCC Expands Rural Broadband

The FCC took steps toward investing an additional $2 billion in rural networks over the next decade when the Commission adopted items to establish market forces to expand broadband in targeted rural areas through an auction. The auction seeks to expand service to census blocks unserved by broadband, delivering speeds of 10 Mbps downloads/1 Mbps uploads in 20 states where the price cap carriers declined last year's Connect America Fund offer. Also included in the auction are locations across the country with extremely high deployment costs.

Funding Mobile Broadband to Close the Homework Gap

In this blog, Kajeet provides an overview of the top 15 federal funding programs that can be utilized for connectivity solutions. It includes Title 1, Part A, Race to the Top, School Improvement Grants, Title 1, Part C, among others.

Kajeet

Kajeet provides a safe, affordable, mobile broadband solution called Education Broadband™ that connects disadvantaged students to the internet outside of school. It includes a Kajeet SmartSpot® device and Sentinel® cloud portal with controls that enable school districts to provide CIPA-compliant filtered Internet access.

Lifeline

The FCC's Lifeline program provides millions of families with discounted monthly telephone service. On March 31, 2016, the FCC voted to modernize the program to include broadband access. For the first time, Lifeline will support stand-alone broadband service as well as bundled voice and data service packages to help provide low-income Americans with access. In addition, for the first time, Lifeline has an option to purchase for an entire building. Plus, the FCC is developing a Digital Inclusion Plan.

Mobile Beacon

Mobile Beacon's i3 internet Inclusion Initiative offers many grants, pilot program opportunities, and device donation programs to help lower the cost of mobile broadband access for schools, libraries, and nonprofit organizations across the US. Schools, libraries, and other community anchor organizations can now become an i3 enrollment partner and offer Mobile Beacon's $10/month, unlimited LTE service directly to students from low-income families.

National Broadband Plan

The National Broadband Plan, released by the FCC on March 17, 2010, sets out a roadmap for initiatives to stimulate economic growth, spur job creation and boost America's capabilities in education, health care, homeland security and more. The plan includes sections focusing on economic opportunity, education, health care, energy and the environment, government performance, civic engagement and public safety.

National Broadband Map
The National Broadband Map (NBM) enables users to view broadband availability through a searchable website. The NTIA, in collaboration with the FCC, and in partnership with 50 states, 5 territories, and the District of Columbia created the NBM.

National Education Technology Plan
The 2016 NETP plan articulates a vision of equity, active use, and collaborative leadership to make everywhere, all-the-time learning possible.

Navigating the Shift: Mapping the Acquisition of Digital Instructional Materials (SETDA)
This research paper provides an analysis of state policy trends related to digital instructional materials, essential conditions for implementation, an update on the states' progress towards SETDA's Out of Print recommendations, and highlights several next steps for consideration as leaders move to advance the learning experiences in the digital age.

Next Century Cities
Next Century Cities is a project of New Venture Fund, a 501(c) (3) public charity. Next Century Cities supports community leaders across the country in developing gigabit level internet to attract new business and create jobs, improve education and health care, and connect residents to new opportunities. Since 2014, Next Century Cities is now helping 144 cities across the US to build next-generation internet networks to support their communities.

Infrastructure: Roadmap for 21st Century Learning Environments
The Roadmap provides a strategic approach to building a robust infrastructure.

Schools, Health & Libraries Coalition
The Schools, Health & Libraries (SHLB) coalition supports affordable, high-capacity broadband connections for anchor institutions and their surrounding communities. SHLB also supports federal initiatives to support broadband and works with the FCC to promote capital investment in the E-rate reform.

Stories of EdTech Innovation
These stories of innovation can connect districts, schools, and educators trying similar strategies so that they can learn from each other's experiences.

Technology in Education: An Overview
This article presents an overview of the trends, opportunities, and concerns associated with classroom technology.

The Next Generation Network Connectivity Handbook, July 2015 (Gig.U)
The Next Generation Network Connectivity Handbook is primarily focused on community-led broadband, usually through a public-private partnership. For example, a city negotiates with a private entity to design, deploy, maintain, and/or operate a broadband network.

The Quilt
The Quilt is a national coalition of regional networks for research and education, representing 36 networks. Participants in The Quilt provide advanced network services and applications to universities and other educational institutions. The Quilt facilitates collaboration; advocates for regional networks, and helps regional networks leverage buying power.

APPENDIX D: EXEMPLARS

Shift in Learning Models Exemplars

Business Demand for Skilled Employees Inspires Robotics STEM Academy

Bridgerland Applied Technology Center, in Cache County, Utah is an example of a Utah Education and Telehealth Network (UETN) connected institution that serves multiple districts and high schools in northern Utah. The recently established Robotics STEM Academy leverages UETN gigabit broadband connection, to access UETN's collaborative distance education technology, and provides face-to-face instruction. The industry demand for robotics technicians locally is high, with over 600 robots manufactured at one company. Local businesses approached the district to establish a robotics class because they need employees that could repair and program the robots on a day-to-day basis. Last year, the school met with industry leaders and directors from all of the surrounding school districts to develop a robotics program and create degree opportunities for students. Students learn about drone technology, build their own small robots, and program the large industrial robots via eight different locations that connect through the Bridgerland Applied Technology Center. Learn more and watch the video.

Wayne Township Leverages Infrastructure for Personalized Learning

Indiana's Metropolitan School District of Wayne Township (Wayne) has made learning a priority. Wayne is leveraging its infrastructure to ensure that all of its students have access to personalized learning opportunities that meet their specific educational needs. With a free and reduced lunch rate of 78%, many of Wayne's students deal with external issues that ultimately put them behind their peers. As such, Wayne's Superintendent Dr. Jeff Butts and Chief Technology Officer Pete Just made the accessibility of engaging and effective digital content a priority, boosting Wayne's infrastructure to deliver two Gbps of Internet access through two points of access, with the ability to double that as needed. Providing every student with seamless and reliable access to accelerated learning opportunities—such as 1-to-1, asynchronous and synchronous online coursework—has enabled Wayne's students to cultivate their own learning pathways. Additionally, Wayne created its *Bridging the Gap* program to help provide its students with home Internet access. Through this program, students and their families receive a free PC or laptop as well as a sharply discounted rate with their local home Internet service provider. MSD Wayne's formula for success is working. *In 2006, Wayne's graduation rate was 65%. Today, it has climbed to more than 94%.* While that is a significant accomplishment for any school district, it is especially impressive given MSD Wayne's size, student mobility, and economic climate.

Cornerstone Academy Uses Online Curriculum to Differentiate Instruction for ESOL Students

Cornerstone Academy Preparatory School is a public charter elementary school in San Jose, California. The school was founded in August 2010 and has 453 students in kindergarten through sixth grade. Many of the school's students speak a language other than English at home and over three-fourths qualify for free or reduced lunch programs. Realizing the importance to its population of technology access, the school adopted a technology plan in 2014. Cornerstone partnered with the Franklin-McKinley School District to provide a 200 Mbps connection to the building, and installed industrial-grade wireless access points in all classrooms. Pursuant to the plan, during the 2014-2015 school year, Cornerstone hired a blended learning director and implemented a 1-to-1 rotational blended learning model that allows teachers to provide differentiated, small group instruction to all

scholars. During the school's morning Reading Power Hour, all students use Chromebooks to access the online English Language Arts curriculum to read and respond to texts, practice new vocabulary, and write collaboratively. Throughout the day in all subjects, teachers use Google Classroom, Google Apps for Education, online adaptive learning programs, and other technology resources to improve learning and to differentiate instruction. For professional development and coaching, teachers and coaches share videos.

Flexible Network Exemplars

St. Vrain Utilizes Views Infrastructure as an On-Going Investment

The St. Vrain Valley School District is the seventh largest school district in Colorado and operates 55 schools with more than 32,000 students, spread over 411 square miles. St. Vrain is nationally recognized as a STEM leader, having won the Invest in Innovation Grant (i3) as well as receiving one of 16 Race to the Top grants. St. Vrain is also known for its thoughtful use of video self-reflection as part of teacher professional development as well as a comprehensive and unique Learning Technology Plan which leverages iPads, Chromebooks, Macs, and PCs. To accomplish this, SVVSD has a proactive infrastructure philosophy that views bandwidth, network gear, and state-of-the-art wireless infrastructure as ongoing investments with planned replacement cycles rather than periodic capital expenses. Staff and students experience pervasive Wi-Fi in 100% of school classrooms and benefit from a 10 Gbps fiber-optic network and over 3.5 Gbps of internet service across two internet service providers, which provides logical and physical redundancy for mission critical web access. All teachers have a MacBook Air as well as a mounted projection system, which enables 21st century learning opportunities.

Addison-Rutland Builds Own Fiber-Optic Network

Addison-Rutland Supervisory Union (Addison-Rutland), located in Fair Haven, Vermont, committed to building and sustaining a robust, commercial-grade fiber-optic network to enable effective 21st century learning. The district previously received Internet access from a network of service providers, a system that required frequent cable modem reboots to establish connectivity. With a solid infrastructure now in place, Addison-Rutland deployed its 1-to-1 initiative in Grades 3–12. Teachers are using Google Classroom to create and organize assignments, provide timely feedback, and communicate with their students. Addison-Rutland's students are also getting hands-on technology experience with the district's 3D printers, by using online tools to design and print 3D models.

Shasta Elementary Network Upgrades Transform Teaching and Learning

In California, Governor Brown included $26.7 million (Senate Bill 852) in one-time funding to enhance broadband infrastructure for the schools with the most severe deficits. In 2014, Shasta Elementary was awarded BIIG grant funding to upgrade to a 1 Gbps fiber-optic circuit between the Redding School District and Shasta Elementary. Before the upgrade, Shasta could only run two or three browsers at the same time at their administrative offices. If the teacher needed to use the Internet in the classroom, the teacher had to coordinate with the district administrative office. Now math and science teachers are utilizing digital resources that they couldn't imagine a year ago. After the network upgrade, Shasta Elementary experienced a 100 times increase in Internet speed. Watch this video to see the changes in teaching and learning.

Maine's Cyberinfrastructure Enables All Students to Participate in Minecraft Programming

What better way is there to improve student engagement than to leverage something that already has a student's attention? A group of University of Maine researchers, in conjunction with a California startup

company, are leveraging the broad appeal of Minecraft, to teach students the basics of computer programming using *Blockly*, a visually based programming language. This project will reach nearly 1,000 Maine youth and 72 STEM educators in primarily rural and economically disadvantaged communities. This program takes advantage of Maine's 4-H STEM Ambassador network across the state, as well as the computational network and infrastructure. By utilizing the Maine Learning Technology Initiative's 1-to-1 program, the necessary devices are in the hands of Maine's students and network in the schools, and the supercomputing facilities at the University of Maine students can be reached on an equal basis, anywhere in the state. This allows small, rural, and economically disadvantaged schools to play on a level playing field. Maine is unique in having all the pieces in place and is serving as a national model of the benefits of a strong state-wide cyberinfrastructure for education.

Wireless Access Exemplars

North Carolina Takes Advantage of New E-rate Funds for Wireless Access

The North Carolina Department of Public Instruction in partnership with The Friday Institute developed the state's Wireless Infrastructure plan, which urged the state to take advantage of new E-rate funds through a state consortium. The approach was optimized against the FCC $150-per-student allocation, and sought out a mix of providers who could deliver wireless equipment, Ethernet switches, wiring, configuration, and install and manage services eligible under the allocation. In 2015, the state provided Wi-Fi to over 375,000 students at an average cost of only $116 per student (pre-discount).

New Mexico Applies Lessons Learned from Other States for Wi-Fi

This program applied lessons learned from North Carolina and Alabama to aggregate buying power for Category 2 (Wi-Fi and networking equipment). The statewide master contract, accessed by all school districts and libraries has resulted in greater discounts than previous statewide contracts. Alabama has offered its *Mini-Quote* system to New Mexico, which functions like "eBay in reverse" as vendors compete with transparency on price in response to district requests against this contract. The 2016 funding year has seen more charter school participation in the E-rate program and an increase in pre-discount of about $15 million.

Prince George's County Provides Wireless Access in All High Schools

Prince George's County Public Schools (PGCPS) is the second largest K-12 school district in Maryland, serving over 129,000 students. PGCPS' Division of Information Technology plays an integral role in the support of the district's overall digital learning vision through the availability of infrastructure, devices, support, and training. PGCPS focused its attention on mobile devices—both personal and district-issued—supporting more than 100,000 devices with its robust infrastructure. The district installed wireless in its 210 schools and 20 administrative and maintenance buildings. Every elementary school currently has 100 Mbps of WAN access and every high school and middle school has 1 Gbps of Internet access.

Kingsport City Schools Installs Wireless Network Covering the Entire District

Kingsport City Schools (KCS), located in northeast Kingsport, Tennessee, serves approximately 7,200 students and is comprised of 13 schools. KCS utilizes D-B EXCEL, a newly designed, virtual and blended learning program for high school students. Recognizing the power of digital learning, KCS' robust technology vision is designed to meet its students' individual instructional needs. Infrastructure and professional learning are two key areas where the district has focused its attention. To support its district-wide BYOD initiative and burgeoning 1-to-1 program, KCS installed a wireless network covering the entire district. KCS also installed a new web filter to provide content filtering on

all student devices, and it upgraded its Internet access to 1 Gbps. Additionally, KCS deployed Wi-Fi on five of its school buses, providing additional learning opportunities to its students who have longer bus routes. Technical support for the district's technology vision is provided through personnel at the district and school level, as well as via students who are trained and capable of providing such support. Visit the KCS website for more information.

Fraser Public Schools—Where Learning Drives Innovation Robust Wi-Fi Infrastructure

Fraser Public Schools, located in Fraser, Michigan, serving approximately 5,400 students, is a school district dedicated to blending traditional offerings with the best digital resources to customize each student's learning experience. Through advanced technology in all classrooms, personalized iPads for all students K-12, and hybrid course offerings, Fraser Public Schools continues to blend the traditional school model with the best digital resources. The district has deployed a robust Wi-Fi infrastructure while actively monitoring access point response times and proactively addressing bandwidth issues and Wi-Fi coverage. District Internet access is 10 Gbps and district buildings are connected via a 10 Gbps WAN. Fraser's 1-to-1 iPad initiative enables teachers to create an environment that extends beyond the traditional classroom while allowing students to experience flexibility in learning, pacing, and demonstrating their understanding. With the strategic use of a learning management system, Fraser Public Schools teachers are able to leverage technology to allow students the ability to move at their own pace anytime, anywhere. Additionally, teachers are able to provide content and use high-impact teaching strategies to increase the rigor of student learning. Utilizing technology, students in Fraser are truly empowered and make choices about their learning on a daily basis.

Community Partnerships Exemplars

Forsyth County Schools Partners with Chamber of Commerce to Host Wi-Fi Directory

Forsyth County Schools (FCS) in Georgia serves over 42,600 students and is the largest employer in the county with over 4,300 full-time employees and 1,300 substitutes. The majority of the district's secondary students had mobile devices. However, students were unable to use their devices once they left the school's wireless network and many did not have a home computer with broadband access for more complicated assignments. The district partnered with the Cumming-Forsyth County Chamber of Commerce to create a Free Wi-Fi Directory for students. This online directory posts a list and interactive map of free Wi-Fi hotspots, sponsored by organizations and businesses in Cumming-Forsyth County. The directory is both for the district's more than 39,000 students and all residents and visitors.

Kansas City Public Library Pilots Mobile Hotspot Lending Program

Nearly 70% of children in Kansas City School District do not have internet access at home. In response, the Kansas City Alliance for Digital Inclusion was formed as a joint community effort involving the school district, public library, and a variety of like-minded nonprofits, local businesses, and internet providers. The Alliance's mission is to maximize collaboration and impact among local organizations and initiatives to bridge the digital divide. The Alliance helps leverage existing digital service infrastructure/programs and work across organizations and traditional boundaries. One example of cross-boundary outreach occurred in the 2015-16 academic year. The Kansas City Public Library (KCPL) partnered with Kansas City Public Schools, Literacy Kansas City, and Connected for Good to pilot a mobile hotspot lending program. Students in two urban high schools who have

challenges in accessing digital content outside of the school day are able to check out laptops and 4G LTE mobile hotspots with free, unlimited 4G LTE data plans. Mobile Beacon awarded the grant to Kansas City Public Library for this pilot program.

District Provided Home Internet Access

South Carolina – Internet Home Access in Richland's District Two

Richland District Two is committed to integrating technology into the classroom and ensuring that technology is available to all of their students outside of the classroom. Most students have their own devices through BYOD or laptop loans from the school. The district used mapping data to determine which families lacked home internet access. After identifying the 25 families, mostly Hispanic, many of whom were first generation immigrants, Richland Two partnered with Kajeet to offer internet hot spot devices to the families with filtered internet broadband. When providing the devices to the family, the district explained that it was not only for students to complete homework, but also for the entire household to use to access community resources. http://www.kajeet.net/engage-parents-richland-two

Albemarle County Public Schools Provides Broadband to Students Living in Areas Without an Internet Service Provider

Albemarle County Public Schools (ACPS) in Virginia repurposed the Educational Broadband Service (EBS) spectrum for home connectivity. ACPS is geographically diverse, encompassing urban and rural communities with areas of poverty and low levels of both broadband access and adoption. About two years ago, CTO Vincent Scheivert discovered that ACPS owned EBS licenses that they could use to bring community broadband to students living in remote areas without a current broadband provider. Over an eight-mile area, ACPS partnered with local police and fire agencies to successfully provide bandwidth to unserved families. The district is working to expand the program to public housing agencies and plans to extend this WiFi/spectrum usage to all students. ACPS hopes to use E-rate funds to address the out-of-school access problems, and has appealed to the FCC for a waiver.

District 87 Uses Curriculum Funds to Provide District Internet Connections to Students at Home

In Bloomington, Illinois, District 87 equips every student in sixth, seventh, and eighth grades with a device for learning that they use at school and at home. However, more than one-half of the students are considered low-income and don't have Internet access at home. The superintendent recognized that not all students have the ability to access community wireless connections and that this is an equity and social justice issue. The district decided to repurpose curriculum budget funds to provide Internet connections for students who qualify for free or reduced lunch. Households are connected to the district's Internet connection, enabling district filters to be in place.

Mobile Hot Spots

Arizona – Mobile Hotspots Provide Access for Vail School District

Vail School District began their mobile hotspot deployment with 1 school bus at $60 per month. Today they have 10 buses with mobile hotspots at a zero cost to the district. They are paying for the service via corporate advertising. The mobile WiFi hotspot enables the district to extend the classroom to the bus for the students to use their 1-to-1 computing technology to its fullest advantage during travel time to and from school which can be up to 45 minutes each way. They maintain CIPA compliance

by having all traffic routed back to the district internet server. Since this is a cellular-based technology, it's not limited to the Tucson area. Even on extended trips, students and faculty have access to email and assignments while on the road making the learning area as mobile as the corporate workforce. http://www.vailschooldistrict.org/#1461700961781-65d1c994-5f2b

APPENDIX E: GLOSSARY

Bits and Bytes

Bits and bytes are both units of digital information. A bit is the basic element; a byte is equal to eight bits. The terms kilobyte (KB), megabyte (MB), and gigabyte (GB) are typically used to indicate the size of a file or a program. The terms kilobit (Kb), megabit (Mb), and gigabit (Gb) are typically used to convey the rate at which data are transferred over a network, i.e., megabits per second, or Mbps.

Kilobit per second (Kbps) = 1,000 bits per second

Megabit per second (Mbps) = 1,000 Kbps

Gigabit per second (Gbps) = 1,000 Mbps

Cloud Computing

The term "cloud computing" refers to a computing model in which data, applications, and other computing resources are available on the Internet from just about any connected device. Another way to think of it: It's computing delivered as a service.

Personalized Learning

Personalized learning refers to instruction in which the pace of learning and the instructional approach are optimized for the needs of each learner. Learning objectives, instructional approaches, and instructional content (and its sequencing) all may vary based on learner needs. In addition, learning activities are meaningful and relevant to learners, driven by their interests, and often self-initiated. http://tech.ed.gov/netp/learning/

Speed vs. Capacity

When we say that a 1 Mbps broadband connection is "faster" than a 1 Kbps connection, what we're really saying is that it has a greater capacity to carry data. The 1 Kbps connection can deliver a maximum of 1,024 bits of information to your computer from the Internet in a second; a 1 Mbps connection can deliver 1,024 KB in a second. Although the bits are moving at the same speed (more or less), one connection delivers more in the same amount of time, so it feels faster to the end user. This capacity is referred to as bandwidth.

Throughput

The actual amount of data that gets transmitted from a PC, through the collection of networks known as the Internet, to the web server—per second—is what is known as throughput. Throughput rates vary, depending on traffic and other factors, but it will always be lower than the speed quoted by the ISP providing the connection. Think of that number as the fastest possible speed under ideal circumstances.

Virtualization

The next generation network, emulates the functions of hardware with software. The network is powered by technologies that include software-defined networking (SDN) and network functions virtualization (NFV). With this approach, administrators can add capacity faster to meet demand.

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