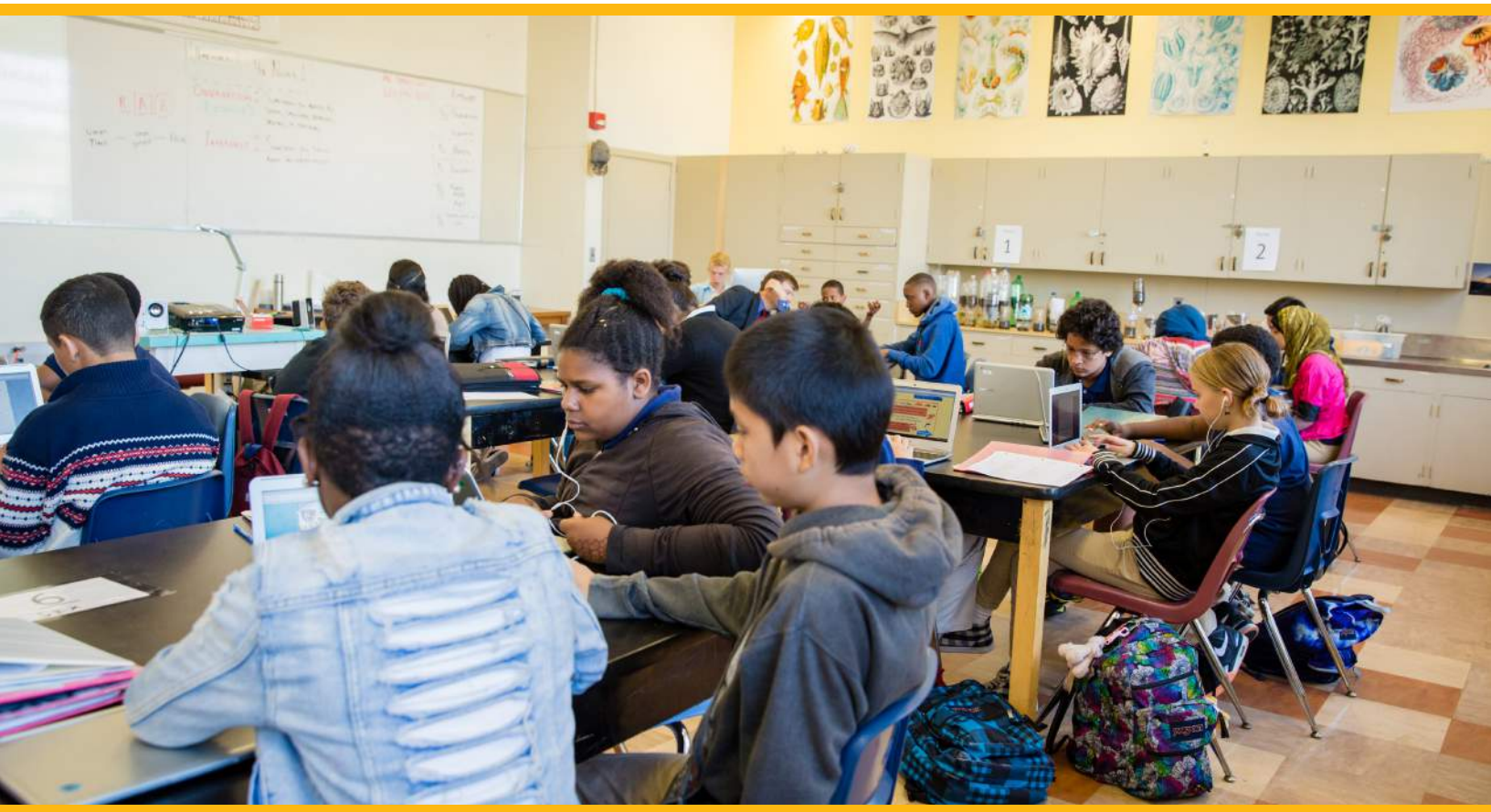
Education SUPERHIGHWAY



November, 2015

2015 State of the States

A report on the state of broadband connectivity in America's public schools

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2015 State of the States

Tracking progress towards upgrading the Internet access in every public school classroom in America so that every student has the opportunity to take advantage of the promise of digital learning

Introduction

The State of the States report tracks progress toward the K-12 connectivity goals established by the Federal Communications Commission (FCC)[1] and provides state leaders with the information they need to finish the job of connecting America's students to high-speed broadband. The report, which will be published annually, does this by reporting on national and state progress toward achieving connectivity goals and the key requirements for meeting future connectivity needs: access to fiber or equivalent high-speed infrastructure, sufficient Wi-Fi equipment in classrooms to support 1:1 digital learning, and affordable pricing.

States are critical actors in the effort to provide and improve broadband access for K-12 students. School connectivity is often strongest in those states where focused action has been taken by state leadership and state agencies. For that reason, this report provides insights broken down by state to help state leaders see where they stand relative to the FCC connectivity targets, understand potential actions they can take to dramatically improve broadband connectivity in schools, and find out what their state peers are doing.

The analysis in this report is based on application data from the FCC's Schools and Libraries Program ("E-rate")[2]. It includes data from 6,781 public school districts, representing over 25 million students in approximately 49,000 schools

[1] See FCC Report and Order And Further Notice of Proposed Rulemaking, WC Docket 13-184, released July 23 2014, ¶ 22-62, https://apps.fcc.gov/edocs_public/attachmatch/FCC-14-99A1.pdf

[2] The schools and libraries universal service support program, commonly known as the E-rate program, helps schools and libraries to obtain affordable broadband. Eligible schools, school districts, and libraries may apply individually or as part of a consortium. Funding may be requested under two categories of service: category one services to a school or library (telecommunications, telecommunications services, and Internet access), and category two services that deliver Internet access within schools and libraries (internal connections, basic maintenance of internal connections, and managed internal broadband services). Discounts for support depend on the level of poverty and whether the school or library is located in an urban or rural area. The discounts range from 20 percent to 90 percent of the costs of eligible services. E-rate program funding is based on demand up to an annual Commission-established cap of $3.9 billion. See FCC, E-rate, https://www.fcc.gov/encyclopedia/e-rate-schools-libraries-usf-program

across all 50 states. These applicants reported a total of $985 million in annual Category 1 broadband spending, corresponding to $667 million in funding requested from the E-rate program. All E-rate applications are subject to review before funds are distributed, ensuring that school districts strive to accurately reflect their purchases. As a result, this data represents the best national source of current information on school district connectivity. Specifically, what broadband services schools are buying and how much they are paying for these services.

In 2014, the FCC made all E-rate application data open for the first time[3]. EducationSuperHighway's team of 25 analysts, data quality specialists, and developers spent seven months verifying and analyzing this open data. Over this period, the team reached out to more than 5,500 E-rate applicants to clarify the broadband services contained in their applications, working closely with school districts, state partners, and E-rate consultants to verify data accuracy and completeness.

Our data verification and analysis efforts supplied us with a comprehensive understanding of connectivity for each school district included in the sample. State-level metrics were then calculated based on a sample of the total school districts in each state. As with any sample-based methodology, there is a margin of error that must be considered when interpreting state-level results. Regardless, we believe that this report serves as a critical foundation for understanding how states can improve connectivity in America's K-12 public schools. An understanding that we will build on in future years to help state leaders close the K-12 digital divide before the end of the decade.

A digital version of this report is available at www.educationsuperhighway.org/stateofthestates. This report is also only the beginning. To fully leverage the potential of the open E-rate data, we will make district-level connectivity and procurement information available in early 2016 when we launch ***Compare & Connect K-12***, an online tool designed to help school districts increase the effectiveness of their broadband procurement.

Reynolds City Schools, Ohio

An engineering and design academy in Ohio that includes digital devices, 3-D printers and laser cutters is taking hands-on learning at a Reynolds City Schools' high school to a new level. Students can also participate in real-world projects with local businesses and supplement in-person classes by enrolling in online courses.

[3] See FCC Report and Order And Further Notice of Proposed Rulemaking, WC Docket 13-184, released July 23 2014, ¶ 158-167, https://apps.fcc.gov/edocs_public/attachmatch/FCC-14-99A1.pdf

Highlights

The arrival of high-speed broadband in America's classrooms has unleashed the power of technology to provide equal access to educational opportunity. It is also ushering in a new era of teaching and learning that is enhancing teacher effectiveness, increasing student engagement, and improving academic outcomes. Specifically, technology is helping to personalize and differentiate learning for each student and meet the needs of every type of learner. It is increasing classroom efficiency, allowing teachers to maximize the time they spend on teaching and learning each school day. It is expanding learning beyond the classroom and providing new and innovative educational opportunities. It is reaching students who were otherwise being left behind. These changes are happening across the spectrum of America's schools, regardless of income level, ethnicity, or zip code but only in schools with sufficient broadband.

Twenty million more students were connected in the last two years.

In 2013, EducationSuperHighway reported that 40 million students[4] were without the broadband they needed for digital learning. At that time, only 30% of school districts were meeting the Federal Communications Commission's minimum Internet access goal of 100 kbps per student.[5] In the last two years, we have made tremendous progress, connecting an additional 20 million students. Specifically, 77% of school districts, representing 59% of schools, and 53% of students are now meeting the 100 kbps per student Internet access goal. Similarly, while less than 300,000 teachers had the tools they needed in 2013, approximately 1.7 million teachers now have the broadband they need to deliver a 21st century education.

These gains were driven in part by an increase in the amount school districts and states are investing in Internet access and more significantly by a decrease in the cost of broadband. Thanks to the FCC's modernization of the E-rate program in 2014, which increased the availability of broadband funding, total E-rate subsidies for Internet access rose 45% from $470 million to nearly $680 million from 2013 to 2015. More importantly, service providers dramatically increased the bandwidth they give schools for their broadband budgets. As a result, the median cost of Internet access declined 50% from $22 per Mbps in 2013 to $11 per Mbps in 2015.

Over 21 million students continue to be left behind.

Despite the progress being made, 23% of school districts are still not meeting the minimum FCC Internet access goal, leaving 21.3 million students without the connectivity they need for digital learning. The good news is that those left behind are not disproportionately rural or poor; the E-rate program has effectively leveled the playing field. Instead three main roadblocks are preventing these students from obtaining the connectivity they need: access to fiber, the affordability of broadband, and, in some cases, school district budgets. The data show the impact of these factors on connectivity:

- **Fiber:** School districts without fiber are 15% less likely to meet the FCC's minimum connectivity goals.
- **Affordability:** For school districts meeting the 100 kbps per student goal, the average cost per Mbps is $5.07, while those not meeting the goal pay more than double, $12.33.
- **Budgets:** The average Internet access budget per student in school districts meeting the goal is $4.93 annually. This is more than 2.4 times the budget per student for school districts not meeting the goal — those school districts are spending $2.08 annually.

[4] See EducationSuperHighway, Connecting America's Students: Opportunities for Action (April 2014), http://www.educationsuperhighway.org/wp-content/uploads/2014/11/Connecting-Americas-Students-K12-E-rate-Spending-Report-April-2014.pdf

[5] See FCC Report and Order And Further Notice of Proposed Rulemaking, WC Docket 13-184, released July 23 2014, ¶ 34, https://apps.fcc.gov/edocs_public/attachmatch/FCC-14-99A1.pdf

School districts that meet the current goal will fall behind if they don't keep up with the rising demand for bandwidth.

In schools using digital learning, bandwidth demand is growing at a rate of 50% or more per year[6]. In order to ensure that students and teachers continue to have the broadband they need to maximize the impact of technology in the classroom, the FCC established a future goal of 1 Mbps per student for Internet access[7]. Today, only 9% of school districts have this level of connectivity. As a result, the vast majority of school districts are going to need to aggressively grow their Internet access, with the typical school district needing to triple its bandwidth over the next three years.

To finish the job of connecting America's students to educational opportunity, we need to:

- **Connect 9,500 schools[8] to fiber.** To meet the FCC's 1 Mbps per student connectivity goal, 92% of schools will need a fiber optic connection. Today, 12% of schools that need a fiber connection do not have one[9]. We estimate that it will cost approximately $1 billion to connect these schools, a number well within the E-rate program's budget.
- **Make bandwidth more affordable.** Increased affordability, resulting from school districts purchasing at greater scale and negotiating more effectively, has been a major driver in the increase in the number of students with access to sufficient broadband. A continued focus on affordability, with a goal of lowering the average cost of Internet access to $3 per Mbps, can enable another 12.2 million students to meet the FCC's minimum Internet access goal. The $3 per Mbps price is already being achieved by nearly a third of the school districts buying 1 Gbps of bandwidth (an amount that 70% of school districts will need to buy) and is a price at which the E-rate program can support every district meeting the 1 Mbps per student goal.
- **Ensure school districts take full advantage of E-rate subsidies for connectivity and Wi-Fi.** E-rate modernization has made $3.9 billion per year available to upgrade the broadband in America's K-12 schools[10]. To ensure that all students have access to high-speed broadband in their classrooms, school districts must take full advantage of these resources. Of the school districts that are not meeting the FCC's minimum connectivity goal today, 11% will continue to be left behind even if they pay the target $3 per Mbps for Internet access. By leveraging E-rate and investing approximately $0.25 per student per year in additional connectivity, these school districts can provide the remaining 9.1 million students with enough broadband to meet the FCC's connectivity goals. Similarly, by effectively utilizing the $3.4[11] billion of funding available for internal connections over the next four years, school districts can ensure that every classroom has access to robust Wi-Fi.

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[6] See Bjerede, Marie, Krueger, Keith R. The Journal. "Network Capacity Growth: Plan for Exponential Increases." June 11th, 2015. https://thejournal.com/articles/2015/06/11/network-capacity-growth-plan-for-exponential-increases.aspx This article states growth of 60% per year. Based on the limited network monitoring data EducationSuperHighway has observed, we prefer the slightly more conservative estimate of 50% growth per year.

[7] See FCC, E-rate, https://www.fcc.gov/encyclopedia/e-rate-schools-libraries-usf-program

[8] Fiber metrics estimate the number of school campuses. Please see the Methodology for more detail.

[9] While 92% of school districts are expected to need fiber, 8% may find that another technology, such as cable, is sufficiently scalable to meet their needs.

[10] See FCC Report and Order And Further Notice of Proposed Rulemaking, WC Docket 13-184, released December 11, 2014, https://www.fcc.gov/page/summary-second-e-rate-modernization-order

[11] E-rate allows for up to $150 per student to be spent on Wi-Fi related equipment ("Category 2"), and will reimburse an appropriate portion of these monies based on the discount rate assigned to the district, which is set based on the affluence of the school. We know that $6.9 billion is available in Wi-Fi funding based on this $150 per student cap and the number of students nationwide. Of this, $2.2 billion has been spent. We therefore anticipate that $4.7 billion remains available. After adjusting for the discount rate, this yields $3.4 billion in anticipated available monies.

Thirty-eight governors have stepped forward to ensure their classrooms are connected to high-speed broadband.

Connecting America's students to high-speed broadband is a bipartisan issue that governors from both parties are embracing as a way to increase access to educational opportunity. When governors act, students win. EducationSuperHighway's research has shown that executive leadership can significantly accelerate the pace at which school broadband is upgraded. Whether funding fiber projects for unconnected communities, facilitating demand aggregation to increase broadband affordability, educating school districts on Wi-Fi procurement best practices, or investing in statewide Internet access purchasing initiatives, governors are helping school districts to meet the FCC's connectivity goals.

Thanks to the modernization of the E-rate program in 2014, there is now sufficient funding in place to connect every public school classroom in America to high-speed broadband. But to extend this opportunity to everyone, governors everywhere need to act now. States only have a three-year window to finish the job of upgrading our schools so students can take advantage of the promise of digital learning. We commend the 38 governors who have stepped forward for their foresight and leadership and urge the rest to join them in taking the actions needed to finish the job of connecting all of America's students to high-speed broadband before the end of the decade.

The promise of digital learning

In schools across the country, students and teachers are becoming educational entrepreneurs and challenging the concept of the traditional classroom as a way to build content knowledge and foster 21st century skills. Robust classroom technology gives students the opportunity to shift from passive observers of knowledge to active stewards of their own personal learning path. For example, students in rural communities who may not have the same traditional field trip opportunities as their urban and suburban counterparts are able to use the Internet to travel the globe, expand their cultural awareness by communicating with people in other parts of the world, and virtually participate in experiments and activities they would not otherwise be able to access easily. With the support of technology, students everywhere are able to interact with and learn core content in ways that they find most engaging—a shift from the "one-textbook-fits-all" mindset that has long governed the American educational system. Technology also fosters an environment of collaboration, both with classroom peers and with students across the country, helping to make all students college- and career-ready.

Where teachers have previously found scaffolding their instruction to meet the diverse needs of their students challenging, technology provides an opportunity to structure lessons, offer practice, and conduct assessments to adapt to different learning styles effortlessly and in real time. Teachers can also provide more virtual one-on-one support to students by sharing real-time feedback on assignments and adjusting the lesson path accordingly, which improves participation from every learner in the group. These scaffolded opportunities are

Clovis Municipal School District, New Mexico

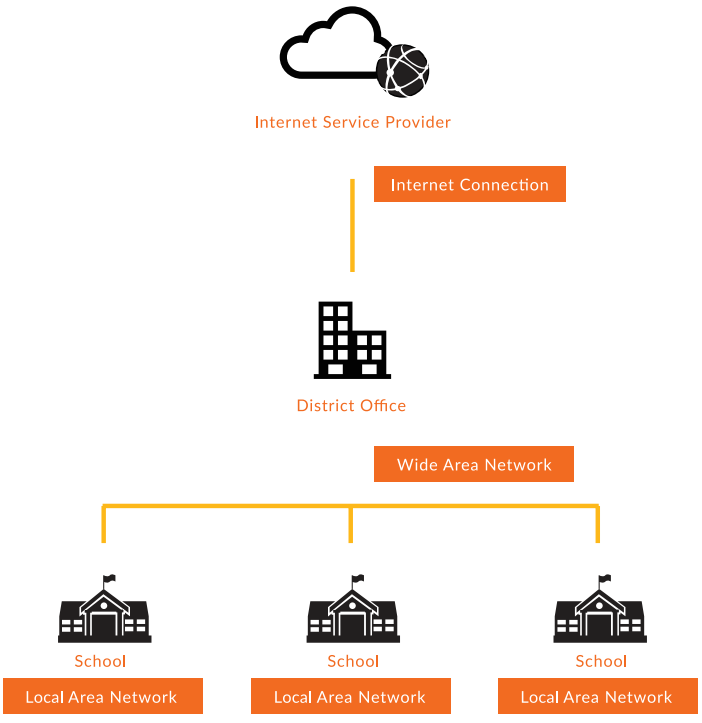
The Clovis Municipal School District in New Mexico can attribute a measurable increase in reading and math proficiency to the digital curriculum offered by Pearson's SuccessMaker. The virtual program adapts to individual student needs, using multimedia to create engaging courses in core subjects.

not just for those that need extra support. Schools can offer enrichment paths by providing access to AP course materials, accelerated pacing in the current or supplemental curriculum, or even by liaising with local community colleges to allow students to receive college credit for their work in high school. Through the use of a variety of digital learning tools, students no longer rely on their classmates to determine the pace, rigor, and style of their lessons. They are able to navigate their learning independently and tailor it to their own needs.

The benefits of digital learning extend well beyond the four walls of the school. Teachers now have access to an unprecedented library of professional development tools, the ability to share resources with other educators across the country, and tools that help with classroom management and standards-based academic data tracking. Additionally, the expansion of technology in classrooms allows parents to be more involved than ever with their children's academics through tools such as online grade books, real-time behavioral and academic progress reports, and parent/teacher conferences via streaming video that can take place more often and with less coordination. Students also have the opportunity to work on assignments at home that are anchored in the existing curriculum and which can enhance their skills and assess their progress. With the proper bandwidth to support all of these digital activities, students, teachers, and parents can embrace this significant paradigm shift and bring American students into the 21st century.

K-12 networks and connectivity goals

Figure 1: Typical School District Network



As a new generation of education technology and digital learning opportunities enter the classroom, basic Internet connectivity is no longer sufficient to educate and prepare America's children for the modern age. To ensure that all students receive a high-quality education and are prepared to compete in today's global economy, our schools need high-speed broadband and Wi-Fi. This requires that each component of a school district's network be upgraded to minimum bandwidth standards to ensure the delivery of high-speed Internet to students' desks. Networks should also be designed to allow for greater capacity in the future, as bandwidth needs are increasing 50% or more per year in schools using digital learning in the classroom.

A typical school district network (see Figure 1) is made up of three components: the Internet connection, the Wide Area Network (WAN), and the Local Area Network (LAN). The Internet connection connects the school district office (or another district hub site) to an Internet Service Provider (ISP), which provides a gateway to the broader Internet. Schools and other support buildings (such as data centers) are then connected to each other through a Wide Area Network (WAN). These WAN connections between school sites provide a method for distributing a single Internet connection to multiple sites, as well as providing an internal network for access to applications entirely within the district's network. The Local Area Network (LAN) exists within a single school site or district building and includes both the wired connections and the equipment required to provide Wi-Fi access, which we collectively refer to in this report as Wi-Fi-related equipment.

The FCC laid out connectivity goals for each part of the network. They are designed to enable every school to take advantage of the promise of digital learning.

Table 1: Connectivity Goals

	Current Goals	Future Goals
Internet Access[12]	100 Mbps per 1,000 users (100 kbps per user)	1 Gbps per 1,000 users (1 Mbps per user)
Wide Area Network (WAN)[13]	10 Gbps per 1,000 students (1 Gbps per school scalable to 10 Gbps)	
Wi-Fi[14]	In every classroom capable of supporting 1:1 digital learning	

In setting its goals, the FCC established 100 kbps per student as a minimum threshold to enable digital learning in the classroom. However, the FCC also recognized that in schools using digital learning bandwidth demand is growing 50% or more per year. In fact, for the 350 school districts that we tracked from 2013 to 2015, the amount of bandwidth per district increased from 337 to 870 Mbps, or 60% per year. This is why the FCC also established a future goal of 1 Mbps per student–to make it clear that 100 kbps per student was not the finish line. While it is unclear when any school district will need this much bandwidth, 50% per annum growth suggests that the typical district will have to triple its bandwidth over the next three years.

In order to be good stewards of taxpayer resources, however, many school districts and state networks use a monitoring-based approach to increasing bandwidth beyond the 100 kbps per student threshold. In essence, they procure bandwidth at a level that is 30-40% above their peak usage levels and add additional bandwidth as their usage levels rise. This is an effective approach that EducationSuperHighway endorses, as long as school districts have an effective monitoring solution in place and the ability to increase bandwidth levels at any time during a contract. This approach is also particularly effective for large school districts and state networks, where the benefits of concurrency[15] allow them to add bandwidth at a slower pace because a smaller percentage of users are likely to be on the network at the same time during peak demand periods.

Estacada School District, Oregon

Estacada School District in Oregon is using technology to help mainstream students in special education programs. A third grader who was struggling with writing uses an iPad to record and transcribe his stories into written text. This allows him to more easily edit his work and turn in a finished product.

[12] See FCC Report and Order And Further Notice of Proposed Rulemaking, WC Docket 13¬-184, released July 23 2014, ¶ 22-62, https://apps.fcc.gov/edocs_public/attachmatch/FCC-14-99A1.pdf

[13] See FCC Report and Order And Further Notice of Proposed Rulemaking, WC Docket 13¬-184, released July 23 2014, ¶ 22-62, https://apps.fcc.gov/edocs_public/attachmatch/FCC-14-99A1.pdf

[14] This goal references the U.S. Department of Education "National Education Technology Plan 2010" p. xix https://www.ed.gov/sites/default/files/netp2010.pdf. The FCC states "we agree with commenters that available bandwidth per device is a more suitable measure to determine whether internal connections are sufficient to support the needs of each individual user at a school or library. However, we need further information from schools and libraries before we adopt a specific measure." See FCC Report and Order And Further Notice of Proposed Rulemaking, WC Docket 13¬-184, released July 23 2014, ¶ 46

[15] A networking concept that estimates overall bandwidth demand based on the number of simultaneous users. Logically, the probability that every potential user will access the network concurrently decreases as the total size of the user population rises; as a result, the additional bandwidth required to serve additional users is lower for larger networks.

The status of broadband in America's public schools

We significantly increased the number of school districts that meet the connectivity goals.

In 2013, only 30% of school districts met the FCC minimum Internet access goal of 100 kbps per student. This left approximately 40 million students behind without the bandwidth they needed for digital learning. Today, 77% of school districts, representing 59% of schools, and 53% of students meet the minimum Internet access goal. This means that we have increased the number of students meeting the FCC's goal by 20.5 million, from 4 million in 2013 to 24.5 million today. We have also increased the number of teachers with the broadband they need to deliver a 21st century education from less than 300,000 in 2013 to 1.7 million today.

Chart 1: More than three-quarters of school districts are meeting the minimum connectivity goal

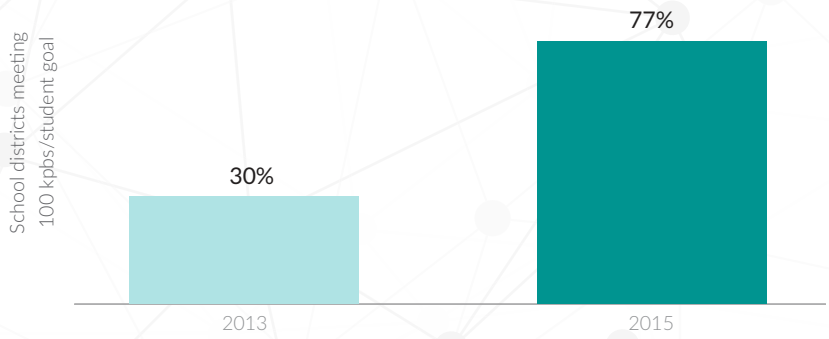
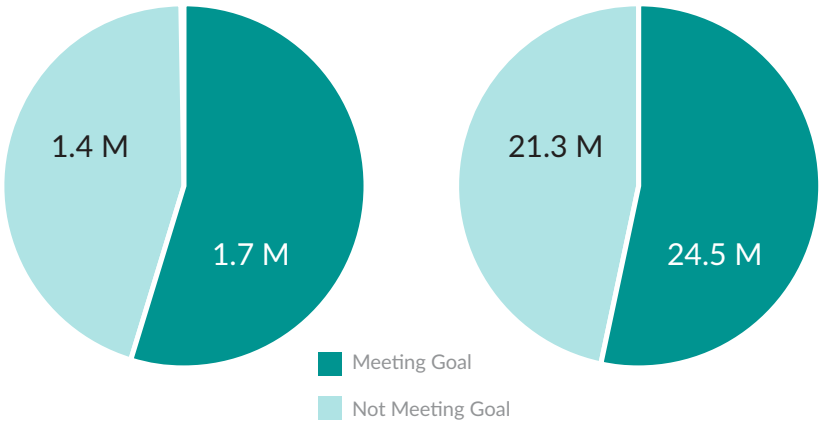


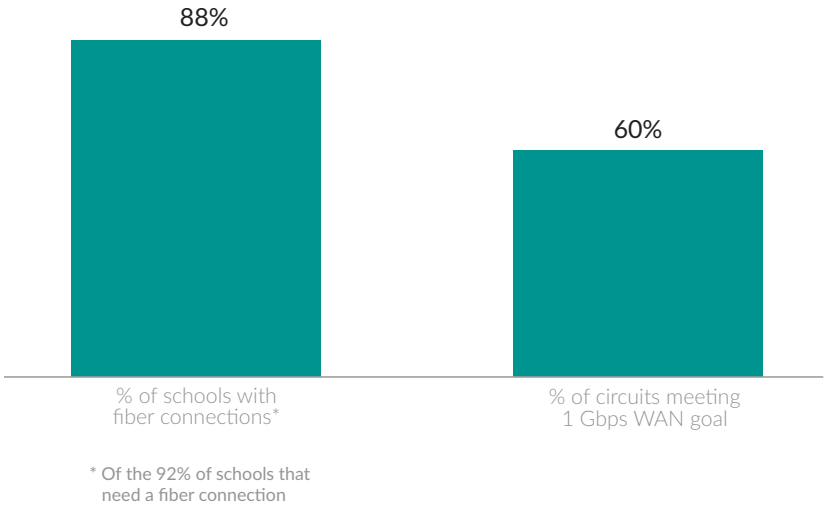
Chart 2: 24.5 M students and 1.7 M teachers have the broadband they need for digital learning today



We also meaningfully improved the availability of scalable infrastructure.

In 2014, the FCC estimated that 65% of schools had access to fiber-optic connections.[16] EducationSuperHighway's analysis of 2015 E-rate applications suggests that this number has risen to 88%. The increase in fiber access has also been accompanied by a significant increase in the percentage of schools that meet the 1 Gbps WAN goal, from 37%[17] in 2013 to 60%[18] today.

Chart 3: Scalable network infrastructure is now available to the majority of schools



[16] See Wireline Competition Bureau & Office of Strategic Planning & Policy Staff Report, WC Docket 13184, August 12, 2014 ¶ 19 https://apps.fcc.gov/edocs_public/attachmatch/DA-14-1177A2.pdf

[17] See EducationSuperHighway, Connecting America's Students: Opportunities for Action p8.

[18] Due to limitations in the E-rate data, this was calculated on a circuit basis. Specifically, this is the percentage of purchased WAN circuits that are over 1 Gbps and on either fiber or fixed wireless technologies and therefore meet the goal of providing 1 Gbps per school scalable to 10 Gbps. We believe this is an effective proxy for schools meeting the goals.

[19] See EducationSuperHighway, Connecting America's Students: Opportunities for Action (April 2014), http://www.educationsuperhighway.org/wp-content/uploads/2014/11/Connecting-Americas-Students-K12-E-rate-Spending-Report-April-2014.pdf

We made this progress while leveling the playing field for poor and rural students.

In 2013, EducationSuperHighway reported that America's most affluent school districts were twice as likely as moderate-income school districts and three times as likely as low-income school districts to meet the FCC's 100 kbps per student goal.[19] Today, those differences have been erased. In addition, while rural schools remain the most in need of infrastructure upgrades to meet their future bandwidth needs, there is no significant difference in the percentage of rural schools that meet the FCC's minimum bandwidth goals.

Pickens County School District, South Carolina

Unable to hire a teacher to lead a keyboarding class, students at Dacusville Middle School in the Pickens County School District in South Carolina accessed a virtual keyboarding class taught by a licensed virtual teacher via Double Robot. The remore teacher is able to "roam" the classroom and interact with the students using a remote controlled tablet set on a moveable base.

Chart 4a: Affluence does not meaningfully impact the ability of school districts to meet the minimum connectivity goal

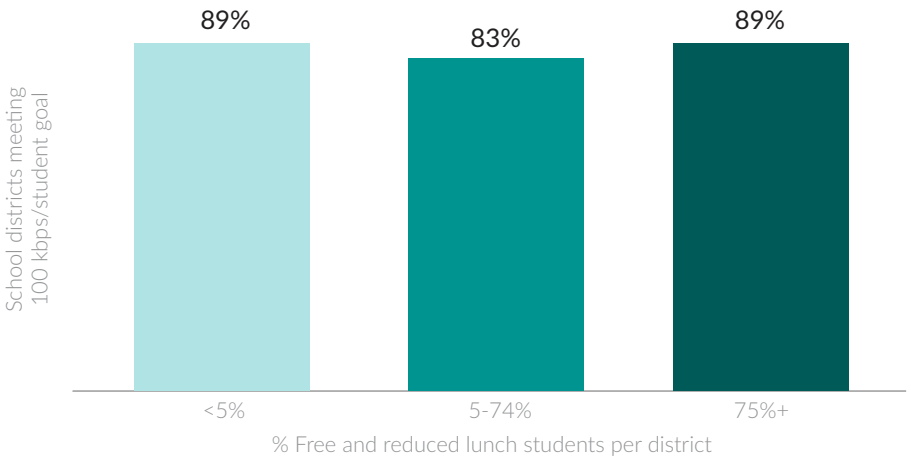
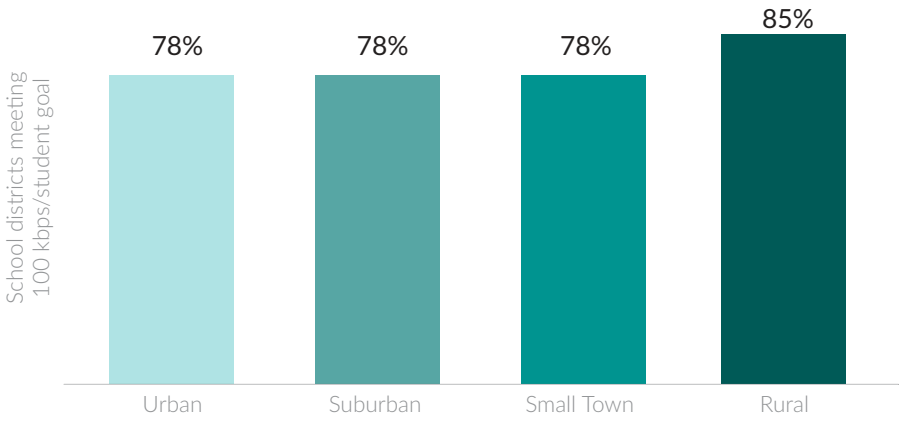


Chart 4b: Locale does not meaningfully impact the ability of school districts to meet the minimum connectivity goal



The drivers of progress

Clear goals established

The establishment and widespread communication of connectivity goals was one of the most important factors that contributed to the increase in the number of school districts meeting the 100 kbps per student goal. The 100 kbps per student goal was first articulated in 2012 with the publication of the State Education Technology Directors Association's (SETDA) *The Broadband Imperative: Recommendations to Address K-12 Education Infrastructure Needs.*[20] This goal was then amplified by the White House as part of the ConnectED initiative, and then widely discussed by the K-12 community during the FCC's E-rate modernization process. Once the FCC formally adopted the 100 kbps per student goal, it provided the guidance that many school districts were waiting for to effectively size their broadband purchases.

Increased technology in the classroom

There was a second factor accelerating the pace of upgrades: school districts realized that in order to bring more technology into the classroom they needed to upgrade their Internet infrastructure. According to the market research firm, IDC, K-12 schools purchased over 23 million devices for their classrooms in the two-year period from 2013 to 2014.[21] The significant increase in classroom devices, coupled with the digital learning programs they enabled, created a tremendous increase in the demand for bandwidth. This prompted school districts to upgrade their Internet access connections. This catalyst for upgrades is also evident in the success of the U.S. Department of Education's Future Ready initiative. To date, nearly 2,000 superintendents have pledged to make the promise of digital learning a reality in their classrooms.[22]

[20] Fox, C., Waters, J., Fletcher, G., & Levin, D. (2012). The Broadband Imperative: Recommendations to Address K-12 Infrastructure Needs. Washington, DC: State Education Technology Director's Association (SETDA) http://www.setda.org/wp-content/uploads/2013/09/SETDA_BroadbandImperative_May20Final.pdf

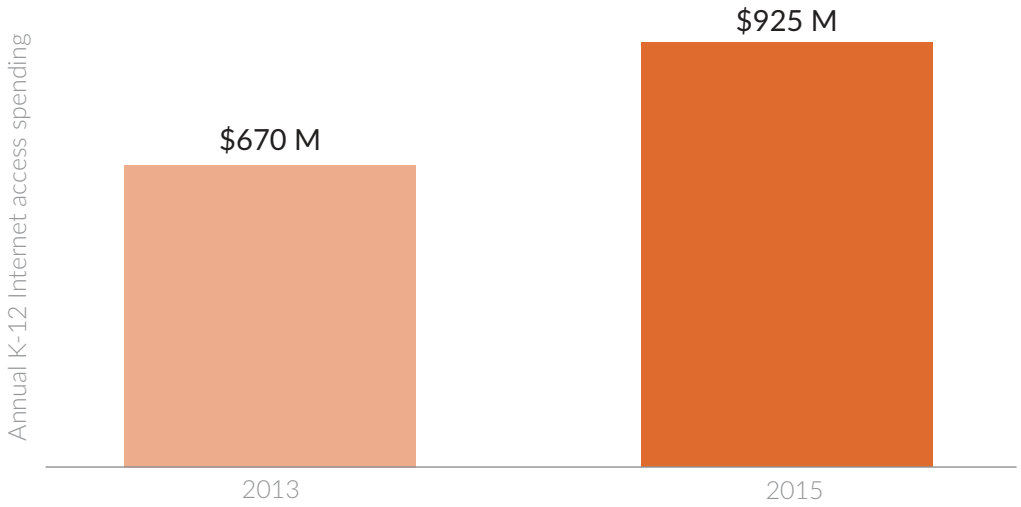
[21] Singer, Natasha. "Chromebooks Gaining on iPads in the School Sector." *The New York Times*. Web. August 19, 2015. http://bits.blogs.nytimes.com/2015/08/19/chromebooks-gaining-on-ipads-in-school-sector/?_r=2

[22] Future Ready Schools. "Take the Pledge." http://www.futurereadyschools.org/take-the-pledge. Web. November 7, 2015.

Increased investment in connectivity

The $2.5 billion per year expansion in E-rate funding for broadband likely gave school districts a green light to increase their investment in Internet access without worrying about whether they would be reimbursed by the program for added expenses. Indeed, total Internet access spending increased from $670 million in 2013 to $925 million in 2015, enough to add 30 kbps per student of bandwidth across the nation.

Chart 5: Increased investment in broadband has helped school districts meet the connectivity goal



STEM Innovation Network, Tennessee

Tennessee STEM Innovation Network's STEMmobile takes the promise of digital learning on the road. The traveling tractor-trailer relies on high-speed broadband and is equipped with iPads, laptops, and other standard STEM tools. It visits 21 rural school districts with 7,000 students, providing hands-on learning opportunities that promote problem-solving skills.

Improved broadband affordability

The final driver of broadband upgrades was a significant improvement in the affordability of Internet access, as service providers gave school districts dramatically more bits for their broadband buck. This is evident in the 50% decline in the median broadband cost per Mbps as well the change in the median costs of Internet access circuits at specific bandwidth capacities from 2013 to 2015. As seen in Chart 7, school districts were able to buy a 1 Gbps Internet access circuit in 2015 for only 17% more per month than for a 200 Mbps circuit in 2013. This is Moore's Law[23] applied to broadband, as decreases in the cost of optical equipment allow service providers to provide significantly more broadband for the same price. This pattern is also seen in the experience of 350 school districts for which we have data in both 2013 and 2015. These school districts increased their broadband 2.6 times while only increasing their budgets by 20%.

Howard-Winneshiek Community School District, Iowa

Spelling practice has received a technology makeover in the Howard-Winneshiek Community School District in Iowa. Students now use their iPads to work on spelling assignments and can scan a QR code to learn the correct spelling. The real-time feedback allows them to revise their work or receive a grade.

Chart 6: The cost of Internet access has declined 50%

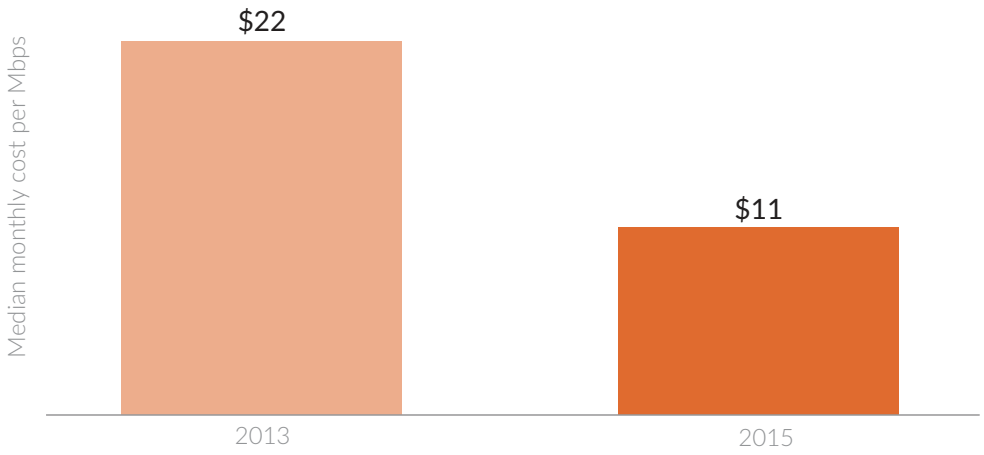
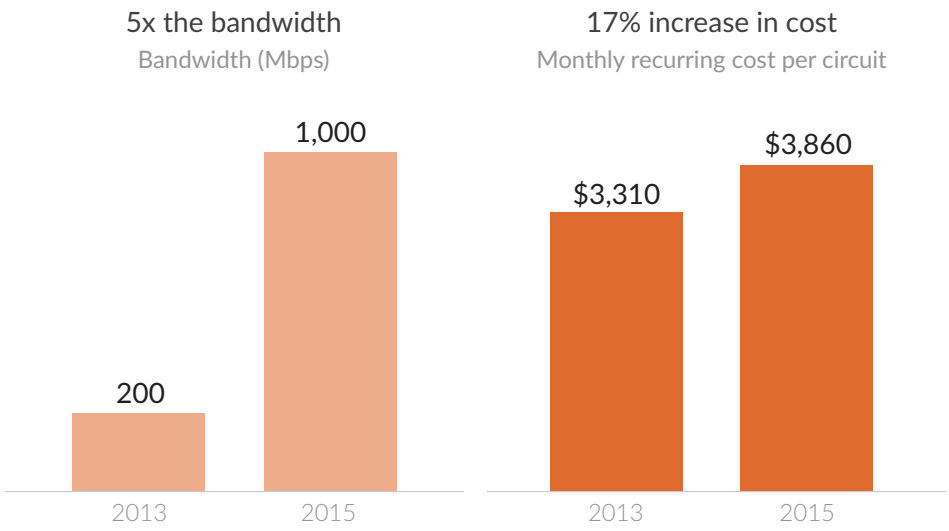


Chart 7: District purchasing power has grown 5x in 2 years



[23] "Moore's law" is the observation that, over the history of computing hardware, the number of transistors in a dense integrated circuit has doubled approximately every two years.

Finishing the job – connecting the last 21 million students

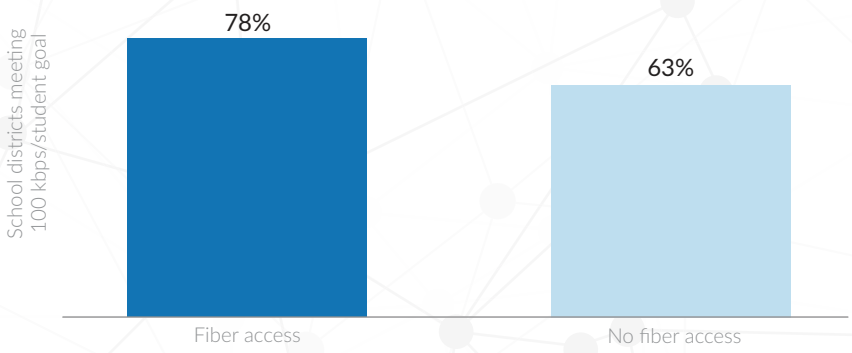
Connectivty Roadblocks

We have made substantial progress over the last two years, but there is more work to do. States can take a leading role in connecting the last 21.3 million students before the end of the decade. Specifically, states must act to address the three primary barriers that prevent America's K-12 school districts from obtaining the high-speed broadband they need.

Access to fiber

Fiber is the highest capacity broadband technology available today. It is also the only commercially available technology that is scalable enough to support the projected bandwidth needs for the vast majority of school districts. As a result, school districts without fiber are 15% less likely to meet the FCC's connectivity goals due to the capacity constraints of

Chart 8: School districts with access to fiber are 15% more likely to meet the minimum connectivity goal

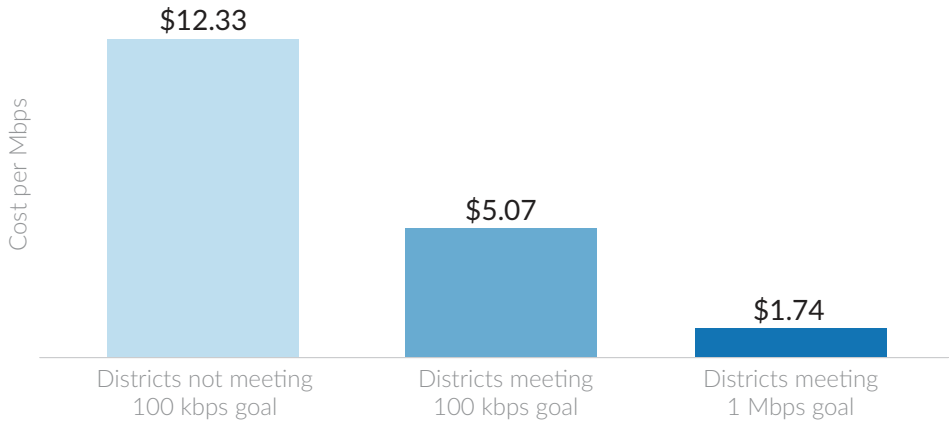


other technologies. To address this roadblock, approximately 9,500 schools[24] will need new fiber connections to meet the FCC's connectivity goals.[25] In some cases, fixed wireless or DOCSIS 3.1 cable modems might be suitable substitutes.

Affordability of broadband

The second major roadblock preventing school districts from meeting the FCC connectivity goal is the affordability of broadband. School districts that do not meet the 100 kbps per student goal reported connectivity costs that were twice as high as those reported by school districts meeting the FCC goal ($12.33 vs. $5.07). When the price of connectivity is too high, school districts are unable to purchase the bandwidth they need. This is also likely to be the case as school districts try to keep up with the anticipated 50% per annum growth in bandwidth demand. School districts meeting the FCC's 1 Mbps per student goal reported prices that were one-third ($1.74) of those meeting the minimum connectivity goal established by the FCC.

Chart 9: School districts meeting connectivity goals pay less for Internet access



[24] The difference is even more pronounced when we look at the difference between those school districts that are on fiber and those on copper technologies. Schools districts on copper are 54% less likely to be meeting connectivity targets.

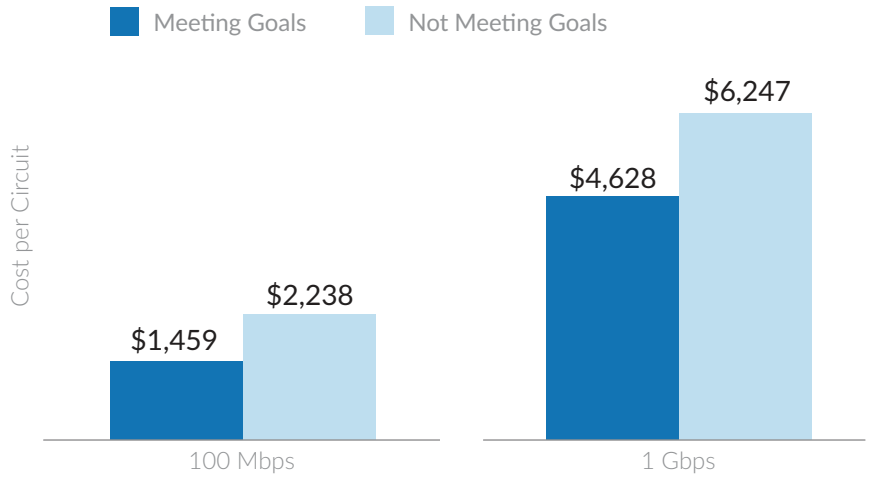
[25] Fiber metrics estimate the number of school campuses. Please see the Methodology for more detail.

Technology Advances in Cable: DOCSIS 3.1

Cable technology continues to evolve to keep pace with growing demand. In the near future, cable might be a viable long-term option for Internet access in school districts with up to 1,000 students. The latest version of cable technology, compliant with the DOCSIS 3.1 standard, would provide connections at speeds of 1 Gbps or more, a significant improvement over the 100 Mbps common for most cable connections today. The exact timing of the availability of this technology in a given area is unclear, but Comcast, for example, has publicly announced that it aims to have the technology deployed across its entire U.S. network footprint in the next three years. As a result, school districts with less than 1,000 students looking to sign a new Internet access contract should evaluate whether this technology will become available in their areas, since cable is often an affordable option.

The impact of affordability on a district's ability to meet the FCC Internet access goals is also evident even when controlling for the amount of bandwidth purchased. As seen in Chart 10, school districts that met the goals are able to purchase Internet access circuits at prices that were 35-53% lower than school districts that did not meet the goals.

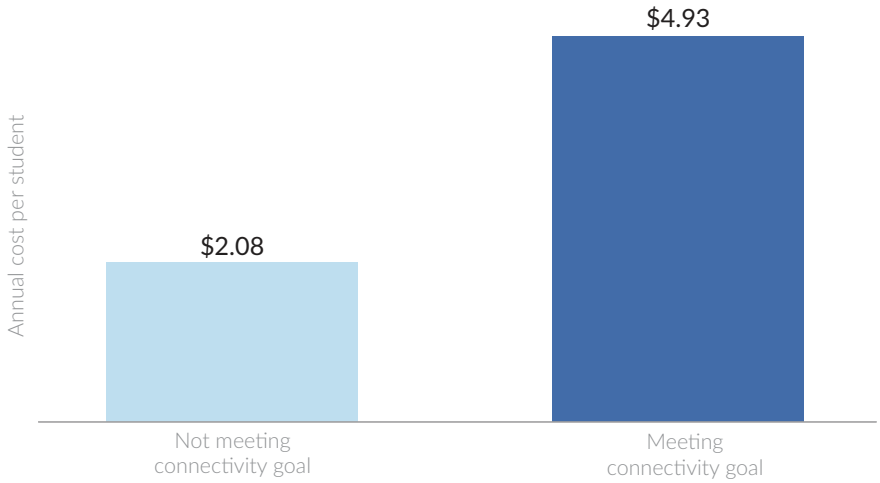
Chart 10: Even when controlling for circuit size, school districts meeting goals pay less for Internet access



Utilization of E-rate

The final roadblock that must be addressed if we are to connect every student to high-speed broadband are district budgets. Some school districts struggle to fully leverage the funding available via the E-rate program. School districts that meet the FCC's minimum connectivity goal invest $4.93 per student per year for Internet access while those school districts that do not meet the goals invest less than half that amount ($2.08). While E-rate pays an average of 70% of connectivity costs, school districts must prioritize resources within their own budgets if they are to ensure every student has access to high-speed broadband.

Chart 11: School districts meeting the minimum connectivity goal invest 2.4x more per student in Internet access



A path to equal access

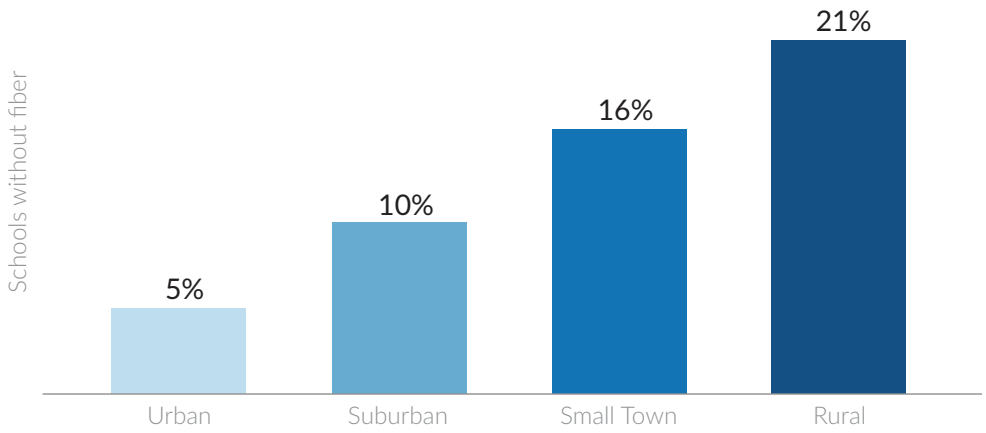
Addressing the connectivity roadblocks will connect the rest of America's students to the broadband they need for digital learning.

- Connecting 9,500 schools[26] to fiber will provide the necessary infrastructure to upgrade Internet access for approximately 4.6 million students who will otherwise be unable to meet the FCC's connectivity goals.
- Lowering the average cost of Internet access to $3 per Mbps will enable school districts to meet the minimum bandwidth needs of 12.2 million students without increasing their existing Internet access budgets.
- Once we reach the $3 per Mbps affordability goal, increasing district investment in Internet access by approximately $0.25 per student per year will allow school districts with insufficient bandwidth to upgrade the final 9.1 million students to meet the FCC's goals.

Improving access to fiber

About 9,500 schools[27] still need access to fiber. Not surprisingly, gaps in fiber access disproportionately affect schools in more rural areas: 21% of rural schools lack fiber connections, whereas only 5% of urban schools lack access. With E-rate modernization, the FCC has created a time-sensitive opportunity to connect all schools to fiber. Over the next three years, the FCC has eliminated the cap on the amount of funding available to subsidize fiber construction by service providers and school districts when existing fiber is unavailable or unaffordable.[28] We estimate that it will cost approximately $1 billion to build fiber to these schools, a number well within the E-rate program's three-year budget.

Chart 12: Rural schools are more likely to lack fiber connections



Upgrading school districts with low bandwidth fiber

At least 7% of school districts nationwide have access to fiber, but are not procuring enough bandwidth to meet connectivity targets. These school districts are connected to Internet access circuits with 100 Mbps of bandwidth or less. For 63% of these school districts,

[26] The Fiber metrics estimate the number of school campuses. Please see methodology for more detail.

[27] Fiber metrics estimate the number of school campuses. Please see methodology for more detail.

[28] FCC Second Report and Order And Order on Reconsideration, WC Docket 13-184, released December 19th 2014 ¶ 17-21 https://www.fcc.gov/document/fcc-releases-order-modernizing-e-rate-21st-century-connectivity

affordability and budget challenges are most likely the reason that they are not buying sufficient bandwidth to meet the FCC goals. The remaining 37% appear to be procuring low bandwidth fiber connections for other reasons.

While it is possible that some of these school districts have simply decided not to pursue digital learning, the most recent CoSN (the Consortium for School Networking) survey suggests another possibility: "Some Internet providers lack capacity to offer broadband: 12% of all respondents and 14% of rural school system respondents reported that their Internet providers were at capacity and could not offer additional bandwidth."[29] EducationSuperHighway's work helping to connect school districts to fiber provides further evidence of service provider bottlenecks and insight on the potential causes. Specifically, we have observed that some school districts with fiber are limited by the capacity of the optical equipment in their service provider's network. This appears to be particularly prevalent in rural areas where smaller service providers are unable to justify the investment in higher capacity networks.

States are leading the way on fiber deployment

California BIIG Fiber Grant

While fiber infrastructure is the most scalable (and in some cases the only) technology that can deliver the bandwidth that schools need for digital learning, high one-time costs associated with new fiber construction preclude access for some sites. During a field test of its new online assessment program, California observed that while most schools in the state possessed fiber connections, a subset of schools lacked this important infrastructure for digital learning and computer-based testing. In response, Governor Jerry Brown included $27 million in the state's budget to connect these schools to fiber infrastructure. The Broadband Infrastructure Improvement Grant (BIIG) program was established under the direction of California K12HSN, a pre-existing state program that facilitates K-12 participation in the state research and education network. BIIG identified the schools most in need and then executed a state-run RFP to solicit fiber construction to connect qualifying sites to the state network. As a result, 171 sites in California will be upgraded, with over 80% of these sites upgrading to 1 Gbps connections. Ninety-five percent of the grant sites will be connected to fiber. K12HSN has started the second phase of the BIIG program to address the remaining schools. The state has budgeted an additional $50 million to support this work.

[29] CoSN's 2015 Annual E-rate and Infrastructure Survey, http://cosn.org/sites/default/files/pdf/CoSN_3rd_Annual_Survey_Oct15_FINALV2.pdf

Montana's Roundup Public Schools: Connectivity Challenges Due to Network Bottlenecks

Motivated by an interest and passion for digital learning, Roundup Public Schools in Central Montana has already surpassed a 1:1 student-to-device ratio, with several portable and permanent computer labs and devices distributed throughout each classroom. The district chose a lit fiber Internet connection at 50 Mbps from its local provider, but as digital learning usage throughout the district soared over time, the 50 Mbps of bandwidth was increasingly overburdened. Unfortunately, when the district pursued a potential upgrade with its current provider, it learned that the fiber infrastructure was limited to a bandwidth maximum of 150 Mbps. The district's rural location has also been a limiting factor in its pursuit of higher bandwidth connections, and the only other options in the area that have emerged so far are satellite-based. Undeterred by these challenges, the district plans to continue negotiating with its current provider and continue the search for the best option for its students and staff.

Networkmaine Upgrades

Established education networks have observed first-hand the incredible growth in bandwidth demand from K-12 students. Networkmaine is one such network. The operators of the network at the University of Maine System knew that getting scalable fiber infrastructure to schools would be critical to ensuring that K-12 bandwidth needs could continue to be met. With the existing transport contracts set to expire in the summer of 2015, Networkmaine structured an RFP for new circuits that was aimed at meeting SETDA (State Educational Technology Directors Association) connectivity goals. The RFP was designed to deploy fiber to as many locations as possible by requesting a minimum bandwidth of 100 Mbps per location. After a successful RFP process in the winter of 2014-15, the average bandwidth per school increased from 187 Mbps to 515 Mbps with no increase in overall cost. Almost 100% of schools now have fiber connections. Networkmaine is working with the four remaining sites without fiber to find alternative connectivity solutions that will meet their digital learning needs.

Improving affordability

Improving affordability is key to ensuring that all schools can meet the FCC's minimum bandwidth goals for digital learning while enabling school districts to keep up with the growth in bandwidth demand as technology enters the classroom. While substantial progress has been made over the last two years—median K-12 Internet access prices have declined from $22 to $11—significantly more progress is needed if we are going to provide all of America's students with high-speed broadband in their classrooms.

Setting affordability goals

Clearly articulated connectivity goals have been a significant driver of improvements in the number of school districts meeting the FCC's 100 kbps per student Internet access goal. School districts knew they needed Internet access but did not have a clear sense of how much was needed to support effective digital learning in the classroom. Similarly, school districts have historically had little information about what broadband should cost and how prices should decline as they buy increasing amounts of capacity. By setting and widely communicating clear affordability benchmarks, we hope to provide school districts with a sense of what they should expect in their negotiations with service providers and thereby enable them to procure the bandwidth they need to meet the FCC's current and future connectivity goals.

Table 2: Affordability Targets

Internet Access	$3 per Mbps
Wide Area Network (1 Gbps circuit)	$750 per circuit
Wide Area Network (10 Gbps circuit)	$1,000 per circuit

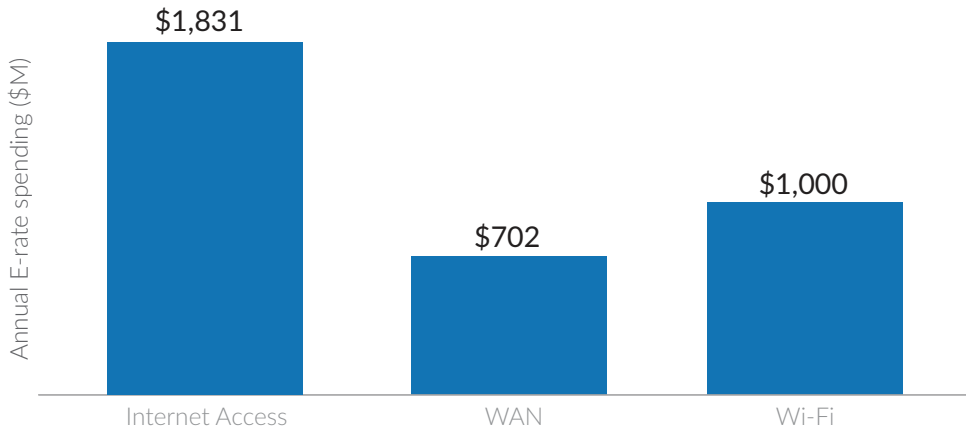
As the primary funder of broadband in America's schools, the E-rate program's budget is perhaps the most significant determinant of what school districts can afford to pay for various components of their broadband infrastructure. To meet the FCC's connectivity goals, including ultimately delivering 1 Mbps per student of Internet access within the E-rate budget, school districts must achieve the affordability targets listed in Table 2.

Gaston County Schools, North Carolina

For a recent lesson on prepositions at Gaston County Schools in North Carolina, a teacher gathered a digital collection of content-specific videos, games, and examples on the Blendspace platform. Students were able to pick and choose their preferred method to learn the same concept, and overall class wide proficiency increased by 20 points through just one personalized lesson.

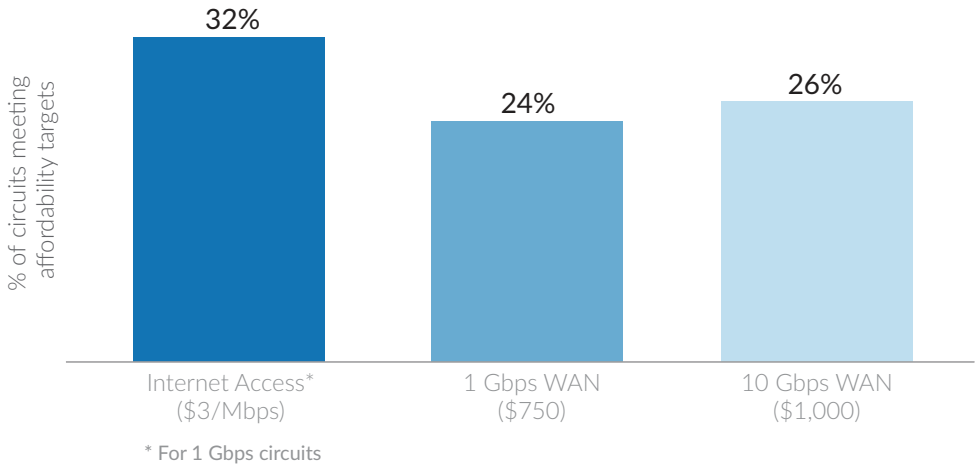
At these prices, the $3.9 billion E-rate budget will be allocated across Internet access, WAN, and Wi-Fi as shown in Chart 13.

Chart 13: Projected E-rate spending by category if affordability targets are met



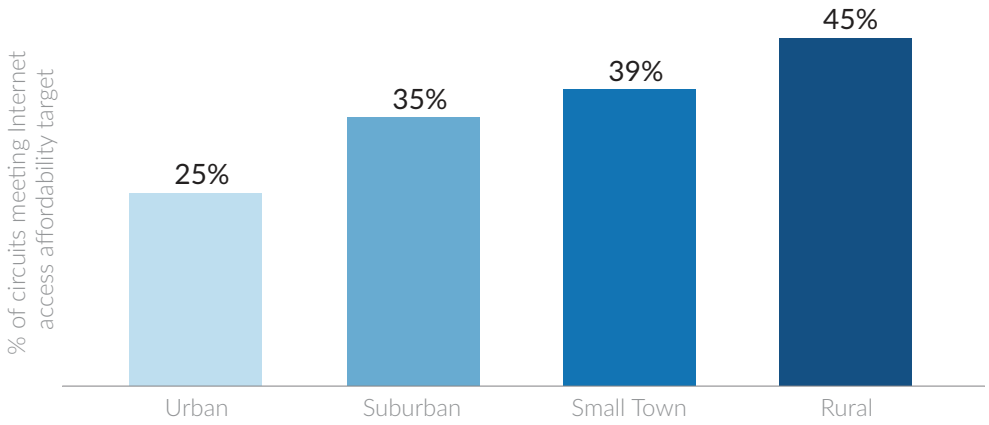
There is already substantial evidence that these goals are achievable. As seen in Chart 14, nearly a third of 1 Gbps lit fiber Internet access circuits already cost $3 per Mbps or less while a quarter of 1 Gbps and 10 Gbps WAN circuits are similarly already meeting the affordability benchmarks.[30]

Chart 14: Many school districts are already purchasing circuits that meet affordability targets



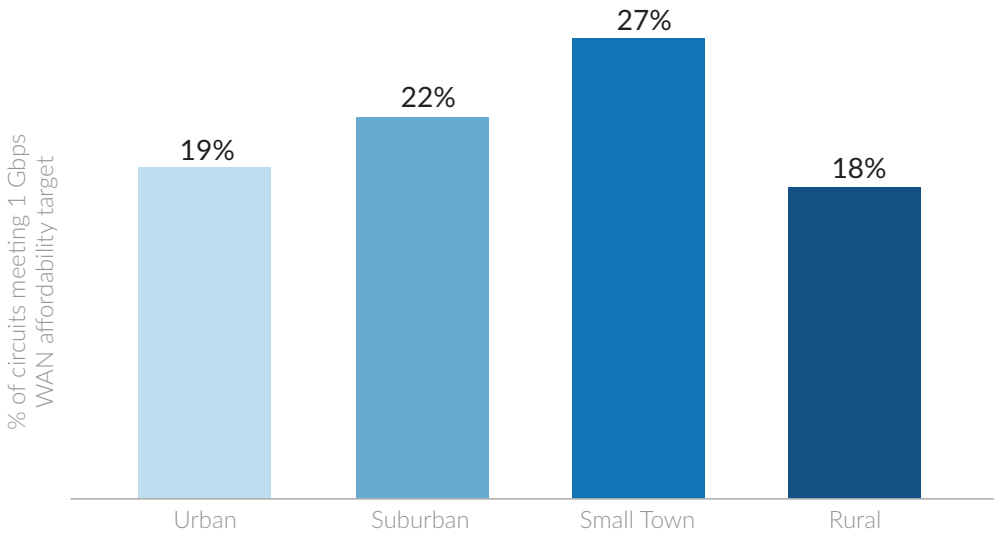
Interestingly, geography does not appear to have a significant impact on the ability of school districts to achieve the affordability targets. As seen in Charts 15a and 15b, the natural assumption that urban and suburban school districts would have an easier time meeting the goals is not supported by the percentile data for 1 Gbps Internet access and WAN connections or the cost of 1 Gbps WAN connections.

Chart 15a: School districts in all locales are purchasing circuits that meet the Internet access affordability target*



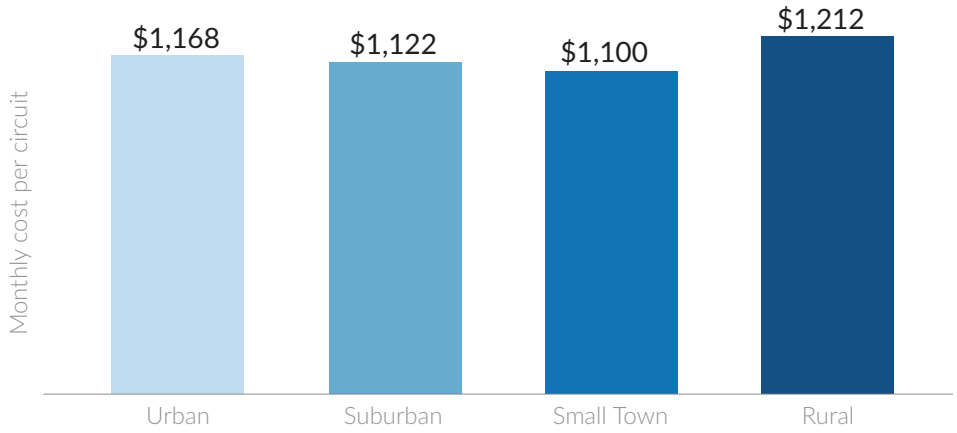
* For 1 Gbps lit fiber Internet access circuits

Chart 15b: School districts in all locales are purchasing circuits that meet the 1 Gbps WAN affordability target



[30] 1 Gbps Internet access circuits will be required by over 70% of school districts, representing 98% of students to achieve the 1 Mbps per student target

Chart 16: The cost of a 1 Gbps WAN circuit is similar across all locales



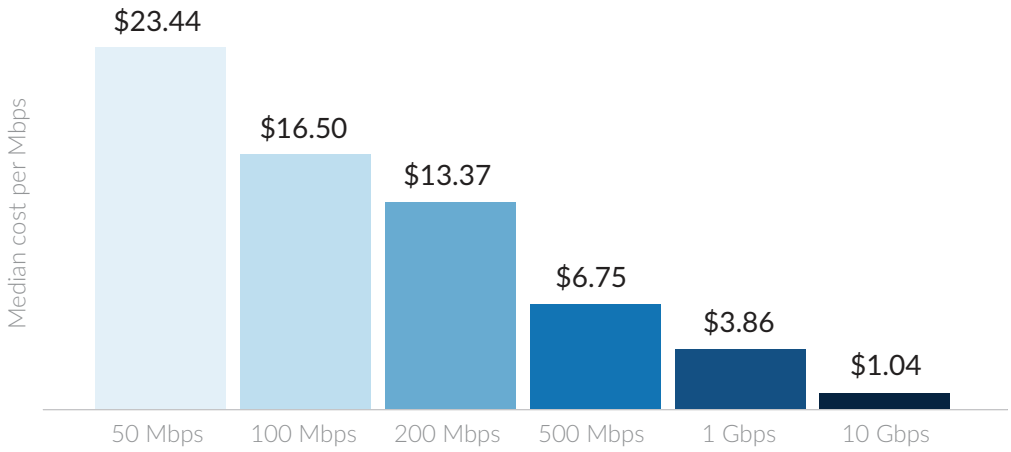
The conclusion that Internet access affordability goals are achievable is also evident when looking at specific district examples. Table 3 shows school districts of varying sizes, locales, and affluence levels that are all achieving the affordability target.

Table 3: School districts that are meeting the $3 cost per Mbps affordability target

Examples of districts meeting $3 per Mbps Internet access affordability target					
State	District Name	Locale	District Size	FRL %	Cost Per Mbps (monthly)
AZ	PHOENIX ELEMENTARY DISTRICT	City, Large	Large	80%	$2.81
TX	SAN ANTONIO ISD	City, Large	Mega	93%	$2.67
LA	LAFAYETTE PARISH	City, Mid-Size	Large	61%	$0.65
PA	ALLENTOWN CITY SD	City, Mid-Size	Large	86%	$2.62
AR	SPRINGDALE SCHOOL DISTRICT	City, Small	Large	68%	$2.41
NJ	TRENTON PUBLIC SCHOOLS	City, Small	Large	90%	$2.07
CO	MANITOU SPRINGS, SCHOOL DISTRICT NO. 14, IN THE COUNTY OF EL	Suburb, Large	Small	25%	$3.00
NJ	MOONACHIE	Suburb, Large	Tiny	47%	$1.12
MN	MOORHEAD PUBLIC SCHOOL DISTRICT	Suburb, Mid-Size	Medium	41%	$2.75
FL	POLK	Suburb, Mid-Size	Mega	67%	$2.21
MS	PETAL SCHOOL DIST	Suburb, Small	Small	59%	$2.91
LA	TANGIPAHOA PARISH	Suburb, Small	Large	76%	$1.65
AR	GREENWOOD SCHOOL DISTRICT	Town, Fringe	Small	37%	$2.88
NJ	NEW HANOVER TOWNSHIP	Town, Fringe	Tiny	51%	$2.20
OH	ARCHBOLD-AREA LOCAL	Town, Distant	Small Town	32%	$3.00
IL	MARSEILLES ESD 150	Town, Distant	Tiny	64%	$2.99
KS	PHILLIPSBURG	Town, Remote	Small	47%	$2.73
MS	MCCOMB SCHOOL DISTRICT	Town, Remote	Medium	96%	$1.86
MS	TUNICA COUNTY SCHOOL DISTRICT	Rural, Distant	Medium	97%	$2.60
MS	LAUDERDALE CO SCHOOL DIST	Rural, Distant	Medium	54%	$2.90
MT	BROCKTON H S	Rural, Remote	Small	83%	$2.57
MT	DODSON K-12	Rural, Remote	Small	88%	$1.99
OK	BYNG	Rural, Fringe	Small	61%	$2.90
OH	AYERSVILLE LOCAL	Rural, Fringe	Small	69%	$2.95

It is important to note that these targets represent average prices across all school districts. Without question, school districts buying large amounts of Internet access (10 Gbps or more) should expect to achieve significantly lower prices, while those buying smaller amounts (less than 500 Mbps) will likely pay more than $3 per Mbps. Current median cost per Mbps at various circuit sizes are seen in Chart 17, though we would expect these prices to continue to decline over time.

Chart 17: Internet access cost decreases significantly as more bandwidth is purchased



Achieving the affordability targets

There are a number of strategies that states and school districts can take advantage of to achieve the affordability targets recommended in this report.

- **Purchasing at scale** will improve the affordability of Internet access by taking advantage of the scale economies evident in bandwidth pricing.
- **Utilizing dark fiber** will improve the affordability of WAN connections by enabling school districts to increase bandwidth through low-cost investments in high-capacity optical equipment upgrades.
- **Leveraging price transparency** will improve affordability by arming school districts and states with the information they need to negotiate broadband contracts more effectively.

Purchasing at scale

As school districts buy more bandwidth, the average cost per Mbps drops. This suggests that as school districts increase their Internet access purchases to keep up with the projected 50% annual growth in broadband demand, they will naturally move closer to the $3 per Mbps affordability target. Indeed, if school districts can achieve the current median price for the circuit size they will need at 1 Mbps per student, the average cost per Mbps nationally will fall below $2.[31]

Utilizing dark fiber

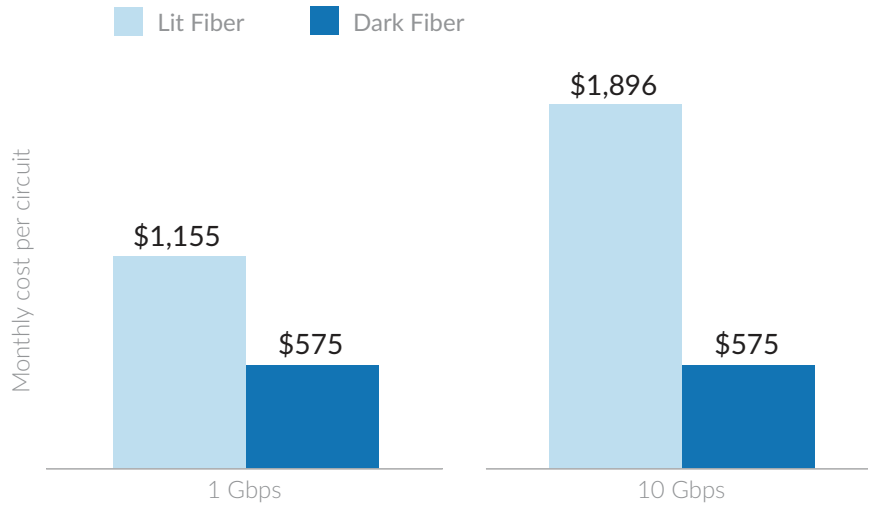
School districts around the country are using dark fiber WAN connections to improve the affordability of high-capacity WAN circuits.[32] In a dark fiber model, school districts either lease or buy fiber from a service provider or fiber construction company and then provide their own optical equipment to turn the fiber into a broadband circuit capable of transmitting data. This allows school districts to dramatically increase the capacity of their

[31] It is likely that by the time most school districts need to meet the FCC's 1 Mbps goal, median prices will actually be meaningfully lower for most circuit sizes.

[32] Approximately 9% of school districts in our sample reported they were using dark fiber connections. Dark fiber was used in all geographic areas. Dark fiber was also primarily used by school districts with six or more schools.

WAN through low-cost upgrades to the optical equipment. As seen in Chart 18, the median cost of a leased dark fiber circuit, which can be configured for either 1 Gbps or 10 Gbps, is $575, well below the WAN affordability targets recommended in this report.

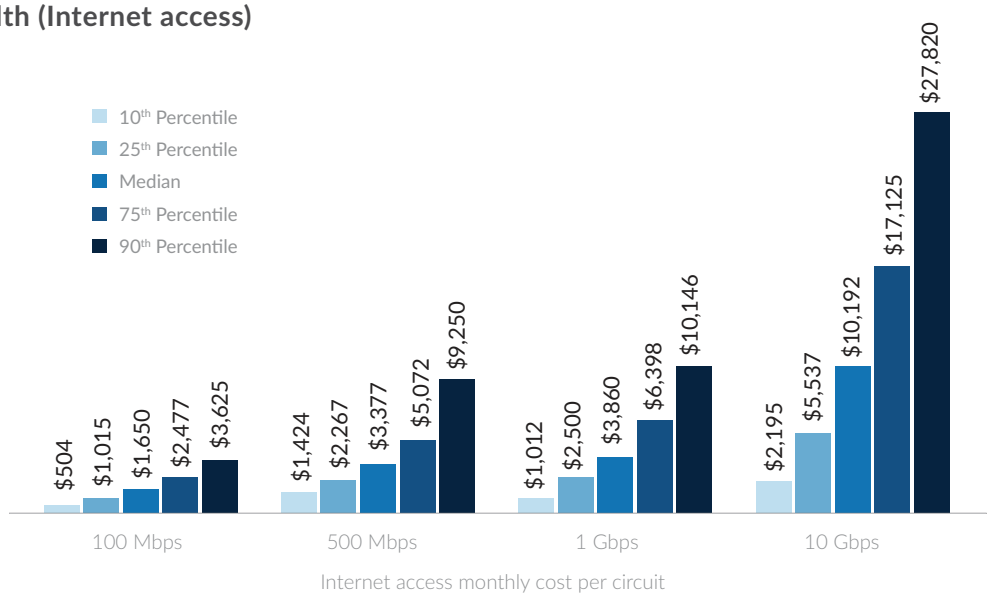
Chart 18: Dark fiber WANs offer significant cost advantages over lit fiber



Leveraging price transparency

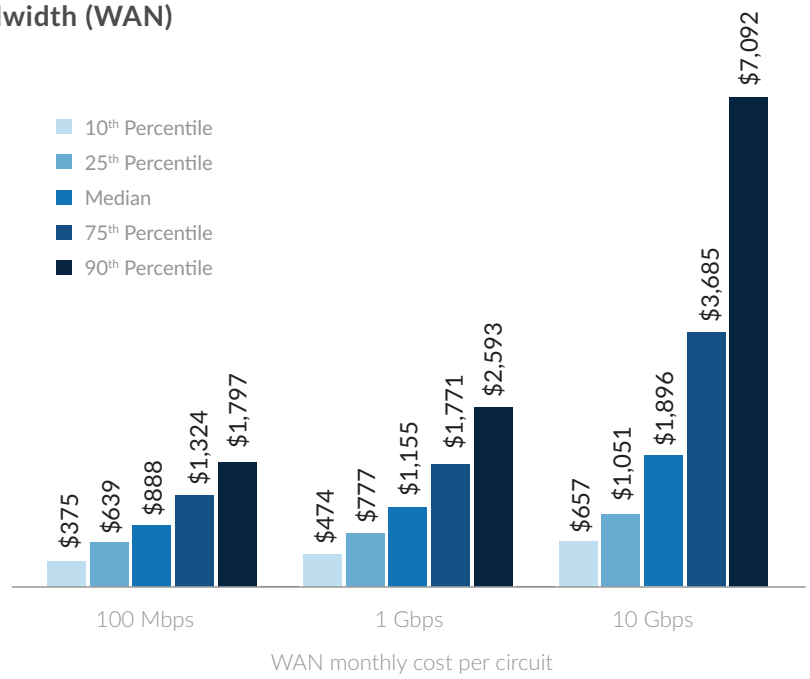
The lack of price transparency in many broadband markets results in school districts paying more than is necessary for bandwidth. This is evident in Charts 19a and 19b. For WAN circuits, price dispersion, defined as the ratio of the 90th percentile price for a circuit to the 10th percentile price of a circuit, ranges from 5.5 times at 1 Gbps ($2,593 vs. $474) to 10.8 times at 10 Gbps ($7,092 vs. $657). For Internet access circuits, price dispersion ranges from 6.5 times at 500 Mbps ($9,250 vs. $1,424) to 12.7 times at 10 Gbps ($27,820 vs. $2,195). Even when comparisons are limited to a specific service provider or state, price dispersion is routinely in excess of 4 times.

Chart 19a: School districts pay widely varying prices for the same bandwidth (Internet access)



Price differences between school districts are generally driven by the need for service providers to recoup their up-front infrastructure investments through the monthly recurring cost of an Internet access or WAN circuit. However, with E-rate now paying for up-front infrastructure costs and with the likelihood that all existing infrastructure investments will be recouped during the first contract term, school districts should generally pay the same prices for broadband services.[33] This suggests that the market should be able to move to the 25th percentile pricing levels, a level consistent with the proposed affordability targets.

Chart 19b: School districts pay widely varying prices for the same bandwidth (WAN)



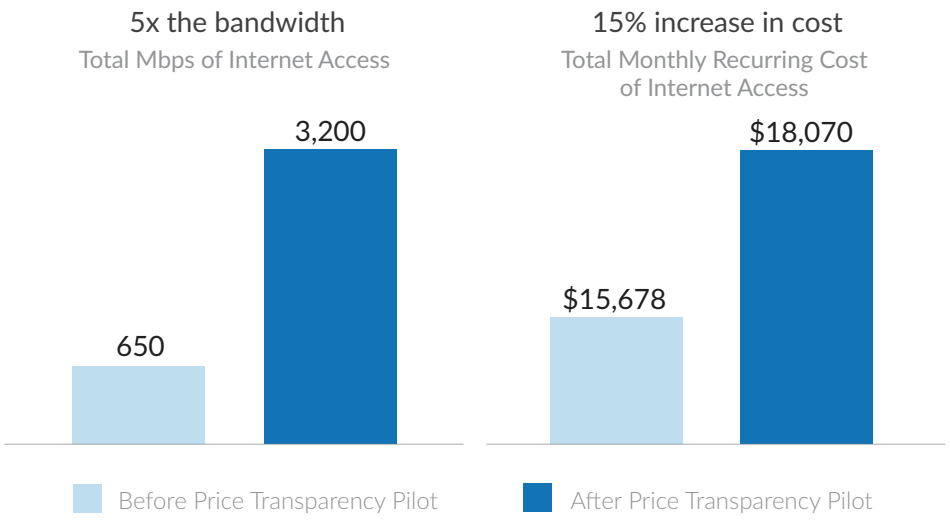
Converse County School District #1, Wyoming

Converse County School District #1 in Wyoming is a rural district determined to equip its students with 21st century skills. Classes use FaceTime to collaborate on projects with other schools and enrich their learning experience. They also practice reading and writing music by composing their own songs on the Garage Band app.

[33] In some cases, the cost of maintaining fiber infrastructure will warrant a higher price for Internet access and WAN services. This is primarily the case for remote rural schools.

E-rate modernization has created an opportunity to leverage price transparency to reduce price dispersion in K-12 broadband procurement and help states and school districts achieve the affordability benchmarks outlined in this report. By providing access to comprehensive information on what school districts are buying, who they are buying it from, and the prices they are paying, the FCC is arming states and school districts with the information they need to more effectively negotiate broadband contracts. In a pilot price transparency program in Virginia during the 2015 E-rate cycle, school districts were able to use pricing information to increase their bandwidth by 5 times with only a 15% increase in their monthly cost (as seen in Chart 20).

Chart 20: Virginia school districts quintupled their bandwidth with only a small increase in total cost



It is important to note that the primary mechanism through which price transparency is likely to impact both affordability and the ability of school districts to meet the FCC's connectivity goals is not by lowering monthly recurring costs, but rather by significantly increasing the amount of bandwidth school districts receive for their broadband budgets. This is a win-win opportunity for schools and service providers. The economics of broadband enable service providers to dramatically increase the bandwidth they provide to school districts with little incremental costs. At the same time, increased E-rate funding will enable service providers to grow their K-12 broadband business over time as school districts invest to keep up with the bandwidth demands of digital learning.

In early 2016, EducationSuperHighway will help states and school districts leverage price transparency to improve the affordability of broadband by launching ***Compare & Connect K-12***, an online tool that will make it easy to access E-rate procurement data and compare prices.

States are leading the way on affordability

In addition to helping districts leverage price transparency, states are particularly well positioned to lower the cost of broadband by aggregating demand. Nebraska, Mississippi, and New Jersey illustrate different approaches to improving affordability through scale purchasing.

Network Nebraska (Less than $1 per Mbps ISP services)

Aggregating K-12 bandwidth demand on a state network has the potential to significantly drive down the cost of Internet access. In order to support distance learning in the state of Nebraska, which had previously been decentralized and inefficient in the state, the Nebraska Legislature created Network Nebraska. The network was formed as a partnership between the State CIO's Office and the University of Nebraska to serve the state's higher education institutions and its K-12 school districts. By aggregating the Internet access demand for 245

public K-12 school districts and 19 public and private colleges, Network Nebraska has driven down the cost of Internet access from $87 per Mbps in 2006 to 94 cents per Mbps in 2015.[34] For a low-cost membership fee of $227 per month, Network Nebraska gives K-12 school districts in the state enough bandwidth to support all of their digital learning needs.

Mississippi State Transport Contract (Postalized transport at $750 for 1 Gbps)

Many school districts lack the procurement expertise and purchasing scale necessary to negotiate high-value broadband contracts. States, on the other hand, are often times well positioned to execute these negotiations. In the 1990s, Mississippi's Council for Education Technology observed an inefficient proliferation of point-to-point T1 circuits that was not only costly to schools, but also resulted in numerous technology standards across Mississippi that were not compatible with each other. The state was able to step in on behalf of all state agencies, as well as K-12 schools, to negotiate a master contract with a single provider that postalized Internet access and transport rates. One of the keys to Mississippi being able to keep rates low is a clause in the contract that allows the state to renegotiate pricing every 18 months. If the contract-holder cannot offer pricing that is competitive with market rates, the state reserves the right to re-bid services. Today, Mississippi has some of the most competitive postalized transport rates in the nation, at $750 a month for a 1 Gbps circuit.

New Jersey Statewide Buying Consortium

District-by-district purchasing of broadband service tends to result in varied levels of connectivity and affordability. School districts in New Jersey had historically bought broadband services in this manner. As a result of the fractured buying, they paid a relatively high price-per-unit for Internet access: $32 per Mbps in school year 2014-15. In an effort to lower costs and increase bandwidth for school districts, the New Jersey Department of Education (NJDOE) adopted a strategy of aggregating district buying power. School districts were asked to sign letters of intent that would allow them to be listed on a consortium Request for Proposal (RFP) issued by a statewide procurement agency. Vendors were allowed to bid on a variety of options for delivering broadband services to the participating school districts. Seven different vendors across the state were ultimately awarded contracts as a result of the RFP. New Jersey's statewide buying consortium had a huge impact on district spending: school districts participating in the consortium saved an average of 16% on their monthly Internet access bill and the average per-unit cost of Internet access for participating school districts was lowered from $26.77 per Mbps to $6.40 per Mbps for school year 2015-16. School districts that were part of the consortium saw their average Internet bandwidth increase by 152%, from 284 Mbps to 718 Mbps. NJDOE plans on releasing a follow up RFP this school year that could lower costs even further.

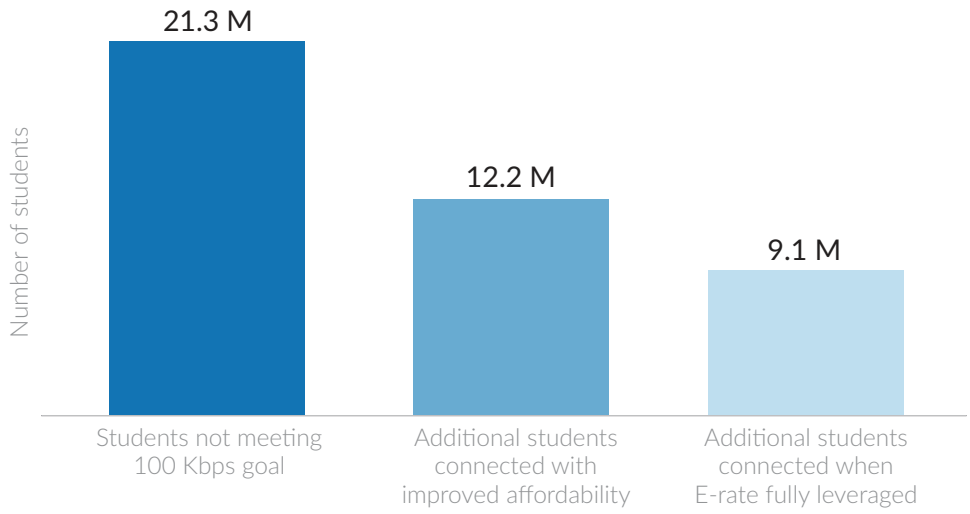
Ensuring that school districts fully leverage E-rate

Achieving the $3 per Mbps Internet access affordability target will enable school districts representing 12.2 million students to meet the FCC's 100 kbps per student connectivity goal using their existing broadband budgets. Unfortunately, 11% of

[34] ISP services only - does not include the cost of transport circuits to the district

school districts, representing 9.1 million students will still not have sufficient connectivity to meet the FCC goals. At $3 per Mbps, these school districts must invest an additional $0.27 per student per year to reach the 100 kbps per student minimum threshold.

Chart 21: Improving affordability and fully leveraging E-rate will enable all students to meet the minimum connectivity goal



States are leading the way by providing resources

Many states have recognized the importance of helping school districts to fully leverage the E-rate program to meet the connectivity needs of their students and have implemented a number of programs to provide matching funds for broadband purchases. These strategies range from establishing recurring funds that subsidize the monthly costs of broadband services, to implementing competitive or qualifying grant programs, to procuring and funding broadband services at the state level on behalf of school districts. Arkansas and Georgia are examples of this last strategy.

Arkansas APSCN Upgrade

Established by statute in 1992, the Arkansas Public School Computer Network (APSCN) has provided connectivity for Arkansas' K-12 students for the better part of the last quarter-century. While it was a model network at its conception, over time the network's infrastructure failed to keep up with the needs of the schools it connected. During the 2014-2015 school year, APSCN was only delivering 5 kbps per student, mostly over outdated copper infrastructure. When Governor Asa Hutchinson took office in January 2015 he immediately recognized the importance of a robust broadband infrastructure to support digital learning initiatives. Part of Governor Hutchinson's education platform was to bring computer science classes to all of Arkansas' high schools—a promise that would be difficult to deliver on with outdated infrastructure. Under Governor Hutchinson's leadership, Arkansas's Department of Information Services and Department of Education worked together to create an RFP that would upgrade the APSCN network's capacity. After a successful bidding process, the network is on track to upgrade the majority of Arkansas' 276 school districts and education cooperatives to 200 kbps per student by the end of 2015, and all but two by July 2017. Almost all of the connections will be delivered over fiber infrastructure, which will allow APSCN to keep up with future bandwidth demand.

GA PeachNet Upgrade for K-12

Recognizing the opportunity to improve educational achievement through digital learning, in 2012 Georgia Governor Nathan Deal formed a task force by executive order. Charged with providing recommendations on how the state could better support digital learning in K-12 schools, the task force made specific recommendations about broadband infrastructure.

One of the recommendations was to connect K-12 schools to the state's higher education PeachNet backbone in order to ensure that enough network capacity was available to meet SETDA's connectivity targets. Governor Deal accepted this recommendation and included funds in his annual budget for the Georgia DOE to work with the University System of Georgia to implement a solution that involved leveraging PeachNet fiber infrastructure. After a year of planning, Georgia released an RFP that asked for a minimum of 100 Mbps of Internet access per school. During the summer of 2015, 191 district hub sites were connected to the PeachNet fiber backbone, marking the completion of a project that will help to ensure Georgia's public schools have the bandwidth they need to support digital learning.

Providing every classroom with robust Wi-Fi

The FCC, through E-rate modernization, provided school districts with a $150 per student budget over a five-year period to upgrade their LAN infrastructure . If spent effectively, this budget should be sufficient to ensure that every classroom has robust Wi-Fi capable of supporting 1:1 digital learning.

In order to understand whether school districts are taking advantage of these resources to upgrade their Wi-Fi infrastructure we analyzed the percentage of school districts that have already accessed their $150 per student budget. While this provides an indication of the pace at which Wi-Fi is being deployed in various states, there are legitimate reasons why school districts may not have accessed these resources in the first year of the program. For example, school districts that had recently upgraded their Wi-Fi networks would likely wait until later in the five-year budget period to access these resources. In 2015, 50% of school districts took advantage of a portion of their $150 budgets, spending $2.2 billion on LAN and Wi-Fi upgrades. This suggests that significant pent up demand existed to deploy robust Wi-Fi in classrooms and that school districts are moving aggressively to make wireless connectivity available to students and teachers.

States are leading the way on Wi-Fi

North Carolina Wireless Networking Initiative

While schools face barriers in getting broadband to their buildings, solving the external connectivity problem is only part of the battle to enable digital learning. Equally difficult challenges exist within the building, and school districts often lack the scale and resources to efficiently design, procure, and deploy robust and sustainable solutions. North Carolina's Wireless Networking Initiative (WNI) provides an example of how states can act to overcome these challenges. The 2013 session of the North Carolina General Assembly announced its intention to transition from funding textbooks to funding digital learning in public schools by 2017. Six years earlier the North Carolina legislature funded the School Connectivity Initiative (SCI) to establish and sustain fiber connections to schools. Internet access was provided via a partnership with the North Carolina Research and Education Network (NCREN), which is operated by MCNC (Microelectronics Center of North Carolina), a non-profit organization. Digital learning advocates from the Friday Institute, an education innovation think tank at North Carolina State University, realized that K-12

McAllen Independent School District, Texas

The McAllen Independent School District in Texas uses digital tools to increase parent engagement. After handing out mobile devices to all students and teachers, they created digital folders where parents can access important information and a cloud-based application to deliver progress reports, report cards, and permission slips.

schools would need to solve the LAN/Wi-Fi problem before the digital learning bill could be realized. Partnering with the Department of Public Instruction, the Office of the State Chief Information Officer, and the Lieutenant Governor, the team from the Friday Institute developed a plan to use Race to the Top grant funds as the local E-rate match in order to finance a school Wi-Fi initiative. Eligible schools completed a survey that provided an inventory of their current Wi-Fi and infrastructure capabilities, school construction details, and future needs. The WNI team designed an RFP that asked vendors to propose solutions for wireless, Ethernet switching, cabling, configuration, caching, and managed Wi-Fi services. Twelve different contracts were awarded from which individual schools can choose which vendors and solutions they wish to implement. In the first year of the program, 61 out of 115 school districts in North Carolina participated in the state program, typically receiving services and equipment for 60% less than vendor list prices. Ninety-five percent of the school districts that participated reported that they were able to place a Wi-Fi access point in every classroom as a result of the initiative. All told, the state of North Carolina procured over $40 million in LAN/Wi-Fi infrastructure and services on a single RFP (and a single E-rate form 470), providing digital-ready infrastructure to nearly a quarter of the state's students, schools, and classrooms. In September 2015, the North Carolina legislature passed a budget that includes additional recurring funding to sustain and support school connectivity to the classroom level for all North Carolina public schools.

Rhode Island Wireless Classroom Initiative

States are well positioned to help school districts overcome affordability and expertise barriers that often inhibit Wi-Fi access in schools. The Rhode Island Wireless Classroom Initiative's objective was to overcome these barriers and provide wireless access to all classrooms in the state, allowing students and teachers to access virtual learning, e-resources, and data systems. The project was funded through a $20 million technology bond approved by the General Assembly. The Rhode Island Department of Education (RIDE) pre-qualified vendors and subcontractors throughout the state and instructed each LEA (Local Education Agencies) to contact at least three of the vendors to survey their buildings and propose Wi-Fi solutions. The vendors submitted their surveys and bids using a comprehensive template that RIDE created. Each LEA then worked with RIDE to select a vendor and begin site upgrades. As of summer 2015, over 8,800 new wireless access points and supporting cabling had been installed in 277 out of 288 schools in the state, giving 98% of Rhode Island's students sufficient high-speed wireless access to stream video from multiple devices. The remaining schools are scheduled to be upgraded during the 2015-2016 school year.

Kodiak Island Borough School District, Alaska

To combat declining math scores, Kodiak Island Borough School District in Alaska set up a distance-learning program using videoconferencing technology. The initiative allows schools to expand their curriculum and connects isolated students to a larger community. Participating students have outperformed their counterparts by 22%.

Governors are stepping forward to lead upgrades

An action plan for governors

Connecting America's students to high-speed broadband is a bipartisan issue that governors from both parties are embracing as a way to increase access to educational opportunity. EducationSuperHighway's research shows that executive leadership can significantly accelerate the pace at which K-12 broadband is upgraded. This is a result of the state's ability to act at scale and implement programs that simultaneously help many school districts address connectivity issues.

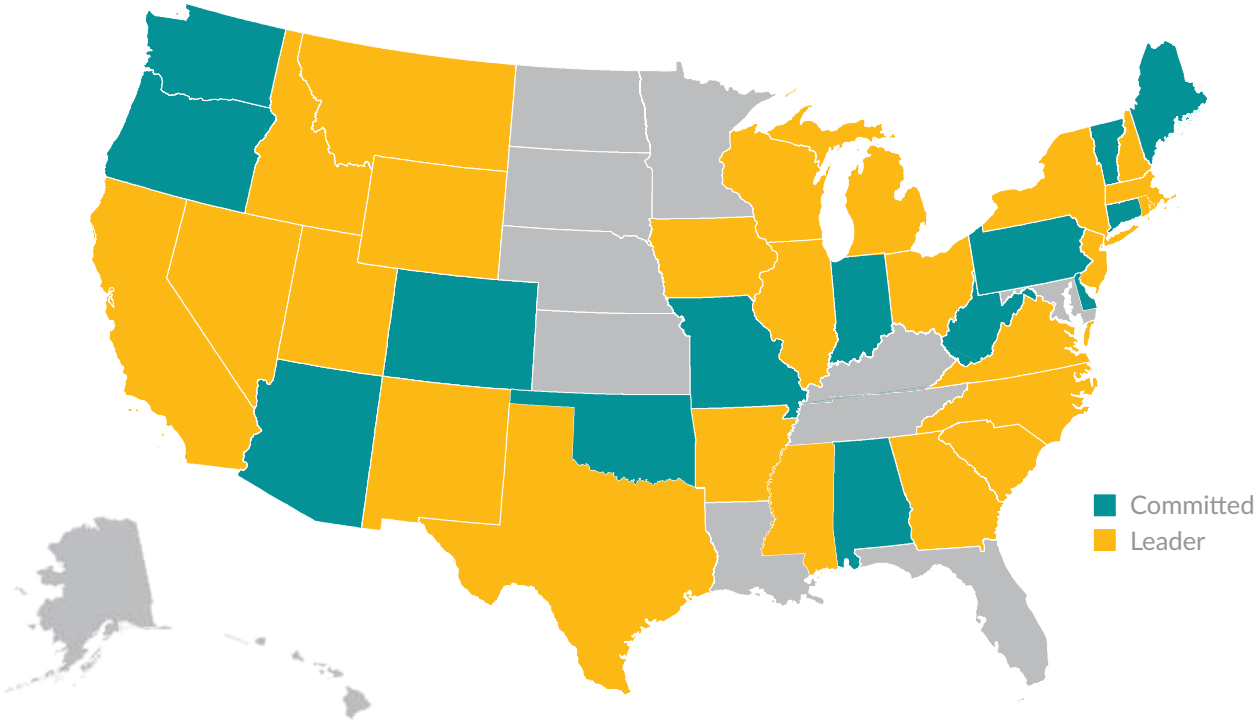
To finish the job of connecting America's students to high-speed broadband, governors must take action in the following areas:

- **Set connectivity goals.** Establishing specific connectivity goals has been a powerful driver of broadband upgrades in America's K-12 schools. Governors can magnify the impact of this strategy by setting and communicating specific goals for their state and then holding school districts accountable for achieving the goals.
- **Close the fiber gap.** Ninety-two percent of America's schools will need a fiber-optic connection to meet their bandwidth needs. Today, 12% of schools still lack access to fiber. Governors have a three-year window to take advantage of E-rate funding to build fiber connections to schools that do not currently have it and help school districts obtain the infrastructure they need by providing technical and procurement support.
- **Put Wi-Fi in every classroom.** E-rate modernization is providing $1 billion per year in funding over five years to put Wi-Fi in every classroom. Governors can help ensure that school districts get the Wi-Fi they need by educating them on Wi-Fi procurement best practices and facilitating consortia purchasing programs that lower costs.
- **Make broadband affordable.** Affordability is the number one barrier to schools meeting the FCC's minimum connectivity goals and keeping up with the 50% per year growth in broadband demand. Governors can significantly improve the affordability of broadband through consortia purchasing, price transparency, and state subsidy programs.

Thirty-eight governors are leading K-12 broadband upgrades

Governors across the country are stepping up to make connecting their schools a priority for their administrations. The map below identifies the governors who are committed to finishing the job of upgrading their schools and leading the way by taking state-level action. To be a leader, a governor's administration must have made a public commitment to improving K-12 connectivity and taken specific actions during the governor's term.

Figure 2: U.S. governor leadership and commitment



State actions to improve K-12 connectivity

The types of action that state leaders have taken are diverse. They range from grant programs, to state-led procurements, to the expansion of statewide broadband networks. Here are some examples of the actions that these leaders have taken:

Setting connectivity goals

- Arkansas re-bid its statewide network with the goal of delivering 200 kbps per student to every school, with scalability for higher bandwidths in the future.
- South Carolina committed $29 million in each of the past two funding years to support the K-12 School Technology Initiative, which adopted SETDA connectivity targets as a benchmark.
- New Mexico committed $49 million in state funds to bring high-speed Internet access to every classroom by 2018.

Closing the fiber gap

- California provided $77 million to upgrade last mile connections through its Broadband Infrastructure Improvement Grants.
- Utah extended fiber connections from the Utah Education Network's statewide backbone to an additional 62 elementary schools and 26 charter schools by taking advantage of a federal capital grant.
- Montana launched a program to bring fiber to schools that are currently on non-scalable connections.

Putting Wi-Fi in every classroom

- North Carolina launched the Wireless Networking Initiative, a statewide procurement effort that resulted in 95% of participating school districts being able to put a Wi-Fi access point in every classroom.
- Rhode Island used a $20 million technology bond to fund the Wireless Classroom Initiative, which has upgraded Wi-Fi connectivity in over 95% of the state's K-12 schools.
- Georgia's Connections for Classrooms grant program provides over $75 million in local match funding for Wi-Fi and equipment purchases.

Making broadband affordable

- New Jersey formed a statewide buying consortium for broadband services that resulted in 16% savings on monthly costs and an average Internet access bandwidth increase of 152%.
- Wisconsin re-bid its state transport contract, Badgernet, with a pricing target of $1 per Mbps for 1 Gbps transport circuits.
- Virginia supported a pilot consortium of five school divisions that upgraded Internet access bandwidth by 500% for only a 15% increase in costs.

America has made tremendous progress in bringing high-speed broadband to its public school classrooms. The task now falls to governors to finish the job of connecting every student to educational opportunity. Each state has its own unique challenges and opportunities, but by setting goals and focusing on fiber, Wi-Fi, and affordability, every governor can do his or her part to ensure that every school in America has the broadband it needs for digital learning.

State metrics

Connectivity

In 2014, the FCC adopted the widely supported connectivity goal of 100 kbps per student as the minimum amount of bandwidth needed to support digital learning in America's classrooms. Today, 77% of school districts nationwide are now at or above this threshold. The following table shows where each state stands relative to the FCC's 100 kbps per student goal. It also provides an overview of which governors have made a commitment to ensuring that all of their students have the bandwidth they need for digital learning and which have already begun to take action against this commitment. States that have connected a high percentage of their school districts should be commended for the work they have done to date while states where governors have made K-12 broadband a priority should be excited about the improvements to come in the next few years.

Table 4: Connectivity and governor commitment status by state

State	% meeting 100 kbps per student goal	Governor Status
WY	100	LEADER
HI	100*	
SD	98	
CT	97	COMMITTED
ME	97	COMMITTED
SC	97	LEADER
ND	93	
KY	92	
NE	92	
NY	92	LEADER
VT	90	COMMITTED
WV	90	COMMITTED
UT	89	LEADER
GA	88	LEADER
WA	88	COMMITTED
IA	87	LEADER
AL	86	COMMITTED
OK	85	COMMITTED
KS	82	
NJ	80	LEADER
AR	79	LEADER
MT	78	LEADER
MI	77	LEADER
MO	77	COMMITTED
CA	76	LEADER
PA	76	COMMITTED
RI	76	LEADER
WI	76	LEADER
MN	75	
MS	75	LEADER
OH	75	LEADER
OR	75	COMMITTED
CO	74	COMMITTED
IL	71	LEADER
IN	69	COMMITTED
LA	67	
TX	67	LEADER
NH	66	LEADER
ID	65	LEADER
NM	65	LEADER
TN	64	
AZ	63	COMMITTED
MA	63	LEADER
DE	52*	COMMITTED
NV	47	LEADER
VA	46	LEADER
NC	44**	LEADER
AK	42	
FL	40	
MD	38	

*Metrics calculated at the school level.
**These states monitor their networks and have indicated that all students have sufficient bandwidth to meet their current demand.

A qualitative look at the top performing states reveals that every state with 85% or more of their school districts meeting the target has aggregated school district demand at the state or regional level. Fifteen out of these top-performing 18 states (83%) allow school districts to connect to statewide fiber backbones operated by a state agency or higher education institution. The remainder use regional aggregation through educational intermediate units. Conversely, of the 16 states where less than 70% of their school districts meet the target, only eight (50%) are aggregating demand at the state level and four (25%) allow their school districts to connect to a statewide fiber backbone operated by a state agency or higher education institution.

Easthampton Public Schools, Massachusetts

High school chemistry students at Easthampton Public Schools in Massachusetts participate in a flipped classroom where the teacher records video lessons which students can view at home and use in class the next day. This allows students to focus their time in class to work on hands-on lab experiments and group research projects.

As discussed elsewhere in this report, strictly applying the FCC's 100 kbps per student goal to all school districts may underestimate the percentage of school districts that have sufficient bandwidth to effectively utilize meaningful digital learning in the classroom. In large school districts, total bandwidth needs are sometimes reduced below the 100 kbps per student level because the ratio of users to peak connectivity demand is lower due to concurrency factors. Nationally, applying concurrency factors has only a 5% impact on the percent of school districts meeting the FCC minimum connectivity goal. However, in our analysis the connectivity statistics in six states are meaningfully impacted by concurrency. We provide their concurrency adjusted connectivity metrics in the table below.

Table 5: Connectivity status adjusted for concurrency by state

State	% of school districts meeting 100 kbps per student connectivity goal	% of school districts meeting 100 kbps per student connectivity goal adjusted for concurrency factors
Alaska	42%	58%
Florida	40%	70%
Louisiana	67%	83%
North Carolina	44%	82%
Tennessee	64%	88%
Virginia	46%	64%

Note: These state metrics were impacted by more than one standard deviation when applying concurrency factors.

It is important to note that as school districts implement digital learning in their classrooms the demand for connectivity typically grows 50% or more per year. As a result, even when the effects of concurrency in large school districts are considered, every district, regardless of size, will need to meet the FCC's 100 kbps per student minimum connectivity threshold. Consequently, in order to be sure that bandwidth is not a bottleneck to the promise of digital learning, EducationSuperHighway believes that connectivity in all school districts should be evaluated against the FCC's minimum threshold goal without applying concurrency factors.

Fiber

In order to meet the minimum and future connectivity goals established by the FCC, school districts and individual schools must have a broadband infrastructure that can scale to meet their needs. For 92% of school campuses, this means they will need access to fiber. Those with less than 100 students may be effectively served by cable modem connections.

The table below shows the percent of school campuses in each state that have access to a scalable broadband connection sufficient to meet the FCC's future connectivity goal of 1 Mbps per student. It also shows the extent to which rural and small town schools will be connected when states close the fiber gap.

Table 6: Fiber status and opportunity by state

State	Fiber Status: % of schools that have fiber connections needed to meet bandwidth targets	Fiber Opportunity: % of new fiber connections that will be for rural & small town schools
AK	97	88
AL	92	61
AR	82	67
AZ	93	65
CA	95	47
CO	90	65
CT	88	32
DE	100	NA
FL	91	35
GA	95	60
HI	100	NA
IA	72	99
ID	90	85
IL	88	64
IN	87	70
KS	72	57
KY	81*	57
LA	98	33
MA	85	24
MD	88	8
ME	99	100
MI	76	59
MN	78	55
MO	85	81
MS	97	74
MT	65	98
NC	94	74
ND	75	100
NE	86	98
NH	77	81
NJ	81	19
NM	89	92
NV	94	58
NY	93	55
OH	82	54
OK	77	61
OR	88	54
PA	81	36
RI	98	25
SC	93	59
SD	76	98
TN	97	86
TX	85	49
UT	100	NA
VA	94	51
VT	87	100
WA	83	57
WI	87*	85
WV	98	22
WY	83*	89

*Calculation based on E-rate data is inconsistent with state self-assessment of fiber availability. State self-assessment indicates KY - 100%, WI - 95%, WY - over 90%. See methodology for more detail on potential sources for this difference.

E-rate modernization has created a three-year window to connect schools to fiber in areas where service providers cannot provide schools with affordable solutions. The new rules eliminate the cap on the amount of E-rate funds that can be used to build fiber to these schools and provide for up to 10% in additional subsidies for fiber construction if matched by the state. This is a game changer for rural and small town schools where the cost of fiber construction has made it difficult for service providers to justify the up-front investment required. It is also a tremendous opportunity for states to partner with service providers to bring high-speed connectivity to underserved communities. As a result, governors across the nation are launching statewide programs to leverage E-rate funds to bring fiber to their schools.

Spokane Public Schools, Washington

Spokane Public Schools in Washington increased graduation rates to 83% by using technology to help struggling students. The Individual Credit Advancement Now online course-recovery program helps middle and high school students to meet graduation goals. The On Track Academy uses blended learning to help students receive their degree.

Affordability

Improving the affordability of broadband is likely the most effective way to increase the number of school districts meeting the FCC's 100 kbps per student goal. It will also enable all school districts to keep up with the 50% per year growth in bandwidth demand that results from the implementation of digital learning. As discussed earlier in this report, $3 per Mbps is a price target that will enable both school districts and the E-rate program to afford the bandwidth required to meet the FCC's future 1 Mbps per student goal. This price target is already being achieved by nearly a third of the school districts that are buying 1 Gbps or more of Internet access, an amount that 70% of school districts serving 98% of students will need. It is also a level at which those school districts that represent nearly 60% of the 21.3 million students without sufficient Internet access can meet the FCC's minimum connectivity goal within their current Internet access budget.

The table below shows the percent of school districts in each state that are already meeting the $3 per Mbps affordability target. Nationally, only 18% of school districts are meeting this goal. This is highly influenced by the amount of bandwidth school districts are currently buying. We would expect this percentage to increase significantly as school districts increase

Table 7: Affordability status and opportunity by state

State	Affordability Status: % of districts meeting $3/Mbps target	Affordability Opportunity: # of students who will have enough bandwidth if affordability target is met
AK	0	116,600
AL	5	189,400
AR	4	109,700
AZ	6	168,200
CA	20	889,600
CO	9	172,500
CT	NA*	NA*
DE	2**	55,400**
FL	19	641,200
GA	30	47,500
HI	2**	0**
IA	2	86,000
ID	7	115,300
IL	11	979,000
IN	1	437,300
KS	5	41,100
KY	1	36,200
LA	9	204,400
MA	24	316,100
MD	44	51,400
ME	36	14,600
MI	53	259,700
MN	14	291,100
MO	7	218,700
MS	9	124,500

State	Affordability Status: % of districts meeting $3/Mbps target	Affordability Opportunity: # of student who will have enough bandwidth if affordability target is met
MT	22	59,000
NC	0	1,220,000
ND	0	15,000
NE	26	34,600
NH	18	47,400
NJ	27	289,000
NM	0	256,100
NV	35	23,900
NY	79	113,400
OH	7	543,500
OK	3	100,500
OR	29	95,000
PA	29	396,100
RI	6	54,000
SC	1	28,300
SD	0	9,600
TN	0	562,400
TX	4	1,458,800
UT	NA*	NA*
VA	5	477,000
VT	13	9,900
WA	29	106,700
WI	14	154,300
WV	3	35,800
WY	33	0

*Cost information was not available.
**Metrics calculated at the school level.
Note: Cost per Mbps includes both ISP and transport costs. In some states, additional services such as firewall are bundled into these costs. Where possible we have excluded these costs, but some states' cost per Mbps are inflated by these services.

their Internet access purchases to the levels required to meet the FCC's 1 Mbps per student goal. The table also shows the number of additional students in each state that would meet the 100 kbps per student goal if all school districts met the $3 affordability target.

It is worth noting that in three states—Georgia, Washington and Maine—the state network that provides Internet access to school districts is already meeting the $3 per Mbps affordability goal when viewed as an average across all of the school districts served.[35] This is further confirmation that the $3 per Mbps target is achievable at both the state and national level despite the fact that some school districts will fall short of the target while others significantly exceed it.

Wi-Fi

To make digital learning available in every classroom, schools must have robust Wi-Fi networks capable of supporting 1:1 student to device ratios in every classroom and learning area. In 2014, CoSN (the Consortium for School Networking) reported that only 24 percent of schools had sufficiently robust Wi-Fi in their classrooms to support 1:1 digital learning. In response, the FCC allocated $5 billion over five years to subsidize the deployment of wired and wireless networks in every school.

The following table shows the percentage of schools in each state that accessed a portion of their $150 per student Category 2 E-rate budget in 2015. This metric is intended to be an indicator of

Table 8: E-rate Wi-Fi status and opportunity by state

State	Wi-Fi Status: % of school districts that have accessed their E-rate budgets for Wi-Fi networks	Wi-Fi Opportunity: $ (millions) in E-rate funds available to support Wi-Fi networks
Alabama	67	$ 54
Alaska	57	$ 7
Arizona	72	$ 57
Arkansas	58	$ 33
California	39	$ 445
Colorado	47	$ 42
Connecticut	37	$ 34
Delaware	50	$ 9
Florida	80	$ 204
Georgia	74	$ 107
Hawaii	100	$ 11
Idaho	41	$ 22
Illinois	54	$ 102
Indiana	41	$ 82
Iowa	37	$ 39
Kansas	53	$ 41
Kentucky	83	$ 48
Louisiana	78	$ 26
Maine	17	$ 16
Maryland	63	$ 72
Massachusetts	43	$ 65
Michigan	37	$ 107
Minnesota	56	$ 52
Mississippi	69	$ 35
Missouri	54	$ 63
Montana	23	$ 11
Nebraska	51	$ 21
Nevada	59	$ 26
New Hampshire	35	$ 14
New Jersey	38	$ 92
New Mexico	61	$ 27
New York	39	$ 216
North Carolina	75	$ 106
North Dakota	31	$ 6
Ohio	59	$ 128
Oklahoma	66	$ 34
Oregon	43	$ 44
Pennsylvania	45	$ 118
Rhode Island	22	$ 11
South Carolina	77	$ 45
South Dakota	30	$ 10
Tennessee	42	$ 89
Texas	58	$ 311
Utah	49	$ 44
Vermont	64	$ 7
Virginia	64	$ 80
Washington	55	$ 78
West Virginia	45	$ 23
Wisconsin	58	$ 57
Wyoming	35	$ 7

[35] We analyzed the average cost per Mbps for Internet access in 13 states where the state network provided both Internet bandwidth and upstream transport to the district. Total cost was inclusive of all Internet access, transport and backbone circuits included in the state network's E-rate application. Total bandwidth was calculated as the sum of the upstream transport circuit bandwidth for all of the school districts served by the state network.

whether school districts are aware of the availability of E-rate funding for upgrading their Wi-Fi networks. It also shows the total remaining Category 2 E-rate funds available to each state to fund the deployment of wired and wireless networks inside the school building.

It is important to note that there are many reasons a district might not have accessed its Category 2 E-rate budget in the first year of the five-year cycle. Some school districts may have needed more time to plan Wi-Fi upgrades while others may have recently upgraded using district resources. Thus, these metrics should not be used to judge whether schools have the Wi-Fi they need, but rather as indicators of whether the school districts in a state are engaged with the program and the magnitude of the opportunity that remains to upgrade the wired and wireless networks in schools for each state.

State snapshots

The fifty state snapshots that follow are intended to help individual governors and state leaders learn where their public schools stand and identify opportunities for action needed to connect all students to the promise of digital learning. Each snapshot consists of the following elements by state: governor status, governor actions to upgrade schools (if applicable), key metrics as described above, and a school district digital learning story. In addition, many governors demonstrated their commitment to connecting K-12 students in their states by providing statements, which are also included in their state snapshots. Finally, each snapshot includes the sample of school districts, schools, and students represented in the analysis for each state.

K-12 Connectivity in Alabama

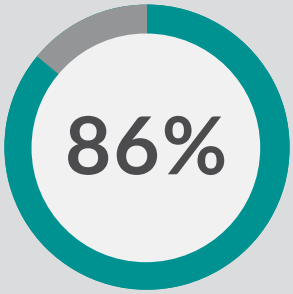
Alabama

Gov. Bentley is committed to school upgrades

> In order to prepare our children to compete in tomorrow's workforce, we must equip them with a high quality education that includes both classroom instruction and digital learning. We have made great strides in adding Wi-Fi to classrooms. Every child needs and deserves this access to digital learning, and we are committed to a continued focus in this area.

K-12 connectivity status

86% of school districts in Alabama are ready for digital learning today. To meet 2018 demand, the typical school district in Alabama will need to **grow bandwidth at least threefold**.

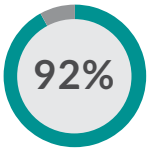


Minimum Goal
100 kbps
per student

Opportunities for action

Alabama can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



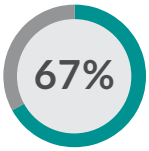
Status:

At least **92%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

61% of new fiber connections will be for rural and small town schools

Wi-Fi



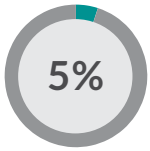
Status:

67% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$54M in E-rate funds are available to support Wi-Fi networks in Alabama

Affordability



Status:

5% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

189,400 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=95 of 132 school districts, n=1,040 of 1,587 schools, n=486,670 of 731,631 students

Why high speeds matter

The ACCESS Distance Learning Virtual School is bringing Advanced Placement courses to every student in Alabama through online classes. The number of African American students taking AP exams increased tenfold from 2004-2014.

Education SUPERHIGHWAY

K-12 Connectivity in Alaska

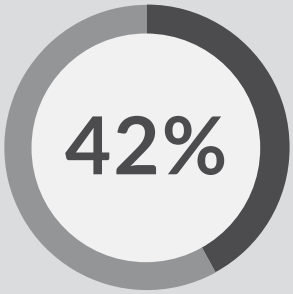
Alaska

Gov. Walker can take action to upgrade schools

Governor Bill Walker has the opportunity to connect all of Alaska's students to the speeds they need to take advantage of digital learning.

K-12 connectivity status

42% of school districts in Alaska are ready for digital learning today. To meet 2018 demand, the typical school district in Alaska will need to **grow bandwidth at least threefold.**



Minimum Goal
100 kbps
per student

Opportunities for action

Alaska can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber

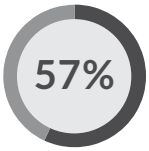
Status:

At least **97%** of schools have the fiber connections (or equivalent) needed to meet bandwidth targets

Opportunity:

88% of new fiber connections will be for rural and small town schools

Wi-Fi



Status:

57% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$7M in E-rate funds are available to support Wi-Fi networks in Alaska

Affordability

Status:

0% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

116,600 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=24 of 53 school districts, n=284 of 494 schools, n=92,808 of 122,104 students

Why high speeds matter

To combat declining math scores, Kodiak Island Borough School District set up a distance-learning program using videoconferencing technology. The initiative allows schools to expand their curriculum and connects isolated students to a larger community. Participating students have outperformed their counterparts by 22%.

Education SUPERHIGHWAY

K-12 Connectivity in Arizona

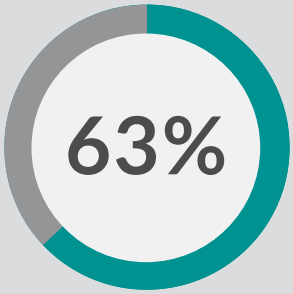
Arizona

Gov. Ducey is committed to school upgrades

> "High-speed Internet is the necessary foundation for taking advantage of technology in the classroom. I support expanding broadband connectivity in every classroom in our state to ensure our students have the tools and skills they need to succeed in school and beyond.

K-12 connectivity status

63% of school districts in Arizona are ready for digital learning today. To meet 2018 demand, the typical school district in Arizoona will need to **grow bandwidth at least threefold**.

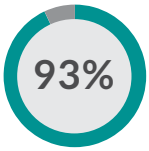


Minimum Goal
100 kbps
per student

Opportunities for action

Arizona can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



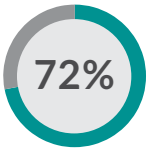
Status:

At least **93%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

65% of new fiber connections will be for rural and small town schools

Wi-Fi



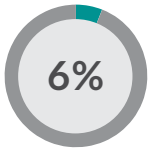
Status:

72% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$57M in E-rate funds are available to support Wi-Fi networks in Arizona

Affordability



Status:

6% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

168,200 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=126 of 208 school districts, n=1,003 of 1,501 schools, n=677,860 of 923,653 students

Why high speeds matter

Using DreamBox Learning's adaptive digital reading and math curriculum, Higley Unified School District is able to offer its students a personalized learning environment. The results are impressive. Most of the district's elementary schools now rank in the 90th percentile in mathematics.

Education SUPERHIGHWAY

K-12 Connectivity in Arkansas

Arkansas

LEADER

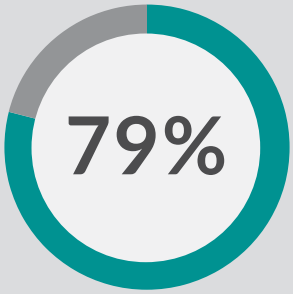
Gov. Hutchinson is taking action to upgrade schools

> Our children are our future, and if they don't have the connectivity they need to use digital learning tools, we all lose out. That is why I am taking action to get high-speed Internet in every classroom and unleash our students' potential to compete in tomorrow's workforce.

- [x] Overhauled the Arkansas Public School Computer Network contract, upgrading school bandwidth from 5 kbps/student to 200 kbps/student by 2017

K-12 connectivity status

79% of school districts in Arkansas are ready for digital learning today. To meet 2018 demand, the typical school district in Arkansas will need to **grow bandwidth at least threefold**.

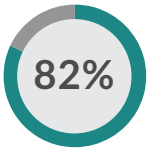


Minimum Goal
100 kbps
per student

Opportunities for action

Arkansas can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



Status:

At least **82%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

67% of new fiber connections will be for rural and small town schools

Wi-Fi

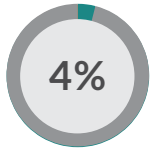
Status:

58% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$33M in E-rate funds are available to support Wi-Fi networks in Arkansas

Affordability



Status:

4% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

109,700 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=151 of 238 school districts, n=696 of 1,053 schools, n=319,872 of 458,149 students

Why high speeds matter

Teachers in Little Rock School District can now share photos of class projects and activities to their private Class Story page on ClassDojo. By showing parents what their children are working on, the technology is helping to increase engagement and support for the learning process.

Education SUPERHIGHWAY

K-12 Connectivity in California

California

LEADER

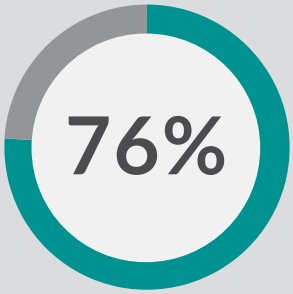
Gov. Brown is taking action to upgrade schools

> Connecting the classrooms of America to high-speed broadband throws open the doors to the world and enriches our children's education in so many wonderful ways.

- [x] Provided $27M in the 2014-15 budget and $50M in the 2015-16 budget to upgrade schools' last mile connections through the Broadband Infrastructure Improvement Grant (BIIG) program

K-12 connectivity status

76% of school districts in California are ready for digital learning today. To meet 2018 demand, the typical school district in California will need to **grow bandwidth at least threefold**.

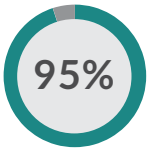


Minimum Goal
100 kbps
per student

Opportunities for action

California can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



Status:

At least **95%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

47% of new fiber connections will be for rural and small town schools

Wi-Fi

Status:

39% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$445M in E-rate funds are available to support Wi-Fi networks in California

Affordability

Status:

20% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

889,500 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=345 of 944 school districts, n=3,473 of 8,987 schools, n=2,298,708 of 5,697,216 students

Why high speeds matter

A new digital communication tool called Remind is helping parents in the Oakland Unified School District to stay on top of how well their children are doing in school. The program allows for easy messaging between parents and teachers. It also provides 24-hour access to grades and conduct scores.

Education SUPERHIGHWAY

K-12 Connectivity in Colorado

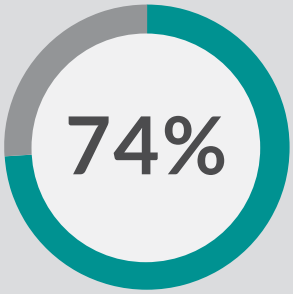
Colorado

Gov. Hickenlooper is committed to school upgrades

> A 21st century Colorado must include a Colorado that is committed to getting high-speed connectivity to all of our K-12 schools, which will ensure growth in our economy and educational opportunities for all students across the state.

K-12 connectivity status

74% of school districts in Colorado are ready for digital learning today. To meet 2018 demand, the typical school district in Colorado will need to **grow bandwidth at least threefold**.

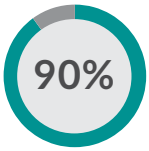


Minimum Goal
100 kbps
per student

Opportunities for action

Colorado can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



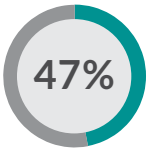
Status:

At least **90%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

65% of new fiber connections will be for rural and small town schools

Wi-Fi



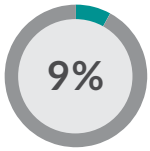
Status:

47% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$42M in E-rate funds are available to support Wi-Fi networks in Colorado

Affordability



Status:

9% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

172,500 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=77 of 178 school districts, n=771 of 1,607 schools, n=391,509 of 743,855 students

Why high speeds matter

Access to high-speed Internet is no longer considered a luxury, but a basic necessity for 21st century learning. With funding to help schools access this vital tool, we can level the playing field and ensure every child in Pennsylvania has access to a high-quality education that will equip them with the tools to compete in a high tech economy.

Education SUPERHIGHWAY

K-12 Connectivity in Connecticut

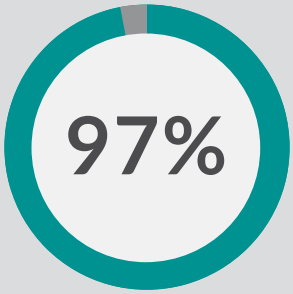
Connecticut

Gov. Malloy is committed to school upgrades

"In Connecticut, we are working to deliver on our promise to prepare all our students for success in college and careers in a 21st century economy. That's why we have been committed to connecting every classroom to high-speed Internet. Technology and broadband connectivity can help provide enriching learning experiences that expand beyond the four walls of a classroom, and in turn help to reduce isolation. Connecticut is proud to have made significant gains and continues to prioritize expanding broadband connectivity.

K-12 connectivity status

97% of school districts in Connecticut are ready for digital learning today. To meet 2018 demand, the typical school district in Connecticut will need to **grow bandwidth at least threefold.**

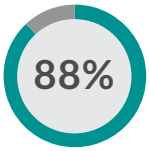


Minimum Goal
100 kbps
per student

Opportunities for action

Connecticut can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



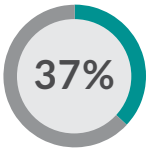
Status:

At least **88%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

32% of new fiber connections will be for rural and small town schools

Wi-Fi



Status:

37% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$34M in E-rate funds are available to support Wi-Fi networks in Connecticut

Affordability

Status:

N/A of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

N/A more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=114 of 169 school districts, n=738 of 1,027 schools, n=371,008 of 506,685 students

Why high speeds matter

Hartford Public Schools employs flexible, technology-based solutions to help teachers meet the needs of students with different learning styles. Using Apex Learning's digital curriculum, the district can add personalized, adaptive instuction to classroom and small group instruction and provide each student with access to the learning style most effective for them.

Education SUPERHIGHWAY

K-12 Connectivity in Delaware

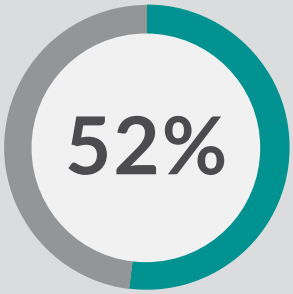
Delaware

Gov. Markell is committed to school upgrades

> Our children are critical to our future and their ability to succeed in a 21st century economy is increasingly tied to their access to high quality broadband. If they don't have the connectivity they need to use digital learning tools, we all lose out. We must take action to get high-speed Internet in every classroom and unleash our students' potential to compete in tomorrow's workforce.

K-12 connectivity status

52% of schools in Delaware are ready for digital learning today. To meet 2018 demand, the typical school district in Delaware will need to **grow bandwidth at least threefold.**



Minimum Goal
100 kbps
per student

Opportunities for action

Delaware can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber

Status:

100% of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

0% new fiber connections necessary to meet connectivity targets

Wi-Fi

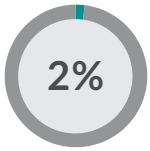
Status:

50% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$9M in E-rate funds are available to support Wi-Fi networks in Delaware

Affordability



Status:

2% of schools are meeting the $3/Mbps Internet access affordability target

Opportunity:

55,400 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=126 of 196 schools, n=83,922 of 109,540 students

Why high speeds matter

A learning management system is helping math students at Carrie Downie Elementary School to learn at their own pace. The differentiated instruction employed by this Colonial School District helps struggling students to focus on one skill while enabling other students to advance to new concepts.

Education SUPERHIGHWAY

K-12 Connectivity in Florida

Florida

Gov. Scott can take action to upgrade schools

Governor Rick Scott has the opportunity to connect all of Florida's students to the speeds they need to take advantage of digital learning.

K-12 connectivity status

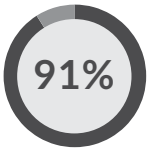
40% of school districts in Florida are ready for digital learning today. To meet 2018 demand, the typical school district in Florida will need to **grow bandwidth at least threefold.**

Minimum Goal
100 kbps
per student

Opportunities for action

Florida can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



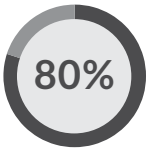
Status:

At least **91%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

35% of new fiber connections will be for rural and small town schools

Wi-Fi



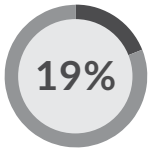
Status:

80% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$204M in E-rate funds are available to support Wi-Fi networks in Florida

Affordability



Status:

19% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

641,200 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=47 of 70 school districts, n=2,271 of 3,648 schools, n=1,546,383 of 2,427,792 students

Why high speeds matter

The Florida Virtual School helps over 206,000 K-12 students enhance their school experience via an innovative, award-winning online program. The personalized online curriculum spans the gamut, offering credit recovery classes, advanced AP courses, and technology certifications that enhance career and college readiness.

Education SUPERHIGHWAY

K-12 Connectivity in Georgia

Georgia

LEADER

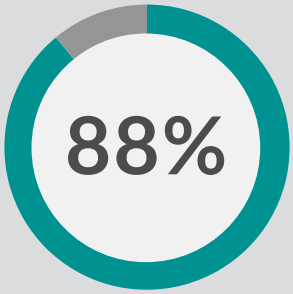
Gov. Deal is taking action to upgrade schools

> Digital literacy skills are becoming increasingly necessary to remain competitive in a global marketplace. My administration is committed to providing students with a foundation for future innovation and academic success. As technology becomes more integrated in the learning process, we are committed to providing students with the connectivity and tools necessary to take full advantage of digital learning opportunities.

- ☑ Upgraded bandwidth from 15 Mbps to 100 Mbps per school through connections to the state-provided network, PeachNet
- ☑ Launched the $75-80M Connections for Classrooms grant program to fund capital equipment and provide local match funding for E-rate Category 2 expenditures

K-12 connectivity status

88% of school districts in Georgia are ready for digital learning today. To meet 2018 demand, the typical school district in Georgia will need to **grow bandwidth at least threefold**.

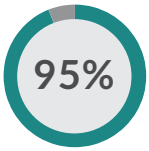


Minimum Goal
100 kbps
per student

Opportunities for action

Georgia can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



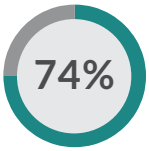
Status:

At least **95%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

60% of new fiber connections will be for rural and small town schools

Wi-Fi



Status:

74% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$107M in E-rate funds are available to support Wi-Fi networks in Georgia

Affordability

Status:

30% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

47,500 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=120 of 180 school districts, n=1,595 of 2,288 schools, n=1,191,151 of 1,593,612 students

Why high speeds matter

Eighth graders at Tift County Schools earned more than 400 high school credits last year thanks to an upgraded district network. This fivefold increase from the previous year is a direct result of having better, faster access to online classes.

Education SUPERHIGHWAY

K-12 Connectivity in Hawaii

Hawaii

Gov. Ige can take action to upgrade schools for 2018

Governor David Ige can ensure that all of Hawaii's schools grow their broadband to keep up with future demand.

K-12 connectivity status

100% of schools in Hawaii are ready for digital learning today. To meet 2018 demand, the typical school district in Hawaii will need to **grow bandwidth at least threefold.**

Minimum Goal
100 kbps
per student

Opportunities for action

Hawaii can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber

Status:

100% of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

0% new fiber connections necessary to meet connectivity goals

Wi-Fi

Status:

100% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$11M in E-rate funds are available to support Wi-Fi networks in Hawaii

Affordability

Status:

2% of schools are meeting the $3/Mbps Internet access affordability target

Opportunity:

0 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=249 of 256 schools, n=172,449 of 173,658 students

Why high speeds matter

Hawaii Volcanoes National Park was the site of a virtual field trip made possible by Keaau Elementary School students wearing Google Glasses and toting Wi-Fi enabled laptops. The live broadcast was streamed to neighboring schools as well as Peterson Schools in Mexico City, which is teaching Hawaiian as a third language.

Education SUPERHIGHWAY

K-12 Connectivity in Idaho

Idaho

LEADER

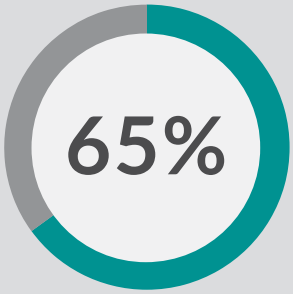
Gov. Otter is taking action to upgrade schools

> Ensuring that our schools have broadband connectivity and wireless infrastructure enables Idaho to overcome our geographic and socioeconomic barriers. It allows us to realize the kind of opportunities for enlightenment and progress that not long ago were available only in our largest and most connected communities. The ability to bring advanced classes and college-level courses into high school classrooms throughout Idaho via online instruction and blended learning is essential in helping prepare students for success beyond high school.

- ☑ Provides funding to cover the non-E-rate portion of school districts' Internet access
- ☑ Signed a 2013 bill appropriating $2.25M to connect all public high schools to high-speed wireless Internet
- ☑ Committed to continuing support for broadband connectivity and wireless infrastructure for all Idaho schools

K-12 connectivity status

65% of school districts in Idaho are ready for digital learning today. To meet 2018 demand, the typical school district in Idaho will need to **grow bandwidth at least threefold.**

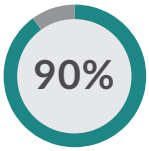


Minimum Goal
100 kbps
per student

Opportunities for action

Idaho can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



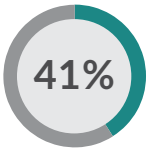
Status:

At least **90%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

85% of new fiber connections will be for rural and small town schools

Wi-Fi



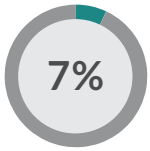
Status:

41% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$22M in E-rate funds are available to support Wi-Fi networks in Idaho

Affordability



Status:

7% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

115,300 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=57 of 114 school districts, n=457 of 725 schools, n=188,283 of 261,977 students

Why high speeds matter

The Idaho Digital Learning Academy is making it easier for middle and high school students throughout the state to accelerate their learning. Students can earn credits that fulfill course requirements, take classes that are not available in their area, and enroll in AP courses to receive college credit.

Education SUPERHIGHWAY

K-12 Connectivity in Illinois

Illinois

LEADER

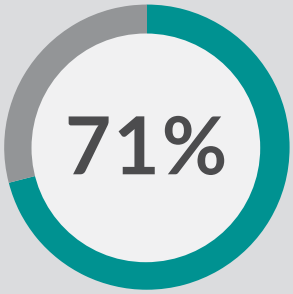
Gov. Rauner is taking action to upgrade schools

> Technology plays an undeniable role in today's workforce. Being able to bring high-speed Internet to more schools in Illinois will help prepare our children to compete both in and out of the classroom. I am committed to providing an equal opportunity to all students in Illinois.

- [x] Appointed a leader to drive K-12 broadband initiatives

K-12 connectivity status

71% of school districts in Illinois are ready for digital learning today. To meet 2018 demand, the typical school district in Illinois will need to **grow bandwidth at least threefold.**

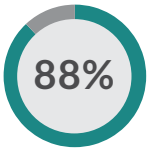


Minimum Goal
100 kbps
per student

Opportunities for action

Illinois can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



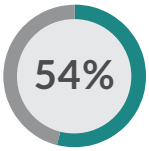
Status:

At least **88%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

64% of new fiber connections will be for rural and small town schools

Wi-Fi



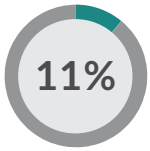
Status:

54% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$102M in E-rate funds are available to support Wi-Fi networks in Illinois

Affordability



Status:

11% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

979,000 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=392 of 860 school districts, n=2,149 of 3,946 schools, n=1,052,048 of 1,909,616 students

Why high speeds matter

At Huntley High School in School District 158 the Haiku communication platform allows students to chat with their teachers and get homework help at any time, including after school.

Education SUPERHIGHWAY

K-12 Connectivity in Indiana

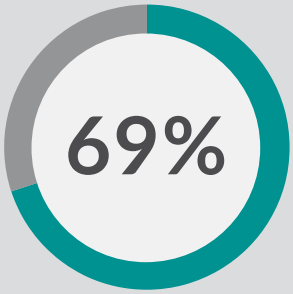
Indiana

Gov. Pence is committed to school upgrades

> The education of our children is critical to Indiana's future. By ensuring that high-speed Internet is available in every Indiana classroom, we can connect Hoosier students to the latest digital learning tools and ultimately set our kids on a course to compete for the careers of tomorrow.

K-12 connectivity status

69% of school districts in Indiana are ready for digital learning today. To meet 2018 demand, the typical school district in Indiana will need to **grow bandwidth at least threefold.**

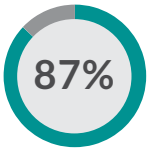


Minimum Goal
100 kbps
per student

Opportunities for action

Indiana can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



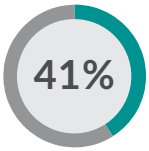
Status:

At least **87%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

70% of new fiber connections will be for rural and small town schools

Wi-Fi



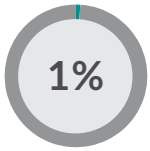
Status:

41% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$82M in E-rate funds are available to support Wi-Fi networks in Indiana

Affordability



Status:

1% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

437,300 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=218 of 292 school districts, n=1,368 of 1,830 schools, n=761,662 of 994,489 students

Why high speeds matter

TEDEd is transforming how teachers in the Bluffton-Harrison Metropolitan School District inspire and connect with their students. The project-based online course content includes streaming video, online quizzes, and supplemental resources that enrich lesson plans and provide for deeper classroom discussions.

Education SUPERHIGHWAY

K-12 Connectivity in Iowa

Iowa

LEADER

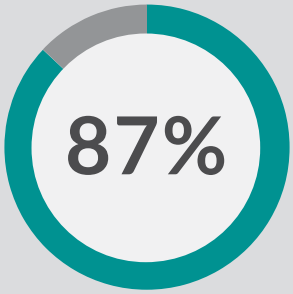
Gov. Branstad is taking action to upgrade schools

> We are committed to putting a focus on broadband Internet expansion so that our students will have access to an abundance of online learning resources, which will provide them a world-class education.

- ☑ Provides a 10 Gbps backbone and Internet access to all school districts through the Iowa Communications Network (ICN)
- ☑ Launched ICN in his first term as governor

K-12 connectivity status

87% of school districts in Iowa are ready for digital learning today. To meet 2018 demand, the typical school district in Iowa will need to **grow bandwidth at least threefold.**

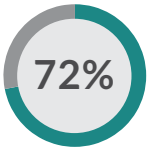


Minimum Goal
100 kbps
per student

Opportunities for action

Iowa can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



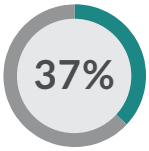
Status:

At least **72%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

99% of new fiber connections will be for rural and small town schools

Wi-Fi



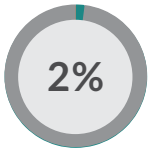
Status:

37% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$39M in E-rate funds are available to support Wi-Fi networks in Iowa

Affordability



Status:

2% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

86,000 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=191 of 347 school districts, n=680 of 1,402 schools, n=206,201 of 471,289 students

Why high speeds matter

Spelling practice has received a technology makeover in the Howard-Winneshiek Community School District. Students now use their iPads to work on spelling assignments and can scan a QR code to learn the correct spelling. The real-time feedback allows them to revise their work or receive a grade.

Education SUPERHIGHWAY

K-12 Connectivity in Kansas

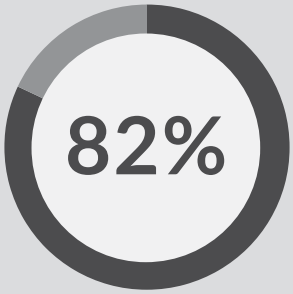
Kansas

Gov. Brownback can take action to upgrade schools

Governor Sam Brownback has the opportunity to connect all of Kansas's students to the speeds they need to take advantage of digital learning.

K-12 connectivity status

82% of school districts in Kansas are ready for digital learning today. To meet 2018 demand, the typical school district in Kansas will need to **grow bandwidth at least threefold.**

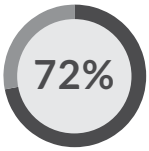


Minimum Goal
100 kbps
per student

Opportunities for action

Kansas can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



Status:

At least **72%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

57% of new fiber connections will be for rural and small town schools

Wi-Fi

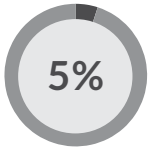
Status:

53% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$41M in E-rate funds are available to support Wi-Fi networks in Kansas

Affordability



Status:

5% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

41,100 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=125 of 285 school districts, n=660 of 1,336 schools, n=243,042 of 454,386 students

Why high speeds matter

The need to prepare students to enter the modern workforce led the Blue Valley School District to join forces with mentors from the tech industry. The resulting curriculum at the Center for Advanced Professional Studies provides students with digital tools to study science and tech fields and earn college credit.

Education SUPERHIGHWAY

K-12 Connectivity in Kentucky

Kentucky

Gov. Beshear can take action to upgrade schools

Governor Steve Beshear has the opportunity to connect all of Kentucky's students to the speeds they need to take advantage of digital learning.

K-12 connectivity status

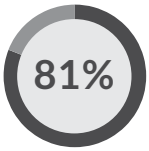
92% of school districts in Kentucky are ready for digital learning today. To meet 2018 demand, the typical school district in Kentucky will need to **grow bandwidth at least threefold**.

Minimum Goal
100 kbps
per student

Opportunities for action

Kentucky can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



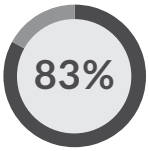
Status:

At least **81%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

57% of new fiber connections will be for rural and small town schools

Wi-Fi



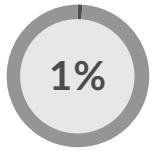
Status:

83% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$48M in E-rate funds are available to support Wi-Fi networks in Kentucky

Affordability



Status:

1% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

36,200 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=153 of 174 school districts, n=1,402 of 1,534 schools, n=598,124 of 658,256 students

Why high speeds matter

For students at Owsley County Schools, snow days no longer mean missing school. The district now uses a digital learning management system to give students access to lessons they would otherwise miss as well as the chance to earn credit for classes that are not typically offered at their school.

Education SUPERHIGHWAY

K-12 Connectivity in Louisiana

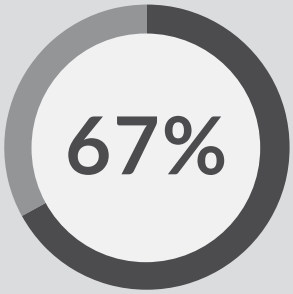
Louisiana

Gov. Jindal can take action to upgrade schools

Governor Bobby Jindal has the opportunity to connect all of Louisiana's students to the speeds they need to take advantage of digital learning.

K-12 connectivity status

67% of school districts in Louisiana are ready for digital learning today. To meet 2018 demand, the typical school district in Louisiana will need to **grow bandwidth at least threefold**.



Minimum Goal
100 kbps
per student

Opportunities for action

Louisiana can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber

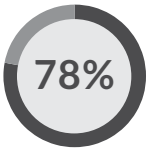
Status:

At least **98%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

33% of new fiber connections will be for rural and small town schools

Wi-Fi



Status:

78% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$26M in E-rate funds are available to support Wi-Fi networks in Louisiana

Affordability

Status:

9% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

204,400 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=46 of 69 school districts, n=937 of 1,267 schools, n=467,660 of 616,348 students

Why high speeds matter

Teachers in Rapides Parish School District are leveraging their 1:1 laptop program to make Algebra 1 come alive. Instead of simply doing problem sets, students are assigned a hands-on project where they can use their algebra skills to run analyses that are then included in a digital business presentation.

Education SUPERHIGHWAY

K-12 Connectivity in Maine

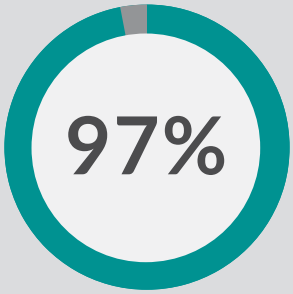
Maine

Governor Paul R. LePage is committed to school upgrades

> High-speed Internet is necessary for taking advantage of technology in the classroom and at home. I am committed to working with the private sector to expand broadband connectivity in every classroom in our state to ensure our students have the tools and skills they need to succeed in school and at home.

K-12 connectivity status

97% of school districts in Maine are ready for digital learning today. To meet 2018 demand, the typical school district in Maine will need to **grow bandwidth at least threefold**.



Minimum Goal
100 kbps
per student

Opportunities for action

Maine can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber

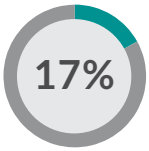
Status:

At least **99%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

100% of new fiber connections will be for rural and small town schools

Wi-Fi



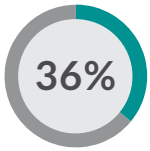
Status:

17% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$16M in E-rate funds are available to support Wi-Fi networks in Maine

Affordability



Status:

36% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

14,600 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=104 of 175 school districts, n=310 of 607 schools, n=84,360 of 174,242 students

Why high speeds matter

The STEM-based curriculum at Regional School Unit 21 is ensuring that students become well versed with technology. All K-12 students participate in engineering, robotics, and coding courses thanks to the school's 1:1 program.

Education SUPERHIGHWAY

K-12 Connectivity in Maryland

Maryland

Gov. Hogan can take action to upgrade schools

Governor Larry Hogan has the opportunity to connect all of Maryland's students to the speeds they need to take advantage of digital learning.

K-12 connectivity status

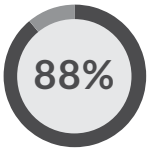
38% of school districts in Maryland are ready for digital learning today. To meet 2018 demand, the typical school district in Maryland will need to **grow bandwidth at least threefold**.

Minimum Goal
100 kbps
per student

Opportunities for action

Maryland can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



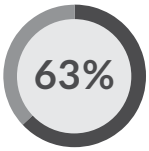
Status:

At least **88%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

8% of new fiber connections will be for rural and small town schools

Wi-Fi



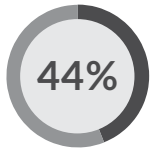
Status:

63% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$72M in E-rate funds are available to support Wi-Fi networks in Maryland

Affordability



Status:

44% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

51,400 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=16 of 24 school districts, n= 934 of 1,398 schools, n=537,454 of 811,173 students

Why high speeds matter

Real-time grading is allowing teachers at Anne Arundel County Public Schools to quickly assess how well their students are doing. Students use online assessments instead of bubble sheets saving teachers time and providing them with powerful insights at both the individual and group level.

Education SUPERHIGHWAY

K-12 Connectivity in Massachusetts

Massachusetts

LEADER

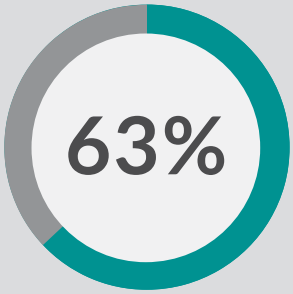
Gov. Baker is taking action to upgrade schools

> High-speed Internet in the classroom provides an important foundation to prepare our kids to compete for the jobs of the future. We are committed to making sure our kids have the tools to succeed and look forward to continuing our efforts to expand high-speed Internet to classrooms across the Commonwealth.

- [x] Appointed a leader to drive K-12 broadband initiatives

K-12 connectivity status

63% of school districts in Massachusetts are ready for digital learning today. To meet 2018 demand, the typical school district in Massachusetts will need to **grow bandwidth at least threefold.**

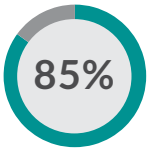


Minimum Goal
100 kbps
per student

Opportunities for action

Massachusetts can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



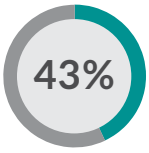
Status:

At least **85%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

24% of new fiber connections will be for rural and small town schools

Wi-Fi



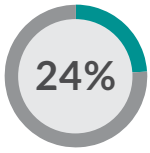
Status:

43% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$65M in E-rate funds are available to support Wi-Fi networks in Massachusetts

Affordability



Status:

24% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

316,100 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=168 of 295 school districts, n=943 of 1,702 schools, n=490,322 of 864,451 students

Why high speeds matter

Easthampton Public Schools' high school chemistry students participate in a flipped classroom where the teacher records video lessons which students can view at home and use in class the next day. This allows students to focus their time in class to work on hands-on lab experiments and group research projects.

Education SUPERHIGHWAY

K-12 Connectivity in Michigan

Michigan

LEADER

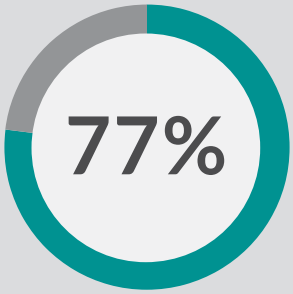
Gov. Snyder is taking action to upgrade schools

> We've embraced an 'any time, any place, any way and any pace' philosophy because we know that the education world is changing and Michigan students need to compete in a global economy. That means it's important for us to take advantage of technology and high-speed connectivity in the classroom so our kids have access to the tools they need to graduate with in-demand skills.

- ☑ Provided $45M for school district technology infrastructure through MDE's Technology Readiness Infrastructure Grant program (TRIG)
- ☑ Building the Michigan Statewide Educational Network for K-12

K-12 connectivity status

77% of school districts in Michigan are ready for digital learning today. To meet 2018 demand, the typical school district in Michigan will need to **grow bandwidth at least threefold**.

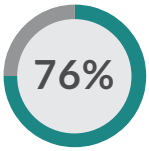


Minimum Goal
100 kbps
per student

Opportunities for action

Michigan can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



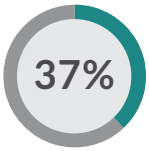
Status:

At least **76%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

59% of new fiber connections will be for rural and small town schools

Wi-Fi



Status:

37% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$107M in E-rate funds are available to support Wi-Fi networks in Michigan

Affordability

Status:

53% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

259,700 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=228 of 546 school districts, n=1,276 of 3,157 schools, n=539,569 of 1,373,257 students

Why high speeds matter

Students at Southfield Public Schools receive real-time feedback on their writing assignments via a virtual editing program. The software provides suggestions for improving structure, context, or narrative. The students can then revise their papers prior to submitting their assignments for a grade.

Education SUPERHIGHWAY

K-12 Connectivity in Minnesota

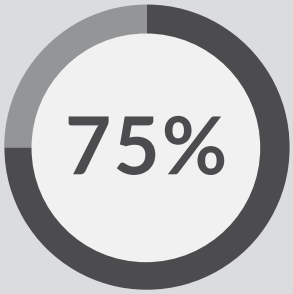
Minnesota

Gov. Dayton can take action to upgrade schools

Governor Mark Dayton has the opportunity to connect all of Minnesota's students to the speeds they need to take advantage of digital learning.

K-12 connectivity status

75% of school districts in Minnesota are ready for digital learning today. To meet 2018 demand, the typical school district in Minnesota will need to **grow bandwidth at least threefold**.



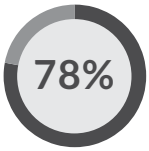
Minimum Goal

100 kbps per student

Opportunities for action

Minnesota can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



Status:

At least **78%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

55% of new fiber connections will be for rural and small town schools

Wi-Fi

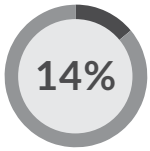
Status:

56% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$52M in E-rate funds are available to support Wi-Fi networks in Minnesota

Affordability



Status:

14% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

291,100 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=248 of 334 school districts, n=1,402 of 1,884 schools, n=582,066 of 781,029 students

Why high speeds matter

Minnetonka Public Schools is helping their students prepare for the needs of the modern workforce by implementing a K-5 coding curriculum, Tonka<codes>, via the Tynker online platform. By providing early exposure to computer programming, the program hopes to help meet the growing demand for computer programming skills.

Education SUPERHIGHWAY

K-12 Connectivity in Mississippi

Mississippi

LEADER

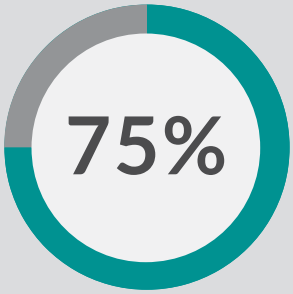
Gov. Bryant is taking action to upgrade schools

"Fostering greater access to enhanced Internet speeds has become a crucial factor for success in the K-12 community. With 97% of our schools leveraging fiber-based connectivity, Mississippi will continue to focus on expanding cost effective bandwidth to ensure affordability of Internet access across our State in meeting the FCC's goal in 2018.

☑ Appointed a leader to drive K-12 broadband initiatives

K-12 connectivity status

75% of school districts in Mississippi are ready for digital learning today. To meet 2018 demand, the typical school district in Mississippi will need to **grow bandwidth at least threefold**.

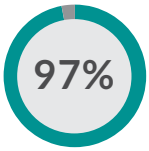


Minimum Goal
100 kbps
per student

Opportunities for action

Mississippi can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



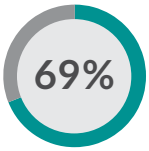
Status:

At least **97%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

74% of new fiber connections will be for rural and small town schools

Wi-Fi



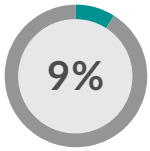
Status:

69% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$35M in E-rate funds are available to support Wi-Fi networks in Mississippi

Affordability



Status:

9% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

124,500 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=111 of 151 school districts, n=824 of 1,062 schools, n=376,159 of 487,501 students

Why high speeds matter

Proximity Learning, an online education provider, is helping the Greenville Public School District to overcome a statewide teacher shortage. Students receive live instruction via web conferencing. An online learning management system permits students to engage with instructors and offers unlimited access to coursework.

Education SUPERHIGHWAY

K-12 Connectivity in Missouri

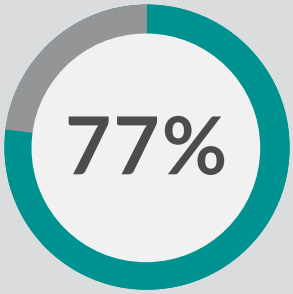
Missouri

Gov. Nixon is committed to school upgrades

"As a growing hub for high-tech jobs and innovation, Missouri is committed to providing students with the tools and resources they need to compete in the 21st century economy. Continuing to expand access to high-speed Internet in the classroom will improve opportunities for students and strengthen our communities.

K-12 connectivity status

77% of school districts in Missouri are ready for digital learning today. To meet 2018 demand, the typical school district in Missouri will need to **grow bandwidth at least threefold**.

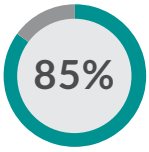


Minimum Goal
100 kbps
per student

Opportunities for action

Missouri can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



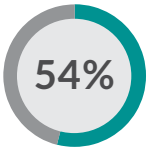
Status:

At least **85%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

81% of new fiber connections will be for rural and small town schools

Wi-Fi



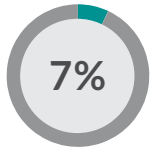
Status:

54% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$63M in E-rate funds are available to support Wi-Fi networks in Missouri

Affordability



Status:

7% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

218,700 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=395 of 520 school districts, n=1,607 of 2,198 schools, n=606,116 of 864,347 students

Why high speeds matter

Students in Grand Center Arts Academy's makerspace use their computers to write code, develop electronic prototypes, and create new inventions with 3D design. Rather than learn about mechanics or plant life in a science textbook, one student mastered this material by building and programing a robotic garden with sensors that measure and automatically adjust light and water intake.

Education SUPERHIGHWAY

K-12 Connectivity in Montana

Montana

LEADER

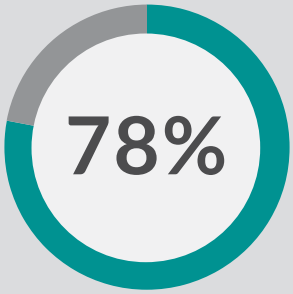
Gov. Bullock is taking action to upgrade schools

> In order to reach their full potential and enjoy equal opportunity in today's digital age, all K-12 students in Montana need access to high-speed Internet. We are committed to making sure each school - rural or urban, big or small - has equal access to the promise of digital learning.

- ☑ Set statewide K-12 connectivity goals
- ☑ Appointed a leader to drive K-12 broadband initiatives
- ☑ Launched an initiative to connect all schools to fiber

K-12 connectivity status

78% of school districts in Montana are ready for digital learning today. To meet 2018 demand, the typical school district in Montana will need to **grow bandwidth at least threefold**.

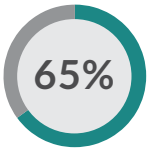


Minimum Goal
100 kbps
per student

Opportunities for action

Montana can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



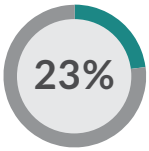
Status:

At least **65%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

98% of new fiber connections will be for rural and small town schools

Wi-Fi



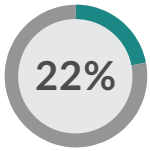
Status:

23% of school districts accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$11M in E-rate funds are available to support Wi-Fi networks in Montana

Affordability



Status:

22% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

59,000 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=170 of 309 school districts, n=545 of 822 schools, n=111,376 of 141,558 students

Why high speeds matter

The Montana Digital Professional Learning Network provides online professional development courses to over 10,000 K-12 educators throughout the state. Teachers can choose their own courses and receive personalized support targeting areas of growth for their individual classrooms, rather than attend traditional standardized development sessions.

Education SUPERHIGHWAY

K-12 Connectivity in Nebraska

Nebraska

Gov. Ricketts can take action to upgrade schools

Governor Pete Ricketts has the opportunity to connect all of Nebraska's students to the speeds they need to take advantage of digital learning.

K-12 connectivity status

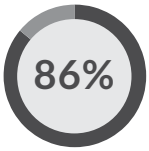
92% of school districts in Nebraska are ready for digital learning today. To meet 2018 demand, the typical school district in Nebraska will need to **grow bandwidth at least threefold**.

Minimum Goal
100 kbps
per student

Opportunities for action

Nebraska can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



Status:

At least **86%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

98% of new fiber connections will be for rural and small town schools

Wi-Fi

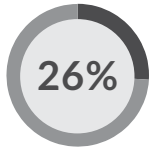
Status:

51% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$21M in E-rate funds are available to support Wi-Fi networks in Nebraska

Affordability



Status:

26% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

34,600 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=92 of 249 school districts, n=395 of 1,010 schools, n=119,088 of 289,405 students

Why high speeds matter

Video conferencing allows Brady Public Schools to provide foreign language courses for its students. As a small, rural district with limited resources, they can't afford to offer a large range of courses. The distance-learning program helps students to enroll in college by satisfying foreign language requirements.

Education SUPERHIGHWAY

K-12 Connectivity in Nevada

Nevada

LEADER

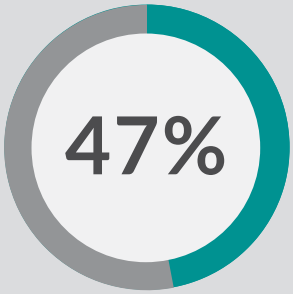
Gov. Sandoval is taking action to upgrade schools

> The growing role technology plays in today's workforce is undeniable. It's vital that our schools have the bandwidth they need to implement digital learning so our students can gain the technology literacy necessary to compete in the knowledge economy.

- [x] Secured $20M to fund the Nevada Ready 21 plan, which sets broadband goals and provides funding for broadband infrastructure to support digitial learning

K-12 connectivity status

47% of school districts in Nevada are ready for digital learning today. To meet 2018 demand, the typical school district in Nevada will need to **grow bandwidth at least threefold**.

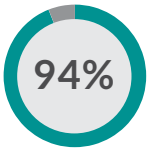


Minimum Goal
100 kbps
per student

Opportunities for action

Nevada can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



Status:

At least **94%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

58% of new fiber connections will be for rural and small town schools

Wi-Fi

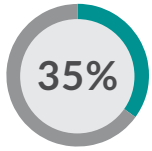
Status:

59% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$26M in E-rate funds are available to support Wi-Fi networks in Nevada

Affordability



Status:

35% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

23,900 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=17 of 17 school districts, n=637 of 637 schools, n=418,102 of 418,102 students

Why high speeds matter

A learning management system is helping teachers in the Carson City School District see how well their students are learning. The technology allows for real-time assessments of student performance and allows teachers to share and pool their knowledge about best curriculum practices for different learning styles.

Education SUPERHIGHWAY

K-12 Connectivity in New Hampshire

New Hampshire

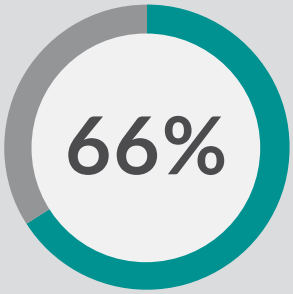
Gov. Hassan is taking action to upgrade schools

> It is our job to ensure that students have every tool necessary to prepare for and compete in the 21st century innovation economy, and we know that broadband is a critical component of a modern economy's infrastructure. By expanding access to broadband in schools throughout New Hampshire, we can broaden educational opportunities across all curricula, including in the critical STEM areas, helping to better prepare our students for future success.

- ☑ Appointed a leader to drive K-12 broadband initiatives
- ☑ Formed a working group to lead the efforts of upgrading K-12 broadband for all schools in New Hampshire

K-12 connectivity status

66% of school districts in New Hampshire are ready for digital learning today. To meet 2018 demand, the typical school district in New Hampshire will need to **grow bandwidth at least threefold**.

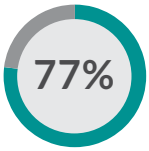


Minimum Goal
100 kbps
per student

Opportunities for action

New Hampshire can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



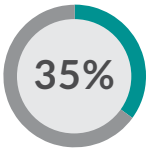
Status:

At least **77%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

81% of new fiber connections will be for rural and small town schools

Wi-Fi



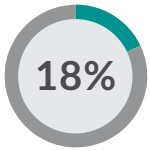
Status:

35% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$14M in E-rate funds are available to support Wi-Fi networks in New Hampshire

Affordability



Status:

18% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

47,400 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=67 of 165 school districts, n=219 of 459 schools, n=95,783 of 183,439 students

Why high speeds matter

Teachers at Milan Village Elementary School, located in School Administrative Unit #20, use technology to match educational activities to individual learning styles and manage lessons. Computer-generated progress reports help them assess when to rotate students to online or offline activities.

Education SUPERHIGHWAY

K-12 Connectivity in New Jersey

New Jersey

LEADER

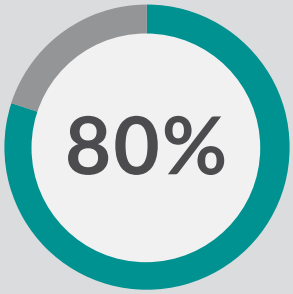
Gov. Christie is taking action to upgrade schools

> New Jersey is a national leader in ensuring our students have access to the Internet and cutting edge digital learning resources essential for them to develop the 21st century skills needed for college and the workforce. We are getting the job done by helping our schools save millions of taxpayer dollars as they increase high-speed bandwidth necessary to deliver these educational necessities.

- [x] Formed a statewide purchasing consortium for Internet access and transport procurement through the New Jersey Digital Readiness Learning and Assessment Program, which resulted in a 150% increase in bandwidth and 16% reduction in cost

K-12 connectivity status

80% of school districts in New Jersey are ready for digital learning today. To meet 2018 demand, the typical school district in New Jersey will need to **grow bandwidth at least threefold**.



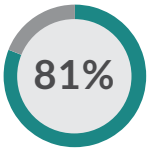
Minimum Goal

100 kbps per student

Opportunities for action

New Jersey can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



Status:

At least **81%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

19% of new fiber connections will be for rural and small town schools

Wi-Fi

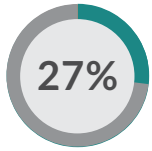
Status:

38% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$92M in E-rate funds are available to support Wi-Fi networks in New Jersey

Affordability



Status:

27% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

288,900 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=256 of 547 school districts, n=983 of 2,278 schools, n=535,734 of 1,269,214 students

Why high speeds matter

With 85% of their students coming from Spanish-speaking homes, the New Brunswick School District needed a solution that facilitated student learning. After integrating bilingual technology into their existing curriculum, teachers are now able to allow students to access lessons in their native language.

Education SUPERHIGHWAY

K-12 Connectivity in New Mexico

New Mexico

LEADER

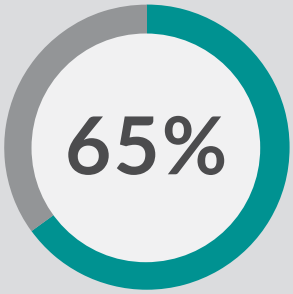
Gov. Martinez is taking action to upgrade schools

"I have always believed that every child can learn – no matter his or her circumstances or background. But as leaders, we must also give our students the tools they need to succeed. In 2015, that means providing every school with access to high-speed Internet.

- ☑ Set statewide K-12 connectivity goals
- ☑ Appointed a leader to drive K-12 broadband initiatives
- ☑ Authorized $50M over a five-year period to improve K-12 broadband infrastructure

K-12 connectivity status

65% of school districts in New Mexico are ready for digital learning today. To meet 2018 demand, the typical school district in New Mexico will need to **grow bandwidth at least threefold.**

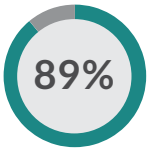


Minimum Goal
100 kbps
per student

Opportunities for action

New Mexico can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



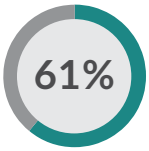
Status:

At least **89%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

92% of new fiber connections will be for rural and small town schools

Wi-Fi



Status:

61% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$27M in E-rate funds are available to support Wi-Fi networks in New Mexico

Affordability

Status:

0% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

256,100 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=57 of 89 school districts, n=523 of 760 schools, n=225,932 of 308,593 students

Why high speeds matter

The Clovis Municipal School District can attribute a measurable increase in reading and math proficiency to the digital curriculum offered by Pearson's SuccessMaker. The virtual program adapts to individual student needs, using multimedia to create engaging courses in core subjects.

Education SUPERHIGHWAY

K-12 Connectivity in New York

New York

LEADER

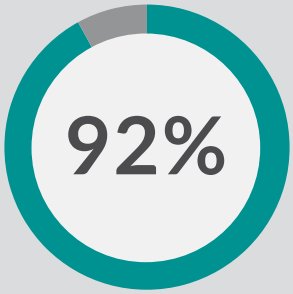
Gov. Cuomo is taking action to upgrade schools

> Technology is changing the face of the world as we know it, and we need to make sure that our schools are equipped for the realities of the information age in order to give every child a world-class education. New York has been a leader in digital learning, and we are continuing to help our schools achieve high-speed Internet access so students and teachers have the tools they need to succeed in the 21st century learning environment.

☑ Passed the Smart Schools Bond Act providing $2B to improve schools for the 21st century, including improved Internet access

K-12 connectivity status

92% of school districts in New York are ready for digital learning today. To meet 2018 demand, the typical school district in New York will need to **grow bandwidth at least threefold**.

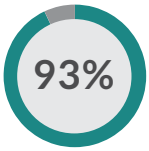


Minimum Goal
100 kbps
per student

Opportunities for action

New York can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



Status:

At least **93%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

55% of new fiber connections will be for rural and small town schools

Wi-Fi

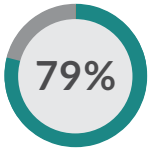
Status:

39% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$216M in E-rate funds are available to support Wi-Fi networks in New York

Affordability



Status:

79% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

113,400 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=346 of 684 school districts, n=2,871 of 4,487 schools, n=1,631,845 of 2,557,860 students

Why high speeds matter

A blended learning program is helping teachers to better connect with students in the Enlarged City School District of Middletown. By using a cloud-based platform to receive real-time data on student performance, educators are better equipped to provide personalized instruction to increase student engagement.

Education SUPERHIGHWAY

K-12 Connectivity in North Carolina

North Carolina

LEADER

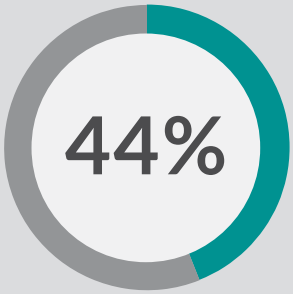
Gov. McCrory is taking action to upgrade schools

> Our ability to create an environment where children are empowered to learn, explore, and prepare themselves for the 21st century knowledge-based economy relies on equipping classrooms with next generation infrastructure that enables high-speed network and Internet connectivity.

- [x] Created the Wireless Classroom Initiative (WCI) to lower Wi-Fi costs for school districts

K-12 connectivity status

44% of school districts in North Carolina are ready for digital learning today. To meet 2018 demand, the typical school district in North Carolina will need to **grow bandwidth at least threefold.**

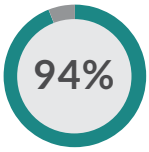


Minimum Goal
100 kbps
per student

Opportunities for action

North Carolina can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



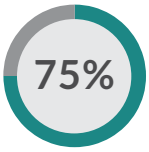
Status:

At least **94%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

74% of new fiber connections will be for rural and small town schools

Wi-Fi



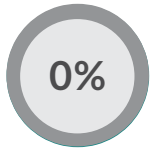
Status:

75% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$106M in E-rate funds are available to support Wi-Fi networks in North Carolina

Affordability



Status:

0% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

1,220,000 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=84 of 115 school districts, n=1,700 of 2,475 schools, n=1,019,337 of 1,437,568 students

Why high speeds matter

For a recent lesson on prepositions at Gaston County Schools, a teacher gathered a digital collection of content-specific videos, games, and examples on the Blendspace platform. Students were able to pick and choose their preferred method to learn the same concept, and overall classwide proficiency increased by 20 points through just one personalized lesson.

Education SUPERHIGHWAY

K-12 Connectivity in North Dakota

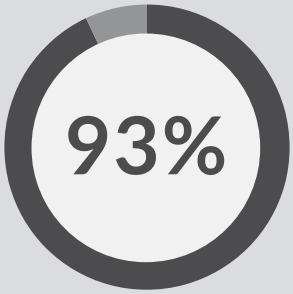
North Dakota

Gov. Dalrymple can take action to upgrade schools

Governor Jack Dalrymple has the opportunity to connect all of North Dakota's students to the speeds they need to take advantage of digital learning.

K-12 connectivity status

93% of school districts in North Dakota are ready for digital learning today. To meet 2018 demand, the typical school district in North Dakota will need to **grow bandwidth at least threefold.**



Minimum Goal
100 kbps
per student

Opportunities for action

North Dakota can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber

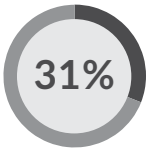
Status:

At least **75%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

100% of new fiber connections will be for rural and small town schools

Wi-Fi



Status:

31% of school districts accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$6M in E-rate funds are available to support Wi-Fi networks in North Dakota

Affordability

Status:

0% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

15,000 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=96 of 177 school districts, n=201 of 481 schools, n=25,309 of 99,100 students

Why high speeds matter

The SmartLab at the North Dakota Center for Distance Education promotes the hands-on exploration of STEAM, digital media arts and workforce opportunities. The lab uses an adaptive digital curriculum to document student progress via an ePortfolio, which also allows teachers, students, and parents to collaborate.

Education SUPERHIGHWAY

K-12 Connectivity in Ohio

Ohio

LEADER

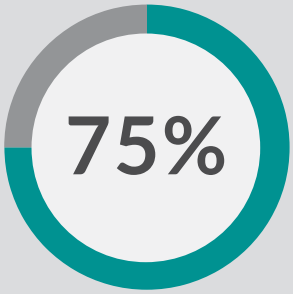
Gov. Kasich is taking action to upgrade schools

> In our classrooms, the methods and technologies we apply to teaching are evolving at record speed and those in education are hungry to expand digital learning opportunities. By becoming the first state to expand our broadband capacity to an impressive 100GB/second statewide, we are better able to help educators who are looking to transform their classroom or expand training and

- ☑ Upgraded the OARnet backbone to 100 Gbps and the middle mile connections to 10 Gbps
- ☑ Released a Request for Quote through the OH Department of Administrative Services and OH Department of Education to deliver fiber to school districts

K-12 connectivity status

75% of school districts in Ohio are ready for digital learning today. To meet 2018 demand, the typical school district in Ohio will need to **grow bandwidth at least threefold.**

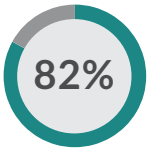


Minimum Goal
100 kbps
per student

Opportunities for action

Ohio can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



Status:

At least **82%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

54% of new fiber connections will be for rural and small town schools

Wi-Fi

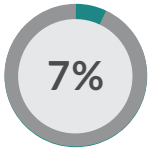
Status:

59% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$128M in E-rate funds are available to support Wi-Fi networks in Ohio

Affordability



Status:

7% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

543,500 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=332 of 614 school districts, n=1,555 of 3,265 schools, n=779,793 of 1,586,598 students

Why high speeds matter

Reynolds City Schools high school is using digital devices, 3-D printers and laser cutters to enable students to combine education with real world experience. By leveraging technology, one student was able to set up a business providing logos to local businesses, making her learning come alive.

Education SUPERHIGHWAY

K-12 Connectivity in Oklahoma

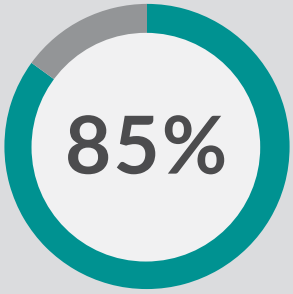
Oklahoma

Gov. Fallin is committed to school upgrades

> Broadband access in the classroom is an important resource for students and teachers. It opens the door to innovative, technology-based learning and helps to ensure our students are exposed to the computer and internet skills they will need in our 21st century workforce. I'm proud of the steps Oklahoma has taken to improve broadband access in our schools, and I will continue to work at bringing broadband to an even greater number of classrooms in the future.

K-12 connectivity status

85% of school districts in Oklahoma are ready for digital learning today. To meet 2018 demand, the typical school district in Oklahoma will need to **grow bandwidth at least threefold**.

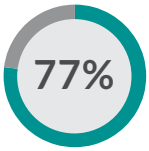


Minimum Goal
100 kbps
per student

Opportunities for action

Oklahoma can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



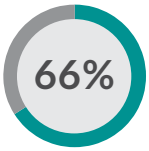
Status:

At least **77%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

61% of new fiber connections will be for rural and small town schools

Wi-Fi



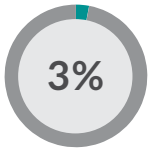
Status:

66% of school districts accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$34M in E-rate funds are available to support Wi-Fi networks in Oklahoma

Affordability



Status:

3% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

100,500 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n= 242 of 520 school districts, n=1,033 of 1,754 schools, n=423,049 of 618,625 students

Why high speeds matter

Oklahoma City Public Schools encourage students to use their cell phones to actively engage in the learning process. They learn how to collaborate on social media, take notes and view digital content. By measuring the real-time results of class polls, students and teachers can adapt lesson plans to meet new needs.

Education SUPERHIGHWAY

K-12 Connectivity in Oregon

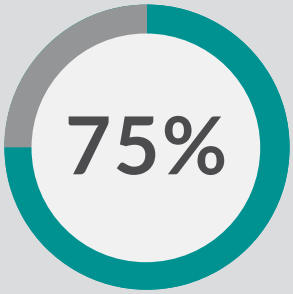
Oregon

Gov. Brown is committed to school upgrades

> Every student in Oregon deserves the opportunity to learn and thrive. We are committed to expanding access to a world of knowledge and skills by improving the reach of high-speed Internet and digital learning in classrooms in every Oregon community.

K-12 connectivity status

75% of school districts in Oregon are ready for digital learning today. To meet 2018 demand, the typical school district in Oregon will need to **grow bandwidth at least threefold.**

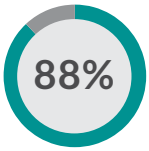


Minimum Goal
100 kbps
per student

Opportunities for action

Oregon can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



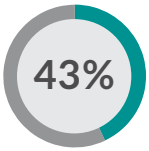
Status:

At least **88%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

54% of new fiber connections will be for rural and small town schools

Wi-Fi



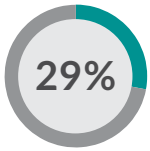
Status:

43% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$44M in E-rate funds are available to support Wi-Fi networks in Oregon

Affordability



Status:

29% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

94,900 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=91 of 180 school districts, n=583 of 1,140 schools, n=272,833 of 527,953 students

Why high speeds matter

Estacada School District is using technology to help mainstream students in special education programs. A third grader who was struggling with writing uses an iPad to record and transcribe his stories into written text. This allows him to more easily edit his work and turn in a finished product.

Education SUPERHIGHWAY

K-12 Connectivity in Pennsylvania

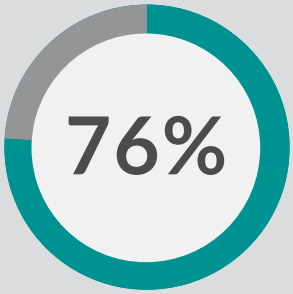
Pennsylvania

Gov. Wolf is committed to school upgrades

> Access to high-speed Internet is no longer considered a luxury, but a basic necessity for 21st century learning. With funding to help schools access this vital tool, we can level the playing field and ensure every child in Pennsylvania has access to a high-quality education that will equip them with the tools to compete in a high tech economy.

K-12 connectivity status

76% of school districts in Pennsylvania are ready for digital learning today. To meet 2018 demand, the typical school district in Pennsylvania will need to **grow bandwidth at least threefold.**

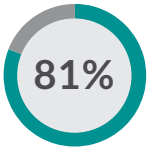


Minimum Goal
100 kbps
per student

Opportunities for action

Pennsylvania can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



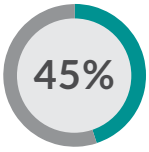
Status:

At least **81%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

35% of new fiber connections will be for rural and small town schools

Wi-Fi



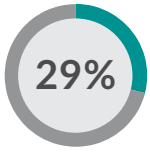
Status:

45% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$118M in E-rate funds are available to support Wi-Fi networks in Pennsylvania

Affordability



Status:

29% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

396,100 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=226 of 499 school districts, n=1,234 of 2,962 schools, n=669,005 of 1,606,730 students

Why high speeds matter

A personalized learning model used by the Spring-Ford Area School District has boosted student test scores in reading, math, and science by at least 19%. Using a blended learning model where students rotate between individual, collaborative, and direct-instruction stations, teachers are able to spend more time with each student providing the instruction they need.

Education SUPERHIGHWAY

K-12 Connectivity in Rhode Island

Rhode Island

LEADER

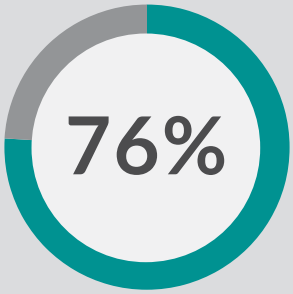
Gov. Raimondo is taking action to upgrade schools

> I am proud that Rhode Island is leading the nation in providing high-speed wireless Internet access in all of our classrooms. Investing in strong broadband access will help Rhode Island students realize the promise of digital learning and empower teachers to personalize education for better student success in school, career, and beyond.

- ☑ Set statewide K-12 connectivity goals
- ☑ Appointed a leader to drive K-12 broadband initiatives

K-12 connectivity status

76% of school districts in Rhode Island are ready for digital learning today. To meet 2018 demand, the typical school district in Rhode Island will need to **grow bandwidth at least threefold.**



Minimum Goal

100 kbps per student

Opportunities for action

Rhode Island can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber

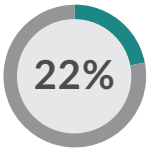
Status:

At least **98%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

25% of new fiber connections will be for rural and small town schools

Wi-Fi



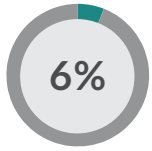
Status:

22% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$11M in E-rate funds are available to support Wi-Fi networks in Rhode Island

Affordability



Status:

6% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

53,900 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=34 of 36 school districts, n=266 of 280 schools, n=125,722 of 131,988 students

Why high speeds matter

The West Warwick School District uses classroom technology to help teachers quickly assess how well students have understood the content in a particular lesson. Depending on the results, teachers can then modify their lessons to best suit students' needs.

Education SUPERHIGHWAY

K-12 Connectivity in South Carolina

South Carolina

LEADER

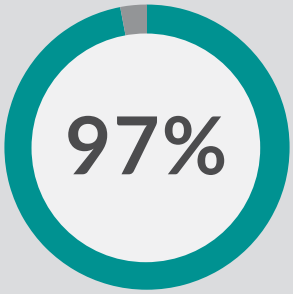
Gov. Haley is taking action to upgrade schools

> Technology, connectivity, and digital learning are critical to unleashing our students' potential. When we invest in them, we equip students with the skills their future employers will demand.

- ☑ Set statewide K-12 connectivity goals
- ☑ Allocated $29M each for the 2014-15 and 2015-16 school years to upgrade school broadband

K-12 connectivity status

97% of school districts in South Carolina are ready for digital learning today. To meet 2018 demand, the typical school district in South Carolina will need to **grow bandwidth at least threefold.**

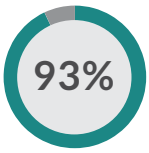


Minimum Goal
100 kbps
per student

Opportunities for action

South Carolina can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



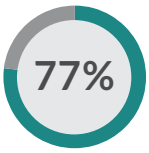
Status:

At least **93%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

59% of new fiber connections will be for rural and small town schools

Wi-Fi



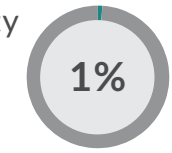
Status:

77% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$45M in E-rate funds are available to support Wi-Fi networks in South Carolina

Affordability



Status:

1% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

28,300 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=79 of 84 school districts, n=1,082 of 1,146 schools, n=648,227 of 690,456 students

Why high speeds matter

Unable to hire a teacher to lead a keyboarding class, students at Dacusville Middle School in the Pickens County School District were able to gain access to a virtual keyboarding class taught by a licensed virtual teacher via Double Robot. The remote teacher is able to "roam" the classroom and interact with students using a remote controlled tablet set on a moveable base.

Education SUPERHIGHWAY

K-12 Connectivity in South Dakota

South Dakota

Gov. Daugaard can take action to upgrade schools

Governor Dennis Daugaard has the opportunity to connect all of South Dakota's students to the speeds they need to take advantage of digital learning.

K-12 connectivity status

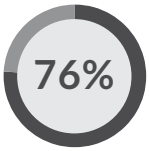
98% of school districts in South Dakota are ready for digital learning today. To meet 2018 demand, the typical school district in South Dakota will need to **grow bandwidth at least threefold.**

Minimum Goal
100 kbps
per student

Opportunities for action

South Dakota can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



Status:

At least **76%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

98% of new fiber connections will be for rural and small town schools

Wi-Fi

Status:

30% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$10M in E-rate funds are available to support Wi-Fi networks in South Dakota

Affordability

Status:

0% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

9,600 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=102 of 151 school districts, n=444 of 696 schools, n=70,231 of 127,141 students

Why high speeds matter

As part of an ongoing technology initiative designed to increase student engagement, Lowell Elementary School students in Sioux Falls School District begin each day by solving a problem sent to their personal device. Teachers use the automatically-generated results to inform that day's lesson.

Education SUPERHIGHWAY

K-12 Connectivity in Tennessee

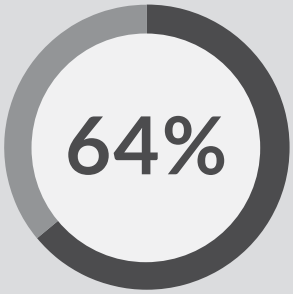
Tennessee

Gov. Haslam can take action to upgrade schools

Governor Bill Haslam has the opportunity to connect all of Tennessee's students to the speeds they need to take advantage of digital learning.

K-12 connectivity status

64% of school districts in Tennessee are ready for digital learning today. To meet 2018 demand, the typical school district in Tennessee will need to **grow bandwidth at least threefold**.



Minimum Goal
100 kbps
per student

Opportunities for action

Tennessee can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber

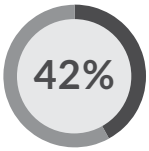
Status:

At least **97%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

86% of new fiber connections will be for rural and small town schools

Wi-Fi



Status:

42% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$89M in E-rate funds are available to support Wi-Fi networks in Tennessee

Affordability

Status:

0% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

562,400 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=75 of 137 school districts, n=834 of 1,766 schools, n=439,847 of 953,483 students

Why high speeds matter

Tennessee STEM Innovation Network's STEMmobile takes the promise of digital learning on the road. The traveling tractor-trailer relies on high-speed broadband and is equipped with iPads, laptops, and other standard STEM tools. It visits 21 rural districts with 7,000 students, providing hands-on learning opportunities that promote problem-solving skills.

Education SUPERHIGHWAY

K-12 Connectivity in Texas

Texas

LEADER

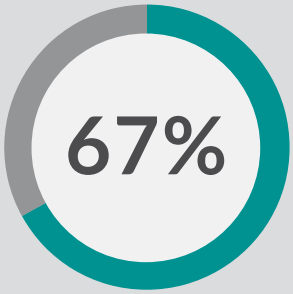
Gov. Abbott is taking action to upgrade schools

> Learning is no longer limited by bricks and mortar – it is expanded exponentially by bytes and bandwidth. Expanding technology in our classrooms will allow the State of Texas to meet future workforce needs, help teachers build a pipeline of qualified graduates, and support our students in their efforts to learn without limits. Every single child deserves access to quality education, and with the expanded use of technology in the classroom, that opportunity will be available to all Texas students.

☑ Appointed a leader to drive K-12 broadband initiatives

K-12 connectivity status

67% of school districts in Texas are ready for digital learning today. To meet 2018 demand, the typical school district in Texas will need to **grow bandwidth at least threefold.**

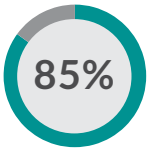


Minimum Goal
100 kbps
per student

Opportunities for action

Texas can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



Status:

At least **85%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

49% of new fiber connections will be for rural and small town schools

Wi-Fi

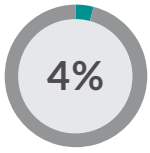
Status:

58% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$311M in E-rate funds are available to support Wi-Fi networks in Texas

Affordability



Status:

4% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

1,458,800 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=408 of 1,026 school districts, n=3,887 of 8,487 schools, n=2,229,558 of 4,625,771 students

Why high speeds matter

The McAllen Independent School District uses digital tools to increase parent engagement. After handing out mobile devices to all students and teachers, they created digital folders where parents can access important information and a cloud-based application to deliver progress reports, report cards and permission slips.

Education SUPERHIGHWAY

K-12 Connectivity in Utah

Utah

LEADER

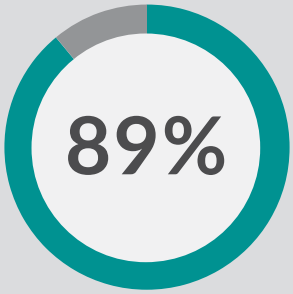
Gov. Herbert is taking action to upgrade schools

Utah's momentum is strong and with Governor Herbert's leadership, the state can meet and surpass connectivity goals, bringing 21st century learning opportunities to every student in Utah.

- Extended fiber to 62 elementary schools and 26 charter schools through a 2010 BTOP grant to the Utah Education Network (UEN)

K-12 connectivity status

89% of school districts in Utah are ready for digital learning today. To meet 2018 demand, the typical school district in Utah will need to **grow bandwidth at least threefold.**



Minimum Goal
100 kbps
per student

Opportunities for action

Utah can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber

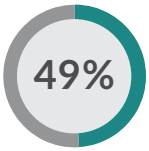
Status:

100% of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

0% of new fiber connections will be for rural and small town schools

Wi-Fi



Status:

49% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$44M in E-rate funds are available to support Wi-Fi networks in Utah

Affordability

Status:

N/A of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

N/A more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=37 of 41 school districts, n=873 of 918 schools, n=532,883 of 549,430 students

Why high speeds matter

The Innovations Early College High School in Salt Lake City leverages blended learning to allow students to mix virtual and onsite classes and set their own schedules. This flexibility has increased student engagement and resulted in an 89% graduation rate.

Education SUPERHIGHWAY

K-12 Connectivity in Vermont

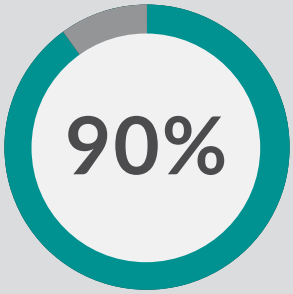
Vermont

Gov. Shumlin is committed to school upgrades

> Providing high-speed Internet to every K-12 school in Vermont is absolutely essential in equipping our students with the tools they need to compete in a 21st century economy.

K-12 connectivity status

90% of school districts in Vermont are ready for digital learning today. To meet 2018 demand, the typical school district in Vermont will need to **grow bandwidth at least threefold**.

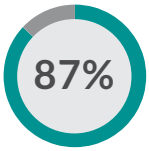


Minimum Goal
100 kbps
per student

Opportunities for action

Vermont can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



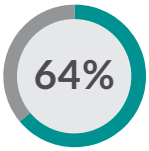
Status:

At least **87%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

100% of new fiber connections will be for rural and small town schools

Wi-Fi



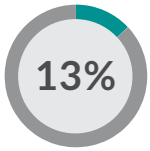
Status:

64% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$7M in E-rate funds are available to support Wi-Fi networks in Vermont

Affordability



Status:

13% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

9,900 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=31 of 58 school districts, n=145 of 312 schools, n=38,608 of 78,919 students

Why high speeds matter

Over 70% of the state's high schools have partnered with the Vermont Virtual Learning Cooperative. The program provides students with personalized learning programs that include credit recovery, AP classes, and supplemental coursework. Teachers can enroll in professional development to prepare them for online teaching.

Education SUPERHIGHWAY

K-12 Connectivity in Virginia

Virginia

LEADER

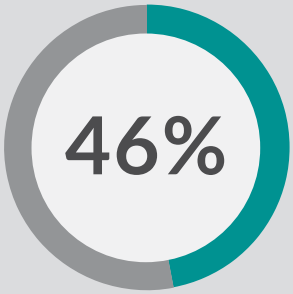
Gov. McAuliffe is taking action to upgrade schools

> Access to high-speed Internet is critical if we want to prepare all of our students to succeed in the new Virginia economy. Improving connectivity and increasing broadband statewide will allow the students of today to become the high-skilled workforce of tomorrow, and I am proud that the Commonwealth is leading the way in this vital effort.

- ☑ Set statewide K-12 connectivity goals
- ☑ Appointed a leader to drive K-12 broadband initiatives
- ☑ Supported a consortium pilot to upgrade bandwidth by 500% for only 15% additional cost for five school divisions

K-12 connectivity status

46% of school districts in Virginia are ready for digital learning today. To meet 2018 demand, the typical school district in Virginia will need to **grow bandwidth at least threefold.**

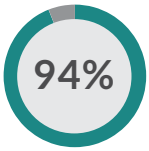


Minimum Goal
100 kbps
per student

Opportunities for action

Virginia can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



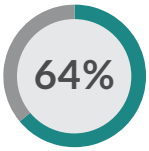
Status:

At least **94%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

51% of new fiber connections will be for rural and small town schools

Wi-Fi



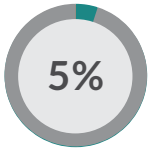
Status:

64% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$80M in E-rate funds are available to support Wi-Fi networks in Virginia

Affordability



Status:

5% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

476,900 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=97 of 130 school districts, n=1,408 of 1,958 schools, n=874,122 of 1,216,812 students

Why high speeds matter

Charlottesville City Schools is preparing its students for careers in advanced manufacturing through a STEM lab partnership with the University of Virginia. Technology enables UVA professors to deliver hands-on lessons to the K-12 students and support their learning with real time interaction enabled by digital collaboration tools.

Education SUPERHIGHWAY

K-12 Connectivity in Washington

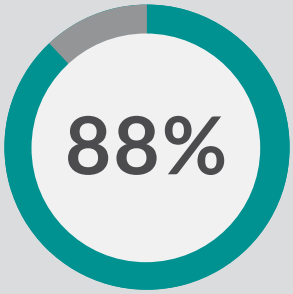
Washington

Gov. Inslee is committed to school upgrades

> Washington was an early leader in bringing broadband to our schools and those investments created important educational opportunities across the state. We need to ensure our current and future students have the tools and skills needed to succeed in school and the workforce and having access to the world of ideas through high-speed Internet is crucial to that success.

K-12 connectivity status

88% of school districts in Washington are ready for digital learning today. To meet 2018 demand, the typical school district in Washington will need to **grow bandwidth at least threefold.**

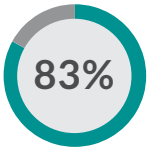


Minimum Goal
100 kbps
per student

Opportunities for action

Washington can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



Status:

At least **83%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

57% of new fiber connections will be for rural and small town schools

Wi-Fi

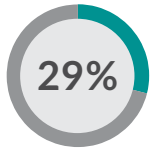
Status:

55% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$78M in E-rate funds are available to support Wi-Fi networks in Washington

Affordability



Status:

29% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

106,700 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=232 of 295 school districts, n=1,451 of 2,307 schools, n=591,562 of 1,038,436 students

Why high speeds matter

Spokane Public Schools increased graduation rates to 83% by using technology to help struggling students. The Individual Credit Advancement Now online course-recovery program helps middle and high school students to meet graduation goals. The On Track Academy uses blended learning to help students receive their degree.

Education SUPERHIGHWAY

K-12 Connectivity in West Virginia

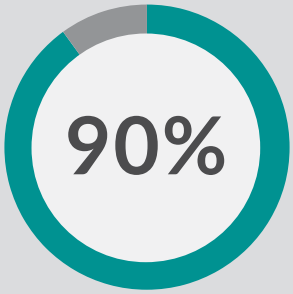
West Virginia

Gov. Tomblin is committed to school upgrades

> High-speed Internet is a critical part of ensuring our students receive the education they deserve, particularly in the growing science, technology, engineering, and math (STEM) fields that will be an important part of West Virginia's future. I look forward to continuing our efforts to expand broadband connectivity to all of our classrooms as part of that effort.

K-12 connectivity status

90% of school districts in West Virginia are ready for digital learning today. To meet 2018 demand, the typical school district in West Virginia will need to **grow bandwidth at least threefold.**



Minimum Goal
100 kbps
per student

Opportunities for action

West Virginia can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber

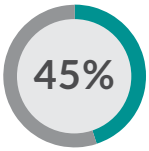
Status:

At least **98%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

22% of new fiber connections will be for rural and small town schools

Wi-Fi



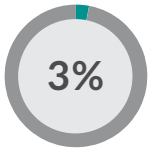
Status:

45% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$23M in E-rate funds are available to support Wi-Fi networks in West Virginia

Affordability



Status:

3% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

35,800 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=31 of 55 school districts, n=460 of 738 schools, n=168,821 of 266,543 students

Why high speeds matter

West Virginia Virtual Academy offers a unique individualized learning experience. The program is integrated into physical classrooms and offers students online access to more than 250 core and elective courses, including credit recovery, AP classes, and Spanish blended delivery to reach English Language Learners.

Education SUPERHIGHWAY

K-12 Connectivity in Wisconsin

Wisconsin

LEADER

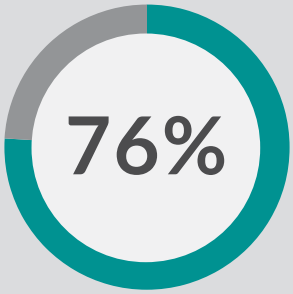
Gov. Walker is taking action to upgrade schools

> Wisconsin has long been a leader in broadband support for our schools. With the recent reforms and investments we have made, Wisconsin will continue to be well positioned to lead the nation.

- [x] Set statewide goal for K-12 pricing on the BadgerNet transport contract for $1 / Mbps

K-12 connectivity status

76% of school districts in Wisconsin are ready for digital learning today. To meet 2018 demand, the typical school district in Wisconsin will need to **grow bandwidth at least threefold**.



Minimum Goal

100 kbps per student

Opportunities for action

Wisconsin can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber

Status:

At least **90%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

85% of new fiber connections will be for rural and small town schools

Wi-Fi

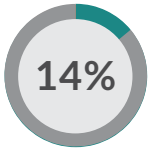
Status:

58% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$57M in E-rate funds are available to support Wi-Fi networks in Wisconsin

Affordability



Status:

14% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

154,300 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=191 of 423 school districts, n=930 of 1,943 schools, n=359,185 of 776,606 students

Why high speeds matter

Kettle Moraine School District is combining adaptive digital learning technology with flexible workspaces to encourage collaboration and increase student engagement. The ability to adapt their physical environment and track their progress encourages students to take control of their own learning.

Education SUPERHIGHWAY

K-12 Connectivity in Wyoming

Wyoming

LEADER

Gov. Mead is taking action to upgrade schools

Wyoming's momentum is strong and with Governor Mead's leadership, the state can meet and surpass connectivity goals, bringing 21st century learning opportunities to every student in Wyoming well into the future.

- Bids and contracts circuits to connect all school districts to the Wyoming Unified Network, which has increased K-12 bandwidth by over 700%

K-12 connectivity status

100% of school districts in Wyoming are ready for digital learning today. To meet 2018 demand, the typical school district in Wyoming will need to **grow bandwidth at least threefold**.

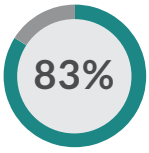
Minimum Goal

100 kbps per student

Opportunities for action

Wyoming can connect all students if they close the fiber gap, put Wi-Fi in every classroom, and make broadband affordable.

Fiber



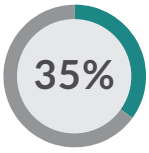
Status:

At least **83%** of schools have the fiber connections needed to meet bandwidth targets

Opportunity:

89% of new fiber connections will be for rural and small town schools

Wi-Fi



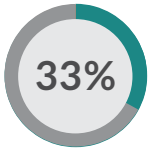
Status:

35% of school districts have accessed their E-rate budgets for Wi-Fi networks

Opportunity:

$7M in E-rate funds are available to support Wi-Fi networks in Wyoming

Affordability



Status:

33% of school districts are meeting the $3/Mbps Internet access affordability target

Opportunity:

0 more students will have enough bandwidth for digital learning if affordability target is met

Source: USAC Form 471 2015/2016 E-rate applications, n=24 of 48 school districts, n=189 of 348 schools, n=56,660 of 90,624 students

Why high speeds matter

Converse County School District #1 is a rural district determined to equip its students with 21st century skills. Classes use FaceTime to collaborate on projects with other schools and enrich their learning experience. They also practice reading and writing music by composing their own songs on the Garage Band app.

Education SUPERHIGHWAY

Methodology

Overview

The goal of the State of the States report is to track progress toward the K-12 connectivity goals established by the Federal Communications Commission (FCC) in 2014 and provide state leaders with the information they need to finish the job of connecting America's students to high-speed broadband.[36] The report, which will be published annually, does this by reporting on national and state progress toward achieving connectivity goals and the key requirements for meeting future connectivity needs: access to fiber or equivalent high-speed connectivity infrastructure, sufficient Wi-Fi equipment in classrooms to support 1:1 digital learning, and affordable pricing.

States are critical actors in the effort to provide and improve broadband access for K-12 students. School connectivity is often strongest in those states where focused action has been taken by state leadership and state agencies. For that reason, this report provides insights by state that will help state leaders see where they stand relative to the FCC connectivity targets, understand potential actions they can take to improve broadband connectivity in schools, and find out what their state peers are doing.

The following methodological considerations are intended to provide district, state, and national practitioners, as well as researchers, with the information required to interpret the analyses contained in this report.

[36] See FCC Report and Order And Further Notice of Proposed Rulemaking, WC Docket 13-184, released July 23 2014, ¶ 22-62, https://apps.fcc.gov/edocs_public/attachmatch/FCC-14-99A1.pdf

Data Collection and Sampling

Data sources

National Center for Education Statistics (NCES)

NCES is a part of the U.S. Department of Education (USDOE) and is responsible for collecting, analyzing, and publishing education data in the United States. For the purposes of this report, NCES' 2012-13 education agency directory provided a comprehensive list of public school districts as well as the following: a unique district identifier (NCES ID); district locale; number of schools; district type; the number and percentage of students eligible for federal free and reduced lunch programs; a list of schools within each district; student race and ethnicity data; district physical address; student and staff counts; and contact information (telephone, fax, and address).

Due to the historical nature of NCES' 2012-13 education agency directory all schools/school districts created between 2012 and the present are unaccounted for in EducationSuperHighway's data. Similarly, schools and districts that are no longer in existence are represented, but receive no services.

Universal Services Administrative Company (USAC) database

The Universal Service Administrative Company (USAC) is an independent, not-for-profit corporation created by the Federal Communications Commission (FCC) in 1997 to administer four universal service programs that help provide communities across the country with access to affordable telecommunications services. The Schools and Libraries Program ("E-rate") administers reimbursements and discounts for telecommunications services (including Internet services) to schools and libraries across the country.

When submitting funding requests for reimbursement, applicants begin by filing Form 470, which details the services that they are attempting to procure. Once the Form 470 has been filed, service providers have a 28-day window in which to submit bids in response to the requested services. Following this 28-day period, school districts choose their service provider and commit to terms. Once committed, school districts submit Form 471, which identifies the service provider they have selected, the specific services for which they are requesting reimbursement, and the actual cost of the services. Then USAC reviews the application to ensure that the requests are eligible for reimbursement. Data from this process is warehoused and made available for public use.

For this report, the following school and school district E-rate application data were sourced from the Form 471 filed with USAC: applicant name; service provider name; service connection type; bandwidth (in megabits per second); purpose ("Internet" or "Transport"); number of circuits; service contract length; cost per month of contract; total (annual) cost of services; unique USAC identifier (Billed Entity Number or "BEN"); private or public school; charter status; applicant state; applicant type; and applicant locale.

Due to timing issues, this report is based on the original Form 471 requests. It does not include any subsequent updates made to the Form 471 as part of USAC's Program Integrity Assurance (PIA) process.

Integration of USAC and NCES Data

Historically, USAC applicant data and NCES district directory data have been notoriously difficult to connect to one another. Integrating these two datasets, however, was critical for the publication of this report. Not only does the NCES dataset provide important demographic context for analysis, it is also essential for painting a complete picture of who received broadband services. Since this report focuses on understanding connectivity for school districts, the latter was critical for analysis.

EducationSuperHighway addressed the challenges associated with integrating these datasets as follows:

1. NCES unique identifiers submitted by applicants were compared to the 2012-2013 NCES district and school directory.
2. For all incomplete matches, postal code, school and/or district name, and number of students (+/- 20%) were used to connect applicant data to the 2012-2013 NCES district and school directory.
3. All remaining unmatched school districts were compared to the 2012-2013 NCES district and school directory using only postal code and school and/or district name.
4. Our data quality team manually mapped all the remaining schools to the associated Billed Entity Numbers (BEN).[37]
5. Utilizing the BEN-NCES mapping, we set up a data model that provided a comprehensive understanding of the relationships between consortia, school districts, and schools. We could then use the data model to more completely allocate all applied for services to the appropriate recipients.

Additional data collected through outreach

EducationSuperHighway also incorporated external data on school district connectivity accumulated through outreach to individual school districts, consortium staff, and E-rate consultants.

While the bulk of the information collected was used to clarify USAC funding request data, some district outreach efforts also identified additional broadband services outside of those listed on the district's E-rate application. For example, rather than leasing point-to-point transport circuits from a private provider, some school districts own the dark fiber connections used to connect their various school sites as part of a district WAN. Since there is no lease or procurement cost associated with these district-owned circuits, they are typically not captured on district E-rate applications.

Whenever identified, these non-reimbursed services were manually added to the EducationSuperHighway database to ensure that school districts were comprehensively represented in the connectivity metrics. Out of the sample of 14,917 total broadband line items, EducationSuperHighway staff manually created 208 line items (1.4%) to represent non-E-rate broadband services.

[37] The unique number assigned by USAC to each billed entity (school, library, district, or consortium) that pays for or receives services.

Data Management Processes

EducationSuperHighway defined data quality concerns and then worked to correct them utilizing both manual and automated procedures. Throughout this process all decisions were made with the goal of establishing a consistent interpretation of E-rate applications.

Definition of data quality concerns

Four pieces of information were critical for the creation of this report: the connection type, the purpose of the service, its bandwidth, and its cost.

- **Connection type** revealed whether the technology used by a district could scale to meet future connectivity needs. Form 471 captured numerous connection types including ATM, Broadband Over Power Lines, Cable Modem, DS-1 (T-1), DS-3 (T-3), Dark Fiber Service, Digital Subscriber Line (DSL), Ethernet, Fractional T-1, Fractional T-3, Frame Relay, Lit Fiber Service, Multi-Protocol Label Switching (MPLS), OC-1, OC-12, OC-3, OC-N, Switched Multimegabit Data Service, and Telephone Dial-up. Because district applicants had so many options to choose from, it was fairly easy for them to select the wrong one in error.
- **Purpose of Service** illustrated where a circuit fit into a given school district's network. This is critical because the bandwidth needs of a district are different for Internet access and Wide Area Networks, as are the costs associated with these different components of the network. Options for this field included Transport, Internet, and Transport and Internet. This presented a data quality challenge because while transport circuits were most commonly used to describe circuits used in the Wide Area Network, school districts sometimes would purchase their Internet access separately from the transport that delivers that connectivity to a district. In this case, the circuit delivering that connectivity could also be identified as transport. To applicants, in addition to any potential confusion about the difference between Internet access and transport more broadly, it was also unclear which category they should use to indicate this situation.
- **Bandwidth** demonstrated whether or not school districts were meeting the 100 kbps per student connectivity goal, and more generally, how much connectivity school districts were delivering to students.
- **Cost** revealed whether affordability was a critical challenge inhibiting a school district from reaching connectivity goals.

Data quality challenges with all four fields were identified in two ways via both automated and manual processes. First, we identified outliers based on analyses of data distributions across several control variables, such as district locale and district size. Second, we identified scenarios that seemed improbable and thus suggested inaccurate data based on our understanding of networking technologies and typical network architectures for school districts. Taken together, these two processes allowed EducationSuperHighway to outline scenarios to capture potential data quality issues within the publically available E-rate data, each of which was flagged for manual review by our data quality team.

Examples of Most Common Logic-based Rules Used to Direct Manual Data Cleaning Efforts

Rule	Description
Applied at the Line-Item Level	
Not Internet Access	If an applicant submitted a line item having the purpose of "Internet" and had more than 3 circuits, except in cases of isolated connection types, we suspect the line item is not used for Internet access to the district.
Product Bandwidth	Excluding fiber, all eligible connection types have a limited range at which they can transmit data. Inaccurate data was flagged when an applicant provided a type of connection with a bandwidth outside of its physical circuit capacity.
Unknown Connection	Many applicants identified Ethernet and Standalone Internet Access as an eligible type of connection having a wide variety of bandwidths. While we assumed that many of these connections over 150 Mbps were fiber (see Assumed Fiber), connections with a lower bandwidth required clarification from the applicant.
Rare Connection Type	With a choice of many different types of connections, in some cases applicants chose unusual connection types for broadband services, so we clarified these to make sure it was not an error (connection types such as Broadband Over Power Lines, Frame Relay or Telephone Dial-Up).
Unknown Purpose	Recognizing that the Form 471 had a limited taxonomy, services were typically identified as Internet Access (Purpose = Internet, WAN=No) or District WAN (Purpose = Transport, WAN = Y). If the purpose could not be determined through the service description or other common data combinations (see Assumed IA or Assumed WAN), then we needed to clarify how the service is used.
Zero Values	If a line item was missing key data necessary for analysis (e.g. bandwidth, quantity of circuits or cost) the line item was removed from analysis until the applicant provided the necessary information.
Telecom Voice	Some applicants inadvertently applied for voice services in the Telecommunications category. If the service description indicated that the cost was for telephone-related services with a high quantity, we clarified the services applied for with the applicant.
Applied at the District Level	
District Missing Internet Access	If we did not detect data indicating a school district receives one or more Internet access services from any applicant, it was necessary to clarify how Internet was being received by the school district.
District Receives Standalone Internet Access but Not Transport Connection	If a district was shown to be receiving standalone Internet Access but no transport connection was detected in the data, the district was flagged to ensure a holistic network architecture was captured.

Manual correction of data quality concerns

The manual review of data quality challenges took three forms: review of the service description and narrative fields, direct outreach to the applicant when the information already provided was insufficient, and direct outreach to other involved parties such as E-rate consultants, service providers, and state network administrators when applicants were unable to answer questions about how their district's broadband infrastructure was represented in E-rate applications. In total, our data quality team manually verified over 2,250 school districts and over 23,500 line items in preparation for this report.

Automated correction of data quality concerns

During the course of our manual review process, we identified that some errors were so common that we could generate rules that would correct those errors. Before implementing any of these rules on an automated basis, we compared the logic against our manually reviewed data and confirmed that the logic would yield the correct result within an acceptable margin of error. Specifically, we applied each proposed logical rule to a sample of 3,400 line items that had previously been verified and corrected by the data quality team. After comparing the corrections made by the automated logic to those made previously during the manual review, we determined that the automated corrections conformed to the confirmed data field values in over 93% of instances. In addition, even after we had applied the assumption algorithms to our dataset, the data quality team continually assessed the efficacy of these rules in the course of the normal data verification process by subjecting affected line items to manual review. In total, 1,792 of these automated corrections were utilized in the final dataset underlying our analyses.

Examples of Logic-based Rules Used to Correct Data Quality Concerns

Rule	Description
Assumed Fiber	For Ethernet or Standalone Internet Access connections over 150 Mbps used for Internet access, we assumed that fiber was the type of connection in use. For Ethernet connections over 100 Mbps and used for Wide Area Network connections, we assumed that fiber was the type of connection in use. Exceptions for certain states or service providers were taken into account.
Assumed Internet Access	If an applicant indicated a line item's purpose to be "Transport and Internet" with a quantity of 1 and WAN = false, we assumed the applicant was applying for Internet Access. Additionally, if the line item specified the purpose to be "Internet" but indicated WAN = true with "Internet access" indicated in the service description, we assumed the purpose to be Internet access.
Assumed WAN	Understanding the limitations in the taxonomy, in some states we were able to identify circuits that only provide transport to the Internet, but not the Internet access itself — in these cases we could assume the circuit was not a district WAN connection. If, however, an applicant indicated a line item with more than 3 circuits and specified the purpose to be "Transport", WAN = false and had a type of connection typically used for WAN, we assumed that the line item represented the connectivity between schools.

Dataset and Exclusions

To ensure the validity of the data underlying our analyses, we only included a given school district in our sample if:

1) all of its line items had been cleared of all applied data quality indicators, and

2) the district itself was cleared of the above-referenced data quality indicators.

In total, our algorithms identified 26,676 potential data quality errors across the 28,667 line items allocated to the national population of public school districts. At the district level, we also imputed 12,196 indicators of incomplete or erroneously documented network architecture. Ultimately, our data quality process resulted in the resolution of 17,307 line item data quality indicators, 9,637 of which would have impacted one of the 6,781 school districts that ultimately constituted our national sample.

EducationSuperHighway chose not to analyze data relating to public charter schools, private schools, libraries, non-instructional facilities, and schools administered by the Bureau of Indian Education. The procurement patterns, as well as market dynamics, that impact broadband purchases for these entities may not be similar to those that affect traditional public school districts. These areas represent opportunities for future research.

The dataset of public school districts used for these analyses includes verified records for 6,781 public school districts (containing a total of 48,981 schools) that received broadband services through the E-rate program during the 2015-2016 FY. These school districts represent approximately 52% of all public school districts, 54% of public schools, and 55% of public school students; and are spread across 50 states. Overall, these school districts were allocated 14,817 line items with a total annual cost of $985 million.

EducationSuperHighway defines a "district" using criteria established by the NCES. For the purposes of this report Type 1 (regular local school district) and Type 2 (local school district that is a component of a supervisory union) entities have been selected for inclusion.

In four states, due to their unique structure, we used an alternative definition of district:

Applicable States	Exception	Explanation
MA, RI	Type 4 agencies are considered districts when at least 2/3 of their schools are Type 1 schools (regular schools).	In these states, in addition to Type 1 and Type 2 entities, Type 4 (regional education service agency) agencies operate as districts for certain sets of schools.
VT	Type 3 agencies are considered districts when at least 2/3 of their schools are Type 1 schools (regular schools);	In Vermont, Type 1 and Type 2 agencies are predominantly single-school "town" districts and Type 3 (supervisory union) agencies operate as their supervising bodies. As such, Type 1 and Type 2 agencies are not considered as districts to avoid double-counting.
MT	Type 1 and Type 2 agencies are not considered districts in this state. ESH designates "new" districts that do not exist in NCES, based on the district-level applications from USAC and the state Department of Education's own list of public school districts; Type 1 and Type 2 agencies are not considered districts in these states.	In Montana, USAC applicants file for E-Rate using a district-level BEN (Billed Entity Number) for services to more than one school. However, NCES considers the individual schools to be distinct districts. These separate NCES districts share connectivity in some cases, but not all.

In order for district records to be fit for analysis, we required data for the following fields: number of schools, number of students, and locale. School districts missing any or all of these values were excluded from analysis.

EducationSuperHighway aimed to create a stratified proportional sample for this report with a 90% confidence interval across three strata: district size, locale, and state. While we came very close to this goal, falling only 38 school districts short nationwide, we are ultimately publishing on a convenience sample of all verified school districts. Due to the targeted nature of our data verification efforts, however, the sample we are using is very well distributed across the groups of interest to our analysis.

Population Distribution — All Districts in U.S. vs. EducationSuperHighway Sample

	Population Distribution (all districts in U.S.)					Verified Sample Distribution (all districts used in analysis)				
	Tiny	Small	Medium	Large	Mega	Tiny	Small	Medium	Large	Mega
Urban	0%	0%	2%	2%	1%	0%	1%	2%	2%	1%
Suburban	2%	9%	9%	3%	1%	2%	9%	8%	3%	1%
Small Town	1%	11%	6%	0%	0%	1%	11%	7%	1%	0%
Rural	11%	36%	5%	1%	0%	9%	37%	5%	1%	0%

District Size Classifications	
Description	# of Schools
Tiny	1
Small	2-5
Medium	6-15
Large	16-50
Mega	51+

Locale Classifications	
Description	ULocal Code from NCES
Urban	11 - City-Large, 12 - City-Midsize, 13 - City-Small
Suburban	21 - Suburb-Large, 22 - Suburb-Midsize, 23 - Suburb-Small
Small Town	31 - Town-Fringe, 32 - Town-Distant, 33 - Town-Remote
Rural	41 - Rural-Fringe, 42 - Rural-Distant, 43 - Rural-Remote

We also were able to obtain data for one third or more school districts in each state, similarly distributed across district size and locale.

Assumptions

District and line item analysis

All analyses were conducted using line item-, circuit-, or district-level records. In all cases, only records that were verified through EducationSuperHighway's data management processes were included in the final sample.

Analysis of line items

Each line item in the data sample represents one distinct service reported in a district's Form 471. School districts may submit multiple funding requests and each funding request may be coded as multiple line items. For example, a district that reports one 1 Gbps WAN connection, two 100 Mbps WAN connections, and ten 50 Mbps WAN connections would have three line items associated with those services, one for each bandwidth level.

The benefit of analyzing the data at the line item level is that it allows for granular analysis of a certain type of product across the market. For example, a line item analysis can be used to calculate the average market rate for a 100 Mbps Internet connection over Lit Fiber. Because much of our analysis was focused on supporting the procurement of broadband, this approach enabled us to look at all services obtained under a single negotiation as a single unit.

Aggregation of services at the school district level

Since the cost and bandwidth information available via E-rate is at the line item level, and a significant portion of our analysis involves understanding district connectivity, many analyses in this report aggregated services up to the school district level. Because school districts procure bandwidth in a variety of ways, our bandwidth and cost calculations take the following scenarios into account:

Bandwidth

- **Bundled Internet Services:** this scenario captured situations where both Internet access and the transport circuit back to the Internet Service Provider (ISP) were procured together and listed for reimbursement as a single line item. Bandwidth was calculated as the sum of the bandwidth represented by all "verified" Internet line items.
- **Unbundled Internet Services:** this scenario captured situations where Internet access and transport were purchased separately. EducationSuperHighway calculated total bandwidth as the lesser of two values: a) the sum of bandwidth of each "upstream" transport circuit to the ISP or b) the total Internet bandwidth purchased. This logic recognized that constraints on district network capacity might be the result of either an insufficient amount of Internet bandwidth or a lack of scalable transport. As a result, either of these network components might serve as the limiting factor in bandwidth calculations.
- **Regional- or State-provided Internet:** this scenario captured situations where a district's Internet access is obtained through access to a regional or state network. The total bandwidth was determined by the capacity of the district's dedicated transport circuit.

Cost

- **Direct district purchase:** For school districts that procure their own Internet services, EducationSuperHighway calculated the total cost of these services as the sum of the one-time and recurring costs associated with both components of Internet access: a) the Internet access provided by the ISP, and b) the "district-dedicated" transport circuit linking the district to the ISP or a consortium network.
- **Internet access via a regional or state network:** In cases where a district accesses the Internet over a regional or state network, EducationSuperHighway estimated the district's proportionate share. They determined the number of students as well as the cost of the network's ISP and "backbone" transport circuits and added the resulting value to the cost of the district's dedicated transport circuit back to the network. The same calculation was used for Wide Area Network (WAN) services.

Concurrency

When there are many potential users on a network, it becomes highly unlikely that every student and teacher will be on the network at the same time or "concurrently". Larger school districts can therefore purchase bandwidth based on the anticipated number of concurrent users on the network, rather than the total number of users within the district, without impacting the connectivity of any individual user.

In order to incorporate this aspect of network technology into our analysis, we sought to identify appropriate concurrency factors that we could use to translate the total number of users in a district to the likely number of concurrent users. To determine the appropriate concurrency factors for use in this report, we analyzed bandwidth use data from statewide or regional networks in three states: Washington, North Carolina, and Michigan[39]. Looking specifically at average peak student usage, we assumed that the usage per student for small schools across this large a sample set would be approximately equal to the usage per student for larger schools. This yielded a set of concurrency factors that explained the observed difference in usage. We worried, however, that the difference in usage might not be entirely due to concurrency. Upon investigation, we received qualitative feedback that several mega school districts in our sample were not in fact able to fully utilize bandwidth because they did not have the sufficient budget to purchase devices for all their students. This means that the differences observed could not be entirely explained by concurrency. Since the degree of concurrency does in fact vary widely across school districts depending on how they use technology, we elected to cut the data-driven concurrency factors in half to ensure that our analysis results would continue to err on the side of identifying those who need assistance.

EducationSuperHighway Concurrency Factors	
District Size	Concurrency Factor
Tiny & Small	1
Medium	1.5
Large	1.75
Mega	2.25

In order to ensure that our assessment of who is being left behind did not unfairly penalize large- and mega-sized school districts as well as the urban and suburban locales in which they are predominantly located, these concurrency factors were applied to almost all our analyses related to connectivity in this report. However, we elected not to apply concurrency in a few instances. Most notably, we did not apply concurrency when calculating the overall connectivity status at both the national and state level. This is because the primary goal of

[39] Wayne RESA data only

this report is to identify those in need of assistance. Given that the connectivity goal of 100 kbps per student is now nearly two years old and widely accepted as the minimum bandwidth standard nationwide, we did not consider it appropriate to allow any district to fall below this threshold. To ensure "apples to apples" comparisons, analyses of how budgets and costs impacted students where the 100 kbps goal had not been met were also conducted without concurrency.

Metric Calculation

In both the state-level snapshots and the nationwide analyses contained in this report, EducationSuperHighway assessed progress against the 100 kbps per student connectivity goal laid out by the FCC. We also provided insight into what it will take to meet an anticipated 50% annual growth in bandwidth demand by quantifying the status and opportunity associated with providing access to fiber, affordable pricing, and sufficient Wi-Fi equipment.

Connectivity

Internet Access

- **Sample:** The sample for Internet access connectivity calculations comprised those school districts that: 1) received Internet access services, and 2) had student enrollment data available from either the NCES (National Center on Educational Statistics) or the USAC (Universal Services Administrative Company). Due to data limitations, EducationSuperHighway chose to evaluate a district's progress toward 2014 FCC Internet access goals by using the number of students in a district instead of the number of users (students and staff).
- **Bandwidth calculation:** Bandwidth per student was calculated as the district's total Internet bandwidth divided by the total number of students in the district according to the 2012-13 NCES data.
    - **Meeting current goals:** To evaluate the ability of a school district to meet their students' immediate bandwidth needs, a district's total bandwidth was compared to the 2014 FCC target of 100 kbps per student. Each district was classified as either "Meeting Current Goal" (greater than or equal to 100 kbps per student) or "Not Meeting Current Goal" (less than 100 kbps per student).
    - **Meeting future goals:** To evaluate the ability of a school district to meet their students' future bandwidth needs, a district's total bandwidth was compared to the future FCC target of 1 Mbps per student. Each district was classified as either "Meeting Future Goal" (greater than or equal to 1 Mbps per student) or "Not Meeting Future Goal" (less than 1 Mbps per student).
- **Concurrency adjustment:** To apply a concurrency adjustment, the number of students in a school district was divided by the appropriate concurrency factor (see the previous table). The result was then used to divide the total bandwidth.

Wide Area Networks (WAN)

The suitability of a school district's WAN was assessed against the current FCC goal of 1 Gbps per school. For the purposes of this metric, EducationSuperHighway assumed that all school districts with six or more schools require a WAN. This six-school threshold was based upon prior observations regarding the frequency of school co-location, and was intended as a conservative estimate to ensure that the sample was limited to relevant school districts.

For these school districts, EducationSuperHighway identified the maximum and minimum bandwidths of the WAN circuits serving schools within the district. We then classified school districts into one of two categories based on the circuit with the maximum bandwidth: "Meeting goal" (greater than or equal to 1 Gbps) or "Not meeting goal" (less than 1 Gbps).

Fiber

Key Assumptions:

Throughout this report, you will see several analyses that refer to fiber or another "sufficiently scalable" or "equivalent technology." This is because depending on the bandwidth demands of the school (which is directly related to the size of its student population) different technologies might be sufficient to meet their needs. However, many schools may find that the school's existing providers simply cannot provide the bandwidth that they require given an anticipated 50% per year increase in bandwidth demand. For example, T-1 connections, DSL lines, and cable modems are technologies that are limited in the maximum capacity that they can offer. Given the capacity constraints of these technologies, we have assumed that all schools connected via T-1 or DSL lines need to upgrade their infrastructure. This is also true of schools that use cable and have more than 100 students. Since microwave (fixed wireless) is a technology that can scale like fiber, we have considered it to be a "fiber equivalent" for the purposes of the state-level fiber metrics. However, while the location of a particular school may make fixed wireless the best available option, it is not the most cost effective choice for most schools.

In keeping with the logic used for the WAN connectivity metric, when school districts have more than six schools yet do not have any WAN Services represented in the E-rate data, EducationSuperHighway assumed the district has owned fiber WAN connections. Since this assumption does not apply to school districts with less than six schools (some of whom presumably do own their own WAN infrastructure), it is anticipated that the metric may underestimate the prevalence of owned fiber, especially in states where the procurement of dark fiber is a common practice.

Metric Calculation:

Status: "% of schools that have the fiber connections needed to meet bandwidth targets"

Due to inconsistencies and inaccuracies by E-rate applicants when identifying the entities receiving broadband services, it was often difficult to allocate all services received by a school district to its component schools. For this reason, EducationSuperHighway chose to calculate the proportion of schools served by fiber connections by dividing a district's total number of fiber/"fiber equivalent" connections by the number of distinct physical campuses in that district. In turn, to estimate the number of campuses in a district, EducationSuperHighway used unique school addresses and their proximity to one another to make determinations regarding co-location.

Due to variations in network topology across school districts in the sample, both Internet and WAN connections are included in the calculation of the number of fiber/"fiber equivalent" lines serving each district.

Opportunity: "% of new fiber connections that will be for rural and small town schools"

Given the challenges of providing scalable connectivity to students in rural areas, the fiber opportunity metric addresses the extent to which the lack of affordable fiber is confined to these underserved regions. Quantifying the percent of schools without fiber that are located in "rural" or "small town" locales (per NCES) provided an indication of the level of fiber penetration across geographic locales, while highlighting instances where increased development and investment in rural broadband infrastructure could significantly improve broadband access for both large numbers of students as well as rural communities as a whole.

Affordability

The setting of connectivity goals has proven to be an extremely successful strategy for closing the digital divide for America's K-12 public schools. With this report, EducationSuperHighway aims to replicate that success by setting achievable affordability targets. Improvements in affordability likely represent our greatest lever for connecting the remaining 21 million students that have been left behind.

Metric Calculation:

Status: "% of school districts that are meeting the $3 per Mbps Internet access affordability target"

For the state snapshots, the Internet affordability metric was calculated by first determining the cost per Mbps for each district and then comparing that cost to the $3 per Mbps affordability target. The cost per Mbps of each district was determined by dividing the total monthly cost of the district's Internet services by the total Internet bandwidth received by the district. In order to capture the full cost of providing Internet access to a particular district, the metric included charges for Internet access (e.g., bandwidth or ISP services) as well as the listed cost of the dedicated transport circuit(s) connecting a district to its ISP. In addition, where a district receives its Internet access via a regional or state network, the costs of any network middle-mile or backbone circuits necessary for providing connectivity to school districts were divided proportionally among the school districts served based on the size of their student populations.

When analyzing and comparing aggregate procurement by state networks and other large consortia, EducationSuperHighway attempted to identify all network backbone circuit purchases and allocated the costs of these circuits to school districts served by the network in our population. However, these services are difficult to identify given the current USAC line item taxonomy, which does not differentiate between services dedicated to a single school district and those shared by multiple school districts as part of a wider network infrastructure. In addition, some statewide and regional consortia did not file E-rate funding requests for their networks' middle-mile infrastructure, which prevented the costs of these network components from being captured by the affordability metrics.

Opportunity: "# of additional students that will have enough bandwidth for digital learning if affordability target is met"

This calculation first determines a "hypothetical bandwidth per student" by examining the cost per Mbps of connectivity for that district. If that cost is less than $3 per Mbps, we assume no change in the bandwidth purchased. If that cost is more than $3, we estimated the amount of bandwidth that the district would be able to procure at their current overall spend if they were able to reduce their monthly cost per Mbps to $3. For example, if a district were receiving services at $6 per Mbps, they would be able to double their bandwidth per student for the same overall price if they could instead receive services at $3 per Mbps. This theoretical total bandwidth value was then divided by the number of students to arrive at the hypothetical bandwidth per student that the district would attain if it were able to meet the $3/Mbps affordability goal.

We then compared the number of students currently meeting the 100 kbps per student connectivity goal to the number of students that would meet the goal based on the hypothetical bandwidth per student calculation. By calculating the difference, we were then able to identify the number of additional students that would meet the 100 kbps per student target if the district met the Internet access affordability target.

Wi-Fi

EducationSuperHighway quantified both the magnitude of Wi-Fi purchasing and the opportunity for additional Wi-Fi upgrades by evaluating the Category 2 funding requests submitted by school districts. Since Category 2 services fell outside the scope of EducationSuperHighway's data verification efforts, these Wi-Fi metrics utilize data from every school district in the country, including those whose Category 1 services were not included in the preceding metrics. The selected metrics focused on utilizing overall cost data, which is the data element we believe to be least subject to data quality concerns.

Metric Calculation:

Status: "% of school districts that have accessed their E-rate budgets for Wi-Fi networks"

The Wi-Fi opportunity metric seeks to quantify the extent to which school districts are utilizing available Category 2 funding to upgrade their wireless infrastructure, following the E-rate modernization efforts, which provided a $150 per student budget to school districts nationwide. Accordingly, this metric reported the percentage of school districts that applied for Category 2 services during the 2015-16 E-rate funding cycle. Since this metric is intended to be an indicator of whether school districts are aware of the E-rate funding, and since most Wi-Fi equipment is replaced on a 5-year re-fresh cycle, a district was counted in this calculation if they applied for any Category 2 funding.

Opportunity: "$ in E-rate funds available to support Wi-Fi networks"

The Wi-Fi opportunity metric estimates the available funds remaining in the Category 2 budget. First, the theoretical maximum amount of funding was calculated by multiplying the number of students in the sample by $150, the 5-year Category 2 cap. The cost of all Category 2 services applied for during the present funding cycle was later subtracted and the remainder multiplied by the statewide average discount rate (across all applicants) to determine the remaining available funding.

National Analysis

The national analysis contains a few key analyses that warrant additional explanation.

Wide Area Network (WAN) connectivity and costs

National analysis of WAN looked at circuits rather than district-level information in order to avoid the complexities and potential inaccuracies associated with both the correct allocation of circuits and missing WAN data due to owned dark fiber and other factors. We also limited our sample to lit fiber connections, since these represented the overwhelming majority of high-speed WAN connections in the E-rate data (except for the analyses where dark fiber was explicitly called out). When assessing national progress against the connectivity target of 1 Gbps per school, we calculated the percentage of WAN circuits in the sample set that were at 1 Gbps or greater. Similarly, when assessing WAN costs, we looked at all circuits in the sample set irrespective of whether they were specific to a given district or part of a broader regional or statewide network.

Low bandwidth fiber characterization

The population for this analysis were school districts who (1) procured bundled Internet access over lit fiber at speeds of 100 Mbps or less, and (2) did not meet the 100 kbps per student Internet access connectivity target. For these school districts, the chief obstacle preventing them from attaining connectivity goals was not a lack of fiber infrastructure, but rather the low amount of bandwidth being procured. EducationSuperHighway explored two potential drivers of this phenomenon: affordability problems and spending challenges.

To determine which school districts had an affordability problem, we looked at the prices for each lit fiber Internet circuit in the overall population, grouped them into buckets, and calculated the 75th percentile price for each bucket. We then matched each circuit to the appropriate bucket based on bandwidth and classified any circuits as "not affordable" if they had a price greater than the 75th percentile price for the bucket. From this, we were then able to classify any district receiving a "not affordable" circuit as having an affordability problem. In the rare cases where a district with multiple Internet connections received both "affordable" and "not affordable" circuits (or a lit fiber Internet circuit with a bandwidth greater than 100 Mbps), it was excluded from the sample.

To determine which of the remaining school districts had a spending challenge, we calculated the per student Internet access spending at the district level and identified the 25th percentile of the overall district population. A district was then classified as having a spending problem if they were spending less than this threshold.

Those school districts that were in the population but were not classified as having an affordability problem or a spending challenge were placed in the "other" bucket.

Budget analysis

The goal of this analysis was to quantify the impact and trade-offs associated with improving broadband affordability versus increasing broadband investment. Using a sample consisting of school districts that were not currently meeting the 100 kbps minimum FCC connectivity goal, and building on the methodology used in the calculation of the "# of additional students that will have enough bandwidth for digital learning if affordability target is met" metric, we extended the frame. Specifically, we looked at how many additional students would have enough bandwidth for digital learning if school districts invested more in connectivity on a per student basis. We assumed that the extra investment could be used to procure additional bandwidth at various cost per Mbps levels. We then investigated the relationship between improved affordability and increased investment in connectivity using the following approach:

- **Current student spend:** We started by calculating the current per student spend by dividing the total cost of their existing services by their student enrollment.
- **Projected additional investment:** We assumed an anticipated increase in spending. For example, $0.10 per student per month.

- **Discount rate adjustment:** We applied each district's committed Category 1 discount rate which enables the district to procure significantly more bandwidth for all monies spent. For example, a $0.10 increase in spending for a district with a 70% discount rate, which is the most common nationwide, would actually result in $0.33 in broadband investment per student per month.
- **Estimated total spend per district:** Taking the amount of investment per student per month, after the E-rate discount rate adjustment, we multiplied this value by the number of students to obtain the estimated total additional spend per district. We added this to the current spend to get the total spend per district.
- **Hypothetical bandwidth procured:** To project the hypothetical amount of bandwidth the district could purchase, we took the total spend per district and divided this by the assumed cost per Mbps based on the affordability target. Note: If the district was already paying a cost per Mbps rate below the affordability target, this rate was used instead.
- **Bandwidth per student:** We took the total hypothetical bandwidth procured and divided this by the number of students in the district to determine the amount of bandwidth per student.
- **Number of students impacted:** If the amount of bandwidth per student met or exceeded 100 kbps per student, then the district was meeting connectivity targets and all students in that district were counted.

This resulted in the table below:

Budget Analysis — Affordability vs. Investment

Monthly $/student increase in student budget	$3/Mbps	$2.50/Mbps	$2/Mbps	$1.50/Mbps
$0.00	12,231,368	14,735,089	16,177,934	17,051,707
$0.05	8,336,450	6,037,637	5,067,037	4,279,738
$0.10	692,775	558,720	86,475	-
$0.15	70,852	-	-	-
Total # of students	21,331,445	21,331,445	21,331,445	21,331,445

We were also interested in determining the national implications for this analysis. By totaling the district-by-district investment requirements, we calculated the following total additional annual investment needed to bring the remaining 9.1 million students to the 100 kbps connectivity goal:

Budget Analysis — Affordability vs. Investment

Cost per Mbps	Average % Increase in Per Student Budget for Districts	Average % Increase in Per Student Budget for Districts — Excluding "no budget increase" districts	Districts' overall annual spending increase
Current cost/Mbps	200%	200%	$61,705,142
$3/Mbps	8%	73%	$2,455,854
$2.50/Mbps	6%	74%	$1,661,799
$2/Mbps	4%	76%	$1,219,106
$1.50/Mbps	2%	74%	$718,982

Affordability target analysis

Once we had quantified the impact and trade-offs associated with improving broadband affordability relative to increasing broadband investment, we wanted to understand what level of improvement in affordability could be reasonably achieved. We looked at this on two dimensions: 1) what could a district afford and 2) what could the E-rate program afford.

Viability of targets relative to district spending

Using the $3 per Mbps as a target, we looked at the total cost of Internet access nationwide and conducted a more granular analysis of district spending based on need.

- **District buckets:** For simplicity, we bucketed school districts by the number of students and then determined how many school districts today were within each bucket.
- **Bandwidth need:** We assumed that school districts would aim to meet the FCC's future connectivity goal of 1 Mbps per student. Based on the number of students in each of the district buckets, we could determine the typical bandwidth need. After understanding bandwidth need, we had to account for the availability of specific circuit sizes on the market. Each district bucket was assigned the circuit size that would cover the anticipated bandwidth need.
- **Bandwidth benchmarks:** For each circuit size, we calculated the median cost. To do this, we identified the cost and bandwidth of over 10,000 distinct Internet access line items submitted by school districts and consortia across every state, excluding Alaska, which due to the unique nature of its geography is omitted from all of our national pricing analysis. Using this sample, we then calculated the national median cost of bundled Internet access services at five discrete bandwidth levels (ranging from 100 Mbps to 20 Gbps).
- **Bandwidth cost:** By multiplying the cost of the circuit size for the bucket by the number of school districts in the bucket, we arrived at the total bandwidth cost for that bucket of school districts. We then added the costs associated with all of the buckets to arrive at a total cost based on the median pricing for circuits.

This analysis clearly shows that, in aggregate, the $3 affordability target actually requires less district spending than an approach based on purchases associated with median circuit pricing today, which would suggest a target closer to $2 per Mbps. It also suggested, however, that mega and large school districts should pay substantially less than $3 per Mbps (specifically, closer to $1 per Mbps) and that smaller school districts may need to spend more.

National View: Affordability Target Analysis

District size (students)	Number of districts	Circuit size (Mbps)	Total cost @ $3	Median cost	Cost/Mbps (median)	Total cost @ median
0 - 50	372	50	$669,600	$615	12.29	$2,743,372
51 - 100	387	100	$1,393,200	$1,500	15.00	$6,966,000
101 - 200	877	200	$6,314,400	$2,503	12.51	$26,340,695
201 - 300	830	300	$8,964,000	$2,600	8.67	$25,896,000
301 - 500	1,339	500	$24,102,000	$3,402	6.80	$54,663,336
501 - 1,000	2,270	1,000	$81,720,000	$3,871	3.87	$105,440,206
1,001 - 2,000	2,442	2,000	$175,824,000	$7,841	3.92	$229,758,012
2,001 - 3,000	1,298	3,000	$140,184,000	$10,160	3.39	$158,252,160
3,001 - 4,000	835	4,000	$120,240,000	$10,718	2.68	$107,398,368
4,001 - 5,000	520	5,000	$93,600,000	$11,685	2.34	$72,914,400
5,001 - 10,000	1,012	10,000	$364,320,000	$10,000	1.00	$121,440,000
10,001 - 20,000	473	20,000	$340,560,000	$20,000	1.00	$113,520,000
20,001 - 30,000	167	30,000	$180,360,000	$30,000	1.00	$60,120,000
>30,000	203	40,000	$292,320,000	$40,000	1.00	$97,440,000
Total	13,025		$1,830,571,200			$1,200,680,682
Cost per Student (per month)			$3.42			$2.18
Cost per Mbps			$3.00			$1.91

Since this analysis made several simplifying assumptions, we cut the data a few other ways to assess the viability of the $3 target at the district level. This revealed that 70% of school districts would need to purchase 1 Gbps of bandwidth to meet the 1 Mbps per student goal. It further revealed that nearly one third of these circuits today were already being purchased at prices of $3 per Mbps or less. Given the natural decline of prices over time, this suggested that the $3 target would be achievable for the large majority of school districts. We also took a look by locale and were able to find examples of school districts that without the benefit of consortia purchasing, municipal networks, or other types of off-market deals, were able to meet the $3 target. While ample opportunities for future research remain in this area, this analysis made us comfortable using the $3 affordability target as a simplifying assumption throughout the analysis of this report, which aims to provide an assessment of connectivity at the national and state level.

For WAN circuits, we evaluated a sample of 2,400 line items representing over 19,000 distinct 1 Gbps transport circuits. Analysis of this sample determined that $750 represented approximately the 25th percentile in "per circuit" cost nationwide. Additionally, to anticipate expanding WAN infrastructure needs, we replicated this pricing analysis for 10 Gbps circuits. Again approximately using the 25th percentile "per circuit" cost as our target, we determined that $1,000 was the appropriate affordability benchmark.

Viability of Targets Relative to E-rate Program

Since the E-rate program is the primary source of funding for K-12 connectivity, we assessed whether the proposed targets would be within its budget. E-rate provides $3.9 billion in funding for schools and libraries per year. Of this, $1 billion is set aside for Wi-Fi-related equipment. Given that we anticipate that it will cost $1 billion to support fiber construction over the remaining 3 years, we can anticipate approximately another $350 million per year going towards this goal. Historically, roughly 5% of E-rate spending has supported libraries, or approximately $200 million. This means that the total E-rate budget for schools for Internet access and WAN is somewhere between $2.35-2.9 billion once the phase-out of voice services has been completed.

Then we assessed the anticipated cost for Internet access at $3 per Mbps. Based on the approach described above, this was $1.8 billion.

Total projected spend on Internet access @ $3 per Mbps	**$1,830,571,200**

Overall WAN budget	**$702,225,949**
Total Projected Spend on WAN	
Campuses in multi-campus districts (in clean sample)	39,575
Total campuses in sample	41,634
Total campuses in nation	77,123
Ratio	1.85
Total schools that need a WAN	73,309
Percent of campuses that need a 1 Gbps WAN	81%
Percent of campuses that need a 10 Gbps WAN	19%
Target for 1 Gbps WAN	$750
Target for 10 Gbps WAN	$1,000
Total budget for 1 Gbps WAN	$532,442,538
Total budget for 10 Gbps WAN	$169,783,411

Total E-rate Budget for Internet Access & WAN	**$2,532,797,149**

Finally, we assessed the anticipated cost for WAN connections, assuming $750 for a 1 Gbps circuit, and $1,000 for a $10 Gbps circuit. To do this, we needed to make key assumptions regarding how many of each circuit type would be required.

- We anticipated that the maximum demand a district would ever see on its WAN is twice its Internet bandwidth per student. Items such as video surveillance, local caching servers, and local file servers would consume this additional bandwidth.
- The minimum demand we would anticipate seeing on a WAN is approximately equal to the district's Internet bandwidth per student. This would happen if the district moved all of its applications and services to the cloud. In this case, the WAN would not have any additional traffic and all traffic would instead come from the Internet.
- If we accepted the 1 Mbps per student goal as our target for the future, and assumed that average bandwidth will be somewhere between the maximum and minimum of our expectations, we anticipated 1,500 kbps per student for WAN. From this assumption, we then determined that 81% of school districts should purchase 1 Gbps circuits and 19% should purchase 10 Gbps circuits.
- Based on the E-rate data we determined the total cost of WAN circuits at the proposed price points, which yielded a budget figure of $702 million.

When combined with the Internet access costs at $3 per Mbps of $1.8 billion, we arrived at a total anticipated cost of $2.6 billion, confirming that the proposed targets are achievable within the E-rate budget.

2013-2015 Cohort Analysis

To quantify changes in the availability of affordable broadband over the past two years, EducationSuperHighway revisited the sample of 2013 E-rate data that previously informed our report Connecting America's Students: Opportunities for Action. This "Item 21 sample" comprised broadband funding requests filed by over 1,000 school districts and consortia during the 2013-14 E-rate cycle. From this historical sample, EducationSuperHighway identified a subset of 350 school districts whose 2015-16 E-rate funding requests were also represented in the national sample for the present report. These 350 school districts were spread across 30 states and contained nearly three million students and 5,000 schools. By comparing these school districts' 2013 broadband purchases with their procurement during the present E-rate cycle, we were able to highlight the ways that recent changes to the national broadband landscape have tangibly impacted Internet procurement on the district level.

This cohort analysis included calculations at three separate levels of aggregation: the school district, the line item, and the circuit. At the district level, we quantified the total cost and bandwidth of all broadband services from the 2013 and 2015 samples as well as the overall increase in district broadband spending per student from year to year. We also determined the overall bandwidth per student for each of the 350 school districts in 2013 and 2015, which in turn allowed us to calculate the longitudinal change in the percentage of school districts in the sample meeting the 100 Kbps and 1 Mbps connectivity targets.

At the line item level, we first identified all bundled Internet (combined Internet access and circuit) line items in both the 2013 and the 2015 samples. We then divided the total of all Internet bandwidth procured by the sum of the monthly cost of each Internet connection to obtain the aggregate cost per Mbps for each year's sample.

Finally, we conducted a cross-sectional pricing analysis of lit fiber circuits procured in each of the two years, evaluating bundled Internet connections and WAN circuits separately. Specifically, we calculated the median and weighted average circuit cost at four discrete bandwidth levels for each type of circuit.

- For bundled Internet: 50 Mbps, 100 Mbps, 500 Mbps, and 1 Gbps
- For WAN: 100 Mbps, 500 Mbps, 1 Gbps, and 10 Gbps

Highlights from this analysis are listed below:

2013 to 2015 Cohort Analysis		
State	2013	2015
Total IA Bandwidth (in Gbps)	118	304
Total WAN Bandwidth (in Gbps)	2091	4731
Total Annual Spend	$64,411,790	$70,265,023
of which is internet spending	$17,508,772	$21,143,582
of which is WAN spending	$46,903,018	$49,121,441
Avg overall cost per Mbps	$13.30	$5.77
Median overall cost per Mbps	$21.67	$9.50
Cost per Mbps for 100 M Lit Fiber circuits	$2,234	$2,150
Total students in sample	2,968,603	2,798,528
Total schools in sample	5,110	4,760
Weighted average BW per student (kbps)	40	109
Median BW per student (kbps)	46	135
Average total BW per district (Mbps)	337	870
Median total BW per district (Mbps)	100	200
% of districts meeting 100 kbps goal	24%	64%
% of district meeting 1 Mbps goal	1%	2%
Total broadband cost per student (annual)	$21.70	$25.11
Total broadband cost per school (annual)	$3,426	$4,442

Definition of Terms

Applicant

The entity applying for universal service support. In the Schools and Libraries Program the entity is a school, library, district, consortium, or other eligible entity that files program forms.

Bandwidth

A measure of the amount of data that can be transmitted per second. Upload bandwidth, or upload speed, refers to the amount of information that can be transmitted away from a site. Download bandwidth, or download speed, refers to the amount of information that can be transmitted to a site. A service provider can provide burstable bandwidth, which is an additional temporary bandwidth allowance in times of extreme bandwidth need.

Billed Entity Number (BEN)

The unique number assigned by USAC to each billed entity (school, library, district, or consortium) that pays for or receives services.

Campus

A physical site containing at least one school (and possibly more with co-location). Since schools that are co-located may be able to share a single Internet or WAN connection, EducationSuperHighway evaluates district connectivity through the lens of the number of distinct campuses in that district. The number of campuses is calculated using an algorithm incorporating the street address and physical proximity of each of a district's schools.

Category One services (C1)

Services used to connect broadband or Internet to eligible locations, or services that provide the basic conduit access to the Internet. Telecommunications services, Internet access, and voice services are Category One services.

Category Two services (C2)

Items classified by the FCC as category two services include: "internal connections, basic maintenance, and managed internal broadband services (more commonly described as managed Wi-Fi)."

Competitive Local Exchange Carrier (CLEC)

Carriers that were allowed into the market after the Telecommunications Act of 1996 was enacted.

Concurrency

A networking concept that estimates overall bandwidth demand based on the number of simultaneous users. Logically, the probability that every potential user will access the network at the same time decreases as the total size of the user population rises. As a result, the additional bandwidth required to serve additional users is lower for larger networks.

Connection type

The material over which electronic data is transmitted.

Consortium

A consortium (plural consortia) is a group of entities that apply together for funding.

Consultant

A company or individual (non-employee of the entity) selected to perform certain activities related to the application process on behalf of the applicant or service provider for a fee. A Letter of Agency (LOA) or consultant agreement must be in place before the consultant undertakes these activities.

Cost

The amount of money paid by the applicant to the service provider for a specific service. Typically shown in monthly or annual amounts.

Dark fiber

Fiber circuits that are purchased or leased without optical equipment; to "light" the fiber connection, the user must procure and install these optics themselves. Since the user thus controls the necessary optical devices, the bandwidth transported over dark fiber can be dramatically scaled via relatively inexpensive upgrades to this equipment.

Direct connections

Direct connections allow rural schools and libraries to share access to high-speed broadband services.

District

An entity that can apply for and receive services under E-rate. The district has schools under its jurisdiction that receive the services it applies for. In the Schools and Libraries Program, Internet connectivity will be measured at this level. Discounts will also be calculated at this level.

E-rate modernization order

The FCC Report and Order that modernized the E-rate Program and focused on high-speed broadband connectivity to schools and libraries (FCC 14-99).

E-rate program

The common term used in place of the Schools and Libraries Program. The E-rate Program provides discounts to schools and libraries for eligible products and services.

Fiber

Fiber optic technology converts electrical signals carrying data to light and sends the light through transparent glass fibers about the diameter of a human hair. Fiber transmits data at speeds far exceeding current DSL or cable modem speeds, typically by tens or even hundreds of Mbps.

Free and reduced lunch program (FRL)

This program provides school lunches to eligible students at a free or reduced rate. In order to be eligible, the family of the student must be under the poverty level by a certain percentage.

Incumbent local exchange carrier (ILEC)

The carrier, defined regionally, which historically held a monopoly in that certain area before other carriers were allowed in the market.

Internet access (IA)

Internet Access services are eligible basic conduit access to the Internet. Ineligible access includes content, equipment purchases, or other services beyond basic conduit access. However, selected services that are an integral component part of an Internet access service (and other services designated as eligible by the FCC) may be eligible for discounts on interconnected VoIP, email service, and web hosting.

Internet service provider (ISP)

A company that provides Internet access service (also referred to as a service provider).

Item 21 attachment

The Item 21 Attachment to FCC Form 471 provides details on the products or services requested in Funding Request Numbers (FRNs) that appear on the form.

kbps/Mbps/Gbps

The abbreviations for kilobits, megabits, and gigabits per second, respectively. These define the speed of an Internet connection. Higher numbers indicate that the connection is capable of transferring more information in a given period of time.

Line items

Services for which an organization has requested an E-rate reimbursement, including details on the service, the cost, and the service provider, if applicable.

Recipient

The entity receiving universal service support. In the Schools and Libraries Program the recipient is a school, library, or district.

Service provider

A company that participates in one of four universal service programs and provides telecommunications or Internet services, equipment, hardware, or software. Types of companies include but are not limited to: competitive access/competitive local exchange carriers (cellular, personal communications, or specialized mobile radio providers), incumbent local exchange carriers, interexchange carriers, Internet service providers, interconnected VoIP, or local resellers (coaxial cable, non-traditional, operator, paging, messaging, or payphone).

Transport

Transport is Internet infrastructure that is not a direct ISP connection, but which serves as the link from a building receiving Internet service to the ISP connection.

Wide area network (WAN)

A voice, data, and/or video network that provides connections from within an eligible school or library to other locations beyond the school or library. By definition, the service provided does not access the Internet.

Education SUPERHIGHWAY

EducationSuperHighway is the leading non-profit focused on upgrading the Internet access in every public school classroom in America. We believe that digital learning has the potential to provide all students with equal access to educational opportunity and that every school requires high-speed broadband to make that opportunity a reality.

EducationSuperHighway's data-driven programs accelerate upgrades in America's schools. We help school districts and state leaders develop strategies to upgrade their K-12 networks, get fiber to schools that need it, provide guidance for effective Wi-Fi purchases, and make broadband more affordable. Our work served as a catalyst for the modernization of the Federal Communications Commission's $3.9 billion E-rate program, earning our CEO the 2015 Visionary of the Year award from the *San Francisco Chronicle*. To learn more about our programs and services for governors, state partners, and school districts, visit our website at www.educationsuperhighway.org.

For more information, please contact
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