State Wi-Fi Leadership for Fostering Digital Learning Ready K-12 Schools:

EXTENDING THE BROADBAND IMPERATIVE II

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ABOUT THIS WORK

SETDA completed this research in partnership with state and private sector leaders including state CIOs, state network managers, E-rate coordinators, and digital learning administrators. Thank you to SETDA's Board of Directors and to Dr. Tracy Weeks, SETDA's Executive Director, and Melissa Greene, SETDA's Director of Strategic Partnerships, for their support of this work.

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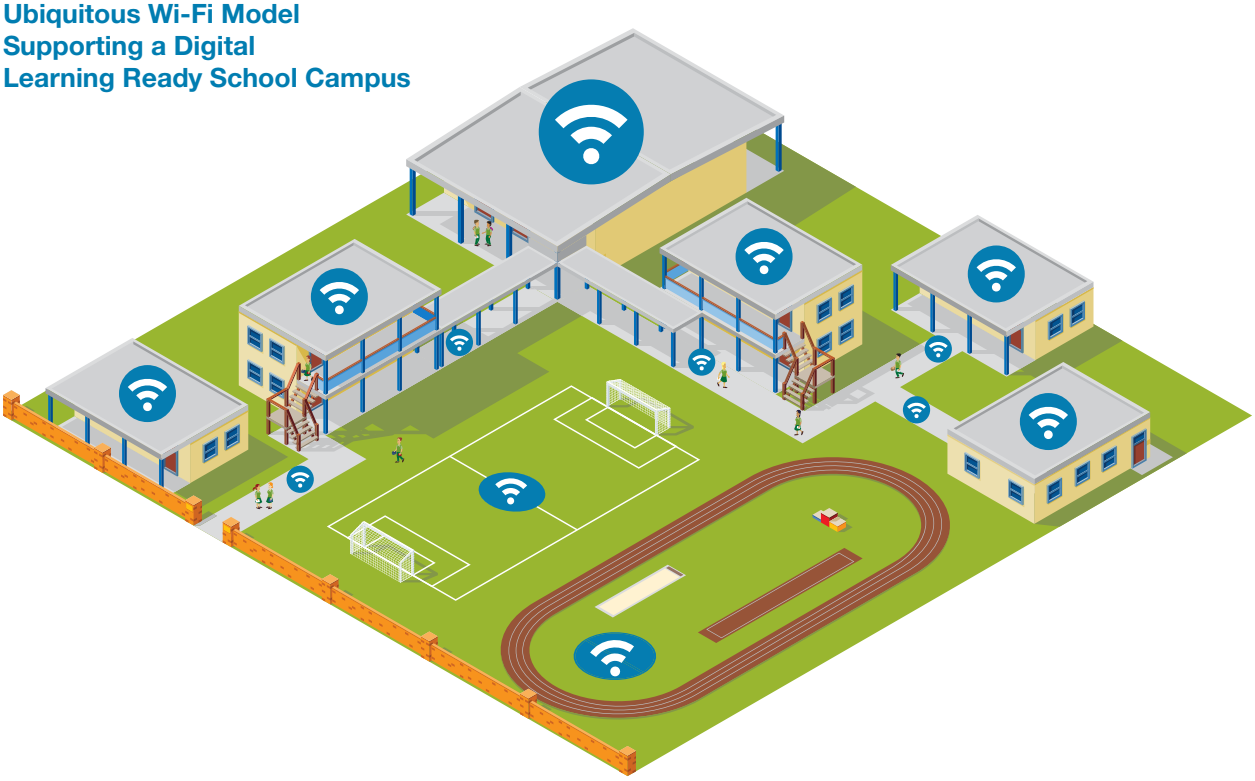
Introduction

Providing access to robust connectivity is critical to ensuring today's students are college and career ready. As such, federal, state, and district-level leaders have dedicated a significant amount of time, effort, and resources toward improving our schools' external broadband access, including both Internet access and wide area network (WAN). The integration of digital tools such as mobile devices, adaptive learning software, and real-time analytics has heightened the need to expand the broadband imperative to include access to high-quality, ubiquitous Wi-Fi access. The *2016 National Education Technology Plan (NETP)* addresses this need and recommends that "students and educators have broadband access to the Internet and adequate wireless connectivity." State education departments are taking note and evaluating the internal accessibility needs of their schools and generating policies and funding pathways to support their growing demands.

This paper explores the steps states are taking to address the wireless equity gaps that exist among their schools. Leaders from Illinois, New Mexico, North Carolina, and Utah outline the planning, policy, funding, and management approaches their state agencies and education technology leaders are adopting regarding Wi-Fi, and they share their recommendations for promoting and/or creating equitable access opportunities to high-quality Wi-Fi connectivity.

Ubiquitous Wi-Fi Model Supporting a Digital Learning Ready School Campus



Putting the Pieces Together—Today's Connected Schools

As states and school districts continue to figure out the "how" behind the delivery of equitable internal broadband access, it is imperative that the "why" remains at the forefront of this important issue. The advent of new technologies and increased access to robust connectivity has made the words "digital transformation" as ubiquitous in education as reading, writing, and arithmetic. School districts nationwide are leveraging their wireless networks to deliver transformative and impactful personalized learning opportunities that are reshaping the K–12 landscape. Teachers are no longer confined to the front of their classrooms, delivering content to rows of students restricted to their desks. Instead, they are fostering interactive and collaborative student-led discussions and engaging their students in hands-on project-based and problem-based learning exercises that often extend beyond the four walls of the classroom.

Digital resources such as online learning management systems, real-time data analytics tools, and web-based collaboration suites are enabling educators to extend the school day and personalize their students' learning experiences in ways that were previously impossible.

Delivering Transformative Learning Experiences

Education is experiencing a digital renaissance of sorts, with new ideas and strategies constantly emerging and reshaping our schools' cultural landscapes. Because one approach is not necessarily better than another, technology leaders and educators have the freedom and flexibility to explore and engage with new technologies in creative and innovative ways that best fit their students' needs.

At **Tennessee's Greeneville City Schools**, Greeneville's technology team works diligently with its instruction team to ensure that technology is enhancing, rather than hindering, instruction. The group's motto—"any device, anywhere, anytime"—has enabled them to create and sustain a comprehensive, device-agnostic environment for their students. With so many new devices entering the market, the Greeneville team acknowledges that it can be difficult to keep up.

> **"Everything is changing all the time. We must have reliable and fast networking connections so that teachers and students can access their digital learning applications. Having a robust infrastructure in place is critical. If you are in the process of creating and reviewing your future technology strategies and you are only looking five or six years down the road—double it. Plan to future-proof and don't skimp on the front end."**
>
> — Chuck Broyles, IT Operations Administrator, Greeneville City Schools

Greeneville teacher Jana Wills sees the impact technology is having on her students. “Technology is positively changing the way my students interact with me and how they interact with each other,” says Wills. At the request of her students, she now records her lessons so students can watch them from home if they are absent or to prepare for quizzes. Technology has enabled Wills’ students to take ownership of their learning. She is the facilitator and gives them information, but they are using technology to enhance the lessons.

At **Idaho’s Wilder School District** teachers are using tablets to drive student-centered instruction, even among their youngest students. “Our kindergarten teachers wanted every student to use their iPad to create a Keynote presentation for their parents that demonstrated what they’d learned in kindergarten over the course of the year,” says Jeff Dillon, Wilder’s superintendent. “During the graduation ceremony, every parent came in and sat down with their child as they went through the presentation with them. These are kids that came in with almost zero knowledge or understanding of the alphabet or numbers at the beginning of the school year. We had one student who turned to his teacher while he was making his presentation and said, ‘This makes me feel so smart.’ It was a phenomenal experience.”

The State of Vermont is moving to a proficiency based requirement system, and its school districts are using technology as a means of cultivating learning experiences around those standards. Vermont’s Two Rivers Supervisory Union is leveraging digital resources and applications to create personalized learning plans for every student. “We want our students to feel invested in their education,” says Tom Ferenc, Two Rivers’ principal. “For example, a lot of students may think they want to be a veterinarian, but when they get into organic chemistry they discover it’s a little different than what they thought. In the very near future, our students will complete a series of interest inventories and aptitude tests that will provide them with valuable insight into their interests and skillsets. We will use that data to create an electronic portfolio for every student that we can all use—the students and the faculty—to track their personal learning pathways from the day they enter the system.”

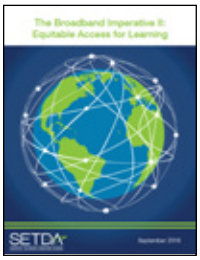
From mobilized classrooms to makerspaces to real-time data capturing, today’s schools are pushing the envelope in terms of the personalized learning opportunities they can provide their students. Unfortunately, insufficient internal broadband connectivity greatly hinders this progress and disrupts the overall learning process, creating a divide between those students with robust wireless access and those without it. Moreover, as more schools begin integrating Bluetooth technologies such as door locks, security cameras, and wearable technologies to enhance and streamline their operations, the need for reliable internal broadband connectivity becomes even more critical.

Broadband Imperative: Where We Are Today

Virtually all our nation's schools have access to the Internet but the quality and type of connectivity vary greatly from region to region. As we explore the internal broadband needs of today's K–12 schools, it is important to first review current external broadband recommendations, as high-speed broadband access is the foundation upon which today's schools create enhanced and empowering learning experiences.

Many states and education organizations have collaborated to advance the state of broadband in our K–12 schools. In 2012, SETDA published *The Broadband Imperative: Recommendations to Address K–12 Education Infrastructure Needs*, a groundbreaking report that challenged educators and policymakers to increase high-speed broadband access in schools. The report suggested current and future bandwidth recommendations for school districts to ensure all students have access to the tools and resources they need to be college and career ready. The report's recommendations were widely-recognized and adopted by many leading organizations, including the Federal Communications Commission (FCC).

In 2016, SETDA and Common Sense Kids Action focused on the role of state leadership in supporting districts and schools to increase high-speed connectivity and access for students in their collaborative report *State K–12 Broadband Leadership: Driving Connectivity and Access*. Through a state broadband survey and independent data collection, SETDA gathered information for all 50 states, the District of Columbia, Guam, and the Commonwealth of Northern Mariana Islands (CNMI) regarding state broadband implementation policies and practices. In that report, SETDA provides specific recommendations regarding state funding and policies to support broadband. As of August 2017, one-third of states do not have any direct state funding for broadband. SETDA recommends that these states provide state funding for broadband to leverage grants and the expansion of the E-rate program through 2018. States can learn more about E-rate modernization in SETDA's *E-rate Modernization toolkit*. SETDA also recommends that states leverage policies, networks, regional consortia, and purchasing options to support increased broadband access in schools.



More recently, SETDA published *The Broadband Imperative II: Equitable Access for Learning* in September 2016. This report assesses the current broadband landscape in K–12 education and sets a new vision and recommendations for increasing robust broadband access both in and out of school to better prepare students for their futures.

The following excerpt from the 2016 report highlights the critical importance of delivering high-speed broadband access to our K–12 communities:

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

CURRENT INFRASTRUCTURE RECOMMENDATIONS PROVIDED BY SETDA

The Broadband Imperative II: Equitable Access for Learning report includes the following updated infrastructure recommendations for policy makers and school leaders:

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

Recommendation 1: Increase Infrastructure to Support Student-Centered Learning

The following recommendations are goals for education leaders, policy makers, and network staff to support effective, seamless digital learning experiences. These recommendations are based on research, analysis of data sets, and input from experts in the field. SETDA provides broadband capacity recommendations for the external connection to the Internet service provider (ISP) based on the size of the district (number of students). This method allows education stakeholders to better understand some of the nuances between very small districts (under 1,000 students) compared to large districts (over 10,000 students).

INTERNET SERVICE PROVIDER RECOMMENDATIONS		
School Year	**2017-18 Targets**	**2020-21 Targets**
Small School District (fewer than 1,000 students)	At least 1.5 Mbps per user (Minimum 100 Mbps for district)	At least 4.3 Mbps per user (Minimum 300 Mbps for district)
Medium School District Size (3,000 students)	At least 1.0 Gbps per 1,000 users^	At least 3.0 Gbps per 1,000 users
Large School District (more than 10,000 students)	At least 0.7 Gbps per 1,000 users	At least 2.0 Gbps per 1,000 users
^Published by SETDA 2012; Adopted by the FCC in 2014 https://www.fcc.gov/general/summary-e-rate-modernization-order *User: students, teachers, administrators, staff, and guests		

Based on the analysis of current trends, research, and consultation with experts in the field, SETDA recommends that for the 2017–18 and 2020–21 school years, districts should plan for at least 10 Gbps per 1,000 users for WAN access. SETDA expects that the WAN requirements will flat line as districts utilize cloud-based services, as well as with the advent of virtualization. These services shift the increased capacity requirements to the Internet access (external connection recommendations highlighted above). SETDA also recommends that schools and districts look closely at their learning goals, device availability and plan for broadband growth based on current and future needs.

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

Recommendation 2: Design Infrastructure to Meet Capacity Targets

State leaders should support their districts in building broadband capacity targets that meet their digital learning needs.

DESIGNING NETWORKS FOR LEARNING

K–12 infrastructure planning is complex. Networks must be both robust and secure to meet learning goals, administrative needs, and privacy requirements, but they must also give educators enough freedom to integrate creative web-based instructional resources and tools. The Consortium for School Networking (CoSN) published its *Smart Education Networks by Design (SEND)* resources to support school and district network planning, and the materials reinforce how critical high-quality wired networks are for supporting robust and effective Wi-Fi networks.

> **Wi-Fi is only as good as the wired network that supports the access points."**
>
> — Derrel Fincher, OUSF E-rate Coordinator, Oklahoma Corporation Commission

THE NEXT PHASE— WI-FI INTERNAL CONNECTIONS

Not only does ensuring widespread availability of high-speed broadband in schools remain a critical issue, state and district leaders must also turn their attention to providing students with access to high-quality internal broadband connections through wireless (Wi-Fi) networks. The rapid influx of mobile devices, digital learning applications, and real-time assessment tools has mobilized our nation's learning environments and enabled educators to personalize each student's learning experience to meet their individual needs. Reliable and robust wireless networks are required to support and sustain these innovative technologies and provide students with the access needed to excel in today's global digital landscape.

Internal broadband connectivity is a complicated issue because there is no "one-size-fits-all" approach to ensuring seamless and reliable wireless access. The design of a network should correlate to its intended use. For example, some school districts prefer to limit access through authorized and guest user accounts. Others elect to facilitate a more open-door policy with their networks. No matter the choice, all network leaders must consider student privacy and security.

High-quality wireless networks require a significant amount of investment in terms of planning, support, and equipment costs. Fortunately, discounts are available through the federal E-rate program for eligible routers, switches, wireless access points (APs), and other internal connections as well as managed internal broadband services. However, many school districts still struggle to pay for the remaining expense after the E-rate discount. Schools are also challenged with overburdened staff members, an increasing reliance on their schools' internal networks, and the inability to scale their networks quickly enough to meet growing demands.

TOP 10 WIRELESS CHALLENGES FACING K–12 SCHOOLS

1. **Outdated Wi-Fi equipment and design**
2. **Piecemeal Wi-Fi networks comprised of equipment, applications, and resources from a variety of vendors**
3. **Poorly engineered Wi-Fi implementations**
4. **Inefficient Wi-Fi access coverage designs using too many or too few access points**
5. **Overburdened technology staff**
6. **Lack of visibility into the network's day-to-day operations**
7. **Insufficient bandwidth**
8. **Lack of proper expertise in choosing equipment, such as APs, cabling, switches, and peripherals**
9. **Security and user access management issues**
10. **Funding**

K-12 Best Practice Guide Wi-Fi Increasing Customer Value by Reducing Operational Complexity

Recommendation 3: Ensure Equity of Access for All Students Outside of School

State leaders need to understand and explore opportunities to work with their districts and communities to increase equity of access beyond the school walls.

THE HOMEWORK GAP— OUT OF SCHOOL ACCESS

Not to be forgotten is the importance of access to the internet outside of school. Unfortunately, the digital divide persists beyond the walls of the classroom, as not all students have access to the Internet at home—often referred to as the "homework gap." The Pew Research Center reports that five million households with school-age children do not have broadband access at home. The FCC's 2016 Broadband Progress Report states that "broadband is not being deployed to all citizens in a reasonable and timely fashion." Additionally, only two percent of school systems report that every student has access to devices outside of school. In a 2015 report published by the Bill & Melinda Gates foundation, 42 percent of teachers stated that student access to technology outside of the classroom continues to be problematic.

Recommendation 4: Leverage State Resources to Increase Broadband Access

State leadership needs to promote state funding for broadband services, enact policies to support deployment and adoption, build state networks for economies of scale, and look at innovative practices in purchasing options for districts.

FUNDING OPTIONS FOR WI-FI

In the *FCC's 2014 E-rate Modernization Order*, the FCC explained how connecting all the nation's schools and libraries to high-speed broadband would be ineffective without addressing needed Internet improvements inside the schools and libraries themselves. In an effort to ensure effective and efficient use of bandwidth delivery down to the classroom, the FCC made additional funds available to provide discounts on local area network (LAN) infrastructure and related services.

The Modernization Orders set a target of at least one billion dollars per year to assist with Category Two funding requests. Included within this was Wi-Fi equipment and/or services during FY2015 and FY2016. Additionally, the FCC expects the availability of at least one billion dollars per year during FY2017, FY2018 and FY2019 in Category Two funds to cover the services necessary to create and maintain "internal connections," or Wi-Fi networks, within schools and libraries. Using these funds, schools and libraries can purchase Wi-Fi access points, Wi-Fi services (such as management or managed services), and new technologies like caching servers. The Orders also include a minimum funding floor so that all eligible schools, regardless of size, can receive minimum funding.

Under the Modernization Orders, Category Two services are funded at a maximum discount of 85 percent with a minimum pre-discount budget of 150 dollars per student for schools. Please see *The E-rate Opportunity: E-rate Modernization Resources for Policymakers & Digital Leaders* published by SETDA and Common Sense Media.

State Perspectives on Building Broadband and Wi-Fi Connectivity Support for K-12 School Districts

State education departments often work with partners including statewide network leaders, regional education networks (RENs), and consortiums of districts and/or intermediate units to help establish equitable internal broadband connections among their schools. To gain a deeper understanding of state leadership related to Wi-Fi implementation, in spring 2017, SETDA surveyed a targeted sample of its members (20 percent of the states). The survey objective was to discover what policy and funding strategies states had adopted pertaining to wireless access. This 20 percent sampling can be considered statistically relevant of the broader states. More than 50 percent of the responding states are currently providing some type of state level recommendations, Wi-Fi standards suggestions, policies, or programs to assist their schools in the implementation of attaining quality Wi-Fi connectivity for their schools.

State Action Plans for Fostering Digital Learning Ready Schools

The following is a snapshot overview of some of the wireless initiatives and strategies our nation's states are implementing to support student learning.

ALABAMA

The Alabama State Department of Education works in partnership with their E-rate office, education technology office, and the Alabama Educational Technology Association (AETA) to actively seek support and funding from the state legislature. The Alabama Ahead Act was implemented in 2015 to leverage E-rate discounts and focus on the improvements their schools required in Wi-Fi infrastructure needs. These needs are guided by a Wi-Fi standards protocol created by AETA now called Alabama Leaders in Educational Technology (ALET).

Base Level Wi-Fi Standards

School systems wishing to accommodate a higher capacity of wireless devices may do so, but the priority is to ensure every regular-use classroom, library media center, and cafeteria meets the following base level of service:

- **All regular-use classrooms should have high-quality wireless access for 30–40 devices simultaneously.**
- **All library media centers should have sufficient wireless access for at least one-third of the room's capacity.**
- **All cafeterias should have sufficient wireless access for one-third of the current enrollment of the school.**
- **Administrative and non-instructional areas of schools should have coverage, but high-density is not required.**

IDAHO

Idaho issued a state-level RFP for internal broadband connections called the Idaho High School Wireless Managed Service Project in 2013. The Idaho State Department of Education selected and signed a five-year contract with ENA to provide, install, maintain, and service a managed wireless technology solution in public schools serving students in grades 9–12.

MICHIGAN

Michigan developed a state education technology plan called the MI Roadmap, which is the beginning of an internal infrastructure, equitable-access strategy. MI Roadmap provides baseline goals that assist and guide the state and schools, and it outlines the plans for developing additional supports during actual implementation.

MASSACHUSETTS AND CONNECTICUT

Massachusetts and Connecticut have elected to partner with national education organizations such as CoSN and SETDA to leverage existing best practices. For example, the Massachusetts Department of Elementary and Secondary Education partnered with EducationSuperHighway to develop and distribute a network upgrade planning tool, a Wi-Fi buyer's guide, and a speed test tool that their schools can use to assess internal connectivity needs.

OTHER STATE STRATEGIES

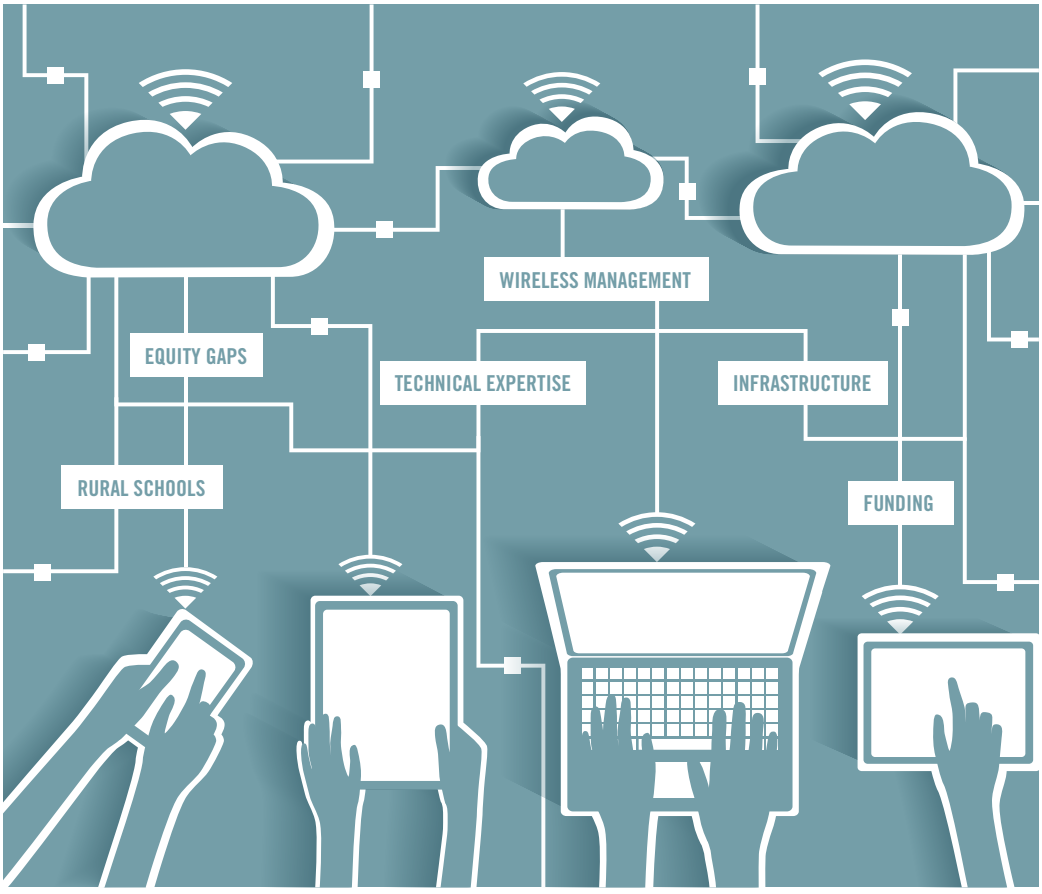
Other states are exploring and promoting opportunities to create policies and practices that support quality Wi-Fi experiences for their school districts. The Oklahoma State Department of Education is currently working closely with the Governor's Oklahoma Connect and Learn Initiative to create a set of Wi-Fi connectivity requirements. Virginia is attempting to procure additional funding for external and internal broadband services.

Several states are extending their current broadband funding programs or planning to add funding programs to help cover the funding gaps created after E-rate funds have been applied. While the E-rate program supports Category Two funding for wireless infrastructure, it does not fully fund a school district's needs. Alabama, Idaho, Massachusetts, New Mexico, North Carolina, and Rhode Island are examples of states that have developed some type of state-level funding stream to support the gap needs of their school districts.

Wireless Challenges and Concerns

SETDA's spring 2017 survey also asked state leaders to identify challenges surrounding the establishment of equitable internal broadband connections among school districts. Gaps in competitive pricing, technical expertise, and wireless management support were some of the top concerns listed in the survey. Accessibility and a lack of competition in rural areas were two other pain points identified by state leaders.

Providers in rural areas are reluctant to build or upgrade existing infrastructure for economic purposes. As a result, many communities have only one provider, which drives up costs and hinders infrastructure growth. Connecticut is addressing this specific challenge through its state collaborative. The organization works with providers to bridge equity gaps by offering opportunities to provide affordable access and to build-out or upgrade their existing infrastructure. Another consideration that extremely rural and/or small schools must consider is a minimum floor for access even if they only have a small number of students.

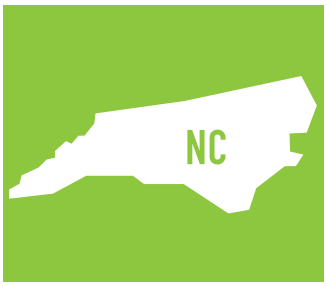


Wireless Challenges

A Closer Look at Wi-Fi—How Four States Are Taking a Leadership Approach to Internal Broadband Connectivity

In addition to the state survey, SETDA and ENA brought together education technology leaders from four different states—Illinois, New Mexico, North Carolina, and Utah—to share how they are promoting equitable internal broadband access among their schools. These brief reports demonstrate the innovative and varied approaches being adopted and successfully implemented across the nation.

Creating Statewide Equitable Access Opportunities for North Carolina's Schools



Over ten years ago, the North Carolina Department of Public Instruction (NCDPI) and its partners MCNC, the Friday Institute and North Carolina State University, and North Carolina's Information Technology Services (ITS) sponsored the School Connectivity Program, which provides funding to the state's K–12 schools for high-speed broadband Internet access, equipment, and support services.

In 2013, North Carolina's state legislature passed a law mandating its schools transition to digital instruction by 2017. To support the school districts' efforts, the School Connectivity Program's original partners expanded the program to include funding for enhanced internal broadband connectivity. Today, approximately 80 percent of North Carolina's schools have access to what state leaders have termed "digital learning ready Wi-Fi," or Wi-Fi that is robust enough to successfully support a school-wide, one-to-one (1:1) learning environment.

ESTABLISHING A FUNDING CHANNEL

North Carolina's connectivity model is certainly unique. "Our school districts are basically 100 percent funded," says Michael Nicolaides, CIO of the North Carolina Department of Public Instruction. This is accomplished by the districts filing for and receiving funding from the E-rate program and the NCDPI funding the remaining broadband and internal connection costs. The state has set aside 32 million dollars in recurring funds for connectivity.

> **"Initially, we had approximately 20 million dollars to support the School Connectivity Program. Those funds cover the broadband costs schools incurred after E-rate, the WAN, the statewide client network engineering services we provide, and training. After the E-rate modernization and our digital learning law was passed, we reassessed the program and determined that we could sustain connectivity down to the user with an additional 12 million dollars."**
>
> — Phil Emer, Director of Technology Planning and Policy, The Friday Institute

CAPACITY AND UTILIZATION

Although the state is not interested in monitoring its schools' content, it is significantly invested in ensuring its schools are optimizing their connectivity. The NCDPI has created an interactive map of North Carolina's school districts that shows usage, and because of that, the state knows what an all-digital school serving approximately 6,000 students looks like from both a peak usage and nominal usage perspective. It also knows what an all-digital large district with more than 10,000 students looks like, and from this perspective, it turns out they do not look the same. This data enables state technology leaders to quickly identify and address anomalies or viruses that may be impacting a school district's network.

> **"Because our federal and state governments are paying the bill in North Carolina, we need to be diligent about monitoring usage and capacity in our schools—not in a big brother type of way, but to ensure we are being good stewards of the money."**
>
> — Phil Emer, Director of Technology Planning and Policy, The Friday Institute

PROVIDING A MANAGED SERVICE OPTION

To ensure all of North Carolina's schools have robust and reliable broadband connections, the state's School Connectivity Program includes access to the state's client network engineering service, which is a cadre of network engineers who help the state's school districts with a variety of issues, including their WAN, security threats, and problems with service providers. The engineers are available to assist with a district's internal broadband connections as well, but that is a more challenging task for the team because the school district often provides and manages its own Wi-Fi instead of a professional provider.

Right now, state education technology leaders are very focused on assessing the types of services that need to be provided to ensure that districts with varying levels of wireless capabilities and skillsets look similar from one side of the state to the other.

"Schools need to be able to monitor their networks, recognize when there is an issue, understand why there is an issue, and know how to fix it," says Emer. "Resolving all those problems can be difficult, but that's what we consider an equitable and manageable, end-to-end connectivity model. That's why we included a managed wireless service provider option in our statewide request for proposal (RFP) for internal broadband connections."

DIGITAL LEARNING READY WI-FI

Although Nicolaides and Emer acknowledge there is Wi-Fi in every school in North Carolina, they quantify the state's Wi-Fi penetration in terms of quality—estimating that approximately 80 percent of its schools have "digital learning ready Wi-Fi." Digital learning ready Wi-Fi is defined by their team as sufficient Wi-Fi coverage to support substantial and simultaneous online learning among a school's students. They have established several benchmarks to help schools assess and gauge if their wireless network is digital learning ready.

The team created an algorithm for shared learning spaces that essentially calculates approximately 1.2 APs per classroom. They also consider the number of students per AP. Those are two defined benchmarks, but they also consider components such as technical and wiring design, radio frequency and density coverage, how a district mixes 2.4 and 5 GHz radios, and the extent to which a school district is managing their infrastructure. Each of these elements is going to vary from school to school, particularly with the state's charter schools because many of those schools are located in strip malls that have drywall instead of cinderblock. The AP ratio needed for a school with cinderblock is not the same for a charter school with drywall.

THE FUTURE

The future is always difficult to predict, but Phil Emer and Michael Nicolaides have identified some key areas where they believe they will see significant growth pertaining to internal broadband connections.

1. Consider a managed service

Developing an effective model that brings monitoring, maintenance, engineering, and support together while still allowing students to learn in an unfettered way.

> **It's easy to procure equipment and bolt it to the ceiling. What's challenging is designing your wireless network in such a way that the wireless connection is consistent and robust. For us, one of the solutions we've used to solve that problem is a managed service."**

— Phil Emer, Director of Technology Planning and Policy, The Friday Institute

BENCHMARKS TO CONSIDER

- **An algorithm for shared learning spaces**
- **Overall access to AP by student ratio**
- **Technical and wiring design standards**
- **Examples of 2.4 and 5 GHz radios**

2. Rethink the current network architecture

School district networks should consider new models for coordination of services and do not necessarily need to continue the current typical model where all network elements link back to a central location.

> **We still architect school district networks in a way that homes everything back to the district central office or a particular high school. I'm not sure that the current model will continue to make sense in the future though. I can see network components like the firewall and content filter being provided from within the Internet Service Provider network."**

— Phil Emer, Director of Technology Planning and Policy, The Friday Institute

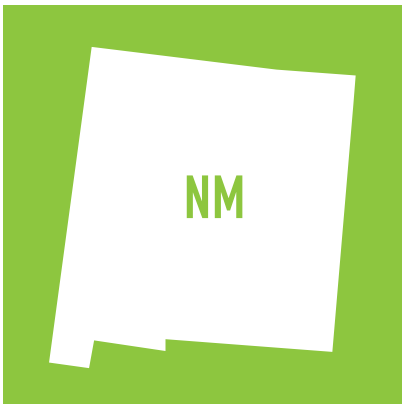
3. Allocate more resources toward network security

The security of student data and network content should be at the forefront of decision making for IT leaders.

> **With the recent ransomware attacks, I think security needs to be much more front and center and wrapped into connectivity services."**

— Phil Emer, Director of Technology Planning and Policy, The Friday Institute

Empowering New Mexico's Schools With Connected Learning Opportunities



In 2015, New Mexico Governor Susana Martinez announced plans to bring high-speed Internet access to every New Mexico classroom by 2018. To meet this goal, state agencies—including the Public Schools Facility Authority, the Public Education Department (PED), and the Department of Information Technology—have been working with the EducationSuperHighway to develop recommendations to support the buildout of infrastructure required to deliver high-speed Internet to New Mexico's classrooms. This initiative—the Governor's Broadband for Education Initiative—has enabled the state's school districts to rapidly expand their broadband connectivity, but the principal focus remains on creating strong educational opportunities for New Mexico's students.

SERVING AS A KNOWLEDGE BASE

The PED and the Department of Information Technology seek to empower New Mexico's schools with the ability to make well-informed decisions that meet their specific learning objectives while still serving as a knowledge base the schools can rely on for assistance. Establishing price transparency is a principal component of that goal.

During the program's first year, the state reissued a statewide request for proposal for E-rate Category Two internal broadband and internal connection services to drive down costs and improve overall price transparency. In addition, the PED created a public mini-quote system that enables New Mexico's school districts to review the quotes of all vendors responding to bids around the state. This information is tracked internally to ensure school districts are receiving adequate wireless coverage for the best value.

> **"We don't have specific parameters around monitoring or tracking our schools because we are a locally controlled state. However, the work we are doing surrounding price transparency and reviewing wireless network plans ensures that everyone is getting the best value for their money."**
>
> — Dr. John Chadwick, Education Technology and E-rate Coordinator, New Mexico Public Education Department

MAKING THE DIGITAL LEAP

Below are two schools embracing the governor's vision and transforming their campuses into comprehensive digital learning environments:

- **Deming Public Schools** in Deming, New Mexico serves approximately 5,200 students. The district is building a new high school to replace its old campus. When constructing the campus, school leaders included factors such as wireless design and connectivity in the school's overall layout and design.

- **McCurdy Charter School** in Espanola, New Mexico recently underwent a major renovation and is now completely wireless.

> **"We know what is possible, and we know we have a lot of work to do. It's incumbent upon us to share our school districts' successes and demonstrate the positive impact this program is having to ensure other programs like this are well-supported in the future. Ultimately, the PED's goal is to help educators identify their specific instructional vision and help them determine what technology is needed to support that vision."**
>
> — Brett Turner, Director of the Blended Learning Bureau, New Mexico Public Education Department

RECOMMENDATIONS

Like other states, New Mexico is still determining how to best assist schools with their wireless needs.

The PED leadership team shared the following recommendations they put together in the hopes of assisting other states and school districts with their internal broadband initiatives:

- **States should establish a fund or plan to offset the undiscounted portion of E-rate.**
- **Districts should adopt a long-term, flexible approach to technology because its capacity to support rigorous teaching and learning amplifies continually, requiring students and teachers to adjust to shifting learning environments.**
- **Districts should form relationships with public libraries to create solutions that benefit the entire community.**

Forming Collaborative and Connected Communities Within Illinois

Illinois public school districts are banding together to champion for statewide equitable broadband and wireless access. Currently, some of the state's rural schools are underserved in terms of connectivity and technology personnel, creating disparity among Illinois students.

To resolve this issue, educational leaders are bringing in partners like EducationSuperHighway to help analyze ways to provide more access to those school districts.

Additionally, the state's technology directors are forming statewide collaborative groups and hosting professional development conferences to share their knowledge and expertise with their peers. They are also introducing service providers to the state's underserved school districts to help deliver robust connectivity to their classrooms.

> **"Most school districts in Illinois have Wi-Fi solutions, but the quality of the Wi-Fi varies greatly. Quality Wi-Fi means you can have 30 students simultaneously connected to devices in one classroom and everybody has coverage. Many school systems lack the WiFi coverage and density to facilitate those types of digital learning environments."**
>
> — Jim Peterson, Chief Technology Officer, Bloomington Public Schools District 87

The school districts' grassroots efforts are paying off, with successful cooperatives like the IlliniCloud being formed to support the state's education technology needs. The IlliniCloud is a member-driven educational cooperative of school districts that provide schools in multiple states with the means to operate smoothly, efficiently, and safely for the benefit of teachers and students.

"Illinois districts collaborate on how to provide the best educational opportunities for their students," says Peterson. "For example, the IlliniCloud cultivates collaboration and brokers relationships between these existing trusted networks. We hold a unique responsibility to provide equity within the services we provide to students, staff, and the communities in which we reside. Sharing knowledge and expertise within cooperatives of districts is important to address these local issues in meaningful ways, thus we continuously encourage districts, regional and state operators, and the like to work with IlliniCloud and other collaborative organizations to assist them in serving these unique local demands."

Wi-Fi and other technology-based issues are common threads of concern across all geographies and demographics. The IlliniCloud was formed to address these technical, teaching and learning, and operational challenges that confront K–12 school districts.

The organization is accomplishing this through collaboration, solving problems at scale, and continually building relationships with similar organizations, regional operators, and vendors to provide sustainable services for others in need.

Below are some of the steps the IlliniCloud is implementing to meet their goals:

- **Extending expertise within the community**
- **Providing meaningful services through public and private partnerships that promote equity**
- **Protecting student data and privacy**
- **Implementing professional development that matches unique district challenges**

WHAT'S NEXT?

Peterson sees Wi-Fi in the cloud as the next step for creating cost savings while delivering a high level of service for districts. "I think cloud-based Wi-Fi will help bridge the connectivity gap that currently exists among our states' schools and will provide all students with equitable access to quality Wi-Fi," says Peterson.

RECOMMENDATIONS

Peterson shared the following approaches he and other Illinois educational technology leaders are implementing to support the widespread integration of quality internal broadband connections:

- **Sharing and collaborating with peers**
- **Focusing on sustainable infrastructure for anytime/anywhere access**
- **Assisting local communities in leveraging relationships and partnerships to solve broadband, internal connections, and home access gaps**

Facilitating Connections Among Utah's Legislative and Education Communities to Create Equitable Internal Broadband Connections

The Utah Education Network (UEN) connects all Utah schools and higher education institutions to a robust network and quality education resources. The organization is making a concerted effort to promote equitable access to quality internal broadband connections among all its education communities.

SUPPORTING ITS SCHOOLS' MISSIONS

The organization is focused on identifying wireless services that will benefit Utah's schools as well as securing statewide contract pricing for those services. "We want to help increase the opportunities for our schools to leverage E-rate funds to make improvements," says Jeff Egly, the UEN's associate director. The state serves as a resource for its schools and is committed to bringing various groups together to push the wireless conversation forward. The UEN hosted its annual Technical Summit this past summer and brought in different professional development and training resources around internal broadband connections. The organization offered a wireless certification course for education technology leaders and staff members that was very popular and well-received.

LEVERAGING GOOD ENGINEERING TO PRODUCE QUALITY WI-FI

Like many other states, Utah is analyzing the quality of its schools' Wi-Fi networks and determining how to establish best practices for its districts.

> **"Our wireless penetration is approximately 98 to 100 percent, but that doesn't mean all of our schools have access to quality Wi-Fi. So much depends on the engineering when it comes to wireless connectivity. The easy approach is to deploy one AP per room, but that's not necessarily the right approach because so many variables come into play with Wi-Fi, including building architecture, technical support, authentication, WAN/LAN access, signal strength, AP management, the age of the equipment, and the application and use of the network."**
>
> — Jim Stewart,Chief Technology Officer, Utah Education and Telehealth Network

To help guide its schools, the UEN regularly brings together subject-matter experts from around the state to discuss and share ideas surrounding internal broadband connections and what qualifies as "quality" Wi-Fi. However, it has been difficult for the group to create a definitive set of benchmarks because of the variables in play.

RESOURCE

Utah Education and Telehealth Network (UETN) WAN, Wi-Fi, Security and Content Filtering Engineering Study & Road Map

> **There is no cookie cutter method when it comes to Wi-Fi. The standards can vary depending on so many factors—the size of the district, the number of students per classroom, the building design, the particular use case, is the network supporting a myriad of devices, Chromebooks, or Apple TVs? The overall message the UEN is communicating with their schools is that good engineering is required to support their students' digital learning needs."**
>
> — Jim Stewart,Chief Technology Officer, Utah Education and Telehealth Network

CLOSING THE ACCESS GAP OUTSIDE OF THE CLASSROOM

Aside from serving as a thought leader in the wireless space for its schools and higher education institutions, the UEN is also striving to bridge the digital access equity gap through its relationship with Eduroam. Eduroam is a global wireless network access service for research and education. Users can access participating institutions' Wi-Fi networks using their home institution credentials. "Eduroam is mostly used in the higher education setting right now, but we've developed several use cases for the K–12 community," says Stewart.

Students who travel to different schools as part of their extracurricular activities often find it difficult to authenticate on the guest network. With Eduroam, they immediately authenticate, enabling them to access their digital resources and complete their assignments in their downtime. The UEN team is hoping to expand Eduroam's presence within the state. "Delivering equitable access outside of the school building is a challenge everybody is struggling with," says Stewart.

The UEN team believes Eduroam can potentially help fill that gap. They are talking to Salt Lake City and the city's airport and aquarium about hosting the service. Because the city has so many students who regularly take trains and buses, it would be immensely beneficial if they could automatically authenticate to the city's wireless network and complete their assignments during their commutes.

COLLABORATE AND COMMUNICATE

Although the UEN team is the first to admit that they still have more work to do when it comes to wireless access, they do emphasize the importance of collaboration. “Communication is key,” says Egly. “I believe the greatest benefit we’ve provided our education community is acting as a facilitator among vendor partners, the state legislators, and our schools.”

The UEN has found it is much more effective and efficient for Utah’s school districts to collaborate and form statewide consortiums rather than trying to figure it out for themselves. The state has some very strong education technology leaders, but they still discover gaps and oversights when making infrastructure upgrades. The UEN has been able to build a strong statewide collaborative community that encourages and enables education technologists to learn from each other and share their successes.

RECOMMENDATIONS FOR OTHER STATES AND SCHOOL DISTRICTS

The state of Utah is making great strides in promoting equitable internal broadband access among its schools. The UEN leadership team has shared some of the lessons they have learned from working with their K–12 technology leaders, vendor partners, wireless experts, and members of the higher education community:

- **Don’t make assumptions.**
- **Don’t pretend to be Wi-Fi savvy if you aren’t.**
- **Collaborate and communicate!**
- **Don’t underestimate the complexity of Wi-Fi.**
- **Invest in good engineering.**
- **Choose your vendors carefully, and don’t take what they say at face value. Vendors need to understand how your students and teachers are using your network, what applications and devices are being supported, your specific building architecture, and your budget to design and build a robust solution that meets your needs.**

Connected States — Lessons Learned

As illustrated in these four case studies, building equitable internal broadband opportunities for school districts vary from state to state. Although the Wi-Fi penetration rate in almost all the above interviewed states is nearly 100 percent, the stumbling block seems to be the quality of the Wi-Fi present in their schools.

Building and maintaining a wireless network is complicated, expensive, and time-consuming for school personnel. Unfortunately, no universal standards exist that schools can turn to for assistance when deploying or upgrading their wireless systems. As a result, many are seemingly relying on the blanket "one AP per room" approach for their Wi-Fi implementation, which may not adequately serve their school's individual needs.

Instead of focusing on the equipment, perhaps the best approach to ensure students have access to quality Wi-Fi is to first identify the specific teaching and learning needs of students and teachers. Once identified, good engineering is required to ensure that the wireless network is designed, implemented, and managed to support those current and future digital learning objectives and goals.

TOP TEN CONSIDERATIONS

Factors for School Districts to Evaluate When Building or Assessing Their Wi-Fi Network

1. **Instructional adoption**
2. **Client or device selection for teachers, students, and staff**
3. **Capacity for the growing number of devices and mobility access**
4. **Current infrastructure and bandwidth access**
5. **Wired versus wireless needs**
6. **Flexibility and scalability**
7. **Wireless network security**
8. **Visibility of users, devices, and applications**
9. **Wi-Fi as a Service and/or the ability or time to self-monitor and manage**
10. **Budget and return on investment**

Wi-Fi Increasing Customer Value by Reducing Operational Efficiency

Pathways to High-Quality Wi-Fi Connectivity

Defining, building, and managing a quality wireless network is a team effort and requires the support of all invested stakeholders, including state education leaders, superintendents, CIOs, CTOs, curriculum team members, teachers, students, and community members.

Unfortunately, due to personnel, budget, and time restraints, district technology staff often find themselves grappling with this issue alone and struggling to make their outdated Wi-Fi networks work efficiently.

The following questions need to be considered and addressed as a team to ensure that a school district's wireless network is digital learning ready:

- **Which spaces within the building and around the campus require wireless access? Who will be accessing these spaces and how often?**
- **What types of teaching, learning, and work applications are required to support the school district's vision and mission for its students, and what funding mechanisms need to be in place to enable these applications?**
- **Which staff members will support and maintain the wireless network, and do they have the capacity to do so successfully?**
- **Should the district retain the services of professional experts to assist with their network design, planning, and management?**
- **How will the district support the growth of the network?**

This type of planning should not be done in isolation. States are working side by side with school systems to assist in facilitating key opportunities and addressing these issues.

Recommendations Checklist

How can states help their school districts define, integrate, and sustain quality internal broadband connections?

☐ Include Wi-Fi in the planning process

While states may vary in their approach, there is a great need for leadership at the state level. School districts are looking for guidance in terms of equipment needs, network speed and connectivity recommendations, and budget recommendations in order to sustain and grow their networks.

It is imperative that considerations for Wi-Fi infrastructure be included in state-led initiatives and/or broadband and digital learning plans. Sharing best practice approaches to supporting and maintaining robust wireless networks will be a valuable resource for schools and districts.

☐ Outline a vision and establish a state standard for what qualifies as digital learning ready Wi-Fi

What does "digital learning ready" mean? States should work collaboratively with school districts, state-level stakeholders, and Wi-Fi experts to define what it means to be digital learning ready and outline the requirements necessary to support the digital learning needs of today's schools.

Considerations should include assessment needs, learning applications, data management and security requirements, devices, guest access, and scalability. It is imperative for schools to understand and clearly define their technology needs based on the teaching and learning requirements of their staff and students.

☐ Support a funding model

Consider a funding model that offsets federal E-rate support. Many schools struggle to fill the funding gap after the E-rate discount has been applied. As a result, they apply a piecemeal approach to their wireless design and maintenance that ultimately hinders them from meeting their users' needs and expectations. Build a program to offer alternative purchasing models for your schools that include lease and buy options for equipment and services, allowing schools to manage budgets in an efficient manner.

☐ Create a pricing guideline and approved vendor qualification form

States need to work with vendor partners and Wi-Fi experts to clarify the myths and realities surrounding internal broadband connectivity. Education technology leaders are inundated with vendors suggesting the easiest way to build a robust wireless network is to install an AP in every space they intend to utilize for connectivity.

Placing an AP in every user area can be very expensive and can sometimes perpetuate network disruptions. Districts need guidance on installation design models that make sense and support their needs without capping their budgets.

☐ Leverage vendors and partners to share best practice models and engineering expertise

Many school districts lack the capacity to build enterprise-grade wireless networks that support the escalating needs of their digital learners. States should collaborate with national and local vendors to create affordable options for schools to engage outside engineering expertise and support.

Managed or co-managed wireless services can also assist schools with limited staff needing to shift their personnel resources toward supporting other mission-critical instructional technologies.

Schools with the capacity to manage and support their own networks would greatly benefit from a state-generated best practice model that provides guidelines for building a quality, digital learning ready Wi-Fi network.

☐ Foster the development of a statewide professional learning community among school districts

Most states have grassroots efforts taking place among their school districts. Unfortunately, these discussions tend to be mostly regional and districts in more rural locations are often left out of the conversation.

Building a statewide professional learning community gives every school district a voice and promotes the exchange of best practices, lessons learned, and recommendations among the state's education technology leaders.

☐ Engage state legislatures in the conversation

State education departments should engage their legislative leaders in conversations about equitable internal broadband access and emphasize the critical role Wi-Fi now plays in today's learning environments.

☐ Evaluate and monitor internal broadband growth and usage throughout your state

It is important to monitor, evaluate, and track the statewide penetration rate of quality Wi-Fi among school districts. Building benchmarks for usage data and growth and sharing best practices will benefit all schools in the state.

☐ Establish a stakeholder team to assist schools in addressing the "homework gap"

There are still many families who lack sustainable Internet access at their homes or within their community. While some cities have worked together to offer opportunities for students and families to access Internet at their local libraries or coffee shops, this is still a critical need.

Students without access to Internet connectivity and wireless connections at their homes or in their local community are at a disadvantage.

☐ Assist schools in planning for today and preparing for the future

Technology is changing rapidly and states can help school districts stay ahead of the curve by assisting districts as they plan for sustainability, growth, and future technology needs.

Anticipating and communicating the future needs at the state level will benefit schools in their long-term planning and sustainability.

Conclusion

States play a critical role in promoting the availability of equitable internal broadband access among their schools. As the four case studies demonstrate, various approaches can be implemented by state leadership teams to assist the K–12 community with this critical issue. What's important to remember is, while there are multiple pathways to providing students with high-quality Wi-Fi in a sustainable and scalable manner, the ultimate focus should always remain on the teaching and learning.

As noted in the 2017 National Education Technology plan, high-speed connectivity to schools and high-speed Wi-Fi throughout schools are essential for creating learning environments that support and enable new types of student engagement and learning. Further, this access needs to be available to students in and out of school.

> **"Although connectivity itself does not ensure transformational use of technology to enable learning, lack of connectivity almost certainly precludes it."**
>
> — National Education Technology Plan

We hope the included recommendations and approaches from the participating state leadership teams provide guidance and insight for states and school districts assessing and devising their internal broadband access plans and strategies.

KEY CONSIDERATIONS

- **State Leadership is Critical**

  Establishing a powerful Wi-Fi network to handle today's data-rich classrooms and day-to-day school operations is critical to the success of our students, teachers, and administrators. School districts look to their state educational technology leaders for guidance, policies, funding, procurement vehicles, and support to ensure equitable access for all.

- **Focus on Teaching and Learning Goals**

  The foundation for any digital learning ready Wi-Fi network should begin with a focus on teaching and learning goals at the school and state level. Instructional adoption and the delivery of curriculum utilizing technology rely on a strong confidence level in network stability, reliability, and performance by teachers, administrators, and students. Extending your network to include a robust and reliable wireless infrastructure is one of the keys to enable digital learning.

- **Consider Multiple Pathways to Success**

  One size does not fit all. State level approaches to supporting and sustaining high-quality, digital learning ready schools vary. State leadership teams should consider multiple solutions for Wi-Fi services and outline a plan that best meets their governing model and creates successful pathways to equitable access for their schools.

- **Consult Experts in Wi-Fi Design**

  Growing demands on network capacity continue to escalate as instructional, administrative, and operational applications rely on network access. As network solutions reach capacity and complexity, often it is difficult to determine how to optimize speed, security, reliability, and capacity on wireless networks. States should leverage partnerships with vendors and organizations to bring expert support to their schools and fill the knowledge gaps that may exist among stretched technology staff.

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