Education SUPERHIGHWAY

Smarter Spending for Smarter Students: Upgrading Arkansas' K-12 Broadband

December 2014

Executive Summary

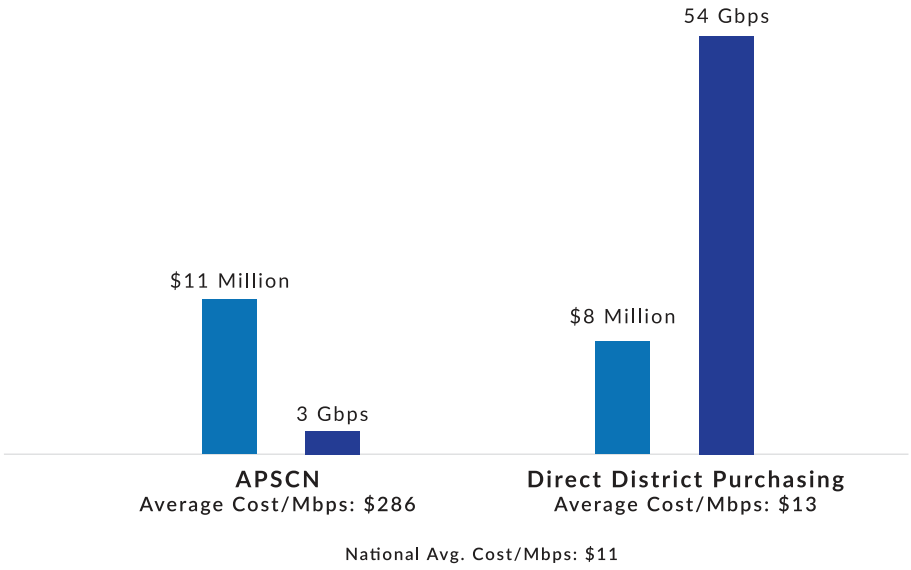
In August 2014, EducationSuperHighway partnered with Arkansas' Office of the Governor and the Arkansas Department of Education (ADE) to **develop a plan to lead the nation in meeting the ConnectED goal of connecting all students to high-speed broadband**. Our work was conducted in two phases. First, we collected data from 260 districts representing 99% of schools and students to analyze the current state of broadband connectivity in Arkansas' K-12 districts. Based on this analysis, we then developed a plan to meet the current ConnectED and FCC Internet access target of 100 kbps/student by the summer of 2015 and the long-term target of 1 Mbps/student by the summer of 2018.

Arkansas is well positioned to achieve the ConnectED goals as a result of ADE's **$11 million annual investment** to provide Internet access to all K-12 districts. If deployed effectively, our analysis suggests that this investment is sufficient to meet the 100 kbps/student target across all districts. In addition, by leveraging this investment to obtain approximately $30 million per year in federal E-rate funds, Arkansas can meet the 2018 Internet access target within ADE's existing budget.

Unfortunately, the ADE's current investment in the Arkansas Public School Computer Network (APSCN) is doing little to meet the needs of Arkansas' public school students. While **58% of Arkansas districts meet the current ConnectED 100 kbps/student target** (versus 37% nationally), EducationSuperHighway's analysis shows that this is due primarily to the fiber-based Internet access purchases that 90% of districts make on their own. In contrast, because APSCN utilizes mostly antiquated network services delivered over copper, none of the districts that rely solely on APSCN meet the 100 kbps/student goal.

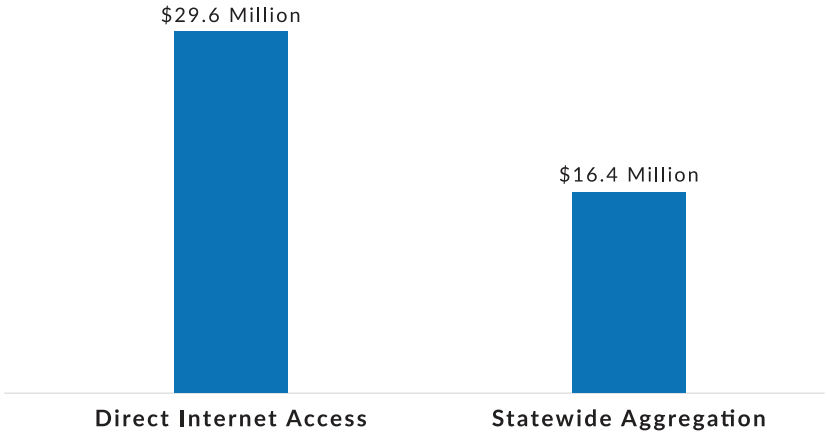
As seen in Figure 1, direct school district Internet access purchases account for 95% of the broadband available in Arkansas K-12 schools while the average price per Mbps ($13) is 95% less than ADE's $286/Mbps APSCN contract. This suggests that **ADE can significantly increase the Internet access it provides to districts by more effectively utilizing its $11 million annual investment**.

Figure 1: APSCN accounts for 58% of total Internet access spend in Arkansas, but contributes only 5% of total connectivity



Understanding this opportunity, EducationSuperHighway engaged the Arkansas broadband service provider community and other stakeholders to inform our strategy for meeting the current and 2018 ConnectED goals. After analyzing bandwidth requirements, expected costs, and technical and qualitative aspects of potential solutions, we concluded that **connecting districts to an aggregated statewide network for Internet access is likely to be the most effective means for Arkansas to meet the ConnectED goals within its existing budget**.

Figure 2: Aggregating demand significantly reduces costs



Estimated Annual Internet Access Costs to Meet 2018 Goal

A well executed state network maximizes the opportunity to use economies of scale to deliver Internet access at the lowest cost, especially as demand for Internet access continues to grow. This strategy builds on the demonstrated ability of the state APSCN network to provide districts with reliable Internet access and good customer service, while enabling significant improvement in speeds and cost effectiveness. In addition, a state network solution will free ADE and E-rate resources for other key network components, such as connectivity and equipment within each district's network.

Implementation of a state K-12 Internet access network can take many forms, with other states successfully utilizing both public and private organizations to implement and manage the network. Arkansas leaders should consider every option moving forward and would be well served to adopt the best practice of involving school district technical leaders and superintendents in the next phase of planning.

EducationSuperHighway expects that planning and implementing a state network will take 12-18 months and, consequently, **we recommend a two-part strategy for upgrading Arkansas' K-12 schools to the current and 2018 ConnectED goals**.

1. Redeploy ADE's $11 million Internet access budget so that all districts meet the 100 kbps/student target by July 2015.
    a. Immediately conduct an RFP process to provide all districts that rely entirely on APSCN for Internet access and those whose direct Internet access contracts expire in 2015 with 100 kbps/student.
    b. Provide subsidies to all districts with continuing direct Internet access contracts to either upgrade their bandwidth to 100 kbps/student or offset their Internet access expense.
2. Simultaneously, plan and implement a statewide Internet access aggregation network with the goal of launching the network in 2016 and connecting 90%+ of districts by 2018.[1]

[1] ~10% of districts have existing contracts that terminate in 2019

In support of this recommendation, EducationSuperHighway has worked with ADE to prepare an RFP that implements the first part of the strategy. We also committed to providing resources to support both the RFP process and continued planning for a long-term statewide solution at no charge to the state or its K-12 schools.

Arkansas has an unprecedented opportunity to lead the nation in upgrading the Internet access to its K-12 schools in a comprehensive and cost-effective way. We urge Arkansas' state leadership and ADE to promptly take action to implement these strategies so that the state does not miss the window for ensuring that every student has the high-speed broadband they need for digital learning in 2015 and beyond.

Background

In order for students and teachers to truly benefit from the promise of digital learning, every school needs access to high-speed, reliable, and cost-effective broadband. Digital tools are transforming the K-12 learning environment, from supporting personalized and differentiated instruction for every student to providing teachers with real-time communication and administrative tools. Yet, these tools are only as powerful as the networks that enable them. While there have been great strides made to get schools basic broadband connectivity, the networks that were set up years ago are simply not fast enough to support today's technology use.

Arkansas has long recognized the importance of broadband to enable a 21st century education, and for that reason, it provides Internet access to all K-12 districts through its $11 million annual investment in the Arkansas Public School Computer Network (APSCN).

Despite this investment, many Arkansas districts do not have the bandwidth they need to support a technology-rich digital learning environment. ConnectED, the Federal Communications Commission (FCC), and the State Educational Technology Directors Association have all adopted Internet access targets of 100 kbps/student today and 1 Mbps/student by the summer of 2018. In order to close the connectivity gap in Arkansas, the Office of the Governor and Department of Education (ADE) engaged EducationSuperHighway to assess the current state of broadband in Arkansas and develop a plan for Arkansas to lead the nation in achieving these targets.

EducationSuperHighway's work commenced in August 2014 with the goal of designing a network solution to meet the following objectives:

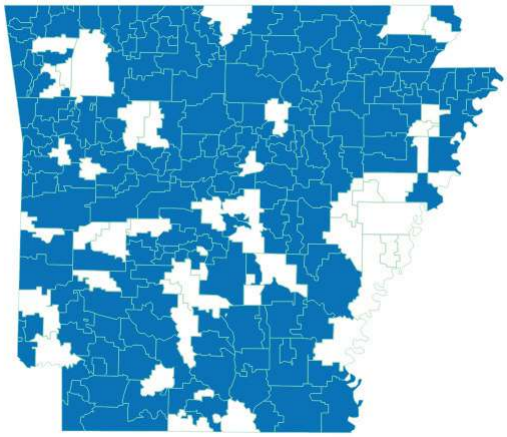
1. Meet the current and 2018 ConnectED Internet access goals in all districts
2. Fit within ADE's current $11 million budget
3. Lower the cost of Internet access for school districts
4. Ensure a cost-effective network as demand continues to grow beyond 2018

This report presents the key findings from our analysis and our recommendations for a path forward for ADE.

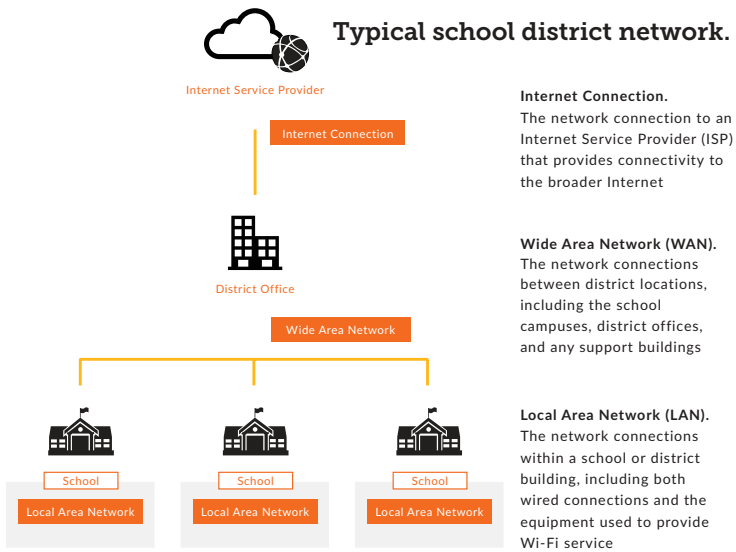
Process and Methodology

EducationSuperHighway's work began by collecting and verifying data on the Internet access and WAN connectivity currently available in Arkansas' school districts. Our data set includes information about the current state of broadband in 260 districts, representing 99% of schools and students. 207 districts (representing 80% of schools, students, and districts statewide) provided connectivity and cost data based on their participation in the federal E-rate program.[2, 3] The Arkansas Department of Information Services (DIS) also contributed data on circuit speeds and pricing purchased through APSCN, which provides Internet access connections to all school districts today.

Figure 3: Comprehensive E-rate purchasing data was collected from 80% of districts



207 districts also participated in a connectivity survey to identify any non-E-rate broadband services and provide additional information about their networks. This survey improved the comprehensiveness of our data set and ensured that our analysis focused on the most critical connectivity gaps.



While network architecture and implementation can vary significantly from district to district, the typical school district network is comprised of the three main components shown in the diagram above: Internet Connection, District Wide Area Network (WAN), and school Local Area Network (LAN). When a student downloads a document using his/her wireless device, the document must traverse the entire network starting with the Internet access connection between the ISP and District Office then through the WAN connection between the District Office to the School, and finally via the LAN before the document reaches the student's wireless device.

Of the three parts of a typical district network, this project focused on upgrading only Internet access to districts because of the state's existing involvement in providing Internet access assistance to districts. In order to fully enable all schools for digital learning, later phases of work will need to address gaps and opportunities for WAN connectivity within each district as well as the LAN within each school building.

[2] For the remaining 20% of districts, we were unable to collect complete E-rate data. Additionally, Great Rivers co-op districts provided data but this data was not included in the district level analyses because they aggregate their Internet access at the cooperative level.
[3] The E-rate program provides discounts to help schools and libraries in the United States obtain affordable Internet access and other telecommunications services. Our data set is based on Item 21 of the Form 471, which specifies the nature of the services ordered as well as the price paid before the E-rate discount. This data is audited by the Universal Service Administrative Company before any funds are disbursed.

Additionally, we conducted follow-up conversations with over 200 districts via phone and email to clarify the data they provided and gain a more in-depth and up-to-date understanding of their network design and connectivity status. In total, the data collection and analysis effort involved a team of nearly 15 EducationSuperHighway staff over the course of five months.

As part of our initial analysis, we evaluated our data set to make sure it was representative of all districts in Arkansas. As shown in Figures 3, 4, and 5, we believe the data set reflects the overall population of districts well in terms of geographical location, locale[4] (classification of urban and rural districts), and size.

Figure 4: District participation across locales

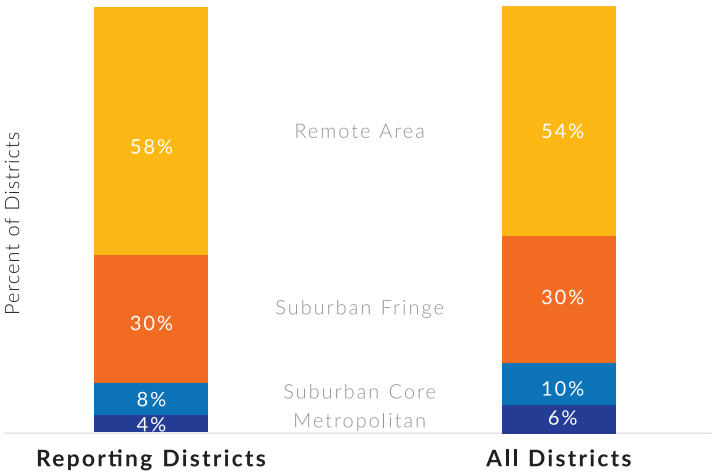
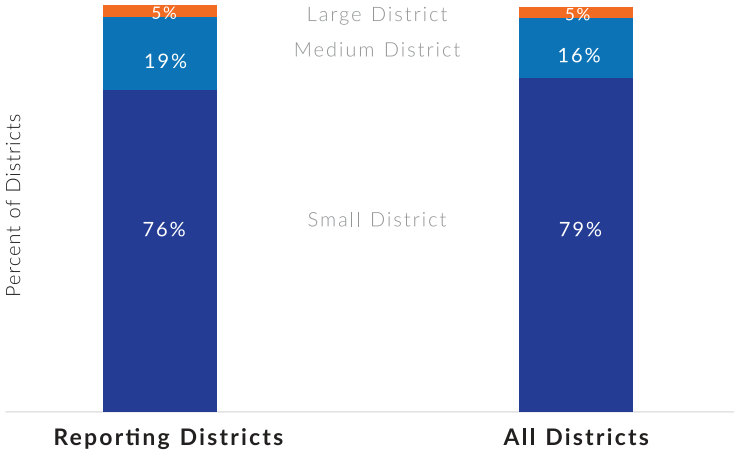


Figure 5: District participation across district sizes



We also engaged key stakeholders including state and public officials, district and cooperative technology coordinators, and service providers. From each group we sought to understand their perspectives on the most impactful opportunities to upgrade schools and to collect their feedback on the state broadband solutions we assessed. This included discussions with 14 technology coordinators from regional school district cooperatives to understand the viability of utilizing cooperatives for our network solution options.

State/ Public

- Governor Mike Beebe
- State Education Commissioner Tony Wood
- Arkansas Speaker-elect Jeremy Gillam, General Assembly, and Joint Education Committee
- Arkansas Department of Education
- Department of Information Systems
- Arkansas Research Education Optical Network (ARE-ON)
- CT&T, Inc. (also engaged by the legislature)

Technology Coordinators

- Cooperatives (14 out of 15)
- Districts for data verification (approximately 200)

Service Providers

- Statewide or regional providers: AT&T, CenturyLink, Windstream, Cox, RasorNET (Yelcot, Ritter, South Arkansas Telephone Company, NewWave Communications, Southwest Arkansas Telephone Company), Verizon, Comcast, Suddenlink
- Local providers : Arkansas Telephone Company, Central Arkansas Telephone Cooperative, Madison County Telephone Company, Magazine Telephone Company, Northern Arkansas Telephone Company, Pinnacle Communications, Prairie Grove Telephone Company, Rice Belt Telephone Company, TDS Telecom, Walnut Hill Telephone Company

[4] Locales are Metropolitan, Suburban Core, Suburban Fringe, and Remote Area. Metropolitan includes large cities, mid-size cities, and large suburbs (NCES locales 11, 12, and 21). Suburban Core includes small cities, mid-size suburbs, and small suburbs (NCES locales 13, 22, and 23). Suburban Fringe includes fringe towns, distance towns, and fringe rural territories (NCES locales 31, 32, and 41). Remote Area includes remote towns, distant rural territories, and remote rural territories (NCES locales 33, 42, and 43).

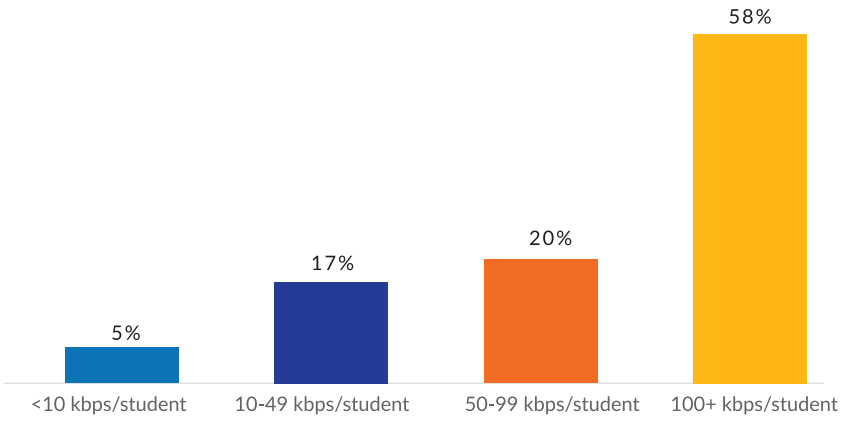
Current State of K-12 Internet Access in Arkansas

The data we collected provides a detailed understanding of the connectivity to K-12 students in Arkansas. Our analysis of the data examined how much Internet access is currently available in Arkansas' K-12 school districts, the cost of that Internet access, and the means by which connectivity is delivered to districts.

Internet Access Availability

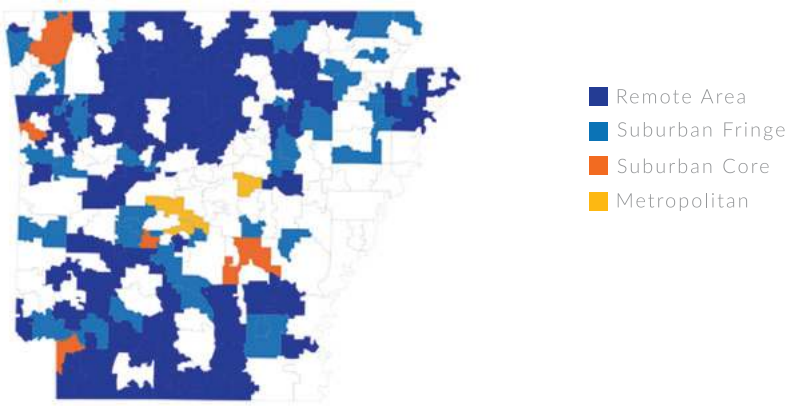
As seen in Figure 6, 58% of Arkansas districts meet the current ConnectED target of 100 kbps/student, substantially higher than the 37% of districts nationally that meet the standard. This suggests that over half of Arkansas' school districts have enough Internet access to implement currently available digital learning tools.[6] However, as teachers and students embrace digital learning in the classroom, the Internet access capacity required to support modern digital learning tools will rise to 1 Mbps/student. Today, none of Arkansas' K-12 school districts meet the 2018 standard.

Figure 6: 58% of districts currently meet ConnectED goal of 100 kbps/student



Encouragingly, the opportunity to leverage digital learning to improve student outcomes is well distributed across the state. As seen in Figure 7, districts meeting the 100 kbps/student ConnectED goal are well distributed across urban, suburban, and rural areas of the state.

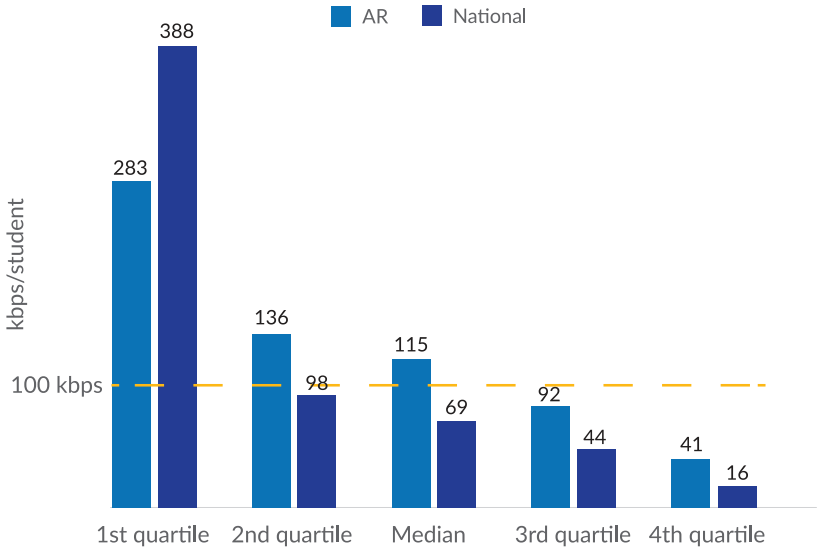
Figure 7: 58% of districts meet goal of 100 kbps/student by locale



[6] It is important to remember, as noted on page 6, that Internet access is only one part of a K-12 broadband network. Districts also require robust WANs connecting their schools and district offices as well as ubiquitous, high-capacity LAN/Wi-Fi networks in their schools.

The data also shows that Arkansas is well positioned to upgrade the rest of its districts to the 100 kbps/student ConnectED standard. As seen in Figure 8, Arkansas school districts that do not meet the ConnectED standard have significantly more Internet access per student than similar districts nationally. As a result, Arkansas only requires an overall increase of 6% in its total Internet access capacity to bring all of its districts to the current 100 kbps/student standard.

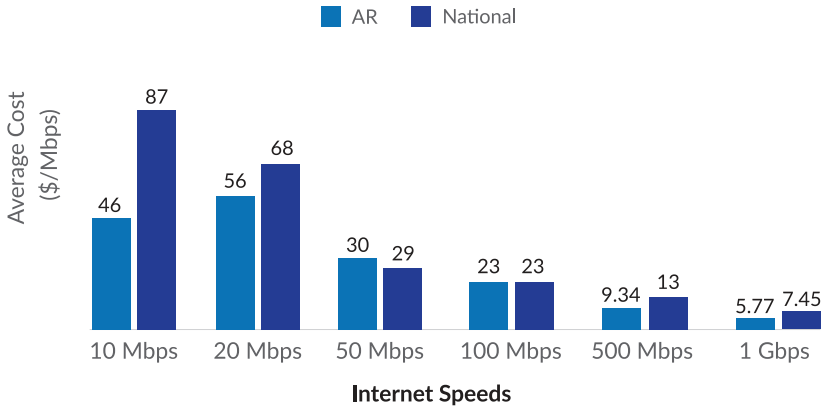
Figure 8: Arkansas districts not meeting the 100 kbps/student goal have more Internet access than similar districts nationally



Internet Access Costs

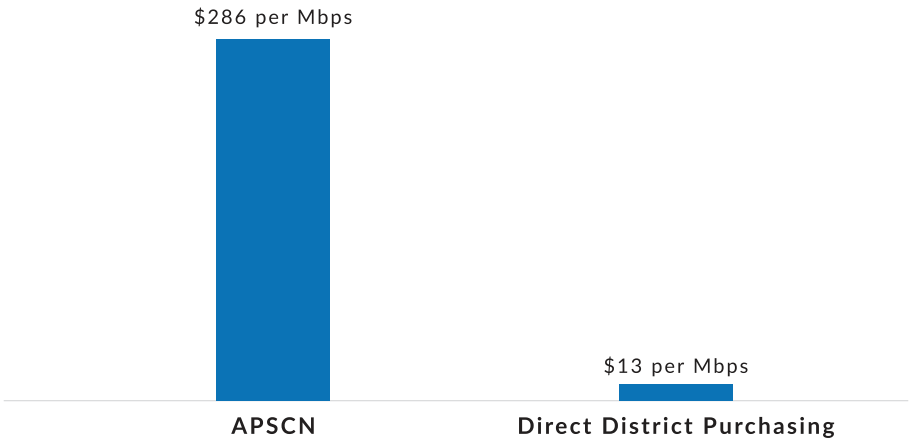
Overall, the median district in Arkansas pays slightly less per Mbps for Internet access ($19/Mbps) than the median district nationally ($20/Mbps). However, as seen in Figure 9, Arkansas' Internet access costs are significantly lower at the high-capacity levels that are required for digital learning. While prices are comparable to the national average at 100 Mbps ($23/Mbps), at the 500 Mbps and 1 Gbps levels, Arkansas prices are 28% and 22% lower than the national average. This further reinforces the conclusion that it will be easier for Arkansas to upgrade all of its K-12 districts to the 100 kbps/student ConnectED Internet access target than other states across the country.

Figure 9: Districts in Arkansas currently pay significantly less than the national average for high bandwidth connectivity



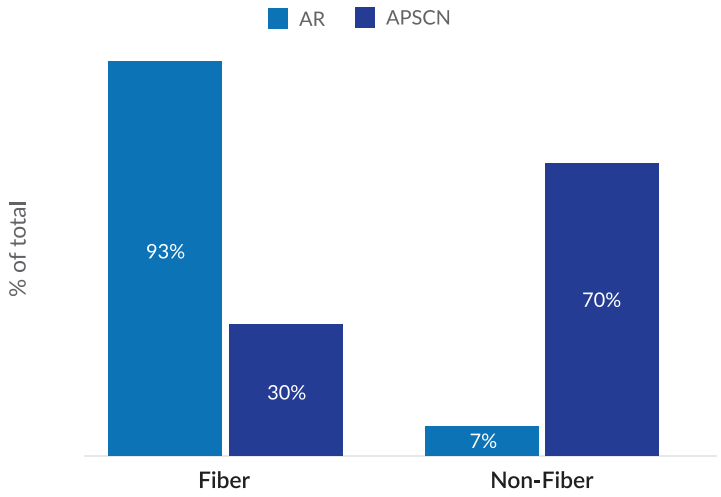
Unfortunately, not all buyers of Internet access in Arkansas are benefitting from low prices. Most striking is the difference between what ADE pays for Internet access under the APSCN contract and what districts pay when they procure bandwidth directly from service providers. As seen in Figure 10, ADE pays an average of $286/Mbps for the Internet access it provides to districts under the APSCN contract while districts pay an average of only $13/Mbps for their direct Internet access purchases from service providers.

Figure 10: ADE pays significantly more for Internet access under APSCN contract than districts purchasing directly from service providers



This is due in large part to ADE relying on outdated copper network technologies while districts use higher-capacity, lower-cost fiber. As seen in Figure 11, 70% of APSCN's $11 million in Internet access costs is used to purchase outdated, copper-based connectivity products such as T1/T3 services while only 30% is used to purchase cost-effective fiber connections. In contrast, 93% of the $8 million invested by school districts in Internet access is spent on fiber connections. Fortunately, 82% of districts already have fiber connections and service providers report that they can easily connect nearly all of the remaining districts to fiber.

Figure 11: Majority of ADE spend is for outdated, copper-based connectivity products; the majority of district spend is for fiber



ADE is not the only organization paying a high price for Internet access. As seen in Figure 12, there is tremendous variability in the prices paid by districts for Internet access (each dot represents a school district's direct purchase). Some of this variability is a result of the speed of the Internet connection (see Figure 13). However, a significant amount of variation also exists within speed categories, suggesting that opportunities exist to lower the cost of Internet access for many Arkansas districts.

Figure 12: Significant variation within speed categories show opportunity to lower cost for Internet access

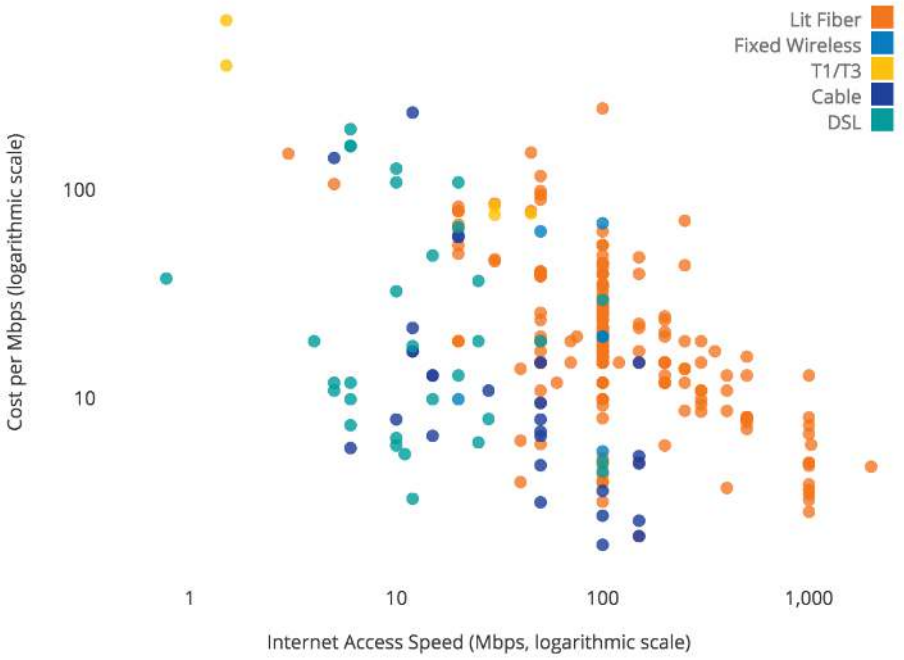
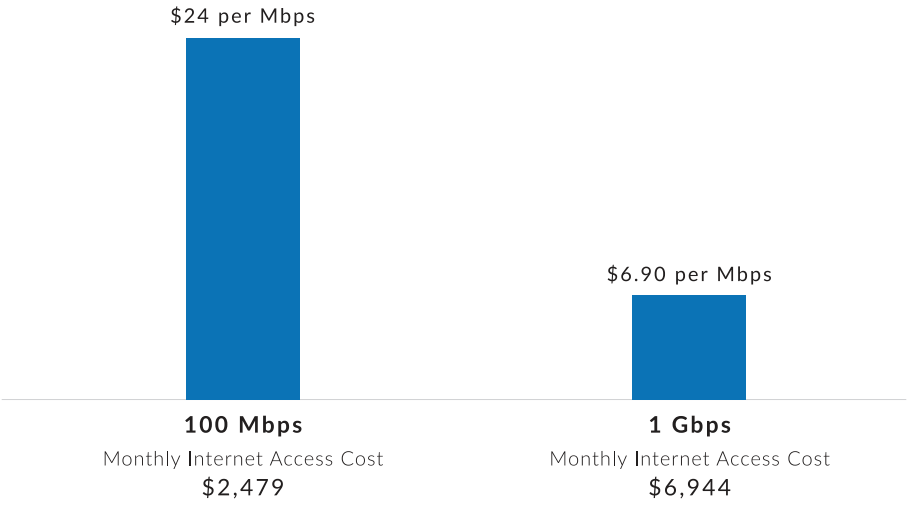
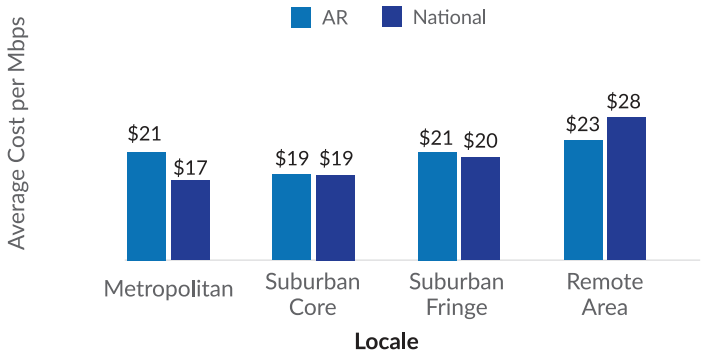


Figure 13: As circuit speed increases, average cost per Mbps decreases



One factor that often drives cost differences is the geographic location of a school district. Nationally, rural school districts pay approximately 50% more than urban and suburban districts for the high-capacity circuits

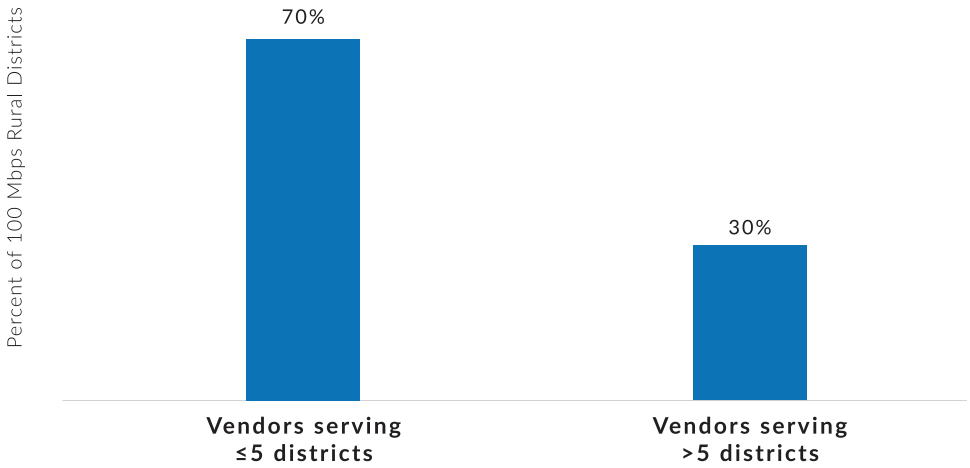
Figure 14: Price of bandwidth is fairly consistent across locales which shows a more competitive landscape in rural areas than national average.



(100+ Mbps) that will be needed to meet the ConnectED goals. In Arkansas, rural districts pay only 13% more for these circuits, likely as a result of the extensive fiber deployment and competitiveness of smaller service providers in rural areas.

Indeed, as seen in Figure 15, 70% of the rural districts with 100 Mbps Internet access connections are served by smaller service providers. More broadly, smaller service providers that generally serve less than five school districts provide Internet access to 28% of Arkansas' school districts. This suggests that it is important for ADE to ensure that smaller service providers are viable partners in its efforts to meet the ConnectED goals and minimize Internet access costs.

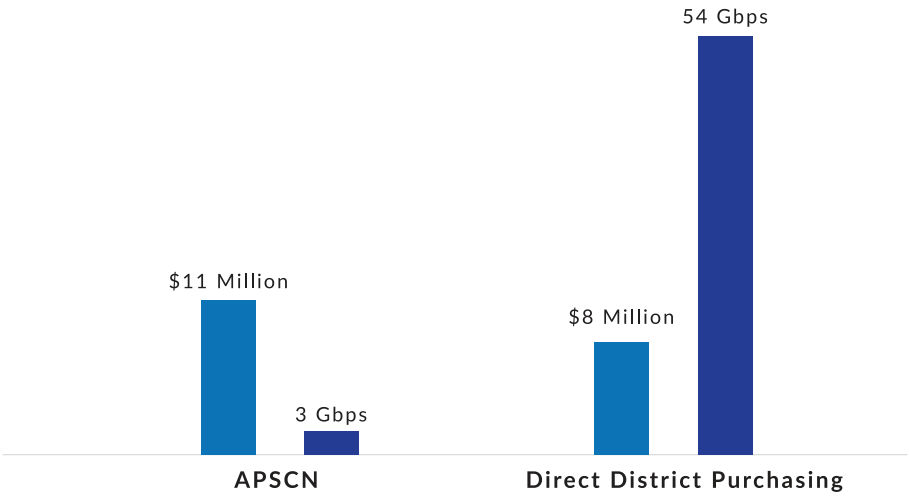
Figure 15: 70% of rural districts with 100 Mbps circuits are being served by local providers



The Upgrade Opportunity in Arkansas

Although Arkansas performs better overall than the national average in meeting the ConnectED goals, APSCN is not meeting district needs alone. Therefore, most districts must supplement their APSCN connections with additional purchases from service providers. As seen in Figure 16, APSCN accounts for 58% of total K-12 Internet access costs yet only 5% of total bandwidth due to the high cost per Mbps associated with the APSCN contract. Total K-12 Internet access connectivity spending in Arkansas is $19 million, of which $11 million is spent by ADE on APSCN. In contrast, total Internet access connectivity is 57 Gbps, of which only 3 Gbps is provided by APSCN. The remaining 54 Gbps of Internet access is purchased directly from service providers by school districts using a combination of district resources and federal E-rate funds.

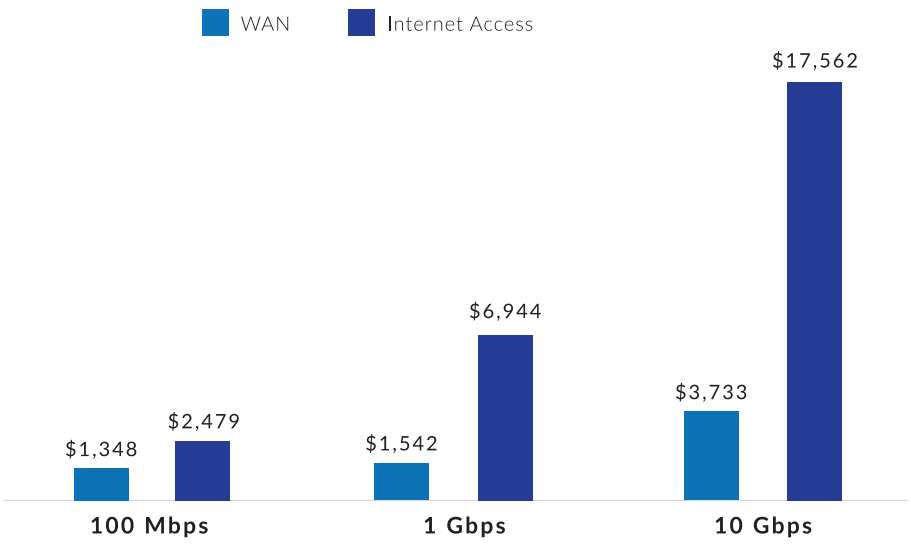
Figure 16: APSCN accounts for 58% of total Internet access spend in Arkansas, but contributes only 5% of total connectivity



This suggests that ADE can significantly increase the Internet access it provides to districts by more effectively utilizing its $11 million annual investment. Specifically, ADE must take advantage of three important opportunities to upgrade Arkansas' K-12 broadband.

1. **Transition ADE's spending to high-capacity, fiber-based circuits.** As discussed previously, much of the inefficiency in ADE's Internet access purchases is the result of buying low-capacity circuits delivered on outdated copper networks. EducationSuperHighway estimates that by transitioning to high-speed circuits delivered over fiber networks ADE can ensure that all K-12 districts have 100 kbps/student of Internet access.
2. **Aggregate Internet access purchases across districts.** As the demand for Internet access grows, direct Internet access purchases by districts will become increasingly expensive. As seen in Figure 17, the cost of a 1 Gbps Internet access circuit is nearly three times the cost of a 100 Mbps circuit. In contrast, a 1 Gbps WAN circuit is less than 20% more expensive than a 100 Mbps WAN circuit. At the same time, the cost of Internet access per Mbps falls significantly as more bandwidth is purchased over a single connection as seen in Figure 13. As a result, ADE can significantly lower the total cost to meet the current and 2018 ConnectED goals by using lower cost WAN circuits to aggregate demand to Internet access circuits that are shared across districts. This is the same logic that causes a district to use a WAN to aggregate Internet access to a single point in the district.

Figure 17: Internet access versus WAN monthly circuit costs

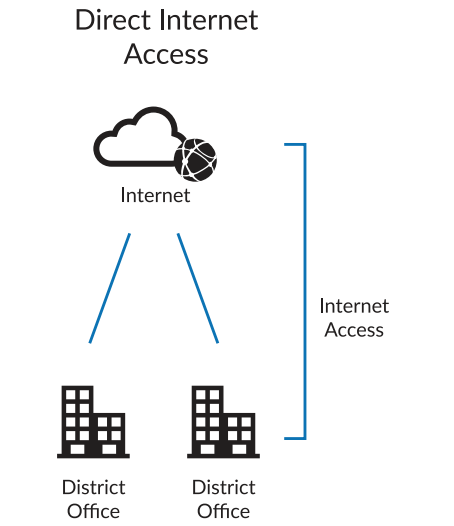


3. **Fully leverage the E-rate program to fund upgrades.** Arkansas is eligible for a 79% E-rate discount rate. This implies that Arkansas can obtain up to $41 million in annual funding from the E-rate program to supplement its $11 million investment. Districts in Arkansas have already effectively leveraged E-rate for their direct purchases, providing $6 million in annual Internet access subsidies against $2 million of district spend. EducationSuperHighway's analysis shows that it will cost approximately $30 million per year to meet the 2018 ConnectED goal of 1 Mbps/student. As a result, if Arkansas fully leverages the E-rate program it can not only deliver the Internet access its students need, but also help districts upgrade the WAN and LAN/Wi-Fi portions of their networks.

Potential Upgrade Strategies

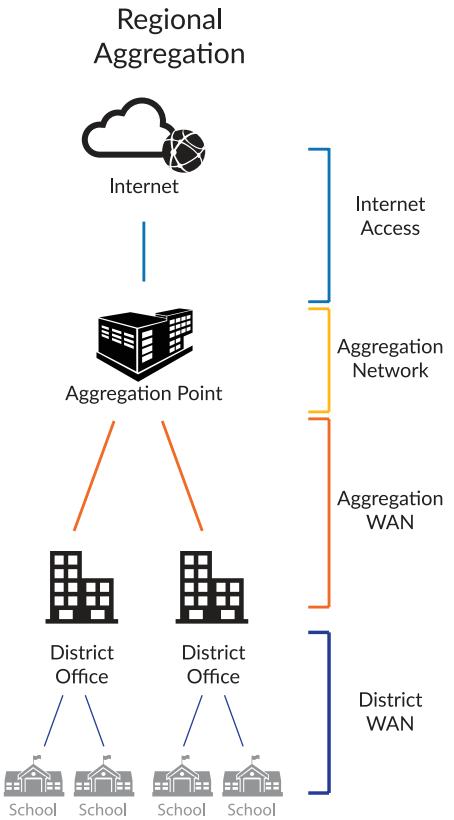
In order to identify a state Internet access solution that leverages these three opportunities and maximizes the impact of ADE's existing connectivity budget, EducationSuperHighway assessed three network design options. The options were selected based on practices observed from other states, feedback collected from Arkansas stakeholders, and options representative of substantively different approaches. We evaluated the following network solution designs: (1) Direct Internet Access; (2) Regional Aggregation; and (3) Statewide Aggregation.

Solution Designs



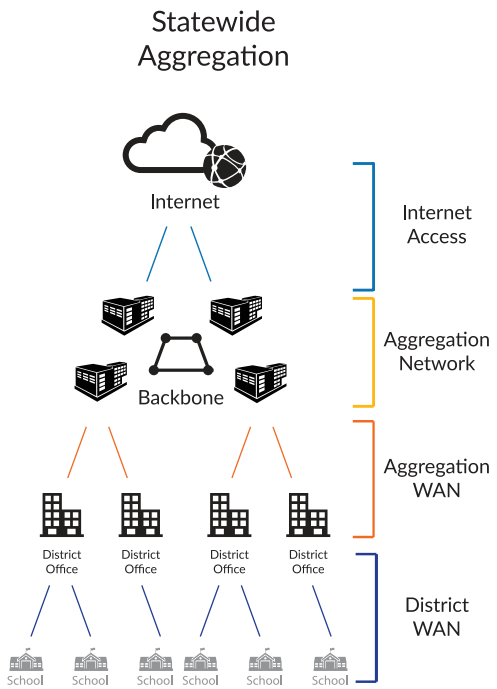
Solution 1: Direct Internet Access

In this solution, the state contracts with Internet Service Providers (ISPs) to provide Internet access directly to districts. The state does not provide or manage an aggregated network. This solution is similar to what Arkansas districts are purchasing directly today and is thus easiest to implement. However, because there is no mechanism to aggregate the networks across multiple districts, this solution does not allow the state to capture the best economies of scale in the long term.



Solution 2: Regional Aggregation

This solution aggregates districts' Internet access demand at regional points of presence and leverages WAN circuits to connect districts. Because WAN circuits are more affordable than Internet access circuits and Internet access is cheaper per Mbps when purchased in bulk, this solution is more cost-effective than direct Internet access. A managed services provider could be used to manage aggregation points, content filtering, and the WAN connections to districts.



Solution 3: Statewide Aggregation

This solution aggregates Internet access demand at regional points of presence, which are then connected to each other via backbone circuits. Districts' bandwidth demand is then aggregated at the state level, providing an opportunity to purchase Internet access in high volume at low rates. WAN circuits are then used to distribute connectivity to districts. The state network could be operated and managed by a service provider or an entity like the Arkansas Research Education Optical Network (ARE-ON).[7]

In order to determine which of the three solutions would best meet the Internet access needs of Arkansas' school districts, we evaluated three key characteristics of each solution: (1) cost-effectiveness, (2) select qualitative measures such as ease of implementation, and (3) network management.

Cost-effectiveness

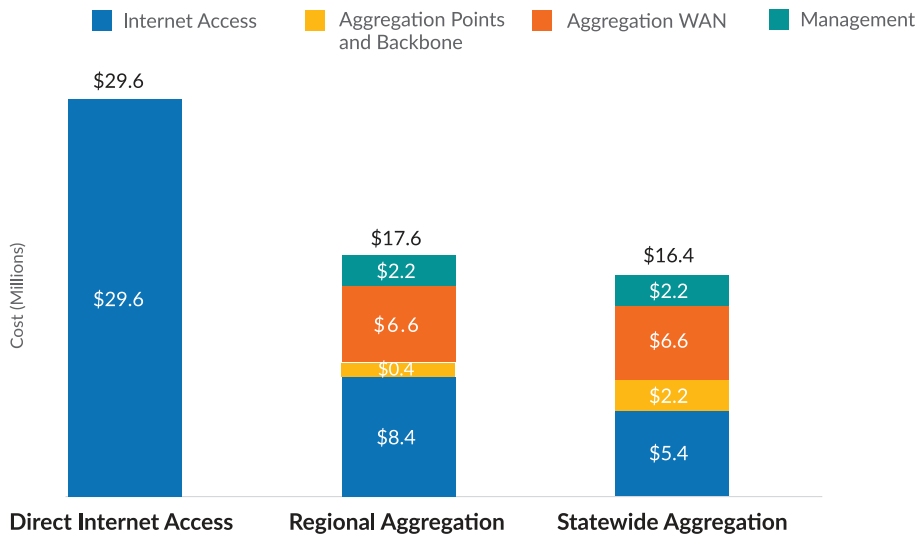
As seen in Figure 19, a statewide aggregation network is the most cost effective solution to meet the ConnectED Internet access goals. This is a result of two main factors. First, a statewide aggregation network allows the state to purchase low-cost WAN circuits ($1,542/month for 1 Gbps) to connect districts to an aggregation hub and then separately purchase consolidated, high-volume Internet access at the aggregation point(s).[8] In contrast, when districts buy Internet access directly, the cost of Internet and WAN circuits are bundled together, and providers charge a premium for their services ($6,944/month for 1 Gbps). This means that as bandwidth demand grows, direct Internet access becomes rapidly more expensive.

Second, using a statewide aggregation network reduces the actual amount of Internet access required to support the digital learning objectives of districts. When a large number of concurrent users are on a single network, not all users are likely to be using the network heavily at the same time. As a result, an aggregated network allows for the purchase of less bandwidth. This strategy is particularly effective because Arkansas has many small districts.

The estimated annual cost to deliver 1 Mbps/student via an aggregated statewide network is $16 million, 45% lower than the cost of purchasing direct Internet access. The following chart shows cost estimates for each solution, which were calculated based on two key inputs: bandwidth need at the school, district, regional, and state level; and the quantity and cost of circuits, equipment, and other cost components for each solution.[9]

[7] Currently, Legislative Act 1050 restricts K-12 schools from using ARE-ON.
[8] These Internet access costs can potentially be further reduced by using settlement-free peering and access to pricing negotiated for the Research and Education community, through contract vehicles provided by The Quilt and Internet2.
[9] To estimate the bandwidth need, we used district and school enrollment data and took into account the benefits of concurrency on a shared network (e.g., networks with a greater number of users do not need to purchase as much bandwidth per user because some traffic can be shared locally). To estimate costs for circuits, equipment, ISP, and management, we used pricing data from service providers statewide, as well as prior EducationSuperHighway research.

Figure 19: Aggregated networks will cost significantly less than the direct Internet access solution



Qualitative Characteristics

While the cost of each network design is a critical factor in determining the best long-term Internet access solution for Arkansas' K-12 districts, several qualitative factors also have a significant impact on the success of a network. We evaluated each of the factors described below as part of our solution development process:

- **Cost Scalability.** In addition to overall cost-effectiveness, we considered the cost scalability of each solution to ensure that the network can remain affordable as bandwidth increases in the future. A scalable network allows the cost to increase marginally rather than linearly as bandwidth demand increases over time. An aggregated network, whether regional or statewide, scales much more efficiently than direct Internet access to districts.
- **Ease of Implementation.** The complexity of, and additional services provided by, a statewide network have a dramatic impact on the ease of implementation. A highly complex network requires a significant amount of time for planning, design, and coordination between stakeholders to be implemented successfully. The direct Internet access solution is of low complexity because districts have already implemented similar solutions. Both aggregated network solutions require more time and effort on behalf of ADE and a network manager.
- **Manageability.** A highly manageable network allows for increased control and visibility of the traffic and services provided. Having this increased level of manageability of the network can be extremely valuable. In the direct Internet access solution, each service provider is in control of the network for the districts it serves, providing limited visibility and opportunity for ADE to offer support to districts. For the aggregated network solutions, ADE and the network manager gain increasing levels of control of the bandwidth, security, services, and visibility of traffic on the network so that network capacity can be planned and scaled to match anticipated demand.
- **Ease for Districts.** Any change to connectivity can be a stressful and expensive event for a district. There is a lot of pressure from district leadership for a smooth transition and any connectivity gaps create huge productivity barriers. District technical leaders want to be sure that they receive consistent and reliable service with good support and equivalent services before they are willing to agree to a change.

- **Customer Service Experience.** In the case of a service outage, district technical leaders need to be able to quickly report the outage and work with appropriate support technicians to resolve the outage. Working directly with service providers can be complicated, especially if there are multiple providers possibly responsible for the outage. A dedicated K-12 Network Operations Center (NOC) that would be part of a statewide aggregation network (provider or state-run) adds tremendous value because it is ultimately responsible for resolving issues and being a single point of contact for districts.
- **Security.** Direct Internet access circuits can provide security equal to a managed network, but they require security equipment and configuration locally at every district. An aggregated network has the opportunity to provide centralized security services, which reduces both the cost and need for individually configured devices per district.
- **Resiliency.** The resiliency of a network is its ability to maintain connectivity for users, even in the event of equipment or circuit failure. This means that the network has redundancy built in and has adaptive configurations to make automatic changes in case of a failure. Service provider networks are highly resilient, so direct Internet access to their network is also highly resilient. Regional aggregation or statewide aggregation networks have the ability to be highly resilient if redundant equipment and circuits are implemented.

Figure 20: Aggregated networks score better than a direct Internet access solution for most qualitative evaluation factors

	Direct Internet Access	Regional Aggregation	Statewide Aggregation
Cost Scalability	**LOW** Does not take advantage of economies of scale.	**MEDIUM** Requires Internet purchases at each regional location, with more limited flexibility as regions grow at different rates.	**HIGH** Statewide Internet access takes maximum advantage of economies of scale and shares costs of resiliency across many districts.
Ease of Implementation	**HIGH** Low complexity for ADE and districts.	**MEDIUM** Requires installation of equipment and aggregation or circuits at aggregation point.	**LOW** Requires complex configurations and aggregation of circuits at multiple network hubs.
Manageability	**LOW** Does not give control and visibility for ADE.	**MEDIUM** Gives high degree of control and visibility for ADE.	**HIGH** Gives high degree of control and visibility for ADE.
Ease for Districts	**HIGH** Little impact or risk for districts.	**MEDIUM** Services, support, and Service Level Agreement (SLA) may change for districts. Requires district trust of network.	**MEDIUM** Services, support, and SLA may change for districts. Requires district trust of network.
Customer Service Experience	**VARIABLE** Depends entirely on individual provider. No unified NOC.	**HIGH** Dedicated K-12 NOC handles support, escalation, and services management.	**HIGH** Dedicated K-12 NOC handles support, escalation, and services management.
Security	**MEDIUM** Requires Virtual Private Network (VPN) to access central ADE services. District provides all security services on premise.	**HIGH** Secure connectivity between district and ADE provided by network. Security services possibly provided on the network versus on premise.	**HIGH** Secure connectivity between district and ADE provided by network. Security services possibly provided on the network versus on premise.
Resiliency	**HIGH** Provider network is highly resilient.	**HIGH** Each aggregation point would require redundant equipment and redundant upstream circuits.	**HIGH** Multiple connected network hubs provide high degree of resiliency.
Overall Conclusions	○ Not cost effective in the long run. at current prices ○ Viable transition solution.	○ Some benefits of aggregation, but not as cost-effective or scalable as a statewide network.	○ Great long term solution. ○ Implementation will take significant time and coordination.

Network Management

In addition to evaluating both cost effectiveness and qualitative factors, we considered who might manage the network and the governance structure that exists within ADE to provide authority over the manager. The network manager along with the clearly defined services and support that they are expected to provide are a critical piece of a successful statewide network.

In the case of the direct Internet access solution, district Internet circuits are managed by the service providers themselves and requires minimal input and governance from ADE. A single network manager is required in the aggregation solutions. Defining that role and working with possible managers to solicit input is a time consuming process and cannot be done well with a short timeline. Taking time to properly develop clear roles, responsibilities, and governance structure are more likely to enable a successful network implementation.

Solution Evaluation Conclusions

Based on our analysis of each solution's defining characteristics, EducationSuperHighway concluded that a statewide aggregation solution is the most scalable and cost-effective option to meet Arkansas' long-term K-12 Internet access needs. A well-executed state network maximizes the opportunity to use economies of scale to deliver Internet access at the lowest cost, enhances the state's ability to meet the continuing growth in demand for Internet access, improves service to districts, and increases the reliability of districts' Internet access, more so than a regional aggregation solution. Both aggregation solutions are significantly more cost effective than the direct Internet access solution making them viable options, but the statewide aggregation network provides a higher quality network and better experience for the districts.

A statewide aggregation network requires a high level of management. Planning and design for the network is not a trivial task and requires significant time and coordination between stakeholders. For the more complex aggregated network solutions, design and services definitions need to be fully developed starting early in the procurement process so that the technical requirements in the request for proposal (RFP) will result in high quality and appropriate responses.

Implementation of a state K-12 Internet access network can take many forms, with other states successfully utilizing both public and private organizations to implement and manage the network. EducationSuperHighway expects that planning and implementing a cost-effective statewide network in Arkansas will take 12-18 months, making it extremely difficult to accomplish in time for the start of the 2015-16 school year.

Recommendation: Transition to a Statewide Network

Due to the complexity of implementation and the level of coordination and input required to launch a state network, EducationSuperHighway recommends a two-part strategy for upgrading Arkansas K-12 schools to the current and 2018 ConnectED goals. First, ADE should adopt a transition solution for 2015-16 that redeploys its $11 million Internet access budget so that all districts meet the 100 kbps/student Internet access goal by July 2015. Second, ADE should plan and implement a statewide Internet access aggregation network with the goal of launching the network in 2016 and connecting 90%+ of districts by 2018.[10]

2015 Transition Solution

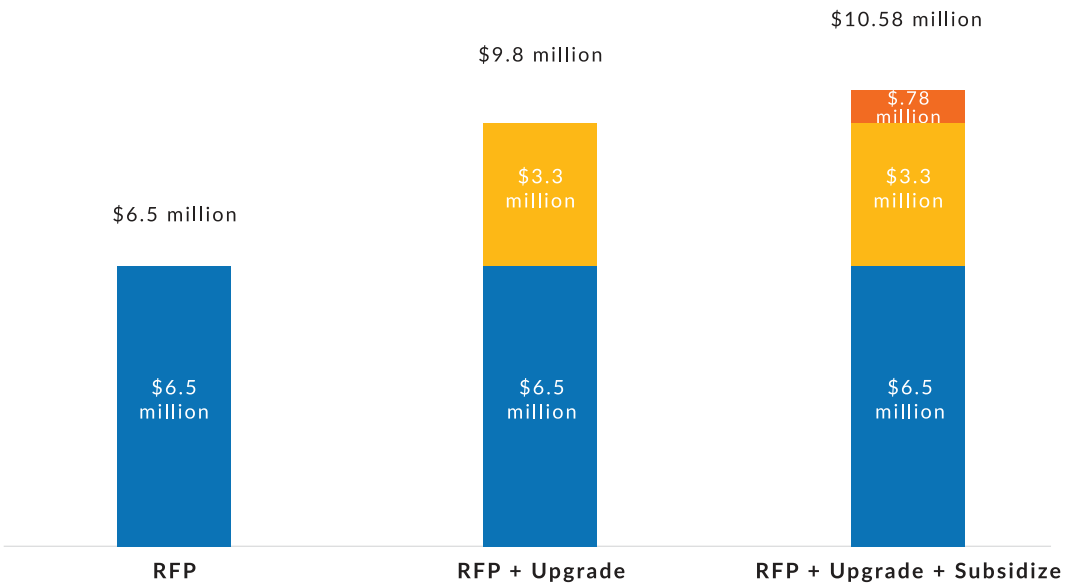
We recommend ADE take immediate action to redeploy its $11 million Internet access budget for the 2015-16 school year. Specifically, ADE should:

Conduct an RFP to establish a new K-12 state contract. There are currently 27 districts that rely solely on APSCN for Internet access and an additional 85 districts whose direct Internet access contracts with service providers expire during the summer of 2015. ADE should conduct an RFP to provide each of these districts with 100 kbps/student of Internet access for the 2015-16 school year. Consolidating districts onto a state contract with multiple service providers will likely be less expensive than having districts purchase Internet access independently and will facilitate a smoother transition to a long-term aggregation solution in the future. Based on the current prices of direct Internet access, we estimate that ADE could deliver at least 100 kbps/student to these districts for $6.5 million.[11]

Upgrade districts with existing contracts to 100 kbps/student. 61 districts whose direct Internet access contracts with service providers do not expire during the summer of 2015 have less than 100 kbps/student. EducationSuperHighway recommends that ADE subsidize these districts to upgrade their existing Internet access connections to meet the 100 kbps/student target. We estimate that this can be accomplished for approximately $3.3 million.

Subsidize district costs for those meeting the 100 kbps/student target. 87 districts with continuing contracts currently meet the 100 kbps/student target. In order to ensure that all districts benefit from ADE's annual investment in Internet access, EducationSuperHighway recommends that ADE subsidize the non-E-rate portion of these districts' Internet access contracts at a total cost of $775,000.

Figure 21: Given current $11 million budget, ADE can meet 100 kbps/student goal for every district in 2015



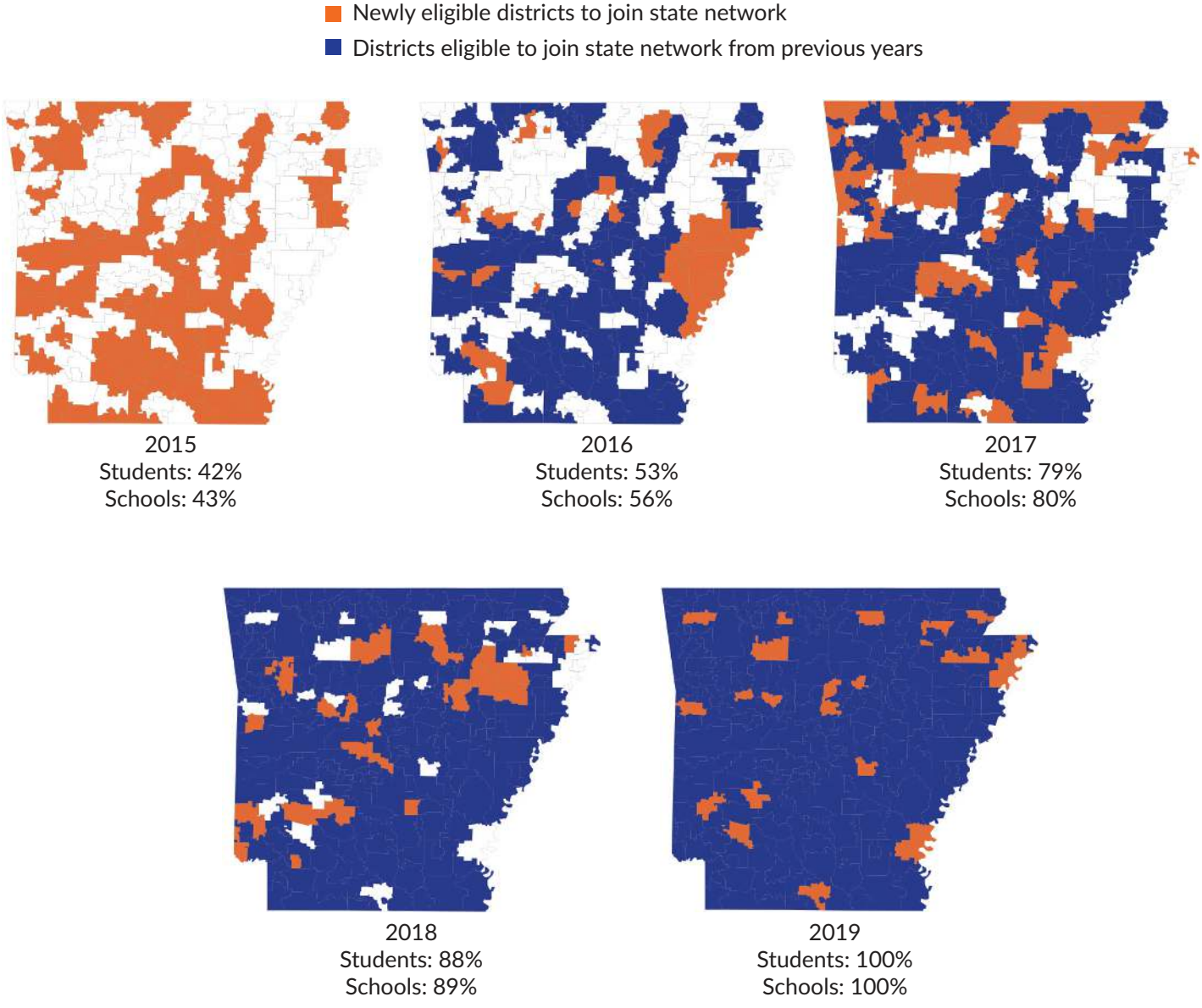
[10] Approximately 10% of districts have existing contracts that terminate in 2019.
[11] In addition to the 27 districts that rely solely on APSCN, there are 37 school buildings that also rely only on APSCN.

This transition plan not only supports all schools in achieving the 100 kbps/student target by 2015 within the existing budget, but importantly, it also frees up districts' current Internet access spending to be reallocated toward other digital learning needs, such as the district WAN, LAN / Wi-Fi in buildings, devices for students, learning software, or technology training for teachers and staff.

State Network Planning

Concurrent with the implementation of the 2015 Transition Solution, EducationSuperHighway recommends that ADE begin the process of planning and implementing a statewide Internet access aggregation network with the goal of launching the network in 2016 and connecting 90%+ of districts by 2018. Districts will be connected to the network as their existing direct Internet access contracts with service providers expire. The expected yearly coverage of the statewide network can be seen in Figure 22.

Figure 22: Expected coverage over time as districts convert to state network



Milestones for Planning and Procurement of a State Network

FIRST 6 MONTH MILESTONES

- Establish program and technical leadership
- Define network scope of services
- Define roles and responsibilities for operational network management
- Assess district interest; collect feedback
- Work with districts to create plan for single demarc per district
- Move target districts off of APSCN and long term contracts

MONTHS FOLLOWING

- Evaluate RFP bids and procure network equipment and services
- Implement network

NEXT 6 MONTH MILESTONES

- Engage potential providers to refine network design
- Ensure competition in each network segment
- Complete financial analysis and budgeting plan
- Develop multi-year implementation roadmap
- Finalize network design and requirements
- Document district commitments
- Release RFP for aggregated network components and management

Several actions will significantly impact the success of the state aggregation network. ADE should pay particular attention to ensuring these activities are well executed:

Define governance and technical leadership. ADE should establish a governance structure that clearly identifies who will be responsible for major high-level decisions, as well as a technical leader to design and implement a process for network management and operations. This includes selecting an entity to procure and manage the network and defining network expectations and services.

Clarify district requirements. ADE must confirm that each district can connect all schools to a single district demarcation point,[12] and collect district requirements for shared services such as network-based firewalls or content filtering. This input and feedback from districts will ensure that the final network design serves the most district needs in the most cost-effective way.

Optimize design. Once the leadership structure and district requirements are clarified, ADE should ensure that the network design is optimized to meet these needs in the most cost-effective way. For example, the number and location of aggregation points will impact, and be impacted by, the plans for operational management of the network and additional services provided (e.g., firewall, content filter, and caching).

Ensure Competition. To ensure optimal pricing when an RFP is issued for a long-term backbone contract, ADE needs to maximize the competitive environment for each component of the network. For WAN aggregation circuits this is most likely to be accomplished by ensuring that both large and small service providers are eligible to bid. For the aggregated network and Internet access components, ADE would be well served by removing the legislative barriers that currently preclude ARE-ON as an option. While it is unclear whether ARE-ON will be the most cost effective option for these network components, it is highly likely that if ARE-ON is allowed to participate in the RFP, its availability of low-cost Internet access will undoubtedly lower the overall cost of the aggregated network and Internet access for ADE and Arkansas' taxpayers regardless of which provider is selected to provide these components.

[12] The physical location where the service provider network connects with the school district network.

Next Steps

Arkansas has an unprecedented opportunity to lead the nation in upgrading the Internet access to its K-12 schools in a comprehensive and cost-effective way. We urge Arkansas' state leadership and ADE to promptly take action to implement the 2015 Transition Solution so that the state does not miss the window for ensuring that every student has the high-speed Internet access they need for digital learning in 2015.

To achieve this goal, ADE should immediately conduct an RFP process to provide all districts that rely entirely on APSCN for Internet access and those whose direct Internet access contracts expire in 2015 with 100 kbps/student. In support of this recommendation, EducationSuperHighway has worked with ADE to prepare an RFP that implements this strategy and has committed to providing resources to support the RFP process.

At the same time, ADE should begin the process of implementing a statewide aggregation network by designating (and potentially hiring) a technical lead within ADE to manage the state network design and implementation process. This individual would be responsible for finalizing the decision to implement an aggregated network based on the results of the 2015 Transition Solution RFP and determining what services will be offered as part of the aggregated network. EducationSuperHighway will provide analytical support to assist in this decision making process at no cost to Arkansas.

EducationSuperHighway is the leading non-profit focused on upgrading the Internet infrastructure in America's K-12 public schools. We believe that digital learning represents an unprecedented opportunity to provide every student 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 help accelerate upgrades in America's schools. We work to raise awareness of the school connectivity gap, provide technical and procurement expertise to states and districts, and advocate on behalf of students to influence policy decisions. Our work has helped shape President Obama's ConnectED initiative and served as a catalyst for modernization of the Federal Communications Commission's E-rate program.

Contact

Nell Hurley
Director of Communications
nell@educationsuperhighway.org
(415) 967-7439