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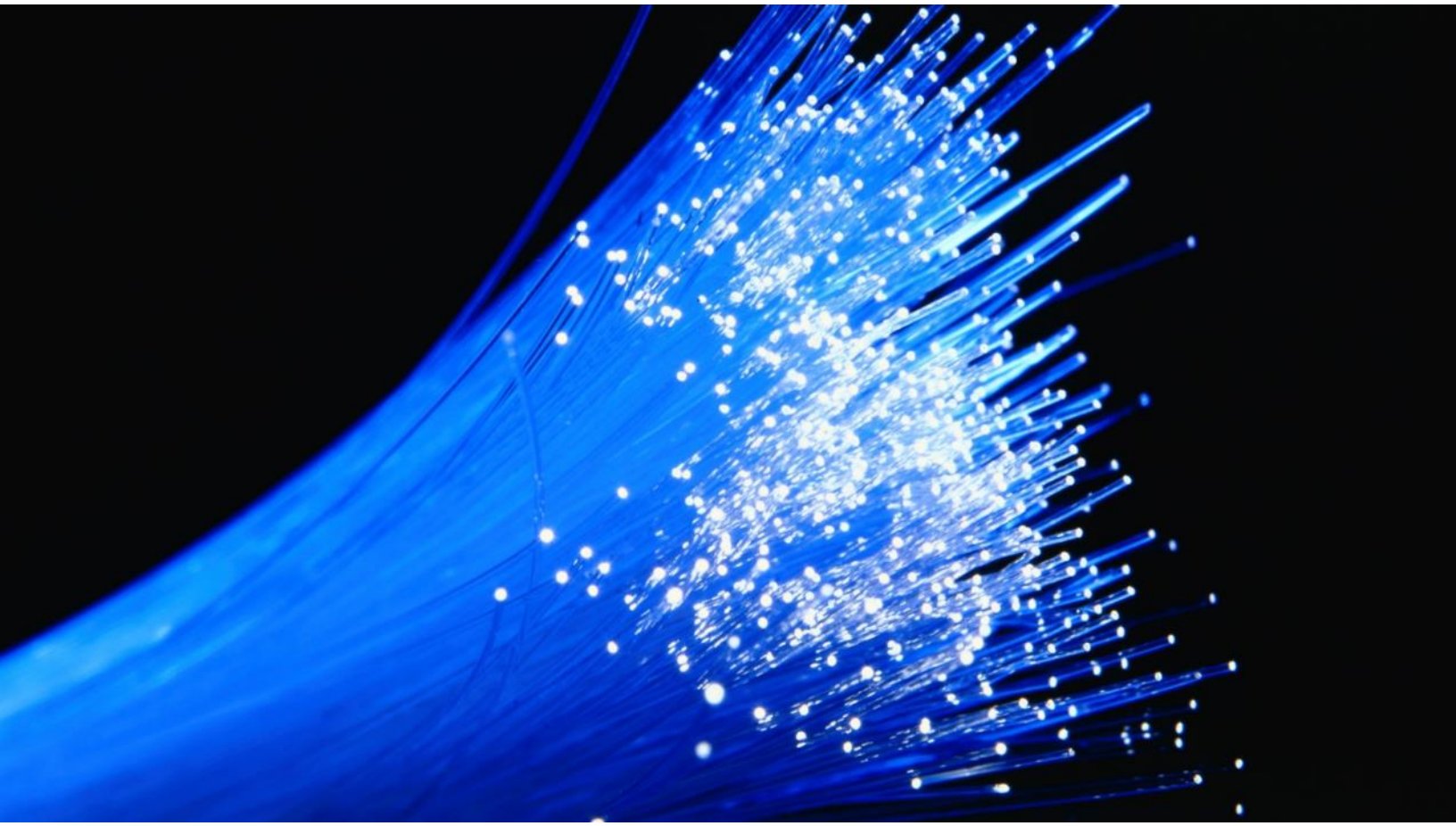

Strategies for Serving New Mexico's Public and Charter Schools with High-Capacity Broadband

Summary of Findings and Recommendations

Prepared for the New Mexico Public School Facilities Authority

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1. Introduction

High-quality, high-bandwidth broadband is essential to the operations of schools. Schools require broadband to enable world-class distance learning, individualized use of computers by students, and centralized, cost-effective administration.

As a minimum national benchmark, the Federal Communications Commission (FCC) has adopted the State Educational Technology Directors Association's (SETDA) targets for Internet access—100 Kilobits per second (Kbps) per user (students and staff) in the short term and 1 Megabit per second (Mbps) per user over the longer term.[1] The FCC further adopted the target of 10 Mbps per user for wide-area networks (WAN) that connect schools in the same district.[2]

In 2014, the State of New Mexico's legislature passed a law that created the Broadband Deficiencies Correction Program (BDCP) with the goal of addressing K–12 public schools' broadband needs and evaluating options for delivering broadband access speeds of no less than 100 Kbps and up to 1,000 Kbps per student and staff.[3]

The New Mexico Public School Facilities Authority (PSFA) engaged CTC Technology and Energy (CTC) [4] to research the existing broadband infrastructure and services at school facilities and develop cost models for upgrading the schools' broadband connections to meet the benchmarks of 100 Kbps, 300 Kbps, 600 Kbps, or 1,000 Kbps (1 Mbps) per user.[5] The benchmarks were chosen at the outset of the project by PSFA in an effort to evaluate the cost-effectiveness of both long-term and interim goals for the State.

CTC's report evaluates the current broadband infrastructure at each of the more than 800 traditional public and public charter K–12 schools in the State and suggests cost models (capital and operating) for a range of options for upgrading the schools' existing connections. The report

[1] Para. 34, https://apps.fcc.gov/edocs_public/attachmatch/FCC-14-99A1.pdf
[2] Para. 39, https://apps.fcc.gov/edocs_public/attachmatch/FCC-14-99A1.pdf
[3] http://goo.gl/PY91Bi
[4] The report was prepared in the spring and summer of 2015. CTC is a 32-year-old communications technology consultancy with experience across a full range of technologies. CTC has planned, designed, or evaluated hundreds of fiber optic and wireless networks since 1983. In recent years, CTC has provided evaluative, strategic, planning, and engineering services for the statewide fiber network in Maryland (which serves schools, libraries, public safety, public health, and government institutions) and for the three-state regional fiber network in the National Capital Region; has provided strategic and business planning services for the statewide fiber network in Pennsylvania (which serves education and health care users); and developed the reference architecture for the national fiber-to-the-home network currently being built in New Zealand. CTC has consulted to the cities of San Francisco, Seattle, Los Angeles, and Washington, D.C. regarding broadband needs, as well as to the states of New York, Kansas, Massachusetts, Maryland, Delaware, and New Mexico.
[5] The per user benchmarks were adopted by the PSFA as a means to evaluate both interim and long-term measures and provide decision-makers with a range of options to upgrade the broadband connectivity for schools in the State.

analyzes the technical and financial considerations of a range of strategies and presents potential approaches to enable the State to meet the goals of the PSFA and the BDCP.

CTC's analysis and the other work underway within the State represent important steps in planning to maximize the benefits of broadband. Both near- and long-term planning is required so that New Mexico is well positioned to realize the full economic and educational potential of broadband.

2. Current State—Broadband Service and Gaps

CTC analyzed the Internet and telecommunications bills of 753 public schools and 102 charter schools (approximately 98 percent of the schools in the State) to determine the service provider, technology, speed, and cost of broadband service for each school. CTC supplemented that data with information provided by Hewlett-Packard (HP), which was engaged by the PSFA in parallel with CTC to perform on-site assessments of public and charter schools in the State. (HP was tasked with evaluating each school's internal networking and technological capacity and current level of broadband service.)

Based on CTC's analysis, the majority of schools in the State of New Mexico have sufficient access to broadband and fiber but will need to scale up existing services in order to meet the future demands of online learning and the SETDA and FCC goals.

A majority of schools in New Mexico—85 percent—are connected to fiber. This was an unexpected statistic, because this percentage is high relative to other states of similar physical size and demographics. The relatively high level of fiber connectivity indicates that, to the extent Internet speeds are insufficient, those deficiencies are not simply caused by lack of fiber availability, but generally have other causes. As discussed further in this report, the scalability of fiber connections means that the majority of schools can technically attain the BDCP bandwidth goals without constructing new infrastructure, but will need to incur greater cost to do so.

Table 1: Majority of schools in New Mexico have fiber connections

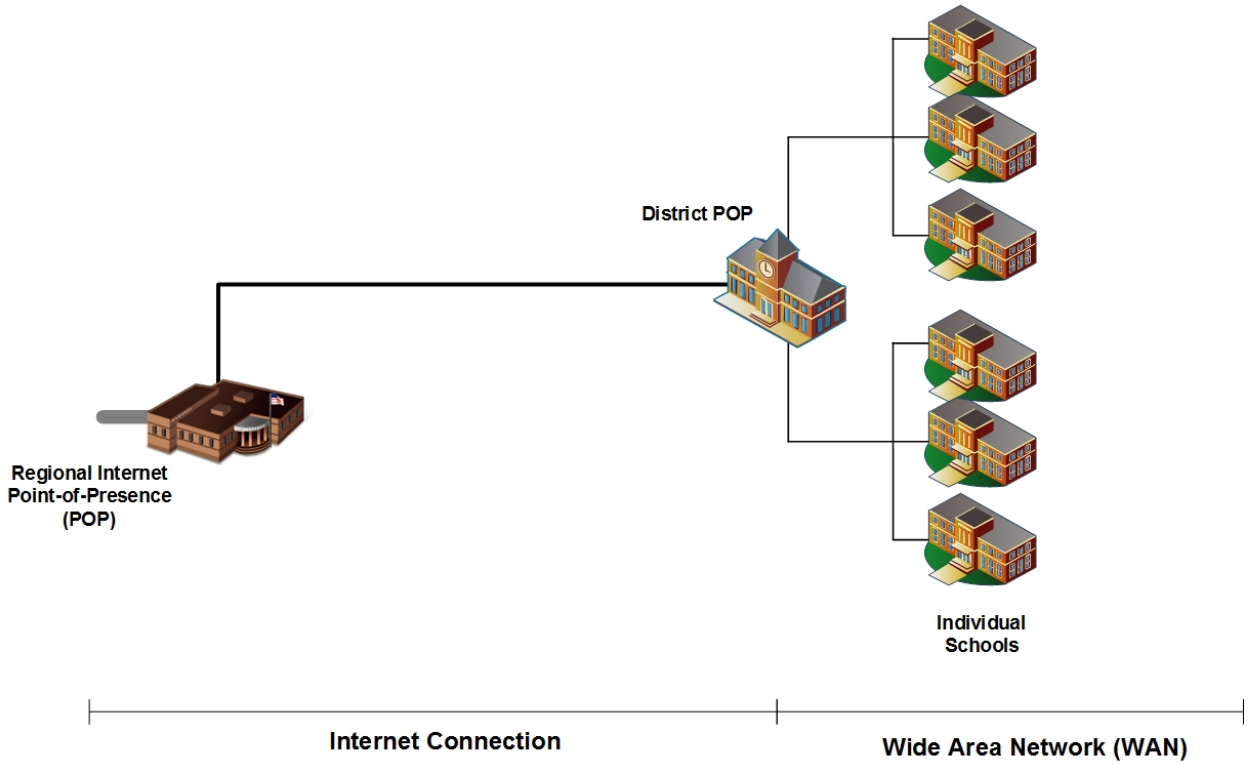
Type	Fiber	No Fiber
All	727 (85%)	128 (15%)
Public	686 (92%)	67 (9%)
Charter	41 (40%)	61 (60%)

Public school districts in the State of New Mexico generally distribute Internet service to individual schools over a wide-area network (WAN) originating from a central point-of-presence (POP) in the district (Figure 1). Districts implement this model to take advantage of economies of

scale—purchasing Internet bandwidth in bulk for an entire district rather than purchasing individual Internet connections for each school. Conversely, charter schools have single locations and therefore purchase single Internet connections.

By purchasing a single connection for the entire district, public schools save money, but also potentially share the Internet connectivity among a large group of users. The model therefore can take advantage of oversubscription for Internet access.[6] This is true for public schools nationwide, not just in New Mexico. For example, the Los Angeles Unified School District (LAUSD), which has approximately 750,000 total users, anticipates that 90 Gbps of Internet access connectivity, or approximately 120 Mbps per 1,000 students (120 Kbps per user), will deliver sufficient bandwidth.[7]

Figure 1: Distributing Internet Service from a District POP to Individual Schools



[6] Oversubscription is a technique used by school districts and Internet service providers to provide the needed level of Internet service at the schools, without needing to buy the full bandwidth at the school district POP, taking into account the likelihood that all students will not be accessing the Internet at full speed at the same time. As an example, consider a ten school system with 1 Gbps connections between the POP and each school. Experience has demonstrated that the POP can provide the needed Internet capacity at each school while buying less than 10 Gbps of Internet at the POP.

[7] Para. 35, https://apps.fcc.gov/edocs_public/attachmatch/FCC-14-99A1.pdf

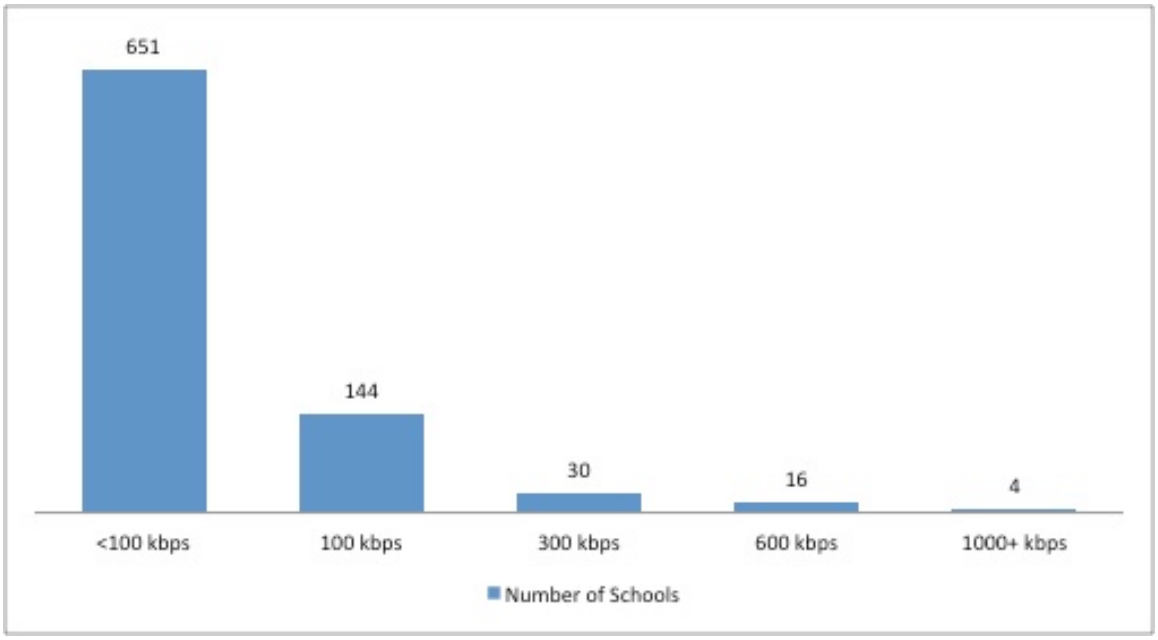
Table 2 provides a summary of speed of Internet connectivity for both public and charter schools in New Mexico. As seen in the table, the speed per user varies considerably across both public and charter schools. Charter schools have a higher average speed per user compared to public schools. The difference is attributable to public school districts sharing Internet bandwidth with a significantly higher number of users (including students and staff) compared to an individual charter school.

Table 2: Summary of Internet Speeds at New Mexico's Schools

Type of School	Speed per User (Range)	Speed per User (Average)
Public	10 Kbps – 641 Kbps	75 Kbps
Charter	4 Kbps – 2,967 Kbps	183 Kbps

However, the lower average speed per user for public schools results in only a small fraction of schools in the State having sufficient Internet access to meet the minimum standard of 100 Kbps per user. As Figure 2 demonstrates, the vast majority of schools (77 percent) have less than 100 Kbps per user and less than one-third of all schools currently meet the 100 Kbps standard. In addition, around 65 percent of charter schools meet or exceed the standard, but just 18 percent of public schools do. As a result, many public school districts will need to upgrade the speed of their Internet connections in order to meet the minimum BDCP standard of 100 Kbps.

Figure 2: Most School Internet Connections Are Less than 100 Kbps per User

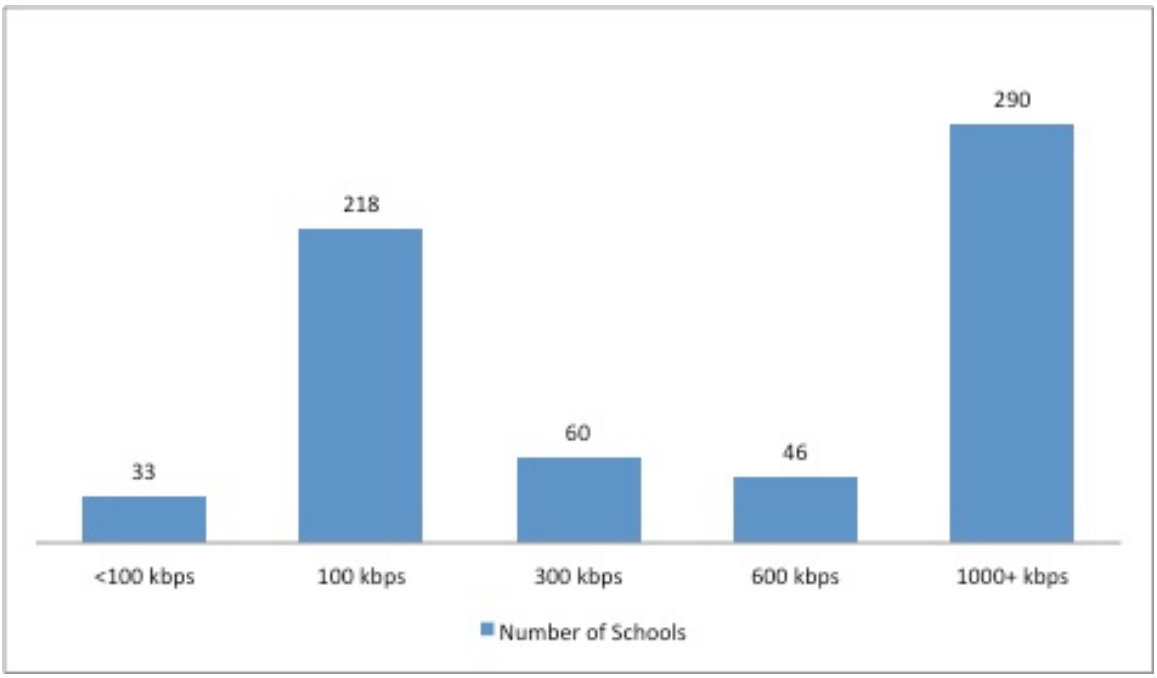


The picture for the wide-area network (WAN) connections (also known as transport connections) that public school districts use to distribute Internet to individual schools is significantly better. WAN connections either rely on data transport services from a private provider or are managed by a district. About one-third of districts manage their WAN connections, while the remaining districts purchase data transport services.

WAN connections that rely on data transport services from private providers average 558 Kbps per user, with a range from 8.5 Kbps per user to 22,000 Kbps (22 Mbps) per user. WAN connections operated and managed by the districts are generally the highest-capacity WANs in the State, with a range of 92 Kbps per user to 122,000 Kbps (122 Mbps) per user and an average of 8,651 Kbps (8.7 Mbps) per user.

As seen in Figure 3, almost all public schools (95 percent) meet the 100 Kbps per user benchmark for WAN, and almost half (45 percent) meet the 1,000 Kbps (1 Mbps) per user standard. The WAN connections are the closest to meeting the State's broadband goal of 1 Mbps per user.

Figure 3: Most School WAN Connections Are over 100 Kbps per User



3. Current State—Spending on Broadband

Spending on broadband access to schools is divided between Internet connections and WAN connections (**Figure 1**). The spending and cost information below reflect pre-E-rate pricing, meaning it does not take into account the subsidy that each school or district may receive from the federal E-rate program. Such subsidies vary from district to district and school to school; the

subsidies are based on the level of financial need in the community. The average discount rate for schools in the State is around 80 percent, with a range of 40 to 90 percent.[8]

The majority of spending on broadband by schools in the State is for the WAN portion (more than 60 percent) compared to the Internet connection (less than 40 percent). Schools spend around $4.5 million annually on Internet access service and approximately $6 million on data transport services from private providers for WAN connections.

Table 3: Current Spending on Broadband Service

Type	Internet Access	WAN (Data Transport Services)
All	$4.5 million	$6 million
Public	$3.7 million	$6 million
Charter	$0.8 million	-

3.1 Spending on Internet Access

On average, public schools in the State pay $19.52/Mbps/month and $10.27/user/year, with a range of as low as $1.35/Mbps/month to a high of $3,780/Mbps/month. Charter schools on average pay $37.10/Mbps/month and $29.16/user/year, with a range of $0.60 to $313/Mbps/month. Charter schools generally pay a higher cost per Mbps because they are purchasing smaller amounts of Internet bandwidth relative to public school districts.

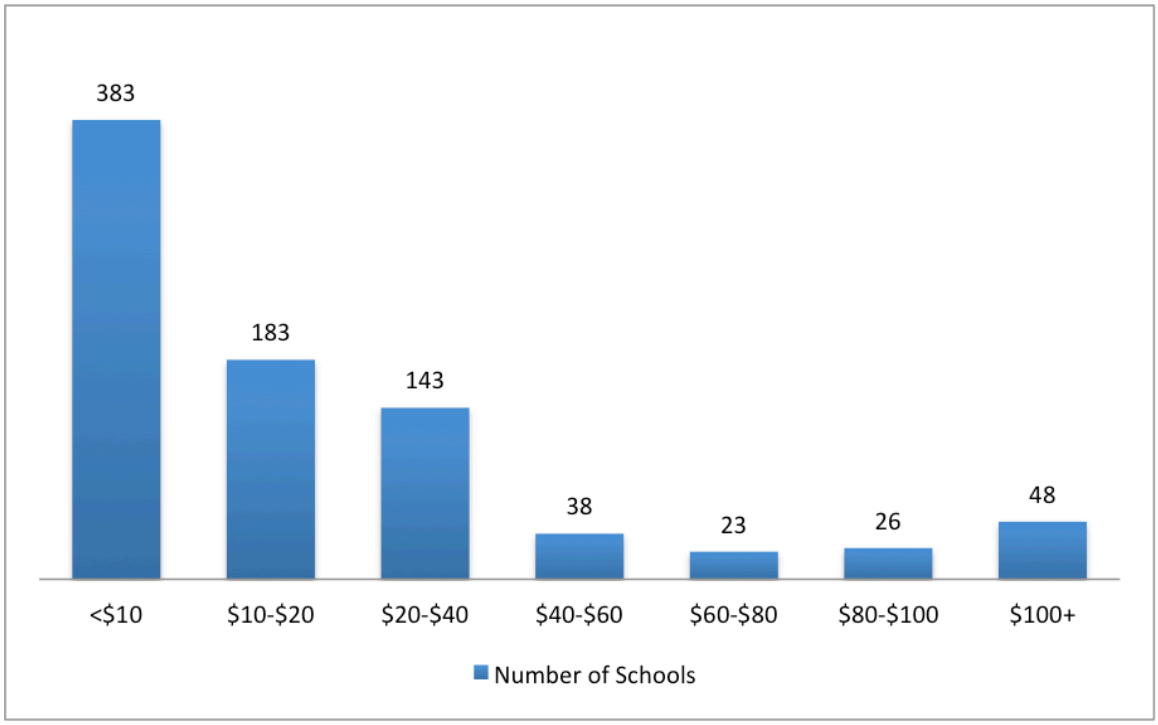
Table 4: Summary of Internet Costs

Type of School	Cost per Mbps (Range)	Cost per Mbps (Average)	Annual Cost per User
Public	$1.35 - $3,780	$19.52	$10.27
Charter	$0.60 - $313	$37.10	$29.16

The range of costs for both charter and public schools indicate a significant variation in the State for pricing of Internet services. As seen in Figure 4, the largest percentage of schools pay less than $10/Mbps/month for Internet service with a majority paying less than $20/Mbps/month. However, 48 schools or about 6 percent of schools pay more than $100/Mbps/month and 134 schools (16 percent) pay more than $40/Mbps/month.

[8] Based on 2014 data from USAC. http://www.usac.org/sl/tools/commitments-search/Default.aspx

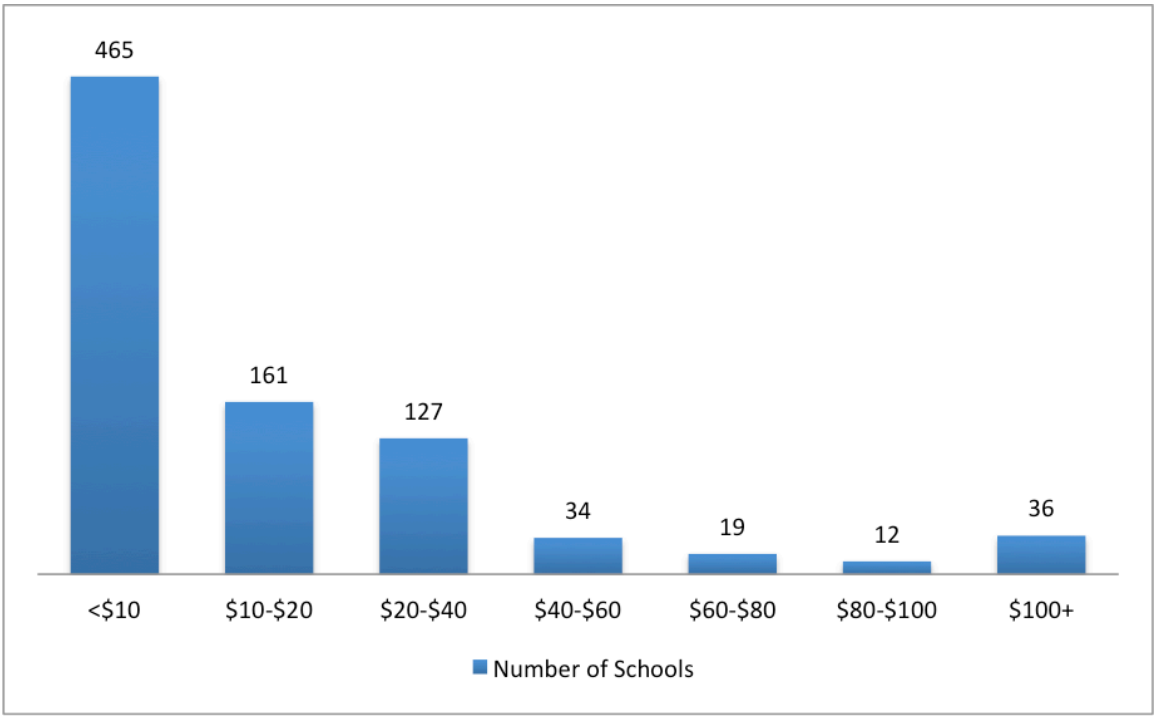
Figure 4: There Is Significant Variation in How Much Schools Pay per Mbps per Month for Internet Service



3.2 Spending on Wide-Area Network (WAN) Connections

Districts' costs for purchasing data transport services to connect individual schools back to the district POP also vary significantly, as seen in Figure 5. However, a majority of schools (55 percent) pay less than $10/Mbps/month. On average, schools pay $10.74/Mbps/month for data transport services and $23.99/user/year.

Figure 5: Most Schools Pay Less than $10/Mbps/Month for Data Transport Services for WAN Connections



4. Options for Meeting BDCP Benchmarks Under Current Broadband Distribution Model

4.1.1 Upgrading Existing Connections to Meet BDCP Benchmarks Is Feasible Only for 100 Kbps per user

As discussed above, fewer than one-third of all schools in the State currently meet or exceed the 100 Kbps benchmarks for Internet access, including 65 percent of charter schools and just 18 percent of public schools. A number of public school districts will need to upgrade the speed of their Internet connections in order to meet the minimum BDCP standard of 100 Kbps and many more will need to upgrade to meet higher benchmarks. CTC developed cost estimates for upgrading schools' existing Internet and WAN connections to meet the goals of 100, 300, 600, and 1,000 Kbps per user.

CTC developed both low and high cost estimates for upgrading schools' existing Internet connections. The low-end estimate reflects a more modest escalation of cost with bandwidth, based on the pricing scale of the State of New Mexico Department of Information Technology's (DoIT) contract with CenturyLink. The high cost assumes that Internet costs will increase linearly as the speed of the connection increases. To estimate the upgrade costs for data transport services, CTC utilized the same pricing scale as in DoIT's State contract with CenturyLink. *The*

estimated costs do not account for E-rate subsidies that would be available to public and charter schools in the State.

As seen in Table 5 below, to upgrade both the Internet and WAN connections at every school in the State to 100 Kbps per user would cost $12.3 million to $19.1 million—or an estimated increase of $1.8 million to $8.6 million over current spending. To meet the 1,000 Kbps (1 Mbps) per user goal would cost between $41 million and $114.1 million or an estimated increase of $30.5 million to $130.6 million.

Based on CTC's estimates, the schools in the State may be able to reach the goal of 100 Kbps per user, but reaching 1,000 Kbps per user is unattainable under the status quo broadband model. Though the E-rate program might cover the bulk of the cost for the poorest districts in the State, even assuming a statewide average E-rate subsidy of 80 percent means individual schools and districts as a whole would still need to spend $8 million to $23 million annually to meet the 1,000 Kbps per user standard.

Table 5: Estimated Annual Costs for Internet and WAN Connection to Meet BDCP Benchmarks Under Current Arrangements

	Standard	Internet Cost	Transport Cost (WAN)	Total
Current Spending				
	-	$4.5 million	$6.0 million	$10.5 million
Low Estimate				
	100 Kbps	$6.2 million	$6.1 million	$12.3 million
	300 Kbps	$9.8 million	$7.6 million	$17.4 million
	600 Kbps	$17.0 million	$10.2 million	$27.2 million
	1,000 Kbps	$24.8 million	$16.2 million	$41.0 million
High Estimate				
	100 Kbps	$13.0 million	$6.1 million	$19.1 million
	300 Kbps	$29.3 million	$7.6 million	$36.9 million
	600 Kbps	$61.4 million	$10.2 million	$71.6 million
	1,000 Kbps	$97.9 million	$16.2 million	$114.1 million

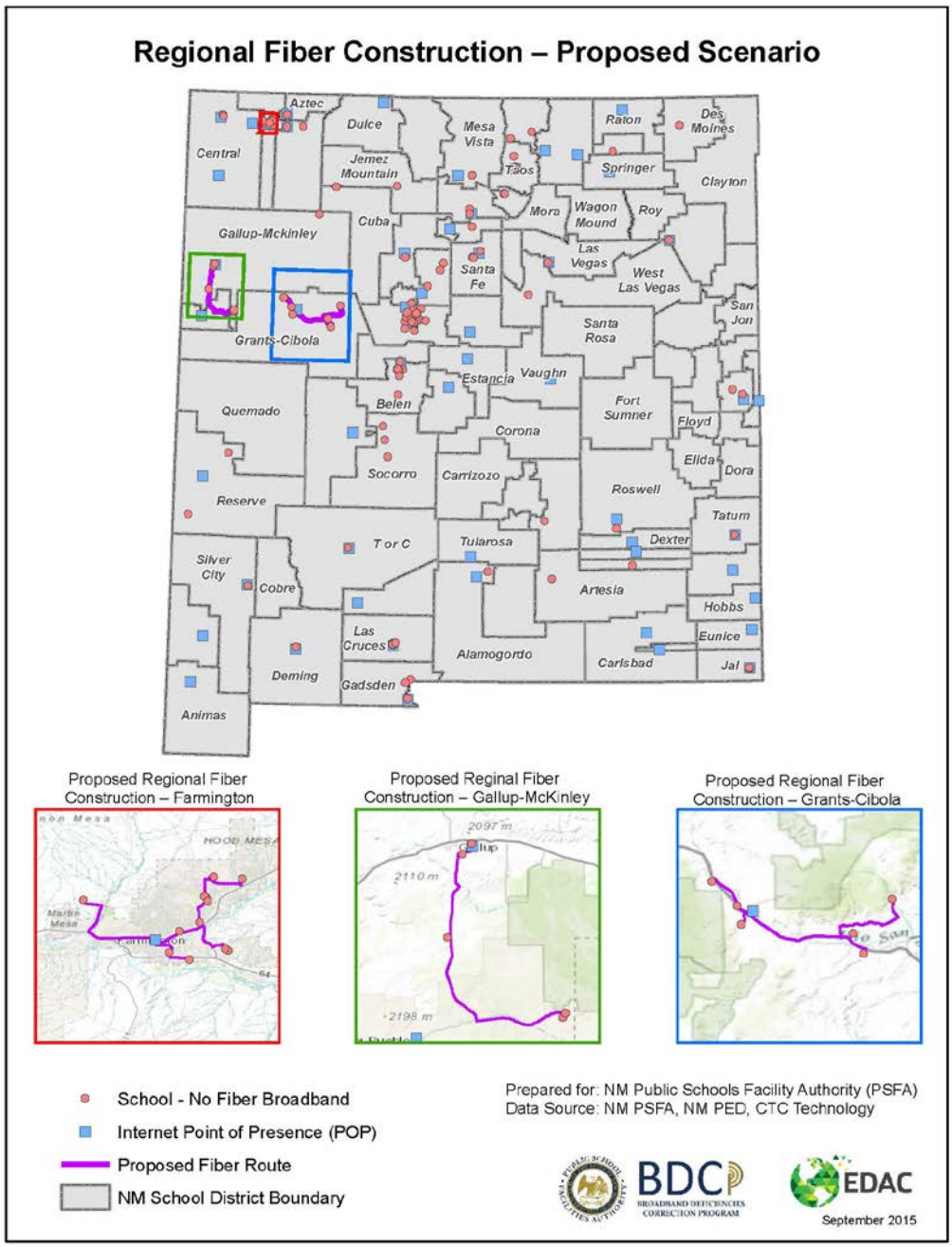
4.1.2 Expanding Fiber to Public Schools Without Fiber Access

CTC also estimated the cost of extending fiber to public schools that currently do not have access to fiber. Of the 67 public schools currently not connected to fiber, 41 do not have immediate

access to fiber-based services.[9] The remaining public schools appear to have access to fiber-based services but have chosen not to subscribe. Additionally, there are 61 charter schools that do not currently subscribe to fiber-based services.

[9] The determination is based upon data gathered from service providers in the State of New Mexico. If a school is located in the territory of a service provider that did not provide CTC or the PSFA with information regarding its infrastructure, then the assumption is that the school is not served by fiber.

Figure 6: Regional Fiber Construction Overview



To estimate the cost of connecting the 41 public schools, CTC developed a low and high-mileage cost estimate. The low-mileage estimate assumes fiber will be built to connect to the nearest fiber point-of-presence (POP) for a school's local telephone company. We assume that the primary roads are fiber routes, and that the incumbent telephone company will typically own the nearest fiber. The high-mileage estimate does not assume fiber will be constructed by a school's local telephone provider, but rather can be constructed by another provider in a more regional

approach to connect a school to the nearest fiber-connected schools in its district. For example, see the model in Figure 6 for regional fiber construction in Grant-Cibola, Farmington, and Gallup-McKinley.

Table 6 and Table 7 provide an overview of CTC's cost estimates for building fiber to public schools. Overall CTC estimates that it will cost $7.6 million to $30.1 million to build fiber to 41 public school facilities.

Table 6: Low-Mileage Estimate for Building Fiber to Public Schools

Cost Category	Unit Cost	Units	Totals
Construction to Schools	$62,500 per mile	116 miles	$7.2 million
Customer premises equipment (CPE)	$10,000	41 sites	$410,000
		Total	*$7.61 million*

Table 7: High-Mileage Estimate for Building Fiber to Public Schools

Cost Category	Unit Cost	Units	Totals
Farmington	$62,500 per mile	17 miles	$1 million
Gallup–McKinley	$62,500 per mile	45 miles	$3 million
Grants–Cibola	$62,500 per mile	64 miles	$4 million
Construction to remaining schools	$62,500 per mile	347 miles	$21.7 million
Customer premises equipment (CPE)	$10,000	41 sites	$410,000
		Total	*$30.1 million*

Given that most of the charter schools in the State are in urban areas, CTC assumes that most of the 61 charter schools have access to fiber-based services. However, many charter schools are in storefront locations or other facilities that may or may not be currently wired for fiber. This makes it difficult to identify all of the charter schools that need fiber construction. Many charter schools that currently subscribe to cable broadband may find it difficult to upgrade to higher speeds, particularly symmetrical higher speeds. Those cable providers would need to extend fiber to those locations. For those 30 charter schools currently subscribing to cable broadband, CTC estimates extending fiber would cost $750,000 or an estimate of $25,000 per site, based on likely average distances to fiber and typical construction costs.

The Federal E-rate program includes an opportunity for New Mexico schools to use E-rate funds to enable providers to build these direct fiber connections. Through the competitive bidding process, applicant districts (or regions, or the State) can select a provider that requires an upfront

E-rate capital payment to build the fiber and can get the subsidy applied to that payment, so long as that solution is more cost effective than other options, evaluated over some period of time to be determined by the applicant. In other words, so long as the total cost to the E-rate program is less over a designated period of time, E-rate funds can be used to subsidize new fiber construction. Further, if the State commits to contributing 10 percent of the capital cost of the construction, the E-rate program will add another 10 percent to the existing subsidy level (80 percent average across the State), thus further reducing the cost to the school district. In our view, this new capital funding under the E-rate program represents a singular opportunity for the State to leverage Federal funds to ensure that every school in New Mexico has a direct fiber optic connection.

5. Alternative Models for Broadband Distribution in the State

Given the significant cost increases associated with upgrading the existing Internet and WAN connections, CTC examined four alternative models for broadband distribution in the State:

1. A statewide fiber network built, operated and managed by the State, that connects every public school in New Mexico;

2. A statewide aggregation network operated and managed by the State, constructed from the Internet core to hub locations in each region of the State and connected to districts over leased WAN connections with rates negotiated under a statewide agreement;

3. A statewide aggregation network operated and managed by private sector partners that leverage private sector infrastructure and connect to districts over WAN connections with rates negotiated under a statewide agreement; and

4. A statewide managed network that is contracted out in a turn-key arrangement to a single provider that leverages existing private sector infrastructure or, where infrastructure is not available, builds new infrastructure.

5.1.1 Statewide Fiber Network

A statewide fiber network would be funded by the State and would connect every public school with a scalable fiber connection. The State would both build and be responsible for managing the network.

The advantages of the model include the following:

- Aggregating Internet bandwidth purchase for the entire State
- Eliminating reoccurring monthly costs for transport services

- Creating a more equitable distribution across all districts of broadband and Internet access
- Creating a statewide intranet that can serve a wide range of government and educational applications, as well as provide a fiber backbone where excess capacity can be used by the private sector
- Managing broadband costs over time, essentially providing a hedge for public institutions in New Mexico against the kinds of cost increases that will occur if districts and schools continue to purchase service under the current arrangement

The disadvantage of this model is that building and operating a statewide network will require a large-scale construction effort, project management and oversight, and increased staffing and contractor support for ongoing operations. Although the State currently operates its own public safety microwave and land-mobile radio networks, it does not operate a large-scale fiber network. Table 8 summarizes the capital and operational costs of a statewide fiber network.

Table 8: Estimated Capital and Operational Costs for Statewide Fiber Network

	Annual Operating					
Capital (Const. and Electronics)	**Internet (100 Gig)**	**Transport**	**Other**	**Total**	**Total 10-Year (Capital and Operating)**	**Total 20-Year (Capital and Operating)**
$357.9 mil.	$1.2 mil.	-	$19.8 mil.	$21.0 mil.	$567.9 mil.	$777.9 mil.

5.1.2 Statewide Aggregation Network – Construction and Operation by the State

A more modest approach to the statewide fiber network is a statewide aggregation network that seeks to build a series of fiber rings that connect to Internet exchange points in Santa Fe and Albuquerque. The rings then connect to hub sites geographically dispersed throughout the State. The State would then purchase transport from private telecommunications providers from the hub sites to the existing district POPs to supply them with Internet bandwidth and interconnect all of them to form a statewide intranet. Districts and charter school would be responsible for purchasing transport from private providers to connect individual schools to the aggregation network.

The advantages of the model include the following:

- Aggregating Internet bandwidth purchase for the entire State
- Creating a more equitable distribution of Internet access across all districts
- Creating a statewide intranet that can serve a wide range of government and educational applications, as well as provide a fiber backbone where excess capacity can be used by the private sector

The disadvantage of this model is that building and operating an aggregation network will still require a large-scale construction effort, project management and oversight, and increased staffing and contractor support for ongoing operations. Although construction costs and operational responsibilities are somewhat less compared to a statewide fiber network, the State would still be taking on a significant management challenge.

Table 9 summarizes the capital and operational costs of a statewide fiber network. It includes an estimate based on the minimum BDCP benchmark of 100 Kbps per user and an estimate based on the maximum BDCP benchmark of 1,000 Kbps per user.

Table 9: Estimated Capital and Annual Cost for Statewide Aggregation Network

	Annual Operating					
Capital (Const. and Electronics)	**Internet**	**Transport**	**Other**	**Total**	**Total 10-Year (Capital and Operating)**	**Total 20-Year (Capital and Operating)**
100 Kbps per user						
$196.5 mil.	$0.12 mil.	$8.3 mil	$13.2 mil.	$21.6 mil.	$412.5 mil.	$628.5 mil.
1,000 Kbps per user						
$196.5 mil.	$1.2 mil.	$28 mil.	$13.2 mil.	$42.4 mil.	$620.5 mil.	$1044.5 mil.

5.1.3 Statewide Aggregation Network – Outsourced to Private Providers

An alternative to constructing a statewide aggregation network would be for the State to outsource the operation and management to a broadband provider in the State.

The advantages of the model include the following:

- Aggregating Internet bandwidth purchase for the entire State
- Creating a more equitable distribution of Internet access across all districts

- Creating a statewide intranet that can serve a wide range of government and educational applications
- Eliminating upfront capital costs and operational responsibilities for the State

The disadvantage would be reduced flexibility and capacity relative to owning the infrastructure and equipment, and the need to pay recurring fees to a private provider for services. Table 10 summarizes the annual operational costs of an outsourced statewide aggregation network.

Table 10: Estimated Capital and Annual Cost for Outsourced Statewide Aggregation Network

	Annual Operating					
Capital (Const. and Electronics)	**Internet**	**Transport**	**Other**	**Total**	**Total 10-Year (Capital and Operating)**	**Total 20-Year (Capital and Operating)**
100 Kbps per user						
-	$0.12 mil.	$10.5 mil.	-	$10.6 mil.	$106 mil.	$212 mil.
1,000 Kbps per user						
-	$1.2 mil.	$30.2 mil.	-	$31.4 mil.	$314 mil.	$628 mil.

5.1.4 Statewide Managed Network

Under a statewide managed network model, the State would outsource the operation and management of a statewide broadband network to a single provider offering a turn-key solution. The provider would be responsible for consolidating the necessary infrastructure to deliver Internet to every school in the State and manage a statewide intranet.

The advantages of the model include the following:

- Aggregating Internet bandwidth purchase for the entire State
- Creating a more equitable distribution of Internet access across all districts
- Creating a statewide intranet that can serve a wide range of educational applications
- Eliminating upfront capital costs and operational responsibilities for the State

The disadvantage would be reduced flexibility and capacity relative to owning the infrastructure and equipment, and the need to pay recurring fees to a private provider for services. In addition, the State would likely need participation from every school district and charter school in order to

make the economics of the model work. Furthermore, depending upon the structure of the network, public school districts would need to give up autonomy over their WAN infrastructures.

Unlike the other models, there have not been procurements for regional or statewide services comparable to a statewide managed network model in New Mexico. The cost of this model depends both on the cost to the turn-key service provider to obtain services from existing service providers, the cost of any required upgrades, the provider's cost of managing the services, and the markup the service provider adds. In order to estimate the costs, the state, regions in the state, or large districts would need to obtain pricing from a service provider that are New Mexico specific.

Although we emphasize this approach is highly speculative, there may be some guidance from comparable costs in other states. From an extremely high-level review of costs from USAC databases of turnkey network solutions for Internet access in other states, we found Internet service to district POPs under this model ranging from $1,500 to $16,000 per Gbps. We found 1 Gbps transport services ranging from $1,200 to $2,000 per site. The central part of this range is lower than current Internet costs per Mbps on average, and lower than the current CenturyLink statewide contract for WAN services. Therefore this model is more promising than the status quo broadband model and therefore should be considered as a viable alternative. However, there is not yet sufficient New Mexico-relevant data to compare potential costs to the other alternative models.

6. Recommended Strategies

Our examination of the current state of broadband access for schools in the State, the cost of upgrading existing connections to meet the BDCP goals, and alternative models for broadband distribution yields many useful insights for the PSFA and State leaders to consider as they determine what strategies to pursue.

First, simply mandating that districts and charter schools request upgrades from service providers in an ad hoc manner to meet bandwidth goals would be costly and potentially unachievable and unsustainable. Public school districts and charter schools would likely instead pursue their current course—with some able to increase bandwidth, while others are unable to add bandwidth due to high costs.

Second, the State would benefit significantly from aggregating the purchase of Internet bandwidth. Aggregation (as proposed in Sections 5.1.2, 5.1.3, and 5.1.4) provides a more sustainable path for scaling up Internet speeds across the State and creating a more equitable distribution across all districts. This is demonstrated by the cost estimates for the alternative models discussed in section 5. All entail lower total cost of ownership over a 10-year period than the worst-case estimates of a status quo model that relies on the existing service arrangements of both public and charter schools.

Moreover, states including Nebraska and North Carolina that have pursued various aggregation models for Internet access have been able to reduce the cost per Mbps. In 2014, the Network-Nebraska Education paid $1.38 per Mbps for Internet, down from $2.50 the previous year. Based on various conversations with stakeholders and providers, CTC expects that schools in New Mexico could pay approximately $1 per Mbps based upon a statewide purchase of Internet bandwidth.

Third, outsourcing a statewide aggregation network for Internet bandwidth (Section 5.1.3) would be significantly cheaper than the best-case scenario estimate of a status quo model. It is the least costly over a 10-year period. Very importantly, that model assumes the State moves to a model of negotiating prices for data transport services on statewide basis alongside the Internet aggregation network. The component is critical to control the high cost of Internet and WAN transport in rural areas.

Fourth, the alternative models that include substantial fiber construction and operation of the fiber network (Sections 5.1.1 and 5.1.2) are both twice as costly over 10 years as the outsourced model. Although building a State-run aggregation network (5.1.2) would cost half as much as building a fiber network to all schools (5.1.1), when all operating costs and the likely remaining service provider costs are included, the costs of the State aggregation network and the statewide fiber network to the schools cost approximately the same over the 10-year period.

Finally, although its upfront capital cost is high, the statewide fiber network is the most scalable and flexible solution from a technical perspective. It can serve State and local government needs and potentially be pursued as a public–private partnership that provides more competitive and cost-effective broadband services to residents and businesses statewide.

Below CTC provides key recommendations based on the above insights. Well-planned business strategies will support whichever technical strategies the State pursues. In summary, we note three particular areas of opportunity:

1. A tested best practice that could enable the State to achieve better per unit pricing, higher bandwidth, and better service quality is to aggregate buying power on a regional or statewide basis. Statewide procurement could encourage providers in the State to see a business opportunity to work, and bid, with other providers—which could flatten pricing and reduce geographical disparities.

2. A significant new opportunity is presented by the new capital funding in the federal E-rate program, which could provide tremendous incentive for private providers to build new fiber or upgrade existing facilities to the benefit of the public schools. In addition, the generosity of the ongoing E-rate support for broadband services can serve to amplify

the attractiveness of the larger procurement opportunity suggested below, thus incenting private providers to invest, improve services, and reduce per unit pricing in consideration of the volume opportunity.

3. To further amplify the schools' buying power, we recommend that the PSFA and its partner agencies consider joint procurement and substantial coordination with the entities representing libraries and healthcare institutions in the State in order to aggregate all of the capital opportunities contemplated within federal funding for all three sectors, and to maximize the net benefit to all three sectors.

6.1.1 Statewide Procurement Could Flatten and Reduce Pricing

In brief, a statewide procurement strategy would leverage the collective buying power of public schools throughout the State, which together represent a massive customer for commercial service providers, and leverage that aggregated annual and ongoing spending to get better pricing and better services. This strategy is a key part of the alternative models proposed in Sections 5.1.2 and 5.1.3, and of course the Section 5.1.4 model is entirely a statewide or regional procurement.

A statewide procurement strategy potentially delivers benefits in a range of areas. Depending on the scale of the collective buying (i.e., on whether it is on a district basis, a multi-district basis, a super-regional basis, or, in a best-case scenario, a statewide basis), these benefits include:

1. Lower per unit pricing across the full range of key services discussed in this report, including Internet bandwidth and WAN transport costs.

2. Potential increased investment and improved services by private sector providers.

3. Reduced aggregate administrative and processing costs to the broader public schools community.

4. Positive ancillary benefits related to enhanced communications infrastructure, wherein the benefits will accrue to other users and the broader community in New Mexico.

Significant administrative efforts are necessary to enable the benefits of this kind of strategy, including convincing stakeholders at the school district level to participate in order to achieve aggregated benefits, as well as some of the paperwork challenges of that process. But in our view and experience, these challenges are greatly offset by the aggregate benefits of the strategy and the aggregate reduced paperwork that it enables.

Under this strategy, multiple school districts on a regional or super-regional basis—or even, ideally, on a statewide basis with support of a State agency such as the PSFA—would combine

their RFP processes to solicit and contract for Internet bandwidth and WAN connections, or any other broadband communications services they were seeking (such as, perhaps, dark fiber, wavelengths, or Ethernet). The RFP process established by the E-rate funding structure is certainly conducive of this model, but the strategy can benefit the districts and public schools throughout New Mexico even without consideration of E-rate.

Ideally, the buying group would be as large as possible and would include both rural and metropolitan-area school districts—thus enabling the rural districts to benefit from the substantial buying power of the higher-volume urban districts, and enabling the urban districts to benefit from the likely higher E-rate subsidy level of the rural districts.

The districts would cooperate to put out the RFP and select the vendor. In order to do this in compliance with the E-rate program, the entity leading the group (which, under E-rate, is termed a consortium) would be required to secure letters of agency from each of the participating districts. This is the additional paperwork burden to which we refer above—but it is modest in scale and is easily offset by the reduced burden of a single RFP process rather than many.

A more substantial challenge, perhaps, will be to convince school districts to work collectively. This challenge potentially presents itself because districts are not accustomed to working in very large consortia in New Mexico. But we strongly recommend that the PSFA and its other State partners work extensively to build stakeholder support for this strategy if it is adopted—because the benefits of consortium buying are so significant.

In addition, as of the reforms of late 2014, the FCC is prioritizing and encouraging consortium buying—and indeed has directed the Universal Service Administrative Company (USAC) to prioritize consortium applications for review, which is a reversal of the previous structure by which applications were reviewed by USAC. Thus the larger the application, the sooner it is likely to be reviewed and approved by USAC—which could be a very substantial advantage with respect to gaining access to the new E-rate capital funding, for which we anticipate considerable competition.

This kind of aggregated buying represents a best practice and has been utilized powerfully in North Carolina, for example, where the State leads aggregated transport purchases on behalf of all of the school districts—and has achieved not only exceptional per unit pricing and efficiencies, but also consistency of service among districts and greatly reduced administrative costs. All school districts in the State receive at least 1,000 Mbps (1 Gbps) of Internet bandwidth (shared among an average of four schools per district). In addition, aggregate costs for Internet

bandwidth have generally decreased each year (despite the 10-times growth in use of recent years) due to the operation of the backbone network.[10]

One way of structuring the procurement would be through soliciting bids on a statewide backbone network to reduce the cost of commodity Internet at many points throughout the State. When coupled with regional aggregation of purchasing for data transport services, underserved districts will have lower-costs and higher quality broadband. We recommend the State plan to procure a backbone and sponsor regional broadband purchasing. As a first step, we recommend the State issue a Request for Information (RFI) to service providers to determine which providers are willing to provide the backbone, potential technical and business models, and ranges of costs, in preparation for a more formal Request for Proposals.

6.1.2 E-Rate Subsidy for Fiber Construction Represents a Potential Opportunity to Fund Last-Mile Connections to New Mexico's Schools

The Federal Communications Commission's Schools and Libraries universal service program, known as the E-rate program, provides financial assistance to schools and libraries to obtain affordable broadband. Under the program, eligible schools and libraries may receive discounts ranging from 20 percent to 90 percent of the pre-discount price of eligible services. The discount rate given to schools and libraries is based upon the percentage of students eligible for free or reduced-price lunch or an alternative mechanism to determine need.

The E-rate opportunity for schools in New Mexico is considerable. The statewide average discount rate is close to 80 percent, meaning that the majority of schools would pay only 20 percent of the annual cost for Internet and data transport service if they participate in the program. In 2014-15, the E-rate program approved over $28 million in funds to New Mexico schools.[11] In addition, recent reforms to E-rate could cover up to 90 percent of the cost of building fiber to currently un-served facilities in the State.

Where there is insufficient infrastructure to meet schools' reasonable broadband needs, the E-rate program will now potentially fund capital expenses to build new infrastructure, so long as that strategy is the most cost-effective relative to other competitive bids. Even where infrastructure does exist, E-rate support for capital costs can be secured—again, so long as that option is more cost-effective than the other competitively offered alternatives.

This new approach to funding fiber construction to schools represents a massive opportunity to bring new funds into the State, particularly for constructing last-mile fiber to unconnected

[10] Based on information gathered from multiple CTC interviews with Mark Johnson, MCNC Chief Technology Officer, between 2012 and 2015. CTC extends its thanks to Mr. Johnson for the information and time.
[11] Number reflects the total amount of committed funds approved by USAC in 2014-15 E-rate year including support for non-broadband services such as voice service.

schools and libraries—and even for fiber-connected schools if constructing new fiber would enable more cost-effective service delivery than other service providers' bids.

The key here is that the FCC has said that school districts can establish the period of time over which they analyze the cost-effectiveness of competing bids. Given that needs for bandwidth will only increase, and that schools can make realistic projections of their long-term needs to increase their bandwidth, the districts might reasonably analyze bids over a 20-year period. Over that duration, the combined cost of constructing fiber and lower recurring charges for service might be more competitive than the higher recurring charges bid by an incumbent service provider. This might be the case if there is no fiber to a given school or district—or even if there is fiber, but the existing service is extraordinarily expensive.

To encourage additional funding from non-federal sources and to further catalyze fiber builds to schools and libraries, E-rate will also now increase an applicant's discount rate for special construction charges up to 10 percent on special construction charges that are matched with State funding. The discount match will begin in funding year 2016, and will match on a one-to-one-dollar basis. Together, the additional State and E-rate program funding will reduce the money owed by applicants for what would otherwise be the applicant's non-discount share.

Together the E-rate capital funding opportunity and large-scale buying power from a statewide or regional procurement strategy would result in significant federal funding to construct new facilities to benefit New Mexico's schools. This year, the State should identify school districts for fiber construction that would be eligible and would benefit from the program, taking into account fiber availability, current costs, and the duration of service contracts. It should support these districts' RFP processes with technical advice and provide matching funds. It should also incorporate libraries into the effort.

6.1.3 Federal Universal Service Programs for Libraries and Healthcare Institutions Might Amplify Buying Power

As we discuss above, new funding for capital expenses from the federal government is an inducement to private companies for better outcomes in terms of services and prices for New Mexico's schools. Interestingly, however, the opportunity for private companies to secure federal funding for capital expenses is significantly larger for the library and healthcare sectors than it is for the public school community.

Our research in New Mexico and nationwide demonstrates that a far greater proportion of libraries are not yet fiber connected as compared to public schools.[12] As a result, the substantial

[12] For significant additional detail on this topic, please see our 2014 report, "A Model for Understanding the Cost to Connect Schools and Libraries with Fiber Optics," which was filed with the FCC by the Schools, Health and Libraries Broadband (SHLB) Coalition (http://www.ctcnet.us/news/shlb-submits-ctc-study-to-fcc/). In that report, we

percentage of libraries yet to be connected may provide a larger opportunity to secure capital funding for New Mexico service providers than would connecting the remaining schools that are not yet directly connected over fiber—which, as described above, is only a small percentage of New Mexico's public schools.

Similarly the healthcare sector may represent a larger opportunity to attract capital funding from the federal government through the Healthcare Connect Fund (HCF) program. Healthcare Connect, which is parallel to E-rate, is focused on rural healthcare facilities—but also offers benefits to metropolitan-area hospitals if they work with their rural counterparts. Further, the support percentage for HCF is a flat 65 percent, unlike E-rate in which the subsidy varies on metrics related to a community's levels of poverty and rural.

The HCF program, like the E-rate program, includes a mechanism for service providers to be funded to cover special construction charges (in essence, funded at the 65 percent level for fiber connections to rural healthcare institutions that do not have direct fiber connections). In our experience, a substantial percentage of rural healthcare facilities in New Mexico and nationwide are not directly connected to fiber—thus suggesting that HCF represents a significant opportunity.

These opportunities for the healthcare and library sectors are potentially enormously helpful to the PSFA's current efforts to improve services and pricing to New Mexico's schools. As with all of the procurement aggregation strategies suggested above, aggregation with the public health and library entities would enable all three to leverage the pricing benefits that are likely to arise from carrier interest in what would be a massive business opportunity for private providers.

This strategy holds true for ongoing subsidized services under E-rate and HCF, and also with respect to the capital opportunity to fund special construction charges. Indeed, the FCC is encouraging consolidated RFPs—and all the efficiencies of joint bidding would accrue here, not only among schools districts but across all three sectors.

We therefore recommend that the PSFA and its partner agencies consider joint procurement and substantial coordination with the entities representing libraries and healthcare institutions in the State in order to aggregate all of the capital opportunities contemplated within federal funding for all three sectors, and to maximize the net benefit to all three sectors.

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calculated the cost to connect over fiber all of the unconnected schools and libraries nationwide. The FCC cited this report in its E-rate modernization order. See: "In the Matter of Modernizing the E-rate Program for Schools and Libraries," WC Docket No. 13-184, Second Report and Order and Order on Reconsideration, FCC 14-189, adopted December 11, 2014, at 44.

Alternatively, a statewide fiber network, if pursued in tandem with State and local government agencies, and leveraging State resources in its rights of way, can potentially address many communications challenges in the state, including those faced by public safety, education, and health care. In addition to serving government needs, excess fiber capacity can be made available to private sector providers to enhance broadband to the public and address the digital divide. We recommend the State analyze State and local government broadband needs alongside the school needs, determine the total cost of services it purchases, and conduct a feasibility analysis for a statewide network with the government, educational and health care users as an anchor.