Public School Network Capabilities Study

A Report to the Texas Legislature
from the Texas Education Agency

December 1, 2015

Submitted to the Governor,
Lieutenant Governor,
Speaker of the House of Representatives, and
Members of the Texas Legislature

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Public School Network Capabilities Study

Executive Summary

"*Imagine an education system where . . . students can expect higher performance and deeper engagement in academic, real-world endeavors by accessing digital tools and resources available twenty-four hours a day, seven days a week (24/7) appropriate to individual strengths, needs, and learning styles. Students know they will be prepared to thrive in a global workforce with changing economic implications . . . In order to have this educational system . . . With the convergence of a variety of technologies, this vision is possible in more ways than once imagined."*

Long-Range Plan for Technology, 2006–2020

This report is a result of Texas Education Code (TEC), §32.005, which requires the commissioner of education to conduct a study to assess the network capabilities of each school district and determine whether the network connections of a district and each school campus in the district meets specific Internet and wide area network (WAN) connectivity targets.

A survey was sent to 1,223 Texas public school districts and open-enrollment charter schools and received an 89.8% response rate. The survey included questions about Internet and WAN connectivity speeds, type of connection to the Internet, and barriers to acquiring Internet and WAN targets and to using the full connectivity currently in place.

Analysis of the survey responses showed that:

1. 26% of the campuses met the target for connectivity to the Internet
2. 62% of the campuses met the target for WAN connection between the district and each of the school campuses in the district.

In order to better understand the data collected, the survey results are reported at the statewide level as well as by the geographic location of the campus and area population density as identified using one of four campus and district locale categories defined by the National Center for Education Statistics (NCES): city, suburb, town, and rural. (See the NCES Locale chart in About the Public School Network Capabilities Survey.)

Internet Connectivity

Survey results found that the most common Internet speed used in city and suburb locale categories is a 1,000–9,998 mbps (1 Gbps) connection, compared to a 1–999 (under 1 Gbps) connection used in town and rural areas. As for the type of connection used to provide Internet access, fiber was by far the most prevalent Internet connection type, regardless of where the campus was located. Locale became a factor only when looking at other connection types. A modest percentage of campuses in town (9%) and rural (19%) areas cited wireless, with a notable presence found in a few ESC regions, while a small percentage of campuses in the city and suburb areas both (3% or less) cited cable modem as their Internet connection type.

Campuses were asked to report up to two barriers that prevent them from acquiring the Internet target. Of the campuses that did not meet the target, the most frequently selected barrier was "Necessary funds are not available in district/campus budget." Locale became a factor when looking at the second most cited barrier; campuses in the city and suburb areas both cited "Current hardware or software does not support

higher speeds" while campuses in the town and rural areas cited "Higher speed connections were only available at premium rate."

Campuses were asked to report up to two barriers that prevent them from using the full speed of the Internet connection currently in place. Of the campuses that met Internet target, the most frequently cited response was "Internet connection is shared with another campus, entity, or facility."

WAN Connectivity

The results on the WAN connectivity questions found that the most common WAN connection speed reported by campuses was 1,000 Mbps (1 Gbps) regardless of where the campus was located. Locale became a factor when looking at the WAN speed for the campuses that did not meet target. Campuses in the city and suburb locales both cited speeds in the range of 1,000–9,998 Mbps (1–9 Gbps) as their most frequent speeds, while those in the town and rural locales cited speeds falling in the range below 1 Gbps as their most frequent speeds.

Districts were asked to report up to two barriers that prevent them from acquiring the WAN target for the connection between each campus and the district. Statewide the most frequent barrier response cited was "Necessary funds are not available in district/campus budget." Locale became a factor when looking at the second most cited barrier; campuses in the city and rural locales both cited "Higher speed connection only available at premium rate," while campuses in the town and suburb locales cited "Current hardware or software does not support higher speeds."

Districts were asked to report up to two barriers that prevent them from using the full speed of the WAN connection currently in place. Of the barriers cited, the most frequent barrier reported was "Connection is shared with another campus, entity, or facility" closely followed by the barrier "Simultaneous use of same connection for multiple applications significantly slows connection speed."

In addition to the results of the Public School Network Capabilities Survey conducted by the Texas Education Agency (TEA), this study also examines the landscape for school broadband across the country, including key national and state initiatives and reports. This report includes a brief synopsis about what some other states are doing to address broadband connectivity for schools. Some states have addressed or are in the process of addressing connectivity. Examples include:

- A program in place to ensure all schools have sufficient connectivity (Nebraska and North Carolina)
- A project in the early stages of implementation (Arkansas and Virginia)
- A statewide network that serves public education, libraries, state and local government (Utah)
- Programs that support bulk pricing without a statewide network (New Jersey)

States are using a variety of strategies to address connectivity of their schools. Each state must adopt a plan that best fits their own circumstances, needs, and goals. Some states appropriate funds that cover the cost of Internet access for their schools; others create a not-for-profit program to ensure schools have affordable connectivity; and some act as a catalyst to bring together stakeholders to research, develop, and implement a plan. The one characteristic that each of the states has in common: state leaders made a decision to study the issue and adopt a strategy to ensure all their schools have the connectivity needed to support 21st century learning.

Background

Texas, like many other states, has recently asked whether public schools in the state have sufficient connectivity to support learning in the 21st century. To address this question, House Bill (HB) 1926, 83rd Regular Session, 2013, directed the commissioner of education to conduct a study to assess the network capabilities of each school district and open-enrollment charter school and each campus. The study is required to gather sufficient data to determine whether the network connections of a district and school campuses in the district meet the following target capacities:

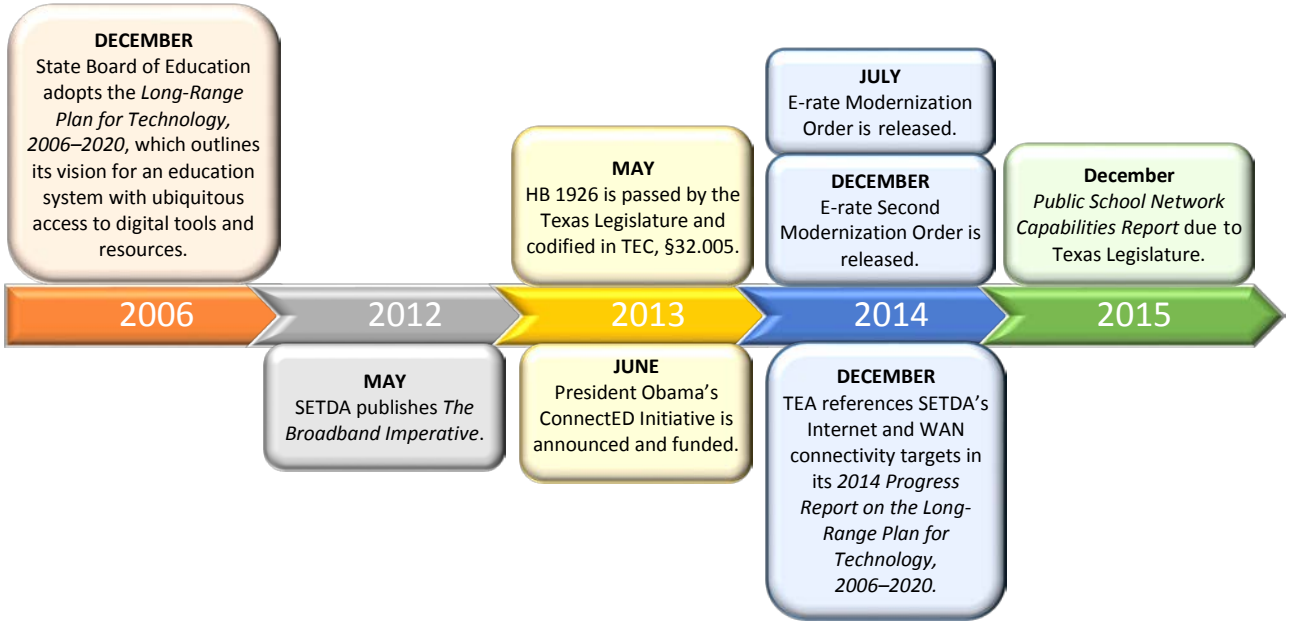
1. An external Internet connection to a campus's Internet service provider featuring a bandwidth capable of a broadband speed of at least 100 megabits (Mbps) per second for every 1,000 students and staff members
2. An internal wide area network connection (WAN) between the district and each of the school campuses in the district featuring a bandwidth capable of a broadband speed of at least one gigabit (Gbps) per second for every 1,000 students and staff

In January 2015, TEA sent the Public School Network Capabilities Survey to 1,223 Texas public school districts and open-enrollment charter schools, comprised of more than 8,000 campuses. (Results from the survey are included in this report.) *The Public School Network Capabilities Study* examines the Internet and WAN connectivity speed ranges reported by public school districts and campuses across the state, how many Texas campuses met the Internet and WAN target bandwidths established by legislation, the type of connection used by districts and schools to access the Internet, and the most common barriers to reaching the established targets and making full use of available connectivity. The study also addresses the broadband landscape in Texas, at the federal level, and in other states, including what is being done to help schools accomplish these goals.

Broadband Landscape: Critical Pieces

Critical Pieces at a Glance

There are a number of important initiatives, studies, and reports at the national level and in Texas that serve as critical pieces for recognizing and understanding the growing movement toward meeting broadband targets that can, in turn, create equitable access to 21st century teaching and learning opportunities that support students, educators, and schools. Each of these pieces represents an action, funding mechanism, or body of information that adds to this state and national broadband landscape.



Broadband Imperative

In 2010 the State Educational Technology Directors Association (SETDA)[1] began to research recommended Internet and WAN connectivity capacities for schools in an effort to help educators and federal and state leaders identify a set of appropriate connectivity targets. The SETDA broadband connectivity recommendations have subsequently been widely adopted across the country as a benchmark for schools to determine whether the current network capabilities of their campuses are ready to enable and support 21st century teaching and learning. SETDA's *The Broadband Imperative: Recommendations to Address K–12 Education Infrastructure Needs*[2] established the following targets.

Broadband Access for Teaching, Learning, and School Operations	**2014–2015 School Year Target**	**2017–2018 School Year Target**
An external Internet connection to the Internet Service Provider	At least 100 Mbps per 1,000 students/staff	At least 1 Gbps per 1,000 students/staff
Internal wide area network (WAN) connections from the district to each campus and among campuses within the district	At least 1 Gbps per 1,000 students/staff	At least 10 Gbps per 1,000 students/staff

In its guide "Future Ready Schools: Building Technology Infrastructure for Learning," the U.S. Department of Education provided several terms and examples that assist in understanding these targets and how they apply in a school environment.

- *Broadband* refers to high-speed Internet access that allows for fast data transfer required for students to access 21st century tools such as high-definition multimedia content and online video classes.
- *Mbps* is an abbreviation for megabits per second. A megabit is a data transfer rate of 1,000,000 bits per second. The SETDA recommendation suggests schools have a minimum of 1 Mbps per student.

[1] SETDA is a not-for-profit membership association whose mission is to build and increase the capacity of state and national leaders to improve education through technology policy and practice.
[2] http://www.setda.org/priorities/equity-of-access/the-broadband-imperative/

To illustrate what that might look like, 1 Mbps of connectivity would enable a single student to stream a 10-minute high-definition video in real time.

- *Gbps* is an abbreviation for gigabits per second. A gigabit is a data transfer rate of 1,000,000,000 bits per second. At this speed 1,000 students could stream a 10-minute high-definition video in real time.

ConnectEd Initiative

Soon after SETDA's broadband connectivity targets were released, President Obama in June 2013 launched the ConnectED Initiative[3] to expand high-speed digital connections to U.S. schools. Under ConnectED, the president established two main goals to be accomplished by 2018.

1. Connect 99% of American students with access to next-generation broadband and high-speed wireless.
2. Ensure the federal government makes better use of existing funds to obtain robust Internet connectivity and educational technology in classrooms across the country.

Since the president's announcement, more than $10 billion has been committed as part of a five-year program to transform school-based access to broadband. This includes Federal Communications Commission (FCC) funding for school and library connectivity, with a current budget of $2.4 billion (adjusted for inflation) and an additional $2 billion to support Wi-Fi[4] in 2015 and 2016. For the subsequent three years, 2017 - 2019, the E-rate program will target $1 billion annually to Wi-Fi while continuing to ensure that funding is available for broadband connectivity to schools and libraries.

Texas' Long-Range Plan for Technology, 2006–2020 and 2014 Progress Report on the Long-Range Plan for Technology, 2006–2020

In the 2006 publication of the *Long-Range Plan for Technology, 2006–2020*, the Texas State Board of Education (SBOE) included a recommendation to schools to "design, install, and maintain a technology and telecommunications infrastructure for communications and services that ensures equitable access." The Internet and WAN connectivity targets recommended by SETDA were referenced in the TEA's *2014 Progress Report on the Long-Range Plan for Technology*, further expanding the state's recognition of these targets.

E-rate Modernization Order

As a result of the president's ConnectED Initiative, the FCC began an overhaul of the federal technology discount program for schools and libraries, known as the E-rate program[5]. This overhaul resulted in the issuance of the *E-rate Modernization Order* in July 2014 and the *Second E-rate Modernization Order* in December 2014. In the first *Modernization Order*, the FCC adopted the following three goals for the E-rate program: (1) to ensure affordable access to high-speed broadband sufficient to support digital learning in schools, (2) to maximize the cost-effectiveness of spending for E-rate supported purchases, and (3) to make the E-rate application process and other E-rate processes fast, simple, and efficient. The first *Modernization Order* adopted SETDA's connectivity targets for Internet access and WAN connections. In addition, the *First Modernization Order* created new category designations, Category 1 (broadband connectivity) and Category 2

[3] https://www.whitehouse.gov/issues/education/K–12/connected

[4] Local area computer network that allows computers, smartphones, or other devices to the Internet or communicate with one another wirelessly in a particular area

[5] The Schools and Libraries Program of the Universal Service Fund, commonly known as the E-rate program, provides discounts of up to 90% to eligible schools and libraries help ensure they can obtain high-speed Internet access and telecommunications at affordable rates.

(internal connectivity), and established separate funding targets for each category. This Order provided an additional $5 billion dollars to be made available over a five-year period to help elementary and secondary schools[6] focus on the internal Wi-Fi networks needed to connect their students to 21st century educational tools and resources.

In the *Second Modernization Order*, the FCC provided additional flexibility to schools seeking to adopt high-speed broadband connections. Based on their research[7], the FCC found that the lack of access to affordable broadband infrastructure, particularly in rural areas, and the high recurring costs of high-speed connections in many other areas were two major obstacles for schools to achieve target goals.

Schools have several options when looking to obtain high-speed broadband, including leasing fiber or building their own fiber network. Most large cities have an abundant supply of service providers and competitive rates. Other areas, such as towns and rural areas, may or may not have access to fiber and competitive pricing. Understanding that fiber is the most affordable solution to give schools a scalable, flexible infrastructure that can last for many years, the FCC in the *Second Modernization Order* created an opportunity to support fiber construction projects through their E-rate rule changes and the additional funding available through 2019. The FCC also encouraged schools that are constructing fiber networks to consider multipurpose projects in which other community partners such as libraries and governmental entities are also served. E-rate will not fund excess capacity (fiber strands), but will cover the construction charges.

The following new FCC E-rate rules can help close the fiber-gap in underserved areas of Texas[8].

- Raising the funding cap to $3.9 billion per year, indexed to inflation
- Funding the cost of deploying new fiber (as opposed to on-going costs of leasing or maintaining and operating fiber)
- Providing capital that will reduce monthly recurring costs if a district leases fiber from a service provider
- Providing up to 10% additional discount on the construction costs if the State of Texas matches up to 10% of the total cost
- Requiring certain service providers in certain areas of Texas to offer high-speed broadband to schools for rates comparable to similar services in urban areas

Connected Texas

Connected Texas[9] was commissioned by the Texas Department of Agriculture to work with all broadband providers in the state of Texas to create detailed maps of broadband coverage in order to accurately pinpoint remaining gaps in broadband availability in Texas. At the same time the E-rate program was being modernized, Connected Texas was conducting a survey of Texas households to determine how children are using the Internet and whether other options were available to students who do not have Internet access at home[10].

[6] To be eligible for support from the E-rate program, schools must meet the statutory definition of an elementary or secondary school found in the No Child Left Behind Act of 2001 (20 U.S.C. § 7801 (18) and (38)).
[7] 2015 E-rate Application Questionnaire, http://www.usac.org/sl/tools/default.aspx
[8] http://www.fcc.gov/page/summary-second-e-rate-modernization-order
[9] Not-for-profit subsidiary of Connected Nation, an organization established to facilitate public-private partnerships to increase access to and use of broadband and related technologies
[10] http://www.connectedtx.org/sites/default/files/connected-nation/Texas/files/tx_education_report.pdf

In its study, Connected Texas found the majority of school-age children have a computer at home. Only 8% of parents who have school-age children report not having a home computer, while nearly twice that number (15%) say they do not have broadband service at home. According to the Connected Texas report, more than 950,000 school-age children in Texas have to rely on alternative ways to study or conduct research online for school when they are at home. Those percentages are higher among Hispanic families, households that earn less than $35,000 per year, and rural households.

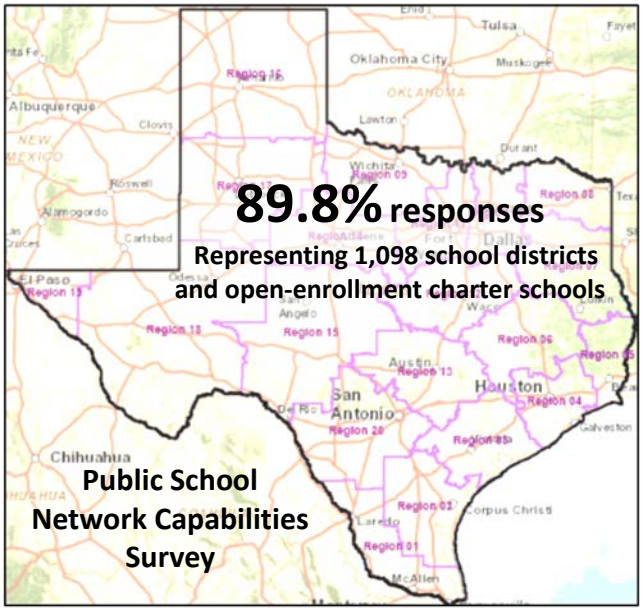
Texas Key Findings

In 2013, the Texas Legislature established TEC §32.005, requiring the commissioner of education to conduct a study to assess the network capabilities of each school district in the state. The study must gather sufficient information to determine whether the network connections of a district and school campuses in the district meet the following targets:

1. An external Internet connection to a campus's Internet service provider featuring a bandwidth capable of a broadband speed of at least 100 megabits (Mbps) per second for every 1,000 students and staff members
2. An internal wide area network (WAN) connection between the district and each of the school campuses in the district featuring a bandwidth capable of a broadband speed of at least one gigabit (Gbps) per second for every 1,000 students and staff members

About the Public School Network Capabilities Survey

On January 6, 2015, TEA sent a letter to school administrators announcing the Public School Network Capabilities Survey[11], which was aimed at gathering information for the required study. The survey was subsequently sent to 1,223 districts and open-enrollment charter schools comprised of more than 8,000 campuses. Of the 1,223 school districts and charter schools 1,098 submitted responses to TEA by March 2015 for a total response rate of 89.8%.



The survey (See Appendix C for complete survey.) consisted of twelve questions that asked districts and open-enrollment charter schools to self-report their networking capabilities and the capabilities of each school campus in the district. Survey questions addressed the following:

- Internet connection speed of each individual campus
- Type of Internet connection used between each campus and the campus's ISP
- Barriers, if any, that prevent the campus from acquiring the Internet target and using the full Internet connectivity speed available
- WAN connection speed between the district and each school campus in the district
- Barriers, if any, that prevent the district from acquiring the WAN target and using the full WAN connectivity speed available

11 http://tea.texas.gov/About_TEA/News_and_Multimedia/Correspondence/TAA_Letters/Public_School_Network_Capabilities_Survey/

About the Survey Data Analysis

For the purpose of this study, the 2013–2014 Public Education Information Management System (PEIMS) district and campus student enrollment was combined with the professional classroom and professional non-classroom staff counts[12] to determine the total headcount for each district and campus. This was the most current data available at the time the survey was conducted. The Survey Results section of this report shows the campus survey responses at the statewide level. Additional detail is provided by a variety of variables such as district size, ESC region, and campus and district locale categories as defined by the National Center for Education Statistics (NCES). (Refer to NCES locale descriptions in the table on page 10.)

Of the 1,098 districts and charter schools that submitted survey responses, a total of 249 campuses were excluded, leaving 7,899 campus responses in the analysis of responses to one or more survey question. The 249 campuses were excluded for a variety of reasons, including the following:

- District reported campus closed
- No responses were submitted for that specific campus
- Campus is a Juvenile Alternative Education Program (JJAEP) special purpose program
- Campus is a Texas Virtual School Network full-time online school and does not have a physical campus
- Campus, district, or charter school was not assigned an NCES locale code

Of the 7,899 campus responses included in the survey data set, an additional 51 campuses were excluded primarily because no staff counts were reported in PEIMS. An additional 10 campuses were excluded because they were not assigned a campus locale code by NCES, leaving a total of 7,838 campuses which could be included in the survey analysis.

Districts and charter schools did not necessarily provide a response for each campus and for each question; therefore, the number of responses varies by survey question. The number of responses is noted for each data analysis item included in this report.

To determine whether a campus met the Internet and WAN targets, TEA calculated the Internet and WAN speeds self-reported by the district for each campus speed per 1,000 students and staff members (based on PEIMS student enrollment and staff counts). Additionally, districts were asked to report whether a campus had a dedicated connection or shared the connection with all or some of the campuses in the district. For campuses that shared a connection, the maximum speed reported for those campuses sharing the connection was used in the calculation. If the district did not provide connection speeds for a campus or if it did not indicate the connection sharing scenario, then not enough information was available to determine whether the campus met target, and the campus was reported in the "NA" category.

In addition to the TEA calculations described above, the survey also asked districts for their perceptions as to whether the Internet and WAN targets were met for each campus in the district. Of the 7,838 campuses included in the data analysis, 3,062 (39%) campuses indicated that they thought they met target. However, calculations indicated that only 2,041 (26%) campuses actually met the target. The difference between the perceptions of whether campuses met the Internet target and the calculated value was 13%. Similarly for the WAN target, calculations for the 7,838 campuses included in the data analysis determined that 4,833 (62%) campuses met the WAN target, compared to the campuses' perceptions that 5,235 (67%) campuses met the target. The difference between the perceptions of whether campuses met the WAN target and the calculated value was 5%.

[12] Available as of November 2015 at http://ritter.tea.state.tx.us/adhocrpt/adste.html and http://ritter.tea.state.tx.us/cgi/sas/broker. As of January 2016, available at https://rptsvr1.tea.state.tx.us/adhocrpt/adste.html and https://rptsvr1.tea.state.tx.us/cgi/sas/broker.

Campus Locale Categories

In this study, campuses are reported under one of four main categories assigned by the NCES (city, suburb, town, or rural). Based upon geographic location and population density, these campus locale categories are frequently used by the FCC and the E-rate program as well as other national studies and discussions on broadband.

One cannot assume that all campuses in a school district are identified in the same geographic classification. In fact, of the 1,223 districts and charter schools across the state that were sent a Public School Network Capabilities Survey, 25% (309) have campuses in multiple geographic categories. For example, Humble Independent School District (ISD) includes Kingwood Middle School in the city category, Humble Elementary in the suburb category, and Humble High School in the rural category.

The chart below identifies the main campus and district locale categories and subcategories as assigned by NCES and used in the Public School Network Capabilities Study, with examples of Texas campuses.

Main NCES Campus Locale Category	**NCES Campus Locale Subcategory with Geographic and Population Density Description**	**Examples of Campus Locale Category with School District**
City	Inside urbanized area* with population of ≥50,000 and inside principle city** with population of • Large = ≥250,000 • Midsize = <250,000 & ≥100,000 • Small = <100,000	Hickey Elementary, Plano ISD Estacado High School, Lubbock ISD Kingwood Middle, Humble ISD Oak Meadow Elementary, Manor ISD
Suburb	Outside principal city and inside urbanized area with population of • Large = ≥250,000 • Midsize = <250,000 & ≥100,000 • Small = <100,000	Humble Elementary, Humble ISD McKinney High School, McKinney ISD Hernandez Elementary, San Marcos ISD Decker Middle, Manor ISD
Town	Inside urban cluster* with population of 25,000–50,000 and outside urbanized area by • Fringe = ≤10 miles • Distant = >10 miles & ≤35 miles • Remote = >35 miles	Elgin Elementary, Elgin ISD Kennedy Elementary, Terrell ISD Lufkin High School, Lufkin ISD Presidential Meadow Elementary, Manor ISD
Rural	Census-defined rural territory outside urbanized area and urban cluster by • Fringe = ≤5 miles from urbanized area & ≤2.5 miles from urban cluster • Distant = >5miles & ≤25 miles from urbanized area and >2.5 miles & ≤10 miles from urban cluster • Remote = >25 miles from urbanized area & >10 miles from urban cluster	Humble High School, Humble ISD Itasca High School, Itasca ISD Wright Elementary, Lubbock ISD Manor High School, Manor ISD

*Urbanized areas and clusters: densely settled cores of census blocks with adjacent densely settled surrounding areas. When the core contains a population ≥50,000 it is designated as an urbanized area; core areas with populations of 25,000–50,000 are classified as urban clusters.

**Principal city: primary population and economic center of one or more contiguous counties that have a core area with a large population nucleus and adjacent communities that are highly integrated by economics or socially with the core.

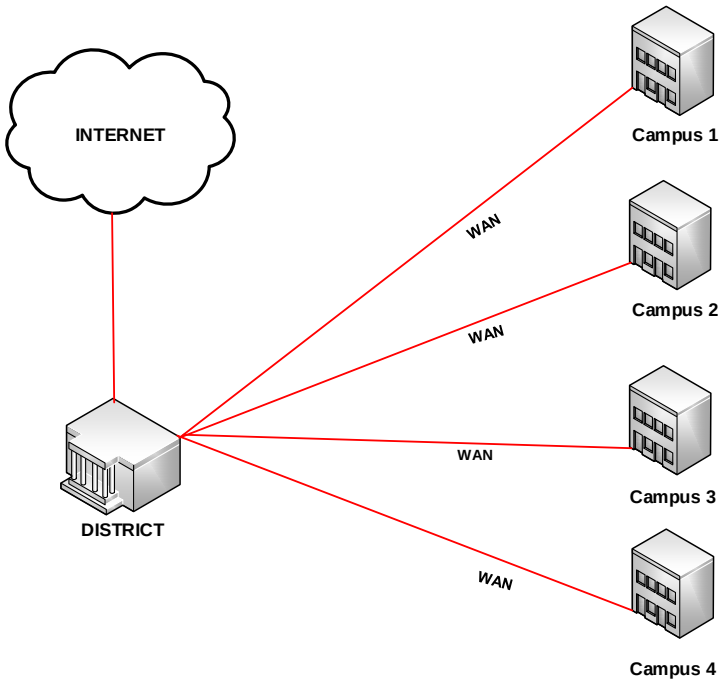
Understanding Internet Access and WAN Connections

This survey is based upon the targets for Internet and WAN connectivity specified in TEC, §32.005, which align to the SEDTA connectivity targets. The survey asked for information on the size of the Internet connection from a campus to its Internet Service Provider (ISP) and the size of the transport connection between the campus and the district's central network site (WAN connection). The responses included in the survey allowed districts to report actual speed up to a maximum of 9,999 Mbps, which is approximately 10 Gbps. Some, but not all, districts entered comments within the survey tool to indicate a higher connection size and speed. For purposes of this study, reported speeds were grouped into three speed range categories: 1–999 Mbps; 1,000–9,998 Mbps[13]; and 10 Gbps or greater. Districts reporting connections of 9,999 Mbps or more are included within the 10 Gbps or greater range.

Of the 7,838 campuses included in the survey analysis, 90% of the campuses reported they receive Internet access in a shared model (Scenario 1: Shared Internet Access). This may indicate the network is designed with one connection to an ISP and Internet access capacity is shared among some or all campuses. Approximately 10% of reporting campuses use a dedicated connection from the campus directly to the ISP (Scenario 2: Dedicated Internet Access). Still other districts reported using a hybrid model in which some campuses are sharing Internet access and others have a dedicated connection to an ISP (Scenario 3: Hybrid Model). The use of a hybrid model, which includes one or more dedicated connections, may be necessitated by an access issue in which the outlying campus has no affordable option for connecting to the district WAN.

Diagram Examples of Several Typical School Networks (Internet and WAN Connections)

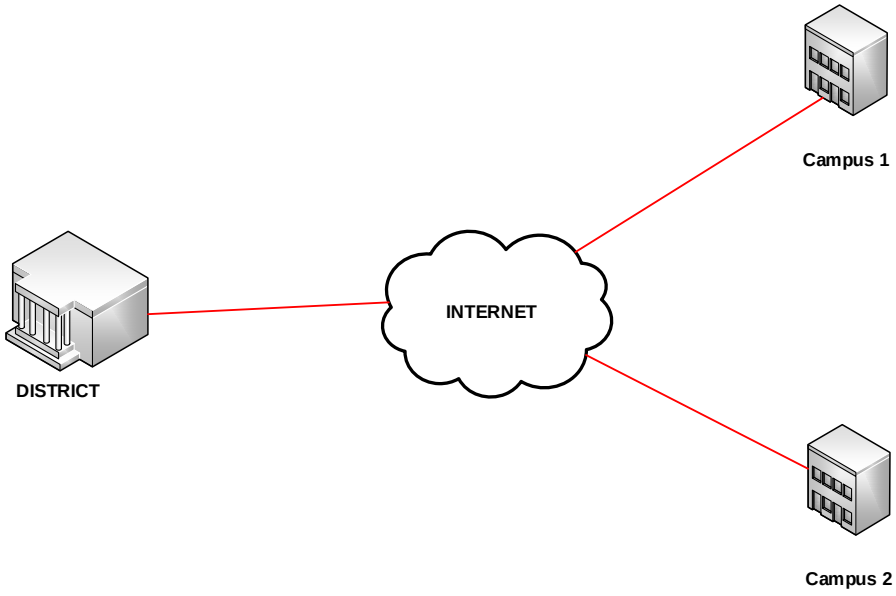
Scenario 1: Shared Internet Access



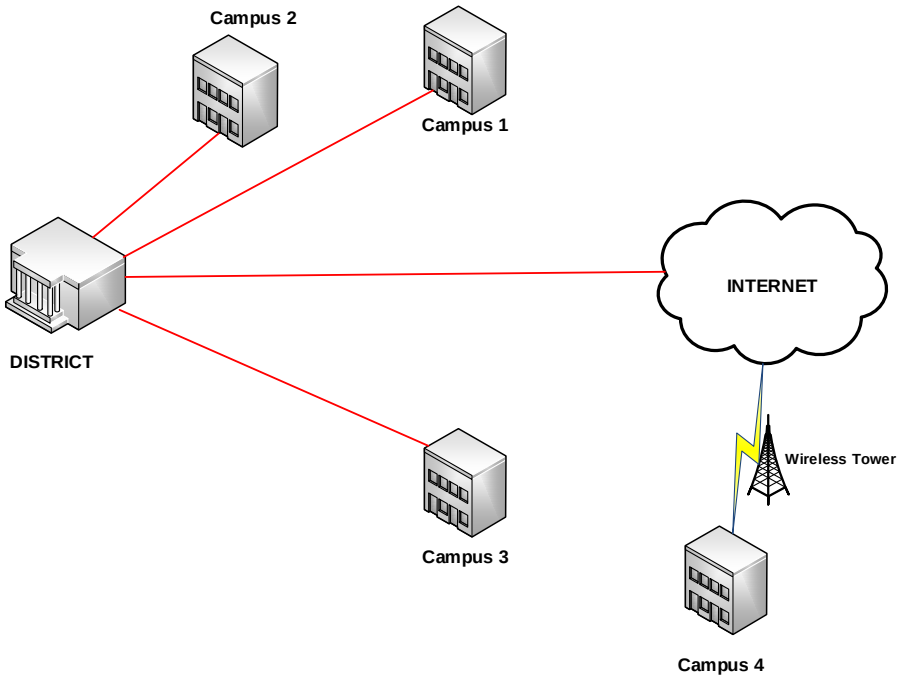
WAN: Internal wide area network between the campus and the district

[13] For survey questions that asked campuses to report connection speeds, the survey instrument allowed a maximum speed of 9,999 (approximately 10 Gbps) to be entered. Additional comments for some campuses were provided elsewhere in the survey and included specific connection speeds which were higher than 9,999.

Scenario 2: Dedicated Internet Access



Scenario 3: Hybrid Model



Survey Results

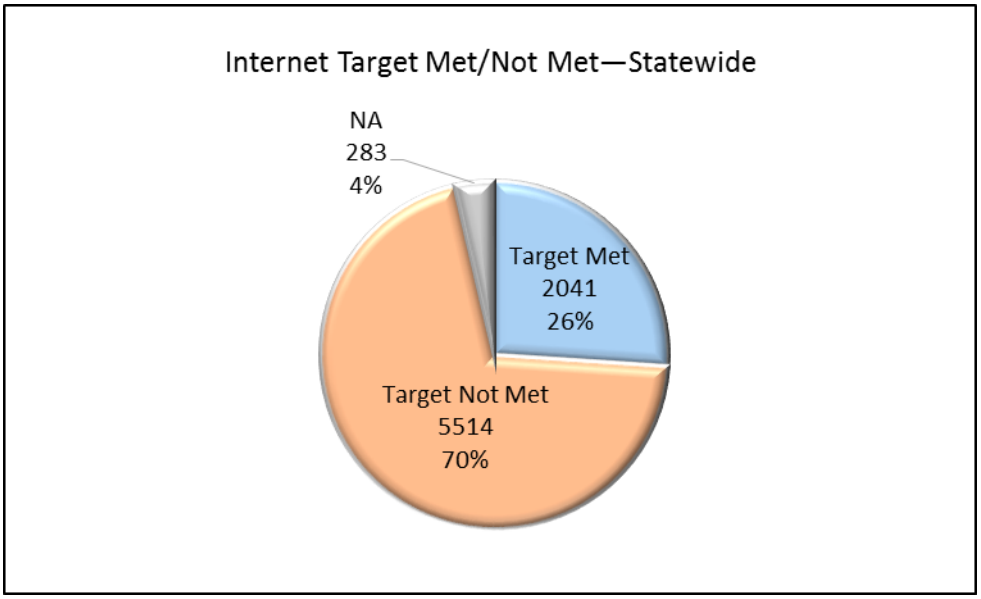
The results of the Public School Network Capabilities Survey are examined below based on Internet Connectivity, including the Internet connectivity capabilities and speed, types of connections between campuses and ISPs, and barriers to more robust Internet access and usage. The analysis also includes issues related to wide area network (WAN) connectivity at the district level, including connectivity speed, targets, and barriers.

Internet Connectivity

Campuses Meeting Internet Target

Of the 7,838 campuses included in the data analysis, 26% (2,041 campuses) met the target of 100 megabits per second (Mbps) for every 1,000 students and staff members and 70% (5,514 campuses) did not meet the target. TEA did not receive sufficient data to make these calculations for 283 campuses (4%). These campuses are shown in the data analysis exhibits as NA.

Exhibit #1



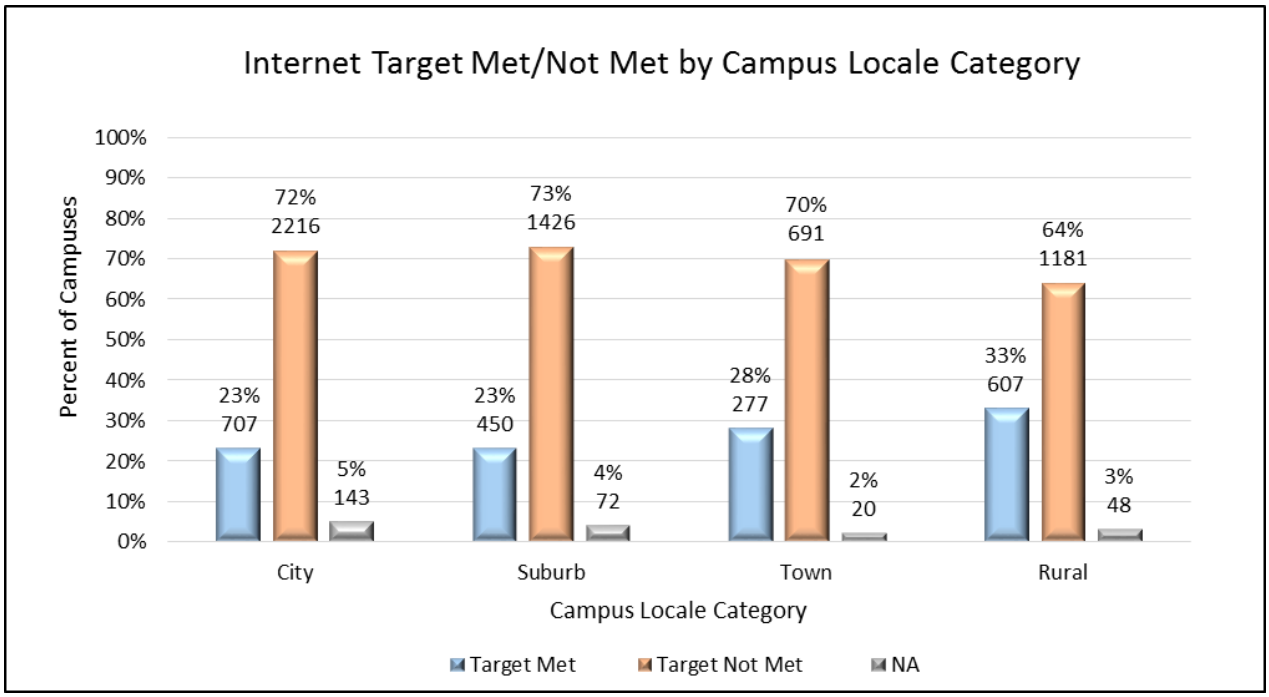
Campuses Responding: 7,838
Source: Public School Network Capabilities Survey

Campuses Meeting Internet Target by Campus Locale Category

Of the 2,041 campuses statewide that met the Internet connectivity target, the campus locale category with the largest number of campuses that met target was city, followed by rural, suburb, and town. For the 5,514 campuses statewide that did not meet the Internet connectivity target, the campus locale category with the largest number of campuses was city, followed by suburb, rural, and town.

It may be more informative to look at the percentage of campuses within each locale that met or did not meet the Internet target. The greatest percentage of campuses that met the Internet connectivity target were in the rural locale category (33%), followed by town (28%), while city and suburb categories were evenly matched with 23% of their campuses having met the Internet target.

Exhibit #2

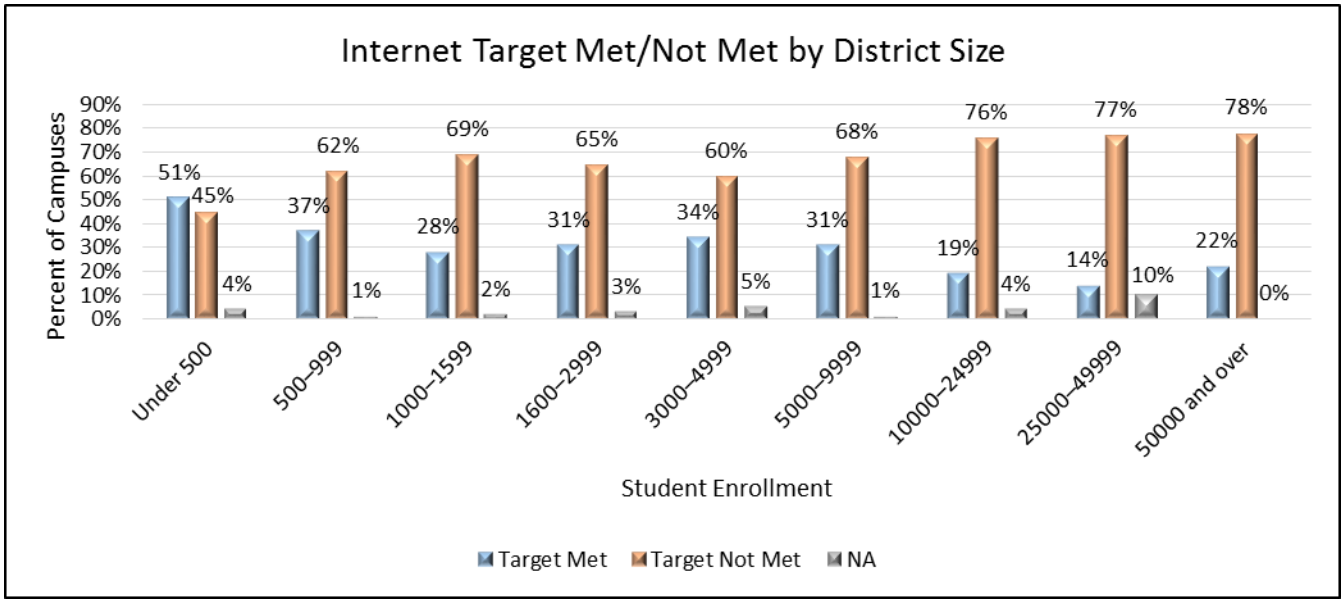


Campuses Responding: 7,838
Source: Public School Network Capabilities Survey

Campuses Meeting Internet Target by District Size

PEIMS identifies districts in nine categories based on student enrollment, ranging from districts with fewer than 500 students to districts with 50,000 or more students. Of those nine categories, small districts—those with fewer than 1,000 students—had the highest percentage of campuses that met the Internet target. Large districts with 10,000 or more students had the lowest percentage of campuses that met target.

Exhibit #3



Campuses Responding: 7,838 *Note: Due to rounding, totals may not equal 100.
Source: Public School Network Capabilities Survey

Campuses Meeting Internet Target by Education Service Center (ESC) Region

The percentage of campuses meeting the Internet target varied widely when looking at the campuses by ESC region. ESC Region 14 (61%) and Region 1 (46%), had the highest percentage of campuses within their regions that met target, followed by Region 13 (41%) and Region 11 (40%). The regions with the lowest percentage of campuses meeting target were Region 15 (7%), Region 17 (8%), Region 4 (10%), and Region 16 (11%). Some ESC regions that include major cities, such as Region 4 (Houston), Region 10 (Dallas), and Region 20 (San Antonio) had a low percentage of campuses that met the Internet target. Others, such as Region 11 (Fort Worth) and Region 13 (Austin) were significantly higher.

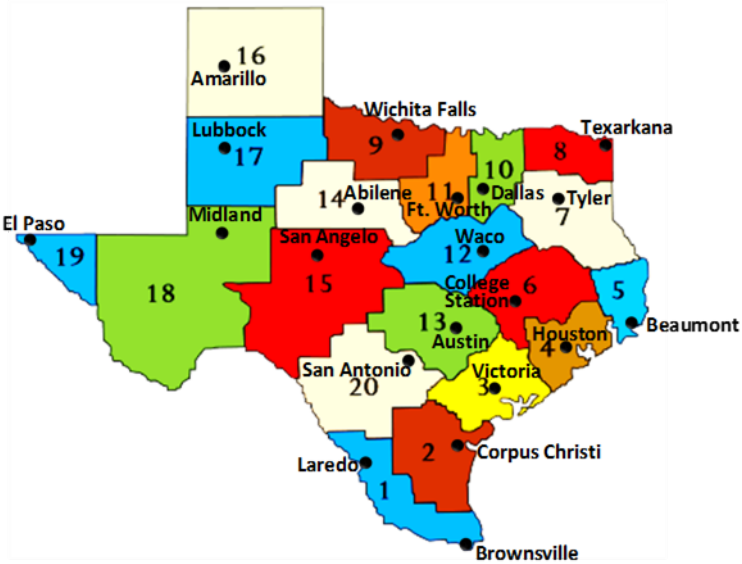
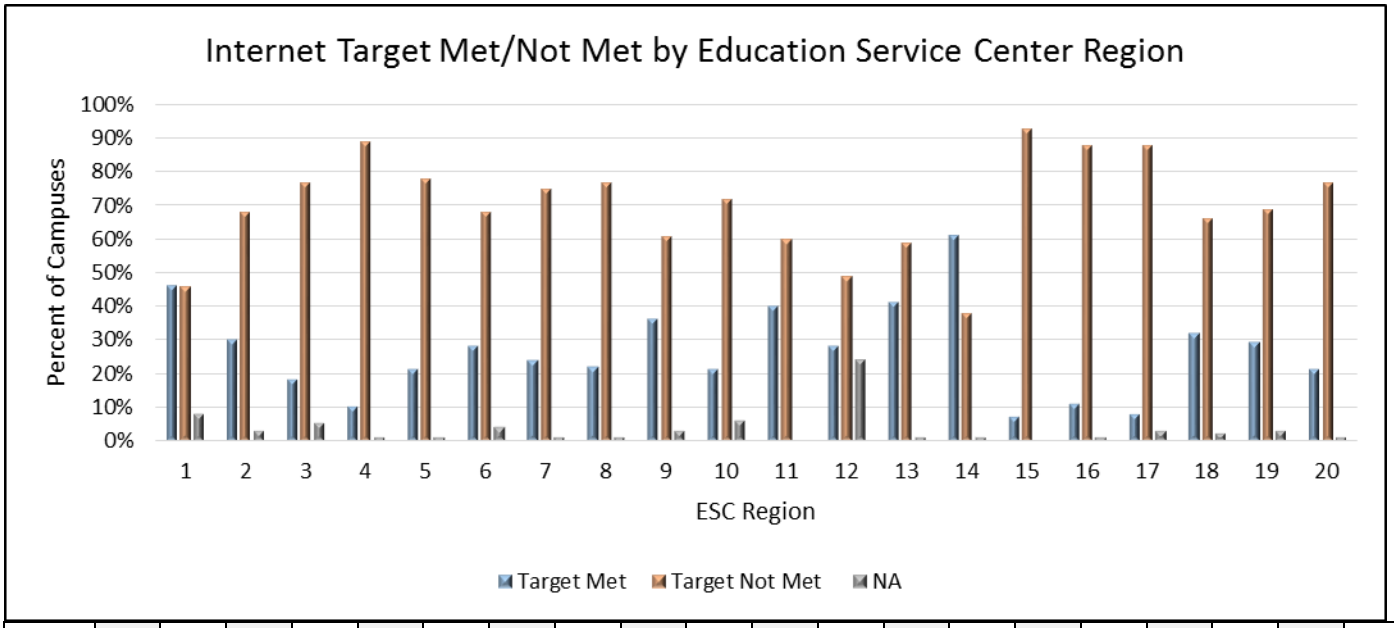


Exhibit #4



ESC Region	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Target Met	46%	30%	18%	10%	21%	28%	24%	22%	36%	21%	40%	28%	41%	61%	7%	11%	8%	32%	29%	21%
Target Not Met	46%	68%	77%	89%	78%	68%	75%	77%	61%	72%	60%	49%	59%	38%	93%	88%	88%	66%	69%	77%
NA	8%	3%	5%	1%	1%	4%	1%	1%	3%	6%	0%	24%	1%	1%	0%	1%	3%	2%	3%	1%

Campuses Responding: 7,838 *Note: Due to rounding, totals may not equal 100.

Source: Public School Network Capabilities Survey

Conclusion: The majority (70%) of campuses reporting an Internet connection do not meet the recommended target of at least 100 Mbps for every 1,000 students and staff. Geographic location and population density (NCES campus locale categories of city, suburb, town, or rural) do not appear to strongly influence whether a campus will meet the Internet connectivity speed target. While rural districts have a slightly higher percentage of campuses meeting the target, this is more likely a result of the size of student enrollment and staff.

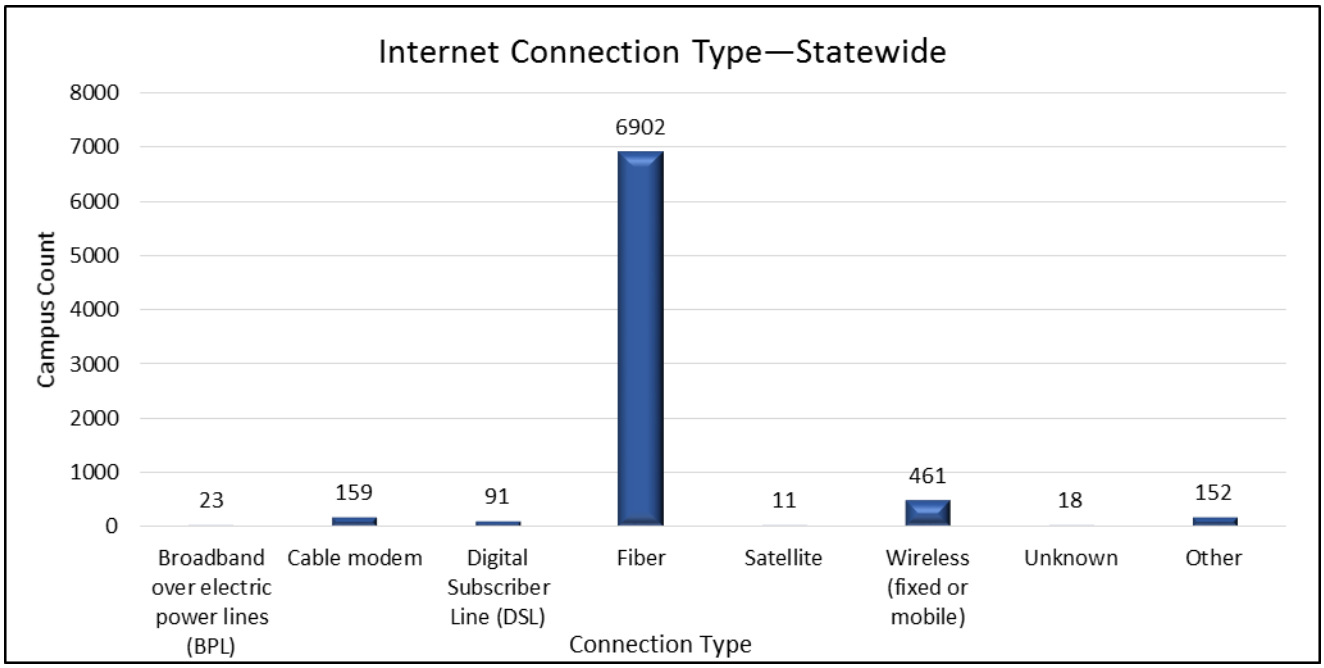
District size does not appear to be a predictor of whether a campus met the Internet target, except that the two smallest district categories were somewhat more likely to have met target (37%–51%) and the two largest district categories were less likely (14%–22%).

Connection between Campus and Internet Service Provider

Internet Connection Type—Statewide

Of the 7,817 campuses that responded to the survey question about the type of connection used for Internet access, 88% (6,902) of campuses indicated that they had a fiber connection to the Internet. Trailing far behind, the next connection type cited was wireless (fixed or mobile), at 6% (461 campuses).

Exhibit #5

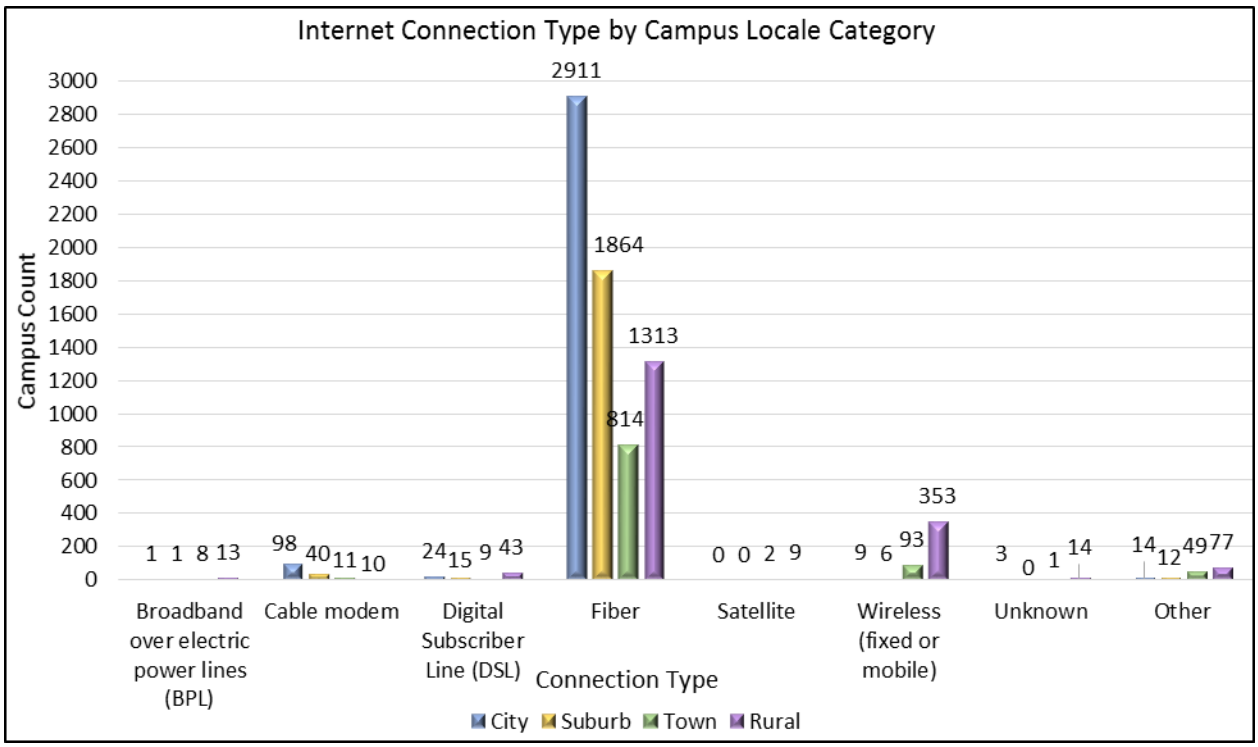


Campuses Responding: 7,817
Source: Public School Network Capabilities Survey

Internet Connection Type by Campus Locale Category

Regardless of a campus's locale, the most frequent connection type reported was fiber. Fiber was prevalent in 2,911 (95%) campuses in the city locale and 1,864 (96%) campuses in the suburb locale. Fiber was also highly present in 814 (82%) campuses in the town locale and 1,313 (72%) campuses in the rural locale. Although reported in far fewer instances than fiber, wireless (fixed or mobile) was the second most frequently cited connection type in rural and town locales with 353 (19%) rural campuses and 93 (9%) town campuses citing wireless connections. Campuses in city (98) and suburb (40) locales cited a very small percentage (3% or less) of cable modem connections as their second most reported connection type.

Exhibit #6

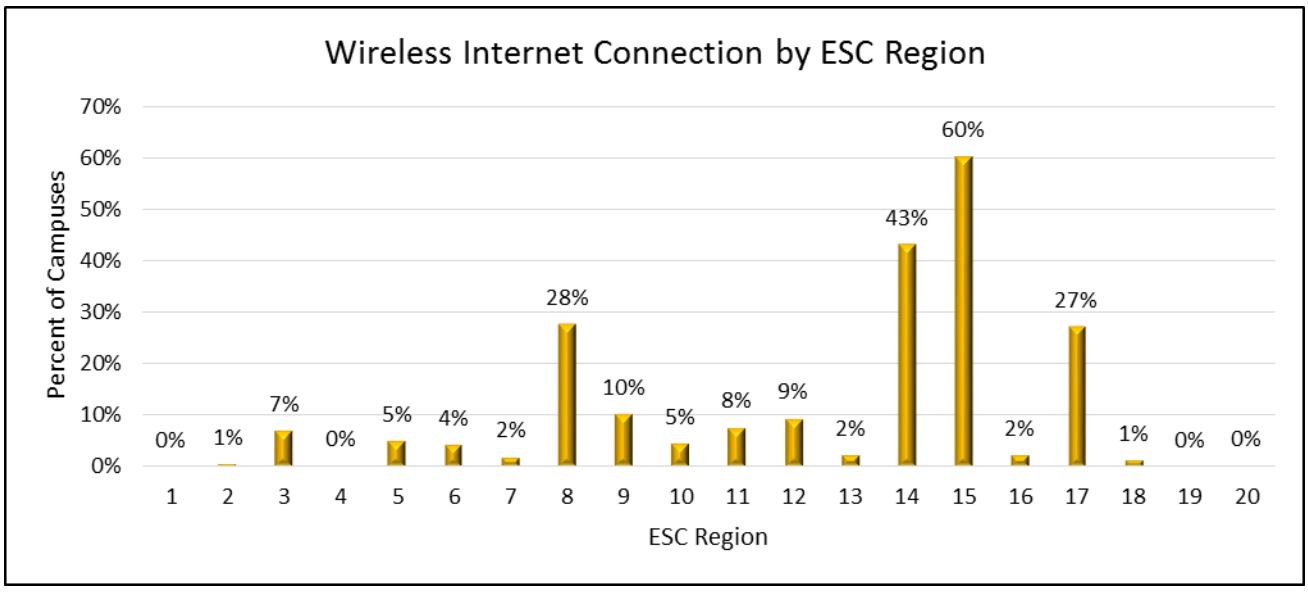


Campuses Responding: 7,817
Source: Public School Network Capabilities Survey

Wireless Internet Connections by ESC Region

Wireless internet connections were reported more frequently by campuses in ESC Region 8, Region 14, Region 15, and Region 17. At the time that these ESCs built wireless connectivity to the schools on their regional networks, wireless was an affordable option available to cover large geographical areas or dense tree-covered areas. This internet connection type remains as a secondary option in these ESCs.

Exhibit #7



Campuses Responding: 7,817
Source: Public School Network Capabilities Survey

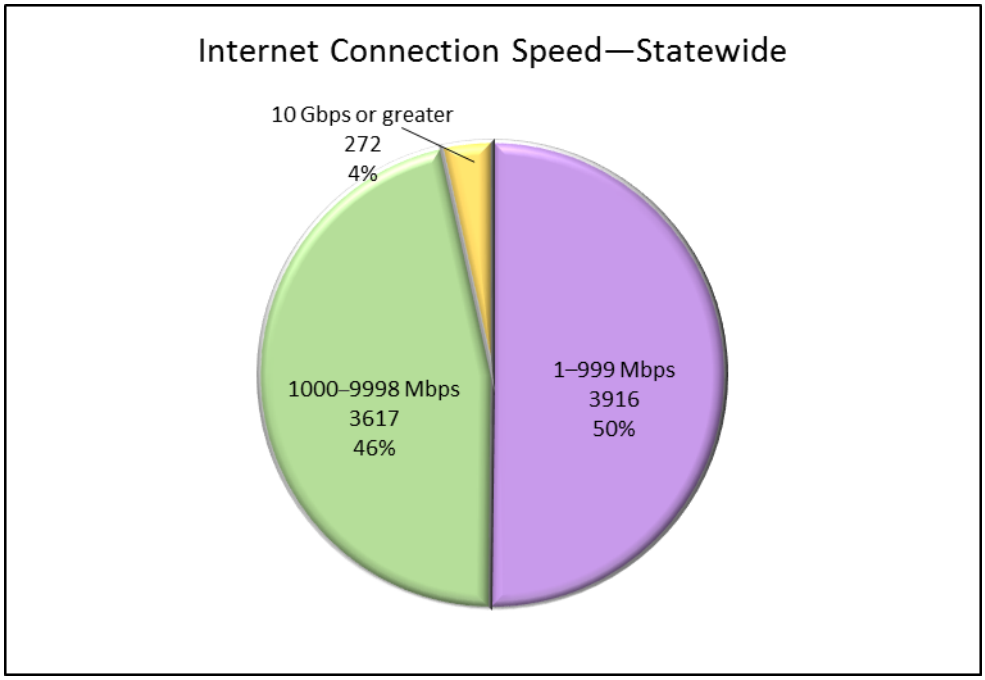
Conclusion: The dominant Internet connection type among Texas public schools is a fiber connection. The vast majority (88%) of campuses responding to the survey reported using fiber to connect to their ISP. Geographic location within the state, as represented by ESC region, may have the greatest influence on campuses using other connection types. Of the small number of campuses that reported other connection types, campuses in the town (93) and rural (353) locales used wireless (fixed or mobile), especially in Regions 8, 14, 15, and 17. A small number of campuses in the city (98) and suburb (40) locales reported using cable modem.

Campus Internet Connection Speed

Internet Connection Speed—Statewide

Of the 7,805 campuses that responded to the survey question about Internet connection speed, the most frequently occurring specific Internet connect speed is 1,000 Mbps, or 1 Gbps, (16% of campuses), followed by 100 Mbps (12% of campuses). The speed ranges most frequently reported are closely split between two categories, with 50% (3,916 campuses) in the 1–999 Mbps range and 46% (3,617 campuses) in the 1,000–9,998 range. A small number of campuses (272, or 4%) reported an Internet connection speed of 10 Gbps or greater.

Exhibit #8



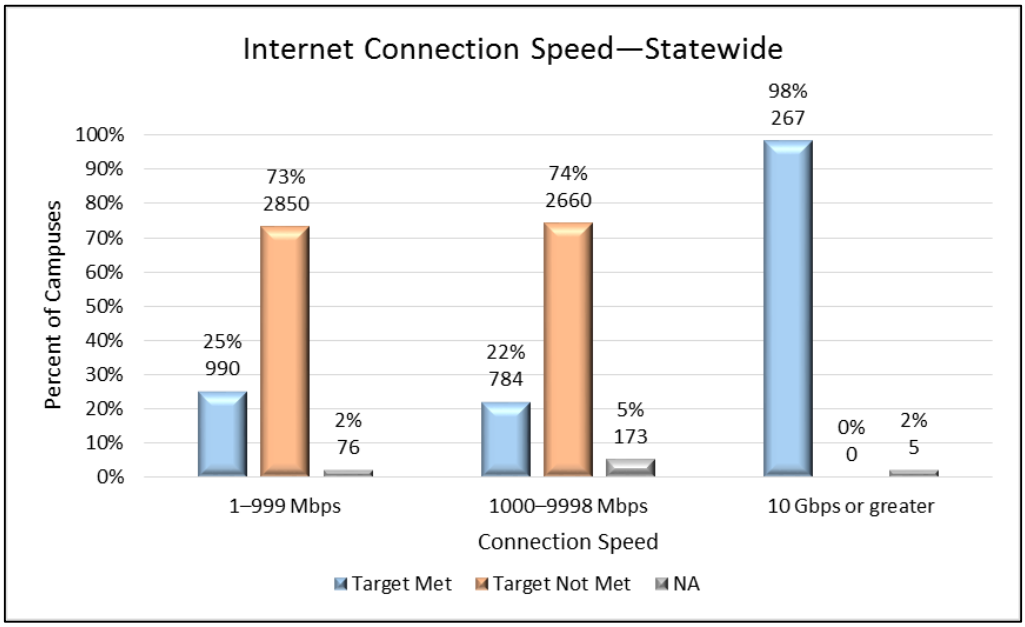
Campuses Responding: 7,805
Source: Public School Network Capabilities Survey

Statewide Internet Connection Speeds for Campuses Meeting Internet Targets

Of the 2,041 campuses that met the Internet target of a bandwidth capable of a broadband speed of at least 100 Mbps for every 1,000 students and staff members, 990 campuses (49%) fell within the speed range of 1–999 Mbps, 784 campuses (38%) fell within the speed range of 1,000–9,998 Mbps, and 267 campuses (13%) had an Internet connection speed of 10 Gbps or greater.

Of the 5,510 campuses that did not meet the Internet target, 2,850 (52%) fell within the speed range of 1–999 Mbps and 2,660 (48%) fell within the speed range of 1,000–9,998 Mbps. No campus with an Internet connection speed of 10 Gbps or greater failed to meet the Internet target.

Exhibit #9

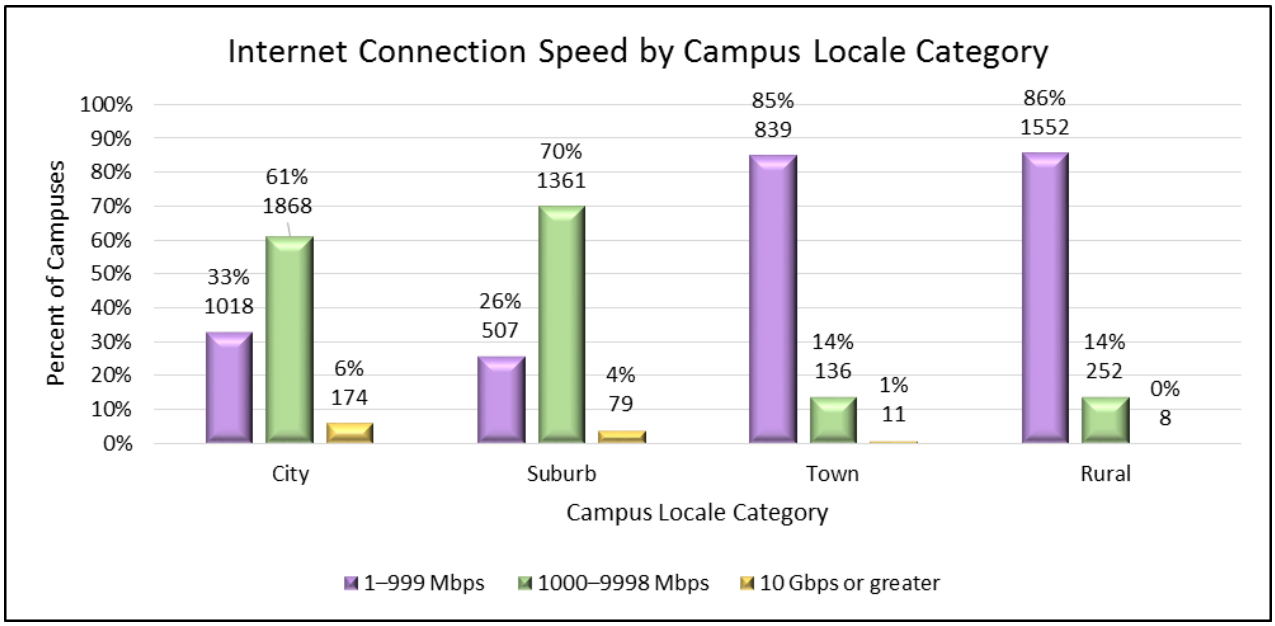


Campuses Responding: 7,805 *Note: Due to rounding, totals may not equal 100.
Source: Public School Network Capabilities Survey

Internet Connection Speed by Campus Locale Category

The city and suburb locales had a majority of connections in the speed range of 1,000–9,998 Mbps, while the town and rural locales had connections in the speed range of 1–999 Mbps.

Exhibit #10

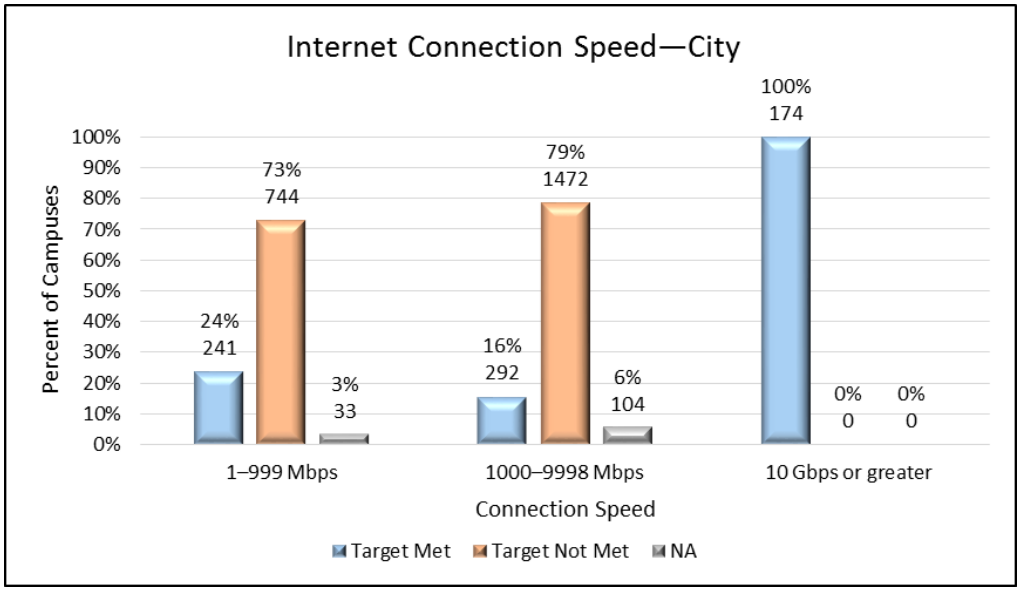


Campuses Responding: 7,805
Source: Public School Network Capabilities Survey

Campus Locale Category Internet Speeds

City: Of the 707 campuses that met target in the city category, the most frequently reported speed range was 1,000–9,998 Mbps. Similarly, of the 2,216 campuses that did not meet target, the most frequently reported speed range was also 1,000–9,998 Mbps. Of the reported 10 Gbps or greater connections, all 174 campuses met the target.

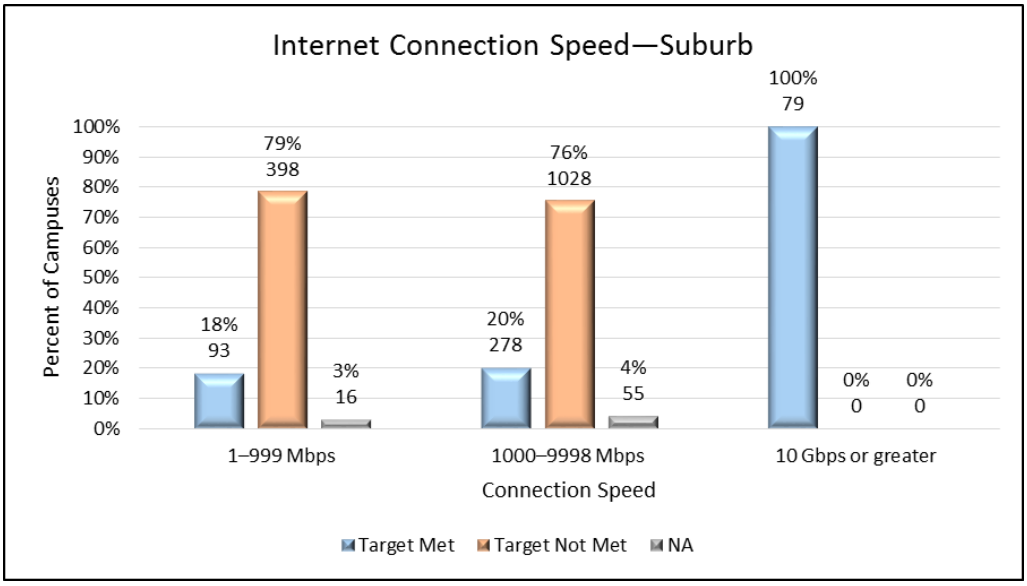
Exhibits #11a



Campuses Responding: 3,060 *Note: Due to rounding, totals may not equal 100.
Source: Public School Network Capabilities Survey

Suburb: Of the 450 campuses that met the Internet connectivity target, the most frequently cited speed range was 1,000–9,998 Mbps. Of the 1,426 campuses that did not meet target, the most frequently cited speed range was also 1,000–9,998 Mbps. The 79 campuses that reported 10 Gbps or greater connections all met the target.

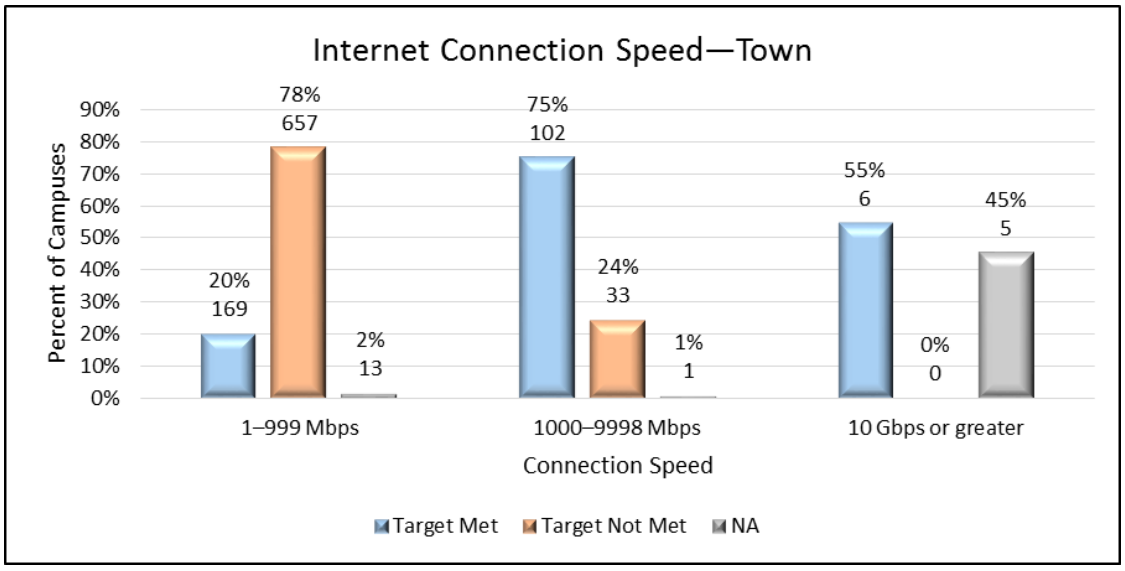
Exhibit #11b



Campuses Responding: 1,947
Source: Public School Network Capabilities Survey

Town: Of the 277 campuses that met the Internet connectivity target, the most frequently reported speed range was 1–999 Mbps. Of the 690 campuses that did not meet, the most frequently reported speed range was also 1–999 Mbps. Of the 11 campuses that reported 10 Gbps or greater connections, 6 campuses met the target and 5 did not provide sufficient data to calculate the target.

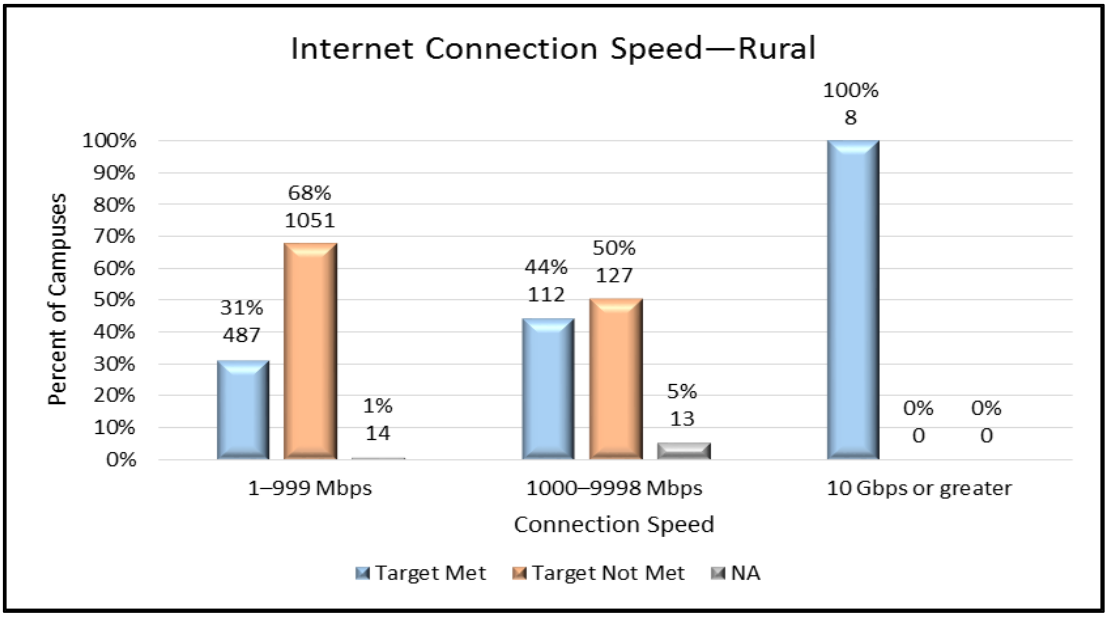
Exhibits #11c



Campuses Responding: 986
Source: Public School Network Capabilities Survey

Rural: Of the 607 campuses that met the Internet connection target, the most frequently cited speed was 1–999 Mbps. Of the 1,178 campuses that did not meet, the most frequent speed was also 1–999 Mbps. All 8 campuses that reported 10 Gbps or greater connections met the target.

Exhibits #11d



Campuses Responding: 1,812 *Note: Due to rounding, totals may not equal 100.
Source: Public School Network Capabilities Survey

Conclusions: TEC, §32.005 specifies the target speed for an external Internet connection to a campus's Internet service provider as a bandwidth capable of a broadband speed of at least 100 megabits (Mbps) per second for every 1,000 students and staff members. A connection speed in the 1–999 Mbps speed range was reported by 50% of campuses, followed closely by the 1,000–9,998 Mbps speed range at 46%. The city locale had the largest number of 10 Gbps connections, followed by suburb, town, and rural. For campuses that did not meet target, city locales (66%) and suburb locales (72%) reported connections in the speed range of 1,000–9,998 Mbps while campuses in the town locales (95%) and rural (89%) locales reported a speed range of 1–999 Mbps.

The speed range reported by a campus did not, by itself, impact whether or not a campus met or did not meet the Internet target. As above, it is the ratio between speed and headcount that determines if the target is met.

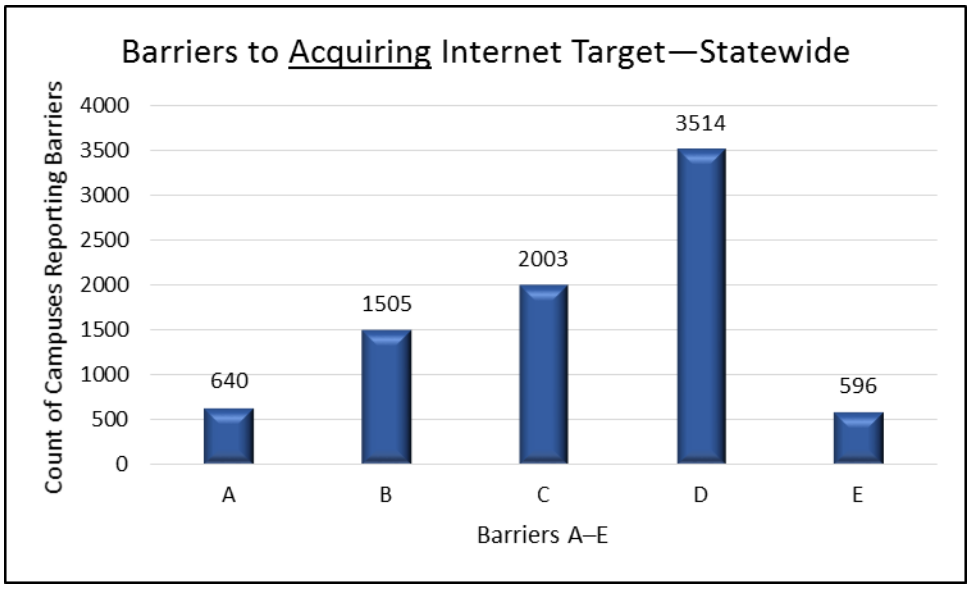
Barriers Preventing Campuses from Acquiring Internet Connection Speeds that Meet Target

Barriers to Acquiring Internet Target

Some 7,816 campuses responded to a question asking about barriers that prevent campuses from meeting the Internet connection target. Each campus was allowed to select up to two barriers, if any, which prevented the campus from acquiring an Internet connection speed of at least 100 Mbps for every 1,000 students and staff members. Because campuses could select multiple barriers, percentage totals do not equal 100%.

Of campuses responding to this question, 2,968 (38%) reported no barriers. Of the 4,848 campuses (62%) that reported barriers, 3,514 campuses (73%) cited "Necessary funds are not available in district/campus budget," making that conclusively the most frequently reported barrier. The second most frequently cited barrier was "Current hardware or software does not support higher speeds," with 2,003 campuses (41%) selecting this as a key barrier. The third most cited barrier (1,505 campuses or 41%) was "Higher speed connection only available at premium rate."

Exhibit #12



A – Internet service provider cannot provide any higher speed or connection

B – Higher speed connection only available at premium rate

C – Current hardware or software does not support higher speeds

D – Necessary funds are not available in district/campus budget

E – Other

Campuses Reporting Barriers: 4,848
Source: Public School Network Capabilities Survey

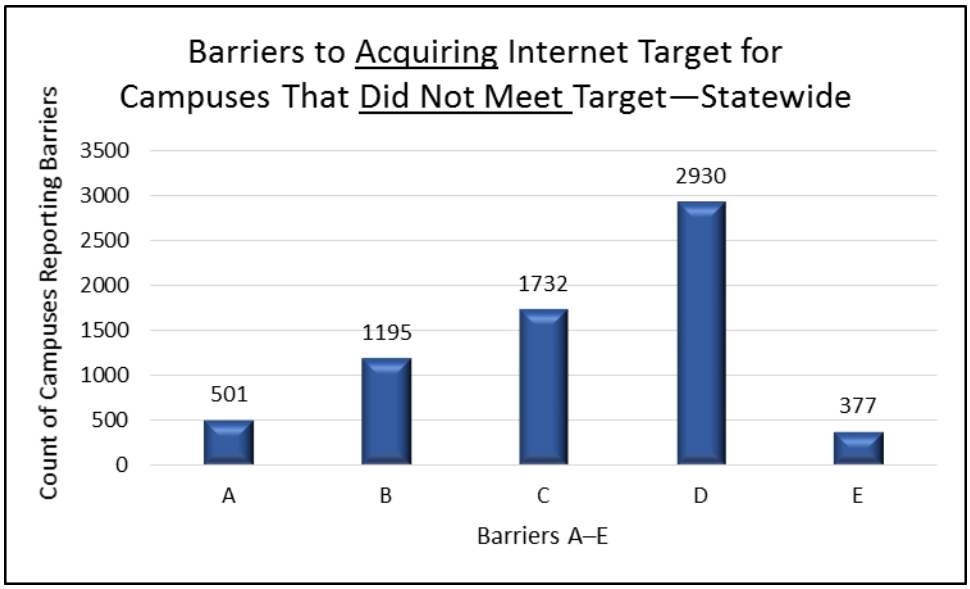
Barriers to Acquiring Internet Target for Campuses That Did Not Meet Target

Of the 7,816 campuses responding to the question, 5,433 (70%) did not meet the Internet connectivity target. Of these campuses, 1,479 (27%) reported no barriers. Comments provided by campuses that reported no

barriers included explanations that the campus is planning an upgrade within the 2015–2016 school year or when their current contract expires. Of the campuses that selected one or more barriers, 2,930 (74%) selected "Necessary funds are not available in district/campus budget," 1,732 (44%) selected "Current hardware or software does not support higher speeds," 1,195 (30%) selected "Higher speed connection only available at premium rate," and 501 (13%) selected "Internet service provider cannot provide any higher speed or connection."

The comments provided by campuses reporting barriers focused on the cost and limited options in rural areas, timing of E-rate application process, need for updated equipment, and access to and cost of fiber construction.

Exhibit #13



A – Internet service provider cannot provide any higher speed or connection

B – Higher speed connection only available at premium rate

C – Current hardware or software does not support higher speeds

D – Necessary funds are not available in district/campus budget

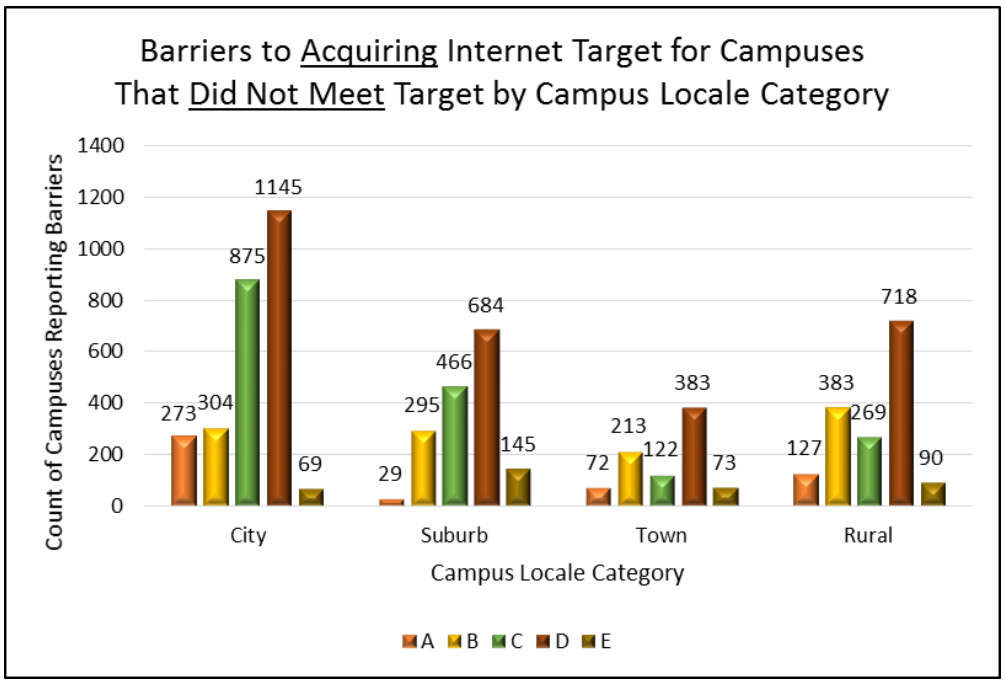
E – Other

Campuses Reporting Barriers: 3,954
Source: Public School Network Capabilities Survey

Barriers to Acquiring Internet Target for Campuses that Do Not Meet Target by Campus Locale Category

Regardless of where a campus was located, the most frequent barrier selected was "Necessary funds are not available in district/campus budget." Locale became a factor when looking at the second most selected barrier. Of the campuses that did not meet the Internet target and reported barriers, campuses in city and suburb locales both chose "Current hardware or software does not support higher speeds" more often, while campuses in the rural and town locales chose "Higher speed connection only available at premium rate."

Exhibit #14



A – Internet service provider cannot provide any higher speed or connection

B – Higher speed connection only available at premium rate

C – Current hardware or software does not support higher speeds

D – Necessary funds are not available in district/campus budget

E – Other

Campuses Reporting Barriers: 3,954
Source: Public School Network Capabilities Survey

Conclusion: Statewide, 3,514 campuses (73%) cited the lack of necessary funds in the budget as one of the top two barriers to meeting the Internet target, followed by 2,003 campuses (41%) reporting that their current hardware cannot support higher speeds as a top barrier, and 1,505 campuses (31%) reporting that higher speeds were only available at premium prices.

Of the 5,433 campuses that did not meet the Internet target, 3,954 (73%) reported barriers to acquiring the Internet target. These campuses also overwhelmingly (74%) cited a lack of necessary funds in the budget. Locale became a factor when reporting the second-most cited barrier, with city and suburb locales reporting that their current hardware cannot support higher speeds and town and rural locales reporting that higher speeds were only available at premium rates.

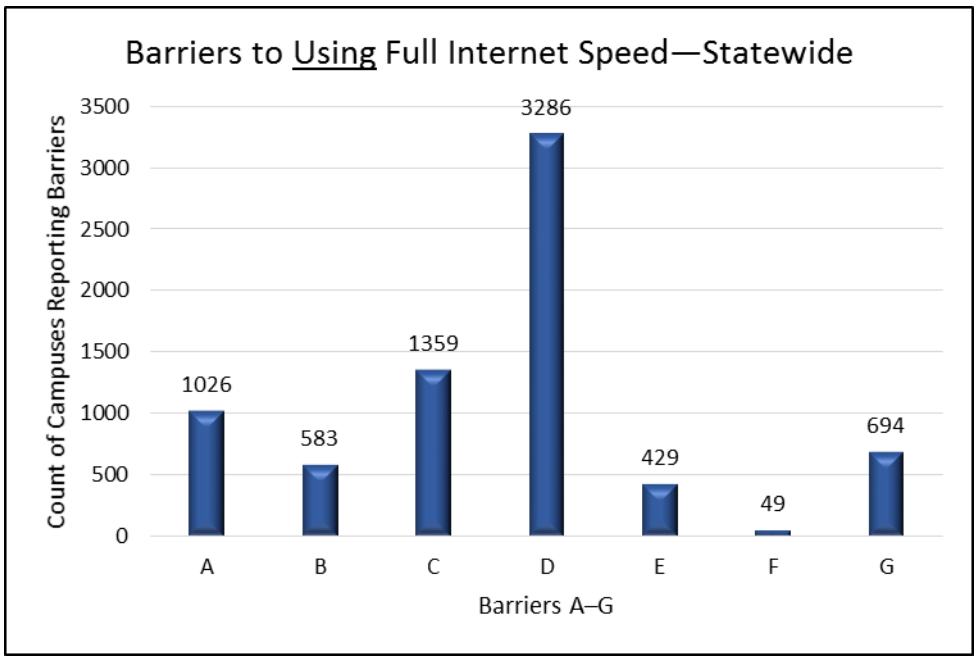
Barriers Preventing Campuses from Using the Full Internet Connection Speed

Barriers to Using Full Internet Speed

7,810 campuses responded to the question about barriers that prevent the campus from using the full speed of the Internet connection currently in place. Each campus was allowed to select up to two barriers, if any, which prevented the campus from acquiring an Internet connection speed of at least 100 Mbps for every 1,000 students and staff members. A campus could select up to two barriers, therefore percentage totals do not equal 100%.

Of campuses responding to this question, 3,559 (46%) reported no barriers. Of the 4,251 (54%) campuses reporting barriers, 3,286 (77%) cited “Connection is shared with another campus, entity, or facility,” making that conclusively the most frequently reported barrier. The second most frequently cited barrier, was “Simultaneous use of same connection for multiple applications significantly slows connection speed,” with 1,359 (32%) of campuses selecting this as a barrier.

Exhibit #15



A – Equipment not properly sized
B – Use of application requiring large bandwidth significantly slows connection speed
C – Simultaneous use of same connection for multiple applications significantly slows connection speed
D – Connection is shared with another campus, entity, or facility
E – Network configuration creates bottleneck
F – Networking technical expertise not available
G – Other

Campuses Reporting Barriers: 4,251
Source: Public School Network Capabilities Survey

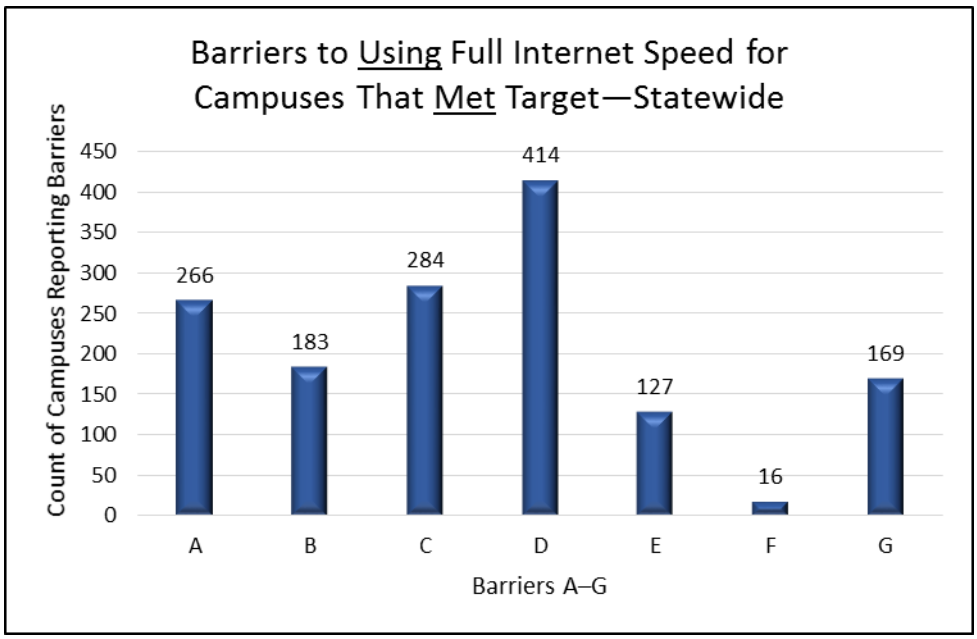
Of the 7,810 campuses, 2,040 (26%) met the Internet target.

Barriers to Using Full Internet Speed for Campuses That Met Internet Target

Of the 2,040 campuses that met the Internet connection target and responded to the question about barriers to using the full speed of the connection currently in place, 1,207 (59%) reported no barriers. Of the 833 campuses that selected one or more barriers, 414 campuses (50%) selected the barrier "Connection is shared with another campus, entity, or facility," 284 campuses (34%) selected "Simultaneous use of same connection for multiple applications significantly slows connection speed," 266 campuses (32%) selected "Equipment not properly sized," 183 campuses (22%) selected "Use of application requiring large bandwidth significantly slows connection speed," and 127 campuses (15%) selected "Internet service provider cannot provide any higher speed or connection." Less than 2% of campuses (16) selected "Networking technical expertise not available."

Campuses were able to provide comments regarding barriers preventing the use of the full speed of the existing connection. Comments focused on the age of the equipment, the need for additional equipment, and the need for technology integration training.

Exhibit #16:



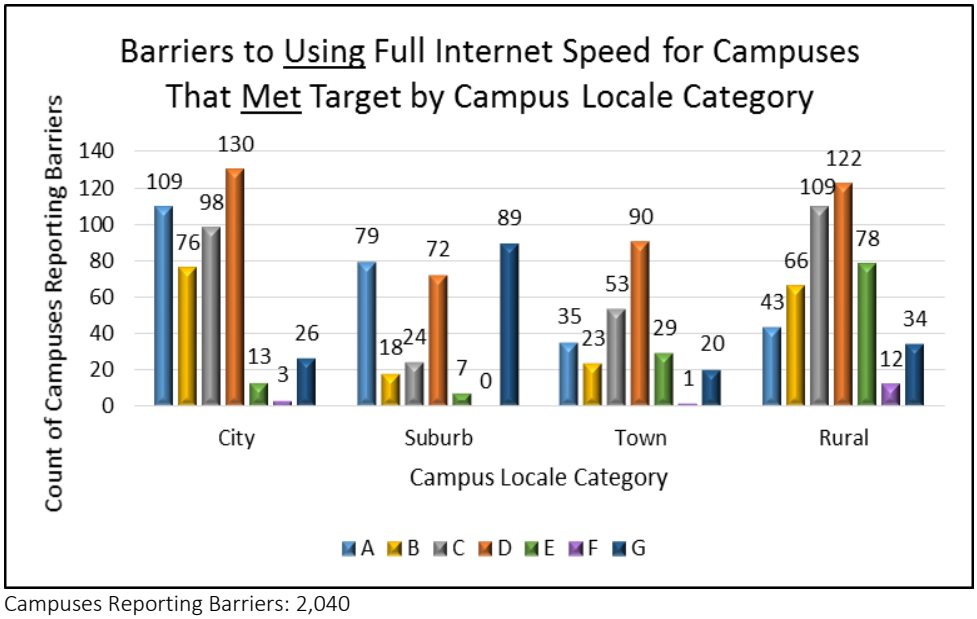
A – Equipment not properly sized
B – Use of application requiring large bandwidth significantly slows connection speed
C – Simultaneous use of same connection for multiple applications significantly slows connection speed
D – Connection is shared with another campus, entity, or facility
E – Network configuration creates bottleneck
F – Networking technical expertise not available
G – Other

Campuses Reporting Barriers: 833
Source: Public School Network Capabilities Survey

Barriers to Using Full Internet Speed for Campuses that Met Target by Campus Locale Category

The results of this question varied slightly by locale, with the city and suburb locales reporting the same two barriers but in a different order. The city locale cited "Connection is shared with another campus, entity, or facility" first and "Equipment not properly sized" second, while the suburb locale reported them in the opposite order. The town and rural locales also chose "Connection is shared with another campus, entity, or facility" as their most frequently cited barrier but both reported "Simultaneous use of same connection for multiple applications significantly slows connection speed" as their second barrier.

Exhibit #17:



A – Equipment not properly sized
B – Use of application requiring large bandwidth significantly slows connection speed
C – Simultaneous use of same connection for multiple applications significantly slows connection speed
D – Connection is shared with another campus, entity, or facility
E – Network configuration creates bottleneck
F – Networking technical expertise not available
G – Other

Campuses Reporting Barriers: 2,040
Source: Public School Network Capabilities Survey

Conclusion: Statewide, both for all campuses and those that met the Internet target, "Connection is shared with another campus, entity, or facility" was the most frequently cited barrier to using the full Internet connection currently in place. Locale appears to be a slight factor, with city, town, and rural locales choosing "Connection is shared with another campus, entity, or facility" first, while the suburb locale chose "Equipment not properly sized" as the most frequently cited barrier and "Connection is shared with another campus, entity, or facility" as the second most cited barrier. Trailing far behind, the least selected barrier was "Networking technical expertise not available."

Wide Area Network (WAN) Connectivity

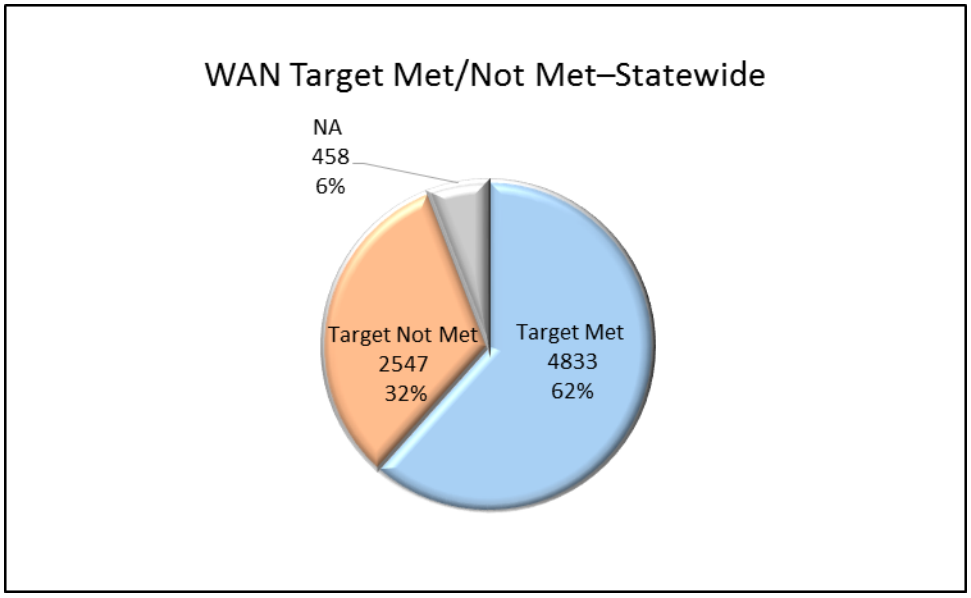
A wide area network (WAN) connection relays data, which may include Internet access, from the district's central network hub, to and among district campuses. This survey asked districts to report whether the WAN connections between each campus and the district featured a bandwidth capable of the WAN target speed of at least one gigabit per second (Gbps) for every 1,000 students and staff members.

Number and Percent of Campuses with Internal Wide Area Network Connection Speed Between the Campus and District of at Least One Gigabit per Second (Gbps) for Every 1,000 Students and Staff Members

WAN Target Met/Not Met – Statewide

Of the 7,838 campuses included in the survey data analysis for this question, 62% (4,833) met the target of 1000 Mbps (1Gbps) per 1,000 headcount and 32% (2,547) did not meet the target. TEA did not receive sufficient data to make these calculations for 458 campuses (6%) of these campuses, therefore they are shown in the data analysis exhibits as NA.

Exhibit #18

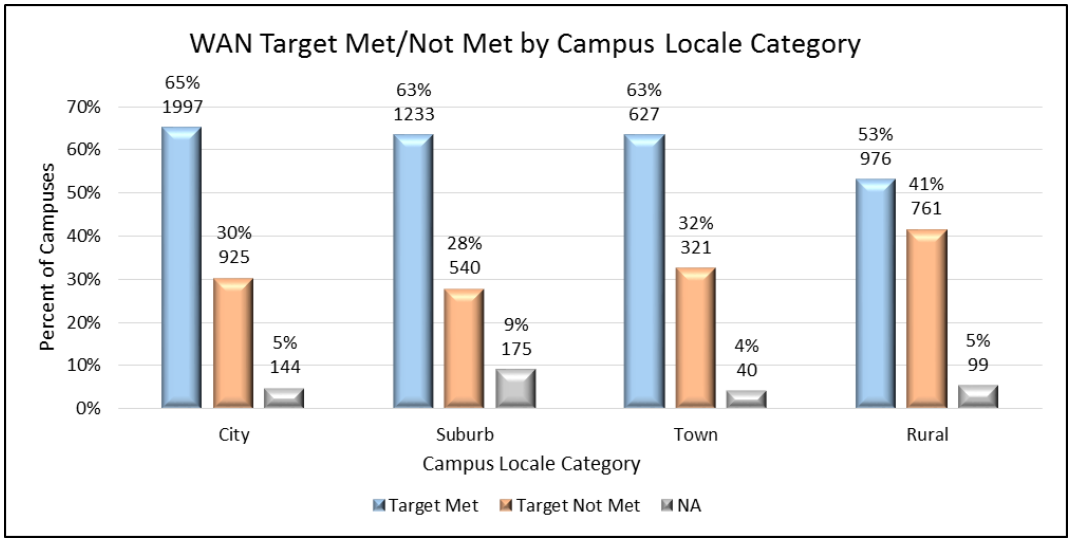


Campus Responding: 7,838
Source: Public School Network Capabilites Survey

WAN Target Met/Not Met by Campus Locale Category

Nearly identical percentages of campuses in three of the four campus locale categories met the WAN target, with city at 65% (1,997 campuses), suburb at 63% (1,233 campuses) and town also at 63% (627 campuses). Rural locale campuses met the WAN target at the rate of 53% (976 campuses.)

Exhibit #19

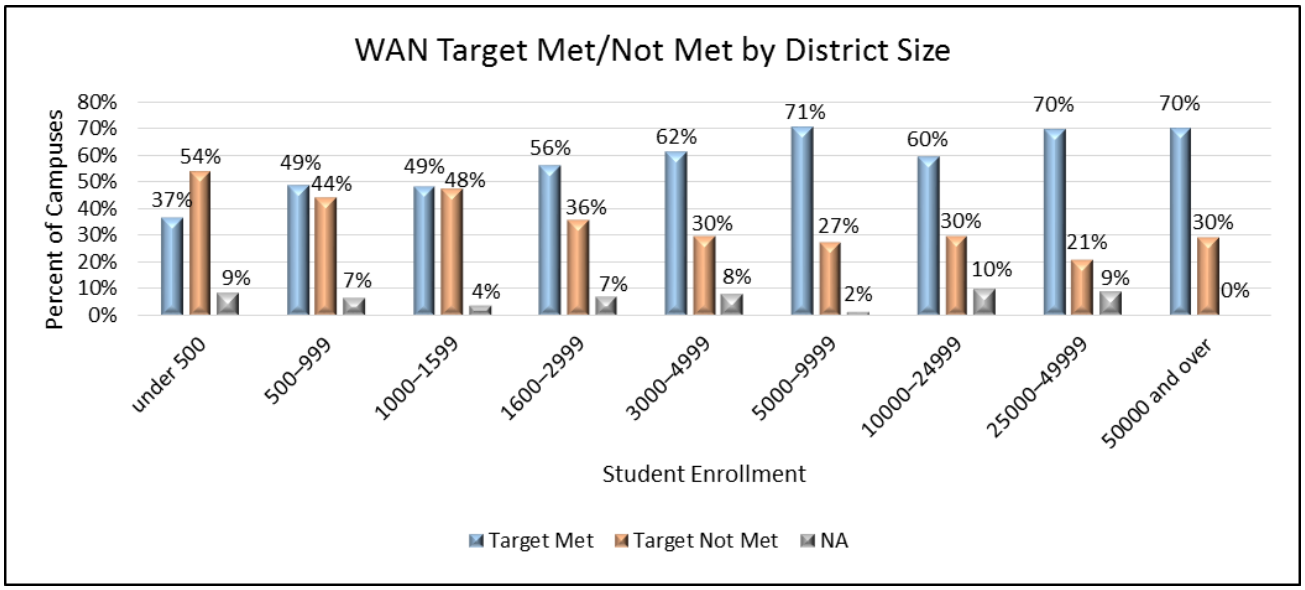


Campuses Responding: 7,838 *Note: Due to rounding, totals may not equal 100.
Source: Public School Network Capabilites Survey

WAN Target Met/Not Met by District Size

Of the nine categories in the state's Public Education Information Management System (PEIMS) definitions of district sizes based on student enrollment, the small districts, those with less than 500 students, have the lowest percentage (37%) of campuses that met the WAN target. Districts with student population of 5,000–9,999 have the highest percentage (71%) of campuses that met the WAN target, followed closely by the two largest district sizes, 25,000–49,999 (70%) and 50,000 and over (70%).

Exhibit #20



Campuses Responding: 7,838 *Note: Due to rounding, totals may not equal 100.
Source: Public School Network Capabilites Survey

WAN Target Met/Not Met by Education Service Center (ESC) Region

The percentage of campuses that met or did not meet the WAN target was fairly consistent when looking at campuses by ESC region. Region 18 (74%) had the highest percentage of campuses within the region that met target, closely followed by Region 7 (70%), and Region 10 (70%). The region with the lowest percentage of campuses meeting target is Region 17 (40%).

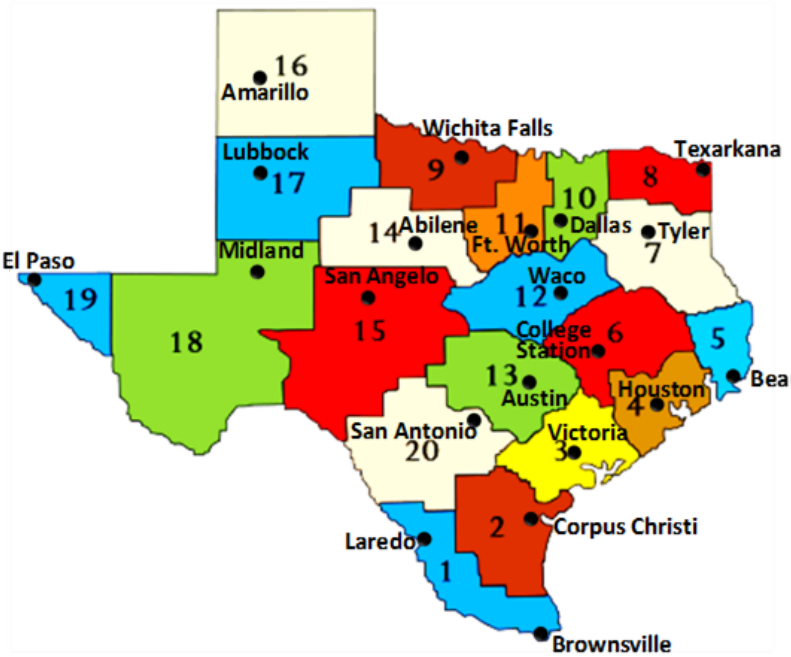
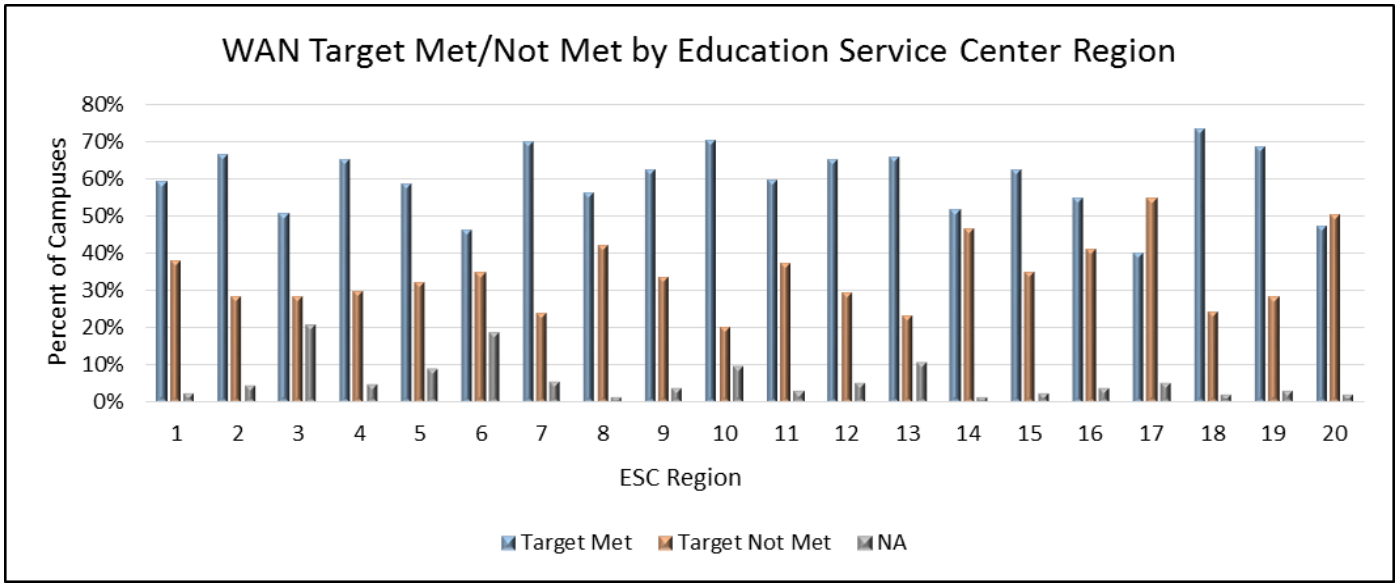


Exhibit #21



ESC Region	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Target Met	60%	67%	51%	65%	59%	46%	70%	56%	63%	70%	60%	65%	66%	52%	63%	55%	40%	74%	69%	47%
Target Not Met	38%	29%	29%	30%	32%	35%	24%	42%	34%	20%	37%	30%	23%	47%	35%	41%	55%	25%	28%	51%
NA	2%	5%	21%	5%	9%	18%	6%	1%	4%	10%	3%	5%	11%	1%	2%	4%	5%	2%	3%	2%

Campuses Responding: 7,838 *Note: Due to rounding, totals may not equal 100.
Source: Public School Network Capabilites Survey

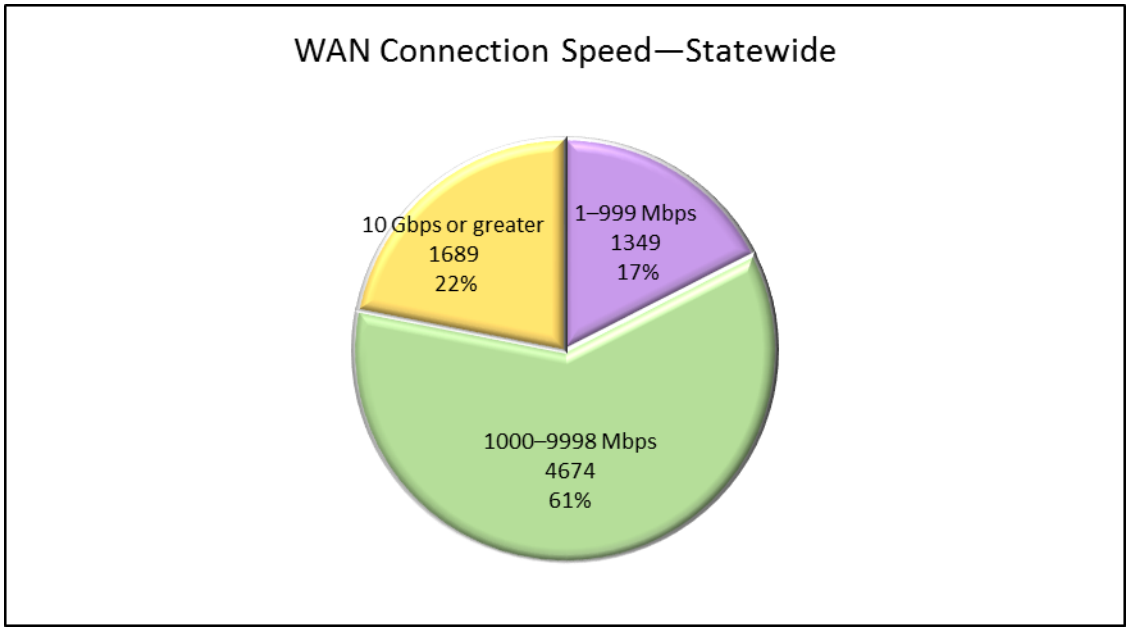
Conclusion: The majority (62%) of campuses reporting a WAN speed met the recommended target of at least 1 Gbps for every 1,000 students and staff. Campus locale did not appear to play a significant role in the city, town, and suburb locales, but the percentage of campuses in the rural locale that met target lagged behind by approximately 10–12%. District size did not appear to have much impact on the percentage of campuses that met target for most district size categories but there were differences of note between the smallest districts and the largest districts. For example, the smallest districts with less than 500 students had the lowest percentage of campuses that met the WAN target (37%) and districts with 5,000–9,999 students had the highest percentage of campuses that met target (71%), with other large districts also faring well. Looking at possible geographic impact, Region 18 had the highest percentage of campuses that met target (74%), while Region 17 had the lowest percentage that met target (40%.)

Wide Area Network Connection Speed between Campuses and District

WAN Connection Speed – Statewide

Of the 7,712 campuses that responded to the survey question about WAN connection speed, the most frequently occurring WAN connection speed is 1,000 Mbps (1 Gbps) (55%). The most common WAN speed range reported, by far, was 1,000–9998 Mbps with 4,674 campuses (61%), followed by the speed of 10 Gbps or greater with 1,689 campuses (22%) and then 1–999 Mbps with 1,349 campuses (17%).

Exhibit #22

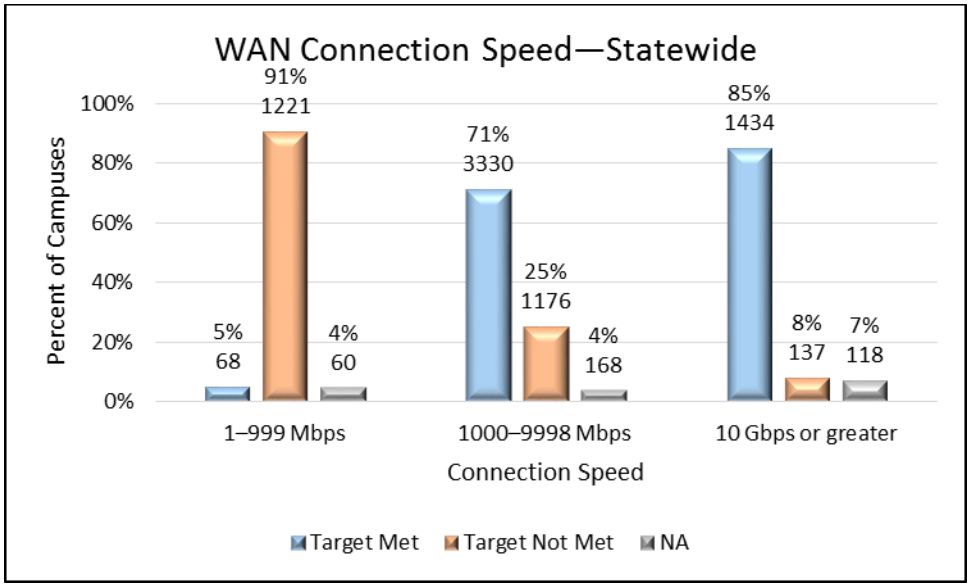


Campuses Responding: 7,712
Source: Public School Network Capabilites Survey

Looking at campuses that reported a WAN speed range of 1–999 Mbps, 68 (5%) had a WAN connection between the campus and the district featuring a bandwidth capable of a broadband speed of at least 1 Gbps for every 1,000 students and staff members and, therefore, met target. Of the remaining campuses in this same speed range, 1,221 (91%) did not meet target; and 60 (4%) did not provide sufficient data to be calculated and, as a result, are in the "NA" category. Of campuses that reported a WAN speed range of 1,000–9,998 Mb, 3,330 (71%) met target, 1,176 (25%) did not meet target, and 168 (4%) were NA. Of campuses in the 10 Gbps or greater category, 1,434 (85%) met target, 137 (8%) did not meet target, and 118 (7%) were NA. The speed range reported by a campus did not, by itself, impact whether or not a particular campus met or did not

meet the target. It is the ratio between the connection speed and student enrollment and staff (headcount) that determines if the Internet connection is sufficient for the campus to have met the target.

Exhibit #23

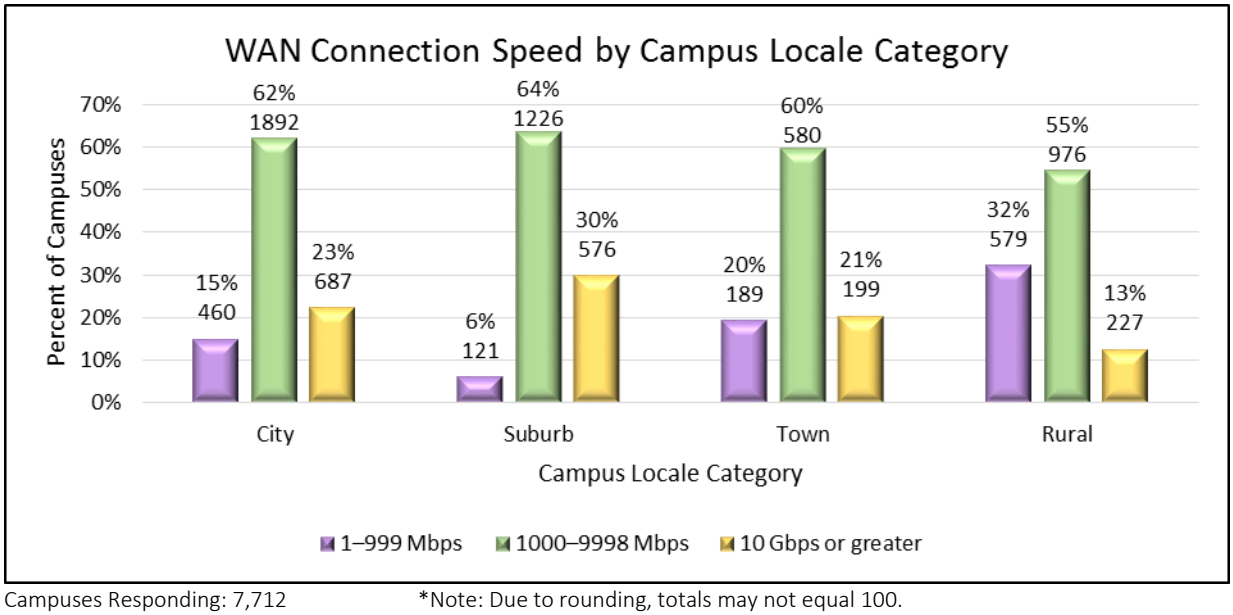


Campuses Responding: 7,712
Source: Public School Network Capabilites Survey

WAN Connection Speed by Campus Locale Category

Campuses within all locales had a majority of their connections in the speed range of 1,000–9,998 Mbps.

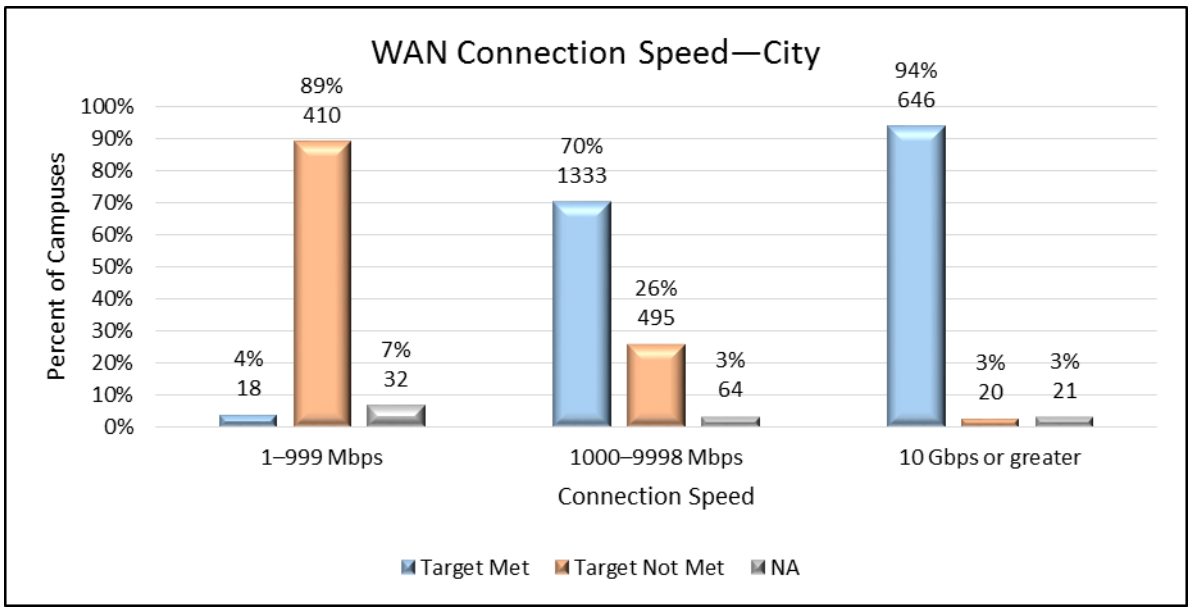
Exhibit #24



Campuses Responding: 7,712 *Note: Due to rounding, totals may not equal 100.
Source: Public School Network Capabilites Survey

City: Of campuses in the city locale reporting a connection speed range of 1–999 Mbps, 18 (4%) met target, 410 (89%) did not meet target, and 32 (7%) were NA. Of campuses reporting in the 1,000–9,998 speed range, 1,333 (70%) met target, 495 (26%) did not meet target, and 64 (3%) were NA. Of campuses reporting 10 Gbps or greater, 646 (94%) met target, 20 (3%) did not meet target, and 21 (3%) were NA.

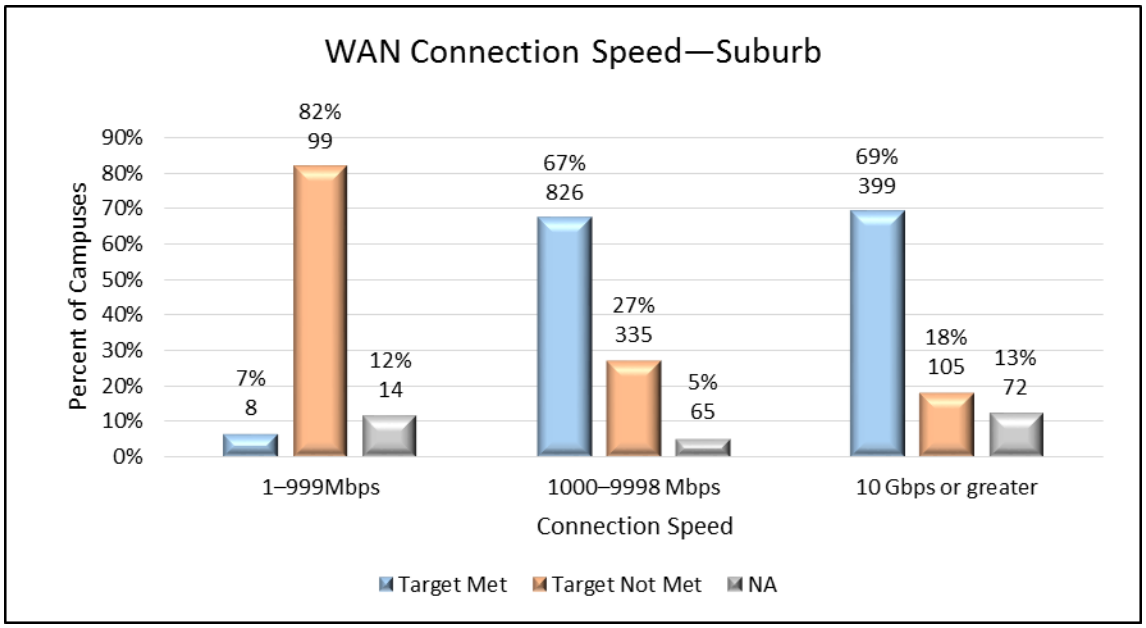
Exhibit #25a



Campuses Responding: 3,039 *Note: Due to rounding, totals may not equal 100.
Source: Public School Network Capabilites Survey

Suburb: Of campuses in the suburb locale reporting a connection speed range of 1–999 Mbps, 8 (7%) met target, 99 (82%) did not meet target, and 14 (12%) were NA. Of campuses reporting in the 1,000–9,998 Mbps speed range, 826 (67%) met target, 335 (27%) did not meet target, and 65 (5%) were NA. Of campuses reporting 10 Gbps or greater, 399 (69%) met target, 105 (18%) did not meet target, and 72 (13%) were NA.

Exhibit #25b

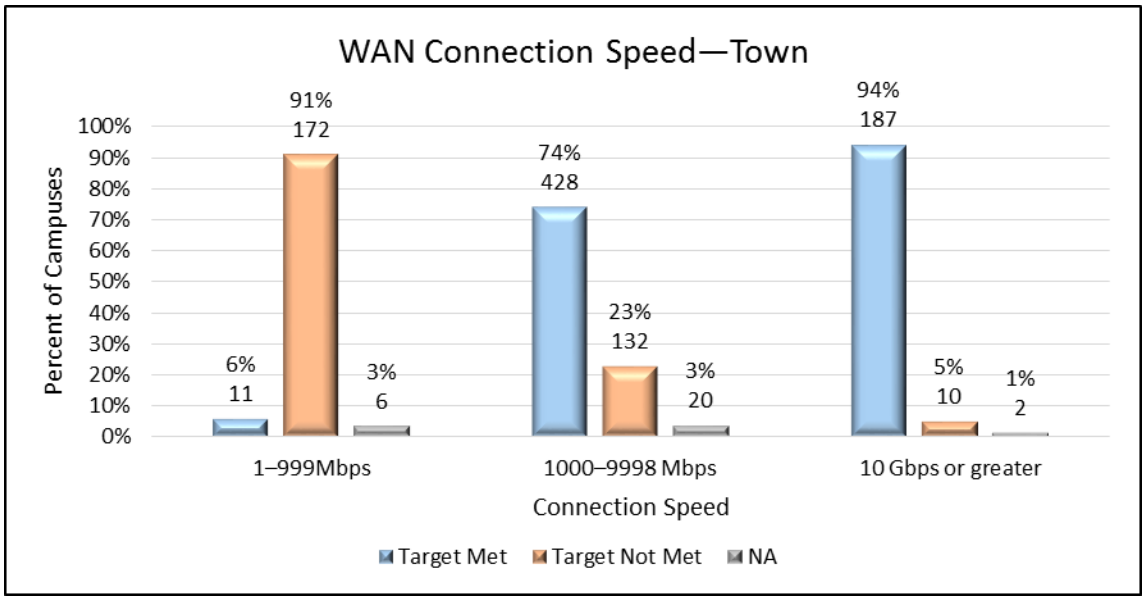


Campuses Responding: 1,923 *Note: Due to rounding, totals may not equal 100.
Source: Public School Network Capabilites Survey

Town: Of campuses in the town locale reporting a connection speed range of 1–999 Mbps, 11 (6%) met target, 172 (91%) did not meet target, and 6 (3%) were NA. Of campuses reporting in the 1,000–9,998

Mbps speed range, 428 (74%) met target, 132 (23%) did not meet target, and 20 (3%) were NA. Of campuses reporting 10 Gbps or greater, 187 (94%) met target, 10 (5%) did not meet target, and 2 (1%) were NA.

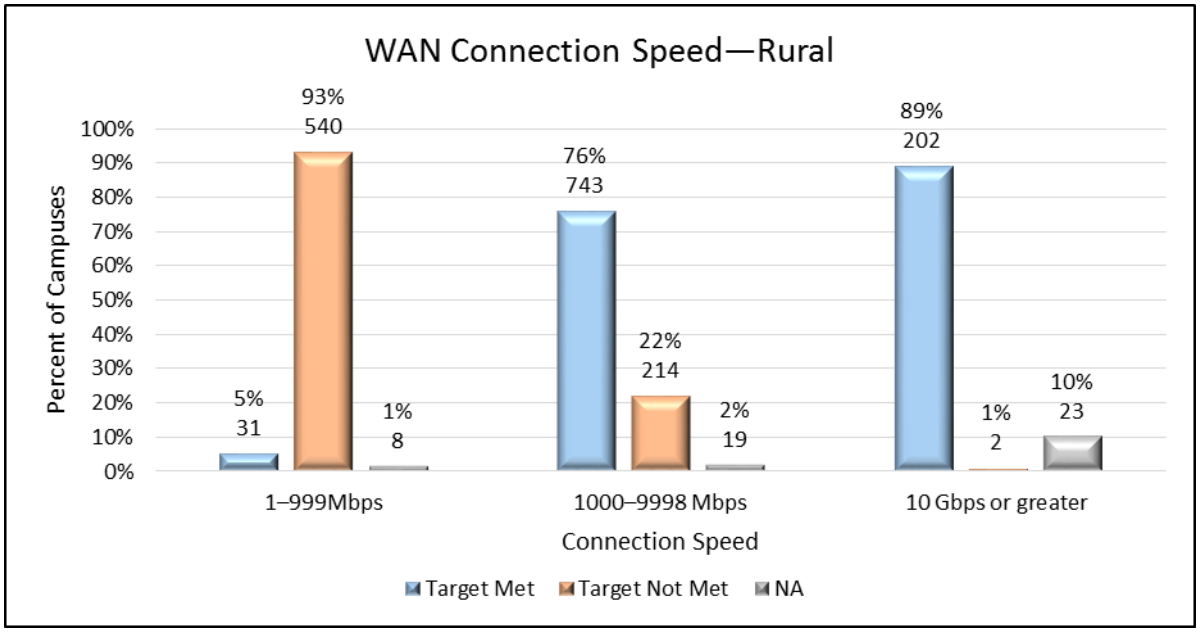
Exhibit #25c



Campuses Responding: 968
Source: Public School Network Capabilites Survey

Rural: Of campuses in the rural locale reporting a connection speed range of 1–999 Mbps, 31 (5%) met target, 540 (93%) did not meet target, and 8 (1%) were NA. Of campuses reporting in the 1,000–9,998 speed range, 743 (76%) met target, 214 (22%) did not meet target, and 19 (2%) were NA. Of campuses reporting 10 Gbps or greater, 202 (89%) met target, 2 (1%) did not meet target, and 23 (10%) were NA.

Exhibit #25d



Campuses Responding: 1,782 *Note: Due to rounding, totals may not equal 100.
Source: Public School Network Capabilites Survey

Conclusion: The majority of campuses reported a WAN connection speed between the campus and district in the 1,000–9,998 Mbps range, across all locales. The majority of campuses in this speed range were able to meet the WAN target. Regardless of locale, most campuses with a WAN speed range of 1–999 Mbps did not meet the WAN target while campuses reporting the highest connection speed range of 10 Gbps or greater were most likely to have met the WAN target. For those campuses that did not meet the WAN target, the most frequently reported speed range in the city and suburb locales was 1,000–9,998 Mbps and in town and rural locales, it was 1–999, or under 1 Gbps.

The following analyses focus on the WAN connectivity capabilities as reported by and for the district or charter school as a whole.

Barriers Preventing Campus from Acquiring a Wide Area Network Connection Speed Between the District and Each Campus of at Least One Gigabit per Second (Gbps) for Every 1,000 Students and Staff Members

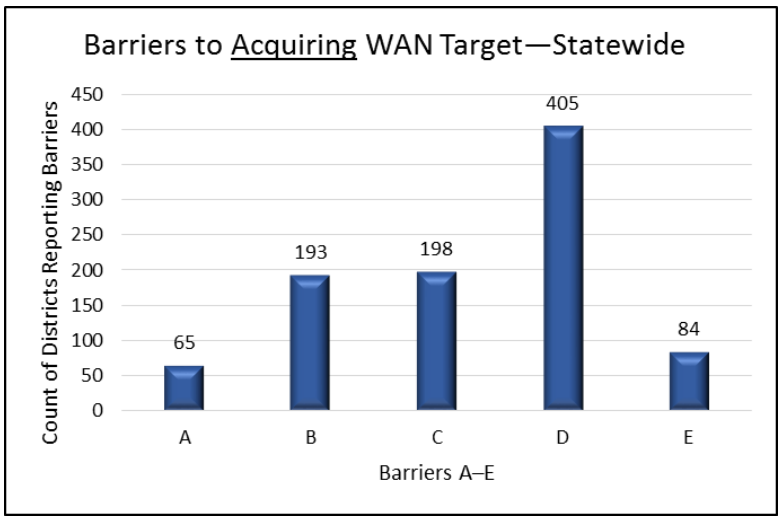
1,083 districts responded to the question about barriers that prevent the district from acquiring a connection (i.e., wide area network) between the campus and each school campus in the district. Each district was allowed to select the top two barriers, if any, which prevented the district from meeting the target of a WAN connection between the district and each school campus in the district of at least one Gbps for every 1,000 students and staff. Districts could select up to two barriers, therefore percentage totals do not equal 100%.

Barriers to Acquiring WAN Target—Statewide

Of the 1,083 districts that responded to the question about barriers to acquiring WAN target, 530 (49%) responded with "No Barrier." Of the 553 districts (51%) that selected one or more barriers from the options listed in the survey, the most frequently cited barrier, by far, was "Necessary funds are not available in district/campus budget," with 73% (405) of districts selecting this barrier. "Current hardware/software does not support higher speeds" was cited by 36% of the districts (198) and "Higher speed connection only available at premium rate" was cited by 35% of the districts (193). By far the least cited barrier, "Connectivity provider cannot provide any higher speed or connection" was selected by 12% of districts (65).

Campuses were also able to select "Other" as one of the barrier options and provide comments regarding barriers preventing the acquisition of the WAN target for each campus. Of the 84 districts that selected this option, comments focused on cost and limited provider options, district or campus size or location, and lack of district WAN.

Exhibit #26



A – Connectivity provider cannot provide any higher speed or connection
B – Higher speed connection only available at premium rate
C – Current hardware or software does not support higher speeds
D – Necessary funds are not available in district/campus budget
E – Other

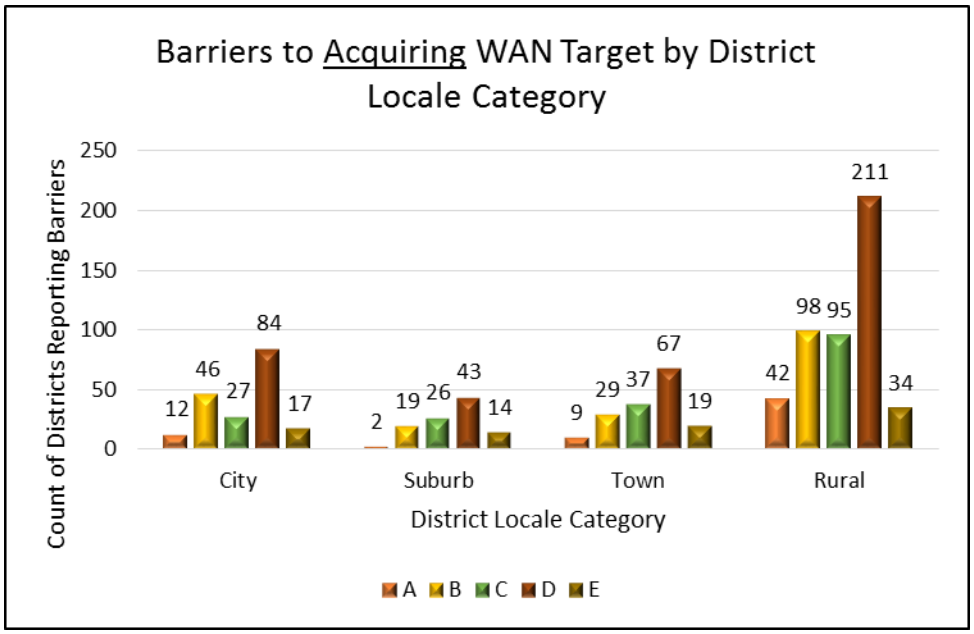
Districts Reporting Barriers: 553
Source: Public School Network Capabilites Survey

Barriers to Acquiring WAN Target by Campus Locale Category

Regardless of the campus locale the most frequent barrier selected was "Necessary funds are not available in district/campus budget."

Of the districts reporting barriers, the second most selected barrier for campuses in the city and rural locales was "Higher speed connection only available at premium rate" although the rural locale cited their third most common barrier, "Current hardware or software does not support higher speeds," nearly as often. Suburb and town locales selected "Current hardware or software does not support higher speeds" as their second most common barrier.

Exhibit #27



A – Connectivity provider cannot provide any higher speed or connection
B – Higher speed connection only available at premium rate
C – Current hardware or software does not support higher speeds
D – Necessary funds are not available in district/campus budget
E – Other

Districts Reporting Barriers: 553
Source: Public School Network Capabilites Survey

Conclusion: Locale did not appear to strongly influence which barriers a district identified as preventing each campus in the district from acquiring the target WAN speed between the district and each campus. Districts overwhelmingly (73%) chose funding constraints, "Necessary funds are not available in district/campus budget," as the most common barrier to acquiring bandwidth that met the WAN target, followed by 36% that chose "Current hardware or software does not support higher speeds," and 35% that chose "Higher speed connection only available at premium rate."

Barriers Preventing Campuses from Using the Full WAN Connection Speed

1,086 districts responded to the question about barriers that prevent the district or campuses in the district from using the full speed of the WAN connection currently in place. Each district was allowed to select the top two barriers, if any, which prevented the district or campuses within the district from using the full speed of the connection (i.e., wide area connection) between the district and its campuses. Districts could select up to two barriers, therefore percentage totals do not equal 100%.

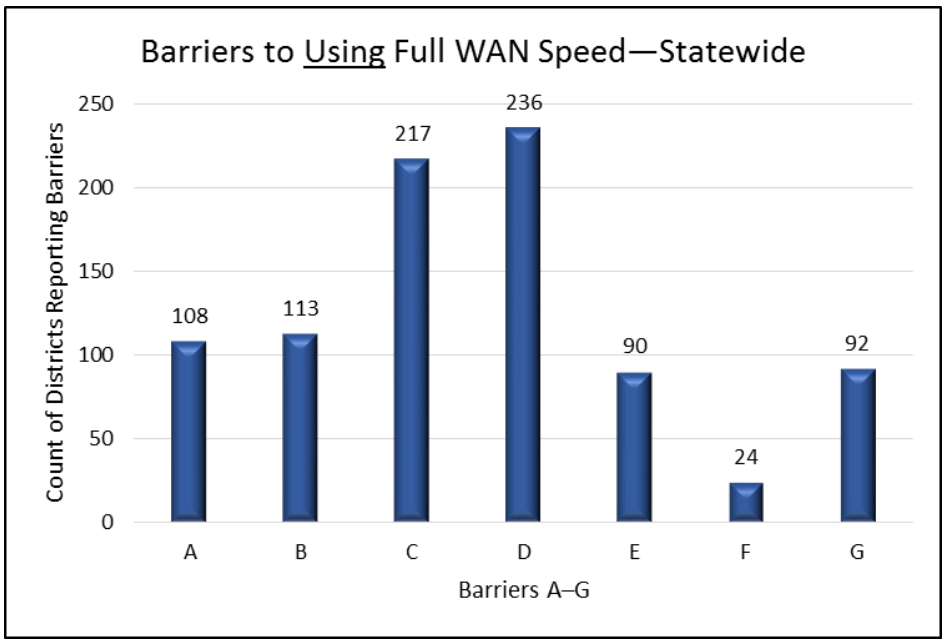
Barriers to Using Full WAN Speed—Statewide

Of the 1,086 districts that responded to the question about barriers preventing them from using the full speed of the WAN connection, 579 (53%) selected "No Barrier."

Of the 507 districts (47%) that selected one or more barriers from the options listed in the survey, the most commonly cited option was "Connection is shared with another campus, entity, or facility" at 47% (236) with "Simultaneous use of same connection for multiple applications significantly slows connection speed" close behind at 43% (217). "Use of application requiring large bandwidth significantly slows connection speed," was selected in 22% (113) of responses, "Equipment not properly sized" was close behind at 21% (108), followed by "Network configuration creates bottlenecks" and "Other" both at 18% (90 and 92 respectively.) Trailing far behind at 5%, 24 districts selected "Networking technical expertise not available."

Campuses were able to select "Other" as one of the options and provide comments regarding barriers preventing the use of the existing WAN connection by the district or its campuses. Comments focused on cost and limited provider options, age and limitations of equipment, lack of district WAN, and the fact that the connection is shared with another campus or other facility.

Exhibit #28



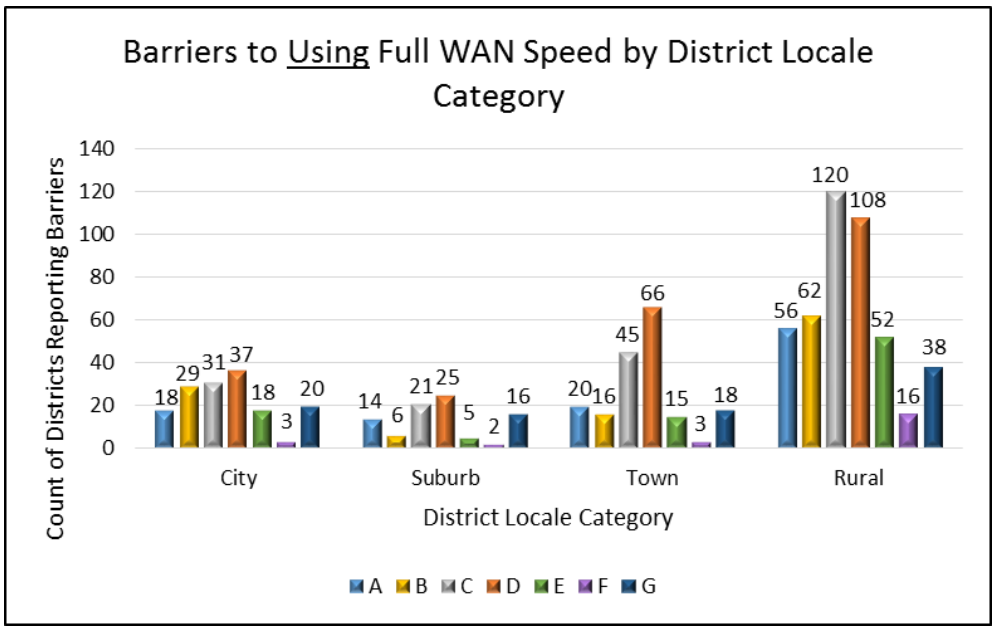
A – Equipment not properly sized
B – Use of application requiring large bandwidth significantly slows connection speed
C – Simultaneous use of same connection for multiple applications significantly slows connection speed
D – Connection is shared with another campus, entity, or facility
E – Network configuration creates bottleneck
F – Networking technical expertise not available
G – Other

Districts Reporting Barriers: 507
Source: Public School Network Capabilites Survey

Barriers to Using Full WAN Speed by District Locale Category

The city, suburb, and town locales selected the "Connection is shared with another campus, entity, or facility" as their most common barrier while rural locales selected "Simultaneous use of same connection for multiple applications significantly slows connection speed" as their most frequent selection. For all locales, "Networking technical expertise not available" was the least frequently cited barrier.

Exhibit #29



A – Equipment not properly sized
B – Use of application requiring large bandwidth significantly slows connection speed
C – Simultaneous use of same connection for multiple applications significantly slows connection speed
D – Connection is shared with another campus, entity, or facility
E – Network configuration creates bottleneck
F – Networking technical expertise not available
G – Other

Districts Reporting Barriers: 507
Source: Public School Network Capabilites Survey

Conclusion: For all campus locales combined, the two most selected barriers, in order of frequency, were "Connection is shared with another campus, entity, or facility" and "Simultaneous use of same connection for multiple applications significantly slows connection speed." Locale moderately influenced the order in which these barriers were selected: city, suburb, and town locales selected "connection is shared" followed by "simultaneous use slows speed" while the rural locale selected these same two barriers but in the opposite order.

Broadband Landscape: Texas Considerations

There are a number of other factors that impact how Texas schools implement broadband access. Funding issues, telecommunication regulations, and existing infrastructure all play a role in how schools address broadband issues.

Funding

Schools have several options for funding broadband infrastructure costs, including leveraging E-rate discounts and then covering the out-of-pocket costs (non-discounted portion) using local funds. In the *Second E-rate Modernization Order*, the FCC agreed to pay the first year of the E-rate portion for fiber construction projects upfront and allow schools up to four years to pay their non-discounted portions. If the state matches up to 10% of the cost, some schools may not have any out-of-pocket expenses. Consider the following example.

> School X has determined that a $1,000,000 fiber project is the most cost effective solution to paying high, month-to month rates for Internet access. E-rate will cover the school's discounted portion of 80% for a total of $800,000 leaving the school with $200,000 in out-of-pocket expenses (non-discounted portion). School X's state has provided funding for school broadband connectivity to cover the part of the non-discounted portion. The state pays an additional 10% of the project for a total of $100,000. The FCC then matches the state's portion of $100,000 and School X pays nothing out-of-pocket for the project.

Source of Funds	Cost
Total Project Cost	$1,000,000
80% E-rate Discount	$800,000
Out-of-Pocket Expense	$200,000
10% State Match	$100,000
10% E-rate Match	$100,000
New Out-of-Pocket Expense	$0

Texas schools that do not currently meet the Internet or WAN targets may choose to take advantage of this funding opportunity through the E-rate program. They may want to consider making a long-term decision to move away from costly, month-to-month connections and to consider a fiber project for the future. The FCC requires schools to go through the process of determining the most cost-effective solution for obtaining broadband and gives schools the opportunity to compare costs over the long-term. Schools, especially in underserved areas, may be able to consider a multi-million dollar project that makes broadband affordable for the next 5, 10, or even 20 years.

Loss of HB 2128 Rates

Schools that do not have the bandwidth to meet Internet or WAN targets have recently lost a source of affordable broadband. In 1995 the 74th Texas Legislature passed HB 2128, a landmark piece of legislation to deregulate the telecommunications industry. Under the law, certain providers were required to offer discounts to schools for the purchase of high-speed broadband services. For over 20 years, schools obtained broadband connections for approximately 10% over the provider's cost. In October 2014, the state authorized full deregulation under the terms of the legislation. This full deregulation lead to the loss of discounted telecommunication rates for Texas schools.

The cost of broadband access for Internet and WAN services is especially important given that a large number of districts and campuses receive services from telecommunications providers ranging from small "mom and pop" telecommunication companies and cooperatives to large industry-leading companies such as AT&T and Time Warner. Strong competition among multiple telecommunication providers is more often found in more populated areas, such as city and suburb locales. In less populated or more isolated areas schools may have very limited options with only one or two providers offering services. The impact of higher costs for services from telecommunication providers can create significant barriers to meeting the Internet and WAN targets that support teaching and learning objectives.

Opportunity to Obtain Affordable Rates in Certain Areas

At the time the FCC created additional funding under E-rate for fiber construction projects, it also adopted new regulations for certain providers who accept Connect America Funds (CAF) to provide broadband in underserved areas. Under the new regulations, providers that accept funding for deploying broadband in certain areas of the state must offer the same rates for similar services they charge their city customers[14].

Existing Infrastructure in Texas

Although a large number of schools and districts access Internet and WAN services through telecommunications companies, an almost equal number receive these services using other means, including regional ESCs, Texas Education Telecommunications Network (TETN), and the Lonestar Education and Research Network (LEARN) consortium.

The SBOE's *Long-Range Plan for Technology (LRPT), 2006–2020*, charts the course for Texas school broadband by recommending broadband access to all digital resources, such as streaming videos and online instructional materials, available 24/7 for all users at school and at home. In its recommendations to ESCs, the LRPT recommended a robust statewide infrastructure as a critical component of providing access to all learners. The LRPT recommended that districts establish an infrastructure that is safe and secure, flexible, scalable, and reliable, and suggested that campus infrastructure have the capacity to integrate voice, video, and data, and host large volumes of digital content and powerful applications.

In the *2014 Progress Report on the Long-Range Plan for Technology, 2006–2020*, the TEA referenced the Internet and WAN connectivity targets recommended by SETDA. Schools have many options for reaching these target goals including common approaches that comply with E-rate eligibility services such as

- contracting directly with an ISP for Internet and contracting (leasing) WAN connections among campuses,
- constructing their own fiber network among their campuses and contracting for Internet access only,

[14] https://www.fcc.gov/maps/connect-america-phase-ii-final-eligible-areas-map.

- leasing a connection with an ESC that provides Internet access and other bundled network services, and
- partnering with other districts to create a network consortia to purchase Internet access and to share resources.

TETN, ESC Regional Telecommunications Infrastructure, and LEARN

The Long-Range Plan for Technology created a statewide network consortium among the 20 ESCs and the TEA in 1996 to save on travel costs and to provide added benefits to educators and students. The TETN video conferencing network was unique among states in 1996 and has remained a vital piece in the school broadband landscape[15].

At the same time TETN was created, the ESCs began building out a telecommunications infrastructure to school districts that contracted for the service. This was a result of the Public Access Initiative 1996–2010 to fulfill the recommendation for ESCs to create, maintain, and expand the regional technology and telecommunications infrastructure to meet the growing demands of school districts. ESCs began buying Internet access from providers and sharing the capacity among their school districts. As reported in the *Long-Range Plan for Technology, 2006–2020*, the ESCs were providing 2 Gbps of Internet access across the state by 2006, a three-fold increase in comparison to the one-half Gbps of Internet access ESCs provided in 2002.

Another recommendation in the *Long-Range Plan for Technology, 2006–2020* was for ESCs to provide equitable and cost-effective connectivity to a high-speed, high-capacity statewide telecommunications network and to other national and worldwide users. To take advantage of changing technology, the ESCs embarked on a project to expand the TETN to become a robust statewide backbone that could share network costs and services. The success of upgrading the TETN backbone from lower capacity, copper-based T1 lines to 1 Gbps fiber was a result of research that led to development of a plan to ensure 1 Gbps connections from one provider to all ESC regions in the state. Beginning in 2008, TETN upgraded to a 1 Gbps backbone using leased broadband from the LEARN consortium.

Organized in 2005, LEARN is a consortium whose members include public and private institutions of higher education, community colleges, and K–12 public schools from across Texas. The not-for-profit consortium connects member organizations and over 630 affiliated organizations together with high-performance optical network services to support members' research, education, healthcare, and public service goals. LEARN is a part of a national community of research optical networks and provides Texas connectivity to the national and international research and education networks.[16]

The Role of Backbone Networks

TETN and LEARN are considered backbone networks. A backbone network does not provide broadband services to end users or devices. Rather, these networks function like a highway carrying broadband over wide areas, with other providers building the last mile to connect to the end user or device. For example LEARN's network stretches 3,200 miles across the state from El Paso to Beaumont and from Corpus Christi to Lubbock. In the case of TETN, its backbone connects the ESCs' regional networks and extends Internet access to schools on the ESC network. TETN also backhauls[17] traffic from the ESCs to major Internet hub locations, optimizing speed and cost effectiveness for schools using the backbone networks.

[15] https://sites.google.com/a/tetnplus.net/tetn/

[16] http:/www.tx-learn.org/

[17] Backhauling is the process of using a backbone network to transport data traffic coming from the end user to the Internet service provider's point of presence.

As non-profit consortia established to design, build, and operate the networks, TETN and LEARN bring together vested members who create services under terms and pricing that meets their needs. They leverage economy-of-scale purchasing and pass the cost savings to their members. Members of LEARN, for example, pay annual dues to fund the administration of the consortium. This entitles them to acquire network services at member rates. On the technical side, these consortia develop policies and procedures to ensure the network performance meets the needs of their members. Based on a plan of growth established for their networks, TETN and LEARN can allow members to increase their reliance on the backbone and comfortably and easily increase their demand over time.

In 2013 the TETN network was upgraded to 10 Gbps after user demand outgrew the 1 Gbps connections. Once the backbone was increased, ESCs could upgrade the Internet services they provide to schools. Benefits of the TETN network include the following services provided to over 500 school districts:

- Access to Internet bandwidth at significantly reduced rates
- Direct access to Texas institutions of higher education, allowing for the removal of dedicated circuits for significant cost savings
- Shared applications and services among ESCs without bandwidth constraints or quality of service

Initiatives in Other States

Texas is not alone in trying to address the issue of school broadband. Below are examples of how other states have approached school broadband targets and other concerns. Some states such as North Carolina and Nebraska have statewide education consortia, while others—such as Utah—have a statewide network serving all public institutions. New Jersey created programs that support bulk pricing with no single backbone network. Still other states, such as Arkansas and Virginia, are in the middle of the process and have yet to fully implement strategies and programs.

Arkansas

A study was commissioned by the Arkansas Bureau of Legislative Research to collect data on the broadband and networking capabilities of every K–12 public school in the state of Arkansas, including public charter schools. Completed in December 2013, the study found that 65% of the state's 257 public school districts and public charter schools met the 2014–2015 SEDTA connectivity targets. Of the schools that met the target, only eight schools met the 2018 SETDA targets.[18]

Arkansas undertook another initiative at the same time. The Arkansas governor's office and the Arkansas Department of Education (ADE) asked Education SuperHighway[19] to survey schools and recommend ways to make effective use of an $11 million dollar budget appropriated for school Internet access. Education SuperHighway conducted an analysis that mirrored the state's findings and recommended a plan of action, which was adopted in August 2015. The group's findings showed that the state's annual investment of $11 million for school Internet access was sufficient to meet the 2018 SETDA target if substantial changes were made to the current approach and if the state implemented a statewide Internet access aggregation network.[20]

[18] http://www.arkleg.state.ar.us/assembly/2013/Meeting%20Attachments/685/I12322/EXHIBIT%20C%20-%20AR%20State%20Broadband%20Mgr%20Rpt.pdf

[19] Education SuperHighway is a non-profit group whose mission is to upgrade the Internet infrastructure in K–12 schools across the country for digital learning.

[20] http://c.ymcdn.com/sites/www.theaaea.org/resource/resmgr/Broadband/BLR_K12_Network_Study_Report.pdf

Nebraska

In 2007 Nebraska helped schools lower their Internet costs and improve the quality, reliability, and speed of their telecommunications services with the creation of Network Nebraska-Education.[21] Since that time, the network, which connects 285 K–12 and institutions of higher education, has lowered the unit cost of Internet by 99% for its members through aggregation of demand and competitive bidding. Network Nebraska-Education is a backbone network. The state centralizes bids and awards for 80% of the circuits from the school district to the backbone. This arrangement is made possible through a consortium of K–12, Education Service Units, and higher education entities working together to provide a scalable, reliable, and affordable infrastructure capable of carrying a spectrum of services and applications.

New Jersey

In 2015 New Jersey's Department of Education created a procurement consortium to aggregate demand for Internet access while increasing capacity and cutting costs. Through the Innovative Broadband Cooperative, 145 New Jersey districts and 219 school buildings are participating in the initial project to acquire sufficient broadband for 21st century teaching and learning. The cooperative issued a single Request for Purchase (RFP) to acquire broadband in four geographic parts of the state. Districts are expected to obtain more broadband while saving an average of 76% of costs over a three-and-a-half year period. The consortium expects to set a precedent for the future for creating effective cooperative solutions. They believe schools that did not or could not join in the initial year will benefit by the creation of a more competitive marketplace for schools.[22]

North Carolina

In 2006 the Developing Regional Networks[17] report was submitted to the North Carolina General Assembly. The report recommended the expansion of the North Carolina Research Education Network (NCREN) to the K–12 community. As a result, the General Assembly enacted a law to expand the number of schools with broadband, selectively build-out networks to rural and underperforming schools, and develop a scalable model for statewide implementation. In 2007, the Friday Institute for Educational Innovation at North Carolina State University led efforts to complete an engineering plan. Approved by the North Carolina State Board of Education, the plan was implemented in 2009 and all 115 K–12 school districts and many charter schools throughout the state were connected to the state's research and education network[23]. Because the plan leveraged existing infrastructure and experience, it was completed in a relatively short amount of time.

Utah

The Utah Education Network was established over 20 years ago by the Utah State Legislature to coordinate telecommunication technology for K–12 and institutions of higher education. With an expansion of stakeholders, the network also serves libraries, government, and other public entities with network, application, and technology support services. The state appropriates approximately $18 million a year (70% of the annual budget) with additional funds coming from E-rate ($13 million) and other grants.[24]

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[21] http://www.networknebraska.net/

[22] http://www.mresc.k12.nj.us/dynimg/_IEAAA_/docid/0x096206D67ED04A84/54/NJDRLAP-Broadband+Report+17JUL15v1.pdf

[23] http://www.ncwiseowl.org/Impact/div_it/docs/Developing%20Regional%20Education%20Networks.pdf

[24] https://utahbroadband.wordpress.com/

Virginia

In 2014 Virginia began a statewide pilot program whose aim is to deliver high-speed broadband to schools while bringing down costs. The Commonwealth entered into a partnership with Education SuperHighway to work with state agencies, service providers, and partners across the state to help ensure all schools met the SETDA/ConnectED goal by 2018.

According to information provided by Education SuperHighway: "In Phase 1 of the Virginia K–12 Broadband Connectivity Project, 97% of districts participated in data collection. The data showed only 33% of districts meet 2014 SETDA connectivity goals for Internet access. It was also determined that Virginia districts pay 26% more for connectivity than the national sample." The subsequent phases of the project will identify and implement the best technical solution for bringing affordable Internet to Virginia schools.[25]

[25] http://www.educationsuperhighway.org/virginia/

Conclusions

The Public School Network Capabilities Study was conducted during a time when the federal government and many states are taking actions to measure the current capacity of broadband in schools. As part of the Public School Network Capabilities Study, TEA conducted a survey that found that only 26% of reporting campuses in Texas met the Internet connectivity target. Campuses fared better on the WAN target, with 62% meeting the established target. Survey responses indicated that the primary barrier in the eyes of the schools is that the funds necessary to put systems in place to reach the targets are not available. The results of this study echo results of research conducted by the FCC that shows there is a lack of affordable broadband infrastructure and that cost is a factor.

Factors that may affect a district's ability to procure high-speed connectivity at a reasonable price include the following:

- Financial resources
- Location
- Access to fiber connections
- Access to research and education networks
- Statewide or regional coordination
- ISP competition
- Well-informed information technology (IT) staff

Results from the Texas study indicate that school leaders agree that some of these factors affect Texas's ability to meet the Internet and WAN targets specified in TEC, §32.005. The survey clearly shows that the primary barrier for all campuses is lack of funds in the district and campus budget. Survey results also illustrated the need for updated hardware and software and access to affordable Internet pricing.

A factor to consider from this study is that, although a very high percentage (70%) of campuses did not meet the Internet target, there were campuses in every NCES campus locale that met the Internet target. There was no overwhelming evidence that campuses in the rural locales were at a marked disadvantage over campuses in the city and suburb locales. In fact, the results showed the rural locale had the greatest percentage of campuses that met the Internet target, likely a result of lower enrollments than in other locales. Yet some of the results did speak to disparity. Of the barriers for not meeting Internet connectivity targets, all locales overwhelmingly reported the lack of necessary funds. City and suburb locales reported that current hardware or software also prevented them from supporting higher speeds, but town and rural campuses cited as a barrier the availability of higher speed connections only at premium rates. City and suburb locales often experience robust competition among multiple service providers as compared to campuses in the town and rural locales, which may only have one or two providers. This competition likely leads to lower prices for services, which may not be available to town and rural campuses.

District size appears to have a moderate impact on whether most campuses met the Internet target, however the very smallest districts with under 1,000 students had the highest percentage of campuses that met target while the largest districts had the lowest percentages. Geographic location within the state, as evidenced by ESC region, appears to have a greater impact with campuses in Region 14 and Region 1 having the highest percentage of campuses in their region that met target and Region 15 and Region 17 having the lowest.

The vast majority (88%) of campuses responding to the survey reported using fiber to connect to their ISP. There are also pockets of the state in which wireless is present, especially in Regions 8, 14, 15, and 17.

The state as a whole was almost evenly split in the range of Internet connection speeds reported, with 50% of campuses reporting a connection speed in the 1–999 speed range and 46% percent reporting a speed range of 1,000–9998 Mbps. The speed range reported by a campus did not, by itself, impact whether or not a particular campus met or did not meet the target. It is the ratio between the connection speed and student enrollment and staff (headcount) that determines if the Internet connection is sufficient for the campus to have met the target. As might be expected, small connection size (1–999) was most often reported by rural and town campuses. Although not many large connections (10 Gbps or greater) were reported across the state, those that can be found were most often located in the city locale.

Campuses, including those that met the Internet target, also reported barriers to using the full Internet speed currently available to them. Sharing the Internet connection with another campus was the most-cited barrier, followed by "Simultaneous use of the same connection for multiple applications slows connection speed." These conditions are inherent in a shared network and require schools to procure adequate capacity and monitor the performance of the network. Bottlenecks can occur from insufficient Internet access from the ISP, not enough capacity in the WAN connections, or even under-sized Wi-Fi connections in school buildings. Schools may be able to maximize their Internet capacity by caching[26] content that stays within the WAN and does not use the Internet connection.

As for WAN connectivity, the survey revealed that 62% of campuses met the WAN target. This is positive since districts may deliver Internet access capacity over their WAN. Campus locale and district size did not appear to have much impact on the percentage of campuses that met target. However, there were some differences between the smallest and largest districts, with smaller districts being less likely to have met target than their larger counterparts. For campuses with sufficient WAN connectivity, increasing Internet capacity is dependent on having the equipment to support higher speeds and access to affordable monthly Internet access fees.

The most frequently reported WAN speed was 1,000–9,998 Mbps. Of campuses reporting in this speed category, 71% met the WAN target. Campuses reporting connections in the smallest speed range of 1–999 Mbps typically did not meet target. Town and rural locales were more likely to report connections in this speed range.

Barriers to acquiring WAN target primarily cited that necessary funds are not available in the district and campus budgets. The most frequently cited barrier to using the full WAN connectivity was that the connection is shared, followed by the simultaneous use of the same connection for multiple applications significantly slows connection speed.

Many states leverage the expertise and infrastructure of their higher education statewide network to assist and serve K–12 schools. Texas has several of these important resources in place, including LEARN as well as TETN, which currently provide Internet access to over 500 school districts[27].

There are a number of opportunities available for the next few years to enable the use of fiber and to increase broadband speed and capacity. For the next four years, the E-rate program has set aside additional funds that can help schools address these needs. The E-rate program has set aside specific funding for schools to construct or lease a fiber infrastructure so that finding affordable Internet rates becomes easier. Initiating a fiber construction project or obtaining a 20-year fiber lease is involved and time consuming but the results have the potential to provide a scalable, sustainable solution. The E-rate program has also set

[26] Frequently accessed information is kept in a location close to the requestor (e.g., web pages and content are stored on a storage device [server] that is located on the district's WAN).

[27] http://www.tx-learn.org/resources/annual_reports/2014.pdf

aside specific funding to address schools' hardware and software needs but schools must apply for the funds and plan for a budget to pay the non-discounted portion.

The TEA Public School Network Capabilities Survey measured Internet and WAN capacity at the 2014–2015 levels established by SETDA and included in TEC, §32.005. The targets established by SETDA for 2017–2018 will increase to 1 Gbps per 1,000 student and staff for Internet and 10 Gbps per 1,000 for WAN capacity. Results of the Public School Network Capabilities Survey revealed that only 272 campuses had 10 Gbps connections, which indicates districts across the state are currently not prepared for an increase in demand for high-speed broadband to support 21st century teaching and learning.

Leveraging existing infrastructure in Texas, such as TETN infrastructure and LEARN, E-rate's new rules related to the use of fiber, and the additional E-rate funding that is available for the next few years can provide important resources to address some of the broadband connectivity issues reported by Texas schools.

Information from this study can inform the decisions that state and education leaders make to determine future directions regarding technology in Texas K–12 public schools and the access that educators and students have to high-speed connectivity.

Resources

Texas

1. 2014 Update to the Long-Range Plan for Technology, http://tea.texas.gov/WorkArea/linkit.aspx?LinkIdentifier=id&ItemID=25769819180&libID=25769819289
2. Connected Texas Report on Education, http://www.connectednation.org/sites/default/files/tx_education_report.pdf
3. Loss of HB 2128 rates, http://www.senate.state.tx.us/75r/Senate/commit/c510/handouts12/0814-WayneWedemeyer.pdf
4. Lone Star Education and Research Network, http://www.tx-learn.org/
5. Texas Education Telecommunications Network, http://www.tetnplus.net/
6. Texas Education Code §32.005, http://www.statutes.legis.state.tx.us/Docs/ED/htm/ED.32.htm

National

1. President's ConnectED Initiative for schools, https://www.whitehouse.gov/issues/education/K–12/connected
2. FCC *Modernization Order*, http://usac.org/sl/tools/modernization-order/default.aspx, FCC Second *Modernization Order*, https://apps.fcc.gov/edocs_public/attachmatch/FCC-14-189A1.pdf

Other States

1. Arkansas, in depth overview, http://c.ymcdn.com/sites/www.theaaea.org/resource/resmgr/Broadband/BLR_K12_Network_Study_Report.pdf (Arkansas Report); http://www.educationsuperhighway.org/wp-content/uploads/2014/12/Arkansas-Final-Report-December-2014.pdf (Education Superhighway)
2. Nebraska, http://www.networknebraska.net
3. New Jersey, http:/www.mresc.k12.nj.us/dynimg/_IEAAA_/docid/0x096206D67ED04A84/54/NJDRLAP-Broadband+Report+17JUL15v1.pdf
4. North Carolina, in depth overview, https://www.mcnc.org/connections/casestudies/school-connectivity-initiative
5. Utah, https://utahbroadband.wordpress.com/; http://www.uen.org/ueninfo/
6. Virginia initiative, in depth overview, http://www.educationsuperhighway.org/virginia-state-project-initial-data-analysis-highlights-broadband-opportunities-for-divisions/

Appendix A

Glossary of Terms

Backbone: A telecommunications network that does not provide broadband services to end users/devices. A network typically has multiple "access points" located across a broad geographical area and typically extends Internet access to providers who service the end users. A network also "backhauls" traffic from providers to major Internet hub locations (peering points). (Note: In Texas, TETN and LEARN would be considered backbone networks.)

Backhauling: Process of using a backbone network to transport traffic coming from the end user to the Internet service provider's point of presence (POP)

Broadband: Typically described as a high-speed connection to the Internet

Fiber Optic Communications: Method of transmitting information from one place to another by sending pulses of light through an optical fiber

Gigabits (Gbps): Gigabits per second is a unit of data transfer rate equal to 1,000 Megabits (Mbps)

Internal Connections: Infrastructure, including Wi-Fi, necessary to deliver Internet access from the district's aggregation point to the actual student or faculty

Internet Access: Connection that allows data traffic to flow from the district's aggregation point to the ISP (e.g., amount of Internet access purchased from an ISP to serve the entire district)

Internet Service Provider (ISP): Typically a Texas district's ISP is a commercial provider, ESC, or higher education institution

LEARN (Lone Star Education and Research Network): A consortium of Texas institutions of higher education that come together to provide a high-performance optical network to serve mainly higher education, community colleges and K–12 schools in Texas

Megabits (Mbps): Megabits per second is a unit of data transfer rate equal to 1,000 kilobits (kb)

Middle Mile/Backbone: See "Backbone"

POP (Point-of-Presence): A building that houses a provider's network equipment. Normally, this is the provider's aggregation point for multiple users and for aggregating Internet traffic

TETN (Texas Education Telecommunications Network): A consortium of TEA and regional ESCs that come together to provide a 10-gigabit backbone network among the ESCs for the purpose of interconnecting the ESC regional networks. Currently the 20 ESC regional networks provide Internet access to over 500 school districts.

T1: Copper-based digital transmission (1.544 Mbps)

WAN: The transport connection from the district's central network hub to and among district campuses for the purpose of relaying data including Internet access

Wi-Fi: Local area computer network that allows computers, smart phones or other devices to connect to the Internet or communicate with one another wirelessly in a particular area

Appendix B

Texas Education Code, §32.005

Sec. 32.005. STUDY ON SCHOOL DISTRICT NETWORK CAPABILITIES.

(a) The commissioner shall conduct a study to assess the network capabilities of each school district. The study must gather sufficient information to determine whether the network connections of a district and school campuses in the district meet the following targets:

(1) an external Internet connection to a campus's Internet service provider featuring a bandwidth capable of a broadband speed of at least 100 megabits per second for every 1,000 students and staff members; and

(2) an internal wide area network connection between the district and each of the school campuses in the district featuring a bandwidth capable of a broadband speed of at least one gigabit per second for every 1,000 students and staff members.

(b) The commissioner may solicit and accept gifts and grants from any public or private source to conduct the study. The commissioner may also cooperate or collaborate with national organizations conducting similar studies.

(c) The commissioner shall complete the study not later than December 1, 2015. This section expires December 1, 2016.

Added by Acts 2013, 83rd Leg., R.S., Ch. 1386 (H.B. 1926), Sec. 24, eff. June 14, 2013.

Appendix C

Public School Network Capabilities Survey

Survey Questions

The first nine (9) questions are asked for each campus in the district or charter school. The last three (3) questions are each asked once for the district or charter school as a whole.

School 1: (Campus Name here) Enrollment: (enrollment here) Staff: (staff count here)
(Campus Type here)
(Staff and Enrollment as reported in the 2013-2014 PEIMS data collection)

Please answer the following questions about connectivity between **THIS CAMPUS AND THE INTERNET**:

1) What is the external Internet connection speed in megabits per second (Mbps) that is currently in place between this campus and the campus's Internet service provider?

(Instructions: If the campus has more than one Internet service provider, add the speeds of all **ACTIVE** connections together and report the resulting total. Do not include connections that are not active such as disaster recovery connections or other passive connections. If the Internet connection is shared with multiple campuses, report the known speed of the full connection.)

_____

_____

2) Is the connection between this campus and the campus's Internet service provider dedicated only to this campus or is it shared with one or more other campuses?

(Select one option)

- ○ Dedicated
- ○ Shared with ALL campuses in the district
- ○ Shared with SOME campuses in the district
- ○ Unsure

3) Does this campus currently have an Internet connection speed of at least 100 Mbps for every 1,000 students and staff members?

(Instructions: If the Internet connection is shared across multiple campuses, divide the bandwidth connection by the total number of students and staff at all of the sites sharing the connection.)

(Select one option)

○ Yes ○ No ○ Unsure

4) Identify the Internet connection type used between this campus and the campus's Internet service provider.

(Instructions: If more than one type of Internet connection is used, choose the most predominately used connection)

(Select one option)

- ○ Digital Subscriber Line (DSL)
- ○ Cable modem
- ○ Fiber
- ○ Wireless (fixed or mobile)
- ○ Satellite
- ○ Broadband over electric power lines (BPL)
- ○ Unknown
- ○ Other (Please specify) _____

5) Select the top two (2) barriers, if any, that prevent this campus from **ACQUIRING** an Internet connection speed of at least 100 Mbps for every 1,000 students and staff members. [Please select at most 2 options.]

- ☐ No barriers exist
- ☐ Internet service provider cannot provide any higher speed or connection
- ☐ Higher speed connection only available at premium rate
- ☐ Current hardware or software does not support higher speeds

- ☐ Necessary funds are not available in district/campus budget
- ☐ Other (Please specify) _____

6) For the connections currently in place, select the top two (2) barriers, if any, that prevent this campus from **USING** the full speed of the connection between this campus and the Internet.

[Please select at most 2 options.]

- ☐ No barriers exist
- ☐ Equipment not properly sized
- ☐ Use of application requiring large bandwidth significantly slows connection speed
- ☐ Simultaneous use of same connection for multiple applications significantly slows connection speed
- ☐ Internet connection is shared with another campus, entity, or facility
- ☐ Network configuration creates bottleneck
- ☐ Networking technical expertise not available
- ☐ Other (Please specify) _____

Please answer the following questions about the connectivity (i.e., wide area network) between **THIS CAMPUS AND THE DISTRICT**.

7) What is the connection (i.e., wide area network) speed in megabits per second (Mbps) that is currently in place between this campus and the district?
(Enter a value between 1 and 9999)

_____

_____

8) Is the connection between this campus and the district dedicated to this campus only or is it shared with one or more other campuses?
(Select one option)

- ○ Dedicated
- ○ Shared with ALL campuses in the district
- ○ Shared with SOME campuses in the district
- ○ Unsure

9) Does the district currently have a connection (i.e., wide area network) between this campus and the district that has a speed of at least 1,000 Mbps for every 1,000 students and staff members?

(Instructions: If the district connection is shared across multiple campuses, divide the bandwidth connection by the total number of students and staff at all the sites sharing the connection.

(Select one option)

- ○ Yes
- ○ No
- ○ Unsure

Thank you for responding to the questions for each campus.

Below are three questions pertaining to the district or charter school as a whole.

For (District name here) overall, please answer each of the following three questions once for the district or charter as a whole.

10) Does the district currently have a connection (i.e., wide area network) between the district and **EACH** school campus in the district that has a speed of at least 1,000 Mbps for every 1,000 students and staff members? (Select one option)

○ Yes ○ No ○ Unsure

11) Select the top two (2) barriers, if any, that prevent the district from **ACQUIRING** a connection (i.e., wide area network) between the district and each school campus in the district that has a speed of at least 1,000 Mbps for every 1,000 students and staff members. [Please select at most 2 options.]

- [ ] No barriers exist
- [ ] Connectivity provider cannot provide any higher speed or connection
- [ ] Higher speed connection only available at premium rate
- [ ] Current hardware or software does not support higher speeds
- [ ] Necessary funds are not available in district/campus budget
- [ ] Other (Please specify) _____

12) For the connections currently in place, select the top two (2) barriers, if any, that prevent the district or campuses in the district from **USING** the full speed of the connection (i.e., wide area network) between the district and its campuses. [Please select at most 2 options.]

- [ ] No barriers exist
- [ ] Equipment not properly sized
- [ ] Use of application requiring large bandwidth significantly slows connection speed
- [ ] Simultaneous use of same connection for multiple applications significantly slows connection speed
- [ ] Connection is shared with another campus, entity, or facility
- [ ] Network configuration creates bottlenecks
- [ ] Networking technical expertise not available
- [ ] Other (Please specify)