Analysis of Costs to Upgrade and Maintain
Robust Local Area Networks for all K-12 Public Schools

May 2014

Presented by:

Introduction

Since 1998, the Federal Communications Commission's E-rate program has helped schools and libraries acquire telecommunications services and basic Internet connectivity. However, as new technologies offering powerful digital learning opportunities are made available to students, teachers, and library patrons, schools and libraries require much higher speed, more ubiquitous and more robust connectivity. Basic connectivity is simply insufficient to support the technologies needed to prepare America's students for postsecondary success.

As America's schools and libraries transition from using technology only in the computer lab to 1:1 digital learning environments and other technology enabled instructional models, they must have robust wired and wireless networks capable of delivering high speed broadband to every student's or library patron's device. This requires schools and libraries to continually invest in modern local area network (LAN), wireless network (Wi-Fi), and core wide area network (WAN) equipment.

Unfortunately, as the demand for Priority 1 services has overwhelmed the E-rate program, the funding available to make these investments has been severely limited. As a result, according to a survey of district technology leaders by the Consortium for School Networking (CoSN), only 43% of America's schools report that they have wireless networks capable of supporting 1:1 digital learning and improving these networks is the most important connectivity upgrade priority for CTOs.[1]

The importance of ubiquitous Wi-Fi was highlighted by President Obama in June 2013 when he announced the ConnectED initiative. In his remarks, the President asked the question "in a country where we expect free Wi-Fi with our coffee, why shouldn't we have it in our schools?" He then called on the FCC to modernize the E-rate program to meet his goal of connecting 99% of America's students to high-speed broadband, including robust Wi-Fi in every classroom, within five years.

Throughout its E-rate modernization proceeding, the FCC has placed significant emphasis on evaluating and addressing the current lack of funding for LAN and Wi-Fi networks. Solving this issue has received nearly universal support from commenters on the Commission's Notice of Proposed Rulemaking on the E-rate Program (NPRM) and the more recent Public Notice by the FCC's Wireline Bureau. However, there has been little data entered into the public record on the amount of funding actually required to ensure that every school and library has the LAN, Wi-Fi, and WAN equipment it needs.

In order to provide the FCC with a consensus estimate of the resources required for LAN, Wi-Fi, and core WAN equipment that meets the ConnectED initiative's goals, EducationSuperHighway and CoSN developed a model (the "LAN / Wi-Fi ConnectED Cost Model") of the equipment and services required for robust LAN, Wi-Fi, and core

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[1] CoSN E-Rate and Broadband Survey 2013 Final Report: http://www.cosn.org/eratesurvey p.12

WAN networks. The process included extensive consultation with school district network experts from around the country to estimate the needs of a "typical" school district as the basis for estimating the aggregate need across all schools and libraries. While we know there is no true "typical district" due to a wide set of unique circumstances and variations, when looking across as many as 100,000 schools in the U.S., we believe averages are a relevant metric (though the model is least precise for the largest 200 districts). In the comments below we outline the results of our effort and the possible implications it presents for the baseline resources required to upgrade the LAN and Wi-Fi networks in America's schools and libraries to meet the ConnectED goal.

About the LAN / Wi-Fi ConnectED Cost Model

The EducationSuperHighway and CoSN LAN / Wi-Fi ConnectED Cost Model (*see Exhibit 1*) identifies the key equipment and services typically used to deploy and maintain a robust LAN, Wi-Fi, and core WAN network and estimates the aggregate cost of the equipment and services for America's K-12 public schools.

Methodology

We consulted with over 50 district chief technology officers, as well as equipment vendors, and networking experts to help define and validate the list of equipment required for a robust wired and wireless network, considering needs on a per-classroom, per-school, and per-district basis. Our objective was to identify the typical equipment required to provide the foundation of high-speed, ubiquitous connectivity to every school, and does not include higher-level infrastructure (e.g., identity management solutions) that some schools may choose to deploy. Our list excludes some items currently eligible for E-rate Priority 2 support that are not required components for robust in-school wired or wireless connectivity, and includes content filters, which are currently not eligible for support.

For each item in the model, we started by estimating the average quantity of each item necessary to provide in-school wired and wireless connectivity for media rich 1:1 digital learning, as well as the expected equipment lifespan. We recognize there can be significant variance from district to district on both of these dimensions that is due to factors ranging from physical building constraints to budget policies. As such, the modeled values represent only our expectation of the average across a large number of schools, not the expected case for any particular district.

Next, we researched and identified the estimated cost of each component of the model. We arrived at our expected average prices using a combination of sources including national price lists, vendor discussions, and recent purchasing experiences of school districts. The model assumes that districts procure only the equipment

necessary for robust connectivity and that they do so at reasonable, but not always best practice, prices.[2]

In addition to capital equipment, the model includes the physical labor costs of installation where those costs represent a significant portion of the overall effort (e.g., installation of wiring). The model does not include network design, configuration, and operational costs, as the need and nature of these services varies to such an extent that they could not be accurately modeled in a feasible timeframe. In many districts these services are provided by in-house staff where there is no discrete cost allocated or by a value-added reseller who provides some of these services as part of a broader relationship.

The following is an abbreviated list of the most commonly referenced equipment along with the quantities and costs represented in the LAN / Wi-Fi Cost Model. A full list and description of modeled equipment and services is provided in *Appendix A*.

School-level local area network

Equipment	Quantity	Unit	Cost[3]
Wireless Access Point	1.2	Per Classroom	$520
Wired Drops	6	Per Classroom	$215[4]
Access Switch Ports	6	Per Classroom	$73
Core Switch	1	Per School	$12,120

District-level wide area network

Equipment	Quantity	Unit	Cost[5]
Internal Core Switch/Router	1	Per District	$12,500
Firewall	1	Per District	$10,000
Content Filter	1	Per District	$10,000

District readiness assumptions

To estimate the investment required to connect 99% of America's students to high-speed broadband by 2018, it is also important to understand where schools' LAN and Wi-Fi networks stand today. According to CoSN's survey of chief technology

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[2] The model assumes districts will make purchasing decisions that optimize the lifecycle of their equipment due to increased reliability of E-rate funding over time. This may be a change of behavior for many districts that previously needed to plan for "feast or famine" from year to year by buying the best equipment on the market rather than high-value solutions that offer a better price-per-performance.

[3] Costs listed include installation, where applicable.

[4] The cost of wiring is the least precise element of the model as it is primarily driven by labor costs, which can vary significantly based on each district's work rules, contracting policies, and geographic location as well as the generally unpredictable nature of modifying wiring in an existing school. Because these costs represent a significant part of the overall modeled cost, this is likely the largest source of uncertainty in the current model.

[5] Costs represent medium-sized districts (6 – 15 schools). Prices will vary for small, large, and very large districts.

officers, 43% of schools currently have LAN and Wi-Fi networks capable of supporting 1:1 digital learning. This suggests that E-rate can initially focus on upgrading the 57% of schools without robust wired and wireless networks.[6]

The magnitude of the resources likely required to reach the ConnectED goal is also impacted by the fact that very few schools are starting from scratch. In the 57% of schools without 1:1 ready networks, many of the required components, especially the expensive but long lasting in-building wiring, are already in place. For example, the CoSN survey found that 74% of schools already use fiber as their in-building backbone network, 80% of schools have wiring to their classrooms capable of supporting gigabit broadband connections, and roughly 80% of schools have some form of Wi-Fi in 90% of their classrooms.[7]

To account for this varying state of network readiness in our model, we made specific assumptions about the percentage of schools and districts requiring upgrades for each component of the LAN, Wi-Fi, and core WAN networks. Using the CoSN survey data as a starting point, we estimated that 57% of schools require Wi-Fi upgrades, 40% of schools and districts require LAN and WAN switch upgrades, 26% of schools require fiber backbone upgrades, 20% of classrooms require wiring upgrades (including upgrades required for new access points) and 50% of districts require content filter and firewall upgrades.

Connecting 99% of Students in 5 Years

As seen in the table below, by combining our estimates of the equipment schools need for robust LAN, Wi-Fi, and core WAN networks, the cost of that equipment, and the current readiness of school networks, the LAN / Wi-Fi ConnectED Cost Model estimates the baseline funding that will be required to achieve the ConnectED goal of ubiquitous wireless networks capable of supporting 1:1 digital learning. Specifically, the model projects that schools will require approximately $2.9 billion of E-rate subsidies over the next four years to upgrade their LAN, WAN, and Wi-Fi networks.[8][9] Assuming that libraries add an additional 10% to the upgrade cost, we arrive at a total E-rate subsidy requirement of approximately $3.2 billion or $800 million per year for the next four years. This does not include resources required to maintain the in-building wired and wireless networks of schools and libraries currently meeting the ConnectED goal, nor does it include any additional resources that schools and libraries may require to meet the Internet access and WAN connectivity goals of the ConnectED initiative. As such, these costs are only included in the "LAN / Wi-Fi Ongoing Cost Model" shown in Exhibit 2.

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[6] CoSN E-Rate and Broadband Survey 2013 Final Report: http://www.cosn.org/eratesurvey p.12
[7] Ibid, p. 13
[8] This estimate includes the cost of the school district equipment required to operate the WAN, but not the WAN network connectivity.
[9] This assumes an average E-rate subsidy of 70%. The actual upgrade cost for schools and libraries is projected to be $4.5 billion.

Network Component	% of Schools Requiring Upgrade	Cost per School	Total Cost
School-Level			
Fiber Backbone	26%	$17,500	$455M
Wiring	20%	$30,850	$617M
Wi-Fi	57%	$16,700	$953M
Switches	40%	$16,150	$646M
District-Level			
Switches/ Routers	40%	$1,825	$73M
Content Filter & Firewall	50%	$2,460	$123M
Wiring	20%	$400	$8M
		Total	$2.9B
		Total including libraries	$3.2B

Based on this analysis, EducationSuperHighway and CoSN recommend that the FCC add a minimum of $800 million per year of new funding to the E-rate program specifically for LAN, Wi-Fi, and core WAN network upgrades and that these funds should be allocated based on a gap analysis of the wired and wireless networks in each school and library. In addition, we encourage the Commission to set aside a portion of the $2 billion in newly available E-rate funds for these upgrades to account for any variances in the actual needs of schools that result from potential overestimation of the current readiness of school networks. Together, these two actions will ensure that America's schools and libraries can meet the ConnectED goal of ubiquitous wirless networks by 2018.

Beyond ConnectED

In addition to providing a robust estimate of the resources required to upgrade school and library networks to the ConnectED goals, the LAN / Wi-Fi Ongoing Cost Model (*see Exhibit 2*) provides insight into the cost of maintaining these networks over time. Specifically, the model suggests that once all schools and libraries have been upgraded, it will cost approximately $2.2 billion per year ($1.6 billion in E-rate subsidies) to maintain these networks and upgrade them periodically to the latest standards. As a result, EducationSuperHighway and CoSN recommend that the dedicated annual funding added to the program for LAN and Wi-Fi upgrades should be maintained in perpetuity, with consideration given to the optimal method of distributing these funds on an ongoing basis.

Exhibit 1: LAN / Wi-Fi ConnectED Cost Model

Assumptions and Calculations

Capital Expenses		
Base E-rate %	**70%**	

Classroom

						Capital Expenses					Totals
	Qty	**Equipment**	**Installation**	**Replacement Life**	**Total Per Unit**	**Total Per Classroom**	**E-rate %**	**E-rate Share**	**% Requiring Upgrades**	**National E-rate Subsidy Required**	
Wireless APs (1)	1.2	$500	$20	4	$520	$624	70%	$ 437	57%	$ 622,440,000	
Wireless Management	1.2	$100	$0	4	$100	$120	70%	$ 84	57%	$ 119,700,000	
Wired Drops (2)	6	$15	$200	12	$215	$1,290	70%	$ 903	20%	$ 451,500,000	
Access Switch Ports (3)	6	$73	$0	6	$73	$438	70%	$ 307	40%	$ 306,600,000	
Switch<->Switch Fiber (4)	0.1	$2,000	$8,000	16	$10,000	$1,000	70%	$ 700	26%	$ 455,000,000	
UPS & PDU	0.1	$300	$0	4	$300	$30	70%	$ 21	20%	$ 10,500,000	
IDF Rack and Accessories (5)	0.1	$2,000	$200	12	$2,200	$220	70%	$ 154	20%	$ 77,000,000	
Total						**$3,722**		**$2,605**		**$2,042,740,000**	

School

						Capital Expenses					Totals
	Qty	**Equipment**	**Installation**	**Replacement Life**	**Total Per Unit**	**Total Per School**	**E-rate %**	**E-rate Share**	**% Requiring Upgrades**	**National E-rate Subsidy Required**	
Core Switching/Routing	1	$ 12,120.00	$ -	6	$ 12,120.00	$ 12,120.00	70%	$ 8,484	40%	$ 339,360,000	
Core APs (6)	4	$ 500.00	$ 20.00	4	$ 520.00	$ 2,080.00	70%	$ 1,456	57%	$ 82,992,000	
Wi-Fi Site Survey	1	$ -	$ 3,200.00	4	$ 3,200.00	$ 3,200.00	70%	$ 2,240	57%	$ 127,680,000	
UPS & PDU	1	$ 1,400.00	$ -	4	$ 1,400.00	$ 1,400.00	70%	$ 980	20%	$ 19,600,000	
MDF Rack and Accessories	1	$ 4,000.00	$ 200.00	12	$ 4,200.00	$ 4,200.00	70%	$ 2,940	20%	$ 58,800,000	
Total						**$ 23,000.00**		**$ 16,100.00**		**$ 628,432,000.00**	

District

	Qty	**Equipment**	**Installation**	**Replacement Life**	**Total Per Unit**		**E-rate %**	**E-rate Share**
Router								
Firewall								
Content Filter				*see next sheet for district level calculations with scaling by district size*			
Gateway Router (7)								
Data Center Rack and Accessories								

Output Summary

	Qty							**National E-rate Subsidy Required**
Classrooms	2,500,000							$ 2,042,740,000
Schools	100,000							$ 628,432,000
Districts	16,064							$ 204,470,700
Grand Total								**$ 2,875,642,700.00**

Notes

(1) Assumes 1 per classroom plus 20% for coverage of common areas (the size of which tend to scale with # of classrooms). Any software licensing costs are built into the euipment list cost.
(2) Assumes 1 per AP plus 4 mixed-use ports (e.g. desktops, VoIP phones, printers, projectors, etc.)
(3) Matches no. of wired drops in (2)
(4) Multimode fiber connectivity between access switch and upstream core switch. Estimate does not account for difficult construction but is likely net conservative due to stacked switches.
(5) Covers a share of overall costs for telco racks, patch panels, patch cables, and installation
(6) Assumes 4 APs in addition to APs per classroom
(7) CPE that terminates the internet connection from the provider, but is not necessarily the district core router
(8) Due to the disproportionately large variance of the student population in the largest 50 districts, they should all be treated as special cases not precisely accounted for here

Exhibit 1 (cont.): LAN / Wi-Fi ConnectED Cost Model
District Level Calculations

Per Tiny District (1 school)

	Qty	Equipment	Installation	Replacement Life	Total Per Unit	Total Per Tiny District	E-rate %	E-rate Share	% Requiring Upgrades	National E-rate Subsidy Required
Firewall	1	$3,000	$0	4	$3,000	$3,000	70%	$2,100	50%	$4,453,050
Content Filter	1	$3,000	$0	4	$3,000	$3,000	70%	$2,100	50%	$4,453,050
Total						**$6,000**		**$4,200**		**$8,906,100**

Per Small District (2-5 schools) | | | | | | | Capital Expenses | | | |

	Qty	Equipment	Installation	Replacement Life	Total Per Unit	Total Per Small District	E-rate %	E-rate Share	% Requiring Upgrades	National E-rate Subsidy Required
District Internal Core Switch/Router	1	$12,500	$0	6	$12,500	$12,500	70%	$8,750	40%	$26,684,000
Firewall	1	$5,000	$0	4	$5,000	$5,000	70%	$3,500	50%	$13,342,000
Content Filter	1	$5,000	$0	4	$5,000	$5,000	70%	$3,500	50%	$13,342,000
Data Center Racks and Accessories	1	$5,000	$0	12	$5,000	$5,000	70%	$3,500	20%	$5,336,800
Total						**$27,500**		**$19,250**		**$58,704,800**

Per Medium District (6-15 schools) | | | | | | | Capital Expenses | | | |

	Qty	Equipment	Installation	Replacement Life	Total Per Unit	Total Per Medium District	E-rate %	E-rate Share	% Requiring Upgrades	National E-rate Subsidy Required
District Internal Core Switch/Router	1	$12,500	$0	6	$12,500	$12,500	70%	$8,750	40%	$10,909,500
Firewall	1	$10,000	$0	4	$10,000	$10,000	70%	$7,000	50%	$10,909,500
Content Filter	1	$10,000	$0	4	$10,000	$10,000	70%	$7,000	50%	$10,909,500
Data Center Racks and Accessories	1	$5,000	$0	12	$5,000	$5,000	70%	$3,500	20%	$2,181,900
Total						**$37,500**		**$26,250**		**$34,910,400**

Per Large District (16-50 schools) | | | | | | | Capital Expenses | | | |

	Qty	Equipment	Installation	Replacement Life	Total Per Unit	Total Per Large District	E-rate %	E-rate Share	% Requiring Upgrades	National E-rate Subsidy Required
District Internal Core Switch/Router	1	$50,000	$0	6	$50,000	$50,000	70%	$35,000	40%	$12,348,000
Firewall	1	$50,000	$0	4	$50,000	$50,000	70%	$35,000	50%	$15,435,000
Content Filter	1	$50,000	$0	4	$50,000	$50,000	70%	$35,000	50%	$15,435,000
Gateway Router	1	$25,000	$0	6	$25,000	$25,000	70%	$17,500	40%	$6,174,000
Data Center Racks and Accessories	1	$5,000	$0	12	$5,000	$5,000	70%	$3,500	20%	$617,400
Total						**$180,000**		**$126,000**		**$50,009,400**

Per Mega District (51-2000 schools) (8) | | | | | | | Capital Expenses | | | |

	Qty	Equipment	Installation	Replacement Life	Total Per Unit	Total Per Mega District	E-rate %	E-rate Share	% Requiring Upgrades	National E-rate Subsidy Required
District Internal Core Switch/Router	1	$250,000	$0	6	$250,000	$250,000	70%	$175,000	40%	$14,000,000
Firewall	1	$250,000	$0	4	$250,000	$250,000	70%	$175,000	50%	$17,500,000
Content Filter	1	$250,000	$0	4	$250,000	$250,000	70%	$175,000	50%	$17,500,000
Gateway Router	1	$50,000	$0	6	$50,000	$50,000	70%	$35,000	40%	$2,800,000
Data Center Racks and Accessories	1	$5,000	$0	12	$5,000	$5,000	70%	$3,500	20%	$140,000
Total						**$805,000**		**$563,500**		**$51,940,000**

District Counts		**Total District Capital Costs**	$ 204,470,700

	Qty
Tiny Districts	4,241
Small Districts	7,624
Medium Districts	3,117
Large Districts	882
Mega Districts	200
Total Districts	16,064

Exhibit 2: LAN / Wi-Fi Ongoing Cost Model

Assumptions and Calculations

					Capital Expenses Base E-rate %	**70%**				Maintenance and Support Base E-	**70%**		

Per Classroom

	Qty	Equipment	Installation	Replacement Life	Total Per Unit	Total per	Capital Expenses				Maintenance and Support Expenses				Totals		
							Annual Amortized	E-rate %	E-rate Share	District Share	Annual Cost	E-rate %	E-rate Share	District Share	E-rate	District	Total
Wireless APs (1)	1.2	$500	$20	4	$520	$624	$156	70%	$109	$47	$60	70%	42.00	$18	$151	$65	$216
Wireless Management	1.2	$100	$0	4	$100	$120	$30	70%	$21	$9	$3	70%	2.10	$1	$23	$10	$33
Wired Drops (2)	6	$15	$200	12	$215	$1,290	$108	70%	$75	$32	$11	70%	7.53	$3	$83	$35	$118
Access Switch Ports (3)	6	$73	$0	6	$73	$438	$73	70%	$51	$22	$7	70%	5.11	$2	$56	$24	$80
Switch<->Switch Fiber (4)	0.1	$2,000	$8,000	16	$10,000	$1,000	$63	70%	$44	$19	$10	70%	7.00	$3	$51	$22	$73
UPS & PDU	0.1	$300	$0	4	$300	$30	$8	70%	$5	$2	$1	70%	0.53	$0	$6	$2	$8
IDF Rack and Accessories (5)	0.1	$2,000	$200	12	$2,200	$220	$18	70%	$13	$6	$1	70%	0.64	$0	$13	$6	$19
Total						$3,722	$455		$318	$136	$93		$65	$28	$383	$164	$548

Per School

	Qty	Equipment	Installation	Replacement Life	Total Per Unit	Total per School	Capital Expenses				Maintenance and Support Expenses				Totals		
							Annual Amortized	E-rate %	E-rate Share	District Share	Annual Cost	E-rate %	E-rate Share	District Share	E-rate	District	Total
Core Switching/Routing	1	$12,120	$0	6	$12,120	$12,120	$2,020	70%	$1,414	$606	$1,212	70%	$848	$364	$2,262	$970	$3,232
Core APs (6)	4	$500	$20	4	$520	$2,080	$520	70%	$364	$156	$200	70%	$140	$60	$504	$216	$720
Wi-Fi Site Survey	1	$0	$3,200	4	$3,200	$3,200	$800	70%	$560	$240	$0	70%	$0	$0	$560	$240	$800
UPS & PDU	1	$1,400	$0	4	$1,400	$1,400	$350	70%	$245	$105	$0	70%	$0	$0	$245	$105	$350
MDF Rack and Accessories	1	$4,000	$200	12	$4,200	$4,200	$350	70%	$245	$105	$100	70%	$70	$30	$315	$135	$450
Total						$23,000	$4,040		$2,828	$1,212	$1,512		$1,058	$454	$3,886	$1,666	$5,552

Per District

	Qty	Equipment	Installation	Replacement Life	Total Per Unit	Total per District	Annual Amortized	E-rate %	E-rate Share	District Share	Annual Cost	E-rate %	E-rate Share	District Share	E-rate	District
Router																
Firewall																
Content Filter					*see next sheet for district level calculations with scaling by district size*										
Gateway Router (7)																
Data Center Rack and Accessories																

Output Summary

Sample District Annual Costs -- Change column B to fit your district. (10)

	Qty			Capital Expenses			Maintenance and Support Expenses			Totals		
				Annual Amortized Total (9)	E-rate Share	District Share	Annual Total	E-rate Share	District Share	E-rate	District	Total
Classrooms	21247			$9,663,844	$6,764,691	$2,899,153	$1,969,951	$1,378,966	$590,985	$8,143,656	$3,490,138	$11,633,795
Schools	34			$137,360	$96,152	$41,208	$51,408	$35,986	$15,422	$132,138	$56,630	$188,768
District	1			$37,917	$26,542	$11,375	$41,250	$28,875	$12,375	$55,417	$23,750	$79,167
Grand Total				$9,839,121	$6,887,384	$2,951,736	$2,062,609	$1,443,826	$618,783	$8,331,211	$3,570,519	$11,901,730

National Annual Costs

	Qty			Capital Expenses			Maintenance and Support Expenses			Totals		
				Annual Amortized Total (9)	E-rate Share	District Share	Annual Total	E-rate Share	District Share	E-rate	District	Total
Classrooms	2,500,000			$1,137,083,333	$795,958,333	$341,125,000	$231,791,667	$162,254,167	$69,537,500	$958,212,500	$410,662,500	$1,368,875,000
Schools	100,000			$404,000,000	$282,800,000	$121,200,000	$151,200,000	$105,840,000	$45,360,000	$388,640,000	$166,560,000	$555,200,000
Districts	16,064			$136,384,833	$95,469,383	$40,915,450	$144,729,675	$144,729,675	43418902.5	$196,780,156	$84,334,353	$281,114,508
Grand Total				$1,677,468,167	$1,174,227,717	$503,240,450	$527,721,342	$412,823,842	$158,316,403	$1,543,632,656	$661,556,853	$2,205,189,508

Notes

(1) Assumes 1 per classroom plus 20% for coverage of common areas (the size of which tend to scale with # of classrooms). Any software licensing costs are built into the euipment list cost.
(2) Assumes 1 per AP plus 4 mixed-use ports (e.g. desktops, VoIP phones, printers, projectors, etc.)
(3) Matches no. of wired drops in (2)
(4) Multimode fiber connectivity between access switch and upstream core switch. Estimate does not account for difficult construction but is likely net conservative due to stacked switches. Low maintenance assumed due to multiple strands.
(5) Covers a share of overall costs for telco racks, patch panels, patch cables, and installation
(6) Assumes 4 APs in addition to APs per classroom
(7) CPE that terminates the internet connection from the provider, but is not necessarily the district core router
(8) Due to the disproportionately large variance of the student population in the largest 50 districts, they should all be treated as special cases not precisely accounted for here
(9) The cost of equipment and installation spread out into even annual amounts across the replacement life-cycle for that equipment
(10) Sample district costs still include fractional APs and switches, which are expected to work out when aggregated

Exhibit 2 (cont.): LAN / Wi-Fi Ongoing Cost Model
District Level Calculations

Per Tiny District (1 school)

	Qty	Equipment	Installation	Replacement Life	Total Per Unit	Annual Amortized Total	E-rate %	E-rate Share	District Share	Annual Maint/Support	E-rate %	E-rate Share	District Share	E-rate Total	District Total	Total
Firewall	1	$3,000	$0	4	$3,000	$750	70%	$525	$225	$900	70%	$630	$270	$1,155	$495	$1,650
Content Filter	1	$3,000	$0	4	$3,000	$750	70%	$525	$225	$900	70%	$630	$270	$1,155	$495	$1,650
Total						**$1,500**		**$1,050**	**$450**	**$1,800**		**$1,260**	**$540**	**$2,310**	**$990**	**$3,300**

Per Small District (2-5 schools)

	Qty	Equipment	Installation	Replacement Life	Total Per Unit	Capital Expenses — Annual Amortized Total	E-rate %	E-rate Share	District Share	Maintenance and Support Expenses — Annual Maint/Support	E-rate %	E-rate Share	District Share	Totals — E-rate Total	District Total	Total
District Internal Core Switch/Router	1	$12,500	$0	6	$12,500	$2,083	70%	$1,458	$625	$1,875	70%	$1,313	$563	$2,771	$1,188	$3,958
Firewall	1	$5,000	$0	4	$5,000	$1,250	70%	$875	$375	$1,500	70%	$1,050	$450	$1,925	$825	$2,750
Content Filter	1	$5,000	$0	4	$5,000	$1,250	70%	$875	$375	$1,500	70%	$1,050	$450	$1,925	$825	$2,750
Data Center Racks and Accessories	1	$5,000	$0	12	$5,000	$417	70%	$292	$125	$0	70%	$0	$0	$292	$125	$417
Total						**$5,000**		**$3,500**	**$1,500**	**$4,875**		**$3,413**	**$1,463**	**$6,913**	**$2,963**	**$9,875**

Per Medium District (6-15 schools)

	Qty	Equipment	Installation	Replacement Life	Total Per Unit	Capital Expenses — Annual Amortized Total	E-rate %	E-rate Share	District Share	Maintenance and Support Expenses — Annual Maint/Support	E-rate %	E-rate Share	District Share	Totals — E-rate Total	District Total	Total
District Internal Core Switch/Router	1	$12,500	$0	6	$12,500	$2,083	70%	$1,458	$625	$1,875	70%	$1,313	$563	$2,771	$1,188	$3,958
Firewall	1	$10,000	$0	4	$10,000	$2,500	70%	$1,750	$750	$3,000	70%	$2,100	$900	$3,850	$1,650	$5,500
Content Filter	1	$10,000	$0	4	$10,000	$2,500	70%	$1,750	$750	$3,000	70%	$2,100	$900	$3,850	$1,650	$5,500
Data Center Racks and Accessories	1	$5,000	$0	12	$5,000	$417	70%	$292	$125	$0	70%	$0	$0	$292	$125	$417
Total						**$7,500**		**$5,250**	**$2,250**	**$7,875**		**$5,513**	**$2,363**	**$10,763**	**$4,613**	**$15,375**

Per Large District (16-50 schools)

	Qty	Equipment	Installation	Replacement Life	Total Per Unit	Capital Expenses — Annual Amortized Total	E-rate %	E-rate Share	District Share	Maintenance and Support Expenses — Annual Maint/Support	E-rate %	E-rate Share	District Share	Totals — E-rate Total	District Total	Total
District Internal Core Switch/Router	1	$50,000	$0	6	$50,000	$8,333	0.7	$5,833	$2,500	$7,500	70%	$5,250	$2,250	$11,083	$4,750	$15,833
Firewall	1	$50,000	$0	4	$50,000	$12,500	70%	$8,750	$3,750	$15,000	70%	$10,500	$4,500	$19,250	$8,250	$27,500
Content Filter	1	$50,000	$0	4	$50,000	$12,500	70%	$8,750	$3,750	$15,000	70%	$10,500	$4,500	$19,250	$8,250	$27,500
Gateway Router	1	$25,000	$0	6	$25,000	$4,167	70%	$2,917	$1,250	$3,750	70%	$2,625	$1,125	$5,542	$2,375	$7,917
Data Center Racks and Accessories	1	$5,000	$0	12	$5,000	$417	70%	$292	$125	$0	70%	$0	$0	$292	$125	$417
Total						**$37,917**		**$26,542**	**$11,375**	**$41,250**		**$28,875**	**$12,375**	**$55,417**	**$23,750**	**$79,167**

Per Mega District (51+ schools) (8)

	Qty	Equipment	Installation	Replacement Life	Total Per Unit	Capital Expenses — Annual Amortized Total	E-rate %	E-rate Share	District Share	Maintenance and Support Expenses — Annual Maint/Support	E-rate %	E-rate Share	District Share	Totals — E-rate Total	District Total	Total
District Internal Core Switch/Router	1	$250,000	$0	6	$250,000	$41,667	70%	$29,167	$12,500	$37,500	70%	$26,250	$11,250	$55,417	$23,750	$79,167
Firewall	1	$250,000	$0	4	$250,000	$62,500	70%	$43,750	$18,750	$75,000	70%	$52,500	$22,500	$96,250	$41,250	$137,500
Content Filter	1	$250,000	$0	4	$250,000	$62,500	70%	$43,750	$18,750	$75,000	70%	$52,500	$22,500	$96,250	$41,250	$137,500
Gateway Router	1	$50,000	$0	6	$50,000	$8,333	70%	$5,833	$2,500	$7,500	70%	$5,250	$2,250	$11,083	$4,750	$15,833
Data Center Racks and Accessories	1	$5,000	$0	12	$5,000	$417	70%	$292	$125	$0	70%	$0	$0	$292	$125	$417
Total						**$175,417**		**$122,792**	**$52,625**	**$195,000**		**$136,500**	**$58,500**	**$259,292**	**$111,125**	**$370,417**

District Totals

	Qty	Capital Expenses — Annual Amortized Total	E-rate Share	District Share	Maintenance and Support Expenses — Annual Total Maint/Support	E-rate Share	District Share	Totals — E-rate Total	District Total	Total
Tiny Districts	4,241	$6,361,500	$4,453,050	$1,908,450	$7,633,800	$5,343,660	$2,290,140	$9,796,710	$4,198,590	$13,995,300
Small Districts	7,624	$38,120,000	$26,684,000	$11,436,000	$37,167,000	$26,016,900	$11,150,100	$52,700,900	$22,586,100	$75,287,000
Medium Districts	3,117	$23,377,500	$16,364,250	$7,013,250	$24,546,375	$17,182,463	$7,363,913	$33,546,713	$14,377,163	$47,923,875
Large Districts	882	$33,442,500	$23,409,750	$10,032,750	$36,382,500	$25,467,750	$10,914,750	$48,877,500	$20,947,500	$69,825,000
Mega Districts	200	$35,083,333	$24,558,333	$10,525,000	$39,000,000	$27,300,000	$11,700,000	$51,858,333	$22,225,000	$74,083,333

Appendix A

Understanding the EducationSuperHighway and CoSN LAN / Wi-Fi Cost Model

Structure of the Model

The base case model consists of two worksheets containing the following information:

- **Totals**: Calculates the capital and maintenance costs for the major LAN, Wi-Fi, and core WAN equipment required at the classroom and school level. Incorporates summary data from the district worksheet and calculates the total costs at the district and national level. Allows the user to adjust the E-rate subsidy percentage separately for capital and maintenance costs.
- **Districts**: Calculates the capital and maintenance costs for the district provided core WAN equipment. Breaks down districts into five size categories and adjusts required equipment and costs accordingly.

Source Data & Analysis

The model incorporates price, quantity, and replacement life data from districts, school technology consultants, hardware vendors and public education pricing available through major purchasing consortia.

When there were multiple price points covering a wide range of potential solutions, we arrived at the average prices in our model using a PERT-style estimating approach that blended the different levels of equipment overweighting the most common solution.

Totals Worksheet

The Totals worksheet lists our assumptions for the type, quantity, and price of equipment required at the school and classroom level and calculates the total cost to meet the core WAN, LAN, and Wi-Fi networks required at the district and national levels. The worksheet is divided into two sections:

Classrooms & Schools

The Classrooms & Schools section includes key model assumptions and calculations at the classroom and school level. At this level, we utilize average costs that we expect are consistent across all district sizes. We recognize that larger districts will generally need classroom and school equipment with more management capabilities due to their scale, but we expect this will be covered within the normal model variance and somewhat offset by their greater purchasing scale.

Fields in this section are color-coded. Blue fields are inputs based on analysis of the source data (more detail below). Green fields are variables subject to policy decisions. White fields are calculations that should not be changed.

The model inputs fall into several categories:

- **Network Components:** For each network infrastructure component, we have estimated the quantities needed, total equipment costs, installation costs and replacement life. Actual inputs were based on our blended source data analysis.

- **Capital Expenses:** For each network infrastructure component, we calculate the annual amortized total by dividing the total cost of the component (equipment plus installation) by the replacement life of the component. We then apply the average E-rate discount percentage to calculate the E-rate subsidy and district share of the costs.

- **Maintenance & Support Expenses:** For each network infrastructure component we utilized source data to estimate the annual maintenance cost. We then apply the average E-rate discount percentage to calculate the E-rate subsidy and district share of the costs.

- **Totals:** For each network infrastructure component, we add the capital and maintenance & support expenses to calculate the total cost at the district or national level. We then apply the average E-rate discount percentage to calculate the E-rate subsidy and district share of the costs.

- **"Per Classroom" Section:** Outlines the infrastructure components required at the classroom level. The components listed are those that scale as you add each classroom.

- **"Per School" Section:** Outlines the infrastructure components at the school level. The components listed are those that scale as you add each school. Some of the components in this section are also in the per classroom section. Depending on the number of classrooms per school, however, you need a different quantity of certain components.

Infrastructure Component Assumptions

As mentioned, the blue fields are those that are based on our analysis of the source data. The below section provides more detail on assumptions that were made for each infrastructure component.

Per Classroom Assumptions

Wireless Access Points (AP): The gateway that client devices use to get onto the network and ultimately the Internet.

- **Quantity:** Assumes 1 access point per classroom with an additional 20% for common areas, which tend to scale with the number of classrooms. A base number of access points are also included in the school model to make sure there is sufficient common area coverage in smaller schools.
- **Equipment Cost:** This cost is based on the source data received from districts and vendors for higher-end 802.11n and lower-end 802.11ac models.
- **Installation:** Includes mounting access point to its fixed location and shared overall cost of any software configuration.
- **Replacement Life:** The general consensus among districts and vendors was that access points should be replaced every 4 years due to the rapidly changing Wi-Fi standard evolution.
- **Annual Support & Maintenance Costs:** Some districts will elect to purchase a vendor supplied support contract, which is typically calculated as a fixed annual % and some will purchase spares. Factoring in these two common options, we assume 10% of the equipment cost on average.

Wireless Management: The wireless network control solution used to manage access points, which could be either hardware-based (including in-switch) or cloud-based.

- **Quantity:** Matches the quantity of Wireless APs.
- **Equipment Cost:** The per-unit cost of the controller solution divided by the average number of individual APs that are supported. Includes both hardware and software license costs.
- **Installation:** There are many methods of implementation, some involving no additional cost and some involving minimal cost.
- **Replacement Life:** Similar to wireless APs, in order to stay up to date with wireless technology advancements, the wireless controller should also have the same life cycle as the access points on average. Some hardware solutions will support longer upgrade cycles with smaller incremental upgrades as needed within the same budget range.
- **Annual Support & Maintenance:** Wireless controller support is provided by the vendor via support contracts that are generally a fixed 10% rate.

Wired Drops: The physical data ports available in the classroom.

- **Quantity:** Assumes a minimum of 1 drop per AP, plus up to 5 additional drops for mixed use, which may include desktops, VoIP phones, and projectors.

- **Equipment Cost:** This includes the cable run from the switch port to the wall plate, the wall plate itself, RJ45 plugs.
- **Installation:** The labor involved in running cable, crimping connectors, mounting wall plates.
- **Replacement Life:** Wiring life cycles have lasted 10-15 years in many schools. We assume 12 years on average.
- **Annual Support & Maintenance:** Wired drops rarely fail once installed properly, however, we accounted for occasional moved cable runs due to either expansion or damage.

Access switch port: The individual source port on the access switch for each wired drop

- **Equipment Cost:** This cost was calculated based on a 48 port switches, providing Power over Ethernet in most cases. We assume that some switch ports will remain empty due to proximity of wiring closets to classrooms and other placement issues, while most districts will also save switch ports by leaving some inactive drops wired but not connected to a switch.
- **Quantity**: Matches the number of wired drops.
- **Installation**: We expect minimal physical installation costs associated with racking the switches, often done by district personnel. Higher-level design work and switch configuration is outside the scope of this model.
- **Replacement life**: Most districts report the replacement life of a switch to be in excess of 6 years.
- **Maintenance/support**: Since access switches have very few features enabled, the typical support strategy is to purchase spare switches in case of hardware failure. We assume one spare for every 10 switches.

Switch-Switch Fiber: Multimode fiber connectivity between the access switch and the upstream core switch. This estimate does not reflect the many schools with particularly challenging construction, but because of the increased usage of stacked switches in schools, we believe these factors average out.

- **Equipment Cost:** Includes the cost of 6 strand multimode fiber, fiber patch panels, and patch cables, along with the pluggable interfaces (e.g., SFP+ adapter) to connect to the access and core switches. Some districts may choose to run Cat 6a copper cable for cable runs <100m, but we do not anticipate this will have a major cost impact.
- **Quantity**: The assumption is based on the number of classrooms concentrated to each IDF switch closet. We believe the average number of classrooms per IDF switch is conservatively 10, higher in new construction where this is part of the design.
- **Installation**: In-wall or in-building fiber installation is time-consuming and involves additional equipment and labor time compared to copper cabling to properly install. This includes installing conduits and cable trays to relieve stress and provide physical protection for the strands, running the fiber

through the conduits/cable trays, terminating fiber at both ends, then testing for continuity, end-to-end terminations and signal loss or attenuation levels.
- **Replacement life**: fiber strands on average last longer than copper, because the conduit and cable trays provide protection.
- **Maintenance/support**: The low maintenance cost assumes some of the strands installed concurrently can be used for backup if needed.

Uninterruptable Power Supply (UPS) & Power Distribution Unit (PDU): Gear that is required to remain powered on to keep the network up and running during short power outages or interruptions.

- **Equipment Cost:** This cost is based on common models used by districts in each school.
- **Quantity**: Assumes 1x UPS and 1x PDU bundle per IDF closet. Given 10 classrooms per IDF closet, this value is .10.
- **Installation**: Just need to be plugged in. PDU attachment considered part of rack installation.
- **Replacement life**: This component will usually get replaced when the school needs to install additional equipment that is deemed critical to the uptime of the network.
- **Maintenance/support**: There is typically no vendor support structure. Failed units are usually due to failed or degraded batteries. Keeping spare UPS units or batteries are not common enough for us to include in this model.

IDF Rack & Accessories: Equipment that resides in the IDF closet, including 2-post telco racks, patch panels, patch cables, and other related accessories

- **Equipment Cost**: Includes half telco rack (19U), patch panel (48-port), and patch cables.
- **Quantity**: Assumption is 10 classrooms to 1 IDF (see Switch-Switch Fiber quantity above)
- **Installation**: Includes installation of base rack and patch panels. Wiring termination is considered part of the wired drop installation.
- **Replacement life**: The non-electronic equipment in this category rarely fails and will likely be replaced when there is a major change in the physical building/site, which causes these items to be moved or upgraded to accommodate additional equipment or network wiring.
- **Maintenance/support**: Similar to wiring, this category of items has a low rate of failure and mostly require maintenance due to network expansions and upgrades.

Per School Assumptions

Core Switching/Routing: The equipment that connects all the switches within the school building to each other and to the wide area network. This is often labeled as the MDF switch or school backbone switch/router.

- **Equipment Cost**: This cost assumes a mid-grade model with sufficient fiber ports to connect the access switches.
- **Quantity**: 1 per school
- **Installation**: We expect minimal physical installation costs associated with racking the switches, often done by district personnel. Higher-level design work and switch configuration is outside the scope of this model.
- **Replacement life**: Assumes 6 years based on observed data. Likely drivers for replacement would be increased demand for more ports or when a circuit upgrade requires different cabling/interfaces, and thus different modules.
- **Maintenance/support**: Because this is a core switch, we assume most districts will opt for a vendor support contract.

Core APs: These units are in addition to the per-classroom APs and are listed separately here so that the model will scale well for smaller schools. All assumptions remain the same.

Wi-Fi Site Survey Cost: This is the process of collecting wireless data for the purposes of designing a Wi-Fi network.

- **Equipment Cost**: This is a service and no equipment purchasing is necessary.
- **Quantity**: Assumes one site survey per school
- **Installation**: Based on $200 per hour for 2 working days (16 hours) of labor. This is meant to represent the time spent on the actual survey, not the overall network design, which is beyond the scope of this model.
- **Replacement life**: The assumption is that a site survey will be completed at the end of every wireless AP replacement lifecycle, therefore this value is the same as the wireless AP replacement life.
- **Maintenance/support**: No related costs pertaining to this service.

UPS & PDU: Gear that is required to remain powered on to keep the network up and running during short power outages or interruptions.

- **Equipment Cost:** This cost is based on common models used by districts in each school. These are sized substantially bigger than the IDF power equipment to account for longer runtime for school core equipment.
- **Quantity**: Assumes 1x UPS and 1x PDU bundle per school.
- **Installation**: Just need to be plugged in. PDU attachment considered part of rack installation.
- **Replacement life**: This component will usually get replaced when the school needs to install additional equipment that is deemed critical to the uptime of the network.
- **Maintenance/support**: There is typically no vendor support structure. Failed units are usually due to failed or degraded batteries. Keeping spare UPS units or batteries is not common enough for us to include in this model.

MDF Rack & Accessories: This line item is intended for equipment that resides in the MDF closet.

- **Equipment Cost**: This cost includes telco racks, patch panels, patch cables, and other related accessories.
- **Quantity**: This is given as a bundled set, one per each school.
- **Installation**: Includes installation of base rack and patch panels. Wiring termination is considered part of the wired drop installation.
- **Replacement life**: The non-electronic equipment in this category rarely fails and will likely be replaced when there is a major change in the physical building/site which causes these items to be moved or upgraded to accommodate additional equipment or network wiring.
- **Maintenance/support**: Similar to wiring, this category of items has a low rate of failure and mostly require maintenance due to network expansions and upgrades.

Output Summary

- **Sample District Annual Costs:** This section can be used to "sense check" the model. You may input the number of classrooms and schools into the green highlighted cells for a district familiar to you and see the model output. The values input here do not impact the National Annual Costs, which are calculated separately.
- **National Annual Costs:** This section calculates the national annual costs based on ALL model inputs from the Classrooms & Schools and Districts tabs. We have provided assumptions on the number of classrooms, schools and districts nationwide based on NCES data, but if you wanted to model other assumptions to see how this might change over time, you may input those values here.

Districts

The Districts tab includes key model assumptions and calculations at the district level, scaled to account for the differing needs districts based on their size. We assume that one school districts need a more limited set of equipment since they do not have a multi-site WAN and the same main switch acts for both the school and the district office.

Column Headings reflect the district size breakdown: Tiny District (1 school), Small District (2-5 schools), Medium District (6-15 Schools), Large District (16-50 schools), and Mega District (51-2000 schools)

Infrastructure Components - General Assumptions

District Internal Core Switch/Router: The device at this level is used to connect to the ISP-provided circuit, either to connect to the primary Internet connection and/or to other nodes on the district WAN. This is often a higher-grade device than the core switch/router at the school level.

- **Equipment Cost**: The device at this level should be of higher grade and support more hardware modules as well as throughput capacity than the school-level core switch/router. We assume a minimum need of an entry-level campus grade model for the small and medium sized districts, increasing to high-end campus grade models for the mega districts. For tiny districts, this equipment is usually one and the same as the per school level core switch/router.
- **Quantity**: Assumes 1 per district
- **Installation**: We expect minimal physical installation costs associated with racking the switches, often done by district personnel. Higher-level design work and switch configuration is outside the scope of this model.
- **Replacement life**: Average replacement life for this type of equipment. A likely replacement scenario: due to network changes or circuit upgrades, the district may need additional ports or modules, which may require a change in router chassis.
- **Maintenance/support**: Calculated as a fixed 15% of the equipment cost. This includes standard vendor hardware and software support.

Firewall: The primary security appliance, protecting the network perimeter from unauthorized access via the Internet. This is typically in the district data center but could also be a cloud-based service and/or hosted at the upstream ISP provider. Many districts choose to combine this with their content filter in which case the total cost includes the modeled amounts for firewall and content filter combined.

- **Equipment Cost**: The type of firewall is dependent on the amount of traffic that will traverse it. We assume a minimum need of 100Mbps stateful throughput for the tiny districts, increasing to 10+ Gbps of throughput for mega-districts.
- **Quantity**: Assumes 1 per district, although it is reasonable to have more than one for redundancy purposes at the same combined budget level or if there is a school that has an Internet connection separate from the main district Internet connection.
- **Installation**: We expect minimal physical installation costs associated with racking the firewall, often done by district personnel. Higher-level design work and switch configuration is outside the scope of this model.
- **Replacement life**: Firewalls will likely be replaced as traffic demands increase or additional security features are required. Unlike routers and switches, firewalls tend to have less modular expansion options, therefore,

when traffic demands increase and capacity upgrades are required, a need to swap the entire device with a higher grade model is often the only option.

- **Maintenance/support**: Calculated as a fixed 30% of the equipment cost. This includes hardware and software support as well as critical security updates.

Content Filter: This can be a dedicated hardware device or a cloud-based service through a provider (not necessarily the Internet Service Provider but can be, especially if the provider is an R&E network). Many districts choose to combine this with their firewall in which case the total cost includes the modeled amounts for firewall and content filter combined.

- **Equipment Cost**: The cost is mostly dependent on the amount of traffic that is expected to flow through, which scales well with district size: the smaller the district, the less Internet traffic for the content filter to analyze. Like the firewall, we assume a minimum need of 100Mbps throughput for the tiny districts, increasing to 10+ Gbps of throughput for mega-districts.
- **Quantity**: Assumes 1 per district, although it is reasonable to have more than one for redundancy purposes at the same combined budget level or if there is a school that has an Internet connection separate from the district Internet connection.
- **Installation**: We expect minimal physical installation costs associated with racking the content filters (if hardware based), often done by district personnel. Higher-level design work and switch configuration is outside the scope of this model.
- **Replacement life**: Content filter functionality tends to work alongside firewalls as a means of analyzing Internet traffic and applying filtering policies accordingly. Often times, a firewall and content filter are one in the same device. Therefore, we assume that any change in firewall specifications will result in a similar change in the content filter.
- **Maintenance/support**: Calculated as a fixed 30% of the equipment cost. This includes hardware or software support and URL/content database updates.

Gateway Router: Intended for those larger districts that are multi-homed and require BGP routing or other advanced gateway capabilities. Small and medium sized districts often do not require an additional gateway router since one is provided by their ISP.

- **Equipment Cost**: At the large and mega district levels, a gateway router is generally a lower grade than the district internal core router, however it needs to be able to support a relatively higher rate of overall throughput compared to the medium sized district.
- **Quantity**: Assumes 1 per district needed.

- **Installation**: We expect minimal physical installation costs associated with racking the gateway router, often done by district personnel. Higher-level design work and switch configuration is outside the scope of this model.
- **Replacement life**: Average replacement life for this type of equipment. A likely replacement scenario: due to network changes or circuit upgrades, the district may need additional ports or modules, which may require a change in router chassis.
- **Maintenance/support**: Calculated as a fixed 15% of the equipment cost. This includes standard vendor hardware and software support.

Data Center Rack & Accessories: This line item is intended for items that reside in the district data center, which may or may not be co-located with a school. This includes telco racks, UPS and PDU, patch panels, patch cables.

- **Equipment Cost**: The cost calculated is based on the district-level gear that is expected to be installed at the district office. The slightly higher cost compared to the school or classroom rack and accessories accounts for the additional level of power protection for these critical infrastructure components. This means more power plugs to accommodate dual power supplies, which means more power consumption, and thus higher level of battery backup protection.
- **Quantity**: One per district, though very large districts will likely have multiple data centers this will be an insignificant cost for those districts.
- **Installation**: Includes installation of base rack and patch panels. Wiring termination is considered part of the wired drop installation.
- **Replacement life**: The non-electronic equipment in this category rarely fails and will likely be replaced when there is a major change in the physical building/site, which causes these items to be moved or upgraded to accommodate additional equipment or network wiring.
- **Maintenance/support**: This category of items, similar to wiring, has a relatively low rate of failure and as is the case with Switch-to-Switch Fiber and copper wiring, requires modification when major changes to the network occur, such as network expansions and/or upgrades.