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Via ECFS

Jon Wilkins, Managing Director
Federal Communications Commission
445 Twelfth Street, SW
Washington, DC 20554

      Re: E-Rate Reform (WC Docket No. 13-184)
              Modeling Internal Connections Costs

Dear Mr. Wilkins:

As the world's foremost producer of computer networking equipment and services, Cisco Systems, Inc. ("Cisco") has 15 years of experience implementing technology solutions at schools and libraries as part of the E-rate program. We have implemented such solutions at thousands of schools and libraries around the nation and across the globe. Our recommendations reflect many of the lessons learned from these implementations.

Classrooms and technology have dramatically changed over the past 15 years. Students have come to expect wireless broadband access at their fingertips so that they can conduct research, view multi-media content, and collaborate with their teachers and peers. The challenge is that the program has not kept up with technology trends, and funding for internal connections for students has dwindled to nothing.

The Commission is rightly looking at ways to modernize the program to address this and other shortfalls. Cisco has supported the Commission's efforts to reform the E-rate program, including submitting an extensive report based on a comprehensive assessment of its experience with the program, with the goals of identifying success stories and best practices for bringing technology into schools and libraries; making concrete recommendations for how the program can be modernized and streamlined based on real-world technology implementations; and recommending a minimum bandwidth speed for school districts, schools, and individual classrooms to meet technology needs.[1]

Following up on Cisco's White Paper, "High-Speed Broadband in Every Classroom: The Promise of a Modernized E-rate Program", Cisco has reviewed its extensive experience with internal network installations to respond to Commission staff's requests for more granular information about the specific equipment and services that are needed to meet schools' and

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[1] Cisco, "High-Speed Broadband in Every Classroom: The Promise of a Modernized E-Rate Program," attachment to Comments of Cisco Systems, Inc., WC Docket No. 13-184 (filed Sept. 13, 2013) ("White Paper").

libraries' internal networking needs and the costs of this infrastructure. The attached cost analysis summarizes the results of Cisco's review.

The attached document sets out Cisco's assessment of the internal network equipment and services that schools and libraries need to achieve the goal of modern levels of E-rate connectivity in the classroom.

We believe our model is conservative and reflects only the equipment and services necessary to deliver connectivity that meets the needs of students and teachers in the classroom, based on a five-year refresh model. Additionally, the model makes the following explicit assumptions:

- Delivery of specified bandwidth to the student: per-student internet bandwidth target of 1.25 Mbps and per-student inter-building/data center bandwidth target of 6 Mbps. This drives the infrastructure modeling to meet this goal on a nationwide basis and to reliably deliver actual access as intended. In the Cisco White Paper referenced above, Part 3, we make recommendations for per-student bandwidth targets. In the attached model, we use a per-student internet bandwidth target of 1.25 Mbps and per-student inter-building/data center bandwidth target of 6 Mbps. These targets are the mid-point between our 2014 and 2018 targets. This is in line with SETDA's 2011 recommendations for 2017-2018.

- Estimated items: Some items, including building wiring, equipment installation and configuration, are not actual and are estimated based upon information collected from a variety of sources. The costs of these types of items also vary widely for schools, depending upon school physical topology, local rates and offerings, and school technical staff resources.

- Infrastructure design goal and type of equipment: In general, the model seeks to utilize best practices in network design, based upon our extensive network infrastructure experience with our wide variety of education customers globally. Our customers have many different design goals. Cisco and our partners seek to meet those goals on a per customer basis. We have taken these customer experiences and broadened them to cover the wide range of school district sizes in the US; from the very smallest one building district to the very largest districts with more than 500,000 students. However, district network design and customer equipment choices and requirements vary from smallest to largest based upon many factors. Therefore we created typical network infrastructure configurations for four ranges of district sizes, then based estimated costs on these configurations. These ranges are loosely based upon National Center for Education Statistics data:

  o Small District (less than 10,000 students)

  o Medium-Small District (10,000-39,999 students)

  o Medium-Large District (40,000-79,999 students)

- o Large District (80,000 or more students)

The network design goal for each type of district uses best practices, to achieve a robust infrastructure capable of delivering highly reliable service throughout each district, with redundant components where needed to prevent system-wide infrastructure outages.

- Existing district network infrastructure: Given the projected 5-year lifecycle for this type of equipment, the model provides an overall infrastructure estimate for all US schools to achieve the desired bandwidth target to the student over a five (5) year period. Because of constantly changing and improving technology, the model assumes that every school would require a total network infrastructure upgrade every the 5-year period, the model does not take into account existing school infrastructure.

- Some infrastructure not included: While important for school communication services, school safety, and personalized learning environment, the following infrastructure elements are not included in this model: voice telephony (IP or analog), video conferencing, content filtering, fiber cabling or installation beyond closet switches (building wiring estimate is classroom to closet switch only).

- Service provider or leased circuit equipment: The model does not include service provider equipment on-premise at building edge or district-owned leased/private optical circuit equipment. The model does not include service provider or district-owned optical internet access equipment on-premise. This functionality is required for inter-building and internet access but it is highly variable from district to district. Our model does include all switching (layer-2) and routing (layer-3) equipment required but not optical (layer-1) equipment.

- Hardware maintenance: The maintenance cost figures shown do not include hardware replacement, per current E-Rate ineligibility. It does include access to services such as: software maintenance, access to telephone-based maintenance technical support on-line resources and documentation.

- Technical design elements:

  - o The model assumes four switched Ethernet jacks would be installed per classroom, each providing Power-over-Ethernet (PoE+ or higher) with one jack reserved for the wireless access point. It also includes wired access for building offices and other spaces by adding one port per classroom for these areas.

  - o Closet uplinks are 1GE multimode optical interfaces, with 10GE upgrade capability available today on existing hardware.

  - o Wireless access points utilize latest 802.11ac Wave 1 standard with multiple spatial stream support, high per-AP throughput to support 25+ active devices per classroom at high bandwidth rate, rogue access point detection and containment, and remote spectrum analysis. A ratio of 1.3 access points per classroom is used,

to accommodate non-classroom areas such as hallways, laboratories, office spaces, auditoriums, cafeterias, gymnasiums, etc.

- o Firewall appliances with VPN server and intrusion protection are included, however these are assumed to be less than 100% eligible.

- o District level hardware and software for network device configuration, performance monitoring, visibility, quality of service management, wireless spectrum management, and identity services management are included, however these are currently Erate ineligible.

- o WAN optimization is not included given the bandwidth goals related to district WAN circuits, however, it will be required if such circuits would not become feasible in certain districts.

- • Libraries. Library estimates are not included in this model.

The attachment provides summary information about the total cost of this equipment and services, estimating that internal networks for all of the nation's classrooms will cost approximately $11.6 billion in equipment (with an expected useful life of 4-5 years) and $460 million per year in maintenance in each of the five years. Distributing the equipment cost over a hypothetical five-year rollout results in an annual cost of $2.33 billion for equipment and $460 million for maintenance. Additionally, we estimate that installation and configuration costs will amount to $1.56 billion over five years. This calculation provides useful information for determining how much support should be directed to internal connections through whatever mechanism and discount rates that the Commission selects for doing so.

Please let me know if you have any information about this information.

Sincerely,

Jeffrey A. Campbell
Vice President, Government Affairs

Enclosure

District Size Categories

District Size	Number of Districts	Number of School Buildings	Derived Total Number of Classrooms
Small (< 10,000)	12,728	55,162	1,292,458
Medium-Small (10,000-39,999)	729	21,511	777,286
Medium-Large (40,000-80,000)	87	7,542	276,140
Large (> 80,000)	35	8,247	333,236
Total	13,579	92,462	2,679,121

Source: National Center for Education Statistics,
School Census 2006-2007

Erate Internal Connections Cost Model - Summary

Classroom Costs

	Total Equipment	Total Maintenance Cost, Years 1-5	Installation and Configuration
Small	$2,721,273,717	$0	$685,649,228
Medium-Small	$1,454,149,433	$217,002,686	$412,350,186
Medium-Large	$638,304,764	$70,465,509	$146,492,486
Large	$800,274,562	$88,874,131	$176,781,877
Total	$5,614,002,475	$376,342,326	$1,421,273,777

School Building Costs

	Total Equipment	Total Maintenance Cost, Years 1-5	Installation and Configuration
Small	$1,894,359,614	$312,172,790	$41,923,120
Medium-Small	$622,323,986	$122,315,848	$16,348,360
Medium-Large	$279,097,367	$58,646,592	$12,670,560
Large	$334,626,973	$61,040,995	$13,854,960
Total	$3,130,407,939	$554,176,226	$84,797,000

District-Level Costs

	Total Equipment	Total Maintenance Cost, Years 1-5	Installation and Configuration
Small	$1,870,218,591	$1,152,785,142	$50,530,160
Medium-Small	$598,531,490	$137,111,778	$7,982,550
Medium-Large	$196,603,000	$38,485,233	$1,396,350
Large	$189,625,007	$33,302,934	$791,350
Total	$2,854,978,088	$1,361,685,087	$60,700,410

Grand Total

	Total Equipment	Total Maintenance Cost, Years 1-5	Installation and Configuration
Small	$6,485,851,921	$1,464,957,933	$778,102,508
Medium-Small	$2,675,004,908	$476,430,312	$436,681,096
Medium-Large	$1,114,005,131	$167,597,334	$160,559,396
Large	$1,324,526,542	$183,218,060	$191,428,187
Grand Total	$11,599,388,502	$2,292,203,639	$1,566,771,187

Erate Internal Connections Cost Model - Equipment Detail

Classroom Costs	Small < 10,000 Total	Medium-Small 10,000 - 39,999 Total	Medium-Large 40,000 - 80,000 Total	Large > 80,000 Total	Grand Total	2013-14 Erate Eligible	Assumed Eligible
Building Closet switches, incl PoE	448,994,694	373,461,599	189,760,236	228,995,845	1,241,212,374	1,241,212,374	
Building WiFi access points	1,363,344,667	614,316,276	282,860,284	371,336,914	2,631,858,140	2,631,858,140	
Building wiring and installation	775,475,093	466,371,558	165,684,244	199,941,802	1,607,472,698	1,607,472,698	
Total	2,721,273,717	1,454,149,433	638,304,764	800,274,562	5,614,002,475	5,480,543,212	
School Building Costs							
School Building Edge router/switch	1,334,479,104	520,394,112	182,456,064	227,122,380	2,264,451,660	2,264,451,660	
School Building Core switch	536,050,526	101,929,874	96,641,303	107,504,593	842,126,295	842,126,295	
WAN broadband optimization	0	0	0	0	0	0	85%
Total	1,894,359,614	622,323,986	279,097,367	334,626,973	3,130,407,939	3,106,577,955	
District-Level Costs							
District Core routers and switches	878,986,134	129,407,524	34,330,244	41,957,449	1,084,681,350	1,084,681,350	
District staff wireless	39,174,238	3,545,564	822,620	551,565	44,093,988	44,093,988	
Wireless controllers		111,853,568	41,807,306	42,696,281	196,357,156	196,357,156	
District internet edge router	376,341,504	96,905,970	21,720,929	15,215,256	510,183,659	510,183,659	
Wireless spectrum monitor management		40,628,993	12,761,138	14,142,398	67,532,528	0	0%
Identity management		148,911,737	56,764,368	56,871,045	262,547,150	0	0%
WAN broadband optimization	0	0	0	0	0	0	85%
Network device configuration, performance, visibility, QoS management		46,286,215	10,256,713	8,741,171	65,284,099	0	0%
Data Center servers							
Firewall/Intrustion Protection	223,977,798	20,991,920	18,139,683	9,449,843	272,559,243	149,907,583	55%
VPN equipment	111,971,398				111,971,398	55,985,699	50%
Total	1,870,218,591	598,531,490	196,603,000	189,625,007	2,854,978,088	2,041,209,435	
Grand Total					11,599,388,502	10,628,330,601	