WIRELINE COMPETITION BUREAU AND OFFICE OF STRATEGIC PLANNING AND POLICY ANALYSIS

E-RATE DATA UPDATE

WC DOCKET NO. 13-184

NOVEMBER 17, 2014

I. INTRODUCTION

1. The staff of the Wireline Competition Bureau and the Office of Strategic Planning and Policy Analysis (Bureaus) have prepared this *E-rate Data Update* to supplement the *Staff Report* released August 12, 2014.[1] The *E-rate Data Update* in conjunction with the *Staff Report* have been prepared to assist the Commission in its ongoing modernization of the schools and libraries universal service support program, commonly known as E-rate. Our intent is to further assist the Commission, stakeholders and the public in navigating the large and data-intensive record in the E-rate Modernization proceeding as the long-term funding needs of the program are considered.[2]

2. In the *E-rate Modernization Order*, the Commission set concrete goals for the E-rate program and specific high-speed broadband connectivity targets for eligible schools and libraries; established a permanent annual funding target for the portion of the program that supports internal connections for schools and libraries, and in the Further Notice of Proposed Rulemaking (FNPRM) accompanying the *E-rate Modernization Order*, sought comment and additional data on the long-term funding needs of the program. Less than a month later, in order to assist parties navigating the data-rich docket and to consider what additional data to submit, staff of the Bureaus released the *Staff Report* summarizing the data in the record at that point on fiber connectivity to schools and libraries and pricing.[3] At the same time, the Bureaus released two Fiber Connectivity Maps.[4]

3. The *Staff Report* also asked: "What are the most important drivers of that growth, and in particular what are the likeliest scenarios for the relationship between volume and price paid by schools and libraries?"[5] Since the release of the *Staff Report*, the Commission has received voluminous additional data on connectivity and pricing.[6] This *E-rate Data Update* summarizes and synthesizes the data we now have in the record that pertain to that question.

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[1] *Wireline Competition Bureau Releases E-rate Modernization Staff Report and Online Maps of School and Library Fiber Connectivity Data*, Public Notice, 29 FCC Rcd 9644, Attach. (2014) (*Staff Report*).

[2] *Modernizing the E-rate Program for Schools and Libraries*, WC Docket No. 13-184, Report and Order and Further Notice of Proposed Rulemaking, 29 FCC Rcd 8870 (2014) (*E-rate Modernization Order or FNPRM).*

[3] *See supra* note 1.

[4] Federal Communications Commission, FCC E-rate Maps of Fiber Connectivity to Schools and Libraries, http://www.fcc.gov/maps/E-rate-fiber-map (last visited Nov. 13, 2014) (Fiber Connectivity Maps).

[5] *Staff Report* at para. 37.

[6] *See, e.g.*, Federal Communications Commission, *E-rate Modernization Data,* http://www.fcc.gov/encyclopedia/E-rate-modernization-data (last visited Nov. 13, 2014) (E-rate Modernization Data Webpage).

II. KEY DATA SUBMITTED SINCE JULY 2014

4. This *E-rate Data Update* summarizes the data and quantitative analysis in the current record concerning the extent of the connectivity and affordability gaps, expected usage growth, projected costs to build high-speed broadband connections, and projected costs to provide broadband services that meet the Commission's targets, including expected pricing efficiencies. We focus particular attention on the detailed cost models submitted into the record since the release of the *E-rate Modernization Order*. Those detailed models analyze the costs associated with reaching the goals and projecting potential efficiency gains from recent modernization efforts. Particularly relevant areas of data in the record include:

- Updates to the FCC's Fiber Connectivity Maps[7] which show at a granular level the gaps in connectivity to schools and libraries across the nation; while we continue to iterate these maps as we receive additional data, these maps are the most comprehensive source describing the current state of the nation's school and library connectivity.[8]
- The FCC *Staff Report*, which for the first time made available detailed data on E-rate spending levels and prices paid by beneficiaries.[9]
- The State School Connectivity Profiles, prepared by FCC staff, describing thirteen states' connectivity and pricing situations.[10]
- The Consortium for State Networking's (CoSN) 2nd Annual E-rate and Infrastructure Survey ("CoSN Survey"), which includes responses from over 1,000 district administrators and technology leaders/Chief Technology Officers, with 584 providing full responses.[11]
- An Education SuperHighway/CoSN ("ESH/CoSN") cost model, which estimates the five-year operational expenditures (OPEX) and capital expenditures (CAPEX) for public schools to reach the Internet access and WAN connectivity targets adopted by the Commission.[12]

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[7] *See supra* note 4.

[8] E-rate Modernization Data Webpage (including a series of updates of the direct access to broadband connectivity datasets based on new data on the record).

[9] *Staff Report*, 29 FCC Rcd 9644.

[10] Federal Communications Commission, State School Connectivity Profiles, WC Docket No. 13-184 (rel. Sept. 19, 2014), https://apps.fcc.gov/edocs_public/attachmatch/DOC-329357A1.pdf.

[11] Letter from Reg Leichty, Partner, Education Counsel to Marlene H. Dortch Secretary, Federal Communications Commission, WC Docket No. 13-184, Attach. (filed Oct. 15, 2014) (attaching CoSN's 2nd Annual E-rate and Infrastructure Survey) (CoSN Survey).

[12] Letter from Evan Marwell, CEO, EducationSuperHighway, to Marlene H. Dortch, Secretary, Federal Communications Commission, WC Docket No. 13-184, Attach. (filed Oct. 17, 2014) (ESH/CoSN Connectivity Ex Parte) (attaching "Bringing Everyone Up to Speed: Analysis of Costs to Upgrade and Maintain WAN and Internet Access Connections for all K-12 Public Schools") (ESH/CoSN Connectivity Model).

- The ESH E-rate Policy Options Analysis, which assesses policy actions to lower the ongoing operating cost of broadband for K-12 public schools.[13]
- A Schools, Health, & Libraries Broadband Coalition ("SHLB") cost model, which estimates the CAPEX necessary to connect all eligible public and private schools and libraries.[14]
- A LEAD Commission/Alliance for Excellent Education ("LEAD/AEE") equity study analyzing gaps in access to high-speed Internet for African American, Latino, low-income, and rural students.[15]
- North Carolina and Washington state data on districts' actual bandwidth usage over time.[16]

5. In addition to these specific items, numerous filers have profiled specific schools' broadband technology needs and challenges.[17] A large amount of data from a variety of sources is also available on the E-rate Modernization Data page.[18]

III. STATE OF AFFORDABLE ACCESS TO HIGH-SPEED BROADBAND

6. In the *E-rate Modernization Order*, the Commission adopted as its "first goal ensuring affordable access to high-speed broadband sufficient to support digital learning in schools and robust connectivity for all libraries."[19] To measure progress towards this goal, the Commission adopted connectivity targets for Internet access and Wide Area Network (WAN) or last mile connections, as summarized in Table 1.

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[13] Letter from Evan Marwell, CEO, EducationSuperHighway, to Marlene H. Dortch , Secretary, Federal Communications Commission, WC Docket No. 13-184 (filed Oct. 30, 2014) (ESH Policy Options Analysis).

[14] Letter from John Windhausen, Jr., Executive Director, SHLB Coalition, to Chairman Wheeler and Commissioners, Federal Communications Commission, WC Docket No. 13-184, Attach. (filed Nov. 14, 2014) (SHLB Coalition Ex Parte) (attaching a study of estimated one-time costs for deploying fiber to schools and libraries without such infrastructure, entitled "A Model for Understanding the Cost to Connect Schools and Libraries with Fiber Optics") (SHLB Model).

[15] Letter from Phillip H. Lovell, VP of Policy and Advocacy, The Alliance for Excellent Education and Blair Levin, Senior Advisor, LEAD Commission, to Chairman Wheeler, Federal Communications Commission, WC Docket No. 13-184, Attach. (filed Oct. 23, 2014) (attaching "School and Broadband Speeds: An Analysis of Gaps in Access to High-Speed Internet for African-American, Latino, Low-Income, and Rural Students") (LEAD/AEE Equity Study).

[16] Letter from Charles Eberle, Attorney-Advisor, Wireline Competition Bureau, to Marlene H. Dortch, Secretary, Federal Communications Commission, WC Docket No. 13-184 (filed Oct. 20, 2014) (North Carolina K12 Internet Usage Growth)*;* Letter from Charles Eberle, Attorney-Advisor, Wireline Competition Bureau, to Marlene H. Dortch, Secretary, Federal Communications Commission, WC Docket No. 13-184 (filed Oct. 17, 2014) (Washington K-12 Bandwidth Utilization History).

[17] *See generally* ESH FNPRM Comments (filed Sept. 15, 2014); NEA FNPRM Comments (filed Sept. 15, 2014).

[18] *See* Federal Communications Commission, E-rate Modernization Data Page, www.fcc.gov/encyclopedia/E-rate-modernization-data (last visited Nov. 17, 2014).

[19] *See E-rate Modernization Order*, 29 FCC Rcd at 8881, para. 26; *see also id.* at 8890, para. 50, 8891, para. 55 (adopting as its second goal "maximizing the cost-effectiveness of spending for E-rate supported purchases" and as its third goal "making the E-rate application process and other E-rate processes fast, simple, and efficient").

Table 1: Long-Term Connectivity Targets[20]

	Schools	Libraries
Internet Access	1 Gbps per 1,000 users	Serving fewer than 50,000 people: 100 Mbps Serving 50,000 people or more: 1 Gbps
WAN/Last Mile	*Scalable* to 10 Gbps	*Scalable* to 10 Gbps

7. The recent CoSN survey found that 68% of all school districts do not have a single school that meets the Commission's long-term connectivity targets.[21] Further, in only 10% of school districts did all their schools meet the Commission's long-term Internet access target of 1 Gbps per 1,000 students.[22] Similarly, ESH has found that 63% of public schools, accounting for over 40 million students, do not have sufficiently robust broadband connections to take advantage of modern digital learning.[23] These and other filings indicate that the Commission's connectivity targets will only be achieved if significantly more schools and libraries are able to overcome their lack of access to high-capacity connections at an affordable price.

A. Access to High-Speed Broadband

8. Since the release of the initial version of the Fiber Connectivity Maps, numerous entities have submitted updated information on schools' and libraries' access to fiber facilities. Based on the most recent data received by the Commission, it appears that 31% of urban public schools and 41% of rural public schools do not have access to fiber facilities.[24] According to ESH, while there are some small schools where non-fiber technologies are a viable option for meeting the Commission's connectivity targets (and meeting the school's connectivity needs), the fiber gap means that tens of millions of public school students attend schools lacking access to the needed telecommunications infrastructure to meet the connectivity targets adopted by the Commission.[25] Recent third-party models support Commission estimates that around 35% of schools and an even greater percentage of libraries lack the ability to achieve the Commission's connectivity targets because they do not have high-speed connections.[26] According to the model submitted by ESH/CoSN, 31,236 public schools – roughly 30% of all public schools – need fiber connections to reach the Commission's connectivity targets.[27] The ESH/CoSN

[20] *See id.* at 8885, para. 34, 8886, para. 39.

[21] *See* CoSN Survey at 5.

[22] *See id.* at 11; *see also E-rate Modernization Order*, 29 FCC Rcd at 8885, para. 34.

[23] *See* ESH FNPRM Comments at 1.

[24] *See* Fiber Connectivity Maps. These estimates include all public schools, including smaller schools where non-fiber technologies may provide a viable option for connectivity.

[25] *See* ESH FNPRM Comments at 3-4 (claiming that for 98% of schools and libraries that the goals will be met with a fiber connection). Discussion in this document about fiber should not be read to suggest that all schools will necessarily need fiber connections to meet the goals.

[26] *See Staff Report,* 29 FCC Rcd. at 9656-57, para. 19, 21. *See also* SHLB Coalition Model at 8-9 (estimating around 40% of schools and 68% of libraries lack fiber); ESH/COSN Connectivity Model at "Fiber Construction" Tab.

[27] *See* ESH/CoSN Connectivity Model at "Fiber Construction" Tab.

model shows this gap is worst in the most rural areas, where 41% and 45% of rural and rural remote schools respectively having over 100 students lack fiber connectivity.[28] For libraries, there is reason to believe the fraction lacking adequate connections is even larger than for schools. The SHLB model estimates that 68% of libraries across the nation lack fiber connections.[29]

B. Affordability of High-Speed Broadband

1. Recurring Monthly Costs

9. Many schools and libraries also face an affordability gap, in which an institution finds the costs of purchasing high-speed Internet access and fiber-based WAN/Last-Mile services to be prohibitively expensive relative to available local resources, even including available E-rate support. The CoSN survey found that 58% of respondents said the cost of monthly recurring ongoing expenses was the most significant barrier to increasing Internet connectivity.[30] The same survey shows that 72% of districts pay at least $5/Mbps/month for their Internet connection.[31] Nine percent pay at least $250/Mbps/month for the connection.[32] In rural areas, 10% of districts pay over $250/Mbps/month.[33] The CoSN Survey found that WAN connection monthly costs were also a major expense with 53% of districts paying at least $5/Mbps/month.[34] It is clear that at current prices both Internet access and WAN services are a major expenditure for districts seeking to meet the connectivity targets.

10. Also of interest from the CoSN survey, and apparent in the prices mentioned above, is the large pricing disparities across districts. One reason for the wide pricing disparities highlighted by CoSN's survey is that there is a lack of bidders responding to some schools' requests for proposals.[35] According to the CoSN Survey, six percent of schools and libraries seeking to purchase telecommunications services receive no bids and 26 percent receive only one bid.[36] ESH also provides statistics showing great variation in institutions' costs, which may be a consequence of a small number of bidders. ESH states that schools "without choices beyond the incumbent telephone and cable companies pay two or three times as much for their connections as those in competitive markets."[37]

11. The LEAD/AEE report provides insight into how the affordability gap may affect certain segments of the population. According to the LEAD/AEE report low-income, African American, Latino, and rural students are more likely than others to be in schools with slow Internet connectivity.[38]

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[28] *See id.*

[29] *See* SHLB Coalition Model at 9.

[30] *See* CoSN Survey at 4.

[31] *Id.* at 10 (Internet Access: $5-50/Mbps/month: 40%; $50-100/Mbps/month: 14%; $100-250/Mbps/month: 9%; $250 or more/Mbps/month: 9%).

[32] *See id.*

[33] *See id.*

[34] *See id.* (WAN Connection: $5-50/Mbps/Month: 31%; $50-100/Mbps/Month: 9%; $100-250/Mbps/Month: 6%; $250 or more/Mbps/Month: 7%).

[35] *See id.* at 15.

[36] *See id.* at 6.

[37] *See* ESH FNPRM Comments at 14.

[38] *See* LEAD/AEE Equity Study at 2.

According to the LEAD/AEE report, Latino and African American students were underrepresented in the group of schools with 100 Mbps or faster connections (compare 37% of white students versus 30.4% and 28.8% of Latino and African American students respectively) and are overrepresented in schools with 10 Mbps service or slower connections (17.3% of white students compared to 25.7% and 22.8% for Latino and African American students respectively).[39] Similarly, the report shows that low-income students are underrepresented in the group of schools with 100 Mbps or more (compare 35.3% of students in schools with free or reduced price lunches versus 32.7% for students in schools where all students receive either free or discounted lunches).[40] At the same time, low-income students are over-represented in schools with 10 Mbps or slower connections.[41]

2. Usage Growth

12. Looking ahead, commenters identified the growth in bandwidth usage as the most significant affordability hurdle. The CoSN survey reports that 24% of respondents expect a 20% to 100% growth in bandwidth usage in the next 18 months and 27% expect 100% to 500% growth in the next 18 months. Only 31% will have sufficient bandwidth for today and the coming 18 months.[42] As a modeling assumption, the ESH/CoSN model assumed 50% compounded annual growth rate in bandwidth.[43] The Commission has also received direct network data from the states of North Carolina and Washington describing usage growth rates over multiple school years.[44] Some North Carolina school districts, which are installing Wi-Fi throughout all their schools and implementing digital learning and 1:1 initiatives, are increasing their bandwidth usage by more than 50% per year.[45] In fact, statewide North Carolina showed that its total monthly bandwidth usage increased by 35% over just the seven months spanning the period from November 2013 to May 2014. This growth rate includes a diverse range of districts, including those both implementing and not implementing major digital learning initiatives.[46] Schools that implemented a 1:1 initiative had even higher bandwidth growth rates. Avery County schools recently implemented a 1:1 initiative had bandwidth usage grow over 100% per year.[47] Mooresville County schools implemented a 1:1 initiative in 2008 and continues to see bandwidth grow over 50% per year.[48] Even districts like Halifax County that have not adopted major digital literacy initiatives have seen 40% annual growth rates in bandwidth usage.[49] Figure 1 shows these North Carolina districts' bandwidth usage over the last few

[39] *See id.* at 7, Table 2.

[40] *See id.* at 4.

[41] *See id.* at 10, Table 4.

[42] *See* CoSN Survey at 12.

[43] ESH/CoSN Connectivity Model at 22.

[44] *See supra* note 16.

[45] *See* North Carolina K12 Internet Usage Growth, Attach. 1 at 1-2.

[46] *Id*.

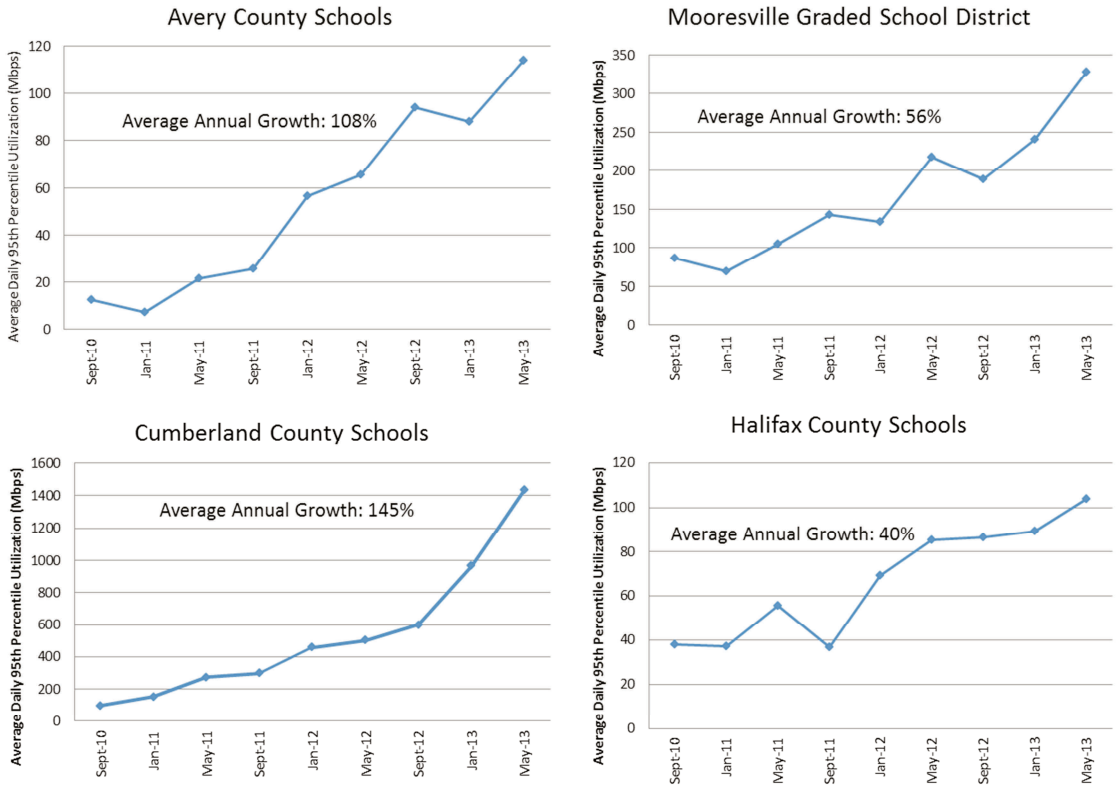
[47] *Id.*

[48] *Id*. Similarly, see ESH/CoSN Connectivity Model, "2018 Bandwidth Needs" Tab, which uses a 50% bandwidth growth rate for schools.

[49] *Id.*

years.[50] In Washington State, annual usage growth between 2010 and 2014 averaged over 40% and increased at similar rates for districts of various sizes.[51]

Figure 1: Bandwidth Usage Growth in Select North Carolina Districts



13. This rapid, broad-based increase in bandwidth will tend to increase costs for connected schools to the extent usage rises faster than prices decline. This point is made clearly by ESH, which explains that even if bandwidth costs decline by 10% per annum, the demand for broadband is growing at least 50% per annum.[52] If the trend continues, total bandwidth costs will continue to grow even with reductions in prices per Mbps per month. The ESH/CoSN model, for example, shows usage-driven costs increasing from 24% to 40% of total costs over the next 5 years.[53]

[50] North Carolina K12 Internet Usage Growth, Attach. 1 at 1-2. Note that North Carolina systematically increased connection sizes for schools as necessary to accommodate increased bandwidth usage.

[51] *See* Washington K-12 Bandwidth Utilization History.

[52] *See* ESH FNPRM Comments at 9-10 (stating that a price decline of 10%cannot offset a demand increase of 50%).

[53] *See* ESH/CoSN Connectivity Model at "Summary" Tab. In Scenario 3 (the middle-cost scenario) for 2015, dividing the Internet Access cost of $894 million by the $3.734 billion yields 24%. Doing the same for 2018 yields 40%.

3. WAN/Last-Mile Construction Costs

14. Another component of the affordability gap that disproportionately impacts rural schools and libraries is the cost of building adequate connections. According to ESH/CoSN, the average cost of connecting rural distant and rural remote schools ranges from $177,000 to $1.61 million respectively as compared to $35,400 to $68,500 for schools in urban and town areas.[54] Similarly, rural libraries are also more affected by the affordability gap because their construction costs are significantly higher as well. SHLB estimates the connection costs for rural libraries at between $55,000 and $275,000, and between $40,000 and $59,000 for libraries in metropolitan areas.[55] It is not surprising that a smaller proportion of rural schools and libraries meet the Commission's goals for high-capacity broadband than suburban and urban ones.[56]

IV. LONG-TERM FUNDING NEEDS TO MEET CONNECTIVITY TARGETS

15. As a framework for thinking about the funding required to achieve the connectivity targets, we begin with the actions taken in the *E-rate Modernization Order*. The *Order* initiated a phase-out of support for non-broadband services and also set a $1 billion annual target for closing the Wi-Fi gap through category two support.[57] Since category two support is targeted at $1 billion annually and non-broadband support will be fully phased out within five years, demand for Internet Access and WAN/Last Mile connections (category one) will likely be the primary driver for additional E-rate funding. The record now includes detailed third-party cost models that provide estimates of the funding required in order to achieve the Internet access and WAN/Last-Mile connectivity targets adopted by the Commission in the *E-rate Modernization Order*.[58]

16. Category one funding includes both CAPEX and OPEX costs for broadband service.[59] The models submitted estimate either both CAPEX and OPEX (i.e., ESH) or the total CAPEX (i.e., SHLB) costs required to meet the Commission's connectivity targets, and they vary in scope of covered schools and libraries; collectively, however, the models provide valuable guidance as to the range of funding needed to achieve the goals while also funding category two services and legacy services as directed by the *E-rate Modernization Order*.

A. Cost Models

17. A brief description of each cost model is provided below:

- **ESH/CoSN:** This model estimates both the CAPEX and OPEX costs for public schools to meet the goals over the next five years.[60] ESH/CoSN input data on public schools

[54] *See* ESH/CoSN Connectivity Model at "Fiber Construction" Tab.

[55] SHLB Coalition Model at 4.

[56] ALA FNPRM Comments at 9.

[57] *See E-rate Modernization Order*, 29 FCC Rcd at 8916, para. 118; 8922-34, paras. 135-54.

[58] *See* ESH/CoSN Connectivity Model; SHLB Coalition Model.

[59] CAPEX is capital expenditures (e.g., money used to build fiber connections or hardware) and OPEX is operating expenses (primarily, the monthly recurring charge for the circuit).

[60] ESH/CoSN only included schools with at least 100 students since the model intends to estimate the cost of meeting the goals through fiber connections. ESH/CoSN assume the smallest schools can meet the goals without necessarily needing a fiber connection. *See* ESH/CoSN Connectivity Model at 3, n.5. ESH/CoSN also submitted a

lacking connectivity, predicted bandwidth growth, and CAPEX and OPEX prices. The model takes in to account variation in connectivity needs based on school size and price declines for specific services resulting from market dynamics.[61] Through several scenarios, the model demonstrates how funding demand would vary as a function of the number of schools and students connected.[62]

- **SHLB Coalition:** This model (prepared by CTC Technology & Energy) estimates the total CAPEX costs of connecting all public and private schools and libraries. The model takes a distinctly engineering-based approach, dividing the nation into regions and then using construction cost estimates to develop a total CAPEX amount.[63] Based on varying parameters in the model, SHLB offers a low and high CAPEX estimate for connecting all schools and a single CAPEX estimate for connecting libraries.[64]

B. Estimating the Amount of Additional Funding Needed

18. Both models indicate that achieving the connectivity targets will require increased E-rate funding. Commenters recognize that pricing efficiencies can be accomplished as a result of a combination of market dynamics, the Commission's recent reforms, and additional reforms.[65] However, even the most aggressive pricing efficiency projections tend to be offset by even larger bandwidth growth projections when the goals are fully achieved. For example, the ESH/CoSN model assumes a 50% annual growth in bandwidth. As discussed above, experience from North Carolina and Washington show that when schools adopt specific digital initiatives the steepest parts of the growth curve may exceed 100% annual rates. It is this interplay between price declines and increasing demand (due to both new fiber connections and increased usage among schools already connected) that will drive future funding needs.

19. To consider what the submitted models say about the total needs of the fund to achieve the goals, we first separately consider the CAPEX costs required to connect schools and then we consider the OPEX costs. The models recognize that many schools and libraries pay a recurring monthly price for service and that this price may cover all, or a portion, of the CAPEX costs incurred by the provider to build the infrastructure. As a modeling convention, however, the models submitted separated the CAPEX and OPEX components. Therefore we can compare across models the estimates of the total CAPEX required to connect all schools in order to meet the goals.

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more limited analysis estimating OPEX costs for private schools and libraries. *See* Letter from Evan Marwell, CEO, EducationSuperHighway, to Marlene H. Dortch, Secretary, FCC, WC Docket No. 13-184, at Attach. (filed Nov. 5, 2014) (ESH Nov. 5th *Ex Parte* Letter).

[61] Note the baseline ESH/CoSN model only includes natural price declines and does not include possible price declines that may be realized due to pricing efficiencies.

[62] ESH/CoSN submitted an Excel workbook with their model that used an average 90% discount factor for non-recurring fiber construction costs. *See* ESH/CoSN Connectivity Model. Throughout this report, we refer to model outputs resulting for the use of an average 69% discount factor for all types of purchases, including fiber construction.

[63] SHLB Model at 1.

[64] *Id*. at 31, 32, 34.

[65] *See* ESH FNPRM comments at 12.

1. Capital Expenditure (CAPEX) Estimates

20. The SHLB and ESH/CoSN models both provide CAPEX estimates. Each model's CAPEX estimate is as follows:

- SHLB estimates CAPEX costs for connecting all currently unconnected schools at between $4.0 billion and $5.7 billion.[66] Simply averaging these CAPEX costs over five years results in an annual pre-discount CAPEX cost between approximately $800 million and $1.1 billion to completely close the connectivity gap for all supported institutions. SHLB also estimates a CAPEX cost for connecting all currently unconnected libraries at $675 million, for an average annual cost over five years of $135 million.
- ESH/CoSN also provides estimates of CAPEX costs. The ESH/CoSN model's estimated CAPEX costs to connect all public schools and achieve the goals is $4.1 billion pre-discount and prior to any pricing efficiencies being realized.[67] Over five years, this averages approximately $810 million each year.

21. The CAPEX costs presented for each model are pre-discount costs and thus do not represent the cost to the fund. However, one could apply a discount rate to estimate the CAPEX costs to the fund. Such an exercise (i.e. SHLB's estimate for both schools and libraries with an average 69% discount rate implies an annual E-rate funding requirement between $645 million and $852 million) reveals that CAPEX costs in addition to category one OPEX costs and legacy service costs will easily exceed the current $2.4 billion cap. The ESH/CoSN model for 2014 estimates post-discount category one and legacy funding demand to be approximately $2.4 billion which means additional CAPEX as estimated by both models would cause funding demand to well exceed the $2.4 billion cap.

2. Operational Expenditure (OPEX) Estimates

22. The ESH/CoSN model estimates OPEX costs of broadband services for various levels of goal attainment for public schools. In their model, growth in category one OPEX results from both growth in the number of schools connected and growth in individual schools' bandwidth costs. Since the category one OPEX is a function of the extent to which the connectivity gap is closed, we can present ESH/CoSN's estimates of "pure" OPEX costs for various levels of goal attainment. The annual post-discount OPEX costs (excluding CAPEX costs paid through OPEX) estimated in the ESH/CoSN model are shown in Table 2.[68]

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[66] SHLB provides a high and low estimate for CAPEX costs to close the gap for schools. SHLB provides a single estimate of CAPEX costs for libraries. *See* SHLB Coalition Model at 31-32, 34.

[67] ESH/CoSN Connectivity Model at 7, "Model Summary" Tab ("All locales" non-recurring cost for fiber construction: $4,050,571,704).

[68] By "pure" OPEX we mean to exclude CAPEX that is paid for through recurring monthly charges. ESH/CoSN identify this type of OPEX in the "Model Summary" tab as "Allowance for new builds paid through OPEX." *See* ESH/CoSN Connectivity Model. These CAPEX costs in this paper for comparison purposes with other CAPEX models are included in the ESH CAPEX totals.

Table 2: Annual E-rate Funding for Public School OPEX Costs Estimated by ESH/CoSN[69]

Scenario	Percent of Public Schools Connected	Maximum Annual E-rate Funding for Category One OPEX
Improved Gap Coverage: Urban, Suburban, Town	94.0%	$1.82 billion
Substantial Gap Coverage: Urban, Suburban, Town, Rural Distant, 80% Rural Remote	99.7%	$1.94 billion
Complete Gap Coverage: All Locales	100%	$1.96 billion

23. ESH/CoSN also provided a supplemental analysis of the OPEX costs for private schools and libraries.[70] In this analysis, ESH/CoSN estimates a total cost impact to E-rate from private school OPEX to be $241 million annually.[71] ESH/CoSN also estimates a total cost impact to E-rate from library OPEX of $218 million.[72]

3. Impact of Price Declines on Recurring (OPEX) Costs

24. ESH's model also analyzes the typical pricing levels paid for schools achieving the goals today and applies a set of projections as to how those prices may decline over the next five years due to basic market factors such as volume discounting. ESH relied on its recent survey of 1,044 school districts that supplied data from the Item 21 attachments to their FCC Forms 471 to develop its current pricing assumptions. The data show a total cost for 1 Gbps of connectivity to a school in 2014 is $6,661 per month ($79,935 per year).[73] As a projection of baseline pricing efficiencies, ESH estimates that by 2018 this cost will fall another 34% to $4,370 a month ($52,445 per year) in 2018.[74]

4. Total Cost Estimates for Public Schools

25. In additional to the specific CAPEX and OPEX funding needs discussed above, the ESH/CoSN model also provides a comprehensive estimate of E-rate funding needs over the next five years for public schools. To compute the total costs for E-rate funding of public schools, ESH/CoSN also takes into account the phase-out of legacy support while assuming the $1 billion category two funding target is achieved for the entire five year period. This ESH/CoSN baseline model estimates that connecting all public schools in five years will lead to annual funding requirements just over $4 billion in

[69] *See* ESH/CoSN Connectivity Model at "Model Summary" Tab (Calculated by applying a 69% discount factor to the sum for each scenario in 2018 of the total cost estimates for Internet access, District WAN, and copper-based service).

[70] ESH Nov. 5th *Ex Parte* Letter, Attach. 1.

[71] *Id.*

[72] *Id.*

[73] ESH/CoSN Connectivity Model at 13, "Service Pricing" Tab.

[74] According to the ESH/CoSN Connectivity Model, at "Service Pricing" Tab, the monthly price for a gigabit circuit in 2014 will be $6,661, which is 0.9*$7,401 (the price of a gigabit circuit in 2013). In 2018, the same circuit will be less expensive because of four more years of 10% price declines (i.e., $4,370=$6,661*0.9*0.9*0.9*0.9).

some years, declining to $3.9 billion in the fifth year.[75] ESH/CoSN also shows that connecting only 99.7% of schools leads to a maximum annual fund requirement in the next five years of approximately $3.9 billion.[76] Note however that the ESH/CoSN baseline estimates do *not* incorporate pricing efficiencies into the baseline estimates but rather estimate costs to connect public schools if only natural price declines are realized. Below we discuss price efficiencies that ESH/CoSN expects can be realized under various policy options.

26. An important caveat to the ESH model which seeks to estimate all costs on an annual basis for public schools is that over the five year period funding may follow a different trajectory. Funding needs may not be felt immediately in funding year 2015 because of the need to plan capital projects.[77] Furthermore, the ESH filing points out that the long-term funding needs could in fact decline as the benefits of efficiency grow and the need for extensive non-recurring construction costs decline.[78]

5. Potential Cost Efficiencies

27. In addition to these cost models, ESH submitted for the record an analysis of the potential pricing efficiencies resulting from several different policy measures.[79] They looked specifically at three policy measures: (1) increased use of cost effective consortia; (2) increased viability of leased and owned dark fiber for WAN connectivity; and (3) enhanced transparency of E-rate pricing. The ESH analysis estimates potential savings of between three and 18 percent resulting from additional consortia, potential savings of up to 50 percent resulting from the equalization of lit and dark fiber, and potential savings of between 15 and 33 percent resulting from pricing transparency.[80] Collectively, ESH estimates that efficiencies can lower the cost of broadband by 10 to 25 percent off the projected category one costs for the E-rate program.[81]

C. Estimated Impact of E-rate Funding Increases on Contributions

28. Telecommunications providers contribute to the Universal Service Fund (USF) based on a percentage of interstate and international end-user revenues, known as the "contribution factor," which they may choose to pass on to customers. The contribution factor is adjusted quarterly based on USF

[75] ESH/CoSN Connectivity Model at 7, "Model Summary" Tab.

[76] *Id.*

[77] *See, e.g.*, Conterra PN Reply Comments at 2-3 (it takes at least two years to build broadband infrastructure under greenfield circumstances); COMPTEL NPRM Reply Comments at 5 (the FCC must emphasize to applicants the importance of providing potential bidders adequate lead time for build projects because service providers may decline to participate in the process because they cannot meet the time deadlines).

[78] *See* ESH/CoSN Connectivity Model at 6.

[79] *See* ESH E-rate Policy Options Analysis at Appendix A.

[80] *See id*.

[81] *See id.* at 1.

demand and total assessable revenues reported by providers, known as the "contribution base."[82] The contribution factor for the fourth quarter of 2014 is 16.1%.[83]

29. Collecting more E-rate funding would increase the contribution factor. The exact impact will depend on the amount of funding needed to meet demand and future changes to the contribution base. In 2013, the Commission estimated that the typical contribution for a residential line was $0.91 - $1.11 per month. [84] Table 3 estimates the increase in the monthly per-line residential contribution if the Commission raises the E-rate cap.[85]

Table 3: Estimated Monthly Per-Line Residential Contribution[86]

E-rate Annual Cap Increase (millions)	Low Estimate of Additional Monthly Per-Line Contribution	High Estimate of Additional Monthly Per-Line Contribution
$500	$0.05	$0.06
$1,000	$0.11	$0.13
$1,500	$0.16	$0.19
$2,000	$0.21	$0.26

[82] *See generally* Federal Communications Commission, Contribution Factor & Quarterly Filings, http://www.fcc.gov/encyclopedia/contribution-factor-quarterly-filings-universal-service-fund-usf-management-support (last visited Nov. 13, 2014).

[83] *See Proposed Fourth Quarter 2014 Universal Service Contribution Factor*, CC Docket No. 96-45, Public Notice DA14-1315 (rel. Sept. 11, 2014).

[84] The annual *Universal Service Monitoring Report* estimates the monthly per-line and per-household USF contribution passed through to residential customers. *See* Industry Analysis and Technology Division, Wireline Competition Bureau, *2013 Universal Service Monitoring Report*, Table 1.10 (2013), http://transition.fcc.gov/Bureaus/Common_Carrier/Reports/FCC-State_Link/Monitor/2013_Monitoring_Report.pdf.

[85] Estimates in the *2013 Universal Service Monitoring Report* are based on the current universal service contribution methodology, which assesses contributions based on end-user revenues. The Commission recently referred to the Federal-State Joint Board on Universal Service the record developed in response to the Commission's 2012 Further Notice of Proposed Rulemaking seeking comment on modifications to the universal service contribution methodology. The matter is currently under consideration before the Joint Board. *See Federal State Joint Board on Universal Service et al,* WC Docket No. 96-45 et al, Order, FCC 14-116 (rel. Aug. 7, 2014).

[86] This is based on contribution estimates as of the fourth quarter of 2013. Low and high estimates vary based on projected ratios of consumer and business contribution levels in future years. *See 2013 Universal Service Monitoring Report*, Table 1.10.