

**BEFORE THE
FEDERAL COMMUNICATIONS COMMISSION
WASHINGTON, D.C. 20554**

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| In the Matter of |) | |
| |) | |
| Modernizing the E-rate |) | WC Docket No. 13-184 |
| Program for Schools and Libraries |) | |

REPLY COMMENTS OF INTERNET2

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Date: April 21, 2014

SUMMARY

Research and education (“R&E”) networks play a critical role in advancing the broadband capabilities of our nation, including our schools and libraries. Internet2, as the country’s National Research and Education Network, is in a special position to assist the Commission’s efforts to reform the E-rate program to provide U.S. students and adult learners with the most innovative learning experiences in the world. Moreover, the R&E community as a whole is exceptionally well-suited to help the Commission accomplish these goals. In fact, because R&E networks are designed and engineered to meet the needs of some of the most demanding Internet users in the country, the R&E community has already overcome many of the same challenges in terms of capacity and quality constraints that schools and libraries currently confront.

Internet2 suggests that the Commission has a golden opportunity in this proceeding to make a difference that will endure for generations. The Commission should fund demonstration projects to achieve innovation within the E-rate program, prioritizing funding for networks that will be future proof. Moreover, these projects should focus on identifying standards necessary to deliver high-quality digital content to students and library patrons. As opportunities for interactive digital learning continue to expand, schools and libraries will risk being unable to take advantage of these opportunities unless quality and reliability keep pace with new application demands.

Given the wealth of digital content available to support educational efforts and transform learning, demonstration projects can play a vital role in the Commission’s efforts by helping to determine how to efficiently deliver this content to students and library patrons through high-capacity – and, just as importantly, high-quality – connections.

TABLE OF CONTENTS

| | <u>Page</u> |
|---|--------------------|
| REPLY COMMENTS OF INTERNET2 | 1 |
| INTRODUCTION | 1 |
| I. The R&E Community is Well-Positioned to Support the Commission’s Goal of Advancing Innovative Educational Experiences Through High- Capacity Networks..... | 3 |
| A. The Internet2 Network and U.S. UCAN..... | 3 |
| B. Internet2 Currently Supports Multiple Programs that Demonstrate the Potential of Online Interactive Educational Opportunities | 4 |
| II. Internet2 Supports the Commission Funding Next-Generation Demonstration Projects..... | 7 |
| A. The Increased Use of High-Bandwidth Educational Opportunities Demands Better Network Connections..... | 7 |
| B. Networks Designed with Quality and Reliability Standards Can Best Support the High-Bandwidth Applications that Will Drive the Future of Education..... | 8 |
| C. The Commission Should Focus on Pilot Projects that Commit to Quality and Reliability to Support High-Bandwidth Applications and Create the Next-Generation Internet for K-12 Schools and Libraries | 10 |
| CONCLUSION..... | 12 |

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Internet2 submits these reply comments in response to the Federal Communications Commission’s (“Commission”) Public Notice requesting focused comments and reply comments on modernizing the E-rate program in the above-captioned proceeding.¹

INTRODUCTION

Internet2 is a member-owned, not-for-profit corporation founded in 1996 by the nation’s leading higher education institutions. Today, Internet2 has grown to more than 440 members, including more than 250 research universities, more than 80 private companies, government agencies and laboratories, and regional networks that provide advanced networking to a wide range of universities, government agencies, and community anchor institutions (“CAIs”). Through its position as the country’s National Research and Education Network (“NREN”), Internet2 promotes the next-generation research and education (“R&E”) missions of its members by providing pioneering network capabilities and unique opportunities for cross-collaboration to develop innovative solutions to common technology challenges. In fact, by providing advanced networks like the Internet2 Network and other R&E networks to research universities, R&E

¹ Public Notice, Wireline Competition Bureau Seeks Focused Comment on E-rate Modernization, WC Docket No. 13-184, DA 14-308 (rel. Mar. 6, 2014) (“*Public Notice*”).

networks have provided the platform upon which such innovations as the network router, the web browser, peer-to-peer file transfers, and social networking were invented.²

Internet2 has tremendous experience installing and managing next-generation broadband infrastructure, including having completed a \$62.5 million Broadband Technology Opportunities Program (“BTOP”) project that, in part, connects CAIs, including schools and libraries, to broadband services. This project, funded by the National Telecommunications and Information Administration, helped to fulfill the recommendation of the National Broadband Plan that government agencies work with the R&E community to facilitate a “‘Unified Community Anchor Network,’ that would support and assist anchor institutions in obtaining and utilizing broadband connectivity.”³ Today, with this infrastructure in place, Internet2 serves as the backbone for state and local networks that interconnect more than 93,000 CAIs throughout the country, including university and college campuses, schools, libraries, hospitals, and state and local government. Internet2’s U.S. Unified Community Anchor Network program (“U.S. UCAN”), the outgrowth of its BTOP award, focuses on extending R&E network resources, in collaboration with partners, to all CAIs, including providing schools and libraries with next-generation, scalable infrastructure that enables the delivery of innovative educational content.

While Internet2 and others have made great progress in connecting schools, libraries, and other CAIs with high-capacity broadband, in many locations there is still much more work to be done. Internet2 therefore supports the Commission funding demonstration projects to foster and enable further innovative platforms through the E-rate program. At the same time, Internet2

² R&E networks also have supported significant discoveries in science, such as the global search for the Higgs Boson particle and enabling the Mars Rovers to be managed by researchers across the United States.

³ *Connecting America: The National Broadband Plan* at 154 (Rel. Mar. 16, 2010) available at <http://www.broadband.gov/plan>.

urges the Commission to prioritize funding for networks that will be future proof.⁴ With many schools and libraries already facing capacity constraints that inhibit the adoption of new educational techniques, Internet2 and its partners are well-suited to assist the Commission's goals in this proceeding because they have overcome similar challenges that faced the higher education community. To that end, Internet2 submits these reply comments to address the proposed demonstration projects to be funded through E-rate and how those projects can focus on quality and reliability to ensure that the nation's students and adult learners can access the high-bandwidth educational opportunities that will drive the future of U.S. education.

I. The R&E Community is Well-Positioned to Support the Commission's Goal of Advancing Innovative Educational Experiences Through High-Capacity Networks

A. The Internet2 Network and U.S. UCAN

Internet2 owns and operates the premier advanced national network infrastructure ("Internet2 Network") and identity management framework that serves such varied constituencies as the R&E community, CAIs, federal agencies, and industry. Using the latest generation of optical transport equipment, the Internet2 Network supports native 100 Gigabit services with near-term potential of offering 200 and 400 Gigabit services. Additionally, the Internet2 Network has advanced Layer 2 services built on software defined networking ("SDN"), which allows users to optimize the network for their specific application needs. Internet2's current 8.8 Terabit capacity national network positions Internet2 as one of the most advanced networks in the world. Internet2 has built its business models to encourage advanced applications to use bandwidth, eliminating per-unit billing systems in favor of investing in capacity in advance of demand.

⁴ *Id.*, ¶¶ 55-62.

As part of the Internet2 U.S. UCAN program, schools and libraries connect to the Internet2 Network through a regional R&E network partner. This program focuses on leveraging R&E resources, including the Internet2 Network, to support the advanced broadband and related application needs of CAIs. Through the U.S. UCAN program, Internet2 member universities sponsor Internet2 connectivity for an entire state. This allows CAIs in the sponsored state, including K-12 schools and libraries, to connect to Internet2, ordinarily through a state's education network that is connected to a local Internet2 affiliated regional network or Internet2 connector. Higher education institutions currently sponsor Internet2 connections in 42 states across the nation.⁵ Approximately 60 percent (or more than 84,000) of all K-12 schools and 25 percent (or more than 4,000) of all of America's public libraries participate in the U.S. UCAN program.⁶

B. Internet2 Currently Supports Multiple Programs that Demonstrate the Potential of Online Interactive Educational Opportunities

Through its K20 Initiative, Internet2 develops programs and partnerships designed to leverage the advanced R&E networking infrastructure to deliver high-quality digital content and learning experiences to K-12 schools, public libraries, and other CAIs across the country. For example, the Presidential Primary Sources Project ("PPSP") is a program series developed by Internet2 in partnership with the National Park Service, Library of Congress, and National Archives and Records Administration Office of Presidential Libraries. Recently, through this project, students from across the country were able to participate in a real-time video conference with former President Jimmy Carter to discuss his contributions to the National Park System and his decision to protect more than 100 million acres of federal lands in Alaska while he was

⁵ All of the 42 U.S. UCAN connected states, except Arkansas, permit or encourage K-12 schools to connect to R&E networks.

⁶ Other schools and libraries obtain broadband connectivity through commercial service providers.

president.⁷ This program series enables students to have access to innovative educational content and to engage in dialog with history makers such as President Carter via advanced interactive videoconferencing enabled through the Internet2 Network.

In addition, as many schools and libraries face budget constraints, the first impulse often is to curtail music and other arts programs, to the long-term detriment of affected students.⁸ Through the Low Latency Initiative (“LOLA”), Internet2 provides audio and videoconferencing technology that enables real-time, simultaneous, live musical performances across long distances.⁹ Some focuses of this initiative include enabling collaborative live performances, master classes, and remote auditions in the performing arts. Internet2 also is engaged with the museum and library community, film departments, and language instruction centers to provide more digital learning content to students.¹⁰

This technological and collaborative paradigm enables knowledge and expertise to flow seamlessly between higher education institutions and schools and libraries by providing limitless opportunities to expand and strengthen learning experiences for all K-12 students and library patrons, no matter where they are located. Internet2’s world-class network enables technologies

⁷ See *Nat’l Park Service Press Release*, President Carter to Share History of Alaskan National Parks – Students Invited to Join Him for Live Webchat on December 2, *available at* <http://www.nps.gov/news/release.htm?id=1539>.

⁸ See *The Consequences of Curtailing Music Education*, *available at* <http://www.pbs.org/wnet/tavissmiley/tsr/dudamel-conducting-a-life/the-consequences-of-curtailing-music-education/>.

⁹ See <https://www.youtube.com/watch?v=QigfsGNW9zw>.

¹⁰ As further examples of the types of innovative educational content being delivered to students through Internet2’s K20 Initiative, students are able to engage in dialog with world-class presidential historians via advanced interactive videoconferencing and access primary source documents for research and presentations, such as the recent PPSP event concerning the Truman Doctrine presented by the Harry S. Truman Library. See <http://video.magpi.net/videos/video/1033/>. Students from across the country also were able to listen to a live reading by Poet Laureate Philip Levine given at the Library of Congress and engage in a question-and-answer session with Mr. Levine after the reading. See <http://video.magpi.net/videos/video/415/>.

such as telepresence, which is the most technologically advanced form of videotelephony and permits different users from across the country to feel as if they are in the same room with one another, provided they have a seamless network connection like the one provided by Internet2.¹¹ What separates telepresence from older technologies such as ordinary videoconferencing is the ability to provide an immersive experience for students based on telepresence's high-quality and high reliability, thus making it even more likely that students will remain engaged in the educational experience. Through such technologies, students are able to interact with presenters hundreds or thousands of miles away in real time, with no fear of losing the students' attention because of poor quality connections or audio/video relay delays. Telepresence thus is able to ensure an unsurpassed learning experience for students by permitting existing faculty to extend their reach to more students, provide access to content and experts previously unavailable, bring together multicultural student groups, deliver instruction and therapy for special-needs students, and increase administrative efficiency.¹²

Each day, the number of options available to schools and libraries through massive online open courses and other online learning resources grows. Increased broadband connectivity will make these resources more readily available. Indeed, students can now interact directly with teachers renowned in their fields, remotely access advanced scientific equipment located at research universities, or perform live with a symphony across the country in real time.¹³ The possibilities for educational collaboration are endless and will lower the costs of educating our

¹¹ See www.ivci.com/pdf/whitepaper-telepresence-vs-videoconferencing.pdf at 3 (noting that in addition to unsurpassed audio and video quality and high reliability, one of the chief features of telepresence is the ability to create "a reasonable illusion that the remote participants are in the same room").

¹² See http://www.cisco.com/web/strategy/education/telepresence_for_schools.html.

¹³ These opportunities also are possible for prominent American universities that are increasingly establishing campuses overseas.

students by allowing these educational experiences to take place inside of the classroom, sometimes for hundreds or thousands of students at a time.

II. Internet2 Supports the Commission Funding Next-Generation Demonstration Projects

A. The Increased Use of High-Bandwidth Educational Opportunities Demands Better Network Connections

The Commission's efforts to reform the E-rate program, and to permit service providers to demonstrate the cost-effectiveness of new models of providing high-capacity broadband connectivity that enable innovative educational opportunities such as those described above, are essential to education. The Administration echoed these sentiments last year when it launched the ConnectED initiative, stating that “[p]reparing America’s students with the skills they need to get good jobs and compete with countries around the world relies increasingly on interactive, individualized learning experiences driven by new technology.”¹⁴ The Administration understands that the converse also is true: schools and libraries without adequate and affordable broadband connectivity put the nation’s students at a disadvantage both at home and abroad.

Of course, no matter how fast the Internet2 Network operates or any network, an individual institution’s capacity is limited by the weakest link in the connectivity chain. For example, a 1.544 Mbps copper connection to a state or regional education network does not provide a school or library with sufficient bandwidth to take full advantage of the 100 Gbps Internet2 Network further downstream and the advanced educational opportunities it enables. To fully realize the potential of the Internet2 Network and the interactive learning opportunities it enables, schools and public libraries throughout the nation must have access to scalable, flexible,

¹⁴ What is ConnectED?, available at <http://www.whitehouse.gov/blog/2013/06/06/what-connected>.

and affordable infrastructure solutions, wherever feasible, to meet their current and future bandwidth needs.

Given the wealth of digital content available for schools and libraries to support educational efforts and transform how students (and adults needing continuing education) learn, the demonstration projects under consideration by the Commission can help to determine how to efficiently deliver this content to students and library patrons through high-capacity – and, just as importantly, as discussed below, high-quality – connections.¹⁵ These efforts not only will lead to a better quality of education for our country’s students but also revolutionize the ability of educational institutions to collaborate and offer remote educational programs, thereby lowering the costs to educate our students. In short, the Commission should move forward quickly with a variety of demonstration projects to support the provision of next generation services to schools and libraries.

B. Networks Designed with Quality and Reliability Standards Can Best Support the High-Bandwidth Applications that Will Drive the Future of Education

R&E networks, like the ones operated by Internet2 and its regional partners, are uniquely designed and engineered to meet the needs of some of the most demanding Internet users in the country, namely scientists, academics, and researchers in the nation’s leading academic and research institutions. These users have expectations that they can move massive amounts of data on demand and that the network will deliver a predictable throughput at all times they offer a workload to the network. These users also expect their network service provider to continuously expand the network to stay slightly ahead of the demand they are likely to generate. The R&E community has had tremendous success operating networks that not only meet the standards that

¹⁵ As more schools embrace online testing to meet statewide and national standards, schools’ networks face heavy demand and require sufficient quality of service guarantees.

these users demand today but also serve as the necessary testing grounds for the applications of tomorrow.

Moreover, R&E networks are designed with the following characteristics in mind: abundant symmetrical bandwidth, low latency expectations, and low jitter guarantees that do not inhibit users' connections and that allow plenty of headroom for bursting applications without needing to cap users' throughput for flash usage events. Indeed, early in Internet2's history, it established a series of headroom policies to ensure that the connectivity it provides functions correctly, no matter the use to which it is put.¹⁶ Although Internet2 concluded that many applications simply require abundant bandwidth, it also determined that many advanced applications require qualitatively different connections to function correctly, such as maximum packet-delay (latency) guarantees and consistent, predictable paths for network traffic that best-effort networks are unable to provide.¹⁷ For example, remote collaborative applications include requirements based on hard thresholds of human perceptual sensitivity that translate into very specific latency and jitter needs, particularly with respect to the performance arts. The Internet2 Network optimizes its paths to bring latency as close to the speed of light as possible, assuring that collaborative applications can work at the maximum distance between collaborators. Failure to design latency expectations into the network results in the application being reduced to smaller collaborations that are degraded or even unusable. For students, this could mean quickly losing

¹⁶ See <http://qos.internet2.edu/wg/>. As noted on this site, a Quality of Service working group was formed early in Internet2's history with the overall objective to specify, deploy, and evaluate new IP services in interdomain testbeds. See also Internet2 and Quality of Service: Research, Experience, and Conclusions, available at <https://net.educause.edu/ir/library/pdf/CSD4577.pdf>.

¹⁷ In a best-efforts network, each network element along an IP packet's path makes nothing more than a good-faith effort to forward the packet toward its destination. If a router's queue is overloaded, packets are dropped with little or no distinction between low-priority traffic and urgent traffic.

interest in an interactive educational experience. Traditional best-efforts services are incapable of meeting the needs of these advanced applications.

C. The Commission Should Focus on Pilot Projects that Commit to Quality and Reliability to Support High-Bandwidth Applications and Create the Next-Generation Internet for K-12 Schools and Libraries

Internet2, as the country's NREN, is in a special position to assist the Commission's efforts to reform the E-rate program to provide U.S. students and adult learners with the most innovative and interactive learning experiences in the world. Moreover, Internet2's regional partners, and the R&E community as a whole, are well-suited to help the Commission accomplish its goals here. In fact, because R&E networks are designed and engineered to meet the needs of some of the most demanding Internet users in the country, the R&E community has already overcome many of the same challenges in terms of capacity constraints that schools and libraries currently confront.

Internet2 respectfully submits that the challenges to innovate previously faced by the R&E community will be similar to those that schools and libraries will face, and the best practices adopted by Internet2 and other R&E network operators should be explored through the use of the demonstration projects contemplated in this proceeding.¹⁸ Moreover, Internet2 is

¹⁸ Internet2 respectfully submits that its participation in these demonstration projects will provide invaluable experience and data for the Commission as it seeks to reform the E-rate program. But as Internet2 stated in its earlier comments in this proceeding, the most recent Eligible Services List ("ESL") issued by USAC continues to conflict with the Commission's *2010 E-rate Reform Order* because the ESL does not list Internet access service as an eligible service under the E-rate program. *See In the Matter of Modernizing the E-rate Program for Schools and Libraries*, WC Docket No. 13-184, Comments of Internet2 at 21-22 (Sept. 16, 2013). Specifically, the current ESL lists Internet2 as an eligible service provider for digital transmission services, but then states that Internet2 is not eligible for funding as an Internet access provider in the glossary section. *See* ESL at 2, 37. Accordingly, the Commission should resolve this ambiguity and clarify that, if Internet2 provides direct Internet connections to schools or libraries, such service – consistent with 47 C.F.R. § 54.502(a)(2) and the *2010 E-rate Reform Order* – is an eligible service under the E-rate program. Moreover, Internet2 also should

concerned that any capacity benchmarks alone will not always provide schools and libraries quality broadband connections that can evolve as digital education evolves and that are future proof.¹⁹ Rapid advancements in both networking technologies and the applications that run over those networks quickly can and do make what would appear to be a high-capacity broadband connection today less than adequate in the near future. Therefore, Internet2 recommends that the Commission should not proceed with a singular focus on bandwidth capacity to the exclusion of quality and reliability, namely latency, jitter, and scalability service levels.

In light of the foregoing, Internet2 urges the Commission to provide funding for demonstration projects that will address standards necessary to deliver high-quality digital content to students and library patrons for many years to come. That is, such demonstration projects should focus on metrics and provide schools and libraries with the technical support necessary to fully realize the capabilities of next-generation networks.²⁰ Moreover, such demonstration projects should be capable of (i) supporting all applications, including all video applications, currently being used by significant numbers of users; (ii) enabling multiple users at the same time; and (iii) providing transmission parameters that will ensure ample uncongested “headroom” to enable both growth and new applications/users to be accommodated. As opportunities for interactive digital learning continue to expand, schools and libraries will face

be eligible to receive funds in connection with any demonstration projects in which it participates.

¹⁹ See *In the Matter of Modernizing the E-rate Program for Schools and Libraries*, WC Docket No. 13-184, Comments of Internet2 at 12-14 (Sept. 16, 2013) (noting that broadband demand grows exponentially rather than linearly, and networks need to be designed and installed with this in mind). As more schools and libraries migrate to cloud-based educational paradigms, high-capacity networks with quality guarantees will be essential.

²⁰ See Comments of the American Library Association, WC Docket No. 13-184, at 15-18 (filed April 7, 2014) (noting that some demonstration projects should include technical support).

the risk of being unable to take advantage of these opportunities unless the quality levels they receive keep pace with new application demands

Successful real-time, remote, interactive instruction and use requires broadband service that is low latency, has less jitter, and reduces packet loss. Therefore, creating performance requirements to ensure that online learning experiences are usable should be a high priority for the E-rate program. The proposed demonstration projects should be used to analyze the best practices currently utilized in the R&E community to serve as the future baseline for schools and libraries.

In sum, the Commission has a golden opportunity in this proceeding to make a difference that will endure for generations, and Internet2 is more than willing to utilize its expertise to assist in this important effort.

CONCLUSION

For all of the foregoing reasons, Internet2 respectfully requests that the Commission fund demonstration projects in this proceeding, and adopt the further reforms of the E-rate program, consistent with the recommendations set forth herein.

Respectfully submitted,

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