BEFORE THE
DEPARTMENT OF COMMERCE
NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION
DOCKET NO. 140925800-4800-01
Telecommunications Assessment of the Arctic Region

COMMENTS OF INTERNET2

John S. Morabito
Danielle Rodier
Internet2
1150 18th Street, NW
Suite 900
Washington, DC 20036

Alan G. Fishel
Adam D. Bowser
Arent Fox LLP
1717 K Street NW
Washington, DC 20006
Counsel for Internet2

Date: November 3, 2014

SUMMARY

Research and education ("R&E") networks play a critical role in advancing the broadband capabilities of our nation. As the operator of the country's National Research and Education Network, the University Corporation for Advanced Internet Development (d/b/a "Internet2") is in a special position to assist with the efforts of the President and the National Telecommunications and Information Administration ("NTIA") to develop communications infrastructure and increase our understanding of the Arctic through scientific research.

Internet2 respectfully submits that NTIA should leverage the strengths of the R&E community to meet the goals of the President's National Strategy for the Arctic Region. Given the unique challenges of deploying communications infrastructure in Alaska, Internet2 urges NTIA to prioritize funding for communications networks that will be future proof. In addition, NTIA should prioritize investments in the Arctic region in networks that offer bandwidth abundance and that are designed to support the data-intensive research that will be necessary to address climate change.

R&E networks, including the Internet2 Network, are engineered to meet the needs of some of the most demanding Internet users in the country. As a result, NTIA should focus on networks that offer the quality and reliability standards that are essential to researchers in the Arctic region. Finally, NTIA should leverage the experience of Internet2 and its membership. Our university members and several government agencies, including the National Oceanic and Atmospheric Administration's Cooperative Institutes, already have engaged in significant climate change research.

BEFORE THE
DEPARTMENT OF COMMERCE
NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION
DOCKET NO. 140925800-4800-01
Telecommunications Assessment of the Arctic Region

The University Corporation for Advanced Internet Development (d/b/a "Internet2") submits these comments in response to the National Telecommunications and Information Administration's ("NTIA") Notice of Inquiry requesting input on the current and potential availability of communications services in the Arctic region.[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 460 members, including more than 265 research universities, government agencies and laboratories, private companies, and regional networks that provide advanced networking to a wide range of universities, government agencies, and community anchor institutions ("CAIs").[2] 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, the Internet2 Network, along with the R&E networks of Internet2's state and regional partners, provided the platform

---

1 *Notice of Inquiry*, Telecommunications Assessment of the Arctic Region, Federal Register, Vol. 79, No. 192, 59746-59750 ("NOI").

2 Government agencies that are members of Internet2 include the Department of Energy, the National Oceanic and Atmospheric Administration ("NOAA"), the National Institutes of Health, and the Department of Agriculture.

upon which innovations like the network router, the web browser, peer-to-peer file transfers, and social networking were invented.[3]

Internet2 has tremendous experience installing and managing next-generation broadband infrastructure, including having completed a $62.5 million Broadband Technology Opportunities Program ("BTOP") project. This project, funded by NTIA, helped to fulfill the recommendation of the National Broadband Plan ("NBP") that government agencies work with the R&E networking community to facilitate a "'Unified Community Anchor Network,' that would support and assist anchor institutions in obtaining and utilizing broadband connectivity."[4] Today, with this infrastructure in place, Internet2 serves as the national backbone for state and local networks that interconnect more than 93,000 CAIs throughout the country, including K-12 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 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 progress in connecting unserved and underserved areas of the country with high-capacity broadband, in many locations there is still much more work to be done, particularly in Alaska. The network externalities of adding these regions to the Internet2 Network are significant. The more entities and regions that connect to the R&E community, the greater the ability for everyone to collaborate on cutting-edge scientific and

---

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

[4] *Connecting America: The National Broadband Plan* at 154 (rel. Mar. 16, 2010) ("NBP") available at http://www.broadband.gov/plan.

research endeavors. Internet2 therefore supports the President's and NTIA's efforts to devote resources to developing Arctic communications infrastructure and increase our understanding of the Arctic through scientific research. The Internet2 Network is uniquely designed to support just this type of demanding scientific research, both now and into the future. The expertise Internet2 has gained from the evolution of its network, in partnership with its state and regional R&E networking partners, can only help to support NTIA's objectives here.

As discussed below, given the unique aspects of Alaska, and the Arctic region in general, Internet2 urges NTIA to prioritize funding for communications networks that will be future proof and are designed with the research and scientific community's data usage in mind.[5] To that end, Internet2 submits these comments to address the investments necessary to meet the goals of the President's National Strategy for the Arctic Region.

I. Alaska's Unique Challenges and its Existing Communications Infrastructure

Alaska is geographically and demographically unique, presenting unparalleled challenges in deploying, maintaining, and operating modern communications networks. Alaska has not only a small population spread over enormous distances, but also an extremely harsh climate and short construction season. For these reasons, Alaska, particularly in the rural areas and above the Arctic Circle, lacks the basic communications and other infrastructure present in the lower 48 states. Indeed, the Regulatory Commission of Alaska stated in the Federal Communications Commission's ("FCC") *Connect America Fund* proceeding that Alaska's "lack of roads, [] small

[5] *Id.*, ¶¶ 55-62; *see also* NOI at Section IV(17) (seeking comment on strategies to facilitate the deployment of advanced communications networks in pan-Arctic region).

population, and extreme arctic weather conditions make providing telecommunications services challenging and expensive."[6]

Satellite middle-mile transport – which is what exists today for rural Alaska and the Arctic region – is very expensive, has limited throughput capacity, and simply cannot economically keep up with bandwidth demand.[7] NOAA and the U.S. Geological Service, for example, have satellite downlink in Fairbanks but are resource constrained when it comes to getting access to data from the lower 48 states.[8] Moreover, even if affordable satellite middle-mile capacity emerged, as discussed further below, many Internet applications are latency sensitive. The only way to eliminate inherent satellite latency is to switch to terrestrial middle-mile service.[9] Further, there simply is not enough satellite capacity to provide even adequate backhaul to support basic speeds of 4 Mbps download and 1 Mbps upload. The comments of Alaska's Cordova School District in the FCC's *National Broadband Plan* proceeding exemplify Alaskan users' frustration at the limitations and implications of satellite-based services in the state:

> Satellite connectivity gives Cordova a basic level of access, but it suffers from serious limits in regard to bandwidth and transmission lag times. Limits that are becoming increasingly apparent as content available on the Internet changes requiring real time feed back with data input and interpretation. As communications technology improves and common Internet applications demand ever-increasing bandwidth and speed, students and teachers in Cordova are being left behind.[10]

---

[6] Comments of the Regulatory Commission of Alaska at 2-3, WC Docket No. 10-90, *et al.*, (filed July 12, 2010).

[7] *See* NOI at Section IV(7) (seeking comment on existing satellite communications services widely used by Arctic Alaskan communities).

[8] NOAA has polar orbiting satellites that link to stations in Fairbanks.

[9] *See* NOI at Section III (seeking comment on availability and adequacy of existing networks).

[10] Comments of Cordova School District at 3, GN Docket No. 09-47, *et al.*, (filed Nov. 20, 2009).

More than half of the nation's CAIs that lack sufficient broadband connectivity are located in Alaska.[11] Internet2 therefore urges NTIA to develop a framework for investing in scalable, fiber-based communications infrastructure in Arctic Alaska that will not only be future proof, but can also support connecting CAIs throughout Alaska that are currently unserved or underserved.

II. NTIA Should Prioritize Communications Infrastructure Investment That Supports Research and Education

A. R&E networks, like the Internet2 Network, have been designed to support the data-intensive science research that will be necessary to address climate change.

Internet2 is well positioned to assist NTIA in achieving its objectives under the President's National Strategy for the Arctic Region.[12] Internet2 owns and operates the premier advanced national network infrastructure and identity management framework. 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 is one of the most advanced networks in the world, providing a unique commitment to its users by offering the abundant bandwidth necessary to support advanced research and encourage new applications of technology to flourish. Internet2 has built its business models to encourage advanced applications to use as much bandwidth as necessary, eliminating per-unit billing systems in favor of investing in capacity in advance of demand.

---

[11] *See* A Blueprint for Alaska's Broadband Future at 5. Available at http://www.alaska.edu/files/oit/bbtaskforce/2013-08-AK-Broadband-Task-Force-Report%7CA-Blueprint-for-Alaska's-Broadband-Future.pdf.

[12] *See* NOI at Section IV(17)-(18).

The next generation of climate science research demands that network connectivity make a strategic shift to a system that is solely dedicated to that purpose. As the President's National Science and Technology Council recently stated, "[a]s data on the Arctic environmental systems has become voluminous, the need for more sophisticated hardware, software, standards, and sharing agreements has increased."[13] Indeed, the Arctic environment is undergoing a rapid transition as sea and land ice diminish, with tremendous implications for natural environments, human well-being, national security, transportation, and economic development. These developments have led the Department of Defense to conclude that "[c]limate change will affect the DoD's ability to defend the nation and poses immediate risks to U.S. national security," and it also has concluded that a "whole-of-government approach" is needed to better understand and mitigate the effects of climate change.[14]

Two of the essential goals of the President's National Strategy for the Arctic Region are to "make decisions using the best available information" and "pursue responsible Arctic region stewardship."[15] Internet2 respectfully submits that NTIA should leverage the strengths of the R&E community and its networks to meet these goals. R&E networks, like the Internet2 Network, 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, the network will deliver a predictable throughput at all times they offer a workload to the network, and their network service providers will

---

[13] Executive Office of the President. National Science and Technology Council. *Arctic Research Plan F2013-2017*. Available at http://www.whitehouse.gov/sites/default/files/microsites/ostp/2013_arctic_research_plan.pdf.

[14] 2014 Climate Change Adaption Roadmap at 1, 8. Available at http://www.acq.osd.mil/ie/download/CCARprint.pdf.

[15] National Strategy for the Arctic Region at 2-3.

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 provide myriad benefits today but also serve as the necessary testing grounds for the applications of tomorrow.

B. R&E Networks have been designed with the quality and reliability standards that are necessary for researchers.

R&E networks are designed with the following quality and reliability 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, such as running climate-change modeling exercises. 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.[17] The Internet2 Network optimizes its paths to bring latency as close to the speed of light as is possible, assuring that collaborative research applications can work at the maximum distance between research collaborators. Failure to

---

[16] *See* 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.

design latency expectations into the network results in the application being reduced to smaller collaborations that are degraded or even unusable.[18]

Internet2 respectfully submits that the innovation challenges previously faced by the R&E community will be similar to the challenges that will confront those responsible for building out communications infrastructure in the Arctic that will satisfy the data-intensive needs to which the infrastructure will be utilized. The best practices adopted by Internet2 and its state and regional R&E networking partners should be explored through the use of the infrastructure investments contemplated in this proceeding. 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, due to a singular focus on bandwidth capacity to the exclusion of quality and reliability, namely latency, jitter, and scalability service levels.

C. The Internet2 Network has a longstanding history of supporting environmental research, particularly through its relationship with NOAA.

The Internet2 Network has been designed with intensive data users in mind. As one example, Internet2 has a longstanding relationship with NOAA as a network infrastructure provider that enables scientific research through advanced layers of networking services. Indeed, from almost the inception of Internet2, NOAA has maintained a membership in and network connectivity to Internet2. The national connectivity provided by Internet2 to its university members and to NOAA Cooperative Institutes has allowed for significant NOAA climate change research to occur.

Since 2010, NOAA has partnered with Internet2 and its state and regional R&E networking partners to develop and deploy NOAA's high-capacity Science Network, called N-

[18] *See* NOI at Section III.

Wave, which serves to significantly enhance the capabilities of NOAA's researchers and their partners across the country.[19] N-Wave is built on a set of dedicated waves on the Internet2 Network that enable NOAA to provide dedicated, high speed, and high capacity connections between climate and weather researchers and NOAA's key high performance computing sites across the nation. As NOAA itself indicates, the Internet2 Network "support[s] large data flows that allow the users – scientists, researchers, and others – to easily share computational resources regardless of location."[20]

NOAA climate scientists around the country therefore leverage the N-Wave network enabled by Internet2 and its state and regional R&E networking partners to understand, predict, and explain changes in climate. This is accomplished by providing and applying state-of-the-art, computationally intensive coupled climate models for advancing climate research, predicting climate from weeks to decades, and projecting future climate out to several centuries. These climate predictions and projections are expected to generate approximately 80 terabytes of data per day to support decision makers regionally and globally with timely and authoritative information. N-Wave provides the critical high capacity network links that can support these large data flows between sites as well as provide the capabilities to allow NOAA scientists to easily share computational resources with the U.S. Department of Energy and other U.S. government agencies.

Moreover, many Internet2 member universities currently are engaged in significant climate science research. For example, the International Arctic Research Center at the University of Alaska Fairbanks currently is engaged in research to improve our understanding of

---

[19] *See* N-Wave News at 4-5, available at http://noc.nwave.noaa.gov/uploads/a6/3d/a63d4dc0a90b80b507efa13e11411929/N-Wave-News-2-_11.2013.pdf.

[20] *Id.* at 4.

the consequences of changing Arctic sea ice and improve predictions on land-ice loss and its impacts on sea levels.[21] Columbia University's Polar Learning and Responding Climate Change Education Partnership ("PoLAR Partnership") allows researchers to focus their efforts on understanding the implications of climate change on Arctic ecosystems and communities.[22] The University of Maryland's Center for Environmental Science facilitates research into the response of Arctic wildlife adapting to the decline of seasonal sea ice and warming water temperatures in the Bering Sea.[23] As one final example, the Fulbright Arctic Initiative, led by Dartmouth, will allow researchers from all Arctic Council member nations to study the Arctic region, exploring topics such as climate change, energy, water, and health.[24]

As noted above, two of the essential goals of the President's National Strategy for the Arctic Region are to "make decisions using the best available information" and "pursue responsible Arctic region stewardship."[25] Internet2, through its partnership with NOAA and the work of its higher education members, already is helping to achieve these goals. But more can be done. Internet2 therefore urges NTIA to ensure that the Arctic communications infrastructure investment projects contemplated in this proceeding will be future proof and will support bandwidth abundance necessary to support the collaborative research envisioned in the President's strategy. In sum, NTIA has an incredible 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.

---

21 *See* http://www.iarc.uaf.edu/research/highlights/2014/search-grant-eicken.
22 *See* http://climate.columbia.edu/projects/polar/.
23 *See* http://arctic.cbl.umces.edu/.
24 *See* http://thedartmouth.com/2014/10/26/news/program-will-explore-arctic-systems.
25 National Strategy for the Arctic Region at 2-3.

Respectfully submitted,

/s/ John S. Morabito
John S. Morabito
Vice President and General Counsel
Internet2
1150 18th Street, NW
Suite 900
Washington, DC 20036