In the Matter of

Development of the Nationwide Interoperable	)	
Public Safety Broadband Network	)	**Docket No. 120928505-2505-01**
	)	
	)	

COMMENTS OF INTERNET2

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COMMENTS OF INTERNET2

Internet2 submits these comments in response to the Notice of Inquiry ("NOI") released by the National Telecommunications and Information Administration ("NTIA") on October 4, 2012, in the above-captioned proceeding concerning the First Responder Network Authority's ("FirstNet") development of the nationwide interoperable public safety broadband network ("PSBN").

INTRODUCTION

Internet2 is a member-owned advanced technology organization founded by the nation's leading higher education institutions in 1996. It is a not-for-profit consortium of several hundred U.S. research universities, government agencies and laboratories, companies, and regional networks that provide advanced networking for a wide range of universities, government agencies, and community anchor institutions ("CAIs"), including public safety entities.

Internet2 operates the leading national research and education network ("NREN") in the United States ("Internet2 Network"). Internet2 is the only U.S. NREN that actively engages its owner-members and works with other global research and education ("R&E") networks to advance Internet technologies. NRENs have been instrumental to the advancement of the nation's broadband capabilities. In fact, NRENs and the broader R&E community played a critical role in developing and popularizing the Internet into the economic and social powerhouse that it has become today.

Since the 1990s, Internet2 has provided a high-performance national network backbone to the R&E community, and the scope of Internet2's support for a wide variety of CAIs continues to expand. The Internet2 Network currently permits more than 66,000 CAIs to connect to each other, directly and indirectly, for advanced broadband applications across the

country. Given recent upgrades and expansions to the Internet2 Network, described in more detail below, it is a unique national asset that is available to support the effort of public safety entities to achieve a nationwide interoperable broadband network.

The R&E community also provides a collaborative environment for organizations, including Internet2, to solve common technology challenges and to develop innovative solutions in support of critical missions for CAIs throughout the country. Activating the same partnerships that produced today's Internet, Internet2's members are forging the future Internet through community, an advanced innovation platform, and transformative services and applications.

DISCUSSION

I.   **The Internet2 Network Can Support the Needs of FirstNet and Public Safety**

      A.   **The Broadband Technology Opportunities Program ("BTOP") Provided Internet2 with Funds for the Express Purpose of Assisting CAIs and Public Safety**

CAIs are located in virtually every community in every state in this country. They consist of not only public safety institutions, but also schools, community colleges and other institutions of higher learning, libraries, health care facilities, public media, and other community support organizations. In enacting and administering BTOP, Congress and NTIA recognized that it is vitally important that CAIs, including public safety entities, have access to the broadband services and applications they need.[1] Congress expressly provided that the broadband stimulus funds should be used, in part, to support "public safety agencies."[2]

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[1] 47 U.S.C. § 1305(b)(3)(A), (4)–(5); National Telecomms. & Info. Admin., Notice of Funds Availability & Solicitation of Applications, 75 Fed. Reg. 3792, 3794 (Jan. 22, 2010) (announcing in its second round of BTOP funding that NTIA would focus its infrastructure grants on projects that emphasize new or substantially upgraded connections to CAIs).

[2] 47 U.S.C. § 1305(b)(4); *see id.* § 1305(g)(5) (directing that BTOP grants be used in part to "construct and deploy broadband facilities that improve public safety broadband communications services").

In the summer of 2010, Internet2 received a $62.5 million BTOP grant to significantly

upgrade and extend its national network. As a result of the grant to fund this effort (which was

referred to as the U.S. UCAN project in the BTOP application), Internet2 has added nearly

18,000 miles of new network, optimized for advanced applications and moving massive and

sporadic sets of data. It is built as both IPv6 and IPv4 native and is uniquely positioned to

support both routine public safety and exigent public safety needs.

A key purpose of the BTOP grant, i.e., the upgrade and extension of the Internet2

Network, was to allow CAIs, including public safety entities, to connect with each other. In the

BTOP application, Internet2 stated that, working with its partners, the expansion and upgrade of

the Internet2 Network could benefit more than 100,000 CAIs in all 50 states initially, and

eventually benefit all CAIs in the United States, including all public safety entities.[3] Not only

did the application state that this project will "catalyz[e] the adoption of transformational

broadband applications that can fundamentally improve education, health care, public safety, and

job-creating economic innovation," but it specifically envisioned that, among other things,

emergency 911 centers could exchange data nationwide over the expanded network.[4]

B.   The Internet2 Network is Well-Suited to Serve as a Back-Up Fiber Network for the PSBN

1.   The PSBN Must be Redundant

The Middle Class Tax Relief and Job Creation Act of 2012 ("the Act") created FirstNet,

authorizing it to take all actions necessary to ensure the building, deployment, and operation of

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[3] UNIV. CORP. FOR ADVANCED INTERNET DEV., EXECUTIVE SUMMARY: UNITED STATES UNIFIED COMMUNITY ANCHOR NETWORK (U.S. UCAN) 1, *available at* http://www.internet2.edu/government//docs/execsummary.BTOP.final.pdf.

[4] *Id.* at 1–2. A leading public safety organization actively supported Internet2's BTOP application. The National Emergency Number Association ("NENA"), which serves the public safety community as the only professional organization solely focused on 9-1-1 policy and technology, not only recognized that expanding and upgrading Internet2's existing network would benefit public safety institutions, but filed a letter in support of Internet2's BTOP application.

the PSBN.[5] The NOI expressly acknowledges that the Act also calls for the PSBN to be redundant.[6]

The PSBN, of course, will only be as strong as its weakest link. Accordingly, all portions of the PSBN should be fully redundant to ensure the utmost reliability, including the fiber backbone that is necessary to support the wireless networks. Without complete redundancy, failure on the part of one provider's network could lead to significant network failure overall, which public safety entities cannot tolerate. Using multiple providers' networks to ensure redundancy in connection with the fiber backbone provides greater reliability because a complete failure of one provider's network would not alone undermine the continuous operation of the PSBN. The services provided by public safety entities are simply too critical for the government to put all of its "eggs" in one network's "basket." In addition, resiliency should be measured not only in technical planning, but in the selection of equipment, corporate organization, and transparency of the operating entities.

2. The Internet2 Network Could be a Cost-Effective Solution

As a result of its BTOP grant, during the past two years Internet2 has dramatically increased its network's bandwidth, resiliency, and footprint to accommodate the connection, with its partners, of the nation's CAIs, including public safety entities. Using Internet2's upgraded and expanded network in connection with the PSBN would maximize the investment taxpayers have already made in Internet2 through BTOP and be a cost-effective means of obtaining the use of a back-up fiber network to support the PSBN. That is, the federal government has already assisted in capitalizing the core portions of the Internet2 Network, and as a not-for-profit entity, Internet2 can assist the public safety community by permitting use, for only the recovery of its

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[5] 47 U.S.C. § 1422(b).
[6] Development of the Nationwide Interoperable Public Safety Broadband Network, 77 Fed. Reg. 60680, 60681 (October 4, 2012).

costs, of its highly-advanced backbone network. Moreover, the network is configured to ensure that all necessary bridges are built to connect with the various CAI sectors. Having the capability to simultaneously serve many communities across a region, a state, and a nation dramatically reduces costs and improves efficiencies.

3. The Technical Characteristics of the Internet2 Network Could Benefit Public Safety

Internet2 operates a cutting-edge 8.8 Terabit per second interconnect with multiple 100G Ethernet interconnects among its core sites. It is optimized for CAI use of advanced broadband applications that use both standards-based technologies and protocols, and also serves as a test bed for future Internet technologies. The network provides the same wide range of IP and optical services available today—from IPv4, IPv6, and multicasting, to new leading-edge services like static and dynamic point-to-point circuits and software defined networks. It provides optical wave transport, Layer 2 Ethernet network services, and custom networking options that can be provisioned over Layers 1, 2, and 3.[7] The network can support live, low latency video and audio applications as well as extremely high definition streams equal to 16 times the normal HD resolution available on the market.

Each of these characteristics would be extremely beneficial to public safety. For example, the flexibility of software defined networking and dynamic ports that will enable an on-demand influx of additional bandwidth where necessary will be of tremendous value during a national or regional emergency or security incident in which a large number of first responders require access to the PSBN at the same time.[8] In addition, the superior quality of audio/video

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[7] Layer 1 service provides dedicated circuits used for the transport of data, video, voice, or other forms of communication traffic. Layer 2 service is an Ethernet service that acts as an open, high-performance distributed exchange facility. Layer 3 service is an IP service, including IP access ports.

[8] Software defined networking is an emerging set of design principles that converge the concept of "the network" with computing resources and makes both more versatile and customizable for advanced applications. This fundamental evolution of the network as an extension of the phone system into the network as an extension of the

that low latency and HD can provide to first responders for situational awareness and incident command systems will greatly benefit the public because crystal clear audio and video live streaming in emergency/response incidents will enhance the public safety community's ability to timely and effectively respond to such incidents.

The Internet2 Network is optimized for peak performance for a smaller number of extremely demanding users rather than commercial networks that traditionally engineer for average demand. Therefore, the Internet2 Network is unique in its ability to not only provide day-to-day services but also to be accommodating, without any new provisioning, reconfiguration, or additional labor, of massive influxes of data across the network. Such a capability would be uniquely suited to allow FirstNet to be more responsive to exigent needs that may arise across its footprint.

Equally important, Internet2 can (i) partition sections of the Internet2 Network's enormous capacity into separate networks, one of which could be the public safety network, affording public safety, as further described in the next section below, a considerable amount of control and security over its portion of the network, and (ii) create a secure and private network for public safety to minimize greatly the risk that unauthorized persons could gain access to sensitive data or disrupt routine data travelling over the network.[9] Finally, Internet2 operates uncongested networks to allow for "bursty" applications, such as weather system modeling and visualization, video conferencing, and transfer of extremely large files like Geospatial Information System databases that may be of significant interest to public safety entities.

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computing environment offers the largest opportunity for network innovation since the invention of the packet based Internet. This allows carriers to "gain unprecedented programmability, automation, and network control, enabling them to build highly scalable, flexible networks that readily adapt to changing business needs." OPEN NETWORKING FOUND., SOFTWARE-DEFINED NETWORKING: THE NEW NORM FOR NETWORKS 2 (2012), *available at* https://www.opennetworking.org/images/stories/downloads/white-papers/wp-sdn-newnorm.pdf.

[9] Under the rules adopted for the BTOP program, public safety is not restricted from deploying secure private networks.

4. Public Safety Can Customize its Portion of the Internet2 Network

Internet2's services are highly customizable to suit the particular needs of the user, and Internet2 has extensive expertise working with key industry, government, research, and educational institutions to develop custom network solutions that integrate the right blend of Internet2's services. CAIs that work with Internet2 regularly assist in determining the appropriate network design, operation, and features. Simply put, Internet2 tailors the network to meet the needs of its partners, and can do so here for the public safety community. In fact, Internet2 was created, in part, to accommodate universities that required far more control over their networks to share data, research, and ideas, and Internet2 developed these highly-advanced networks to suit those needs.

5. The Internet2 Network is Highly Reliable

Internet2 and its members have substantial expertise operating high-performance, state-of-the-art networks. As described above, Internet2 operates the leading NREN in the United States. Internet2 has developed safeguards to ensure that its network is one of the most reliable in the country. These safeguards include, for example, maintaining substantial headroom on alternative paths out of each city, so that a failure on one path can be fully accommodated on another path without any service degradation, even in peak times. Internet2 also encourages end-to-end architecture development among the national backbone and regional partners to assure resiliency between partner networks, which also assures resiliency and capacity to maintain peak services even in failure modes. In addition, Internet2 constantly monitors its network for performance, measuring for loss, latency, and jitter. Of course, congestion, packet loss, and jitter can cause just the type of unacceptable performance that public safety must avoid in order to be properly responsive to the public's needs.

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Moreover, Internet2 has collaborated with its member organizations to develop a suite of tools to help network managers "troubleshoot" connections to ensure that advanced applications can work properly end-to-end. Internet2 oversees several layers of resilient 24x7 network operations centers, providing real-time validation and characterization of the underlying transport system, which assures uptime and allows for accurate and efficient troubleshooting. With these tools, network problems are generally prevented and no longer unsolvable when they do occur. Problem resolution is a more easily manageable issue when interested parties can pinpoint connectivity issues immediately and, as described in more detail in the next section, such is the case with the Internet2 Network. Together, these features create an extremely reliable network. The IP network's node availability, for example, consistently surpasses 99.999%.

6. The Internet2 Network Could be Transparent to Authorized Public Safety Users

The Internet2 Network can provide the necessary, and protective, transparency that public safety needs. Public safety entities must know what is occurring on their network at all times, including where along the network problems are occurring in those rare instances when there are issues that need to be addressed. Internet2 would support transparent operations—coordinating maintenance, allowing shared views of network status, and generally working as an embedded partner with FirstNet's own operating entities—to deliver a portion of the PSBN. Internet2 will allow its public safety users, and only its authorized public safety users, to see these features.

Internet2's performance tools, which allow managers to "troubleshoot" network connections as described above, render the federation of national, regional, and state networks operationally transparent to their users. Additionally, Internet2 has measurement and other tools that allow all operational aspects of the network to be published to the public safety community

in near-real time. These tools, along with a shared development of architecture and engineering plans, open budgeting process, public operational ticketing and performance tools, and regular communications among organizations, form the foundation of operational transparency in a multi-provider environment. Simply put, end users have access to their portion of the network at any time to see how it is functioning, which is a valuable network feature for the PSBN.

C.   **Internet2 and the Broader Internet2 Community Currently Support Public Safety**

1.   **Internet2 Currently Supports Public Safety and Connects the CAIs that Public Safety Entities Use to Further Their Missions**

Use of the Internet2 Network would provide tremendous synergies that would benefit the public safety community. First, Internet2 already directly or indirectly supports thousands of public safety entities and sites of public interest throughout the country. For example, public safety entities on dozens of campuses use their networks, which are interconnected with Internet2, to operate university alert systems, interconnect state and local governments with University-based venues, interconnect PSAPs, and facilitate other communication systems. Many of the CAIs that the Internet2 Network supports are high-profile venues that are part of public safety's critical public support mission. These entities include hospitals and other healthcare facilities that render care, large sports stadiums and schools where public safety entities establish emergency shelters, and municipal buildings where officials gather. Public safety entities patrol and protect CAIs every day. Because the Internet2 Network is already designed precisely to support the missions of these CAIs, the public safety community already relies, both directly and indirectly, on the Internet2 Network. Partitioning additional secure network capabilities using the Internet2 Network as one leg of FirstNet's resiliency strategy for these facilities should be relatively straightforward, and potentially free up additional investment capital for other FirstNet initiatives.

2. Internet2's Member Organizations are at the Forefront of Research and Development for Public Safety

Internet2's member institutions include 221 U.S. universities, many of which were instrumental in developing the new networking technologies that have fundamentally changed our society over the past several decades and led to the global transformation on which on current information-based economy is built. For instance, Google, Facebook, Twitter, and Cisco all were created on college campuses. Universities are now leveraging their resources to place themselves at the forefront of innovating access to high-quality advanced broadband technologies that will transform public safety. For example, Internet2's member organizations currently are working with public safety institutions around the United States with respect to the following innovation projects:

- The Texas A&M University Internet2 Technology Evaluation Center ("ITEC") is working to support Harris County, Texas, in the deployment of an experimental 700 MHz public safety broadband network.

- Columbia University's Department of Computer Science is working with the U.S. Department of Transportation's National Highway and Traffic Safety Administration in its Next Generation 911 Program Office. Columbia was a key member of the project team that developed the initial Next Generation 911 concept.

- Georgia Tech's Research Institute manages and operates the National Information Exchange Federation Center ("NIEF"). NIEF is a collection of agencies in the federal government that have come together to share sensitive law enforcement information.

- The University of Colorado is working with NIST to resolve in-building coverage issues that arise in energy efficient buildings.

- Rutgers University's Wireless Information Network Laboratory ("WINLAB") is working on LTE and WiMax integration with next generation software defined networks.

- The Connecticut Education Network, led by the University of Connecticut, is now being expanded by the Connecticut Department of Information Technology to connect every PSAP in the state with a private, secure network using BTOP public safety funds.

In addition, the National Institutes of Health, which is an Internet2 member, has partnered with neighboring military and private hospitals in the Bethesda, Maryland, area through the R&D division of the U.S. National Library of Medicine to conduct research on technologies for emergency and disaster events. An example is the development and deployment of People Locator, a website/database to which the public can post the photos and brief metadata (name, age, last seen location) of missing friends and family, and of those who have been found. People Locator can be accessed through the Web and by ReUnite, an iPhone app, and has been deployed during disasters in Haiti, Japan, the Philippines, Joplin, Missouri, and other places.

As the foregoing demonstrates, the broader Internet2 community is also already working with the public safety community to improve its access to advanced broadband technologies and transform the public safety community.

D. Internet2 Can Assist Public Safety by Coordinating Efforts with Other Providers

Internet2 has a solid history of working with public and private networking partners across the nation to deliver high-quality advanced networking to tens of thousands of CAIs. Most recently, Internet2 has worked with these partners to expand the reach of the Internet2 Network with funding from the BTOP award. These relationships place Internet2 in an excellent position to work in conjunction with such other entities to support the needs of the public safety community.

Moreover, Internet2 does more than just operate a network. It helps lead an extraordinary community that shares, collaborates, provides self-help and education, and explores new opportunities in advanced networking. Internet2, as a member-owned organization, is an extension of the broader R&E community that it serves. As discussed earlier, the Internet would likely not exist in its current form had it not been for the seminal role the R&E community played in its development. Indeed, the emergence of R&E networks as the driver of the most innovative and exciting network developments and services compelled the commercial world to take note and eventually adopt these standards and extend these networks globally.

E.   The Internet2 Network Can Serve as a Test Bed for New Public Safety Applications and Technologies

Development and support of a test bed for continuous innovation, including the next generation of the Internet and future broadband evolution, is a critical long-term strategy to satisfy the goal of meeting and advancing the broadband needs of public safety entities. The R&E community has had tremendous success operating networks that provide myriad benefits today and provide the necessary testing grounds for the applications of tomorrow. In general, R&E networks have formed close partnerships with many other entities with respect to research and development, including facilities owners and equipment manufacturers, to ensure that the services blend the most advanced technologies into the test bed and are open to continuous renewal in advance of traditional cycles. Such new opportunities may be extremely beneficial to public safety entities in both the short and long run.[10]

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[10] In addition, Internet2's federal government contracting experience shows that it can help FirstNet deploy the PSBN. Internet2 has a strong history of supporting high-performance networking for the government, including for the Department of Education, the National Oceanic and Atmospheric Administration, and the National Institutes of Health. It is also currently assisting ESnet, which is funded by the Department of Energy Office of Science, and managed and operated by the Lawrence Berkeley National Laboratory, and which provides scientists with access to DOE research facilities and computing resources.

II. Applications

A. Internet2 is a Leader in Developing Certain Applications that Could Benefit Public Safety

Internet2 has developed breakthrough technologies that support the most exacting applications of today and will spark the most essential innovations needed for the future. Public safety institutions need more than just connectivity; there has to be significant work done at the applications level to make the deployment of advanced broadband meaningful. For example, Internet2 is at the forefront of developing applications that provide secure user authentication and identity management.

Internet2 and the broader R&E community have developed identity management software and inter-institution trust systems, referred to as "middleware," which allow users to use single and multifactor authentication techniques to access protected resources and to collaborate among institutions. Middleware permits greater collaboration and resource/idea sharing among users while providing protection against any unauthorized use, and has become a model for efforts being deployed by the federal government as well as other countries.

Internet2 operates the middleware technology through the InCommon Federation, a collection of organizations that have agreed to interoperate using a common set of privacy rules. Since 2004, the InCommon Federation has provided a secure and privacy-preserving trust fabric for research and higher education institutions in the United States. InCommon currently serves nearly 6 million users who use local-managed institutional credentials to access hundreds of external online services, while protecting sensitive personal information, without having to create an account with each one of those services, and it is extremely flexible in how it operates.

B.   Public Safety Organizations Could Successfully Use Internet2 Applications

Internet2 could develop and deploy services within the InCommon Federation to support public safety communities. Internet2's applications are particularly well-suited for public safety organizations because they focus on security, while allowing entities to share electronic data. Two such applications are:
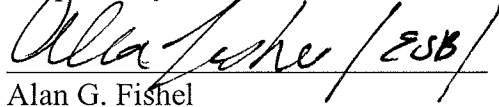
- Shibboleth Single Sign-On and Federating Software: This open-source project provides single sign-on capabilities and allows sites to make informed authorization decisions for individual access of protected online resources. In the public safety context, the federating software has the effect of enabling local control and management of public safety personnel while also assuring a trust fabric and mutual assurance that other collaborators are who they say they are when data is shared across local entities.

- Grouper: The open-source Internet2 Grouper toolkit allows project managers, departments, and institutions to create groups, roles, and permissions. The steward of the online content can manage which users can access and control the information. In a public safety context, such a tool would be immensely helpful in allowing cross-organization collaborations for both routine and exigent situations.

In addition, InCommon provides multiple assurance levels to accommodate services and applications that require increased privacy and security. InCommon is an approved Federal Identity Credential and Access Management framework provider. Using Internet2's assurance and privacy innovations, first responders and public safety personnel could exchange information across the nation privately, securely, and with confidence.

CONCLUSION

For all of the reasons set forth herein, Internet2 strongly encourages FirstNet to deploy the PSBN in a manner consistent with these recommendations.

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