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EAGLE-Net in Context: an analysis of the processes and benefits of middle-mile broadband projects

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1 Executive Summary

This report analyzes some of the benefits of the EAGLE-Net network and reviews its processes and actions in light of the opposition recently raised about EAGLE-Net by some Colorado companies concerned about the impact EAGLE-Net might have on their current business models. The observations in this report are based on Columbia Telecommunications Corporation (CTC) staff-members' decades of experience planning, analyzing, and overseeing communications infrastructure projects across the United States.[1]

1.1 Background

EAGLE-Net is a public middle-mile[2] fiber optic network currently under construction throughout Colorado. It was funded partially through a federal BTOP grant[3] and partially through local "match" obligations. In keeping with the funding parameters of the federal BTOP program, EAGLE-Net's fiber is designed to bridge gaps and deliver high-bandwidth connectivity all the way from the Internet backbone to rural communities and community anchor institutions,[4] enabling middle-mile access (backhaul) for local providers throughout the state and bringing

[1] CTC is a 30-year old communications technology consultancy with experience across a full range of technologies. It has planned, designed, or evaluated hundreds of fiber optic and wireless networks since 1983. In recent years, CTC has provided planning and engineering services for the statewide fiber network in Maryland and for the three-state regional fiber network in the National Capital Region; has provided strategic and business planning services for the statewide fiber network in Pennsylvania; and developed the reference architecture for the national fiber-to-the-home network currently being built in New Zealand. CTC consults to the cities of San Francisco, Seattle, and Washington DC regarding their fiber plans, as well as to the states of Kansas, Maryland, Delaware, and New Mexico.

[2] The term "middle-mile" refers to facilities used for backhaul between the Internet service provider and the Internet backbone. The "last-mile" refers to the portion of the network that connects the middle-mile directly to the home, business, or mobile device of the user. In one commonly-used analogy, communications networks are compared to traditional infrastructure: the "Internet backbone" is comparable to the Interstate Highway System; the "middle-mile" is like the network of smaller highways that reach rural communities and roads that reach neighborhoods and key facilities; the "last-mile" is the neighborhood street and driveway that leads directly to the user.

[3] The term "BTOP" refers to the Broadband Technology Opportunities Program. BTOP is one of the two broadband funding programs created by the passage of the American Recovery and Reinvestment Act of 2009 (ARRA). It is administered by the National Telecommunications and Information Administration (NTIA) of the U.S. Department of Commerce.

[4] The term community anchor institution refers to "schools, libraries, medical and healthcare providers, public-safety entities, community colleges and other institutions of higher education, and other community support organizations and agencies that provide outreach, access, equipment and support services to facilitate greater use of broadband service by vulnerable populations, including low-income, unemployed, and the aged." Dep't of Agriculture, Rural Utilities Service, 74 Fed. Reg. 33104, 33107, July 9, 2009, "Broadband Initiatives Program; Broadband Technology Opportunities Program; Notice" (http://www.ntia.doc.gov/files/ntia/publications/fr_bbnofa_090709.pdf) (accessed Nov. 2, 2012).

some measure of parity to rural areas and rural anchor institutions relative to those in metropolitan areas.

The requirements of EAGLE-Net's BTOP grant were determined by NTIA and are consistent with the great majority of the other BTOP programs NTIA funded around the country: competitive grants were awarded for middle-mile communications facilities to connect regions and neighborhoods to each other and to the Internet backbone—at the same time as connecting community anchor institutions over the new, enhanced communications facilities.[5] Grant awardees were required to commit to interconnection and non-discrimination obligations that would enable many, competing providers to use the new federally-funded infrastructure—and to ensure that monopolies would not be created or perpetuated in the middle-mile.[6]

EAGLE-Net is an intergovernmental entity that developed from the efforts of the Centennial Board of Cooperative Educational Services (CBOCES) to expand broadband in Colorado.[7] The CBOCES had served as an aggregator and broadband service provider for Colorado school districts and, in that capacity, identified that Colorado school children, on average, had less access to bandwidth than their counterparts in other states and that Colorado ranked 42nd among U.S. states in broadband.[8] BOCES staff developed EAGLE-Net to meet that need and expanded to include other anchor institutions and broadband users (such as public safety) in keeping with the requirements of BTOP's enabling legislation and related grant requirements.

NTIA funded EAGLE-Net in August 2010.[9] In recent months, significant opposition to EAGLE-Net has been raised by a range of commercial providers in Colorado.[10] Among other things, the providers accuse EAGLE-Net of "overbuilding" their existing fiber optic facilities such that they face competition in areas where they previously did not, thus putting at risk their existing business models and putting them at risk for default on their federally-guaranteed loans.[11] They also claim that Coloradans will lose jobs as a result of the competition from EAGLE-Net because they will be forced to lay off staff.[12]

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[5] *Notice of Funds Availability.* Federal Register/Vol. 74, No. 130, p. 33108. July 9, 2009, http://www.ntia.doc.gov/files/ntia/publications/fr_bbnofa_090709.pdf (accessed Nov. 2, 2012).
[6] *Id*.
[7] See http://www.co-eaglenet.net/about-us/history/.
[8] *Id*.
[9] A wide range of EAGLE-Net-related documents are available on the NTIA website, including the application, award and special conditions documents, and quarterly reports. http://www2.ntia.doc.gov/grantee/centennial-board-of-cooperative-educational-services-cboces-transferred-to-eagle-net-allianc.
[10] "Stimulus-funded project irks some rural telecoms in Colorado," Greg Avery, Denver Business Journal, http://www.bizjournals.com/denver/print-edition/2012/09/07/stimulus-funded-project-irks-some.html?page=all, (accessed Nov. 12, 2012).
[11] Many Colorado phone companies have federal loans from the U.S. Department of Agriculture Rural Utilities Service (RUS). In addition, many receive ongoing support from the U.S. Universal Service Fund, which subsidizes the construction and operations of communications infrastructure and services in remote areas.
[12] According to the Denver Business Journal, "[m]any schools and local institutions are expected to be eager about EAGLE-Net's arrival, and its promise of more affordable broadband. But some rural telecoms that built their own

1.2 Data and methodology

EAGLE-Net retained CTC in fall 2012 to provide an evaluation of the overbuild claims and to evaluate the benefits to Colorado of the project. During the last few months of 2012, CTC conducted independent research and analysis of EAGLE-Net as well as of other, comparable BTOP projects in other states. CTC also drew on its own experience with planning, designing, or evaluating large public communications networks, including comparable BTOP projects in Pennsylvania, Maryland, New Mexico, North Carolina, and Illinois.

Ideally, CTC would have conducted comprehensive comparison of maps, design specifications, sales policies, and service prices as a means of determining whether EAGLE-Net's new facilities truly duplicate existing facilities, as is claimed by EAGLE-Net's opponents, and whether the existing facilities can support the open, high-bandwidth middle-mile access EAGLE-Net offers. Ideally, for an effort of this sort, we endeavor to conduct a methodical analysis that compares (1) fiber and wireless routes, (2) network technologies, (3) end points to be served, (4) products and services offered, (5) pricing structures, and (6) service and use policies including potential anti-competition provisions or limitations on how a customer can use the services purchased.

What we found is that this analysis is not possible because EAGLE-Net's opponents have not made public the level of data that would allow evaluation of their claims. The publicly-available data do not enable verification of the opponents' overbuild claims or of their claims that EAGLE-Net's existence would lead to loan defaults and employee layoffs. Absent these specific data and confirming analysis, the opposition to EAGLE-Net is based on hypotheticals and allegations, not evidence.

Given the lack of adequate data, CTC engaged in an effort to evaluate, based on our experience, whether EAGLE-Net's actions were consistent with its counterparts in other states we have observed; how EAGLE-Net's new capabilities complement to those generally offered by commercial carriers in rural parts of Colorado; and how the new communications capabilities could benefit Colorado in a range of areas from job-creation and economic activity to enhanced education and library capabilities.

1.3 Findings

Based on the limited data available and our own experience, CTC came to the following conclusions:

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fiber-optic networks using other federal subsidies complain that EAGLE-Net's summer construction duplicated existing broadband infrastructure and will undermine their businesses." Id.

EAGLE-Net tried to work with the rural carriers and followed best practices to maximize win-win outcomes with existing providers. EAGLE-Net has followed appropriate best practices: (1) it has sought to be open and transparent in communications with rural carriers through direct communications and also through open, competitive procurement processes by which it has sought partnerships and business relationships with rural carriers; (2) it has purchased access to existing fiber where possible, including from rural carriers, rather than building where fiber might already exist; and (3) it has sought to partner with rural carriers for last-mile connections where possible and to reach "win-win" outcomes that would benefit both parties.

It is our understanding that many of the entities now opposing EAGLE-Net did not themselves respond to EAGLE-Net's RFIs and RFPs that sought to lease fiber from rural carriers and partner with them. We also understand that some that did respond required EAGLE-Net to agree to anti-competitive terms that violated EAGLE-Net's grant obligations and would have required EAGLE-Net to limit its use of the leased fiber, not serve certain users, and not serve competing companies or entrepreneurs.

EAGLE-Net's approach has been successful and non-controversial in other states. In our experience, the extraordinary opposition that has been leveled against EAGLE-Net is singular among BTOP projects. In other states where BTOP awardees are working on substantially identical projects, existing carriers have not opposed the new fiber in this way. Rather, so long as the BTOP awardee has followed the best practices described above, which are consistent with and extend beyond the requirements of the grant funding to ensure non-discriminatory competitive access to the network infrastructure, the existing carriers have generally worked toward win-win scenarios rather than going to war against the new network.

And in none of these states, to our knowledge, have rural carriers alleged or demonstrated that the new BTOP fiber will cause them to lay off workers or default on federal loans. EAGLE-Net's opponents appear to be unique in alleging these hypotheticals.

EAGLE-Net's fiber provides unique and necessary capabilities that are not provided by existing fiber. Indeed, existing fiber is not comparable to that of EAGLE-Net unless it meets many conditions simultaneously. In our experience planning and engineering broadband networks, we have found that even where fiber currently exists, it: (1) may not be available to local and competing providers and entrepreneurs, whether at competitive prices or at any price; (2) may not provide contiguous connectivity from major Internet points of presence (POPs) to key community facilities or into key rural areas where local entrepreneurs can make use of it; (3) may not provide interconnection opportunities that local entrepreneurs can utilize—even if the fiber does run through the local rural area; (4) may not deliver state-of-the-art services to community anchors; and (5) may be capable of delivering such services—but not offered by its owners at a price that community anchors can afford.

If any of the above circumstances exist, EAGLE-Net is not duplicating existing fiber infrastructure because that infrastructure does not provide EAGLE-Net's direct, end-to-end

fiber routing and price accessibility. Moreover, EAGLE-Net provides a level of unprecedented accessibility as mandated by the special conditions connected to the Federal grant funding supporting the EAGLE-Net build-out. This funding requires that EAGLE-Net's infrastructure is available on a non-discriminatory and competitive basis. Existing fiber is unlikely to provide the full suite of benefits EAGLE-Net was designed to deliver: high bandwidth services all the way to key community facilities; additional fiber available to local entrepreneurs to reduce barriers to entry; and state-of-the art communications facilities that will drive economic development and competitive markets.

EAGLE-Net delivers unique benefits that differ from the existing networks. EAGLE-Net will offer the benefits of a dedicated statewide intranet that will connect schools to each other, enabling high-bandwidth educational applications (such as distance learning and collaborative teaching) at low cost, high quality, and without the bottlenecks of the public Internet. EAGLE-Net also offers unique access to national and international educational resources and high-bandwidth connections to other schools all over the country that connect to those peered networks. EAGLE-Net's statewide intranet feature will also create great value for public-safety users throughout Colorado: dedicated, secure bandwidth will enable high-bandwidth communications among public-safety agencies statewide, offering both interoperability and sharing of high-bandwidth resources and services (such as computer-aided dispatch). Part of what will enable many of these benefits is the fact that EAGLE-Net consists of its own fiber, leased fiber, and state-of-the-art wireless infrastructure—rather than relying on lesser circuits.

EAGLE-Net delivers substantial economic and job-creation benefits. EAGLE-Net represents a significant boon to rural Colorado. EAGLE-Net's expenditures stimulate significant additional economic activity. The Congressional Budget Office utilizes a multiplier that, if applied to the total EAGLE-Net budget of $135.3 million,[13] demonstrates that EAGLE-Net supports an additional $135.3 to $338.25 million of economic activity in addition to its budget. The Bureau of Economic Analysis formula suggests a multiplier that indicates every $1 of EAGLE-Net investment will generate $2.01 of economic activity. Applying the BEA multiplier to the EAGLE-Net budget ($135.3 million) suggests that EAGLE-Net supports an additional $272-million of economic activity in Colorado.

EAGLE-Net creates jobs, both directly and indirectly. The direct job creation impact alone is extensive[14] and many of the jobs EAGLE-Net is currently creating are permanent. Workers have

[13] EAGLE-Net's budget includes both the BTOP grant and a locally provided "match," as required by the Recovery Act.

[14] Independent researchers have estimated that BTOP and other public broadband investments "could create hundreds of thousands of jobs over a four-year period by stimulating new businesses, market transactions, and innovative industries in previously underserved areas." Executive Office of the President National Economic Council, Recovery Act Investments in Broadband: Leveraging Federal Dollars to Create Jobs and Connect America, Dec. 17, 2009, at 11 (citing "Estimating the Economic Impact of the Broadband Stimulus Plan." Raul Katz, Columbia Business School, and Stephan Suter, Polynomics AG. February 2009). (http:/www.whitehouse.gov/sites/default/files/20091217-recovery-act-investments-broadband.pdf) (accessed

already been engaged in engineering, planning, and environmental compliance. During the intensive construction phase that began in 2011 and will continue over the next nine months, workers will dig trenches, place fiber in the ground and on utility poles, splice fiber cables, and build towers for wireless connections. Additional information technology workers will place and configure communications equipment, manage installation, repair towers and lines, and interact with customers. At the same time, EAGLE-Net is also indirectly creating jobs in a range of sectors by increasing the demand for equipment and materials, including construction machinery, physical components of wireless towers, optical fiber, and network electronics. This category also includes such ongoing services as manufacturer equipment maintenance.

On the basis of our experience with fiber networks, we conservatively estimate that at least 180 jobs will be created during EAGLE-Net's construction and that at least 50 permanent jobs will be created to maintain and operate the network (not including sales, marketing, and other ongoing jobs related to customer support, which could support another dozen permanent jobs).

EAGLE-Net delivers substantial economic benefit through middle-mile availability and stimulation of investment in the last-mile. EAGLE-Net enables private carriers and entrepreneurs to cost-effectively bridge the middle-mile (without having to build their own middle-mile facilities) and concentrate their investment in last-mile deployment—thus increasing last-mile investment in high-speed Internet service to homes and businesses. The National Broadband Plan recognizes that middle-mile costs directly impact the cost of providing last-mile broadband in unserved areas.[15] One of the most critical metrics for broadband availability and adoption is the wholesale cost of commodity Internet service in a community. Such costs determine whether or not it is feasible for a service provider to enter or sustain its business. The cost of middle-mile service from the Internet backbone to a rural area can be hundreds of dollars per megabit per second (hundreds of times the cost in metropolitan areas for the same megabit), making it infeasible for a rural carrier or entrepreneur to sell cost-effective services. With EAGLE-Net, Colorado carriers will be able to obtain services for a small fraction of that cost, making high-speed services feasible and cost effective in any community linked by EAGLE-Net. EAGLE-Net thus reduces a sizeable expense for last-mile developers by opening up competitive middle-mile access and removing a key barrier to building and operating broadband networks.

EAGLE-Net delivers substantial benefits in education and library services. EAGLE-Net will provide high-speed Internet access directly to 223 community anchor institutions, including 168 out of 178 K-12 school districts (that serve over 1,700 schools and 830,000 students), 11 Boards of Cooperative Educational Services, 15 community colleges, and three higher education

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Sept. 30, 2012). The federal government has also estimated that, nationwide, public broadband projects "will create tens of thousands of jobs in construction and other sectors." *Id.* at 11.

[15] Federal Communications Commission, "National Broadband Plan: Connecting America," Chapter 8 (http://www.broadband.gov/plan/8-availability/#r8-8) (accessed Oct. 1, 2012).

institutions.[16] EAGLE-Net will also connect 26 public libraries and offer library users in these communities significant benefits related to libraries' vital role in providing information access, supporting job searches, and fostering citizen participation. For many of these anchor institutions, *the new services offered by EAGLE-Net will provide up to a gigabit per second capacity—600 times the bandwidth* of many of their pre-EAGLE-Net T-1 connections—at comparable or lower price. These new connections will bring to many Colorado anchor institutions the kind of capacity that the FCC has recognized is essential for *all* anchor institutions.[17]

[16] For a full list of community anchor institutions covered by EAGLE-Net, see: http://www.co-eaglenet.net/btop/for-colorado-citizens/colorado-community-anchors-list/

[17] The FCC's National Broadband Plan establishes as one of the nation's key goals that "[e]very community should have affordable access to at least 1 gigabit per second broadband service to anchor institutions such as schools, hospitals, and government buildings." National BroadbandPlan: Connecting America, Goal 4, http://www.broadband.gov/plan/goals-action-items.html (accessed Nov. 12, 2012).

2 EAGLE-Net's fiber offers unique and necessary benefits that cannot be matched by existing fiber

EAGLE-Net has been accused of "overbuilding" existing infrastructure. Our concern with this argument is that it suggests that the existing fiber is ubiquitous in the area where EAGLE-Net plans to build and that EAGLE-Net's planned fiber will duplicate existing fiber; at first look, such duplication of ubiquitous fiber seems unnecessary and unfair. *But this is too simplistic an understanding of rural fiber*.

In our observation of many rural areas (and, indeed, suburban and urban areas), even where fiber exists, it: (1) may not be available to competing carriers, whether at competitive prices or at any price; (2) may not connect all the way to from the Internet backbone to all key community facilities; (3) may not deliver state-of-the-art services to community anchors; and (4) may be capable of delivering such services—but not at a price that community anchors can afford. We note that existing fiber likely does exist in some of the areas EAGLE-Net seeks to serve (and that EAGLE-Net has, in multiple ways, sought information regarding where it exists, to little avail). *But* where the existing providers have this patchwork of fiber and services, rather than ubiquity, EAGLE-Net is not an "overbuild."[18] Rather, EAGLE-Net provides an additional infusion of infrastructure that will complement and enhance the existing patchwork.

In addition, we note that in most states, much of the rural fiber that exists is "last-mile" – local fiber that directly connects end users such as residences and businesses – rather than middle-mile. In this way, EAGLE-Net's fiber further complements the existing rural fiber by creating new connections to the Internet backbone and to other regions of the state.

The following are the ways in which existing fiber, assuming it exists, does not necessarily provide the optimal functionality for the community and the competitive market that EAGLE-Net was designed to enable.

2.1 Existing fiber is not comparable to EAGLE-Net's, unless it is comprehensive and ubiquitous

For EAGLE-Net's fiber to be a true overbuild, the existing fiber must be contiguous and it must completely cover the proposed service route—partial routes are not equivalent. In many parts

[18] The term "overbuild" has traditionally been used to refer to the construction of a competing communications network that duplicates the existing infrastructure and services of an incumbent network. For example, the competitive cable companies (such as RCN and Wide Open West) that emerged after the passage of the 1996 Communications Act to compete with existing cable providers were "overbuilders" because they built networks that served the same customers as the incumbents (residences), with the same services (cable television, as well as phone and data), in the same general footprint (a local franchising area) as the existing providers.

of Colorado, where population centers may be 10, 20, or more miles apart, having existing fiber near a town does not necessarily mean that the town can be served by that infrastructure without significant and costly additional construction. EAGLE-Net is designed to deliver fiber into the heart of rural communities—to the key community anchor institutions such as schools and libraries that are found at the center of rural communities and neighborhoods.

Some of EAGLE-Net's opponents have claimed that they have fiber on EAGLE-Net's proposed service routes, but the carriers that oppose EAGLE-Net have not provided data regarding those routes and the identities of the anchors they may serve over such fiber. Absent those data, we cannot regard EAGLE-Net as duplicating comprehensive and ubiquitous fiber.

2.2 Existing fiber is not comparable to EAGLE-Net's, unless it is connected with no fiber gaps to the Internet backbone

To be truly duplicative of EAGLE-Net, the existing fiber must connect (either itself or over other available fiber) all the way back to the Internet backbone, such that an ISP user of the fiber has a direct route to secure cost-effective transport to the Internet and commodity Internet bandwidth. Absent this full routing to a major Internet point of presence (POP), the existing fiber is a rural island—and its users will face bottlenecks when attempting to connect from the fiber islands to the Internet backbone. EAGLE-Net is designed to connect all the way through—linking islands back to the Internet POPs in major metropolitan areas that enable them to purchase cost-effective Internet bandwidth.

If EAGLE-Net's opponents have fiber all the way to the Internet backbone, that information has not, to our knowledge, been made public. And without knowing whether that fiber connects without gaps to the Internet backbone, we cannot regard EAGLE-Net's infrastructure as duplicative.

2.3 Existing fiber is not comparable to EAGLE-Net's, unless it is accessible via interconnection points at appropriate locations

It is insufficient for the fiber to simply pass through an area. For EAGLE-Net to be a true overbuild, the existing fiber must have interconnection points that are available to competitive providers to enable them to build broader networks that connect to other fiber resources for the rest of the state. In our experience, fiber frequently passes through rural areas, but is unavailable to ISPs or other users because the fiber owner cannot or will not create interconnection points such that the fiber can be accessed in that rural area.[19] In contrast,

[19] In California, for example, local communities have long registered concern that existing fiber owned by an incumbent carrier traverses rural Trinity and Humboldt Counties but has not been made available—at any price or under any terms—to local carriers or entrepreneurs; nor has the owner of that fiber used it to provide services in

EAGLE-Net includes frequent, affordable interconnection points in rural areas, allowing access to ISPs and rural carriers. EAGLE-Net is intended to provide interconnection at any location where it has a splice point or can accommodate a mid-span splice. In our experience, this is a very flexible policy and will enable a wide range of options for local entrepreneurs to cost-effectively make use of the new fiber.

2.4 Existing fiber is not comparable to EAGLE-Net's, unless it is openly available to any qualified user

Existing fiber is not truly available unless its owner is willing to lease access to qualified users, including competitors, on a non-discriminatory basis. As long as fiber is available, there are many technical possibilities for enabling access, through leasing of individual strands of optical fiber, or through the use of technologies (such as wave-division multiplexing) that allow fiber owners to increase the number of users of a strand. As a consequence, there is rarely, if ever, a purely technical limitation to providing capacity over fiber. Rather, such limitations only exist because of a business decision. Existing fiber is not truly "available"—and therefore not truly duplicated by EAGLE-Net's fiber—unless the owner chooses to make it so. EAGLE-Net's BTOP grant and its business model require EAGLE-Net to sell access to its fiber to any qualified entity on a non-discriminatory basis. Indeed, EAGLE-Net's own experience in being denied access to some providers' existing fiber demonstrates that not all of the existing fiber assets in rural Colorado are "available."

2.5 Existing fiber is not comparable to EAGLE-Net's, unless offered at a viable price

In addition to being openly available, the fiber must be offered at a price that is viable for potential ISP and carrier users. Price is an effective barrier to entry if it is too high for local ISPs and entrepreneurs. The entire community suffers from a lack of competition and market domination that results from a monopoly fiber owner who can set the price as high or low as it chooses. Even where there is currently fiber, it is therefore not "available" when price remains a barrier to access.

2.6 Existing fiber is not comparable to EAGLE-Net's, unless it is available for a reasonable period of time through an IRU

Existing fiber is not truly "available" unless its owner is willing to enter into binding agreements for long-term use of the fiber. Such agreements are known as Irrevocable Rights of Use (IRUs) and can range in duration from a few years to more than 20 years. The IRU mechanism provides a negotiated, guaranteed right of use that enables local ISPs and entrepreneurs to develop their

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those counties. *See* Laura Sydell, Mar. 15, 2010, "County Stuck In Information Superhighway Slowlane." (http://www.npr.org/templates/story/story.php?storyId=124703744) (accessed Nov. 6, 2012).

business over time with an assurance that they will at least have an opportunity to recover investments made toward building their own service offerings over a reasonable timeframe. EAGLE-Net offers fiber IRU agreements for any of its fiber routes, providing a stable, sustainable source of middle-mile connection to any service provider.

2.7 Existing fiber is not comparable to EAGLE-Net's, unless it is connected directly to end users

To be truly duplicative of EAGLE-Net, the existing fiber must connect directly to the end users to whom EAGLE-Net plans to build. In our experience throughout the country—including in Colorado—in many rural areas existing fiber frequently does not directly connect the key anchor institutions at their most important facilities. Rather, the fiber will often go only as far as a central office (CO) or Internet point of presence (POP), with the final connection to the user provided over aging copper. For this reason, one cannot claim that EAGLE-Net is "overbuilding" if it is building fiber directly to an anchor that is not currently served directly over fiber. It is not sufficient for the existing carrier or service provider to be in the general area of fiber, as the additional charge for a direct fiber connection may be prohibitive. We understand that some of EAGLE-Net's opponents may have fiber to some of the key anchors in EAGLE-Net's planned service area but, to our knowledge, the list of anchors currently served over fiber has not been made public.

2.8 Existing fiber is not comparable to EAGLE-Net's, unless comparable services are cost-effectively provided over that fiber

We also note that existing infrastructure does not necessarily mean that services are available. This is particularly true in rural areas. Even when a single provider in the vicinitymay be able to cost-effectively expand its fiber, the service provider may not necessarily provide affordable service. In our experience, the cost of intranet and Internet services in rural areas are often exponentially higher than in competitive metro-area markets.

The BTOP grants are designed to bring competition to new markets by enabling many carriers and entrepreneurs to access the new fiber assets, which will be made available on a non-discriminatory basis.

2.9 Claims regarding existing fiber cannot be verified absent data

Finally, we note that one cannot call EAGLE-Net's construction plan an "overbuild" without a credible, detailed analysis of the actual routes and services of the service providers who claim they are being overbuilt. These service providers have not made public the specific routes, on a mile-by-mile basis, where they claim they are being overbuilt, nor have they made public

specific data regarding what services are being duplicated. To our knowledge, such information has not been made public—making it very difficult to verify, or refute, the allegations that EAGLE-Net has overbuilt existing fiber. If such data are made available, we recommend a comprehensive and thoughtful comparison of maps, design specifications, service descriptions, sales policies, and prices to determine whether EAGLE-Net's fiber truly duplicates existing fiber. Absent such data, the claims of EAGLE-Net's opponents are not verifiable.

3 EAGLE-Net has followed industry norms and best practices for working with rural carriers to maximize the benefits of the new fiber to all parties

We have observed a set of best practices for how new middle-mile fiber providers can work with rural carriers to maximize mutual benefit and minimize conflict. We have observed these practices as public and non-profit BTOP grantees have developed mechanisms for working with rural carriers in their states. Such practices are essential given the (understandable) discomfort of many rural carriers about the prospect of competition, particularly from fiber-based services that are far often superior to much of the existing communications infrastructure in rural areas.

These best practices include: (1) openness and transparency in communications with rural carriers; (2) efforts to purchase access to rural carrier fiber infrastructure where it exists and is made available; and (3) efforts to partner with rural carriers for last-mile connections to schools and other anchor institutions where existing carriers are willing to do so.

Based on our observations and research, EAGLE-Net has followed these best practices and sought to build win-win partnerships with rural carriers. In our observation, EAGLE-Net is working with those rural carriers who are willing; the network cannot be faulted for failing to work with others who reject it.

The following are the specific best practices we have observed and recommend:

3.1 Best Practice 1: use openness and transparency in communications with rural carriers

BTOP awardees should communicate with existing rural carriers in areas where they will build fiber. In our experience, the most successful models in other states with BTOP grants involve an open dialogue and information exchange between the parties—even as network plans change and evolve over time. In Maryland, for example, one of the other states to which NTIA granted a very large sum for a public statewide network comparable to that of EAGLE-Net, the network deployer (in this case, the state) has communicated with a wide range of incumbent and competitive carriers by partnering with the non-profit Maryland Broadband Cooperative, whose members include many of the rural carriers.

BTOP awardees should also communicate openly during the planning and engineering process. Project engineers and planners spend considerable time on the ground in rural areas to design the network; that time is required to do mile-by-mile and block-by-block design, as well as to perform make-ready work for aerial construction, and to work with the pole owners, local utilities, and the local government for permitting and rights-of-way access. The best practice is for the BTOP awardee to be in contact with the rural carriers about its plans. We have observed this practice in a range of states including Illinois, Maryland, and North Carolina.

We believe that EAGLE-Net has followed this particular best practice. Based on our observations of EAGLE-Net's operations, EAGLE-Net appears to have approached, met with, and shared information with many of the rural carriers in the territory to which it will build, seeking win-win scenarios and partnerships. Its engineers and project managers have communicated with local carriers as they have conducted fieldwork and design tasks throughout the state. In the context of our own research in the small community of Crestone in rural southeast Colorado on behalf of another client, we found that EAGLE-Net had approached a small rural ISP, Crestone Telecom, and provided data regarding its plans.

In addition, EAGLE-Net has sent representatives to rural broadband symposia and other planning and industry events throughout the state since the early period of the grant. We even observed EAGLE-Net presentations at municipal conferences before the grant was filed when the project was in early planning stages.

And significantly, over the course of the past year as it prepared for construction, EAGLE-Net hired five dedicated "Regional Community Representatives" to work in each of the four quadrants of the state and the metropolitan areas, with the specific purpose of providing community communications.

Another best practice in this regard is open procurement processes that ensure all parties can access information. BTOP awardees can communicate with parties throughout their territories through procurement processes that provide information through the public documents used and through the formal question-and-answer process that accompanies an RFI or RFP process.

In our observation, EAGLE-Net used this best practice to openly communicate information about its plans to all interested parties. EAGLE-Net released two RFIs and five RFPs seeking to lease fiber or other communications services throughout the state, and then released many RFPs seeking construction services for fiber and wireless infrastructure in particular areas. These documents served as an important means of communications with rural carriers regarding EAGLE-Net's plans. As open, competitive processes, they created an appropriate means of formal communications, consistent with the terms of the BTOP grant and EAGLE-Net's own policies.

We understand that EAGLE-Net has been criticized because the public version of its successful grant application included redactions of specific construction routes. We note, based on 30 years of engineering communications networks, that it is an *industry standard* to keep confidential specific route information – *as a matter of public safety*. In our experience, most network owners, particularly those like EAGLE-Net who seek to optimize their networks for public-safety users, do not share specific routing.

Further, most private sector carriers refuse to share specific route information on the grounds that such data are trade secrets. In our experience designing and evaluating fiber networks

throughout the country and in Asia, we have never seen specific route data made public, either by public or private fiber deployers.

We note also that the modest redactions in the public version of the EAGLE-Net application are very consistent with the redactions of the other BTOP awardees.[20] Indeed, the EAGLE-Net redactions were quite minor compared to many of the applications, some of which (quite reasonably) redacted even the names and locations of the sites to which they planned to build, as well as the number of sites. To our knowledge, these BTOP awardees have not faced criticism for the redactions, nor do we consider their redactions unreasonable, in light of the public-safety concerns that require the confidentiality of detailed design data regarding critical infrastructure.

We conclude, based on these observations, that EAGLE-Net, like its counterparts in other states that have not faced extensive opposition from rural carriers, has been actively engaged and communicative with rural carriers. Based on our judgment and experience, EAGLE-Net is being held to a far higher standard for information disclosure than other BTOP projects and fiber owners.

3.2 Best Practice 2: purchase access to existing fiber where possible

In our observation, it is a best practice that a BTOP grantee seek to utilize existing fiber owned by incumbent carriers wherever possible—so long as the existing fiber is available and reasonably priced.

It is important to note that the ability of the grantee to use existing fiber is limited by (1) the existing fiber footprint and (2) the willingness of the fiber owner to lease it.

First, even in rural communities where fiber currently exists, the fiber is frequently not comprehensive, contiguous, or does not reach the key institution or economic development location that the BTOP awardee seeks to connect. As a result, BTOP awardees nationwide have frequently found that, while there is some fiber available to lease through an irrevocable right of use (IRU), that fiber needs to be expanded or connected to the new-build fiber that they are adding to reach the full rural footprint.

Second, existing fiber owners are sometimes unwilling to lease their fiber to BTOP awardees, or are unwilling to allow interconnection points at the particular locations that the BTOP awardee needs to connect its new fiber to the existing fiber footprint. In this case, while it is the best practice to use the fiber where available, availability is frequently limited by the fiber owner's

[20]The redacted applications of BTOP awardees are publicly available on the NTIA website at http://www2.ntia.doc.gov/grantees. NTIA allowed the grantees to redact portions of their applications with an explanation to NTIA. All applications we reviewed including redactions, many of them far more extensive than those of EAGLE-Net.

unwillingness to lease. As a result, there are circumstances in which some BTOP awardees are not able to gain access at a reasonable price, or sometimes at any price, to fiber on the routes they seek to serve.

To our knowledge, EAGLE-Net has followed this best practice. Very early in the grant period, immediately after NTIA authorized it to proceed with tasks unrelated to environmental assessment, EAGLE-Net released two successive requests for information (RFIs) seeking existing high-speed infrastructure throughout the state.[21] The RFIs sought information regarding where broadband infrastructure already exists and whether the owner would be willing to work with EAGLE-Net as a potential lessor of that infrastructure.

Based on the responses to the IRUs, EAGLE-Net then released a series of Requests for Proposals (RFPs) seeking specific leasing arrangements in each of the four quadrants of the state, as well as in the Denver and Colorado Springs metropolitan areas.[22]

On the basis of the bids received, EAGLE-Net has entered into agreements with most of the respondents to the RFPs—thus providing those carriers and other fiber owners with revenue on their existing routes, while alleviating EAGLE-Net's need to build duplicative infrastructure. To our knowledge, EAGLE-Net has leased more than 2,000 miles of fiber throughout Colorado, to complement approximately the same amount of new fiber and wireless capacity it is constructing. Based on our review of its RFIs and RFPs, EAGLE-Net sought to purchase IRUs on many more miles, but in many cases simply was not offered leases by the fiber owners.

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[21] G4S Technology LLC, Sept. 22, 2011, "Request for Information for Telecommunication Infrastructure for the EAGLE-Net Alliance Project Colorado Community Anchor Broadband Consortium," RFI # 107057-03 (http://www.co-eaglenet.net/wp-content/uploads/2012/01/RFI-107057-03-Phase-II-IRU-2011-09-22.pdf) (accessed Nov. 6, 2012); G4S Technology LLC, Aug. 10, 2011, "Request for Information for Dark Fiber Indefeasible Right of Use for the EAGLE-Net Alliance Project Colorado Community Anchor Broadband Consortium," RFI # 107057-01 (http://www.co-eaglenet.net/wp-content/uploads/2012/01/RFI-107057-01-Dark-Fiber-Indefeasible-Right-of-Use-2011-08-11.pdf) (accessed Nov. 6, 2012).

[22] *See, e.g.,* EAGLE-Net, May 7, 2012, "RFP-0004-OPS: Support Services" (http://www.co-eaglenet.net/wp-content/uploads/2012/05/EAGLE-Net-RFP-0004-OPS-Support-Services-1.pdf) (accessed Nov. 6, 2012); EAGLE-Net, Mar. 26, 2012, "RFP-0003-OPS Wireless Towers" (http://www.co-eaglenet.net/wp-content/uploads/2012/03/RFP-0003-OPS-Wireless-Towers-2012-03-26.pdf) (accessed Nov. 6, 2012); G4S Technology LLC, Feb. 3, 2012, "Request for Proposal for Fiber Assets Southeastern Colorado by EAGLE-Net Alliance for the Colorado Community Anchor Broadband Consortium Project RFP # 107057-12" (http://www.co-eaglenet.net/wp-content/uploads/2012/01/RFP-107057-12-Fiber-Assets-SE-Quadrant-2012-02-03.pdf) (accessed Nov. 6, 2012); G4S Technology LLC, Dec. 14, 2011, "Request for Proposal for Fiber Assets Northeastern Colorado by EAGLE-Net Alliance for the Colorado Community Anchor Broadband Consortium Project RFP # 107057-10" (http://www.co-eaglenet.net/wp-content/uploads/2012/01/RFP-107057-10-Fiber-Assets-NE-Quadrant-2011-12-14.pdf) (accessed Nov. 6, 2012); G4S Technology, Oct. 26, 2011, "Request for Proposal for Fiber Assets Metropolitan Denver Endpoints by EAGLE-Net Alliance for the Colorado Community Anchor Broadband Consortium Project RFP # 107057-04" (http://www.co-eaglenet.net/wp-content/uploads/2012/01/RFP-107057-04-Fiber-Assets-Denver-22-CAIs-2011-10-26.pdf) (accessed Nov. 6, 2012); additional RFPs available online at http://www.co-eaglenet.net/btop/procurement/.

On those routes that EAGLE-Net was not able to secure leasing arrangements for existing infrastructure, it then planned to build new infrastructure. Importantly, the design for the network was not completed until after the leasing arrangements were confirmed, so that EAGLE-Net knew where it would need to complement existing infrastructure. Only after the RFP responses were received did EAGLE-Net confirm its design and release RFPs for construction of the new infrastructure.

It is our understanding that many of the entities now opposing EAGLE-Net did not themselves respond to the RFIs and RFPs. We also understand that some that did respond required EAGLE-Net to agree to anti-competitive terms that would have violated EAGLE-Net's grant obligations by requiring EAGLE-Net to limit its use of the leased fiber, not serve certain users, and not serve competing companies or entrepreneurs.

We conclude that EAGLE-Net, like its counterparts in other states, followed a best practice in which it did not decide to build new infrastructure until it had exhausted the possibility of leasing infrastructure or services to its target locations. EAGLE-Net reasonably declined to enter into leases with entities that required anti-competitive terms.

3.3 Best Practice 3: partner with rural carriers for last-mile connections where possible

In our experience, it is a best practice that BTOP awardees work in partnership with rural carriers wherever possible. BTOP awardees have engaged in states throughout the country in working with rural carriers to aggregate infrastructure through a partnership that enables them to reach as many anchor institutions (in the case of the BTOP awardee) and as many rural areas and neighborhoods (in the case of the rural carriers) as possible.

Because BTOP is a middle-mile program and the vast majority of BTOP-funded projects were middle-mile (i.e., connecting into a neighborhood, but directly connecting only anchor institutions), there is a useful symbiotic relationship between the BTOP fiber and the existing rural carrier infrastructure—which in many cases will be limited to older copper cables. In general, the BTOP fiber traverses the middle-mile and reaches into a rural community, and then connects to existing infrastructure (usually older copper but in some cases, newer fiber) to reach end users. Given the infeasibility of building fiber to every location in a community, the copper infrastructure is used in the last-mile, and then connected to the robust middle-mile fiber.

Where the BTOP awardee reaches only one or a small number of anchor institutions in a community, the rural carrier's copper can bridge the last-mile to enable an anchor to expand its BTOP connectivity. If a rural school building were connected by BTOP fiber, the school district could use the rural carrier's infrastructure to connect the district's other facilities—thus enabling the district to operate a capable wide-area network (WAN) over the carrier's existing

infrastructure, and to connect to the Internet backbone over the BTOP awardee's middle-mile fiber. For example, in rural Maryland, Garrett County is connecting many of the key community facilities, such as Head Start centers, to the state's BTOP-funded One Maryland Broadband Network. This enables the county to connect its anchor sites to the state's middle-mile network and to leverage the state-wide fiber network to connect to a metro-area Internet Point of Presence.

Similarly, because the BTOP awardee's fiber is not ubiquitous in any community, BTOP awardees have partnered with local providers to extend the new connectivity to their customers. In Pennsylvania, for example, the BTOP-funded KINBER network has partnered with the private carrier Sunesys to lease KINBER fiber and connect it to Sunesys' existing last-mile fiber throughout the state–thereby extending service to customers in the local area that KINBER's fiber will not reach.

In our observation, EAGLE-Net has followed the best practice in this regard. Throughout the process of the grant application, as well as during the network deployment period, EAGLE-Net has reached out to rural carriers that may serve as logical last-mile partners. We also note that EAGLE-Net has attempted to address questions or concerns by rural carriers, and tempered its language and endeavored to avoid unpleasant confrontations, to avoid burning bridges with last-mile carriers that EAGLE-Net sees as potential partners.

In the process of fulfilling its mission of serving the K-12 community, EAGLE-Net has formally and informally reached out in numerous cases to rural carriers seeking partnerships or subcontractor relationships to enable last-mile service—for example, to the remote schools connected over rural copper where EAGLE-Net hopes to serve the board of education buildings with fiber connectivity and commodity Internet bandwidth. It has sought to include the rural carrier as the last-mile solution to get to the many schools in the area so as to enable the operation of a WAN by the schools.

Similarly, EAGLE-Net has sought to establish partnerships with rural carriers who would serve as their local partners—extending the new connectivity enabled by EAGLE-Net to their residential and business customers in a rural area.

EAGLE-Net's efforts in this regard are entirely consistent with the Colorado Legislature's resolution in favor of the use of private sector infrastructure, where that infrastructure exists:

> Every effort should be made to prioritize the provision of broadband service to unserved customers through the efficient distribution of resources to avoid over-building of existing facilities and to *strongly encourage the use of private sector local telecommunications providers*.[23]

[23] 2010 Colorado House Joint Resolution 10-1026 (emphasis added).

Indeed, the express purpose of the EAGLE-Net RFIs and RFPs was to follow this recommendation, and EAGLE-Net has worked with those private sector entities who responded to these and other outreach efforts.

4 In similar middle-mile broadband projects in other states, job losses and bankruptcies have not materialized, nor have rural carriers raised similar objections

The Colorado complainants appear to be alone nationally in the extent of their opposition to the new BTOP fiber that is planned for rural Colorado. In our observation in multiple other states, there has been no comparable opposition. Rather, in most of the states we have observed or researched, individual carriers have noted their concerns with the fact that they face some new competition but the great majority of rural incumbents and competitive providers have agreed to work with the BTOP recipient to maximize the benefits of the new fiber investment for all parties.

Our analysis in this regard is based on (1) our observations of the reception of new fiber during our fieldwork in multiple states where BTOP funds are currently being expended to build new networks to rural areas, including to schools and libraries; (2) conversations with a number of other BTOP projects around the country who, like EAGLE-Net, are building middle-mile fiber to rural areas and schools, libraries and other community anchors; and (3) our independent research of publicly available documents and coverage in the trade and mainstream press.

Based on these sources of data, it appears that in most states there has not been opposition by rural incumbents in any way similar to that encountered by EAGLE-Net. Indeed, in the states we have observed or whose project stakeholders we interviewed, reception of the new BTOP middle-mile projects by rural carriers has been cordial and, in some cases, enthusiastic given that the middle-mile competition will open up new opportunities for cost-effective transport and bandwidth connections to the Internet backbone.

Our observation is that the great majority of rural carriers have been welcoming or reserved – not hostile – in Pennsylvania, Maryland, Massachusetts, New Mexico, North Carolina, and Illinois. These are all states in which extensive new fiber is being deployed in rural areas by BTOP awardees and in which the technology and business model for the BTOP program is effectively identical to that of EAGLE-Net: (1) BTOP funds were awarded to build middle-mile fiber; (2) the fiber will connect rural schools, libraries and other community anchors; (3) the fiber will be available on an open access basis to existing carriers as well as ISPs who are likely to compete with the existing carriers.[24]

[24] Where BTOP fiber projects have been stopped, the reasons have been unrelated to the arguments used against EAGLE-Net in Colorado. In Wisconsin, for example, the state chose to return the BTOP funds to the federal government and cited excessive federal bureaucracy as the reason. Samantha Bookman, "Wisconsin's Stimulus Rejection," Fierce Telecom, February 17, 2011 (http://www.fiercetelecom.com/story/wisconsins-stimulus-rejection-too-many-strings-or-too-much-scrutiny/2011-02-17?utm_medium=nl&utm_source=internal) (accessed October 12, 2012). In Louisiana, NTIA chose to rescind the grant because of management, schedule, and budget problems, and because of a changed implementation plan that did not comply with the BTOP rules. Jonathan Tilove, "Federal Grant for Broadband Access in Rural Louisiana Rescinded," New Orleans Times-Picayune, October

In fact, in other states the rural providers have initiated or participated in the implementation of BTOP middle-mile efforts, rather than obstructing them. In California, the Central Valley Next Generation Broadband Infrastructure Project (CVNGBIP) was created by the state and rural private sector providers. It is a $66 million network funded by BTOP and the state. It covers 18 counties and dozens of anchor institutions. The private sector partners opted for CVNGBIP to cost-effectively link their isolated fiber and copper islands to the Internet backbone and metropolitan areas and have competitive and cost-effective middle-mile service to serve them and potential future service providers.

Similarly, in Maryland the private carriers have welcomed the BTOP fiber being constructed by the state. Indeed, the Maryland Broadband Cooperative—whose membership includes almost all private carriers in Maryland, whether incumbent or competitive—has partnered with the state to connect its members' rural infrastructure to the new fiber, thus bridging the middle-mile barrier between Maryland's metro-area and rural communities.

Most significantly, our field work and interviews in each of those states resulted in no suggestion or evidence that the rural providers in any of these states have laid off workers or defaulted on RUS loans as a result of competition enabled by the BTOP grant.

27, 2011 (http://www.nola.com/politics/index.ssf/2011/10/federal_grant_for_broadband_ac.html) (accessed Oct. 1, 2012). In neither case, to our knowledge, was there significant opposition from rural carriers who claim duplicative fiber infrastructure as has been the case with EAGLE-Net.

5 EAGLE-Net delivers economic benefit by lowering middle-mile costs for private entities and enabling private rural investment

EAGLE-Net enables private carriers and entrepreneurs to cost-effectively bridge the middle-mile (without having to build their own middle-mile facilities) and concentrate their investment in last-mile deployment—thus increasing last-mile investment in high-speed Internet service to homes and businesses.

The National Broadband Plan recognizes that the cost of middle-mile directly impacts the cost of providing last-mile broadband in unserved areas.[25] EAGLE-Net reduces a sizeable expense for last-mile developers by opening up competitive middle-mile access and removing that barrier to building and operating broadband networks.[26]

5.1 Cost-prohibitive middle-mile facilities inhibit rural investment and innovation

It is widely understood that the middle-mile serves as a "critical enabler of 'last-mile' broadband service to homes and local businesses."[27] Lack of affordable, available middle-mile transport creates enormous costs to competitive carriers and entrepreneurs and to local and broader economic activity.[28] The high cost of traditional middle-mile facilities creates a costly barrier to last-mile broadband investment because the carrier cannot access the market it wishes to serve, thus resulting in an "utter lack of meaningful competition,"[29] and limiting investment and innovation in areas like rural Colorado. In the same way, if an existing carrier owns middle-mile capacity but is unwilling to lease access to entrepreneurs and competitors, or will only do so at infeasible prices, the middle-mile serves as a barrier – rather than a bridge – for entrepreneurs to reach rural markets.

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[25] Federal Communications Commission, "National Broadband Plan: Connecting America," Chapter 8 (http://www.broadband.gov/plan/8-availability/#r8-8) (accessed Oct. 1, 2012).

[26] Many rural providers share this concern about the high costs of middle-mile service. A recent presentation by the National Exchange Carrier Association (NECA), an association of approximately 1,100 rural Local Exchange Carriers, expresses skepticism about the ability of rural carriers to build out the middle-mile. According to the presentation, a survey of NECA members and their ISP affiliates found that the cost of upgrading the middle-mile is so substantial as to prove a barrier to upgraded consumer Internet services. Victor Glass, Joseph Prinzivalli and Stela Stefanova, "Persistence of the Middle-mile Problem for Rural Local Exchange Carriers" (http://scenic.princeton.edu/SDP2012/Talks-VictorGlass.pdf) (accessed Sept. 30, 2012).

[27] Testimony of The Honorable Lawrence E. Strickling, Assistant Secretary for Communications and Information National Telecommunications and Information Administration, United States Department of Commerce, July 18 2012, before the Committee on Small Business United States House of Representatives, "Digital Divide: Expanding Broadband Access to Small Businesses." http://www.ntia.doc.gov/speechtestimony/2012/testimony-assistant-secretary-strickling-digital-divide-expanding-broadband-acc

[28] See Jim Baller and Casey Lide, June 2008, "Bigger Vision, Bolder Action, Brighter Future: Capturing the Promise of Broadband for North Carolina and America," at 123-24 (http://s.ftthcouncil.org/files/final_bhlg_white_paper__5-27-08__jim_baller.pdf) (accessed Sept. 30, 2012).

[29] Economics and Technology, Inc., "Special Access Overpricing and the U.S. Economy," prepared for the Ad HocTelecommunications users Committee, August 2007 at 19.

As the FCC explains:

> In many cases, the rural broadband provider will need to obtain backhaul transport from more than one provider, often over facilities that were designed for voice telephone or cable television services…. Some of these 'middle-mile' facilities may have insufficient capacity, causing the transmission speed on otherwise adequate last-mile broadband facilities to come to a crawl or stall before the data reach the Internet backbone. Overcoming this may require the construction of a dedicated facility, which drives up costs and can deter last-mile broadband investments. *Moreover, even when the last-mile provider acquires access to adequate middle-mile facilities, that access may be prohibitively expensive*.[30]

In sum, lack of access to the middle mile inhibits investment in the last mile. For this reason, NTIA focused BTOP on the middle mile—and funded open access networks such as EAGLE-Net that bridge these barriers to enable rural broadband deployment.

As a result, EAGLE-Net and the other BTOP projects fill an important gap, providing a cost-effective middle mile alternative in markets where none has otherwise developed. Their open access business models encourage competition and offer access to all qualified providers. They enable entrepreneurs and rural providers to connect without paying monopoly rents. By lowering barriers to entry, they offer far-reaching economic benefits economy-wide.

Indeed, with NTIA funding the middle mile through the BTOP program, the FCC, in transitioning its largely phone-focused Universal Service Fund (USF) into a more broadband-focused Connect America Fund,[31] declined to adopt a proposal made by rural phone carriers (including the Colorado Telecommunications Association) to compensate them for building middle mile infrastructure.[32] Instead, the FCC retained its focus on the last mile in its rural phone carrier subsidies,[33] and sought focused comment on how adding middle-mile support to such subsidies

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[30] FCC, May 22, 2009 "Bringing Broadband to Rural America: Report on a Rural Broadband Strategy" (italics added) http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-291012A1.pdf (accessed Sept. 30, 2012).

[31] Federal Communications Commission, Report and Order and Further Notice of Proposed Rulemaking, October 27, 2011, http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-11-161A1.pdf (accessed Nov. 27, 2012), at paragraph 1.

[32] Connect America Fund/Intercarrier Compensation Transformation NPRM, FCC Docket 10-90, Comments of the National Exchange Carrier Association, Inc.; National Telecommunications Cooperative Association; Organization for the Promotion and Advancement of Small Telecommunications Companies; and Western Telecommunications Alliance (with concurring associations including the Colorado Telecommunications Association), Apr. 18, 2011, at pp. 29-31.

[33] Federal Communications Commission, Report and Order and Further Notice of Proposed Rulemaking, October 27, 2011, http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-11-161A1.pdf, at paragraphs 26-27 (accessed Nov. 27, 2012).

could be made consistent with the budgetary framework adopted as part of the transition.[34] In sum, NTIA and FCC funding for broadband are not duplicative; rather, they complement each other to ensure that both middle-mile and last-mile infrastructure and services are available and affordable.

5.2 Better broadband to anchors has been linked to increased economic activity

At the local rather than national level, the link between economic activity and cost-effective middle-mile has also been noted by economists: a 2005 study demonstrated that a Florida county had "experienced approximately 100% greater growth in economic activity—a doubling—relative to comparable Florida counties since making its municipal broadband network generally available to businesses and municipal institutions in the county," thus enabling significantly enhanced services to those entities.[35] According to the authors, economist George Ford and broadband expert Thomas Koutsky, in the first five years of operations, the county "experienced a significant and sustained burst of economic activity relative to its peers."[36]

5.3 This model represents the international standard for modest public investment to enhance private sector broadband opportunities

The United States is not alone in using federal resources to stimulate middle-mile broadband deployment. As a recent World Bank report explains, "[c]ompetitive and well-functioning wholesale markets for backhaul capacity [middle-mile] are a critical component of broadband diffusion and adoption."[37] Governments focus on developing the middle-mile because they recognize that the "availability of adequate fib[er] backhaul networks in each region is a fundamental prerequisite for any broadband development."[38]

Such publicly funded middle-mile investments are prevalent in our competitor nations. In both Asia and Europe, foreign governments have allocated national funds to support next-

[34] Federal Communications Commission, Report and Order and Further Notice of Proposed Rulemaking, October 27, 2011, http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-11-161A1.pdf, at paragraph 1035 (accessed Nov. 27, 2012).
[35] George Ford and Thomas Koutsky, April 2005, Applied Economic Studies, "Broadband and Economic Development: A Municipal Case Study from Florida," http://www.aestudies.com/library/econdev.pdf (accessed Sept. 30, 2012).
[36] *Id.*
[37] The World Bank, Tim Kelly and Carlo Maria Rossotto, eds., 2012, Broadband Strategies Toolkit, at 115 (http://broadbandtoolkit.org/Custom/Core/Documents/Broadband%20Strategies%20Handbook.pdf)
[38] Filomena Chirico and Norbert Gaál, 2011, Competition Policy Newsletter, "State Aid to Broadband: Primer and Best Practices," at 57, http://ec.europa.eu/competition/publications/cpn/2011_1_10_en.pdf (accessed Oct. 3, 2012).

generation, public-private partnership broadband development in 2010.[39] One European publication explains:

> Generally speaking, the practice of the Commission shows that *in this segment of broadband networks [i.e., the middle-mile], there is often market failure*… The rollout of fib[er]-based backhaul networks is also an indispensable pre-requisite for any future [Next Generation Access] network deployment. Therefore many public authorities direct available funds into backhaul network deployment to pave the way for both basic and NGA roll-out.[40]

This public support is viewed as "stimulat[ing] infrastructure-based competition" —a process by which public funding enables private innovation and investment.[41] Moreover, since backhaul networks are not limited to particular technology platforms, last-mile providers can offer end-users whatever access technology they prefer or can afford (such as, fiber, DSL, mobile, or wireless).

[39] *Id.* at 50.
[40] *Id.* at 53 (emphasis added).
[41] *Id.* at 53.

6 EAGLE-Net stimulates economic activity and job creation

Rural carriers in Colorado have suggested that EAGLE-Net will result in a parade of economic horribles, ranging from rural layoffs to loan defaults to failed small businesses.

Based on our experience with middle-mile and K-12-focused fiber infrastructure, we believe these concerns to be misplaced. Indeed, our analysis suggests the opposite: that EAGLE-Net has already had, and will continue to have, positive economic impact on the Colorado economy with respect to the impact of the funds expended there, the jobs created, and the last-mile broadband investment enabled. As we describe below, scaling back or eliminating EAGLE-Net would result in significant lost benefit to the Colorado economy.

6.1 EAGLE-Net is creating economic activity

Middle-mile broadband deployment will have economic benefits for the EAGLE-Net project area. The Congressional Budget Office (CBO) assigns a multiplier ranging from 1 to 2.5 to "[p]urchasing goods and services – for instance, by funding construction and other investment activities that could take several years to complete."[42] The multiplier represents the "estimated direct and indirect effects on the nation's output of a dollar's worth of a given policy"[43] Applying the CBO multiplier to the total EAGLE-Net budget of $135.3 million[44] demonstrates that the BTOP award supports an additional $135.3 to $338.25 million of economic activity. To date, roughly $76 million of the original award has been expended.[45] If EAGLE-Net were halted as of the date of this writing, Colorado would lose $60 to $150 million in direct and indirect economic benefit.

The Bureau of Economic Analysis (BEA) uses a 2.01 output multiplier for Information-Telecommunications investments, suggesting that every new dollar in the telecommunications utility industry in Colorado will generate $2.01 of economic activity. This growth not only includes direct expenditures in the telecommunications industry, but also induced expenditures, including purchases made by employees and money circulated through the economy. Applying the BEA multiplier to the EAGLE-Net budget ($135.3 million) demonstrates that the BTOP award supports an additional $272 million. To date, roughly $76 million of the original award has been expended. Stopping EAGLE-Net construction now would deprive Colorado of the benefits of $120.6 million in direct and indirect investments under the BEA multiplier.

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[42] Congressional Budget Office (CBO), May 2011, Pub. No. 4284, "Estimated Impact of the American Recovery and Reinvestment Act on Employment and Economic Output from January 2011 Through March 2011," at 1 & 6 (Table 2) (note that Table 2 is limited to "Major Provisions of the American Recovery and Reinvestment Act" and does not explicitly mention broadband deployment. Nonetheless, telecommunications construction can clearly be deemed a purchase of goods and services by the federal government, thus supporting use of this multiplier).

[43] *Id.* at 4.

[44] Budget includes NTIA award and matching funds.

[45] Based on Q3 reporting, indicating $66.1 million in federal funds and $9.9 million in matching funds expended.

The CBO and BEA frameworks are consistent with other economic models. For instance, the Center for Strategic Economic Research, an economic research and consulting group specializing in applied research and strategy development in the regional economics and economic development fields, applies a multiplier of 1.8 to infrastructure and public works projects, including telecommunications construction. Specifically, the Center explains that every $1 million of public works and infrastructure construction supports an additional $825,858 of output through indirect and induced activities.[46] Applying this model to EAGLE-Net, the original $135.3 million project budget will ultimately support more than $243.5 million in direct and indirect economic benefits. Terminating support at this time, with $60 million yet to be expended, would deprive the Colorado economy of $108 million.

6.2 EAGLE-Net is creating jobs

EAGLE-Net creates jobs, both directly and indirectly. The direct job creation impact alone is extensive[47] and many of the jobs EAGLE-Net is currently creating are permanent.

Studies identify a range of categories of direct job creation from broadband: first, that attributed to the direct labor associated with construction and deployment of the network. This includes the technicians and construction workers who lay the broadband pipes.[48] Second is the category of job growth comprised of the direct labor associated with manufacturing the infrastructure components and equipment that take the fiber to the user location. This includes optical fiber, wireless tower structures, and network electronics.

In the first category of job-creation, EAGLE-Net is having an immediate impact in the construction and information technology sectors—benefits that are immediate, because of the

[46] SRRI, "Stimulus Calculation Tool: Statewide Economic Impacts of Construction Spending in California" (http://www.strategiceconomicresearch.org/AboutUs/StimCalcTool.pdf) (applying a 1.8 multiplier to "[a]irport runways, buildings, & related work; arenas, stadiums, & other recreational facilities; bridges, tunnels, & elevated highways; harbor & port facilities; highways, streets, & related work; levee, dam & reservoir construction; mass transit construction; parking facilities; petroleum refineries, chemical facilities, & related work; pipeline construction; power & communication transmission lines; power plants; sewage & water treatment plants; sewers, water mains, & related facilities; solid waste disposal facilities; and water storage facilities").

[47] Independent researchers have estimated that BTOP and other public broadband investments "could create hundreds of thousands of jobs over a four-year period by stimulating new businesses, market transactions, and innovative industries in previously underserved areas." Executive Office of the President National Economic Council, "Recovery Act Investments in Broadband," *supra* note 14, at 11 (citing Raul Katz, Columbia Business School, and Stephan Suter, Polynomics AG, Feb. 2009, "Estimating the Economic Impact of the Broadband Stimulus Plan.") (http:/www.whitehouse.gov/sites/default/files/20091217-recovery-act-investments-broadband.pdf) (accessed Sept. 30, 2012).) The federal government has also estimated that, nationwide, public broadband projects "will create tens of thousands of jobs in construction and other sectors." *Id.*

[48] Robert D. Atkinson, Daniel Castro and Stephen J. Ezell, "The Digital Road to Recovery: A Stimulus Plan to Create Jobs, Boost Productivity and Revitalize America," ITIF Study, Jan 7, 2009, at 2 (http://www.itif.org/files/roadtorecovery.pdf) (accessed Oct. 3, 2012).

rapid pace of the BTOP projects (EAGLE-Net's network deployment is projected to be complete by August 2013). In construction, workers are already engaged in engineering, planning, and environmental compliance. During the intensive construction phase of the next nine months, workers will dig ditches and trenches, place fiber in the ground and on utility poles, and build towers for aerial connections. In information technology, additional workers will place and configure communications equipment, manage installation, repair towers and lines, and interact with customers.

In the second category of job creation, EAGLE-Net is directly creating jobs in a range of sectors by increasing the demand for such equipment and materials as construction machinery, the physical components of wireless towers, optical fiber, and network electronics. This category also includes such ongoing services as manufacturer equipment maintenance.

CTC engineers undertook an independent analysis of likely job creation based on our 30-year experience analyzing, testing, and designing communications networks. Our analysis is also based on our direct experience with BTOP projects in other states on networks that are substantially similar to EAGLE-Net.

On these bases, we conservatively estimate that at least 180 jobs per year have been created in the construction phase of EAGLE-Net and that at least 50 jobs will be created per year in the operations phase for fiber maintenance and network operations only (not including sales, marketing, and other ongoing jobs related to customer support, which could support another dozen jobs).

Our analysis is summarized in the table below.

Table 1: Estimate of Job Creation During Network Implementation and Operations

Item	Unit	Avg. Hours per Unit	Eagle-NET Units	Estimated Total Hours	Eagle-NET Annual FTE's (3-year grant period avg.)
Project Management and Quality Control	Miles	110.5	1,470.0	162,474.4	26.0
Physical Plant Engineering and Permitting	Miles	82.4	1,470.0	121,102.0	19.4
Construction	Miles	579.1	1,470.0	851,313.7	136.4
Network Electronics Design and Deployment	Sites	4.0	290.0	1,160.0	0.2
			Total:	1,136,050.2	182.1
Operations					
Item	Unit	Annual Hours per Unit	Eagle-NET Units	Estimated Hours	Eagle-NET FTE's (annual)
Fiber Maintenance	Miles	20.0	1,470.0	29,400.0	14.1
Fiber Locates	Miles	41.6	1,470.0	61,152.0	29.4
Network Engineering Support	Entire Network	16,640.0	1.0	16,640.0	8.0
			Total:	107,192.0	51.5

6.3 EAGLE-Net enables economic activity by stimulating last-mile investment

The job-creation impact of middle-mile investment extends beyond the middle-mile.[49] As middle-mile projects trigger construction of last-mile networks, additional jobs will be created to build and operate last-mile infrastructure to homes and businesses.[50] A 2002 study by TeleNomic Research for the New Millennium Research Council found that a national broadband network would lead to the creation of 1.2 million permanent jobs: 166,000 jobs in the telecommunications sector; 71,700 manufacturing jobs generated by the direct purchase of network plant and equipment and customer premises equipment; and 974,000 indirect jobs.[51] Notably, direct jobs related to the "building and manufacture of broadband networks" pay 42 percent more than the average for manufacturing jobs in other sectors,[52] and IT jobs, on average, pay 85 percent more than other private sector jobs.[53]

New jobs and economic activity will also result from the capabilities created by new broadband services—as new last-mile facilities are enabled, the cumulative effect of direct and indirect jobs is quite large. While projections of the precise economic effects vary, studies consistently find that "at the individual, local/ community, and national levels, the deployment of fast, reliable, and affordable broadband will stimulate tremendous economic development and creates hundreds of thousands—if not millions—of well-paying jobs that might otherwise be lost or go offshore."[54]

The Communications Workers of America project that each $1 million invested in broadband creates 20 jobs.[55] The U.S. Bureau of Economic Analysis assigns a jobs multiplier of 9.10 for the telecommunications sector. The U.S. Department of Commerce has found that communities with broadband added 1 percent to 1.4 percent to their employment growth rate, 0.5 percent to 1.2 percent to the growth of business establishments, and 0.3 percent to 0.6 percent to the share of IT establishments.[56] Others, such as the Information Technology and Innovation

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[49] Executive Office of the President National Economic Council, "Recovery Act Investments in Broadband," *supra* note 14, at 12.
[50] *Id.*, at 12.
[51] Stephen Pociask, "Building a Nationwide Broadband Network: Speeding Job Growth," TeleNomic Research, LLC, Feb 2002, at 7, www.newmillenniumresearch.org/event-02-25-2002/jobspaper.pdf (accessed Oct. 3, 2012).
[52] Atkinson, Castro and Ezell, *supra* note 48.
[53] Pociask, *supra* note 51 , at 3. *See also* "Digital Economy 2000," U.S. Department of Commerce, June 2000 (http://www.esa.doc.gov/Reports/DIGITAL.pdf).
[54] Jonathan Rintels, "An Action Plan for America: Using Technology and Innovation to Address Our Nation's Critical Challenges," The Benton Foundation, 2008, at 13 (http://www.benton.org/initiatives/broadband_benefits/action_plan) (accessed Oct. 3, 2012).
[55] Eric Auchard, "The Case for a Broadband Bailout," Reuters (Opinion), Feb 13, 2009. http://www.reuters.com/article/reutersComService4/idUSTRE51C2W920090213 (accessed Nov. 3, 2012).
[56] William Lehr, Carlos A. Osorio, Sharon E. Gillett, and Marvin Sirbu, "Measuring Broadband's Economic Impact," U.S. Department of Commerce, Economic Development Administration, Feb 2006, at 4 (These numbers represent the average of the RIMS II Model multipliers for Construction and Broadcasting and Communications Equipment)

Foundation, project as much as twice this level of growth because of broadband's multiplier or "network" effect.[57] The Brookings Institution has measured the marginal value of increased broadband access, concluding that every 1 percent increase in broadband penetration leads to a 0.2 percent to 0.3 percent increase in annual employment growth.[58] A study by the Sacramento Regional Research Institute found more modest job growth, with each 1 percent increase in broadband use triggering 0.075 percent growth in employment and 0.088 percent increase in payroll. Even this modest projection translates to significant gains. The study concluded that a 3.8 percent increase in national broadband use over a decade would result in a cumulative 10-year gain of 1.8 million jobs and $132 billion in payroll.[59]

The U.S. Department of Commerce has found that "communities in which mass-market broadband was available … experience more rapid growth in employment, the number of businesses overall, and businesses in IT-intensive sectors, relative to comparable communities without broadband at that time."[60] The Department of Commerce also found a statistically significant impact on property values.

According to the Bureau of Economic Analysis, nearly one-third of the job creation associated with telecommunications investments are in the Information sector. The next five highest industries by employment impact are professional services, administrative services, retail trade, real estate, and health care.

(http://www.eda.gov/ImageCache/EDAPublic/documents/pdfdocs2006/mitcmubbimpactreport_2epdf/v1/mitcmubbi mpactreport.pdf) (accessed Nov. 6, 2012).

[57] Atkinson, Castro, and Ezell, *supra* note 48, at 6.

[58] Robert Crandall, William Lehr, and Robert Litan, "The Effects of Broadband Deployment on Output and Employment: A Cross-sectional Analysis of U.S. Data," The Brookings Institution, Issues in Economic Policy, July 2007, at 2 (www.brookings.edu/views/papers/crandall/200706litan.pdf) (accessed Nov. 6, 2012).

[59] "Economic Effects of Increased Broadband Use in California," Sacramento Regional Research Institution, Nov 2007 (http://www.srri.net/AboutUs/EconEffectsBB_Research.pdf) (accessed Nov. 6, 2012).

[60] Sharon Gillett *et al*., "Measuring Broadband's Economic Impact," U.S. Department of Commerce, Feb 28, 2006, at 3, 10 (http://www.eda.gov/PDF/MITCMUBBImpactReport.pdf) (accessed Nov. 6, 2012).

7 EAGLE-Net delivers unique, substantial benefits to Community Anchor Institutions that are not comparable to local networks

EAGLE-Net delivers unique benefits that differ from the existing networks, even those that have some fiber optics: a statewide dedicated network optimized for use by schools and other anchors—and with bandwidth and services that represent a step function improvement over the bandwidth available to most anchors in the pre-EAGLE-Net environment.

It is precisely because these benefits are "beyond the balance sheet"—not reflected on profit and loss statements—that they are foundational to an inter-governmental, non-profit entity like EAGLE-Net. Little direct economic profit is likely to be realized from the investment and *absent that profit, private sector investment is unlikely to build comparable infrastructure*.

7.1 EAGLE-Net represents a unique network, optimized for education, offering Colorado schools the benefits enjoyed by schools in other states

EAGLE-Net will offer the benefits of a dedicated statewide intranet that will connect schools throughout Colorado to each other. The intranet feature will enable schools to use high-bandwidth educational applications (such as distance learning and collaborative teaching) at low cost and with very high quality and reliability because the EAGLE-Net intranet will eliminate the need for Colorado schools to traverse the public Internet to communicate with each other. In this way, EAGLE-Net represents one of many education-focused networks throughout the U.S. that connect schools with this important feature of dedicated bandwidth: in Maryland, for example, the One Maryland Broadband Network is building dedicated fiber to schools in every county in the state, across a wide range of geographies (ranging from the Allegany mountains to the shore areas on either side of the Chesapeake Bay).[61] One of the key features of this network is that it will offer schools throughout the state the opportunity to communicate between and among each other over dedicated, cost-effective bandwidth without needing to incur the costs, and the bottlenecks, of the public Internet.

EAGLE-Net also offers the unique feature of a broad national and international perspective. While local providers, to their credit, focus on their infrastructure and services in local areas, EAGLE-Net's educational mission includes providing schools in Colorado with access to the national and international research and education networks such as Internet2 and its affiliates in most parts of the U.S. and abroad. Through peering relationships with its educational

[61] *See* Recovery.gov, Grants – Award Summary, "Information Technology, Maryland Department of" (noting that the 1,294 network will reach 458 schools (K-12) and 21 community colleges in every Maryland county), http://www.recovery.gov/Transparency/RecipientReportedData/pages/RecipientProjectSummary508.aspx?AwardIdSur=112600&AwardType=Grants (accessed Nov. 6, 2012).

counterparts, EAGLE-Net will offer access to national and international educational resources and high-bandwidth connections to other schools connected to those peered networks. These are unique features, with unique educational benefits, that the existence of EAGLE-Net makes possible for Colorado schools. In this way, EAGLE-Net will bring to Colorado schools benefits that schools in other states have realized through EAGLE-Net's counterparts: in North Carolina, for example, MCNC's various fiber projects connect schools in many parts of the state to the national and international resources available to an educational network.[62]

EAGLE-Net's statewide intranet feature will also create great value for public-safety users throughout Colorado: dedicated, secure bandwidth will enable high-bandwidth communications among public-safety agencies statewide, offering both interoperability and sharing of high-bandwidth resources and services (such as computer aided dispatch). This model is also proven in other parts of the country: in the metropolitan Washington, DC area, for example, NCRnet represents publicly-owned dedicated fiber connectivity among emergency operations centers, fire houses, police stations, and other public-safety facilities. [63] This regional intranet was developed after the interoperability challenges of September 11, 2001 and serves to connect public-safety agencies and localities in three states to each other in this unique, dedicated way. [64]

It is important to note that part of what will enable many of these benefits is the fact that EAGLE-Net consists of its own fiber, leased fiber, and state-of-the-art wireless infrastructure. The benefits of a dedicated statewide intranet are simply not comparable if an educational network utilizes lesser, leased circuits because the bandwidth and reliability are simply not comparable to that enabled over a largely fiber network. For this reason, the Federal Communications Commission, in the National Broadband Plan, praised high-bandwidth educational networks like EAGLE-Net and called for more support and more development of such networks.[65]

EAGLE-Net's benefits are not easily quantified, in part because they represent a new form of benefit – that associated with world-class connectivity for the Community Anchor Institutions that will be connected by EAGLE-Net. These less quantifiable benefits have nothing to do with traditional financial measures. Rather, they represent the "return" to Colorado citizens in terms

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[62] MCNC: Connecting North Carolina's Future Today, "About MCNC" ("MCNC … operates the North Carolina Research and Education Network (NCREN). NCREN connects all K-12 schools, community colleges, universities, and select non-profit health care sites (collectively called Community Anchor Institutions) throughout the state to each other, the Internet, and global research networks at very high speeds"), https://www.mcnc.org/about.html (accessed Nov. 6, 2012).

[63] Public Safety and Homeland Security Bureau & Federal Communications Commission, Aug. 2009, "NCRnet: How the National Capital Region Built a 21st Century Regional Public Safety Communications Network" (http://www.broadband.gov/docs/ws_pshs/pshs_afflerbach_reference.pdf) (accessed Nov. 6, 2012).

[64] *Id.* at 2.

[65] Federal Communications Commission, "National Broadband Plan: Connecting America," Chapter 11 (http://download.broadband.gov/plan/national-broadband-plan.pdf) (accessed Nov. 6, 2012).

of such largely intangible societal benefits as narrowing the digital divide and providing enhanced educational opportunities to schoolchildren.

7.2 EAGLE-Net enhances educational opportunities at Colorado schools

EAGLE-Net will provide high-speed Internet access to 234 Community Anchor Institutions (CAIs) in Colorado. These CAIs include 178 K-12 school districts with over 1,700 schools and 830,000 students, 12 Boards of Cooperative Educational Services (BOCES), 15 community colleges, and three higher education institutions.[66] EAGLE-Net will provide a variety of educational applications for students and professionals alike.

Adequate broadband enables a range of educational applications. And it is absolutely necessary to enable some core educational functions. The U.S. Department of Education will require certain standardized tests to be administered online as soon as the 2014-15 school year. The tests will entail large numbers of students working online simultaneously—a function that simply cannot be accommodated, even in a small school, over copper-based Internet access.

A significant number of the nation's schools suffer from inadequate Internet access. Insufficient bandwidth precludes creative and expansive online learning, such as video conferencing or collaborative work. Such schools are restricting classroom use of broadband applications, such as streaming video, to preserve bandwidth. As the Benton Foundation explains:

> Distance learning over broadband is a distant dream. Online curricula is offline. Teachers are insufficiently trained to use technology in their classrooms, so that whatever technology is available to them languishes. Students are taught the basic 3 Rs, as required by the No Child Left Behind Act, but not the digital skills that will enable them to translate those 3 Rs into success in today's Information Age.[67]

"The content-rich world in which we live requires bandwidth to view it."[68] Yet, according to the 2008 America's Digital Schools report, 37 percent of school districts anticipate a problem obtaining sufficient bandwidth and the majority have implemented policies to conserve bandwidth by limiting student Internet use.[69] Despite these problems, Internet proficiency is assumed at the college level, leaving many children at an educational disadvantage.

In no more than a few years more, hard-copy text books will cease to be printed in favor of electronic textbooks. This process is underway in Korea with a fixed deadline. The U.S. FCC has

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[66] For a full list of CAIs covered by EAGLE-Net, visit: http://www.co-eaglenet.net/btop/for-colorado-citizens/colorado-community-anchors-list/

[67] Jonathan Rintels, *supra* note 54, at 20.

[68] Edwin Wargo, "2008 Digital Schools Report and Bandwidth," The Brute Thing, May 16, 2008 (http://edtecheconomics.blogspot.com/2008/05/ed-tech-trends-report.html) (accessed Nov. 6, 2012).

[69] Meris Stansbury, "Researchers Identify Key Ed-Tech Trends," eSchoolNews, May 15, 2008. (http://www.eschoolnews.com/2008/05/15/researchers-identify-key-ed-tech-trends/) (Summarizing Thomas W. Greaves and Jeanne Hayes, "America's Digital Schools Report 2008: The Six Trends to Watch.")

challenged the private sector to enable this process by 2015.[70] Without adequate broadband, some rural school districts and students will be unable to access the text books required for learning.

American schools are migrating to one-to-one computer programs (also known as "ubiquitous computing"), whereby each student and teacher has one Internet-connected wireless computing device for use both in the classroom and at home. A 2006 survey found that 31 percent of superintendents are implementing ubiquitous computing in at least one grade, up from an historical average of four percent. Moreover, over 75 percent of superintendents recognized the potential benefits of one-to-one computing, agreeing with the statement that "ubiquitous technology can reduce the time, distance, and cost of delivering information directly to students and that teachers can spend substantially more one-on-one time with each student and personalize the education experience to each student's needs."[71]

By 2007, 78.7 percent of U.S. school districts reported moderate to significant improvement in one-to-one computing programs,[72] with potentially significant benefits for student learning. A 2006 report by America's Digital Schools found that one-to-one computing programs correlated with increased student retention and attendance, improved writing skills, and reduced disciplinary problems.[73] As Michael Davino, Superintendent of Schools in Springfield, New Jersey explains, "[a] wireless laptop program provides up-to-date information, access to virtual experiences, instant feedback, individualized attention for all learning styles, student independence, and constant practice. And it's highly adaptable to individual, small group, or whole class instruction."[74]

Many schools are using the Internet to expand course offerings. For instance, in Greenville, South Carolina, students are enrolling in an online Latin course taught by a teacher at another school in the district. Elsewhere, students can use the Internet to take higher level or better-quality courses than those available at their home schools.[75] The Greaves Group has found that many schools are even offering core courses over the Internet, with vocational technology (91 percent) leading, followed by science (78 percent) and social studies (76 percent). Online learning is often used for advanced-placement courses, including art and music (38 percent),

[70] "FCC Chairman Genachowski Joins Secretary of Education Duncan to Unveil New 'Digital Textbook Playbook,' A Roadmap for Educators to Accelerate the Transition to Digital Textbooks" (http://transition.fcc.gov/Daily_Releases/Daily_Business/2012/db0201/DOC-312244A1.pdf) (accessed Oct. 11, 2012).
[71] "America's Digital Schools 2006: A Five-Year Forecast," The Greaves Group and The Hayes Connection, at 15 & 18 (http://www.ads2006.net/ads2006/pdf/ADS2006KF.pdf) (accessed Nov. 6, 2012).
[72] Stansbury, *supra* note 69.
[73] "America's Digital Schools," *supra* note 71, at 15.
[74] *Id.* at 18.
[75] Rintels, *supra* note 54, at 21.

math (35 percent), and science (31 percent), which may not have sufficient student enrollment to support a live course.[76]

The Internet helps break down the walls of the classroom, allowing students to participate in virtual fieldtrips and better visualize their lessons. Students are going online and "touring the Smithsonian National Air and Space Museum, experiencing a tribal dance in Africa, or scouring the depths of the Pacific Ocean in a submarine." Users are exploring the digital archives at the Library of Congress and collaborating with students, professors and government officials in other states and around the world.[77]

Research by the International Society for Technology in Education and the Consortium for School Networking confirms that these applications have meaningful results. In particular, technology has:

- Led to measurable improvements in school performance (as measured on the Adequate Yearly Progress Tests under the No Child Left Behind Act of 2001).
- Improved attendance, decreased dropout rates, increased graduation rates, and allowed increased parental involvement.
- Improved school efficiency and productivity.
- Helped teachers satisfy professional requirements by helping develop lesson plans and providing continuing education opportunities.
- Enhanced students' problem-solving and independent-thinking skills.
- Enabled schools to meet the needs of special education children.
- Increased equity and access in education by creating learning opportunities for geographically isolated students.
- Improved workforce skills.[78]

Case studies bear out these benefits. For instance, elementary school students in the "Enhancing Missouri's Instructional Networked Teaching Strategies" (eMINTS) program consistently scored higher on standardized achievement tests than students who did not have access to the same technology. Participants' classrooms are equipped with a teacher's desktop computer and laptop computer, a scanner, a color printer, a digital camera, an interactive white board, a digital projector, and one computer for every two students. In New York, middle and high school students enrolled in the "Points of View media project" used broadband to access museums and historical collections, streaming video and video conferencing, and primary

[76] "America's Digital Schools," *supra* note 71, at 19.
[77] Rintels, *supra* note 54, at 21.
[78] "Why Technology in Schools?" Ed Tech Action Network (http://www.edtechactionnetwork.org/why-technology-in-schools) (accessed Nov. 6, 2012).

documents to explore the Theodore Roosevelt era. Seventy-five percent of program participants reported that they learned more than they would have from a traditional class.[79]

7.2 EAGLE-Net transforms Colorado libraries to digital community centers

EAGLE-Net will also connect at least 26 public libraries. Residents in these communities will realize significant benefits from broadband deployment to these facilities. Indeed, public libraries play a vital role in providing information access and fostering citizen participation.

Libraries have long served as "a premier Internet access provider in the continually evolving online culture."[80] In fact, a 2008 study found public libraries provided the only free Internet access in 72.5 percent of U.S. communities nationwide. This number rose to 82 percent in rural communities.[81] A 2012 study reaffirms the role of libraries as the sole public provider of free Internet access in the majority (64.5 percent) of American communities.[82]

Public libraries serve a variety of functions. They offer desktop workstations for Internet use, technical training, and access to locally relevant content. Public library Internet access is used for an array of reasons—job seeking, educational research, travelers looking to keep in touch with their families, and emergency information. Libraries play a key role in providing access, assistance and training through e-government sites and services. Public libraries also provide a safety net during disasters when Internet access may be limited elsewhere.[83] In light of this wide array of services, "the role of the public library as a stable Internet provider cannot be overestimated."[84]

Public libraries, however, are facing significant capacity constraints. Bandwidth requirements are growing as public use expands and matures, but libraries are unable to keep up. As Bertot, McClure and Jaeger report:

> Libraries may be struggling to meet demands as a result of a combination of factors such as the limits on physical space in libraries, the increasing complexity of Internet content, the continual costs of Internet access and computer maintenance, the inherent

[79] "Ed Tech and Student Achievement," Ed Tech Action Network. (http://www.edtechactionnetwork.org/student_achieve.html) (accessed Nov. 6, 2012).
[80] Marijke Visser and Mary Alice Ball, Dec. 2010, "The Middle-mile: The Role of the Public Library in Ensuring Access to Broadband," Information Technology and Libraries, at 193 (http://www.ala.org/lita/ital/sites/ala.org.lita.ital/files/content/29/4/visser.pdf) (accessed Sept. 28, 2012).
[81] *Id.* at 191.
[82] Information Policy and Access Center (IPAC), 2012, "Public Libraries and Broadband" (http://www.plinternetsurvey.org/analysis/public-libraries-and-broadband) (accessed Sept. 27, 2012).
[83] John Carlo Bertot, Charles R. McClure, and Paul T. Jaeger, 2008, "The Impacts of Free Public Internet Access on Public Library Patrons and Communities," *Library Quarterly* 78, no. 3, at 286 (http://mcclure.ii.fsu.edu/publications/2008/The%20impacts%20of%20free%20public%20Internet%20access%20on%20public%20library%20patrons%20and%20communities.pdf) (accessed Sept. 27, 2012) (citations omitted)
[84] Visser and Ball, *supra* note 80, at 192.

> limitations of the telecommunications grid, and the rising demands for bandwidth, processing speed, and numbers of workstations, among other factors.[85]

In recent years, libraries have expanded wireless access to allow for a larger number of users at limited workstations. While this allows more users to get online, it also creates additional traffic on limited bandwidth.[86]

Libraries are seeking ways to add bandwidth as applications become more intensive (e.g., streaming video, online communications, social networking tools), yet this growing need is seldom accompanied by a corresponding increase in budget or capacity. And while bandwidth has increased in recent years, this growth has been outpaced by the increase in bandwidth-hungry applications. Consequently, despite supposed high-speed connections, users may experience "slow connectivity and near dial-up speeds."[87]

Data from the Public Libraries and the Internet studies reveal a "'disconnect' between what their communities expect and what levels of Internet access that they are able to provide to their communities."[88] In fact, a 2012 study found that 41.1 percent of public libraries report that their connection speeds are insufficient to meet patron needs some or all of the time.[89] While this is an improvement from nearly 58 percent reporting inadequate speeds in a similar 2007 survey,[90] it reveals that additional bandwidth is needed. The data suggests that libraries have reached an "infrastructure plateau for provision of and access to Internet services."[91] This problem is only compounded by the economic downturn, as more people depend on libraries for free Internet access. As a consequence, infrastructure limits are being hit precisely at a time when consumer demand for library services is increasing.

While libraries have long served the role of "community guarantor of free public Internet access,"[92] they cannot meet these needs without public support. As Visser and Ball acknowledge, "[o]vercoming the challenges successfully will require support on the local, state, and federal level."[93] Indeed, "[w]hat else can the federal government fund that simultaneously serves so many educational, economic, employment, communication, government, and emergency preparedness functions?"[94]

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[85] Bertot *et al, supra* note 83, at 297.
[86] *Id.* at 292.
[87] Information Policy and Access Center (IPAC), *supra* note 82.
[88] Bertot *et al*, *supra* note 83, at 287.
[89] Information Policy and Access Center (IPAC), *supra* note 82.
[90] Visser and Ball, *supra* note 80, at 191.
[91] Bertot *et al., supra* note 83, at 297.
[92] *Id.* at 299.
[93] Visser and Ball, *supra* note 80, at 191-92.
[94] Bertot *et al., supra* note 83, at 300.