Northwest Colorado Council of Governments

Regional Broadband Strategic Plan

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OVERVIEW

For the purposes of supporting economic development, improving quality of life, and enhancing public safety, the Northwest Colorado Council of Governments will improve broadband in northwest Colorado with strategies that increase broadband capacity, improve broadband reliability, and lower broadband costs. These strategies include:

- Policy Efforts
  The COG will support public policies that enhance broadband competition, lower barriers to new broadband entrants, and encourage expansion of incumbent provider service areas.
  Some policy effort actions may include:
  P1 Assisting member jurisdictions to implement broadband friendly policies.
  P2 Supporting state legislation designed to extend high cost fund support to broadband development.
  P3 Working to ease state restrictions on municipal broadband projects in rural communities.
  P4 Developing and supporting primary and secondary revenue generating mechanisms to fund implementation and sustaining of broadband improvements.
  P5 Investigating the relative benefits of regional franchising vs. individual community franchising.
- Knowledge Efforts

The COG will engage in developing and disseminating information regarding broadband asset availability, broadband service availability, and enhancements to quality of life that can be had through broadband adoption.

Some knowledge actions may include:

K1 Working with GOIT to improve regional broadband mapping.

K2 Working with GOIT and other partners to develop resources to help subscribers find the best broadband services at prices that meets their individual needs.

K3 Implementing community education efforts to increase adoption rates and increase demand.

- Coordination Efforts

  The COG will maximize broadband capital spending efficiency in the region by coordinating public projects and working with private sector providers to encourage cooperative ventures.

  Some coordination effort actions may include:

  C1 Coordinating existing and future projects to enhance infrastructure investment efficiencies.

  C2 Facilitating interconnectivity between regional middle mile providers to enhance middle mile redundancy throughout the region.

  C3 Supporting development and execution of local community and county action plans.

- Deployment Efforts

  The COG will build, or cause to be built, broadband infrastructure targeted at providing relief to the greatest need areas, ensuring regional redundancy, enhancing public safety communications, and lowering barriers preventing private sector expansion or service improvement.

  Some deployment effort actions may include:

  D1 Establishing mechanisms to aggregate demand and by doing so improve service selection and reduce cost.

  D2 Implementing targeted infrastructure builds that lower existing barriers preventing private sector broadband companies from providing or improving services using RUS Rural Broadband loans or alternative funding.

  D3 Pursuing Community Connect Grants to extend service to currently unserved communities.

Pursuing these strategies will likely require that the Northwest Colorado Council of Governments establish a permanent broadband committee and may require the establishment of a regional telecommunications cooperative (501(c)(3) or other legal structure). Advancing efforts to improve broadband in the region will require capital expenditures and may require temporary subsidization and continuing sustaining revenue.

In this overview, we will briefly expand on these strategies and introduce, at a summary level, their associated potential actions. Before doing so, we would like to set the stage by summarizing the broadband strategic plan project; describing broadband, how it's delivered, and how northwest Colorado broadband compares with the rest of the state, the nation, and the world; and identifying barriers to broadband progress in the region.

The full plan more fully addresses these topics, offers alternatives to the courses of action described in this overview, and provides data supporting the conclusions we have made.

1.1 PROJECT OVERVIEW

The Northwest Colorado Council of Governments has undertaken to develop a regional broadband strategic plan with the intent of improving broadband throughout the region primarily for the sake of contributing to economic development but also to improve quality of life and contribute to public safety.

The study region includes all of the Northwest Colorado Council of Governments members (Eagle, Grand, Jackson, Pitkin and Summit Counties; most municipalities in those counties; Steamboat Springs; Glenwood Springs; and Carbondale). Additionally, the NWCCOG chose to invite Moffat, Rio Blanco and Routt Counties and they chose to participate.

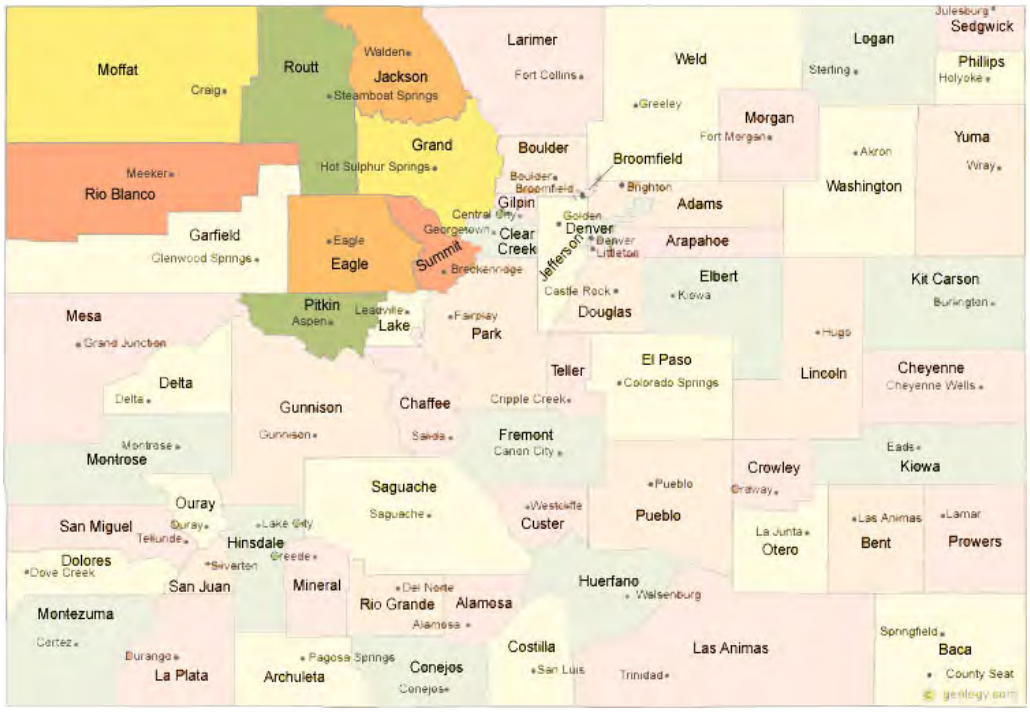

Figure 1: Study Region

The study region represents a significant geographic scope with wide ranging broadband development and economic needs. The effort undertaken here represents a regional strategic plan. The intent is that this regional broadband strategic plan can serve as a foundation for specific local actions – some of which are defined herein and others that may need to be developed by member jurisdictions (perhaps, "local action plans"). In the following, we will sometimes describe specific problems and their potential solutions; this is done to describe regional strategies and potential actions with examples from the region.

1.1.1 WHAT IS BROADBAND

As early as 1958 the Bell System implemented their dedicated line Data-Phone service which allowed high-speed transmission of data over regular telephone circuits. The first "Internet" was built in 1969 between UCLA, the Stanford Research Institute, UC Santa Barbara, and the University of Utah. Email was introduced in 1972. In 1986, Al Gore sponsored the Supercomputer Network Study Act and the groundwork was laid to move the Internet from a defense and research tool to a commercial platform. In 1990, Tim Berners-Lee brought the first "web" server online. In December of 1991, Paul Kunz brought the first US web server online at the Stanford Linear Accelerator Center.

But as the Internet got started, it was in the "slow" lane. From the first data connections in the late 50s through the development of the commercial Internet in the 90s, data was typically passed on dedicated lines or using dial-up modems to connect at 56 Kbps. In about 2000, broadband technologies started becoming widely available. First, ISDN services offered data speeds of up to 128 Kbps. Shortly on the heels of ISDN came DSL with data speeds above 1 Mbps and the DOCSIS standard which allowed for two way data transmissions on the cable companies' coaxial systems.

Today broadband speeds are delivered over the airwaves via fixed and mobile wireless, using a variety of DSL technology, over cable companies' coaxial networks, and at the speed of light over fiber optic cabling.

The literal definition of broadband has to do with the range of frequencies across which data signals travel. But for most people, broadband consists of two primary characteristics:

1. It is faster than dial-up service and
2. It is always on and doesn't interfere with voice calls.

The definition of adequate broadband speed is constantly shifting and will continue to for the near-term. As data capacity increases, application developers build services that take advantage of the new speed. As applications require more data transfer capacity, broadband network owners look for ways to increase speeds. On their Broadband.gov web site, the FCC states:

> *Broadband provides access to the highest quality Internet services—streaming media, VoIP (Internet phone), gaming, and interactive services. Many of these current and newly-developing services require the transfer of large amounts of data that may not be technically feasible with dial-up service. Therefore, broadband service may be increasingly necessary to access the full range of services and opportunities that the Internet can offer.*[1]

We like to joke that broadband is Internet access that is faster than whatever you have now. But in some senses, the joke is real. As we look at improving broadband in northwest Colorado, we want to come to a strategic plan that has potential to improve broadband for everyone. Those that have no broadband today would be greatly served to get a one or two Mbps wireless link; but those speeds

[1] Broadband.gov. "What is Broadband?" FCC. http://www.broadband.gov/about_broadband.html.

would not "provide access to the highest quality Internet services." To get the highest quality Internet services, subscribers need access to data speeds closer to the 20 or 30 Mbps range. Even at 20 to 30 Mbps many businesses and some residences find their broadband speeds to be inadequate. They struggle with their connectivity and hope for improvements that will lift them to above 100 Mbps. To attract data centers, call centers, and other data intensive businesses, 100 Mbps service is inadequate. Economic development may demand improving broadband to the 1 Gbps range or better. Even at these faster speeds, if the network isn't reliable, if it doesn't have diverse paths, or if costs are too high, communities are at a disadvantage when trying to attract and retain 21st century businesses. While the economic development director unable to attract a call center and the jobs it represents to her town and the potential subscriber outside the range of any broadband service have very different problems, they both have broadband problems.

1.1.1.1 WHY IS BROADBAND IMPORTANT

The Internet has become an integral part of many aspects of our lives. We bank online; we learn online; we keep in touch with our families online; we conduct business online. We share pictures of our cat and learn about the Arab spring online. We correspond with Town Council members about the sewer system and with the Vatican about clergy sex scandals online. We meet people who share our interests around the world and just down the street through online services. We book tour groups from Bulgaria to our resorts, control natural gas production based on international prices, and sell hay to the rancher across the valley – all online. Our doctors can review our x-rays with specialists in distant cities through broadband links. Our pharmacists can track our prescriptions and be more aware of potential medicinal conflicts through broadband links. As we age, we can use Internet connected health monitoring devices and services to stay in our homes longer. We can use Internet connected cameras to ensure the city park is empty before we use Internet connected switches to turn off the lights. The Internet can give us information about an AMBER alert, help us track the progress of a wildfire, and link our police officers to criminal databases from around the country.

The NWCCOG has made improving broadband a priority because of the high value broadband contributes to economic development, quality of life, and public safety.

1.1.1.2 BROADBAND DELIVERY

Broadband delivery shares some characteristics regardless of speed or specific infrastructure.

The Internet is sometimes called the "information superhighway" and it can be understood using a road analogy. Like the road system, the Internet has "highways" and "surface streets". On the information superhighway, the highways are called "middle mile" infrastructure and the surface streets are called "last mile".

Of course surface streets and freeways come in many varieties. Highways range from multi-lane interstate freeways to two-lane state highways. Surface streets can be major collector roads, neighborhood streets, or even driveways. The broadband road system has as just as much variety as the

streets. Because of this variety, we may sometimes need break last mile infrastructure into distribution level infrastructure (collector roads), access level infrastructure (neighborhood roads), or drop level infrastructure (driveways). We may need to talk about "off-ramps" or add/drop points on middle mile infrastructure. We may need to layer Internet access by local, regional, and national/international Internet service providers. When we need to do so, we will do our best to explain what we are talking about. For most of this regional broadband strategic plan, we are going to focus on middle mile and last mile and not worry too much about the variety in these categories.

To complete the analogy, we need one more piece. Just like the road system tends to channel vehicle traffic towards large population centers where multiple roads (and other transportation options) come together, broadband networks channel data traffic towards "peering points" or "Internet exchange points" (IXPs). Peering points are data centers where national and international broadband networks (called Tier 1 Networks) converge. At these peering points, Internet traffic can easily cross from one major network to another and, for the user, viewing a web page from South Africa can be just as easy as watching a movie hosted on a server in South Carolina; sending an email to your grandkids in Denver can be just as easy as video conferencing with your client in Dusseldorf.

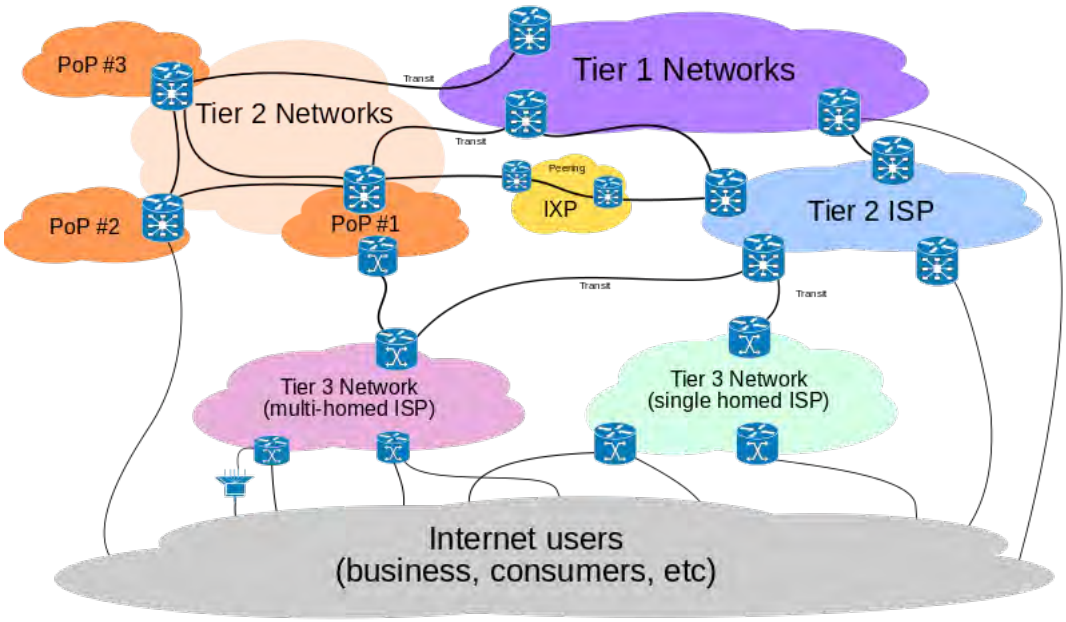

Figure 2: High Level Internet Diagram

"Figure 2: High Level Internet Diagram" depicts how these pieces interrelate. The black route lines at the bottom of the diagram (from the "Internet users" cloud) represent last mile infrastructure. The black route lines in between the local and regional ISPs (the pink and green clouds) and between the national and international networks (the purple, orange, and blue clouds) represent middle mile infrastructure.

Hopefully understanding a little about how broadband is delivered builds a frame around how the COG and its member jurisdictions might be able to improve broadband in the region.

1.1.2 THE BROADBAND PROBLEM IN NORTHWEST COLORADO

To get an understanding of the state of broadband in northwest Colorado, it is helpful to see how the US stands in international broadband comparisons, how Colorado compares to the rest of the US, and how northwest Colorado compares to the rest of the state. As we have shown, defining broadband can be a little difficult. When we try to compare broadband the challenge is even greater.

In one effort at international broadband comparison, the Said Business School at the University of Oxford published "Global Broadband Quality Shows Progress, Highlights Broadband Quality Gap" in October of 2009[2]. As per "Figure 3: International Broadband Comparison" Said compared countries based on broadband quality (meaning speed, reliability, and price) and penetration (meaning percentage of population subscribing to broadband services).

Figure 3: International Broadband Comparison

The Said study places the US in about the middle of the pack for developed countries. Some may argue that data from 2009 is ancient in Internet years. However, download speed data presented by Google

[2] Said Business School (October 2009). "Global Broadband Quality Study Shows Progress, Highlights Broadband Quality Gap." University of Oxford. http://www.sbs.ox.ac.uk/newsandevents/Documents/BQS%202009%20final.doc.

on the Google Analytics[3] site suggests that the US still falls at about the middle of the pack when it comes to download speeds.

Comparing Colorado with the rest of the nation reveals that the state sits at about the middle of the national pack. In December of 2012, TechNet produced "TechNet's 2012 State Broadband Index"; in it, Colorado ranks 22nd using TechNet's set of broadband measurement variables[4].

Within Colorado, northwest Colorado broadband speeds compare poorly to the Front Range. Both upload and download speeds are significantly lower than those enjoyed by Front Range communities. Based on surveys, we find:

	Northwest Colorado		Front Range	
	Download	Upload	Download	Upload
Public Schools	4.9 Mbps	2.8 Mbps	16.2 Mbps	9.2 Mbps
Libraries	3.3 Mbps	4.3 Mbps	100 Mbps	100 Mbps
Government Offices	4.8 Mbps	5.8 Mbps	81.0 Mbps	8.9 Mbps

Table 1: Northwest Colorado and Front Range Anchor Institution Broadband Speeds

In sum, we find northwest Colorado broadband sits at the tail end of a middling state in a middling country. The NWCCOG has decided that simply isn't good enough.

1.1.3 IMPROVING BROADBAND IN NORTHWEST COLORADO

So, the question is, can progress be made towards improving broadband in northwest Colorado? First, let's look at some of the barriers to making progress and then turn our attention to potential solutions.

1.1.3.1 BARRIERS TO PROGRESS

Broadband development in northwest Colorado faces natural and political barriers.

First, the rugged terrain and rural nature of northwest Colorado represent variables that contribute to broadband market failure. Broadband infrastructure requires significant capital investment – especially to cross mountains, to reach into canyons, and to cover large rural areas. In many cases, investing in difficult to build infrastructure to serve the low number of customers available simply does not meet the return on investment requirements of for-profit private sector businesses.

With telephone service, the high cost to deliver service is partly resolved through high cost fund support in which telephone providers receive state and federal subsidies to provide service where it simply does

[3] http://www.google.com/publicdata/explore?ds=z8ii06k9csels2_#!ctype=c&strail=false&bcs=d&nselm=s&met_y=avg_download_speed&scale_y=lin&ind_y=false&idim=country:LT:RO:IS:BG:RU:US&ifdim=country&hl=en_US&dl=en_US&ind=false

[4] Horrigan, John and Ellen Satterwhite (December 2012). "TechNet's 2012 State Broadband Index". TechNet. http://www.technet.org/wp-content/uploads/2012/12/TechNet_StateBroadband3a.pdf.

not make business sense. Some grant and other federal and state funds exist to support broadband but there is no program of comparable consistency or expansiveness as exists for telephone service.

Politically, Colorado's prohibition on government entities providing telecommunications services (CRS 29-27 – also known as Senate Bill 152) discourages government intervention. Many options are available to local governments within the constraints of the law but the constraints of the law are not clear. Many communities choose to avoid any intervention in telecommunications rather than risk crossing boundaries in the law that may or may not be there.

Finally, some may see the ever changing nature of broadband as a barrier to improving broadband in northwest Colorado. The goalposts keep moving. If the COG does nothing to alleviate today's broadband problems, in five years, the region will have a broadband problem. However, if the COG is able to take effective action to resolve the broadband problem today, in five years the region will have a broadband problem because target service levels will have changed.

1.1.3.2 WHAT CAN BE DONE

The NWCCOG intends to improve broadband in the region with the goal of enhancing economic development, contributing to the high quality of life enjoyed in the region, and to address public safety. The COG defines improving broadband as:

- **Increasing Capacity** – that is, extending broadband to places it may not currently be available, increasing bandwidth to all subscriber classes where it is available, or increasing the number of service providers offering service.
- **Decreasing Cost** – that is, decreasing subscriber cost per Mbps by reducing monthly cost for subscribers at the same level of service or increasing bandwidth without increasing subscriber costs.
- **Improving Reliability** – that is, ensuring service is nearly always available – whether a middle mile line has been cut or the town's population has tripled because of an event.

Regardless of the current state of broadband in any particular town or area within the region, the COG believes broadband can be improved.

Before looking at potential solutions, we should first address the question of whether government should be involved in broadband at all. There are legitimate arguments on both sides of the question. On the one hand, the government should only interfere with private business when the need is great. Telecommunications services have been provided in America by private enterprise since the first telegraph line was strung from Washington, DC to Baltimore. Over the decades, AT&T and the Bell Operating Companies built a legacy that remains strong in CenturyLink. With deregulation, some competition has entered into the marketplace. With the entry of Comcast into the broadband marketplace and the growth of fixed wireless and cellular broadband, an argument could be made that the free market will stabilize broadband delivery and meet the needs of the marketplace.

On the other hand, the free market is failing to meet the needs of the marketplace. Furthermore, physical infrastructure represents a natural monopoly structure. Finally, an argument can be made that, because of its integral place in commerce and quality of life, broadband should be treated like other universal service utilities. Market failures; natural monopolies; universal service requirements. These are areas that call for government intervention.

We understand the delicate nature of the question and do not recommend government involvement lightly. We believe the strategies and actions recommended for the COG address market failure, natural monopoly, and universal service.

We find many areas where government action could improve broadband throughout the region. However, resources simply do not exist to address every need. The COG should prioritize its efforts based on greatest need and greatest value.

Greatest Need

Greatest need projects are those projects that will extend any broadband to areas without broadband today or will provide fixed wire service where only cellular or wireless service is currently available.

When looking at extending broadband to areas without broadband today, the priority will first go to communities – that is towns or other census designated places where no service is available. Red Cliff, Redstone, Montezuma, and Maybell are examples of communities without service. Next, we will look at areas with high public safety needs like Highway 9 between Silverthorne and Kremmling.

The region has a number of wireless service providers who do a great job of extending broadband access to areas where it otherwise would not be available. Without the region's wireless providers, significant geographic areas could not receive any broadband service. Improving broadband will involve helping extend the reach of the region's wireless providers so they can serve even more potential subscribers. But fixed wireless coverage suffers from limitations when compared with wireline services. In particular, fixed wireless packages tend to offer lower data speeds and higher cost per Mbps. When looking at projects to extend broadband reach, we may include some projects that extend wireline service where fixed wireless service is currently available in order to increase capacity and reduce cost.

High need projects may have a significant impact on the residents of those areas where broadband remediation occurs. However, they may come at high cost and have low impact on economic development in the region.

Greatest Value

High value projects are to be selected based on the value they contribute relative to their cost. For example, if the COG is able to arrange and mediate conversations between middle mile network owners in the region and facilitate them connecting their networks, redundancy through the region would be greatly enhanced. Creating redundancy will limit the chances that communities will be cut off from the Internet because of damage to a fiber fifty or a hundred miles away. Middle mile redundancy is also a

critical feature for high data intensive businesses. Helping create a regional redundant network with multiple geographically diverse middle mile paths out of the region by getting regional middle mile infrastructure owners to cooperate represents a project with low cost and a very high return value.

1.1.4 RECOMMENDATIONS

So, what can actually be done? In spite of the barriers making broadband improvement in northwest Colorado difficult, the Northwest Colorado Council of Governments can implement a strategy that will contribute to increased capacity, improved reliability, and reduced cost. We propose the COG pursue policy, knowledge, coordination, and deployment efforts. To affect action in these areas, the COG should establish a permanent broadband committee and may need to sponsor an organization designed to implement broadband solutions.

1.1.4.1 POLICY EFFORTS

Public policy affects broadband deployment. The COG's policy strategy will be to support public policies that enhance broadband competition, lower barriers to new broadband entrants, and encourage expansion of incumbent provider service areas. Some policy effort actions may include:

P1 Assisting member jurisdictions to implement broadband friendly policies.
Broadband friendly policies (like "dig once" policies and easy access to rights of way and permitting) can significantly lower the cost of deploying and operating broadband infrastructure. Working with legal counsel, the COG should develop a set of "broadband friendly" policies or model ordinances that member jurisdictions can modify and implement.

P2 Supporting state legislation designed to extend high cost fund support to broadband development.
Colorado is in the process of reviewing its high cost fund support model and considering moving some funds to broadband service. We encourage this development but we also recognize that we cannot expand broadband on the shoulders of diminishing telephone revenue. The high cost fund should support broadband and broadband subscribers should contribute to the fund.

P3 Working to ease state restrictions on municipal broadband projects in rural communities.
CRS 29-27 (also known as Senate Bill 152) places restrictions on government entry into broadband. We believe SB 152 causes more problems for northwest Colorado communities than it solves. In "Broadband and Economic Development: A Municipal Case Study from Florida," George S. Ford and Thomas M. Koutsky demonstrate the measurable improvement to economic activity in Lake County due to the implementation of a generally available municipal fiber network. They conclude:

> *… our econometric model shows that efforts to restrict municipal broadband investment … could deny communities an important tool in promoting economic development. Municipalities build schools, roads, hospitals, parks, marinas and convention centers in*

> *order to attract businesses, jobs, and improve the quality life of their communities. Broadband investment is another form of infrastructure that could offer those and other community benefits. If further municipal investment is hindered or prohibited, the economic development boost Lake County seems to have received from its broadband investment would be denied to other communities. (p. 16)*[5]

Western Slope counties and communities should work to modify SB 152 to incorporate a rural exemption, a lack of competition exemption, a service level exemption, or some combination of the three. Achieving this objective will likely require coordination with other regional organizations like Club 20.

P4 Developing and supporting primary and secondary revenue generating mechanisms to fund implementation and sustaining of broadband improvements.
Primary revenue mechanisms include fees for service and other revenue that can be generated by COG of municipal owned infrastructure.
Secondary revenue generating mechanisms are efforts to shift some of the burden of broadband improvement to user classes that do not currently participate in the funding stream. For example, in the region's resort communities, significant broadband capacity and reliability is expected by visitors. Yet, these visitors do not pay for broadband service. The COG should look at mechanisms for adding room or other taxes to help fund broadband improvements.

P5 Investigating the relative benefits of regional franchising vs. individual community franchising.
Community franchising gives individual communities a regulatory tool they can use to influence the behavior of the primary broadband provider in many areas, the cable company. Unfortunately, most community officials have very little expertise when it comes to cable franchise agreements. The region's communities might benefit from "collective bargaining" of franchise agreements.

1.1.4.2 KNOWLEDGE EFFORTS

Broadband adoption helps drive demand and demand helps shape private sector provider behavior. The COG should engage in developing and disseminating information regarding broadband asset availability, broadband service availability, and enhancements to quality of life that can be had through broadband adoption. Some knowledge actions may include:

K1 Working with GOIT to improve regional broadband mapping.
It is important to keep data about the state of broadband in northwest Colorado up to date. This project has produced a map data set (available in a separate Google Earth KMZ file) but rather than maintaining redundant mapping efforts it would be prudent to work with GOIT to ensure the broadband mapping application and the pending asset map meet the COG's planning and management needs.

[5] Ford, George S. and Thomas M. Koutsky (April 2005). "Broadband and Economic Development: A Municipal Case Study from Florida". Applied Economic Studies: April 2005. http://www.aestudies.com/library/econdev.pdf.

Additionally, cellular service should be more widely surveyed. Some local jurisdictions in the region may have MobilePulse[6] licenses. We recommend continued use of the MobilePulse app and sharing of data in the region. The COG should inventory who has MobilePulse licenses and who does not and should work with jurisdictions with licenses to redistribute them throughout the region. Data collected from MobilePulse should be used to improve the information provided on the state broadband map. The COG should then work with regional cellular providers to implement infrastructure to close cellular gaps and improve service in weak signal areas.

K2 Working with GOIT and other partners to develop resources to help subscribers find the best broadband services at prices that meets their individual needs.
Information about service providers and service packages should be readily available to the public and economic development teams. If GOIT cannot expand their information resources to accommodate these reasonable needs, the COG or a COG sponsored entity should take on this task.

K3 Implementing community education efforts to increase adoption rates and increase demand.
As broadband improves in the region, demand will increase; as demand increases, broadband improvements will be required. By implementing community education efforts aimed at increasing awareness of the quality of life and business opportunities available from broadband, the COG can increase demand. The COG can then use increased demand in the region to help shape private sector provider behavior and to prioritize government sponsored improvements.

1.1.4.3 COORDINATION EFFORTS

The COG should maximize broadband capital spending efficiency in the region by coordinating public projects and working with private sector providers to encourage cooperative ventures. Some coordination effort actions may include:

C1 Coordinating existing and future projects to enhance infrastructure investment efficiencies.
In July of 2013, Colorado was one of the first five recipients of the NTIA State and Local Implementation Grant Program (SLIGP), receiving a $2.5 million grant with matching fund requirements. SLIGP funding will be awarded in two phases, with the first phase focused on such activities as expanding existing governance bodies to consult with FirstNet, conducting education and outreach to relevant stakeholders, and identifying potential public safety users.
The Governor's Office of Information Technology is taking the lead on Colorado's FirstNet efforts. While FirstNet's mission is to provide a nationwide network dedicated to public safety, GOIT has recognized that the assets deployed to support FirstNet can be used for other than public safety needs. We recommend the NWCCOG work carefully with regional organizations called on to provide information and support towards the development and deployment of FirstNet. A tendency may exist to perceive public safety broadband needs separately from other broadband needs. The COG should work aggressively to overcome this tendency.

[6] See http://www.mobilepulse.com/ for more information about MobilePulse.

Other publicly funded projects are underway or may happen in the region. The COG should work diligently to coordinate the multiple public projects to ensure the most efficient use of public funds in the region.

Privately funded projects may be harder to influence. However, by working well with incumbent providers, the COG may be able to influence private sector broadband improvement spending and to coordinate it with public projects.

C2 Facilitating interconnectivity between regional middle mile providers to enhance middle mile redundancy throughout the region.

In aggregate, the fiber paths in the region offer good regional egress diversity. Paths exist through Vernal to Salt Lake City, through Rifle to Grand Junction, and along at least two geographically diverse routes to Denver. Taking into consideration microwave links as well, diversity will be added to Cheyenne as well. Unfortunately, route diversity is largely owned by competing network owners and the competing network owners have not come to agreements to create diversity in their disparate networks by carrying each other's traffic.

We recommend working with the various network owners in the region to help them come to agreements to carry each other's traffic. Several of the network owners in the region have expressed an interest in doing so. Failing to get service providers to enter into traffic sharing agreements, towns may pursue carrier neutral locations and create redundancy for themselves. Of course, the utility of a CNL is limited to its subscribers.

C3 Supporting development and execution of local community and county action plans.

This regional plan and its recommendations may have some direct utility for individual member jurisdictions. We believe it is prudent to drive the broadband improvement effort to the local level while providing resources and tools at the regional level. Therefore, member jurisdictions should have local broadband action plans. These plans should be coordinated with one another to ensure efficient broadband development throughout the region.

1.1.4.4 DEPLOYMENT EFFORTS

The COG should build, or cause to be built, broadband infrastructure targeted at providing relief to the greatest need areas, ensuring regional redundancy, enhancing public safety communications, and lowering barriers preventing private sector expansion or service improvement. Some deployment effort actions may include:

D1 Establishing mechanisms to aggregate demand and by doing so improve service selection and reduce cost.

Middle mile data access prices are typically tiered with the cost per Mbps dropping dramatically as the volume of bandwidth purchased increases. However, Northwest Colorado is a rural area. The data demands an individual county or hospital put on middle mile infrastructure are limited. Disaggregated these customers seldom reach discount thresholds. Aggregating demand can serve to overcome some middle mile cost barriers.

Some demand aggregation mechanisms include carrier neutral locations and local metropolitan area networks.

D2 Prioritizing and implementing targeted infrastructure builds that lower existing barriers preventing private sector broadband companies from providing or improving services using RUS Rural Broadband loans or alternative funding.

For example, Jackson County could probably attract a fixed wireless service provider if middle mile infrastructure costs were reasonable, tower locations were in place, or other infrastructure investments were made to bring the service provider business model within return on investment bounds.

As another example, the middle mile highway infrastructure requires off-ramps in order for it to be regionally valuable. A business case may not exist to develop add/drop points but service providers may be willing to allow them if the capital expense is absorbed by the government. An example of where this might be needed is along Highway 9 between Silverthorne and Kremmling. CenturyLink fiber exists on this route but there are no add/drop points. The regional broadband cooperative might be able to invest in add/drop points and other infrastructure needed to provide cell service and broadband along this route.

The U.S. Department of Agriculture's (USDA) Rural Broadband Loan Program is administered by the Rural Utilities Service (RUS) of USDA Rural Development could be a source of loan funds for these projects. The program funds the costs of construction, improvement, and acquisition of facilities and equipment to provide broadband service to eligible rural areas on a technology-neutral basis. Direct loans are in the form of a cost-of-money loan, a 4-percent loan, or a combination of the two.

D3 Prioritizing and pursuing Community Connect Grants to extend service to currently unserved communities.

The Rural Utility Services Community Connect program serves rural communities where broadband service is least likely to be available, but where it can make a tremendous difference in the quality of life for citizens. The projects funded by these grants will help rural residents tap into the enormous potential of the Internet.

Unserved communities in the region are viable candidates for Community Connect grants. We recommend producing a preliminary cost estimate to bring service to each unserved community and then prioritizing projects based on cost per potential subscriber. As many Community Connect grants should be applied for as matching funds are available for.

1.1.4.5 STRUCTURE

Many of the actions needed to improve broadband in the region require significant effort, multi-jurisdictional coordination, or both. We recommend creating a regional broadband cooperative (a 501(c)(3) or other legal structure) to meet this task load. A regional broadband cooperative may also have the benefit of being a non-governmental agency and thus freed from the restrictions of SB 152.

1.2 ABOUT THE DOCUMENT

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1.2.2 DOCUMENT HISTORY

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1-2	26 Sep 2013	Recanzone	Version published to Steering Committee and regional vendors. • Changed overview to v 1-2 overview. • Began restructuring the document to match overview structure. • Continued development of incomplete sections. • Added initial survey data review in appendix "NWCCOG Online Survey".
1-1	17 Sep 2013	Recanzone	Added overview. Continued development of incomplete sections.
1-0	27 Aug 2013	Recanzone	Version for first Steering Committee review. Version still has some significant sections to be written.
0-1	21 Aug 2013	Recanzone	Version for Mid-State internal review

Table 2: Document History

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2 INTRODUCTION

Broadband is important. Through broadband, residents and business have access to the Internet and other tools that connect the far reaching corners of the world to their living rooms and inventories. The Northwest Colorado Council of Governments (NWCCOG) recognizes the importance of broadband and has made its improvement a focus for regional development.

2.1 PURPOSE

The Northwest Colorado Council of Governments has undertaken to develop a regional broadband strategic plan with the intent of improving broadband throughout the region primarily for the sake of contributing to economic development but also to improve quality of life and address public safety needs.

This regional broadband strategic plan focuses on improving broadband by increasing capacity, decreasing cost, and improving reliability.

It should be noted that, while out of the current scope, in order to achieve the objectives of contributing to economic development, improving quality of life, and enhancing public safety, broadband adoption should also be addressed. Quality (capacity and reliability) and value (cost) are not the only variables that prevent people from adopting broadband. Access to data devices, education, cultural bias, and other factors also affect broadband adoption.

2.1.1 STUDY REGION

The study region includes all of the Northwest Colorado Council of Governments members:

- Eagle, Grand, Jackson, Pitkin and Summit Counties
- Most municipalities in those counties
- Steamboat Springs
- Glenwood Springs
- Carbondale

Additionally, Moffat, Rio Blanco and Routt Counties chose to participate in the study.

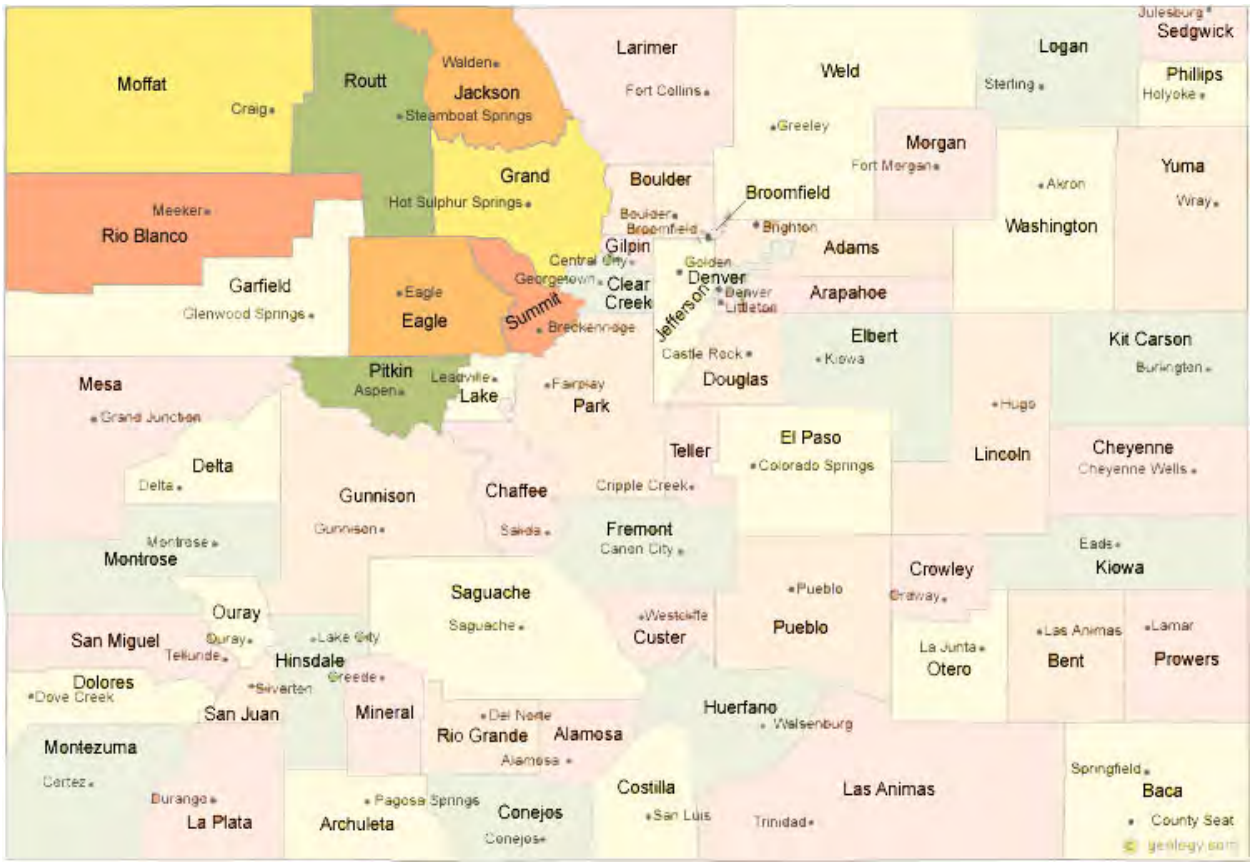

Figure 4: Study Region

The study region represents a significant geographic scope with wide ranging broadband development and economic needs. The effort undertaken here represents a regional strategic plan. The hope is that this regional broadband strategic plan can serve as a foundation for specific local actions (perhaps, "local broadband tactical plans").

2.1.2 IMPROVING BROADBAND

The NWCCOG defines improving broadband as:

- **Increasing Capacity**
  Increasing capacity may involve extending broadband to communities and areas where no service exists today; or it may mean increasing available bandwidth and service tiers to all subscriber classes in places where service is already available; or it may mean enabling additional last mile service providers to help generate the benefits of competition. In sum, increasing capacity simply means "making more" – making any broadband is more; making more broadband is more; making more competition is more.
- **Decreasing Cost**
  Decreasing cost may involve decreasing subscriber cost per Mbps by reducing monthly cost for subscribers at the same level of service. Or cost may be reduced by increasing bandwidth without increasing subscriber costs.
  It should be understood that sometimes subscribers will benefit from decreasing cost while paying higher monthly service bills. That is, a subscriber paying $55 per month for a 4 Mbps wireless connection ($13.75 per Mbps) may benefit from decreasing cost if they can subscribe to a $115 per month 105 Mbps cable connection ($1.10 per Mbps).
- **Improving Reliability**
  Improving reliability involves taking actions that ensure service is nearly always available. That is, addressing the causes of service failures whether those failures occur because a middle mile line has been cut or because the town's population has tripled because of an event.

2.2 SCOPE

In December 2012/January 2013 the COG solicited requests for proposals from qualified firms or individuals to assist NWCCOG staff in the development of a Regional Strategic Plan for Broadband. In February 2013 the COG entered into a contractual agreement with Mid-State Consultants of Nephi, Utah. Mid-State Consultants brought OHIvey into the agreement to assist with the plan development and presentation. In April of 2013 the COG Broadband Steering Committee met in a project planning seminar. As per the contract and the planning seminar, the Steering Committee established a project objective statement of, "The NWCCOG will research and develop a broadband strategic plan for participating jurisdictions before December 2013 for under $130,000 ($80,000 maximum contract value)."

Critical defining characteristics of the scope include the fact that the plan is 1) regional (as opposed to locality specific) and 2) strategic (as opposed to tactical). We have worked to ensure that we have produced deliverables that are both regional and strategic while avoiding abstracting them so much from the localities and implementation tactics that the plan and other deliverables are of no worth to the individual COG jurisdictions.

Key project deliverables are identified as:

- Assessment of needs, both infrastructure and services, through surveys, public meetings, and asset mapping (Needs Assessment).

- Educational workshops to ensure that the participants have the information needed on regulations, economics, and technology to develop a realistic plan (Education and Training).
- Identification of public and private projects already underway to address these needs (Current Projects).
- Address sustainability and maintenance of the network into the future (Sustainability).
- Strategic Plan Document (Strategic Plan).

2.2.1 NEEDS ASSESSMENT

Three primary tools were used to assess infrastructure and service needs:

1. Surveys
   Both service providers and subscribers were surveyed either through conversations or using the COG's online survey tool.
2. Public Meetings
   Public meetings were held to conduct training. These meetings also served as a forum for attendees to ask questions and provide feedback.
3. Asset Mapping
   Some of the broadband infrastructure in the region has been collected onto the associated Google Earth KMZ file "NWCCOG.KMZ". This data is more fully described in the "Google Earth Notes" section of the "Sources" appendix.

Broadband needs are in continual flux. It is easy to identify that an unserved area needs service. It is more difficult, though still feasible, to identify that an area that has access to 100 Mbps service requires redundancy in order to satisfy basic reliability conditions. It is far more difficult to assess subscriber needs. Regular broadband usage introduces subscribers to services they were not previously aware of. Application developers continue to devise new services that push current broadband capacity to its limits and beyond. Broadband creates new ways for businesses to reach their customers, for customers to buy goods and services, for neighbors to interact, for schools to teach their students, for fire departments to be alerted to emergencies and to respond. As broadband is more fully available in a community, it is more fully integrated into the lives and economies of the community; as broadband is more fully integrated into the lives and economies of the community, the need for reliability, speed, and affordability increases.

We feel the study has been successful in assessing certain needs. Other needs are so much in flux that not only have we not thoroughly captured them at this time but we feel that to do so would be a disservice to the goal of improving broadband. Let us say, for example, we determined delivering 4 Mbps download and 1 Mbps upload was what was needed in regards to improving broadband in the region. If, once we accomplished that goal, we were satisfied; we would be doing a disservice to the region.

2.2.2 EDUCATION AND TRAINING

In the second half of June the COG conducted ten training session around the region attended by more than 90 people. The training was designed to:

- Introduce the project to a wider audience,
- Help attendees understand what broadband is and why it's important,
- Describe how northwest Colorado broadband compares with the rest of Colorado, the US, and the world,
- Offer a high level introduction to how broadband is delivered, and
- Introduce some potential solutions.

To make the training more broadly available, we posted the presentation online at http://www.ohivey.com/test/training/intro1.php. A video presentation is also available on YouTube at http://youtu.be/_-J7qUee6wk.

The training was well received and we believe we were able to accomplish our education and training goals.

In addition to providing training, the training sessions offered a venue for feedback from the various communities.

2.2.3 CURRENT PROJECTS

We have compiled a list of the current projects we were able to identify in the "Public and Private Projects Underway or Planned" section starting on page 69. We are fully aware that this list is incomplete. ** It is very important that as the COG moves forward with actions to improve broadband that mechanisms are put in place to identify broadband improvement projects and to coordinate them to the greatest benefit for the region.

C1: Coordinating existing and future projects to enhance infrastructure investment efficiencies.

It is very important that as the COG moves forward with actions to improve broadband that mechanisms are put in place to identify broadband improvement projects and coordinate them to the greatest benefit for the region.

2.2.4 SUSTAINABILITY

As we discuss sustainability there are two facets that bear scrutiny:

1. What level of broadband service is required to support the economy and quality of life in the region? and
2. How can the region sustain needed broadband infrastructure – whether it is public or private?

We discuss the need for broadband and its contribution to the economy, quality of life, and public safety at length in the "Needs Assessment" section starting on page 7.

The question of sustaining needed broadband infrastructure depends heavily on how that infrastructure is deployed. Regardless of public or private deployment, we see the need to identify revenues required to maintain and improve service through time. We discuss sustainability in greater detail in the "Financial Modeling and Sustainability" section starting on page 129.

2.2.5 STRATEGIC PLAN

This strategic plan document represents the key deliverable of the project. We believe it represents a well-researched and carefully considered set of strategies and recommendations highlighted in the "Conclusions and Recommendations" section starting on page 144.

2.2.6 OTHER SUPPORTING EFFORTS

Associated with delivering the project objectives we have had the opportunity to provide other support activities. We understand the challenges associated with delivering fast, reliable, affordable broadband services in northwest Colorado. Nonetheless, we are optimistic that with careful actions the COG can have a significant positive influence.

3 NEEDS ASSESSMENT

This "Needs Assessment" section endeavors to define the broadband need in northwest Colorado by first establishing the value of broadband to the community at large and to the primary industries in the region, then by taking a summary look at current demand for broadband, and finally by surveying service availability.

3.1 BROADBAND VALUE

Broadband has value to the community at large and to primary industries in the region.

3.1.1 BROADBAND VALUE TO THE COMMUNITY/REGION

As we look at broadband value to the community at large, we will review economic development benefits and potential quality of life enhancements made available by fast, reliable, affordable bandwidth.

3.1.1.1 ECONOMIC DEVELOPMENT

The NWCCOG and its member jurisdictions are not necessarily interested in becoming broadband providers. Rather, the COG and its member jurisdictions hope to leverage improved broadband to grow economic development opportunities and improve quality of life throughout the region. Many studies indicate broadband enabled technologies enhance economic opportunity. In May of 2012 David Salway,

in an article for About.com suggests, "there is little debate that increasing broadband access spurs economic development, but can this be quantified?"[7] Salway then compiles a list of some of the leading research completed on the economic effects of broadband. Paraphrasing Salway's list:

- Robert Atkinson of The Information Technology and Innovation Foundation[8] claims in an Associated Press/USA Today article by Joelle Tessler that, "a $10 billion investment in broadband would produce as many as 498,000 new jobs."[9]
- In "The Effects of Broadband Deployment on Output and Employment: A Cross-Sectional Analysis of U.S. Data," Robert Crandall, William Lehr, and Robert Litan of the Brookings Institute, the authors determine that for every one percentage point increase in broadband penetration in a state, employment is projected to increase by 0.2 to 0.3 percent per year.[10]
- In "Broadband Infrastructure and Economic Growth," Nina Czernich, et. al. find that "a 10 percentage point increase in broadband penetration raises annual per-capita growth by 0.9-1.5 percentage points."[11]
- For a US Department of Commerce report, Gillete, et. al. estimated that between 1998-2002 communities that gained access to broadband service experienced an employment growth increase of 1% to 1.4%, a business establishment increase of 0.5% to 1.2%, and a rental value increase of 6%.[12]
- Kristen Van Gaasbeck, et. al. found in their "Economic Effects of Increased Broadband Use in California Research Report"[13] that "this analysis paints a clear picture of how increased broadband use (and the migration from dial-up to broadband) affects employment and payroll in California and a select group of its regions – the direction of the effect is always positive and the magnitude depends on the size of the shift in the percentage of the adult population using a broadband Internet connection. Even a small increase in broadband use could generate a substantial cumulative gain over the next 10 years compared to what could be expected under business as usual conditions." (p. 36)

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[7] Salway, David (May 2012). "Broadband as an Economic Driver." About.Com. http://broadband.about.com/od/economicdevelopment/a/Broadband-As-An-Economic-Driver.htm.

[8] http://www.itif.org/

[9] Tessler, Joelle (6 February 2009). "Broadband Funding in Stimulus Plan Sparks Debate." USA Today. http://www.usatoday.com/tech/news/2009-02-06-broadband-funding_N.htm.

[10] Crandall, Robert W., William Lehr, and Robert Litan (July 2007). "The Effects of Broadband Deployment on Output and Employment: A Cross-Sectional Analysis of U.S. Data." The Brookings Institute Issues in Economic Policy; Washington, DC. http://www.brookings.edu/views/papers/crandall/200706litan.pdf. http://www.brookings.edu/~/media/research/files/papers/2007/6/labor%20crandall/06labor_crandall.pdf.

[11] Czernich, Nina, Oliver Falck, Tobias Kretschmer, and Ludger Woessman (December 2009). "Broadband Infrastructure and Economic Growth." CESIFO Working Paper. http://www.cesifo.de/pls/guestci/download/CESifo%20Working%20Papers%202009/CESifo%20Working%20Papers%20December%202009/cesifo1_wp2861.pdf.

[12] Gillett, Sharon E., William H. Lehr, Carlos A. Osorio, and Marvin A. Sirbu (28 February 2006). "Measuring Broadband's Economic Impact." Prepared for the U.S. Department of Commerce, Economic Development Administration. http://cfp.mit.edu/publications/CFP_Papers/Measuring_bb_econ_impact-final.pdf.

[13] Van Gaasbeck, Kristin, Stephen Perez, Ryan Sharp, Helen Schaubmayer, Angela Owens, and Lindsay Cox (November 2007). "Economic Effects of Increased Broadband Use in California Research Report." Sacramento Research Institute. http://www.strategiceconomicresearch.org/AboutUs/EconEffectsBB_Research.pdf.

3.1.1.1.1 BROADBAND SPURS ECONOMIC DEVELOPMENT

In "Broadband and Economic Development: A Municipal Case Study from Florida[14]," George S. Ford and Thomas M. Koutsky compare economic activity as measured by gross sales receipts of Lake County, Florida and a set of similar counties[15]. In 2001 the City of Leesburg made its fiber optic network generally available throughout the County to community anchor institutions and private businesses. The purpose of Ford and Koutsky's study was to determine if the investment in generally available municipal broadband resulted in a measurable change in economic activity. Ford and Koutsky conclude:

> *Our study shows that Lake County has experienced approximately 100% [double] greater growth in economic activity relative to comparable Florida counties since making its municipal broadband network generally available to businesses in the county. (p. 4)*

Ford and Koutsky concede that private network owners were developing broadband in the comparison counties. They postulate:

> *Our findings provide support for the position that municipal broadband infrastructure may better serve the overall community than relying solely on private telecommunications firms. This is not to say that private firms do not provide quality service – indeed, the Lake County municipal system was constructed by private companies, the system leases capacity to private network providers, and customers use the system to supplement service from other providers (for example, Lake-Sumter Community College uses the municipal fiber network to deliver its educational television station to the local cable television company). But our analysis shows that since 2001, when the network was launched, Lake County has experienced a significant and sustained burst of economic activity relative to its peers, all of which have at least some private investment in broadband network. As a result efforts to restrict municipal investment in broadband stand the risk of removing a significant and substantial tool for cities and towns that want to grow their economies and develop their communities. (p. 4)*

In spite of anecdotal evidence indicating that broadband spurs economic development and research like Ford and Koutsky's and others[16], the hard truth of the matter is that it doesn't always work out that

[14] Ford, George S. and Thomas M. Koutsky (April 2005). "Broadband and Economic Development: A Municipal Case Study from Florida." Applied Economic Studies. http://www.aestudies.com/library/econdev.pdf.

[15] Lake County is suburban/rural county with a population of about 250,000 at the time of the study. The comparison counties include Broward, Charlotte, Highlands, Hillsborough, Manatee, Madison, Palm Beach, Sarasota, Seminole, and Suwannee. Comparison counties are a mix of demographics. Some of them are very similar to Lake County in population, others in size and density, others in economic activity per capita. The comparison counties were statistically selected to be those nearest Lake County in economic performance for the three years prior to Leesburg making its fiber network broadly available in the County.

[16] To list but a few, see, for example:

- Gillett, Sharon E., William H. Lehr, Carlos A. Osorio, and Marvin A. Sirbu (28 February 2006). "Measuring Broadband's Economic Impact." Prepared for the U.S. Department of Commerce, Economic Development Administration. http://cfp.mit.edu/publications/CFP_Papers/Measuring_bb_econ_impact-final.pdf.

way. The Utah Telecommunication Open Infrastructure Agency (UTOPIA) frequently claims its network is valuable to economic development and cites individual incidents of businesses that either move into the community or stay because of the all fiber network[17]. However, UTOPIA doesn't provide actual evidence of economic development results.

We should be able to look at census data[18] economic development indicators in UTOPIA cities and compare them with near neighbor non-UTOPIA communities and see a difference. Of course broadband doesn't directly influence the number or value of single family unit permits. Rather, SFU permits are a measure of economic development. Increasing volume and value of SFU permits is an indicator that other economic factors in the area are improving.

To conduct an evaluation of census available economic development indicators, first we collect information for the UTOPIA communities of Lindon, Midvale, Murray, Orem, Payson, and West Valley City (that is, those UTOPIA communities with operational network elements in place long enough to make a difference). Then we select non-UTOPIA near neighbors that are fairly comparable to their UTOPIA counterparts in size and other demographics. Those cities selected are Pleasant Grove, Riverton, Sandy, American Fork, Springville, and Salt Lake City respectively. To compensate for population and other differences, we look at the percentage change in each indicator from one set of census data to another (date ranges for the various indicators vary) rather than actual change.

- Qiang, Christine Zhen-Wei, Carlo M. Rossotto, and Kaoru Kimura (13 January 2009). "Economic Impacts of Broadband." In Information and Communications for Development pp 35-50. The World Bank. http://siteresources.worldbank.org/EXTIC4D/Resources/IC4D_Broadband_35_50.pdf.
- Singer, Hal J. and Jeffrey D. West (2 March 2010). "Economic Effects of Broadband Infrastructure Deployment and Tax Incentives for Broadband Deployment." Fiber to the Home Council. http://www.ftthcouncil.org/d/do/72.
- Bilbao-Osorio, Benat, Soumitra Dutta, and Bruno Lanvin, Editors (2013). "The Global Information Technology Report 2013: Growth and Jobs in a Hyperconnected World." World Economic Forum and INSEAD. http://www3.weforum.org/docs/WEF_GITR_Report_2013.pdf.

[17] See, for example:

- Utah Telecommunication Open Infrastructure Agency (26 November 2003). "White Paper: Utah's Public-Private Fiber-to-the-Premises Initiative." Utah Telecommunication Open Infrastructure Agency. http://broadband.cti.gr/en/download/Utah_fiber.pdf.
- Broadband USA Applications Database (26 March 2010). "Utah Telecommunication Open Infrastructure Agency Community Partnership Project." National Telecommunications & Information Administration. http://www.ntia.doc.gov/legacy/broadbandgrants/applications/summaries/5714.pdf.
- Broadband Properties (June 2012). "Municipal FTTH Deployment Snapshot: Utah Telecommunication Open Infrastructure Agency (UTOPIA)." Broadband Properties Magazine; May/June 2012. http://www.bbpmag.com/snapshot/snap0612.php.
- Coleman, Rick, James Behunin, and Matthew Harvey (August 2012). "A Performance Audit of the Utah Telecommunication Open Infrastructure Agency." Office of the Legislative Auditor General State of Utah. http://le.utah.gov/audit/12_08rpt.pdf.

[18] http://www.census.gov/.

In "Table 3: UTOPIA to Non-UTOPIA Economic Development Performance," in the "UTOPIA" column, we see the percentage change for each indicator in the first column for the time period indicated in the first column. The "Non-UTOPIA" column shows the same for the near neighbor cities. Finally, the "Difference" column depicts how much better (a positive number) or worse (a negative number) the UTOPIA cities performed compared to their near neighbor communities.

	UTOPIA	Non-UTOPIA	Difference
Housing	**-18.3%**	**-17.4%**	**-1.0%**
SFU New Permits (1996-2010)	-77.6%	-76.6%	-1.0%
SFU Permit Average Value (1996-2010)	79.4%	83.4%	-4.1%
SFU Permit Total Value (1996-2010)	-56.8%	-58.9%	2.1%
Employment	**22.0%**	**10.9%**	**11.1%**
Employment (2000-2010)	-28.6%	-32.1%	3.5%
# of Firms w/ Employees (2002-2007)	17.2%	14.0%	3.2%
# of Employees (2002-2007)	39.5%	17.6%	21.9%
Annual Payroll (2002-2007)	59.8%	44.0%	15.8%
Income	**-1.3%**	**9.7%**	**-11.0%**
Median HH Income (2000-2010)	18.8%	22.4%	-3.6%
Per Capita Income (2000-2010)	25.9%	32.3%	-6.4%
Individual Poverty (2000-2010)	-48.6%	-25.7%	-22.9%
Industry	**37.5%**	**49.3%**	**-11.8%**
# of Firms (2002-2007)	18.6%	25.5%	-6.9%
Sales (2002-2007)	56.5%	73.2%	-16.7%
Productivity	**5.1%**	**33.8%**	**-28.7%**
Sales / Payroll (2002-2007)	-2.1%	20.3%	-22.4%
Sales / Employees (2002-2007)	12.2%	47.3%	-35.1%
Average	**8.2%**	**13.3%**	**-5.2%**

Table 3: UTOPIA to Non-UTOPIA Economic Development Performance

"Table 3: UTOPIA to Non-UTOPIA Economic Development Performance" demonstrates that across all indicators except employment indicators and "SFU Permit Total Value" the UTOPIA cities have performed worse than their non-UTOPIA near neighbors. It is unreasonable to suggest UTOPIA has dampened economic development but there certainly is no evidence of the project improving the economies of its member cities.

What happened in the UTOPIA cities that prevented the economic activity doubling experienced by Lake County, Florida? Or was Lake County simply an anomaly?

Perhaps the doubling of economic activity over three years was anomalous. Nonetheless, the other research cited suggests broadband leads to economic development. Speedmatters.org writes[19]:

> *Studies show that each additional $5 billion investment in broadband creates 250,000 jobs – 100,000 direct and indirect jobs from telecom and IT equipment spending plus and another 150,000 in "network effects" spurring new online applications and services. With every percentage point increase in broadband penetration, employment expands by nearly 300,000 jobs.*
>
> *Jobs involved in the building and expansion of broadband networks pay 42 percent more than the average for manufacturing jobs in America.*
>
> *From 1998 to 2002, employment in communities with broadband grew 1 percentage point more than in communities without it.*
>
> *Broadband networks attract investment to areas that would not otherwise be viable to many businesses such as rural areas and inner-city regions.*

3.1.1.1.1.1 BROADBAND ECONOMIC DEVELOPMENT BEST PRACTICES

Research shows, broadband creates economic development. The striking performance in Lake County may be an anomaly; UTOPIA's lackluster economic development results certainly are. We can examine some lessons learned from these two projects and others to glean broadband economic development best practices.

- Know and Extol the Benefits
- Set and Meet Achievable Expectations
- Celebrate Successes
- Control the Dialogue

3.1.1.1.1.1.1 KNOW AND EXTOL THE BENEFITS

In order to achieve measurable economic development benefits, broadband projects must have an idea of the impact they hope to make – either as a primary result of the project or as secondary economic development results.

Primary results could involve improvements in attracting new businesses or in retaining existing businesses. Broadband may lead directly to new jobs, increases in productivity, or higher wages. All of these are good characteristics of economic development that can be a direct resultant from broadband improvement.

Secondary economic development benefits from deploying broadband can include such factors as increased new home starts, increased home values, increased post secondary education attainment and

[19] See http://www.speedmatters.org/benefits/archive/economic_growth_quality_jobs/.

improvements in other economic development indicators that occur because broadband is available and the economic environment is improving.

Of course, neither primary nor secondary economic development benefits occur in a vacuum. Many factors other than broadband have positive and negative effects on the economic environment. Nonetheless, knowing potential economic development benefits and advertising expectations (or extolling economic development benefits) helps drive the economy forward.

3.1.1.1.1.1.2 SET AND MEET ACHIEVABLE EXPECTATIONS

In order to achieve economic development, the community must set achievable goals and then work to accomplish them. Through setting achievable goals, communities can measure the direct benefits of broadband deployment. Furthermore, if progress is inadequate, corrective actions can be defined and pursued.

Some communities simply deploy broadband and then start casting about in the hopes of finding economic development indicators. While you may certainly discover unanticipated benefits, it is very difficult to measure change and honestly claim success from these "discovered" benefits.

3.1.1.1.1.1.3 CELEBRATE SUCCESSES

As goals are met and unanticipated benefits discovered, be sure to celebrate and advertise these successes. Success breeds success and as local newspapers and other media outlets document the benefits of broadband deployment the community will attract more development.

3.1.1.1.1.1.4 CONTROL THE DIALOGUE

One of UTOPIA's key failures was losing control of the dialogue early in the project process. UTOPIA convinced its participating communities that the project would represent a positive cash flow enterprise fund. This aspect of the project became the primary measure of success. Because profitability became the primary measure of UTOPIA's success, any effort to change the conversation and discuss the economic development benefits of the project felt like obfuscation.

3.1.1.1.2 POTENTIAL ECONOMIC DEVELOPMENT BENEFITS

Knowing and extolling the benefits is one of the important lessons learned from the UTOPIA experience. Of course better broadband means better access to virtual marketplaces – both to buy and sell – from around the world.

The potential for telework is also a very real economic development benefit of improving broadband.

Dependable, high-speed Internet access greatly improves the ability to work from home, or telework. This is often touted as the "most transformative" benefit of expanding broadband and especially of fiber to the premises. Indeed, telework confers a wide array of primary and secondary benefits, creating new

work opportunities and potentially offering cost savings to communities and their residents by reducing vehicle-operating expenses, the amount of time spent traveling, road repairs, and traffic congestion. In addition, by decreasing miles driven and gasoline burned, telecommuting benefits the environment and reduces GHG by lowering auto emissions. Where telework occurs full time, it can reduce demand for constructing office space and related electricity use.

"Universal, affordable, and robust broadband" is a "necessary prerequisite" for telework. In market research conducted by CTC in San Francisco[20], for example, 67 percent of respondents reported that they needed higher speeds than cable modem to telework and 70 percent of respondents indicated that they would telework more if they had sufficient broadband speed. Other studies support this finding. Indeed, fiber networks have quadrupled the amount of time employees spend working from their homes.

CTC's market research team conducted similar market research in Seattle, Washington in August 2008[21]. In total, CTC completed and analyzed telephone surveys of 301 randomly selected businesses and 381 randomly selected homes in the City. The surveys provided market information about Internet, telephone, and cable television services. The market research team asked a number of questions to establish the current working environment of Seattle's residents. These questions included working status, primary mode of transportation, distance traveled to work, and ability or willingness to telecommute on a daily or weekly basis.

Out of the households surveyed in Seattle:

- 73 percent of respondents work on a full- or part-time basis.
- 57 percent of respondents who work travel to work alone by car when they commute; of those, over 70 percent drive alone at least five days per week.
- The average one-way commute to work for respondents who drive alone is 10.2 miles and takes, on average, 21.3 minutes.
- Given that approximately 267,254 households are located in the Seattle area, 129,401 commuters drive alone in their vehicles sometime during the workweek.

CTC's market research confirms that Seattle residents require high-speed Internet access to support telework. As seen in "Figure 5: Internet Speed Needed to Telecommute", more than 54%of respondents indicated that speeds beyond cable modem/DSL are required for telecommuting (25% indicated speeds of 10 Mbps to 100 Mbps are required, 29% indicated speeds of 100 Mbps or greater are required).

[20] Columbia Telecommunications Corporation (January 2007). "Fiber Optics for Government and Public Broadband: A Feasibility Study." http://www.ctcnet.us/SFFiberFeasibilityReport.pdf.
[21] Columbia Telecommunications Corporation (September 2009). "Benefits Beyond the Balance Sheet: Quantifying the Business Case for Fiber-to-the-Premises in Seattle." http://www.seattle.gov/broadband/docs/SeattleFTTNBenefits_091109.pdf.

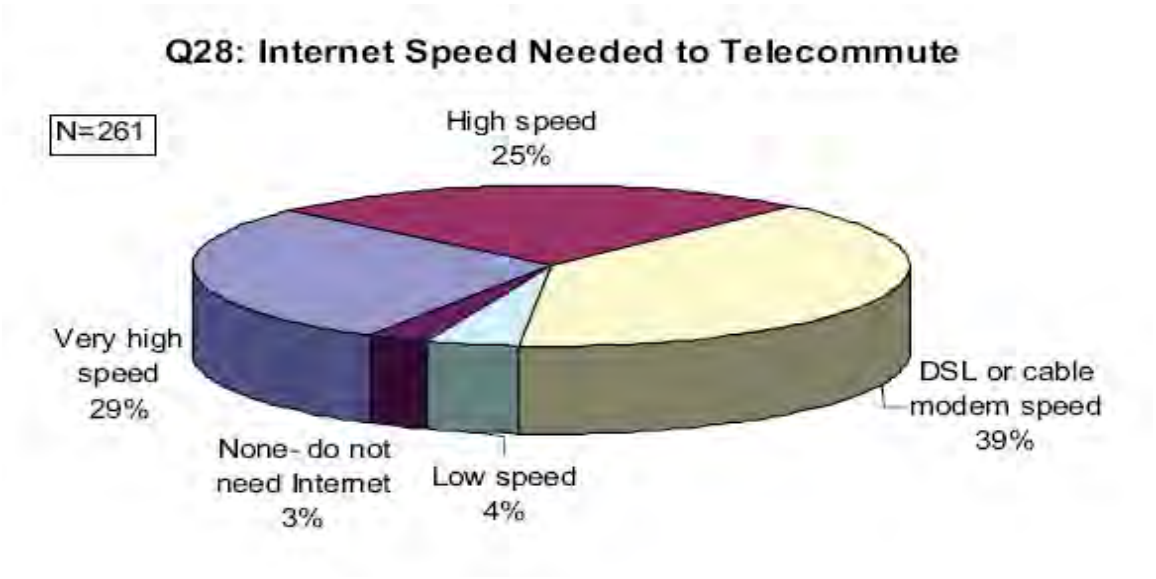


Figure 5: Internet Speed Needed to Telecommute

57% of respondents would be willing to telecommute at least one day per week if connection speed were not an issue. This is an increase of 20 percentage points over the number of workers who telecommute today (37% of Seattle workers telecommute at least occasionally today). CTC's market research clearly demonstrates a strong interest in telework, assuming adequate Internet access.

That interest may not be fully duplicated in northwest Colorado. Workers in the region would likely telework to their current occupations occasionally if given the opportunity and the resources to be able to do so. More likely, telework would open new employment opportunities as northwest Colorado residents could more effectively work on projects around the world. Some of the regions areas have large numbers of second or vacation homes. Telework could make it possible for the owners of these homes to spend more time in the region.

3.1.1.2 QUALITY OF LIFE

One of the primary purposes for developing the Northwest Colorado Council of Governments Broadband Strategic Plan is to enhance economic development in the region. As described above, broadband can certainly contribute to economic development. Broadband can also enhance quality of life.

3.1.1.2.1 BUILDING A SENSE OF COMMUNITY

Exceptional quality and capacity broadband driven to reasonable prices by real competition enables professionals to work around the world from their home office. But it is also having another interesting impact. Tim Harford writes[22]:

> *In a study published in the American Economic Review, researchers examined 4,000 US-based commercial innovations and found that more than half came from just three areas: California, New York/New Jersey, and Massachusetts. Almost half of all US pharmaceutical innovations were invented in New Jersey, a state with less than 3 percent of the nation's population.*
>
> *In theory, technology should allow new-economy firms to prosper as easily in Nebraska as in Silicon Valley. But far from killing distance, it has made proximity matter more than ever.*

Harford suggests this may be because, as Harvard economist Ed Glaeser argues, "technology and face-to-face interactions are complements like salt and pepper, rather than substitutes like butter and margarine. Paradoxically, your cell phone, email, and Facebook networks are making it more attractive to meet people in the flesh." In other words, our electronic lives enrich and enhance our personal lives and strengthen our communities.

Relevant to this point is the interesting fact Geoff Daily writes about in his AppRising article[23] that in Vasteras, Sweden (one of the first and largest open access fiber to the premises networks in the world):

> *Before this community fiber network was put in place, more than 80% of the traffic on local networks was outbound, pulling in and sending out information over the world wide web.*
>
> *After the fiber network came into being? That ratio basically flipped as now more than 80% of the bandwidth being consumed is for moving data around within the Vasteras network, so neighbors talking to neighbors rather than users pulling in data from all over the Internet.*
>
> *It should be noted that just because the percentage dropped, doesn't mean people on the network are consuming outlying Internet content less. Instead, it's a sign of just how massively demand for bandwidth in-network has grown, literally more than a thousandfold."*

While nay-sayers suggest the digital age is damaging human relations, the evidence shows otherwise. True choice of true broadband appears to actually increase local interaction and build a sense of community.

[22] Harford, Tim (18 January 2008). "How Email Brings You Closer to the Guy in the Next Cubicle." Wired; Issue 16 Volume 2. http://www.wired.com/culture/lifestyle/magazine/16-02/st_essay.
[23] Daily, Geoff (28 January 2008). "Internet Reinforces Local Bonds." AppRising. Viewed 1 March 2012 at http://www.app-rising.com/2008/01/internet_reinforces_local_bond.html.

3.1.1.2.2 EDUCATION

No amount of technology can ever replace the powerful impact of a teacher interacting face to face with a student one on one or in reasonably sized classrooms. But even the best of teachers can augment the education they offer with online resources. Furthermore, true broadband can bring critical training resources and those in need of the training together more often and in more ways than can be imagined.

Broadband enables educational applications for students, parents, and professionals. A 2009 survey conducted in Colorado demonstrated the need for broadband for currently available services:

K-12 Bandwidth Application and Software Analysis

Model Basis
250 Students; 12 Teacher/Admin; 260 Computers; 12 VoIP Phones; 10/100 Ethernet LAN
Dynamic Use - 260 Computer Users using one or more Applications simultaneously across LAN and Internet

Application *	Per User*	One T-1 (1.5 Mbps)	Two T-1s (3 Mbps)	Four T-1s (6 Mbps)	10 Mbps Ethernet	20 Mbps Ethernet
VoIP	50 kbps	Full Functionality	Full Functionality	Full Functionality	Full Functionality	Full Functionality
Email and Web Browsing	50 kbps	Full Functionality	Full Functionality	Full Functionality	Full Functionality	Full Functionality
Audio Streaming (MP3)	100 kbps	Problematic	Full Functionality	Full Functionality	Full Functionality	Full Functionality
School Portal	100 kbps	Problematic	Problematic	Full Functionality	Full Functionality	Full Functionality
Student Created Content	150 kbps	Unable to utilize with concurrent users	Problematic	Full Functionality	Full Functionality	Full Functionality
Online Learning	150 kbps	Unable to utilize with concurrent users	Unable to utilize with concurrent users	Problematic	Full Functionality	Full Functionality
Virtual Field Trips	150 kbps	Unable to utilize with concurrent users	Unable to utilize with concurrent users	Problematic	Full Functionality	Full Functionality
Web/School 2.0 Tools	250 kbps	Unable to utilize with concurrent users	Unable to utilize with concurrent users	Unable to utilize with concurrent users	Full Functionality	Full Functionality
Online Assessment	250 kbps	Unable to utilize with concurrent users	Unable to utilize with concurrent users	Unable to utilize with concurrent users	Full Functionality	Full Functionality
TV-Quality Streaming Video (320 x 240)	250 kbps	Unable to utilize with concurrent users	Unable to utilize with concurrent users	Unable to utilize with concurrent users	Full Functionality	Full Functionality
Interactive Video at a Desktop Standard Definition Good Quality	250 kbps	Unable to utilize with concurrent users	Unable to utilize with concurrent users	Unable to utilize with concurrent users	Problematic	Full Functionality
DVD Quality Streaming Video (640 x 480)	1040 kbps	Unable to utilize with concurrent users	Unable to utilize with concurrent users	Unable to utilize with concurrent users	Problematic	Full Functionality
1/2 HD Quality Streaming Video (1024 x 720)	4977kbps	Unable to utilize with concurrent users	Unable to utilize with concurrent users	Unable to utilize with concurrent users	Unable to utilize with concurrent users	Full Functionality
H.264 HD (1080 P) Video Conference	6000 kbps	Unable to utilize with concurrent users	Unable to utilize with concurrent users	Unable to utilize with concurrent users	Unable to utilize with concurrent users	Problematic
Full HD Quality - Streaming Video (1920 x 1080)	13998 kbps	Unable to utilize with concurrent users	Unable to utilize with concurrent users	Unable to utilize with concurrent users	Unable to utilize with concurrent users	Problematic

KEY
- Full Functionality
- Problematic
- Unable to utilize with concurrent users

Figure 6: Broadband Use for Current K-12 Applications

Of course, as technology continues to develop, the need for broadband to support education will become ever greater.

Colorado's schools are moving to online core curriculum testing. The Partnership for Assessment of Readiness for College and Careers (PARCC) has released its "Technology Guidelines for PARCC

Assessments: Version 3.0"[24] In the guidelines, PARCC recommends 100 Kbps per student or faster connections or about 1 Mbps per 10 students. Looking at connection speeds listed in "Figure 6: Broadband Use for Current K-12 Applications", schools could simultaneously test as follows:

Speed	Simultaneous Tests
One T1 (1.5 Mbps)	15
Two T1s (3 Mbps)	30
Four T1s (6 Mbps)	60
10 Mbps Ethernet	100
20 Mbps Ethernet	200

Table 4: Simultaneous School Assessment Tests by Bandwidth

The nation's schools suffer from inadequate Internet access and IT training. For most, access is too slow with insufficient bandwidth to allow creative and expansive online learning, such as video conferencing or collaborative work. Schools with constrained bandwidth have limited options for classroom use of IT applications such as streaming video. 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.*[25]

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 district school. Elsewhere, students can use the Internet to take higher level or better-quality courses than those available at their home schools. The Internet helps break down the walls of the classroom, allowing students to participate in remote classes and in virtual field trips. 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.[26]

[24] Partnership for Assessment of Readiness for College and Careers (September 2013). "Technology Guidelines for PARCC Assessments: Version 3.0". Partnership for Assessment of Readiness for College and Careers. Viewed 8 November 2013 at http://www.parcconline.org/sites/parcc/files/TechnologyGuidelinesforPARCCAssessmentsV3.0Sept2013.pdf.

[25] Rintels, Jonathan (2008). "An Action Plan for America: Using Technology and Innovation to Address our Nation's Critical Challenges: A Report for the new Administration from the Benton Foundation." Benton Foundation. http://benton.org/sites/benton.org/files/Benton_Foundation_Action_Plan.pdf.

[26] Rintels, Jonathan (2008). "An Action Plan for America: Using Technology and Innovation to Address our Nation's Critical Challenges: A Report for the new Administration from the Benton Foundation." Benton Foundation. http://benton.org/sites/benton.org/files/Benton_Foundation_Action_Plan.pdf.

According to the "America's Digital Schools 2008", 37% of school districts anticipate a problem obtaining sufficient bandwidth and the majority have implemented policies to conserve bandwidth by limiting student Internet use[27]. Nonetheless, Internet proficiency is assumed at the college level, leaving many children at an educational disadvantage.

Outside of traditional classroom environments, broadband enables adult continuing education and professional development by bringing instructors and students together without travel costs.

3.1.1.2.3 REDUCED COST AND ENHANCED QUALITY OF HEALTHCARE

The US healthcare system is expensive, overburdened, and inefficient. In 2006, national healthcare costs grew 6.7 percent to $2.1 trillion, or $7,026 per person, and accounted for 16 percent of gross domestic product (GDP). Similar growth is projected to continue until 2017, at which point healthcare will account for nearly 20 percent of GDP. Some of this expense can be attributed to the inappropriate reliance on costly hospital emergency rooms, which are often sought after traditional office hours or in communities with a shortage of physicians. In fact, over half (55 percent) of the 114 million emergency room visits Americans make each year are for non-emergencies, accounting for $31 billion annually, or $300 per American household. Broadband technology can dramatically reduce these expenses by providing the tools to remotely monitor patients, allow collaboration between medical professionals, facilitate the transfer of medical data and images, and increase access to emergency services in remote areas. By one estimate, these services can lead to savings of $165 billion per year. "Always-on broadband" is "essential" for some of these applications and greatly improves others that "depend on uninterrupted real-time transmission."

3.1.1.2.3.1 MEDICAL INFORMATION

Broadband can allow users to access medical information online, avoiding costly trips to medical professionals. Approximately 20,000 health-related websites provide information to the more than three-quarters of online Americans who access medical information over the Internet. More than 10 percent of broadband users use the Internet for this purpose on a given day. Broadband users can also avoid scheduling (and driving) to multiple appointments by using the Internet to get a second opinion based on their medical records or by exchanging e-mails with their doctors. Notably, Kaiser Permanente reduced appointments with primary care physicians by 7 percent to 10 percent by allowing its enrollees to e-mail questions to their doctor through a secure messaging system. Thirty-seven percent of Kentucky broadband users report that access to online information has saved them an average of 4.2 unnecessary trips for medical care in a single year.

[27] Greaves, Thomas W. and Jeanne Hayes (2008). "America's Digital Schools 2008: The Six Trends to Watch." The Greaves Group; The Hayes Connection. http://www.schooldata.com/pdfs/ADS08_intro.pdf.

3.1.1.2.3.2 REMOTE HEALTH MONITORING

Telehealth holds particular promise for remote monitoring of chronic conditions. Nearly half of Americans (45 percent or 130 million people) suffer from at least one chronic condition, such as arthritis, asthma, cancer, depression, diabetes, heart disease, and obesity. Combined, treatment of these conditions accounts for 75 percent of healthcare spending—$1.5 trillion annually. Despite this enormous expense, most Americans with chronic conditions suffer from inadequate treatment. For instance, according to the National Center for Policy Analysis, less than one-fourth of patients with high blood pressure control it adequately. Twenty percent of patients with Type-1 diabetes fail to see a doctor annually, with 40 percent of diabetics failing to regularly monitor their blood sugar level or receive recommended annual retinal exams.

Through remote health monitoring, tens of millions of Americans can manage and address their chronic illnesses at dramatically lower cost. In fact, both the Benton Foundation and the University of Texas estimate that remote monitoring could lower hospital, drug, and outpatient costs by 30 percent, reducing the length of hospital stays from 14.8 days to 10.9 days, office visits by 10 percent, home visits by 65 percent, emergency room visits by 40 percent, and hospital admissions by 63 percent.

Remote-monitoring applications are incredibly varied. Patients with chronic obstructive pulmonary disease can improve lung function with the use an inhaler and monitor airflow to and from their lungs with a spirometer, lowering hospital readmissions to 49 percent as compared to 67 percent for patients lacking home monitoring. Similarly, remote monitoring of a group of congestive heart failure patients in one study cut rehospitalizations in half over a six-month period. Diabetics in Pennsylvania using home monitoring systems for their glucose levels were able to reduce hospitalization costs by more than 60 percent from a control group with traditional in-person nurse visits. The Veterans Administration reports similar savings from its home-monitoring system, which has reduced emergency room visits by 40 percent and hospital admissions by 63 percent. As discussed later, remote monitoring holds particular promise for the elderly, by allowing them to defer or avoid institutionalization, thereby enhancing quality of life and reducing medical costs.

3.1.1.2.3.3 LOWERED MEDICAL TRANSPORTATION COSTS

Broadband can also reduce transportation costs between medical facilities by allowing doctors to remotely monitor patients and collaborate with one another. As the Center for Information Technology Leadership (CITL) notes in "The Value of Provider-to-Provider Telehealth Technologies"[28], widespread adoption of telehealth technologies can "bring the collective wisdom of the entire healthcare system to any patient, anywhere, any time," allowing "quantum leaps in the efficiency of the healthcare system." These efficiency gains are accompanied by dramatic cost savings.

In fact, CITL estimates that telehealth technologies can prevent:

[28] Center for Information Technology Leadership (2007). "The Value of Provider-to-Provider Telehealth Technologies." Healthcare Information and Management System Society (HIMMSS); Charlestown, MA. Google books extract at http://books.google.com/books?id=mn0oaG-0zfgC&printsec=frontcover#v=onepage&q&f=false.

- 39 percent (850,000) of transports between emergency departments, with an annual savings of $537 million.
- 43 percent (40,000) of transports from correctional facilities to emergency departments and 79 percent (543,000) of transports from correctional facilities to physician office visits, with an annual savings of $280 million.
- 14 percent (387,000) of transports from nursing facilities to emergency departments and 68 percent (6.87 million) of transports from nursing facilities to physician office visits, with an annual savings of $806 million.

It should be noted that the costs and benefits associated with avoided medical transport are not necessarily borne by the same people. The underlying costs of installing the telehealth technology are borne by the physician office or hospital. Savings associated with avoided transports because of this technology, however, accrue to the payer, which (with the exception of correctional institutions), is likely the patient, the state, or insurance provider. Moreover, these savings will only accrue if both institutions (e.g., the correctional facility and hospital) have adequate bandwidth.

3.1.1.2.3.4 IMPROVED MEDICAL EFFICIENCIES

Broadband can help cut costs by improving efficiency in a number of ways. In hospitals, remote monitoring with high-resolution video allows a single doctor to simultaneously observe and treat multiple patients. The American Consumer Institute reports that this application reduced ICU deaths by 50 percent at Johns Hopkins. The potential benefits of telemedicine outside a single institution are even greater. Because the current medical system is fragmented, doctors seldom have comprehensive information about a patient's medical history, leading to costly and invasive duplicate procedures. This disjointed system means that "[p]atients may be treated at multiple locations by multiple doctors who keep multiple paper records and fill out multiple paper forms seeking reimbursement from multiple insurance carriers." By creating a universal repository for medical records, caregivers can coordinate treatment, easily provide second opinions, streamline billing, and avoid duplicative procedures. Online access to medical records could help doctors avoid such inefficiencies, with savings totaling $81 billion annually—or $670 per household. Of course, these savings will require a significant up-front investment from medical professionals who will have to upload medical histories and transition to electronic record keeping[29].

3.1.1.2.4 AGING IN PLACE AND OTHER SUPPORTS FOR SENIORS

In 2005, 12 percent (35 million) of the U.S. population was over 65. By 2030, that number will rise to 21 percent (71 million). This growing demographic also represents a rapidly growing segment of the broadband market. In fact, the Pew Internet and American Life Project reports that the largest increase in Internet use since 2005 occurred in the 70- to 75-year-old age group, with online use for this age

[29] Rintels, Jonathan (2008). "An Action Plan for America Using Technology and Innovation to Address Our Nation's Critical Challenges." Benton Foundation; Washington, DC. http://benton.org/sites/benton.org/files/Benton_Foundation_Action_Plan.pdf. pp 17-18.

group increasing from 26 percent in 2005 to 45 percent in 2009. Broadband use has increased by about half for Americans ages 12 to 24, roughly doubled for 25- to 64-year-olds, and more than tripled for seniors 65 and older. Notwithstanding this dramatic increase, broadband use by seniors 76 and older remains relatively low, at only 16 percent. By contrast, 61 percent of those aged 50 to 64 have broadband at home. Broadband use will undoubtedly continue to rise as younger users age. This provides a tremendous opportunity for extending the benefits of broadband access. Moreover, communities can help expand these benefits by accelerating broadband development and promoting its use among seniors.

Broadband promises a range of applications that can benefit an aging population. In particular, broadband access can lower medical costs and prevent hospitalization through home-based monitoring; extend employment opportunities through telework; and foster ongoing relationships by allowing homebound seniors to connect to the outside world. These benefits translate to dramatic savings in Medicaid and Medicare expenses for the federal and state governments, reduced demand for limited space in hospitals and long-term care facilities, and increased income and savings for residents. Because 60 percent of U.S. healthcare spending is on seniors, initiatives that target this population translate to significant government savings. In fact, considering only three categories of benefits (lower medical costs, lower costs of institutionalized living, and additional output generated by more seniors and individuals with disabilities in the labor force), economist Robert Litan identified up to $927 billion in cost savings and output benefits from “business as usual” broadband deployment and an additional $532 billion to $847 billion in economic benefits from accelerated broadband deployment. Even the low end of this estimate is equal to half of what the United States currently spends annually for medical care for all its citizens ($1.8 trillion).

3.1.1.2.4.1 MEDICAL COST SAVINGS FOR SENIORS

Broadband access allows seniors to search for medical information online, rather than scheduling costly appointments with their physicians. Approximately 20,000 medical websites exist for online research, with a substantial subset targeted toward senior users. For instance, both the Mayo Clinic and the National Institutes of Health (NIH) have Web pages dedicated to senior health information. Similarly, AARP recently launched a series of online tools designed to help seniors select a physician or hospital and understand and diagnose their symptoms. Seniors are already taking advantage of these services. Pew estimates that 70 percent of online adults (ages 64 to 72) and 81 percent of those aged 55 to 63 have used the Internet to find medical information. Seniors are more likely to seek information online if they have a dependable, high-speed broadband connection. Such access empowers seniors by allowing them “to be preemptive and interactive in their efforts to combat the harmful effects of aging.” It also translates to reduced medical expenses. In fact, as noted previously, Kaiser Permanente found that allowing enrollees (of all ages) to e-mail questions to their doctor through a secure messaging system led to a 7 percent to 10 percent reduction in primary care visits.

Broadband also reduces medical costs for seniors by facilitating remote monitoring. Through the use of remote monitoring devices like ECG electrodes or blood glucose sensors, healthcare providers can

continuously observe cardiac performance, food intake, and glucose levels, without requiring costly medical examinations or hospitalization. One study reports that 3.4 million seniors will be using such devices by 2012. Remote monitoring is particularly useful for chronic diseases (such as coronary heart disease, chronic obstructive pulmonary disease, mental health disorders, diabetes, hypertension, and asthma), which require continued medical care and coordinated treatment among physicians. Chronic illness is prevalent among seniors. In fact, 45 percent of Medicare beneficiaries nationwide suffer from at least one chronic condition, representing nearly 80 percent of national healthcare spending—more than $1 trillion each year. Economist Robert Litan estimates that remote monitoring could cut Medicare expenses for the chronically ill by 30 percent, or $350 billion each year. As indicated previously, data from the Veterans Administration supports this estimate. The VA has cut hospital admissions by up to 60 percent for participants in its remote monitoring program, which relies on a network of "care managers" who track patient data online and contact participants if records indicate a need for immediate medical attention.

3.1.1.2.4.2 REDUCED COST OF INSTITUTIONALIZED LIVING

Medical monitoring enabled by broadband may also delay and potentially eliminate the need for institutionalized living, with dramatic savings. As of 2002, 5 percent of Medicare-eligible seniors (1.6 million) lived in nursing homes. This number is expected to increase as baby boomers retire and life-span increases. In fact, 44 percent of seniors will live in nursing homes at some point during their lifetime. This care comes at a significant cost. In 2004, the federal government spent $135 billion on long-term care for the elderly. Nationally, the annual cost is nearly $78,000 for a private room in a nursing home.

Internet applications that are designed to "sharpen brain function" could lead to even greater potential savings. (At a minimum, these applications can help reduce isolation and depression among seniors.) Neurologists have reported that mental exercises, like puzzles, logic games, and reading material available for free through the Internet, can reduce an individual's chance of developing Alzheimer's disease by 70 percent. Accessing such sources of "mental exercise" online also means that elderly people with limited mobility are not dependent on driving to a store or library to get what they need. According to one analysis, "interventions that could delay the onset of Alzheimer's disease by as little as one year would reduce prevalence of the disease by 12 million fewer cases in 2050." Because Alzheimer's and dementia currently cost the United States more than $148 billion annually in Medicaid and Medicare services, the potential savings are significant. In addition to these economic benefits, such applications will help allay the concerns of nearly 60 percent of seniors who worry about "staying 'mentally sharp.'"

3.1.1.2.4.3 INCREASED SENIOR PRODUCTIVITY THROUGH TELEWORK

Seniors represent a sizable and growing percentage of the workforce. According to the U.S. Census and the Bureau of Labor Statistics, 14.8 percent of seniors (ages 65 and up) were working or looking for work in 2005. These numbers are projected to increase given the current economic crisis, which has affected

retirement savings; trends away from defined pension plans; and longer life expectancies, which increase the amount of savings required to sustain a constant quality of life into retirement. According to the Social Security Administration's actuarial office, delayed retirement is expected to increase the U.S. labor force by one million additional workers, or 1.5 percent, by 2030. Several analyses by the Urban Institute project an additional 6.2 million workers (4.4 percent). Assuming that the midpoint of these estimates can "plausibly" be "attributed to broadband technology," Litan projects an increase of roughly 3.6 million workers (roughly 2 percent of the total workforce) by 2030. Using a 2005 median income figure of $29,000 for working seniors and assuming comparable earnings for the additional members of the workforce, Litan projects additional output gains of $121.51 billion in 2010 and $822.40 billion in 2030.

The potential for increased output through telework is also great for disabled Americans, whose unemployment rate was 62.5 percent in 2004. While it is difficult to project the precise effect of broadband on this population, the flexibility afforded through telework would allow some additional disabled workers to enter the workforce. Assuming a modest, 1 percent increase in employment and a median income of $30,000—scaled up in future years at a growth rate of 2 percent—output could increase by $11.37 billion nationwide in 2010.

3.1.1.2.5 WIDE ARRAY OF ENVIRONMENTAL BENEFITS

Ubiquitous deployment of true broadband can support energy and water conservation. Smart meter deployments in less robust network environments must rely on minimizing data communications. This need to conserve bandwidth hampers the value of the smart meter as a real-time feedback tool the utility subscriber can use to monitor and change their behavior. With ubiquitously deployed broadband utilities can open the floodgates of data to and from the meter and the utility subscriber.

Through broadband networks traffic management teams can monitor and more effectively manage traffic flows – saving travelers fuel and time.

True broadband to every address opens telecommuting options unheard of over traditional networks. Extending an effective work environment to the workers' homes means they have to drive in to work less often – saving workers fuel and time.

The United States represents 5 percent of the world's population yet is responsible for more than 20 percent of global GHG emissions. There is a growing scientific consensus that developing countries must reduce their carbon emissions by 25 percent to 40 percent from 1990 levels by 2025 and upwards of 80 percent by 2050 to avoid the most catastrophic effects of climate change.

The widespread adoption of Information and Communication Technologies ("ICT") can facilitate these needed reductions. Like most industries, ICT is directly responsible for GHG emissions: The industry consumes 6 percent to 10 percent of global energy and is responsible for 2 percent to 3 percent of the world's carbon emissions, roughly the same contribution as aviation. Conversely, however, ICT also functions as an "enabler" to support significant carbon reductions from other sources. In fact, one

analysis holds that ICT alone could reduce global GHG emissions by 15 percent by 2020 (an amount at least five times larger than the sector's carbon footprint), representing about $946.5 billion in savings to the economy. Another study finds that widespread adoption of ICT could support a net reduction of 1 billion tons of GHG emissions over 10 years. Indeed, fiber to the premises—which is, broadly speaking, based on ICT—conveys a broad range of environmental benefits, including increased opportunities for and access to telework, teleconferencing, telemedicine, and e-commerce, as well as increased efficiencies in home energy use and transportation. Connectivity is "the backbone" of each of these solutions.

3.1.1.2.5.1 SMART GRID

By allowing two-way communication and the transmission of real-time information between consumers and utilities, utilities are better able to manage the power grid as an integrated system and adjust supply to changing demand. At the same time, end-users can make informed decisions about energy consumption. This is particularly effective where prices vary depending upon demand.

The potential benefits of such a "Smart Grid" approach are dramatically illustrated in a case study of 112 homes in the Olympic Peninsula, west of Seattle, Washington. Participating houses were given a digital thermostat and a computer controller for their water heaters and clothes dryers. Residents used an Internet website to set their favorite home temperature and pre-determine an allowed variance from that temperature. On average, participating houses reduced their electric bills by 10 percent, with some participants reporting even greater savings. The environmental benefits of this approach are enormous. For example, the Pacific Northwest National Laboratory reports that, over a 20-year period, this simple technology could save $70 billion on spending for power plants and infrastructure, and avoid the need to build the equivalent of 30 large coal-fired plants.

Although fiber is not specifically mentioned as an enabling technology for most Smart Grid applications, fiber is a critical, growing component of facilitating customer and distribution automation/Smart Grid technologies. Fiber is essential for robust and secure backhaul communication to distribution substations, data concentrators, and other demarcation points.

3.1.1.2.6 ENHANCED GOVERNMENT SERVICES AND GOVERNMENT EFFICIENCIES

Broadband can make myriad services available to improve government efficiency and performance. While many of these individual services can be performed through a wireless network, these and the wide array of other services require a fiber backhaul to provide sufficient speed and capacity.

Examples of innovative services that could be provided over a broadband network include expanded monitoring and control of the community's water systems. Human Services could utilize broadband to extend educational and vocational training programs into served communities. Video-based teleconferencing capabilities could improve the efficiency of government employees' daily work. Teleconferencing could reduce need for travel throughout the community and permit employees to work from home.

Broadband can be used to improve emergency medical response, too. By accessing real-time video while patients are en route, emergency room doctors can ensure that appropriate treatment is ready when patients arrive. Such in-field assessment (enabled by wireless connectivity supported through a robust fiber optic backbone network) expedites treatment and gives doctors more time to consider an appropriate response for critically ill patients. If necessary, staff can consult by teleconference with multiple doctors before patients arrive to better inform the diagnosis. In field-diagnosis also allows emergency room doctors to identify (and re-route) non-emergencies before patients arrive at the hospital. This helps avoid unnecessary and costly emergency room visits, ensuring that medical staff is available to assist with true emergencies. Broadband also improves diagnoses en route by providing electronic access to patient information. This could allow staff to process vital information regarding the patient's condition to expedite treatment upon arrival. Moreover, by alerting emergency medical technicians of drug reactions, allergies, and medical history, the EMTs can improve patient care and safety. Finally, traffic management can improve travel time, speeding access to appropriate medical care. Tucson, Arizona is already realizing many of these medical benefits in the nation's first video-based Emergency Medical Services telemedicine system.

Broadband access also improves the performance and efficiency of municipal employees, while reducing overall staffing needs, by allowing a virtual presence. Surveillance cameras allow remote monitoring of wildlife, high-fire areas, and high-crime areas. Similarly, automated utility meter readings and real-time management of networked parking meters can reduce staffing requirements while increasing revenue. Broadband access improves emergency response and allows employees to spend more time in the community by enabling them to access information and file paperwork from the field. This also facilitates simultaneous filing for multiple departments, such as building inspections and building permits. Broadband also allows the City to track its vehicles and staff, reducing response time when problems occur and improving safety for City staff. For instance, GPS can improve safety by tracking a firefighter's location within a building during an emergency. Mobile voice-over-IP phones can further reduce costs.

3.1.1.2.7 INFRASTRUCTURE DEVELOPMENT AND MAINTENANCE

Public broadband infrastructure adds a new infrastructure development and maintenance opportunity to local governments. But more than that, public broadband infrastructure can be used to help improve the efficient use and maintenance of existing public works. Broadband enabled cameras can be used to monitor remote public works sites, lights and irrigation systems can be automatically or remotely operated based on information gathered via broadband, traffic can be more effectively managed, power systems monitored and managed, water systems controlled, and so on.

Broadband can relieve traffic congestion by allowing cities to coordinate traffic lights to improve flow. A 2005 U.S. Department of Transportation survey concluded that poor traffic signal timing is responsible

for 10 percent of all traffic delay – roughly 300 million vehicle hours annually[30]. By using a broadband network to coordinate traffic signals, a municipality can expect to:

- Reduce congestion by allowing for the smooth flow of traffic at a constant speed.
- Improve mobility and decrease capital costs for intersection improvements by increasing the traffic handling capacity of intersections.
- Improve air quality and increase fuel efficiency by reducing vehicle stops, starts, and idling.

These benefits require an intelligent transportation system, or ITS. ITS features are enhanced when supported by the true broadband offered only by fiber.

Austin, Texas implemented an ITS in 2005 and 2006. The city reports more than $40 million in annual savings for its residents including:

- $35 million annually in delay reduction (a 9.8% reduction in travel time along all arterials reducing traffic delay by 2.342 million hours).
- $3 million annually in reduced stopping (28% reduction in the number of stops per intersection for a total of 195.1 million fewer stops each year).
- $2.6 million in fuel savings (3.5% or nearly 1.3 million gallons of gasoline in annual fuel consumption reductions)[31]

Of course broadband can help with complex systems like traffic management, power monitoring, and water flow. But what about simple infrastructure – like street lights?

The city of Chattanooga, Tennessee is using their municipally owned network to significantly improve their street lighting. First, the city has installed new LED street lamps. The change to LEDs is expected to cut energy use by 70%. However, the city decided to take their streetlights seriously and to install a Global Green Lighting system expected to save the city 85% or nearly $2.7 million per year. The system, managed using Chattanooga's broadband system, provides the ability to control each light's output to tailor the level of light specifically to each lamp, the environment, the time of night, and even what might be happening on the ground. Furthermore, when a light is not working, it can self-diagnose and send a message to maintenance describing the problem it is having and what is needed to fix it.

The community sees public safety benefits to the new lighting as well. Police can control the brightness of the lights when they are chasing suspects in parks, alleys, or other areas where lighting is typically

[30] U.S. DOT (2005). "Intelligent Transportation systems for Traffic Signal Control." Retrieved 2 October 2012 from http://ntl.bts.gov/lib/jpodocs/brochure/14321_files/a1019-tsc_digital_n3.pdf.

[31] See Columbia Telecommunications Corporation (September 2009). "Benefits Beyond the Balance Sheet: Quantifying the Business Case for Fiber-to-the-Premises in Seattle." http://www.seattle.gov/broadband/docs/SeattleFTTNBenefits_091109.pdf for more information.

dim. David Crockett, director of the city's office of sustainability says, "A policeman can sit in his car and double the intensity or turn the lights off if there is a need to cover a SWAT team."[32]

Other infrastructure can also be supported through ubiquitous broadband deployments – whether it is keeping an eye on remote sites to protect them from graffiti, remotely checking a park for occupants before turning off the lights, allowing residents to report potholes via a smart-phone app, or any other data enabled innovation – a municipal fiber network helps make it better.

3.1.1.2.8 CLOSING THE DIGITAL DIVIDE

Data show that certain race, income classes, and geographic locations have far less access to broadband in America. This is simply unacceptable. Access to the information and opportunities available through true broadband should be equally available to all residents.

Unfortunately, the exigencies of incumbent telecommunications providers' business plans drive them to "cherry pick" those areas where they are more likely to generate the highest revenues. This practice serves to widen the digital divide. In some cases, cities have been able to effectively use franchise agreements to force incumbents to deploy in underserved areas but it is typically done at perceived sacrifice on behalf of the provider.

A municipal deployment of open access fiber to the premises can have as one of its guiding principles ubiquitous deployment – thus making the network reasonably available to all residents regardless of demographic standing. Furthermore, appropriate business models can be implemented to help make some level of service available to nearly all residents.

3.1.1.3 PUBLIC SAFETY

Ubiquitous deployment of true broadband can support public safety. Police and private security companies can deploy high definition and heat sensitive security cameras for remote monitoring of sensitive areas. Fire departments can take advantage of data provided via intelligent alarm systems. Police departments can more effectively use systems like Shot Spotter to detect and deter violent crime.

The FCC has this to say about broadband and public safety and homeland security: "Broadband technology is particularly critical to public safety because it can provide enhanced situational awareness from first responders in emergency situations. Through broadband use, public safety entities can access medical records, site information and other video and data information useful for emergency responses. Broadband will also improve the nation's current 9-1-1 system by establishing the foundation for the

[32] See Gonzalez, Lisa (22 May 2012). "Green Lighting In Chattanooga – Savings, Safety and Jobs." Community Broadband Networks. http://muninetworks.org/tags-263.

transmission of voice, data or video to Public Safety Answering Points (PSAPs) during emergency phone calls."[33]

In February of 2012, Congress enacted "The Middle Class Tax Relief and Job Creation Act of 2012." The Act included a provision to create a nationwide interoperable broadband network that will help police, firefighters, emergency medical professionals, and other public safety officials stay safe and help them do their jobs. The law establishes the "First Responders Network Authority", or FirstNet, within the Department of Commerce's National Telecommunications and Information Administration. The network will be based on the 700 mhz spectrum set aside for public safety. FirstNet will hold the spectrum license for the network and is charged with taking all actions necessary to build, deploy, and operate the network. The Act provides $7 billion in funding towards deployment of the network and another $135 million for a new state and local implementation grant program.[34]

In a panel discussion at Fire-Rescue International in August of 2012, Chief R. David Paulison, former U.S. Fire Administrator highlighted the essentiality of broadband for high speed data and quality video transmission.

> *'What it's really going to give us is data where we simply couldn't access it before' which will increase situational awareness…*
>
> *Paulison recalled a fire he was watching on television news, which allowed him to see information that the incident commander could not – and that firefighters on scene were about to make a trench cut in the wrong place. He called in, and they changed tactics as a result of his input. With broadband, the IC could have seen such video firsthand.*
>
> *Paulison added examples for using broadband, such as for biometric firefighter monitoring, for transmission of building layouts and information about hazardous materials within, and for conference calling with subject matter experts and allowing them to see what you are seeing on the scene.*
>
> *He also spoke of the potential for EMS – for responders to access patient records on scene, and transmit real-time video and vital signs of patients back to doctors and specialists, with the possibility of making faster treatment plans and sometimes avoiding the need to wait for doctors or surgeons to make assessments on scene.*
>
> *'These are the things that I see in the future,' Paulison said. 'This folks, to me, is the future of the fire service… I think it's time for us to get on board and bring ourselves into the twenty-first century.'*[35]

[33] From FCC Public Safety and Homeland Security Bureau viewed 2 Oct 2012 at http://transition.fcc.gov/pshs/broadband.html.
[34] See http://www.ntia.doc.gov/category/public-safety for more information.
[35] Caspi, Heather (2 August 2012). "Experts Present Update on Broadband for Public Safety." Firehouse. http://www.firehouse.com/news/10754689/experts-present-update-on-broadband-for-public-safety.

Fire and EMS personnel are not the only public safety beneficiaries of broadband deployments. The Utah Broadband Project writes:

> *Broadband also puts information instantly in the hands of law enforcement, including photos and fingerprints of suspects, and allows monitoring of both police and suspects in high-risk situations. Broadband can also enable more timely assistance from citizens who can quickly send text, photos or video from mobile devices to law enforcement.*
>
> *Law enforcement must constantly access multiple large databases such as Department of Licensing, Department of Corrections and local jails. Broadband-enabled searches are faster, putting important information at the scene in a timely manner. And in some circumstances broadband can be an effective communication tool when traditional tools such as radios or cell phones don't work.*[36]

Of course, many public safety needs require mobility. Some may argue wireless is the only reasonable solution. Wireless broadband is a critical component of public safety broadband, but the sooner that wireless signal can be placed on a piece of fiber, the better and more reliable the service will be.

3.1.1.3.1 ENHANCED VIDEO SURVEILLANCE AND SECURITY

Broadband allows a range of video surveillance applications. Using a digital camera, either a wired or wireless Internet Protocol ("IP") network, and a back-end monitoring system, communities can remotely monitor people, buildings, and traffic to enhance public safety and reduce crime. Outdoor Wi-Fi mesh networks supported by abundantly available fiber connections are transforming the field of video surveillance by offering easy-to-install, highly-scalable solutions.

Fiber is needed for high-quality video surveillance. Depending on bandwidth, surveillance cameras can provide information ranging from simple black-and-white still images to high-resolution, 30-frames-per-second color video. Surveillance cameras can be hardwired into the network via Ethernet, directly connected through Ethernet to a collocated Wi-Fi base station, or deployed as Wi-Fi clients. Bandwidth requirements will vary, depending on the application and the quality of the video. Inadequate bandwidth could result in unstable and insecure signals.

Video surveillance is attractive because it enables a low-cost solution to monitor public spaces without adding any more feet on the street. A single employee can simultaneously observe multiple cameras and deploy personnel where they are most needed. Surveillance cameras can be used to detect trespassers, loitering, illegal parking, dumping, and theft, and help with crowd control. These services have been deployed on roads at industrial construction sites, in crowded public spaces such as airports, train stations, and public festivals, and in remote open areas, such as parks.

Potential applications include:

[36] From http://blog.broadband.utah.gov/impact/public-safety/.

- Remote monitoring of construction sites after hours to prevent vandalism, trespassing and theft.
- In-vehicle cameras to enable security officers to identify where they are most needed, efficiently deploy staff, and be prepared to act appropriately when they arrive on the scene.
- Forensic evidence to expedite legal proceedings to apprehend criminals.
- Video monitoring to ensure compliance with safety procedures (thereby reducing liability).
- Remote monitoring of vehicle and equipment "health" to ensure that maintenance is provided as needed.
- Inventory tracking to facilitate just-in-time equipment transfers and detect theft if it occurs.
- Internet access for employees to expedite paperwork and remote communications.
- Virtual neighborhood watch to cost-effectively monitor and deter crime.
- Crowd control and observation at large public gatherings.
- Observation of forested areas during times of high fire danger, to allow rapid detection and response.
- Real-time communication between emergency medical technicians and emergency room doctors to help prepare hospital staff for new arrivals and to allow hospital staff to recommend treatment during transport.

Many municipalities are already employing surveillance cameras for these purposes. Of particular note, Chicago has used a combination of unified fiber and wireless mesh networking to create a "virtual shield" around the city. The network covers the entire city with thousands of real-time, high-quality video access points. These cameras (which cover both private and public sector establishments) are combined into a single unified system, with bandwidth requirements that would exceed the capabilities of a simple wireless network. The Chicago system is state-of-the-art, featuring some cameras that will automatically film in the direction of gunshot sounds before dialing 911. The network can capture, monitor, and index footage for safety and forensic applications. The system "entailed building a unified fiber network throughout the downtown Chicago area, deploying a critical wireless infrastructure to offer flexibility as required, installing hundreds of new surveillance cameras, linking thousands of preexisting cameras to the network, and creating a fully redundant backend system to monitor the video, store the images and allow for business continuity and disaster recovery applications." Theresults have been dramatic. Before the system was installed, from January to May 2003, there were 24 murders in the city's District 11. In 2005, there were only four murders during the same period—an 83 percent decline.

Other municipalities have used more modest networks to enhance public safety, despite a shortage of police officers. In Savannah, Georgia, surveillance cameras monitor the City's 22 historic squares offering police "'eyes in the sky' and provid[ing] greater security for the nearly three quarters of a million people" taking advantage of public spaces around the city[37]. Cameras also supplement security by providing "eyes in the sky" during large public gatherings, such as the City's Saint Patrick's Day Festival. Cameras have helped improve the efficiency of the limited police force, allowing officers to

[37] ABB Tropos (15 March 2007). "Savannah, GA Deploying Public Safety and Municipal Wi-Fi Networks Citywide with Tropos System." Viewed 7 November 2013 at http://www.tropos.com/news/pressreleases/2007_03_15.php.

locate problem areas, witness crimes in progress, reduce response time, and enable access to criminal and DMV records in the field.

The City of Laguna Beach, California has deployed a state-of-the-art wireless video network for a variety of applications around a 20-square-mile area that encircles the city. Solar-powered cameras are stationed at areas with high fire risk and monitored by park rangers to allow early detection of—and rapid response to—wildfires. The same network can also be used to monitor wildlife activity. The surveillance system supplements a streamlined staff during the winter by providing virtual lifeguards focused on the most dangerous locations, allowing lifeguards to spot—and approach—swimmers as they enter. The same network provides webcast coverage of local events, such as historical society meetings and the Patriot's Day Parade. The city plans to expand the network to allow for automated utility meter reading and mobile city operations, whereby city staff can submit field reports remotely.

Traffic safety on rural roads can be enhanced through speed camera monitoring. A 2010 study in Germany found that, "The deployment of… speed camera supervision on [rural] road sections with a very high accident severity could remarkably improve road safety. The number of accidents with serious injury could be reduced by up to 51%."[38]

3.1.2 BROADBAND VALUE TO THE RESORT/TOURISM INDUSTRY

Put simply, visitors expect their cell phones to work, expect to access the Internet from their mobile devices, and expect broadband service at their lodging and other locations. Failure to provide these basic levels of service will drive visitors away – temporarily while they go to a nearby location to connect to the world or permanently as they schedule visits to other locales that offer these basic 21st century amenities. [39]

> **The reliability** of free Wi-Fi that we provide to our lodging guests is sporadic. We have spent over $2,500 in the last two years to optimize it, but people still often have trouble. It sometimes means they don't stay as planned.
>
> *Grand County Survey Respondent*

Tourism businesses create jobs and ensure the vitality of northwest Colorado communities. The resort and tourism industry generates significant dollars for the economies of local communities and the northwest Colorado region as a whole. Businesses can leverage broadband to attract new visitors, train employees, and market their products or services in a way that makes size and location less relevant than ever before.

Broadband is increasingly becoming essential for tourist destinations and business in the resort and tourism industry. Travelers may seek out distant locales to "get away from it all" but they still want – or need – to be somewhat connected to the rest of the world.

[38] Weber, Roland and Thomas Jahrig (26 March 2010). "'AOSI' Improving Road Safety on Rural Roads in Germany." Viewed 8 November 2013 at http://www.4ishgd.valencia.upv.es/index_archivos/16.pdf.
[39] Some of the data for this section comes from research done by the Missouri broadband development organization MoBroadbandNow. MoBroadbandNow can be found on the web at http://mobroadbandnow.com/.

Northwest Colorado, with numerous destinations, ski resorts, and activities for tourists, has a vested interest in ensuring the region's resort and tourism industry is equipped to handle the changing needs of today's travelers. Of course, this also means the communities in and around tourist destinations must have the basic infrastructure to support the broadband needs of their visitors.

Resort and tourism broadband is characterized by three critical (though not necessarily unique) issues: 1) resorts and tourist destinations must be able to reach out to potential visitors, 2) like all businesses, resorts and tourist destinations must be able to bank, manage personnel, conduct training, and otherwise conduct business, and 3) visitors need connectivity when they arrive and businesses need connectivity to support them.

Increasingly, travelers are planning trips and making reservations online. Booking online is usually cheaper without the added commission and cost of a travel agency, and there are some great deals to be found on transportation and lodging. If a resort, travel destination, or supporting business is not found online, it's likely invisible to all but locals and regularly returning clients.

More than just an advertising tool, small businesses are increasingly using cloud and other bandwidth intensive services to manage their businesses. They use online accounting to track their finances and issue payroll. They use credit services to run credit cards. They conduct market research online. They connect to parent companies and partners. They manage supply chains electronically. All of these functions require significant reliable bandwidth.

Once visitors have planned their trip using online information provided by local businesses, they expect to connect when they arrive. Not only do they expect to connect, but they expect the businesses they are dealing with to be connected as well.

In his paper, "Broadband and the Hospitality Industry"[40], Douglas Rice writes:

> *Proliferation of e-mail, growing sizes of attachments, and the advent and refinement of multimedia content have continually raised the bar for bandwidth. Ten years ago, most homes with Internet access had bandwidth of perhaps 28 kilobits per second. Today, standard home offerings in many markets can start at 10 megabits per second downstream, and 50 megabits or more is not unusual – nearly a two thousand-fold increase in ten years. …it sets the expectation of virtually instantaneous response for any type of content, no matter how bandwidth-intensive.*
>
> *The vast majority of hotels have lagged behind this trend, however. Many hotels have only a few megabits of capacity to share among hundreds of potential users in their guest rooms and administrative offices. This may be sufficient for light use such as e-mail, where only a handful of users may be active at any point in time. But with the recent growth in video streaming, hotel usage of Internet bandwidth has become heavily skewed toward the evening hours when*

[40] Rice, Douglas (no date). "Broadband and the Hospitality Industry". Viewed 5 November 2013 at http://10yearsofbroadband.com/public/images/pdf/Douglas%20Rice%20Hotel%20Technology%20Next%20Generation.pdf.

guests are in their rooms, and those guests expect performance similar to what they have at home. The numbers simply don't work: if just 10 guests are streaming video at one time, even at low quality, they will overwhelm the capacity of most of today's hotel Internet connections. Not only will those particular guests be unhappy, but in most hotels, this will prevent other guests from even accessing their e-mail or doing light web surfing.

Rice suggest that hotels and resorts are reluctant to purchase sufficient bandwidth to meet their guests expectations because a) they are constrained by ISP business and pricing models that don't align with the hospitality industry and b) hoteliers and resort property owners see very little opportunity for direct cost recovery. Nonetheless, he suggests that if a property could get "cheap, effectively unlimited bandwidth" they could add services that would enhance the property's competitive edge. Rice lists:

- Entertainment content that might include:
  - Licensed programming from Internet-based sources, which may be free, subscription-based, or pay-per-view;
  - High-value programming such as sports and concerts, as well as traditional cinema, television, and short subject programming;
  - Content stored elsewhere, such as on a guest's home DVR; and
  - Content that was broadcast live at an earlier point in time and stored on a network-based device.
- Videoconferencing and meeting technology.
  - Rice writes, "To be sure, face-to-face meetings and conferences will always have important advantages over electronic ones, and hotels will always be a preferred venue for face-to-face meetings. But few meetings and conferences cannot be enhanced by videoconferencing and virtualization technology."
- Virtualization of hotel systems.

Besides the rural nature of northwest Colorado and the difficult terrain (making broadband deployment generally difficult), resort communities in the region face an additional hurdle to advancing broadband in that a significant user base – the tourist population – expects connectivity as an amenity but has low tolerance for paying to support the infrastructure needed to provide connectivity. Thus, the burden of deploying and supporting broadband infrastructure for this customer base is shifted to the residents and local businesses who only indirectly benefit from their guests' broadband use. ** Communities may need to develop secondary revenue sources like room taxes or other use taxes to support broadband implementation or subsidize operations.

P4: Developing and supporting primary and secondary revenue generating mechanisms to fund implementation and sustaining of broadband improvements.

The cost of supporting tourists' use of broadband is shifted to local residents and businesses. Therefore, communities may need to develop secondary revenue sources like room taxes or other use taxes to support broadband implementation or subsidize operations.

3.1.3 BROADBAND VALUE TO THE FARMING/RANCHING INDUSTRY

Rural areas where cattle and agriculture operations tend to be located have lower broadband access and adoption rates due to the higher cost of service deliver, but these areas have much to gain from using broadband to conduct business; connect with colleagues, classmates, family, and friends; and access and share information[41]. At the Wyoming Broadband Summit in 2012, Governor Matt Meade said, "particularly in a rural state, the ability to communicate through broadband is an equalizer, bringing telemedicine, tele-education and tele-commuting to small towns."[42]

Broadband helps farmers and ranchers with a range of activities including monitoring water, power, and energy consumption; engaging in veterinary telehealth; sharing equipment and labor resources; monitoring pesticide application; promoting safety and compliance; promoting consumer knowledge; competing in regional, national, and global markets; improving data collection; and monitoring market trends. In describing the Recovery Act, WhiteHouse.gov says, "Internet access provides resources to help today's farmers and ranchers compete in an increasingly online world. With broadband access, a producer can now log on to the Internet every day and get immediate access to real-time commodity pricing, as well as consumer information and weather forecasts. This means that a rancher in Iowa can sell cattle to a buyer in Texas without the prohibitive costs of travel or delay of information preventing it."[43]

In early 2012 (January – March) the South Dakota Broadband Initiative (SDBI) conducted a survey gauging Internet usage in South Dakota's agricultural community[44]. Survey respondents ranked the value of the Internet to their farm/ranch business as follows (in "Figure 7: South Dakota Survey - Value of the Internet to Farm/Ranch Businesses"):

[41] ICF International and LinkWYOMING produced a report titled "Broadband's Positive Impact on Ranching & Agriculture in Wyoming." This report was heavily used in the writing of this section. ICF International and LinkWYOMING (September 2013). "Broadband's Positive Impact on Ranching & Agriculture in Wyoming." LinkWYOMING. Retrieved 6 November 2013 from http://linkwyoming.org/lwy/docs/Broadbands%20Impact%20on%20Ranching%20and%20Agriculture.pdf.

[42] CBS 5 New Channel, Cheyenne, WY – Sottsbluff, NE (23 October 2012). "Governor Talks Technology, Broadband. Viewed 7 November 2013 at http://www.kgwn.tv/story/19896928/governor-talks-technology-broadband.

[43] http://www.whitehouse.gov/recovery/innovations/building-platform-private-sector-innovation viewed 7 November 2013.

[44] South Dakota Bureau of Information and Telecommunications (BIT) (2012). "Survey Results from the "2012 Internet Usage in South Dakota's Agricultural Community" Survey." Retrieved 7 November 2013 from http://broadband.sd.gov/Docs/2012%20State%20Broadband%20Initiative%20Ag%20Survey%20Report.pdf.

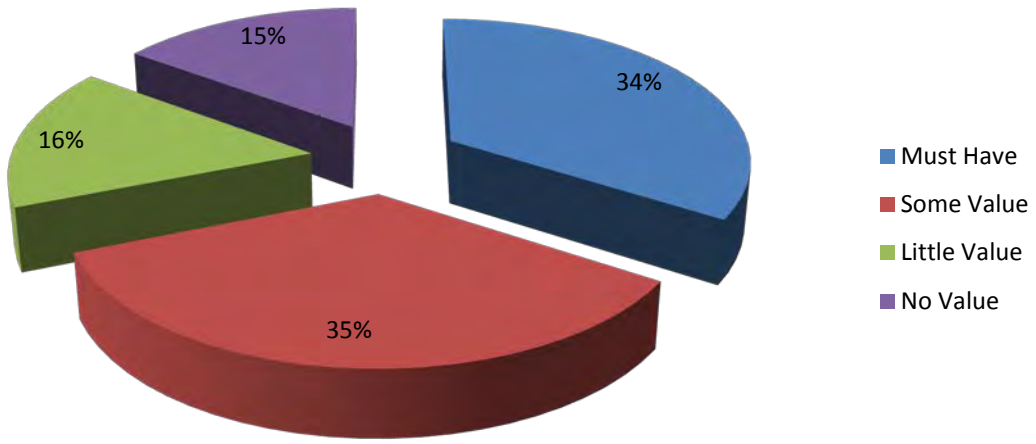


Figure 7: South Dakota Survey - Value of the Internet to Farm/Ranch Businesses

Key uses of the Internet found in the survey included checking weather reports, general browsing, reading news, and communicating with friends and family. 51% of respondents paid some or all of their bills online. 30% of respondents checked prices of commodities and 12% checked prices of inputs. 66% of respondents used the Internet to research new agricultural related resources and products.

One of the very interesting statistics from the South Dakota survey was that those who reported not ever using the Internet skewed much older than those that use broadband regularly.

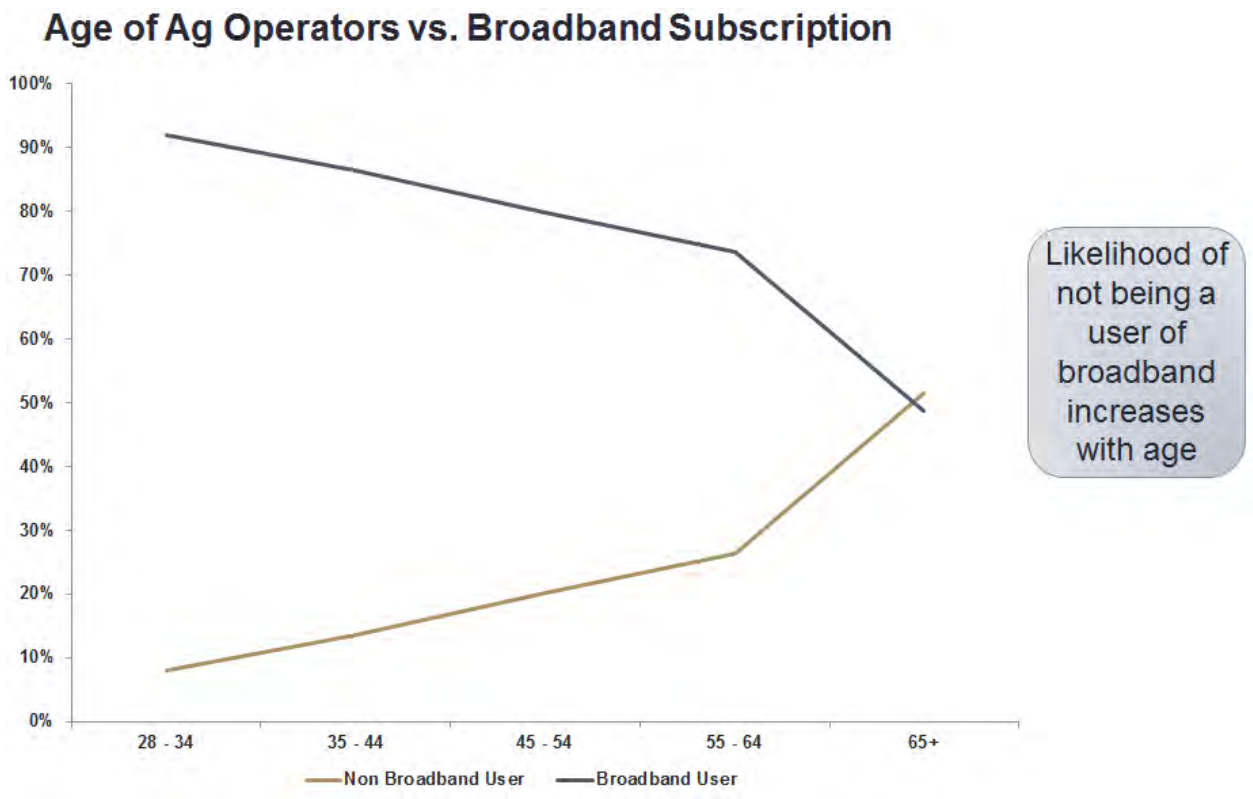


Figure 8: South Dakota Survey - Age of Agriculture Operators vs. Broadband Subscription

While not directly addressed by the survey, "Figure 8: South Dakota Survey - Age of Agriculture Operators vs. Broadband Subscription" may suggest that in order to retain the next generation of agriculturists, rural communities may need to expand rural broadband capabilities. Broadband access can help keep youth in their rural communities Broadband for America responded to the National Grange's question, "How can broadband help keep youth in rural communities?" with, "By giving them access to social media, job opportunities, higher education, resources for homework, etc. We need to give youth incentives to stay in rural America and become the next generation of food producers."[45]

The economic benefits of using broadband technology in ranching and agriculture seem undeniable. Jess Peterson of the US Cattlemen's Association noted that, "those who have embraced this technology have no doubt seen it pay dividends in the quality, quantity, and profitability of the products they grow and sell."[46] In an evaluation of the impact of USDA broadband loans on US agriculture, Kandilov, et al. confirmed that broadband's economic potential is present in the farming and ranching industry. The

[45] Broadband for America Staff (8 March 2012). "BfA Talks Rural Broadband with the National Grange in Twitter Interview." Broadband for America. Viewed 7 November 2013 at http://www.broadbandforamerica.com/blog/bfa-talks-rural-broadband-national-grange-twitter-interview.

[46] Peterson, Jess (8 March 2012). "Broadband Keeping America's Farmers and Ranchers Connected as they Feed the World." Broadband for America. Viewed 7 November 2013 at http://www.broadbandforamerica.com/blog/broadband-keeping-america%E2%80%99s-farmers-and-ranchers-connected-they-feed-world.

study showed that USDA broadband loans increased access to high speed Internet which led to a 6% growth in farm revenue resulting in a 3% net increase in farm profits.[47]

Ultimately, broadband technology will ensure that farmers and ranchers can stay on top of the market and diversify their industry offerings. According to Peterson, "modern farming practices, including innovation and broadband technologies, will allow US farmers and ranchers to compete in the global marketplace and continue to provide high-quality and sustainable food to the developing world."

Some potential ranching and agriculture broadband applications include:

- Remote monitoring and data capture,
- Advertising and marketing,
- Commodity pricing and market trend analysis,
- Veterinary telehealth, and
- Safety.

3.1.3.1 REMOTE MONITORING AND DATA CAPTURE

As with many other industries, farming is evolving toward one based on data and information, rather than mechanics, and broadband is an essential component of that transition. According to the "Report on Broadband Access, Usage, and Potential on Missouri's Farms and Rural Communities" from MoBroadbandNow, the future of farming and ranching will depend on "smart machines" that can adjust to varying conditions automatically and run self-diagnostics. Many of these machines require high-speed Internet to allow for remote monitoring and data capture. These machines can support monitoring of water, power, and energy consumption, allowing farms and ranches to use only what they need. The use of pesticides, herbicides, and fertilizers can also be monitored, reducing their use, which saves money as well as the environment.[48] Lloyd Treinish of the IBM Thomas J. Watson Research Center writes, "By combining supercomputing and Big Data analytics with other technological innovations, even farmers with modest means can bolster production and profits."[49]

3.1.3.2 ADVERTISING AND MARKETING

Broadband has opened opportunities for small businesses and the self-employed – including family or individual owned farms and ranches throughout northwest Colorado – to advertise, generate business, and identify new business opportunities. With high-speed Internet, equipment and livestock auction

[47] Kandilov, Amy M. G., Ivan T. Kandilov, Xianping Liu, and Mitch Renkow (24 July 2011). "The Impact of Broadband on US Agriculture: An Evaluation of the USDA Broadband Loan Program." Agricultural and Applied Economics Association. Retrieved 7 November 2013 from http://ageconsearch.umn.edu/bitstream/103634/2/KKLR_AAEA_2011.pdf.

[48] MoBroadbandNow (May 2013). "Report on Broadband Access, Usage, and Potential on Missouri's Farms and in Rural Communities." MoBroadbandNow. Retrieved 7 November 2013 from http://mobroadbandnow.com/files/2013/05/AgBroadbandNowFinalReport5272013.pdf.

[49] Treinish, Lloyd (12 June 2013). "Precision Farming Gains Global Foothold (Op-Ed)." LiveScience. Viewed 7 November 2013 at http://www.livescience.com/37400-smart-farming.html.

houses can stream live video over the Internet, giving potential buyers a much more detailed look at the animals and products available for purchase. With broadband, small farms and ranches can compete in regional, national, and even global markets that were once restricted to large corporations.

The current focus on healthy food and local and organic farming has also placed farmers and ranchers in the public eye, as consumers seek to gain a greater understanding of the origins of their food and what their local farms have to offer. Across the country, the local food movement now constitutes almost one percent of total food sales. The Internet serves as a primary source of consumer knowledge of the industry and supports urban-rural linkages by allowing urban residents to interact more with their local and regional farmers online. This serves the dual purposes of increasing farm and ranch revenues, while expanding local food consumption options for both urban and rural residents.

3.1.3.3 COMODITY PRICING AND MARKET TREND ANALYSIS

The traditional means of gathering, processing, and communicating information about prices, market trends, and source of inputs and services for farms through radio, television, newspapers, and the state extension service is being augmented and replaced by the Internet, mobile phones, and satellite systems.

Subscription based services provide data for real-time weather tracking, futures market information and live auction prices. Other web-based network provide farmers and prospective farmers, livestock buyers, and consumers with the information they need about particular industries and current pricing to make smart economic decisions for their businesses. These websites also build regional capacity to meet consumer demands for agricultural products. Networks such as the Texas Organic Cotton Marketing Cooperative[50], Sheep and Goat Marketing[51], and Wholesome Harvest[52] provide information about pricing and market trends and also strengthen the connection between sellers and buyers by serving as platforms for marketing and portals for selling products and livestock.

3.1.3.4 VETERINARY TELEHEALTH

As the telehealth industry grows, veterinary telemedicine is becoming more prevalent. Veterinary telehealth offers all of the benefits of telehealth – real time consultations with specialists, remote monitoring, specialty care, and reduced healthcare costs – for animal patients. Many veterinarians are finding that partnering with a telemedicine specialist provides added value and efficiency to their practice. On-site veterinarians can consult virtually with specialists in real time and can even access tele-radiology and tele-ultrasound services. Ranchers are less likely to have to spend time and money transporting their livestock for veterinary care, while large animal and other veterinarians are able to instantly access a network of care, allowing them to obtain additional resources beyond the resources they would have on-site, resulting in an increased quality of care.

[50] http://www.texasorganic.com/
[51] http://www.sheepgoatmarketing.info/
[52] http://www.wholesomeharvestcsa.com/

3.1.3.5 SAFETY

Internet enabled remote surveillance systems can help farmers and ranchers ensure farm buildings, equipment, crops, and livestock are safe form theft, natural disaster, or other problems. In Iowa, for example, farmers have access to "smart-farm technology" that allows for just this type of property monitoring.[53] This type of technology can also support tracking livestock through the production process and promoting food safety and compliance with the Food Safety Verification Act.

The federal government has recognized the importance of broadband to rural America. The 2009 American Reinvestment and Recovery Act (ARRA) provided $7.2 billion to expand broadband access and adoption across the US. Significant portions of this investment were allocated to programs designed to focus on infrastructure projects that help bring broadband access to rural and remote communities. This investment was designed to narrow the divide between rural and urban Internet access that results, in part, from the difficulties associated with providing reliable high-speed Internet connections to areas with low population density.

Nationally, the NTIA and RUS received 3,199 grant and grant/loan applications for a total requested amount of over $41.7b. Applicants submitted 75 projects (with a dollar value of over $2.2b) with planned impact in Colorado. 41 of these (with a request value of nearly $2b) were infrastructure projects – eight of which would have had some impact in northwest Colorado.

Eight projects affecting Colorado (with a dollar value of $206,376,308) were awarded. Five of these were infrastructure projects of which only the EAGLE-Net project impacted the northwest region.

3.1.4 BROADBAND VALUE TO THE EXTRACTION INDUSTRY

The oil and gas industry faces a significant challenge staying connected across great distance, in remote areas, and in harsh conditions. Because of this, for much of its history, the oil and gas industry has had to operate without the benefit of real-time access to field generated data or reliable communications with field technicians or equipment. In the 21st century, this simply will not do. Oil and gas companies need to extract more material from more remote areas with greater efficiency and less environmental impact. This can only be done with effective field communications – for the field technicians and for field equipment machine to machine communications. More technology than ever is available in the field and every well, pipeline, and remote office is producing more data than ever. Super high-speed networks allow for more applications to be taken deeper into the oil field. The digital oil field of today is completely different from anything we have seen before. Data communications bring the field into the head office and centralized operations center and extend the head office and centralized operations center into the field.

[53] Anderson, Ken (28 August 2013). "Remote Monitoring Technology Improves Safety, Security." Brownfield. Viewed 7 November 2013 at http://brownfieldagnews.com/?s=remote+monitoring+technology.

Redline Communications[54] produces and sells a line of ruggedized wireless products used heavily in the mining and extraction industries. Redline has done extensive research into the use of communications technologies in the extraction industry and has identified five key uses, or value propositions.

- Increase Oil Production
- Reduce Costs
- Improve Operational Efficiency
- Enhanced Oil Recovery
- Safety and Security

3.1.4.1 INCREASE OIL PRODUCTION

Data is an essential element in extracting difficult oil reserves. Hundreds – even thousands – of sensors monitor each well and all production. Effective broadband communications networks allow oil and gas companies to deploy enhanced oil recovery techniques and access real-time machine to machine data from smart drills, down-hole sensors, reservoir monitors, and 3-D seismic surveys. These data allow visualization and successive modeling of fluid movements in extreme environments and increase oil production.

3.1.4.2 REDUCE COSTS

Broadband networks allow oil and gas extraction companies to use monitors and smart equipment to reduce drilling times by managing remotely steerable down-hole tools and integrating measurement-while-drilling real-time data. Reduced drilling times mean cost savings, reduced environmental impacts, and increased profits.

3.1.4.3 IMPROVE OPERATIONAL EFFICIENCY

Establishing remote broadband allows companies to monitor and control operations from anywhere. This allows them to detect and correct problems without having to send a field crew. Companies can also establish collaborative work environments and access the machine to machine data needed to make more informed and better decisions in real-time.

3.1.4.4 ENHANCED OIL RECOVERY

Machine to machine communications allow centralized operations real-time visibility to remote drilling rigs and even individual components of those rigs. This allows centralized systems and personnel to balance inputs and extraction and to optimize oil recovery.

[54] See http://www.rdlcom.com/.

3.1.4.5 SAFETY AND SECURITY

Oil and gas companies around the world and throughout northwest Colorado are improving safety and protecting employees, property, and vital assets using innovative broadband solutions for video surveillance.

3.1.5 SUMMARY OF BROADBAND BENEFITS

We have looked at the potential impact of improved broadband on economic development and quality of life. We have also taken a summary look at the value of broadband to major industries in northwest Colorado – specifically, resort/tourism, farming/ranching, and tourism. It is important to remember that broadband development will not only prove beneficial to these major industries but can also serve to broaden the region's economic base.

3.2 EVALUATE DEMAND

Demand is difficult to effectively measure. Like many emerging technologies, demand increases as applications expand. For example, for many households, early electricity use was limited to lighting. For many, the cost of electrification was too high a hurdle for the convenience of electric lighting. But as the variety of electric appliances expanded and their cost declined electrification became more and more desirable.

Data connectivity, and in particular broadband, is similar. The cost of subscribing to broadband services is hardly justified for a user who only occasionally checks email. However, as the variety, bandwidth demand, and cost of Internet services continues to mature, the appeal of broadband connectivity grows.

The current growth of video streaming services is one key feature driving new demand. As other services are developed and secure themselves within our culture, demand will continue to grow.

Demand is, of course, a precursor to sustainability. As demand increases, the cost per subscriber decreases and providing abundant, reliable, affordable broadband falls more in line with public and private means. ** For this reason, even though adoption is outside of the scope of this broadband strategic plan, we recommend implementing community education efforts to increase broadband demand and adoption.

3.2.1 ADOPTION AND USAGE/CURRENT DEMAND

Around the nation there tends to be a gap between urban and rural areas in computer ownership, Internet use, and broadband adoption.

	Computer Ownership	Internet Use	Broadband Adoption
Urban	77%	74%	72%
Rural	67%	62%	58%

Table 5: Urban vs. Rural Broadband Adoption[55]

At 78%, Colorado's statewide Internet adaption rate[56] ranks higher than the national urban average of 74%. However, there is no reason to believe the gap between urban and rural areas is any less in Colorado than it is in the rest of the nation. In fact, the terrain barriers in western Colorado are likely impediments to broadband delivery and may cause a dampening of broadband adoption on the western slope. Without specific data collection, it is safe to assume that western Colorado Internet use is about 65% and that broadband adoption is at about 60%.

However, the Internet doesn't know if you are using it from your office in a high-rise in downtown Denver or the basement of your ranch-house outside of Rangely. The same benefits attracting urbanites to Internet can inure to rural residents in northwest Colorado.

The Internet is used for web browsing, streaming audio and video, two way communication and many other services. How much bandwidth you need vs. how much you want results in two responses.

For example, Bradley Mitchell of About.com suggests that, "Broadband Internet connections of 512 Kbps or higher support Web surfing adequately."[57] So, to be adequate, you want at least .512 Mbps speeds.

But what does that mean?

The NWCCOG home page is just over 10 Kilobytes (or 80 Kilobits). At 512 Kbps, the NWCCOG home page should load in one to two tenths of a second. That seems reasonable.

However, the HTTP Archive[58] suggests that the average web page has grown to 1.653 Megabytes (or just over 13 Megabits).

[55] National Telecommunications and Information Administration and Economics and Statistics Administration (June 2013). "Exploring the Digital Nation: America's Emerging Online Experience." US Department of Commerce. Viewed 11 November 2013 at http://www.ntia.doc.gov/files/ntia/publications/exploring_the_digital_nation_-_americas_emerging_online_experience.pdf.
[56] US Census Bureau (2011). "Reported Internet Usage for Individuals 3 Years and Older." Viewed 11 November 2013 at http://www.census.gov/hhes/computer/files/2011/table1.xls.
[57] Mitchell, Bradley (no date). "How Fast Does Your Network Need to Be?" About.com. Viewed 18 November 2013 at http://compnetworking.about.com/od/speedtests/tp/how-fast-does-your-network-need-to-be.htm.
[58] Viewed 18 November 2013 at http://httparchive.org/trends.php?s=All&minlabel=Nov+15+2010&maxlabel=Nov+15+2013#bytesTotal&reqTotal.

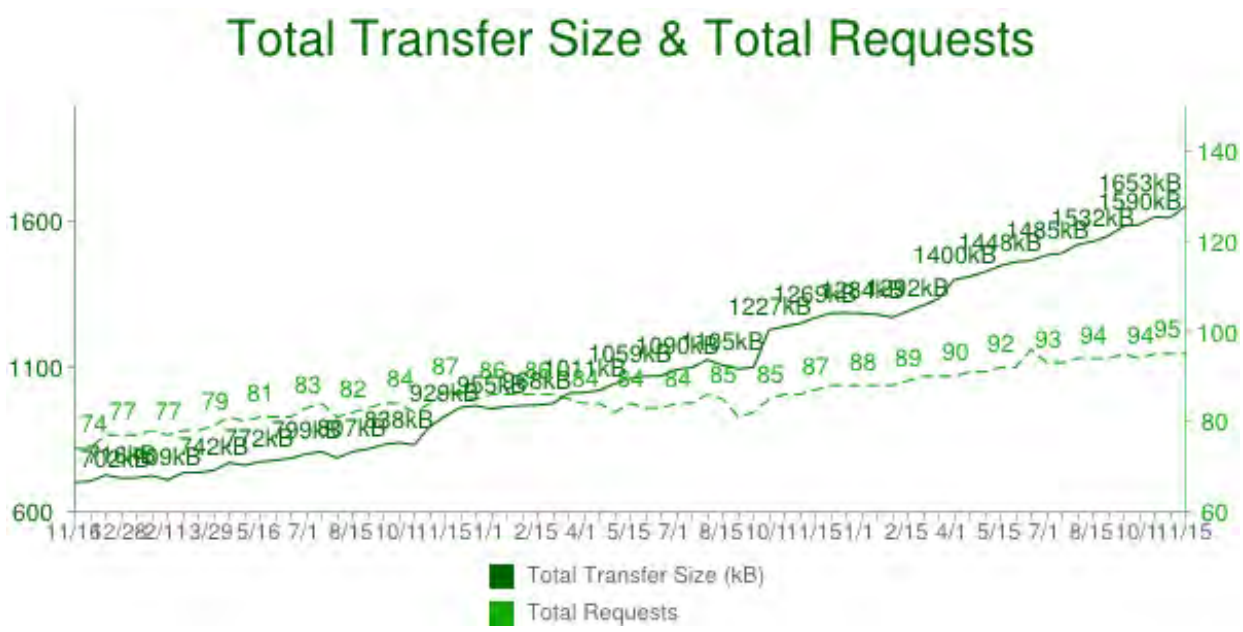


Figure 9: Average Web Page Size - 2010-2013

At .512 Mbps speeds, the average web page will take more than 25 seconds to load. Even with the US average connection speed of almost 28 Mbps, the average web page will take about a half second to load. This may not seem like long but when loading multiple pages it can grow quite tedious.

Web pages don't put the biggest strain on your data connection. More and more people are watching more and more streaming video online. Netflix recommends the following minimum download speeds[59]:

- Required connection speed: 0.5 Mbps
- Recommended connection speed: 1.5 Mbps
- DVD quality video recommended connection speed: 3.0 Mbps
- HD (720p) quality video recommended speed: 5.0 Mbps
- Super HD (1080p) quality video recommended speed: 7.0 Mbps

Netflix can only make these recommendations based on their compression and data flow management capabilities. Stepahnie Crawford did the math for How Stuff Works[60] and found:

Suppose the video you're streaming is one hour long, and the file size for that video is 6 GB. While a broadband connection of up to 10 Mbps lets you easily stream a lot of video content online, you'll want 15 Mbps or more for this six-gigabyte HD video. Here's a quick look at the math:

[59] Netflix (no date). "Internet Connection Speed Recommendations." Netflix. Viewed 18 November 2013 at https://support.netflix.com/en/node/306.
[60] Crawford, Stephanie (no date). "How Fast Should My Internet Connection be to Watch Streaming HD Movies?" How Stuff Works. Viewed 18 November 2013 at http://entertainment.howstuffworks.com/fast-internet-connection-for-streaming-hd-movies.htm.

- Approximate megabytes: 6 GB = 6,144 MB (1 GB = 1024 MB)
- Approximate megabits: 6,144 MB = 49,152 Mb (1 byte = 8 bits)
- Number of seconds per hour calculation: 60 x 60 = 3,600
- Megabits per hour calculation: 49,152 / 3,600 = 13.65 Mbps

Business needs may drive bandwidth requirements even higher. Many businesses share a single Internet connection among multiple employees. Also, businesses have a tendency to transfer larger files (requiring more bandwidth to transfer in reasonable amounts of time) and to use more cloud services.

3.2.2 PROJECTED NEAR TERM AND FUTURE DEMAND

So, calculating needed bandwidth today is a little bit tricky. It's even trickier to say what we will need in the future. As shown in "Figure 9: Average Web Page Size - 2010-2013", the average web page has been on a steady growth curve. We must assume that as bandwidth availability grows, developers will create applications that take advantage of it. Back in the 1990s, a 64 Kbps modem was adequate for most Internet usage. Today, dial-up speeds are simply inadequate for most Internet uses.

Incumbent providers dismiss the probability that consumer Internet usage will grow to Gigabit proportions. In "US the Leader on Broadband", David L. Cohen, Executive Vice President of Comcast suggests American consumers can't handle the speed. He writes, "Most websites can't deliver content as fast as current networks move, and most US homes have routers that can't support the speed already available to the home."[61] While Comcast thinks we can't handle the speed, Time Warner Cable suggests we simply don't want it. Irene Eseves told the Morgan Stanley Technology Conference, "We're in the business of delivering what consumers want, and to stay a little ahead of what we think they want," when asked about Time Warner's broadband speeds in comparison with Google Fiber[62].

These arguments are similar to those heard from northwest Colorado's incumbent providers.

However, the "Cisco Visual Network Index: Forecast and Methodology, 2012-2017" projects continued growth of annual global IP traffic[63].

[61] Cohen, David L. (24 May 2013). "US the Leader on Broadband." Philadelphia Inquirer. Viewed 18 November 2013 at http://articles.philly.com/2013-05-24/news/39478428_1_broadband-connectivity-mbps-access.
[62] Graziano, Dan (28 February 2013). "Time Warner Cable Executive Claims Consumers don't want Gigabit Internet." BGR. Viewed 18 November 2013 at http://bgr.com/2013/02/28/google-fiber-time-warner-cable-347728/.
[63] Cisco. "Cisco Visual Network Index: Forecast and Methodology, 2012-2017." Cisco. Viewed 18 November 2013 at http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-481360.pdf.

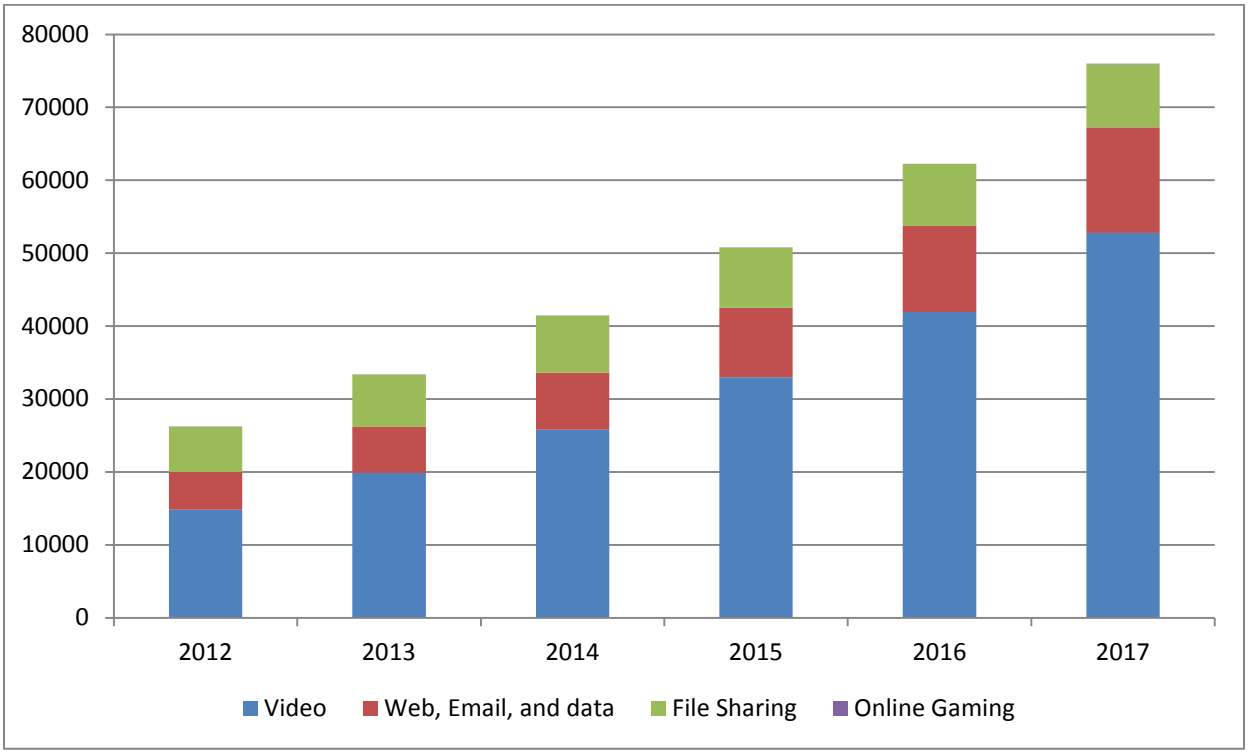


Figure 10: Projected Global IP Traffic Growth

Based on the Cisco data ("Figure 10: Projected Global IP Traffic Growth"), global IP traffic is projected to nearly triple by 2017. If I am consuming my share of Internet traffic with 20 Mbps today, it stands to reason I will desire nearly 60 Mbps by 2017 – assuming no new innovations drive demand even higher even faster. On this same trend line, I will desire gigabit connectivity in the next 20 years. However, we can anticipate consumer demand growing to gigabit speed even faster as telemedicine, expanded entertainment, more sophisticated cloud services, and other applications drive greater demand.

3.2.2.1 SURVEY RESULTS

In 2013, the NWCCOG conducted an online survey of self-selected respondents. The survey asked respondents to rank certain priorities as high, medium, low because it's fine, low because it's unimportant, or unsure.

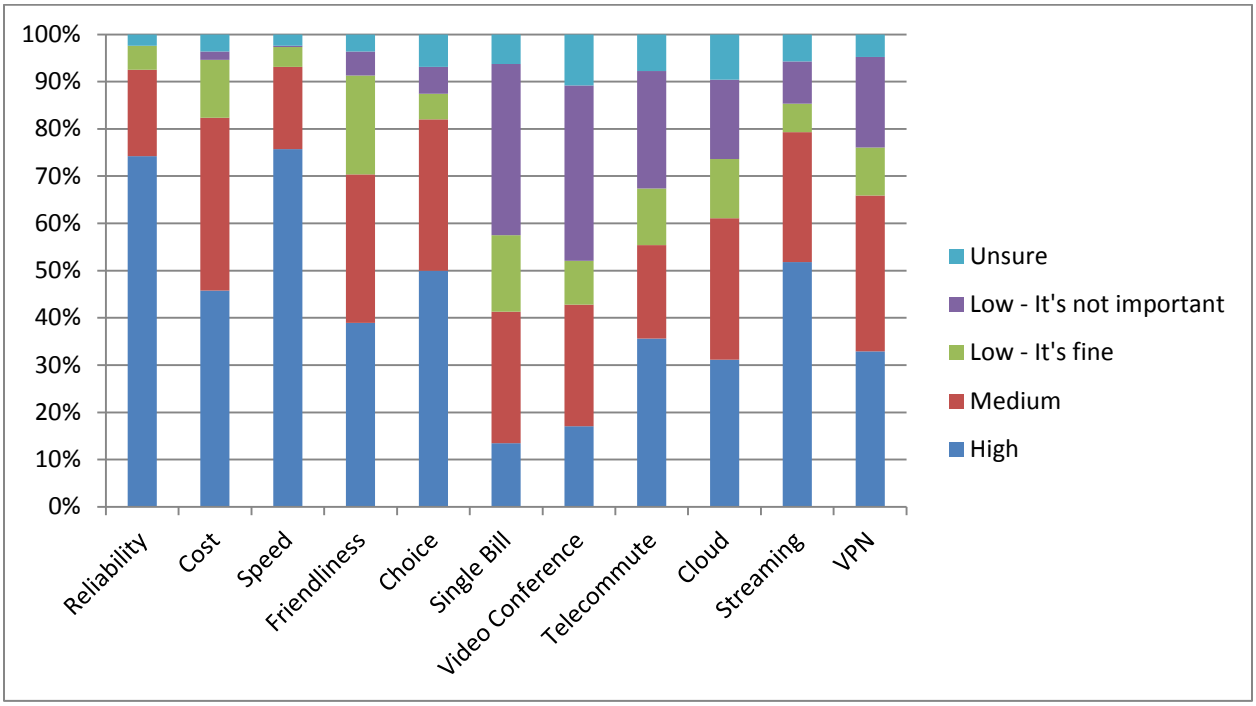


Figure 11: Priority Rankings

The priorities fall into two general categories: 1) characteristics of the service and 2) uses of the service.

The characteristics of service received the following ranking order for high or medium priority:

1. 93.1% - Speed
2. 92.5% - Reliability
3. 82.3% - Cost
4. 82.0% - Choice of Providers
5. 70.4% - Friendliness
6. 41.3% - Single Bill for Multiple Services

While anticipated speed and reliability would be important, we were a little surprised to see cost come in third to these service characteristics. We were also surprised that more respondents assigned a high priority on choice of providers (50.0%) than they did to cost (45.8%).

Also of note, no respondents indicated reliability was unimportant and only 0.3% of respondents rated speed as unimportant.

Finally, when looking at service characteristics, the 21.0% of respondents who rank user friendliness as a low priority because it's fine (by far the highest "it's fine" response rate) suggests the region's service providers are doing a reasonable job of customer service.

In the uses of service we find the following ranking order for high or medium priority:

1. 79.3% - Streaming Video

2. 65.9% - VPN
3. 61.1% - Cloud Services
4. 55.4% - Telecommute
5. 42.8% - Video Conference

3.3 DETERMINE AVAILABILITY

Broadband availability depends on a layered set of technologies and services. Most subscribers receive their broadband services from a service provider with network assets known as the "last mile". Last mile infrastructure can be telephone lines (DSL), the cable company's coaxial cable (DOCSIS), the airwaves (Wi-Fi, WiMAX, etc.), or other transmission media.

Last mile infrastructure typically routes to some sort of aggregation point in the community or region. At the aggregation point, data signals are transferred from last mile infrastructure to middle mile infrastructure – that is infrastructure that interconnects communities and provides extra-regional connectivity.

Middle mile infrastructure typically carries data signals to a "peering point" where multiple national/international providers tie the multiple networks that make up the Internet together.

3.3.1 PEERING POINTS

Peering points (or intermediate steps to peering points) for networks serving northwest Colorado are found in communities like Denver, Salt Lake City, Grand Junction , Albuquerque, and Cheyenne.

The NWCCOG has minimal influence over peering points. The greatest influence the COG can exercise over peering points is by helping create physical path diversity to as many peering points as possible. Each middle mile carrier should have paths to two or more peering points to support network reliability in the region.

3.3.2 MIDDLE MILE INFRASTRUCTURE

Broadband capacity, reliability, and cost are dependent, in part, on middle mile infrastructure. The accompanying Google Earth KMZ file depicts those middle mile infrastructure assets we were able to identify during the study period. We know two things about this map:

1. There are more middle mile infrastructure assets in the region than we were able to identify during the study period.
2. New middle mile infrastructure is continuously being deployed.

** We recommend the COG establish a mechanism to continually update and improve the data available on the map. This effort can be accomplished in conjunction with the Governor's Office of Information Technology's asset mapping effort. Rather than creating redundant efforts it would be prudent to work with GOIT to ensure the GOIT asset map meets the COG's planning and management needs.

K1: Working with GOIT to improve regional broadband mapping.

We recommend the COG establish a mechanism to continually update and improve the data available on the map. This effort can be accomplished in conjunction with the Governor's Office of Information Technology's asset mapping effort. Rather than creating redundant efforts it would be prudent to work with GOIT to ensure the GOIT asset map meets the COG's planning and management needs.

Identification of existing broadband assets is an iterative process involving conducting research and seeing assets in the field through a process we call cursory field verification. We describe many of our research methods in the "Research Notes" section of the "Sources" appendix.

We qualify our field verification as cursory because for the sake of this research we do not coordinate with asset owners to inventory and verify their infrastructure. We simply look for evidence of it in the areas our research indicates it should be. We also watch for probable broadband infrastructure throughout the region and research its ownership and purpose when we find it.

When we look for broadband assets in the region, we watch for buried infrastructure, aerial infrastructure, wireless infrastructure, supporting infrastructure, and signs of new construction.

Buried Infrastructure

When looking for buried infrastructure we are primarily looking for buried fiber. The best indicator of buried fiber is fiber route markers.

A Fiber Route Marker

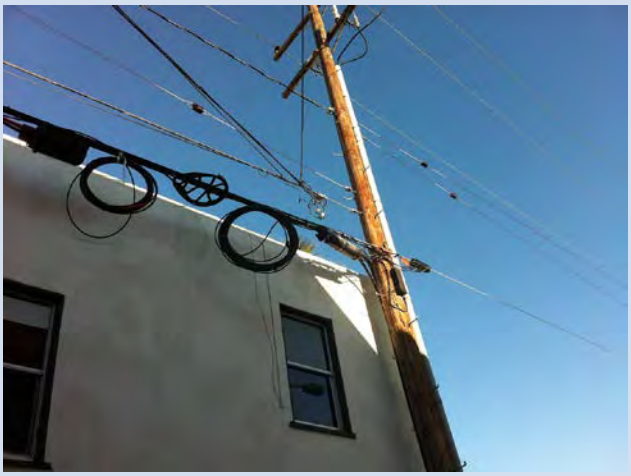
Fiber route markers come in a variety of shapes. Most of them are orange or orange capped. Most fiber route markers indicate they mark a buried fiber path. It is important not to confuse fiber route markers with other buried infrastructure markers.

Aerial Infrastructure

It is often difficult to distinguish broadband aerial infrastructure form other more traditional infrastructure. On middle mile routes, aerial fiber can sometimes be distinguished by its position on the pole (usually at least two feet below power infrastructure or sometimes on a line attached at the very top of the pole). Middle mile aerial fiber is often characterized by a lack of insulators at pole attachment points.

Much of the existing last mile telecommunications has or can be repurposed for use in broadband networks – given middle mile availability within attenuation distances (thus, the installation of supporting infrastructure).

Aerial Coaxial Cabling in Dinosaur



Aerial Fiber

Wireless Infrastructure

Wireless infrastructure is evident in cellular, microwave, and other wireless antennae.

Microwave Antennae

Cellular Antennae with Microwave Backhaul

Yagi style antennae – Broadband at the Home or Small Business

Supporting Infrastructure

Supporting infrastructure represents a lot of different facilities we see in the field. For example, VDSL usually requires a fiber to the node construction methodology which means we should find nodes in VDSL supported neighborhoods.

A VDSL node

New Construction

Buried fiber or broadband construction is characterized by bore machines, plows, and other specialized equipment and materials.

A Plow Installing Conduit

Middle mile infrastructure can have a significant impact on capacity and cost but it plays a critical role in reliability.

On 31 October 2011 CenturyLink experienced an eight hour outage in northwest Colorado because of damage to its middle mile infrastructure near Dillon.

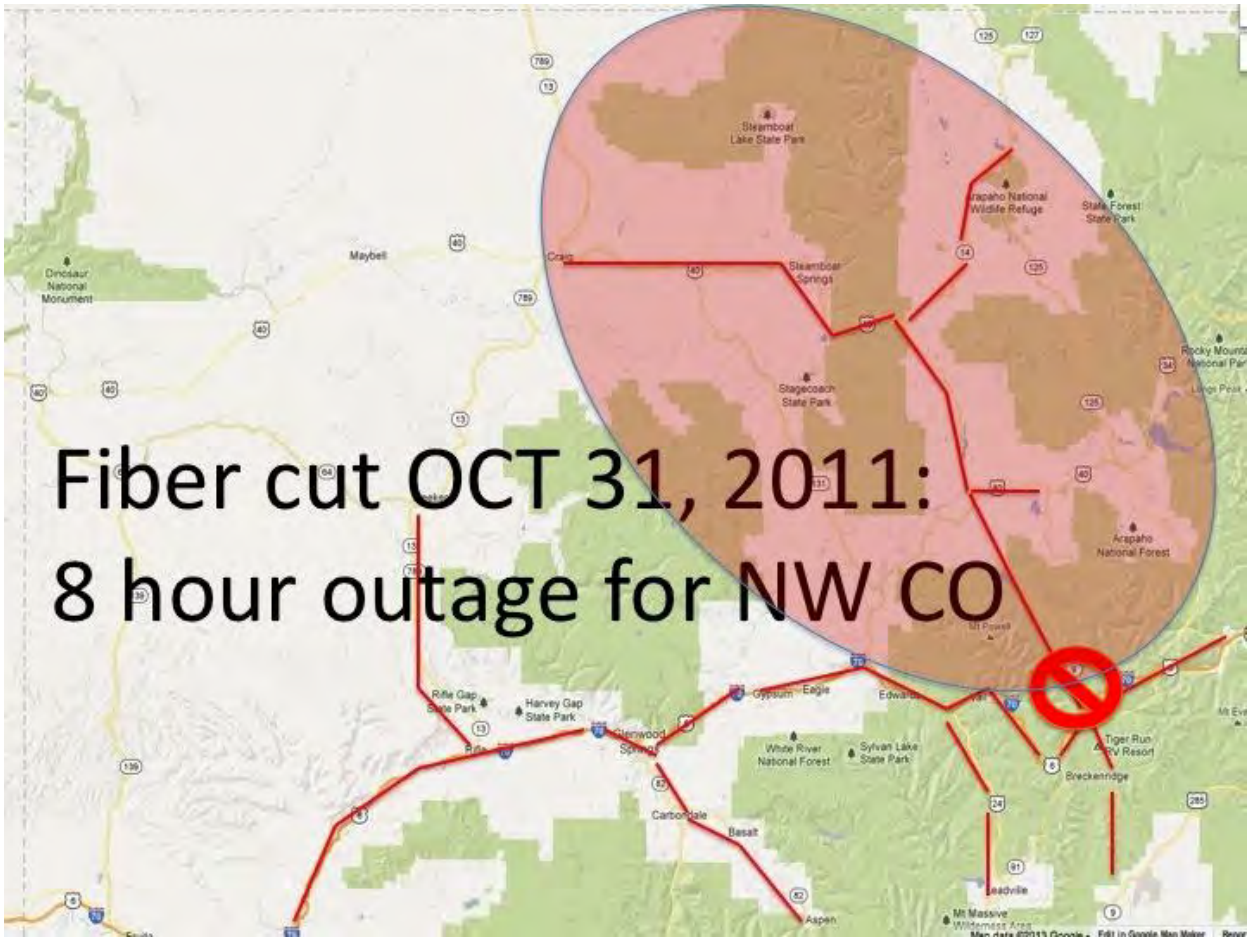


Figure 12: Area Affected by 31 October 2011 Middle Mile Outage

In public meeting with CenturyLink staff 12 December 2011, Steamboat Springs Resort Chamber of Commerce CEO, Tom Kern said of the October CenturyLink outage:

> *At the chamber, we estimate that outage cost our businesses $100,000 per hour in lost sales. If that outage had occurred between Christmas and New Years, it would be $1 million per hour. This must not happen again!*

Lost sales were not the only effect of the outage. Productivity and public image were also both tarnished. We can't estimate the tourism cost of the tarnished image but we can speculate on the cost of lost productivity:

Lost Sales	Lost Productivity	Total Cost of Outage
$100,000/hour X 8 hours	1,000 workers X $30/hour X 8 hours	
$800,000	$240,000	$1,040,000

Table 6: Steamboat Springs Middle Mile Outage Cost Estimate

Elsewhere in Colorado, a fiber cut in the San Luis Valley on August 14, 2010 took down all telecommunications in the 6-county region for 14 hours. A similar outage occurred in January 2011 near Colorado City, which took the San Luis Valley off-line for many hours. As a result, the San Luis Valley Broadband Cooperative took measures to invite additional middle mile services to the region and they now enjoy 7 middle mile routes into the region.[64] The FCC stopped making records of telecommunications network outages public in 2004. Colorado Public Utilities Commission offers no such record keeping or requirement of service providers.

Northwest Colorado has a reasonable amount of middle mile fiber infrastructure connecting most population centers in the region. Three critical weaknesses characterize the available middle mile fiber assets:

1. Redundancy
   In aggregate, the fiber paths in the region offer good regional egress diversity. Paths exist through Vernal to Salt Lake City, through Rifle to Grand Junction, and along at least two geographically diverse routes to Denver. Taking into consideration microwave links as well, diversity is added to Cheyenne. Unfortunately, route diversity is largely owned by competing network owners and the competing network owners have not come to agreements to create diversity in their disparate networks by carrying each other's traffic.
   ** We recommend working with the various network owners in the region to help them come to agreements to carry each other's traffic. Several of the network owners in the region have expressed an interest in doing so. Failing to get service providers to enter into traffic sharing agreements, towns may pursue carrier neutral locations and create redundancy for themselves. Of course, the utility of a CNL is limited to its subscribers.
2. Access
   Potential subscribers seem to have difficulty accessing the fiber in the region.
   ** We recommend establishing a regional information repository potential subscribers can turn to in order to learn about available middle mile infrastructure.
   ** There may also be a need to invest in building add/drop points on the existing middle mile fiber infrastructure. Network owners may need subsidies, business guarantees, or some other incentive to justify the business case for building and maintaining an add/drop location.
3. Cost
   Middle mile data access prices are typically tiered with the cost per Mbps dropping dramatically as the volume of bandwidth purchased increases. However, Northwest Colorado is a rural area.

[64] Service providers include: Viaero, GoJade Communications (2 routes), Skywerx, EAGLE-Net, and CenturyLink (2 routes)

The data demands a given county or hospital put on middle mile infrastructure are limited. Disaggregated these customers seldom reach discount thresholds. Aggregating demand can serve to overcome some middle mile cost barriers.
** We recommend looking for opportunities and methods to aggregate demand.

3.3.3 HIGH SPEED INTERNET SERVICES – LAST MILE

As we look at last mile broadband in the region, we should look at availability, price, and speed.

3.3.3.1 AVAILABILITY

Last mile broadband in the region is delivered via wireline (fiber, coaxial cable, and twisted pair cable), fixed wireless services (typically referred to as wireless service), and mobile wireless (or cellular).

Known broadband providers in the region[65] include:

Provider	Towns Served	Notes
Wireline Providers		
CenturyLink www.centurylink.com	Aspen, Avon, Basalt, Blue River, Breckenridge, Carbondale, Coalmong, Cowdrey, Craig, Dillon, Dinosaur, Eagle, Edwards, Frisco, Fraser, Glenwood Springs, Gould, Granby, Grand Lake, Gypsum, Hayden, Heeney, Hot Sulphur Springs, Kremmling, Meeker, Meredith, Oak Creek, Phippsburg, Rand, Rangely, Redstone, Silverthorne, Snowmass, Snowmass Village, Steamboat Springs, Tabernash, Vail, Walden	CenturyLink offers xDSL for businesses and residences. CenturyLink also has specialized circuits (T1, DS3, etc.) and Metropolitan Optical Ethernet (MOE) services available for business subscribers.
Comcast www.comcast.com	Aspen, Avon, Basalt, Blue River, Breckenridge, Carbondale, Dillon, Edwards, Frisco, Fraser, Glenwood Springs, Granby, Hot Sulphur Springs, Silverthorne, Snowmass, Snowmass Village, Steamboat Springs, Vail	Comcast offers DOCSIS 3 services in most places they offer service.
FastTrack Communications www.fasttrackcomm.net	Meeker	FastTrack is primarily a business fiber provider in Southwest Colorado.

[65] This service provider survey based primarily on the Governor's Office of Information Technology Colorado Broadband Data Program found at http://www.colorado.gov/oit/broadband. Additional information added through experience in the region.

Provider	Towns Served	Notes
GSCBN www.gscbn.com	Glenwood Springs	GSCBN offers fiber connections for businesses. GSCBN also has a wholesale wireless service.
San Isabel Telecom www.sanisabel.com	Avon, Eagle, Edwards, Gypsum, Hayden, Vail	San Isabel Telecom offers business and residential DSL. San Isabel also offers T1 services and Ethernet over Copper at data rates up to 45 Mbps for businesses.
Strata Networks stratacolorado.com	Craig, Meeker, Rangely	Strata Networks has fiber assets in Rio Blanco and Moffat Counties.
Wireless Providers		
Grand County Internet wireless.rkymtnhi.com	Fraser, Granby, Grand Lake, Hot Sulphur Springs, Kremmling, Tabernash, Winter Park	Grand County Internet is a wireless service provider in Grand County.
JAB Broadband/Skybeam www.skybeam.com	Basalt, Blue River, Breckenridge, Carbondale, Dillon, El Jebel, Frisco, Glenwood Springs, Redstone, Silverthorne, Woody Creek	Skybeam is a JAB Broadband company. JAB Broadband is a wireless service provider MSO.
Resort Broadband www.resortbroadband.com	Steamboat Springs	
Slopeside Internet www.slopesideinternet.com	Fraser, Granby, Tabernash, Winter Park	Slopeside Internet is a wireless service provider in Grand County.
Zirkel Wireless www.zirkelwireless.com	Craig, Clark, Hayden, Oak Creek, Phippsburg, Steamboat Springs, Yampa	Zirkel Wireless is a wireless service provider with antennas reaching Steamboat Springs, Craig, Hayden, Milner, Oak Creek, Stagecoach, Phippsburg, Yampa, and Clark.
Cellular Providers		
AT&T www.att.com	Aspen, Avon, Basalt, Blue River, Breckenridge, Carbondale, Craig, Dillon, Eagle, Edwards, Frisco, Fraser, Glenwood Springs, Gypsum, Meeker, Minturn, Red Cliff, Silverthorne, Snowmass, Snowmass Village, Steamboat Springs, Tabernash, Vail, Woody Creek	
Sprint www.sprint.com	Aspen, Avon, Basalt, Blue River, Breckenridge, Carbondale, Craig, Dillon, Dinosaur, Eagle, Edwards, Frisco, Fraser, Glenwood Springs, Granby, Gypsum, Hayden, Minturn, Silverthorne, Snowmass, Steamboat Springs, Tabernash, Vail, Winter Park	

Provider	Towns Served	Notes
T-Mobile www.t-mobile.com	Aspen, Avon, Breckenridge, Craig, Dillon, Edwards, Frisco, Fraser, Minturn, Silverthorne, Snowmass Village, Steamboat Springs, Tabernash, Vail, Winter Park, Woody Creek	
Union Wireless www.unionwireless.com	Craig, Dinosaur, Hayden, Meeker, Rangely, Steamboat Springs	Union provides voice services but not currently cellular broadband in Jackson County.
Verizon www.verizonwireless.com	Aspen, Avon, Basalt, Blue River, Breckenridge, Carbondale, Clark, Cowdrey, Craig, Dillon, Dinosaur, Eagle, Edwards, El Jebel, Frisco, Fraser, Glenwood Springs, Granby, Grand Lake, Gypsum, Hayden, Hot Sulphur Springs, Kremmling, Maybell, Minturn, Oak Creek, Phippsburg, Rangely, Silverthorne, Snowmass, Snowmass Village, Steamboat Springs, Tabernash, Vail, Walden, Winter Park, Woody Creek, Yampa	

Table 7: Regional Broadband Providers

"Table 7: Regional Broadband Providers" presents known broadband providers and the communities they serve. "Table 8: Known Broadband Providers by Community" presents known broadband providers by community.

	Wireline						Wireless					Cellular				
Eagle County	**Century Link**	**Comcast**	**FastTrack**	**GSCBN**	**San Isabel**	**Strata**	**Grand County**	**JAB/Skybeam**	**Resort**	**Slopeside**	**Zirkel**	**AT&T**	**Sprint**	**T-Mobile**	**Union**	**Verizon**
Avon	X	X			X							X	X	X		X
Basalt	X	X						X				X	X			X
Eagle	X				X							X	X			X
Edwards	X	X			X							X	X	X		X
El Jebel		X						X								X
Gypsum	X				X							X	X			X
Minturn		X										X	X	X		X
Red Cliff												X				

	Wireline						Wireless				Cellular					
	Century Link	Comcast	FastTrack	GSCBN	San Isabel	Strata	Grand County	JAB/Skybeam	Resort	Slopeside	Zirkel	AT&T	Sprint	T-Mobile	Union	Verizon
Vail	X	X			X							X	X	X		X
Garfield County																
Carbondale	X	X						X				X	X			X
Glnwood Spgs	X	X		X				X				X	X			X
Grand County																
Fraser	X	X					X			X		X	X	X		X
Granby	X	X					X			X			X			X
Grand Lake	X	X					X									X
Hot Sulphur	X	X					X									X
Kremmling	X						X									X
Tabernash	X						X			X		X	X	X		X
Winter Park							X			X			X	X		X
Jackson County																
Coalmont	X															
Cowdrey	X															X
Gould	X															
Rand	X															
Walden	X															X
Moffat County																
Craig	X					X					X	X	X	X	X	X
Dinosaur	X												X		X	X
Maybell																X
Pitkin County																
Aspen	X	X										X	X	X		X
Basalt	X	X						X				X	X			X
Meredith	X															
Redstone	X							X								
Snowmass	X	X										X	X			X
Snowmass Vill	X	X										X	X	X		X
Woody Creek								X				X		X		X
Rio Blanco County																
Meeker	X		X			X						X			X	
Rangley	X					X									X	X
Routt County																
Clark											X					X
Hayden	X										X		X			X
Oak Creek	X										X					X
Phippsburg	X										X					X
Steamboat Spg	X	X							X		X	X	X	X	X	X

	Wireline						Wireless				Cellular					
	Century Link	Comcast	FastTrack	GSCBN	San Isabel	Strata	Grand County	JAB/Skybeam	Resort	Slopeside	Zirkel	AT&T	Sprint	T-Mobile	Union	Verizon
Toponas																
Yampa											X					X
Summit County																
Blue River	X	X						X				X	X			X
Breckenridge	X	X						X				X	X	X		X
Dillon	X	X						X				X	X	X		X
Frisco	X	X						X				X	X	X		X
Heeney	X															
Montezuma																
Silverthorne	X	X						X				X	X	X		X

Table 8: Known Broadband Providers by Community

3.3.3.2 PRICE

Where service is available, northwest Colorado residential subscribers pay similar prices as Front Range residential subscribers. The two largest broadband providers in the region – Comcast and CenturyLink – offer the same residential package pricing on both sides of the Rockies. Where wireless is the only available option, subscribers tend to pay more per Mbps than wireline subscribers. Satellite subscribers pay significantly more for service than wireless or wireline subscribers.

	Package 1	Package 2	Package 3	Avg. $/Mbps
CenturyLink[66]	7/.896 Mbps $45 per month $6.43/Mbps	12/.896 $50 per month $4.17/Mbps	40/5 $70 per month $1.75/Mbps	$4.12
Comcast[67]	Performance Starter 6/1 Mbps $49.95 per month $8.33/Mbps	Blast! 50/10 Mbps $74.95 per month $1.50/Mbps	Extreme 105 105/20 $114.95 per month $1.09/Mbps	$3.64

[66] Prices for "Pure Broadband" product after promotional period retrieved 12 August 2013 from http://www.centurylink.com/common/popups/residential/pricing_details_popup.html.
[67] Package names and prices for a randomly selected Steamboat Springs address retrieved 12 August 2013 from https://www.comcast.com/shop/buyflow2/products.cspx?TargetId=00a04f7c-c2c8-4b41-8da3-e49dc121b422&&Inflow=1.

	Package 1	Package 2	Package 3	Avg. $/Mbps
Zirkel Wireless[68]	Choice 3/1 Mbps $46 per month $15.33/Mbps	Turbo 12/4 Mbps $86 per month $7.17/Mbps	Turbo Plus 18/6 Mbps $116 per month $6.44/Mbps	$9.65
Grand County[69]	2.5/1.5 Mbps $40 per month $16/Mbps	4/1 Mbps $55 per month $13.75/Mbps	6/2 Mbps $80 per month $13.33/Mbps	$14.36
JAB/Skybeam[70]	5/1 Mbps $39.95 per month $7.99/Mbps	10/2 Mbps $49.95 per month $5.00/Mbps	15/3 Mbps $59.95 per month $4.00/Mbps	$5.66
WildBlue[71]	Speeds are 12/3 Mbps with prices varying based on usage and ranging from $49.99 to $129.99 per month.			$27.08

Table 9: Sample Residential Broadband Pricing

Business pricing is harder to determine. Most service providers provide business pricing on a case by case basis. Significant anecdotal evidence suggests business pricing is higher in northwest Colorado than on the Front Range.

3.3.3.3 SPEED

We primarily used four tools to gather information about broadband speeds available in the region:

1. Service Provider Interviews, Conversations, and Other Anecdotal Evidence,
2. The Colorado Broadband Mapping Application,
3. Surveys, and
4. Speed Test Data

3.3.3.3.1 SERVICE PROVIDER INTERVIEWS, CONVERSATIONS, AND OTHER ANECDOTAL EVIDENCE

From service provider interviews, conversations, and other anecdotal evidence, we can identify certain gaps in coverage. For example:

- We know that the northern half of Summit County, from just north of Silverthorne to Kremmling along Colorado Highway 9 is a very sparsely populated area with almost no service.

[68] Package names and prices retrieved 12 August 2013 from http://www.zirkelwireless.com/order.html.
[69] Prices retrieved 12 August 2013 from http://wireless.rkymtnhi.com/wirelesspricing.html.
[70] Prices retrieved 12 August 2013 from http://www.skybeam.com/residential/pricing-plans-colorado-wyoming/.
[71] Prices retrieved 12 August 2013 from http://www.wildblue.com/options/availability-results?availabilityZip=80446&availabilitySubmit=submit for a Granby Zip code.

- We know that DSL service is not available to many addresses in Jackson County outside of Walden. DSL service is available along Highway 14 to about Gould and sporadically towards Highway 40 and in some other areas.
- We know that while Kremmling is a Comcast served community, Comcast cannot provide data services in Kremmling. Comcast may have a plan to resolve this.
- We know that communities like Clark, Winter Park, and Woody Creek can only get wireless service.
- We know that communities like Montezuma, Red Cliff, Toponas, Yampa, and Maybell are unserved.

Any capacity to some areas represents an increase in capacity. We believe that some of the recommendations in this regional strategic plan can help bring broadband to these and other unserved areas in the region.

3.3.3.3.2 COLORADO BROADBAND MAPPING APPLICATION

The Colorado Broadband Mapping Application (http://maps.co.gov/coloradobroadband/) may have some accuracy issues. Among them, geographic bounds for services have been difficult to define. On About.com David Salway writes about the national broadband map (which is based on the data collected for state maps like the Colorado Broadband Mapping Application):

> *There are a number of problems which have been identified in the methodology used to produce the national map. For one, the mapping granularity used by the NTIA to measure broadband access was at the census block level. This permitted broadband providers from reporting areas 100% served, when they only reached one residence in the census block. Additionally, some funding decisions required grant applicants to serve 100% of a census block, if they proposed to serve any part of the census block. In rural and remote areas of the country, proving service to the farthest reaches of a census block can significantly increase the cost for providing service. In fact, this is a large part of the problem in providing broadband service to rural areas*[72].

Also, service providers self report their services and there is no real mechanism to validate accuracy. Reporting is based on the ill-defined geography addressed above and on advertised maximum download speeds this may lead to over reporting reach and speed as, quoting from Salway again, "Providers have a significant proprietary interest in protecting service areas which they have invested a large amount of private capital. By overstating coverage areas, or simply following NTIA guidelines for data reporting, many unserved areas appear to be served by incumbent broadband providers."

[72] Salway, David. "National Broadband Map Data Called Into Question." About.com. http://broadband.about.com/od/broadbandavailability/a/National-Broadband-Map-Data-Called-Into-Question.htm.

In spite of some data accuracy issues, the Colorado Broadband Mapping Application is the most comprehensive resource available for identifying speed tiers and other broadband data in northwest Colorado and throughout the state. The application provides a wealth of data (most of it reasonably accurate) and is regularly updated. The mapping team is also willing to listen to concerns and to work to resolve them. ** Rather than trying to duplicate the state's efforts, we recommend working with GOIT to continually improve the Colorado Broadband Mapping Application.

K1: Working with GOIT to improve regional broadband mapping.

Rather than trying to duplicate the state's efforts, we recommend working with GOIT to continually improve the Colorado Broadband Mapping Application.

In the process of developing this regional broadband strategic plan, we have conducted speed tests throughout the region. The purpose of these data is to complement the data available from the state mapping application.

3.3.3.3.3 SURVEYS

We use three surveys as data sets for development of this regional broadband strategic plan:

1. 2010-2011 Statewide School Survey,
2. 2011 Grand County Survey Partial Results, and
3. NWCCOG Online Survey

This section provides summary results of the surveys. Detailed results are provided in the appendix "Survey Results".

3.3.3.3.3.1 2010-2011 STATEWIDE SCHOOL SURVEY

In 2010-2011 schools across the state were surveyed to see what their actual connection speeds were (see "2010-2011 Statewide School Survey" on page xii for more detail). The statewide school speed survey found the average connection for schools in northwest Colorado was 10.1 Mbps download with a 4.1 Mbps upload. The fastest connection was near 100 Mbps download speed (Middle Park High School in East Grand School District) and the slowest was a 250 Kbps download speed at Maybell Elementary School (Moffat School District).

It will be interesting to see if these speeds change as EAGLE-Net begins to make school connections.

3.3.3.3.3.2 2011 GRAND COUNTY SURVEY PARTIAL RESULTS

In 2011 Grand County conducted a survey and found the following (see "2011 Grand County Survey Partial Results" on page xiv for more detail):

	Grand County Survey Results (2012)		COG Survey Results (2013)
	Download (Mbps)	Upload (Mbps)	Download (Mbps)
Fraser	5.41	1.95	10.10
Granby	9.54	2.40	8.5
Grand Lake	7.98	3.53	6.77
Hut Sulphur Springs[73]	10.45	6.10	13.31
Kremmling	1.05	0.40	5.41
Tabernash	1.74	1.18	4.93
Winter Park	10.92	2.86	17.29
County Average	5.18	1.67	8.00

Table 10: Grand County Survey Summary Results

3.3.3.3.3.3 NWCCOG ONLINE SURVEY

In 2013, the NWCCOG conducted an online survey where respondents could self select to participate. The COG collected 1,117 valid responses of which 625 provided connection speed data (see "NWCCOG Online Survey" on page xvii for more detail). We are still parsing the data generated by the survey. We intend to leave the survey online and to generate new results from time to time. This report is influenced by learning from the survey.

While we continue to learn from these data, we include here some interesting findings.

First, we broke connection speeds into slow (up to 5 Mbps), medium (5 to 20 Mbps), and fast (above 20 Mbps) and looked at the counties (and individual municipality participants) based on these speed tiers.

[73] Grand County survey had only a single test.

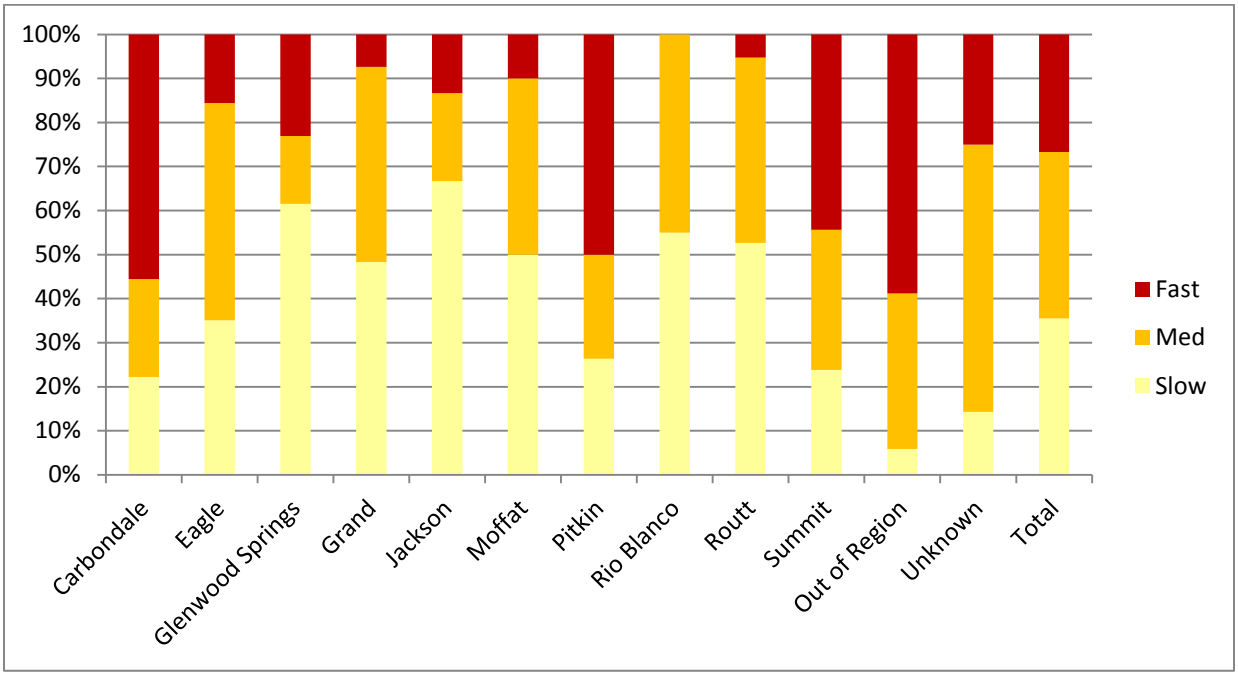


Figure 13: Speed Tiers by County

"Figure 13: Speed Tiers by County" shows the majority of survey respondents (64.5%) have medium or fast speed tiers. It further shows that no survey respondents in Rio Blanco County subscribe at the fast service tier and only a small number in Routt (5.3%), Grand (7.4%), Moffat (10.0%), and Jackson (13.3%) do so. Based on other collected data, we believe this has more to do with availability than price or other decision factors.

It is also interesting to note that the respondents from out of the study region subscribe at 5.9% slow, 35.3% medium, and 58.8% fast – that is, at faster service connections than even the fastest area in the region (Carbondale with 22.2% slow, 22.2% medium, and 55.6% fast).

We also looked at the region's service providers based on these same speed tier categories.

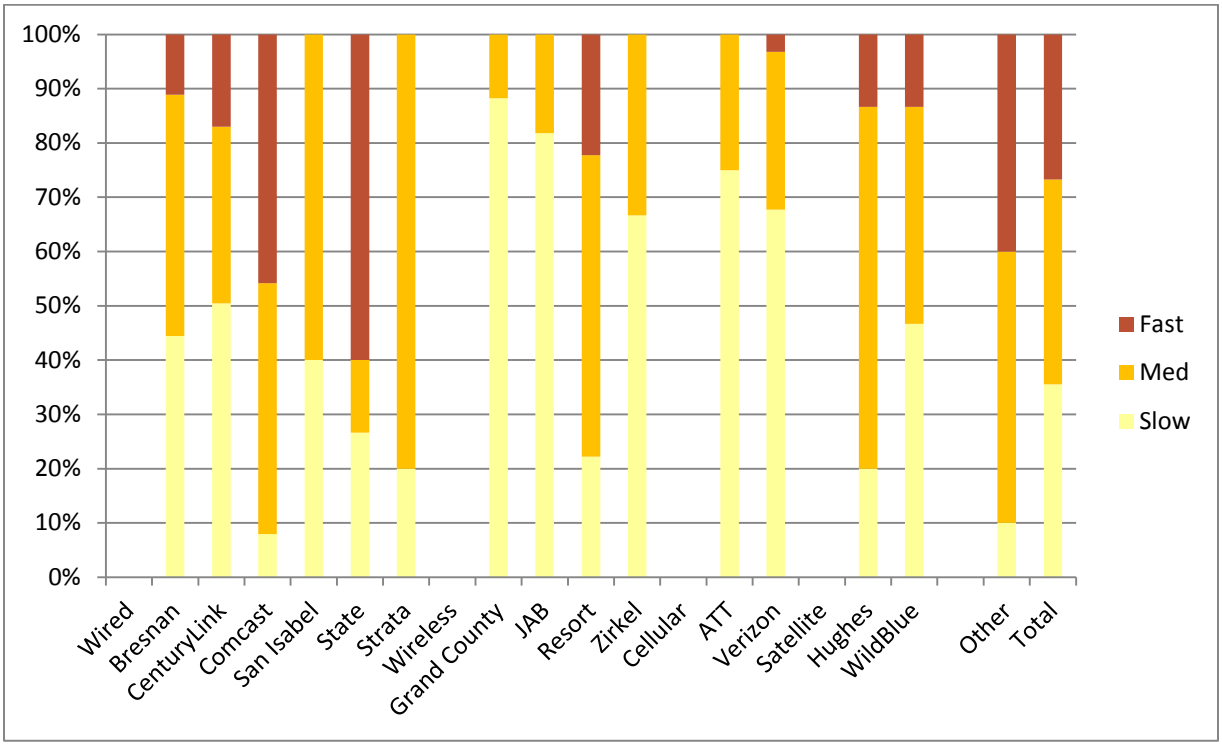


Figure 14: Speed Tiers by Service Provider

As we would expect, "Figure 14: Speed Tiers by Service Provider" demonstrates that wired service providers are generally faster than wireless which are generally faster than Cellular. The service provider data demonstrate some interesting differences between service providers:

- San Isabel and Strata provide wired service but no survey respondents connect at the fast speed tier through these providers.
- Comcast has minimal respondents (7.9%) connecting at the slow tier.
- Wireless provider Resort Wireless has a larger percentage of respondents in the fast and medium tiers than do wired service providers Bresnan, CenturyLink, and San Isabel.
- Grand County and JAB have larger percentages of respondents in the slow tier than their cellular counterparts ATT and Verizon.

3.3.3.3.4 SPEED TEST DATA

Speed tests are affected by numerous variables – most of them outside the control of the subscriber and many of them outside the control of the service provider. A subscriber can test speeds one day and see unbearably slow performance and on the next day see blazing fast speeds.

Average speed test data shows a realistic picture of what subscribers are experiencing. Speed test data does not typically point to specific problems that can be fixed to improve broadband capacity. Rather, speed test data can be used to review performance and to determine if further investigation is needed.

The primary speed test tool used in the development of this regional broadband strategic plan is TestMy.Net (http://testmy.net/). TestMy.Net uses a server based speed test model that is effective and as accurate as speed test data can be. TestMy.Net tracks speed tests by city (as reported by the ISP for the IP address of the testing workstation). Colorado city data can be found at http://testmy.net/list/state/co. In the TestMy.Net Colorado city data, clicking on a city and then clicking the "ISP Rank" tab provides some information about service providers detected by TestMy.Net in the City.

One disadvantage of the city data reported by TestMy.Net is the fact that cities are reported as per the owner of the IP address associated with the speed test. In most cases, these are reported as the actual city. However, in some cases, it may be a near neighbor, a large city in the state, or even a distant city in a distant state. To help us overcome this weakness and to give us more precise geographic placement of survey respondents' download and upload speeds, TestMy.Net constructed a utility that allows the NWCCOG's data analysts to capture TestMy.Net data associated with the COG's online survey respondents. The locations associated with these test result data are based on user reported addresses instead of Internet service provider reported addresses (as per the generic results).

		Survey Results[74]		Generic Results[75]	
	Tests	Down Mbps	Up Mbps	Down Mbps	Up Mbps
Carbondale	40	22.3	3.21		
Eagle	178	13.4	1.29	8.87	1.58
Glenwood Springs	20	18.1	4.04		
Grand	317	8.0	1.93	12.88	3.24
Jackson	21	6.5	1.29		
Moffat	14	6.8	1.09	3.70	1.20
Pitkin	128	18.7	5.05	10.13	2.36
Rio Blanco	26	5.3	0.60	3.20	0.61
Routt	27	6.6	1.10	14.17	4.13
Summit	258	21.7	2.12	10.08	2.85
Average:		**14.6**	**2.5**		

Table 11: Local Survey TestMy.Net Results by County

3.3.4 CELLULAR COVERAGE

Cellular coverage in more rural areas of the region is intermittent. Lack of cellular service can represent a public safety risk.

Efforts to improve broadband in the region may lead to improvements in cellular coverage. Cellular coverage depends on connecting to traditional landline networks at some point. As improving

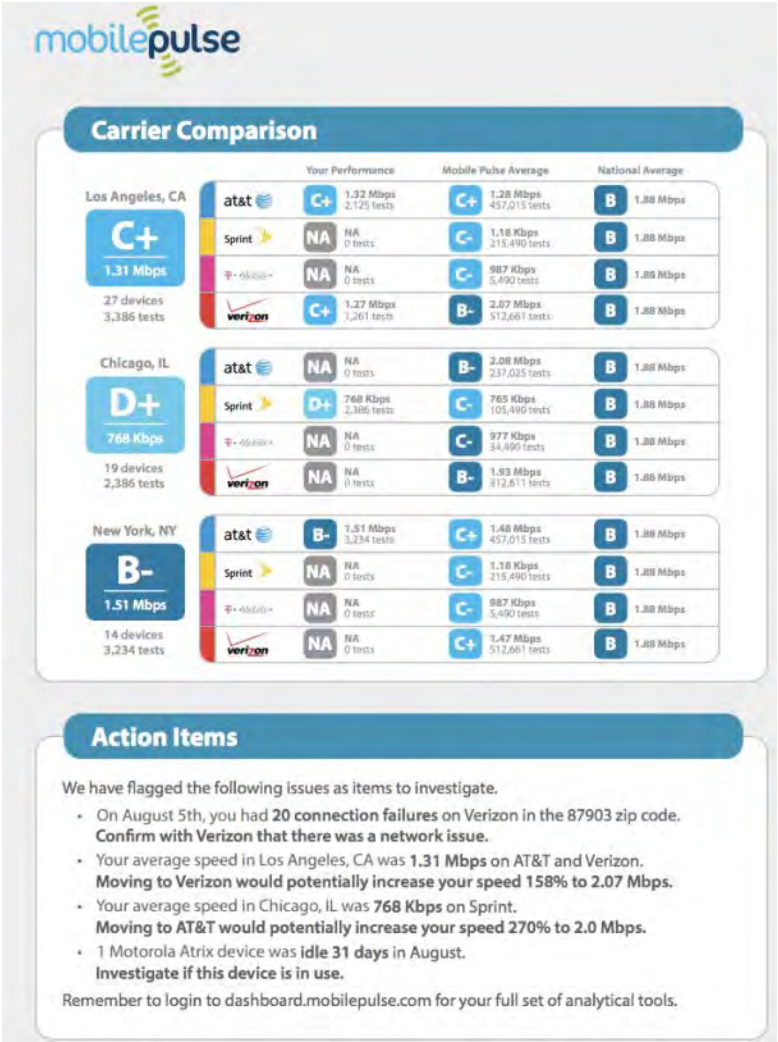
[74] Based on survey data as of October 2013.
[75] Based on data collected from http://testmy.net/list/state/co in August of 2013.

broadband extends the reach of traditional landline networks in the region, the business case for placing cellular antennas to cover areas where service is currently unavailable may be strengthened.

A study of cellular coverage is outside the scope of this regional broadband strategic plan. However, many of the actions executed to improve broadband may also improve cellular coverage.

Inasmuch as cellular providers provide broadband services, cellular providers are included in this study. Service provider reported coverage can be found on the Colorado Broadband Mapping Application (http://maps.co.gov/coloradobroadband/).

As with any broadband service, reported service areas and speeds do not always reflect reality. Denver-based MobilePulse (http://www.mobilepulse.com/) offers a mobile app that serves as the front end to a powerful data gathering and analysis tool. The app can be loaded on local government mobile devices. Once the app is loaded, it tracks mobile network performance. MobilePulse provides intuitive and detailed analytic tools as well as data summaries represented in the form of a “report card” as depicted in “Figure 15: Mobile Pulse Sample "Report Card"”.



mobilepulse

Carrier Comparison

		Your Performance	Mobile Pulse Average	National Average
Los Angeles, CA — C+ — 1.31 Mbps — 27 devices, 3,386 tests	at&t	C+ 1.32 Mbps 2,125 tests	C+ 1.28 Mbps 457,015 tests	B 1.88 Mbps
	Sprint	NA NA 0 tests	C- 1.18 Kbps 215,490 tests	B 1.88 Mbps
	T-Mobile	NA NA 0 tests	C- 987 Kbps 5,490 tests	B 1.88 Mbps
	verizon	C+ 1.27 Mbps 1,261 tests	B- 2.07 Mbps 512,661 tests	B 1.88 Mbps
Chicago, IL — D+ — 768 Kbps — 19 devices, 2,386 tests	at&t	NA NA 0 tests	B- 2.08 Mbps 237,025 tests	B 1.88 Mbps
	Sprint	D+ 768 Kbps 2,386 tests	C- 765 Kbps 105,490 tests	B 1.88 Mbps
	T-Mobile	NA NA 0 tests	C- 977 Kbps 34,490 tests	B 1.88 Mbps
	verizon	NA NA 0 tests	B- 1.93 Mbps 312,611 tests	B 1.88 Mbps
New York, NY — B- — 1.51 Mbps — 14 devices, 3,234 tests	at&t	B- 1.51 Mbps 3,234 tests	C+ 1.48 Mbps 457,015 tests	B 1.88 Mbps
	Sprint	NA NA 0 tests	C- 1.18 Kbps 215,490 tests	B 1.88 Mbps
	T-Mobile	NA NA 0 tests	C- 987 Kbps 5,490 tests	B 1.88 Mbps
	verizon	NA NA 0 tests	C+ 1.47 Mbps 512,661 tests	B 1.88 Mbps

Action Items

We have flagged the following issues as items to investigate.

- On August 5th, you had **20 connection failures** on Verizon in the 87903 zip code. **Confirm with Verizon that there was a network issue.**
- Your average speed in Los Angeles, CA was **1.31 Mbps** on AT&T and Verizon. **Moving to Verizon would potentially increase your speed 158% to 2.07 Mbps.**
- Your average speed in Chicago, IL was **768 Kbps** on Sprint. **Moving to AT&T would potentially increase your speed 270% to 2.0 Mbps.**
- 1 Motorola Atrix device was **idle 31 days** in August. **Investigate if this device is in use.**

Remember to login to dashboard.mobilepulse.com for your full set of analytical tools.

Figure 15: Mobile Pulse Sample "Report Card"

In 2012, about 600 MobilePulse licenses were made available to Colorado local governments through the State Internet Portal Authority (SIPA). For those who missed that opportunity, demonstration versions of MobilePulse can be acquired directly from the company.

** Some local jurisdictions in the region may have MobilePulse licenses. We recommend continued use of the MobilePulse app and sharing of data in the region. The COG should inventory who has MobilePulse licenses and who does not and should work with jurisdictions with licenses to redistribute them throughout the region. Data collected from MobilePulse should be used to improve the information provided on the state broadband map. The COG should then work with regional cellular providers to implement infrastructure to close cellular

K1: Working with GOIT to improve regional broadband mapping.

Some local jurisdictions may have MobilePulse licenses. We recommend continued use of the MobilePulse app and sharing of data in the region.

broadband gaps and improve service in weak signal areas.

4 POTENTIAL DEVELOPMENT PATHS

To determine and evaluate potential development paths, we must first look at regional broadband objectives. We should then look at projects currently underway or planned that might help meet those objectives. Next we should define potential development paths. Finally, we should evaluate the potential paths and make a selection from among them.

4.1 DEFINE REGIONAL BROADBAND OBJECTIVES

We have already defined improving broadband as improving reliability, increasing capacity, and lowering cost. The question now at hand is to what end. What are the COG's regional broadband objectives?

In broad strokes, the COG hopes to leverage broadband to spur economic development, improve quality of life, and enhance public safety.

As described throughout this regional broadband strategic plan, improving broadband can contribute to each of these objectives. However, improving broadband alone won't necessarily advance the COG's objectives. The COG and its member jurisdictions must take steps to leverage broadband to achieve their regional broadband objectives. Defining specific mechanisms for doing so is outside of the scope of this regional broadband strategic plan. In general terms, the COG and its member jurisdictions could (among other things):

- Economic Development
  - Use improved broadband to attract and retain business.
  - Help existing businesses improve efficiency through better utilization of broadband services.
  - Help consumers increase their buying power by exposing them to the worldwide marketplace.
  - Encourage local businesses to take advantage of expanded customer based by advertising and selling through the Internet.
- Quality of Life
  - Use broadband to improve and expand education opportunities throughout the region.
  - Help community anchor institutions better reach their intended audiences through online outreach programs.
- Public Safety
  - Implement real-time video monitoring and recording of select areas.
  - Integrate disparate public safety systems so multiple agencies work together.

4.2 PUBLIC AND PRIVATE PROJECTS UNDERWAY OR PLANNED

Broadband infrastructure is in constant flux. Aging infrastructure, improvements in technology, competitive forces, and other influences demand that network owners regularly upgrade, repair, and extend their networks. We have conducted a survey of regional providers and government entities to identify as many public and private projects underway or planned as possible. It must be noted that this list cannot be comprehensive. The plans that were in place at the time of the survey may already be complete – or cancelled – or replaced with other plans.

4.2.1 PUBLIC PROJECTS

Several public projects have been initiated in the last couple of years and are either recently completed or currently underway.

4.2.1.1 EAGLE-NET

In 2007, the Centennial Board of Cooperative Educational Services (CBOCES) developed EAGLE-Net as a cost-sharing consortium for Colorado. After conducting a broadband survey of all of Colorado's K-12 school districts in 2008, CBOCES/EAGLE-Net determined that market forces weren't sufficient to drive technological investment in Colorado's most remote, rural and underserved areas. It found that Colorado ranked 42nd out of all 50 states in broadband connectivity. In response to these findings, CBOCES, as the operator of the EAGLE-Net network became an American Registry for Internet Numbering (ARIN) acknowledged Internet service provider with its own IP addressing capability.

In 2009, EAGLE-Net responded to 78 school district requests for Internet services and began to connect districts to the EAGLE-Net network. In coordination with the American Recovery and Reinvestment Act

(ARRA) and Colorado's Recovery Act Broadband Framework, CBOCES determined that in order to expand its technology-rich broadband Internet services, it would respond to the Round-1 notice of funding availability offered via the U.S. Department of Commerce Broadband Technology Opportunities Program (BTOP), with the intent to create the EAGLE-Net Alliance as an independent intergovernmental entity to deploy and operate the statewide network.

The initial Round-1 BTOP application proposed using public-private partnerships to improve Colorado's technological infrastructure. Although the Round-1 application was not funded, another application for connecting Colorado's middle mile was submitted in Round-2 and was awarded a $100.6 million grant from BTOP in September 2010.

The original BTOP grant application listed 234 community anchor institutions (CAIs). The following notes describe changes that revised the current CAIs in the project from 234 to 223. In the study area, EAGLE-Net intends to provide new or enhanced connectivity to:

- Eagle County
    - Eagle County School District RE-50, Eagle
- Glenwood Springs
    - Roaring Fork School District RE-1, Glenwood Springs
- Grand County
    - East Grand School District 2, Granby
    - West Grand School District 1-JT, Kremmling
- Jackson County
    - Jackson County Public Library, Walden
    - North Park School District R-1, Walden
- Moffat County
    - Moffat County School District RE-1, Craig
- Pitkin County
    - Aspen School District 1, Aspen
- Rio Blanco County
    - Colorado Northwestern Community College, Rangely
    - Meeker Regional Library, Meeker
    - Meeker School District RE-1, Meeker
    - Rangely School District RE-4, Rangely
    - Rio Blanco BOCES, Rangely
- Routt County
    - Colorado Mountain College, Steamboat Springs
    - Hayden School District RE-1, Hayden
    - South Routt School District RE-3, Oak Creek
    - Steamboat Springs School District RE-2, Steamboat Springs
- Summit County
    - Summit County Public Library, Frisco

- Summit School District RE-1, Frisco

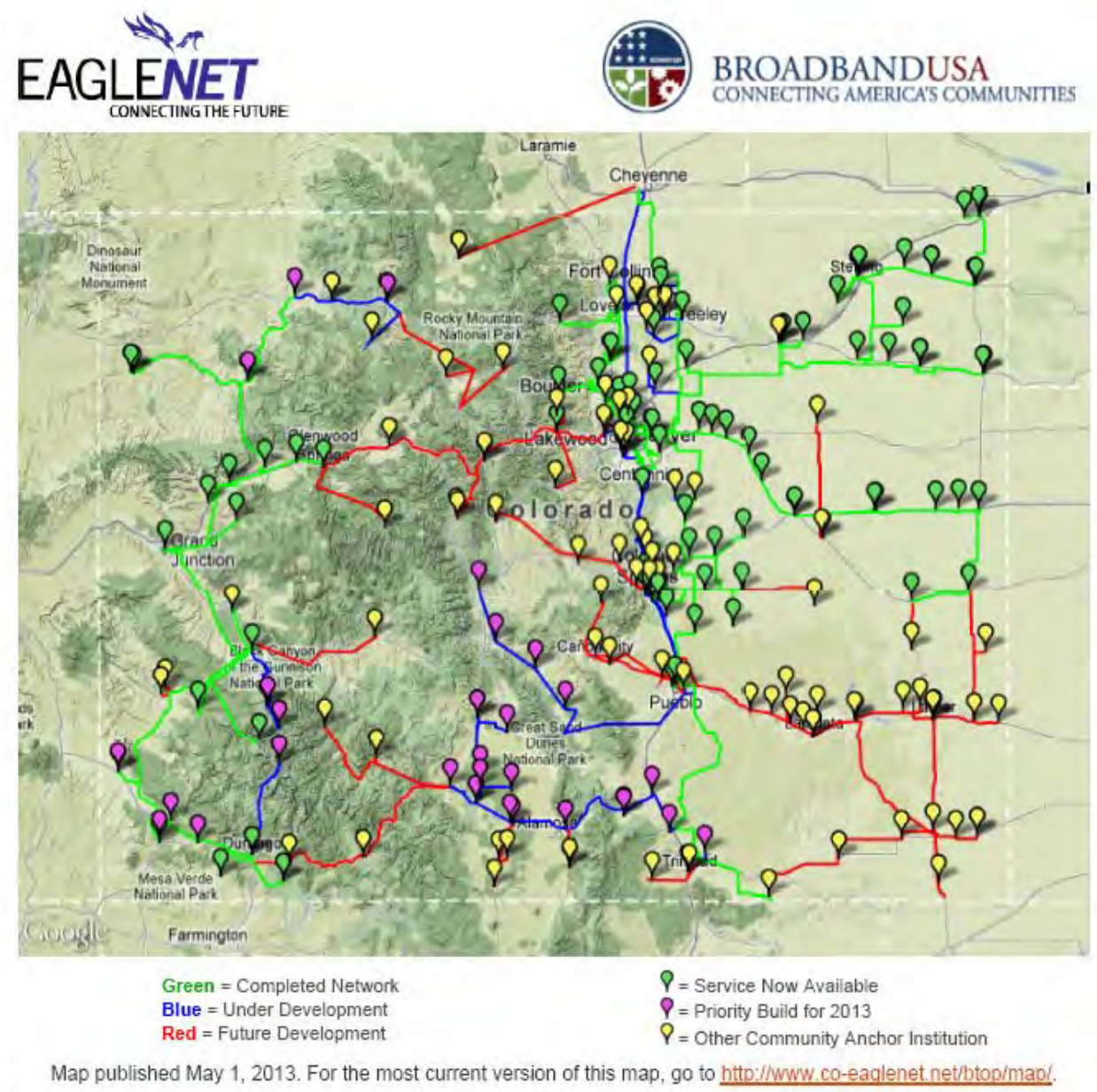


Figure 16: EAGLE-Net Locations

4.2.1.2 COLORADO BOARD OF EDUCATION BRIDGING COLORADO'S DIGITAL DIVIDE

The Colorado State Library, with support from the Bill and Melinda Gates Foundation, was awarded a $3.3 million grant and match project that will fund computers, training, partnerships and a public awareness campaign to develop or augment Public Computer Centers in public libraries and Tribal centers. Coloradans in need of computer training and assistance with education, work force, health, and other support will find support through these public computing centers. According to the Colorado

Department of Education's site (see http://www.cde.state.co.us/cdelib/BTOP/), Walden was scheduled to be a beneficiary of this project. However, the project's "Spending by Colorado BTOP Public Computer Centers" report[76] reports no spending in Walden.

4.2.1.3 COLORADO TELEHEALTH NETWORK

The Colorado Telehealth Network (CTN) is a statewide information and communications platform and highway that will enable patients, providers and payers to improve the quality of care, reduce costs and increase access for health care services. By connecting patients and providers on a high speed and secure statewide network, CTN can provide access to educational, business process and clinical care products. Full production deployment began in August 2010 to connect 200 community medical facilities and another 170 health care provider facilities over this $34 million initial network. The initiative is managed by the Colorado Hospital Association (CHA) and is a collaborative venture between CHA and Colorado Behavioral Healthcare Council (CBHC). Funding for CTN has been provided by the Colorado Hospital Association, Colorado Behavioral Healthcare Council, Federal Communications Commission, and the Colorado Health Foundation. Most of the funding is being used to secure service from CenturyLink – some of that service being offered over usually prohibitively expensive ATM circuits. However, much of the service is being offered via more reasonable optical Ethernet (that is packet based fiber). In some cases, provisioning optical Ethernet may require network improvements that could inure to the benefit of other potential subscribers. A map of CTN sites can be found at https://data.colorado.gov/Health/Map-of-Colorado-Telehealth-Network-Locations/p285-itqq. The map shows sites in Aspen, Craig, Eagle, Frisco, Glenwood Springs, Granby, Kremmling, Meeker, Rangley, Steamboat Springs, Vail, and Walden.

4.2.1.4 RIO BLANCO COUNTY METROPOLITAN AREA NETWORK IMPROVEMENTS

Many northwest Colorado communities have town owned infrastructure connecting multiple town buildings. In some cases this infrastructure is also used to connect school buildings and other community anchor institutions. A good example is the infrastructure managed by Rio Blanco County in Meeker. The County extends connectivity to schools and Town facilities. The County is currently in the process of repairing and upgrading this vital intra-community connectivity resource.

4.2.2 EMERGENCY MANAGEMENT COMMUNICATIONS SYSTEMS

The First Responder Network Authority (FirstNet) is an independent authority within NTIA chartered to provide emergency responders with the first high-speed, nationwide network dedicated to public safety.

In July of 2013, Colorado was one of the first five recipients of the NTIA State and Local Implementation Grant Program (SLIGP), receiving a $2.5 million grant with matching fund requirements. SLIGP funding will be awarded in two phases, with the first phase focused on such activities as expanding existing

[76] http://www.cde.state.co.us/sites/default/files/SpendingbyColoradoBTOPPublicComputerCenters.pdf

governance bodies to consult with FirstNet, conducting education and outreach to relevant stakeholders, and identifying potential public safety users.

The Governor's Office of Information Technology is taking the lead on Colorado's FirstNet efforts. While FirstNet's mission is to provide a nationwide network dedicated to public safety, GOIT has recognized that the assets deployed to support FirstNet can be used for other than public safety needs.

** We recommend the NWCCOG work carefully with regional organizations called on to provide information and support towards the development and deployment of FirstNet. A tendency may exist to perceive public safety broadband needs separately from other broadband needs. The COG should work aggressively to overcome this tendency.

It is important to note that FirstNet will deploy a public safety network. This network will be designed and implemented for the primary use of emergency response personnel. FirstNet will not directly address issues associated with placing 911 calls or other public (i.e. non-emergency response personnel) communications.

C1: Coordinating existing and future projects to enhance infrastructure investment efficiencies.

We recommend the NWCCOG work carefully with regional organizations called on to provide information and support towards the development and deployment of FirstNet.

4.2.3 PRIVATE CARRIER PROJECTS

Gathering information about private carrier projects can be difficult. Private carriers are under no obligation to release infrastructure project information. Furthermore, private carriers often consider such information proprietary and the release of it damaging to their competitive position.

4.2.3.1 COMCAST KREMMLING CONNECTION

Comcast provides video and Internet service to a number of communities in the region. Comcast has upgraded their network to provide packages that range from 3 Mbps download to 105 Mbps – except for in Kremmling. In Kremmling Comcast has been held back by the cost of crossing the Union Pacific tracks to connect their middle mile route to their last mile infrastructure in town.

Recently, Comcast has suggested that this problem has been resolved and Kremmling should be getting Comcast network upgrades similar to those already complete in other northwest Colorado Comcast communities.

4.2.3.2 CENTURYLINK CONNECT AMERICA FUND PROJECTS

CenturyLink recently announced that the company would accept $5.16 million in Colorado from the second round of Phase 1 Connect America Fund (CAF). This funding, combined with CenturyLink's

matching investment will enable 8,976 homes and businesses in Colorado with broadband speeds of no less than 4 mbps downstream/ 1mbps upstream.

When coupled with the $6.56 million of Phase 1 CAF support accepted in the first round, CenturyLink will now bring broadband service to a total of 17,443 homes and businesses in Colorado over the next three years.

NW Colorado CAF Round 1 Funding Commitments		
Wire Center	**CAF Round 1 Customers**	**County**
Avon	407	Eagle
Breckenridge	17	Summit
Dillon	2,149	Summit
Kremmling	235	Grand
Maybell	84	Moffat
Oak Creek	10	Routt
Steamboat Springs	1,965	Routt
Yampa	3	Routt
Total Round 1	**4,870**	
NW Colorado CAF Round 2 Funding Commitments		
Wire Center	**CAF Round 1 Customers**	**County**
McCoy	65	Eagle
Maybell	72	Moffat
Steamboat Springs	62	Routt
Walden	503	Jackson
Total Round 2	702	
Total Both Rounds	**5,572**	

Table 12: CenturyLink Connect America Fund Commitments

This means that a total of 5,572 homes and businesses in northwest Colorado represented by NWCCOG will be provided broadband service, as the result of approximately $7.25 million in private and public funding from CenturyLink and CAF. These new broadband served addresses represent a third of CenturyLink's CAF investment in Colorado and demonstrate CenturyLink's continued commitment to improving broadband in the region.

4.2.4 PUBLIC-PRIVATE PARTNERSHIPS

Public-private partnerships can come in many varieties. CenturyLink looks at their investment in the Connect America Fund projects in northwest Colorado as a public-private partnership inasmuch as they are using public funds matched by private investment to build new privately held infrastructure. In other instances, private funds can be used to help fund public infrastructure or arrangements can be made to cooperatively use assets.

4.2.4.1 TOWN OF VAIL DISTRIBUTED ANTENNA SYSTEM

The Town of Vail in partnership with Vail Associates, Crown Castle, and Aspen wireless has deployed a Distributed Antenna System which a) greatly boosts cell/smart phone performance and b) offers high speed Wi-Fi to residents, businesses and visitors enhancing "the Vail experience".

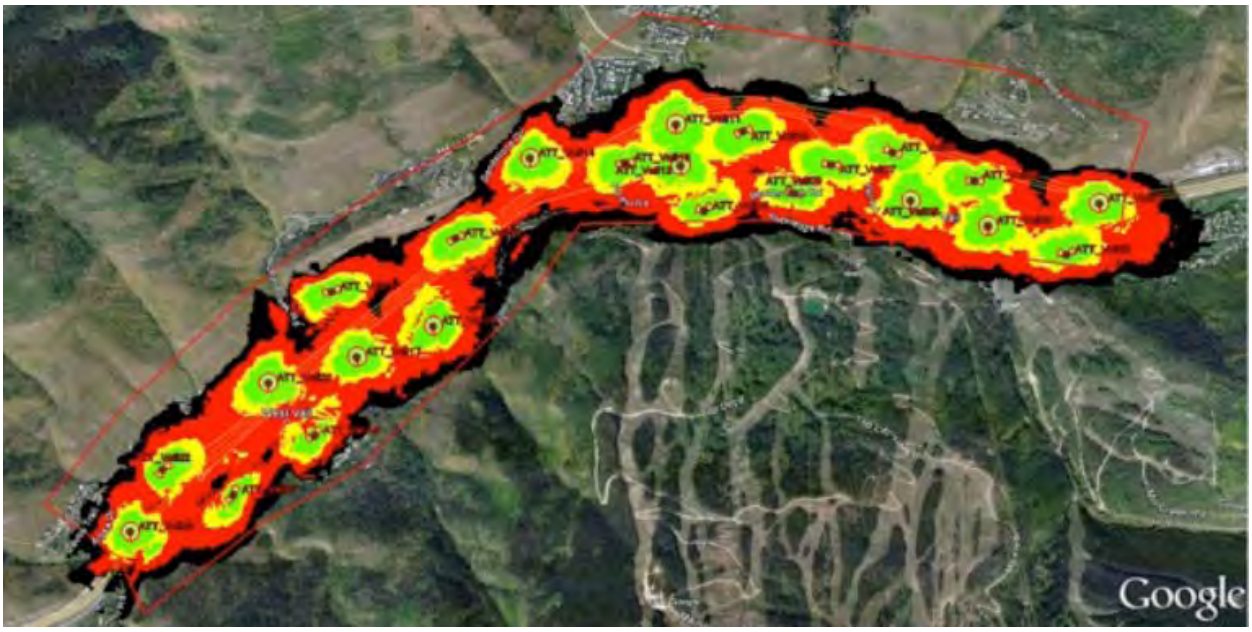


Figure 17: Town of Vail Projected DAS Coverage Area

4.2.4.2 NORTHWEST COLORADO BROADBAND

The public-private partnership Northwest Colorado Broadband (NCB) is the responsible agent for an early adopter Carrier Neutral Location (CNL) in Steamboat Springs. A CNL is a local peering point location where multiple middle mile providers can meet and provide service to multiple last mile providers. "Figure 18: Carrier Neutral Location vs. Traditional Central Office" illustrates, a carrier neutral location (CNL) as an alternative to the traditional central office model. The CNL allows a variety of service providers to reach a market such as communities in rural northwest Colorado at low cost as the switching facilities are hosted by a third party and the service provider leases space in the facility in order to provide services in that community.

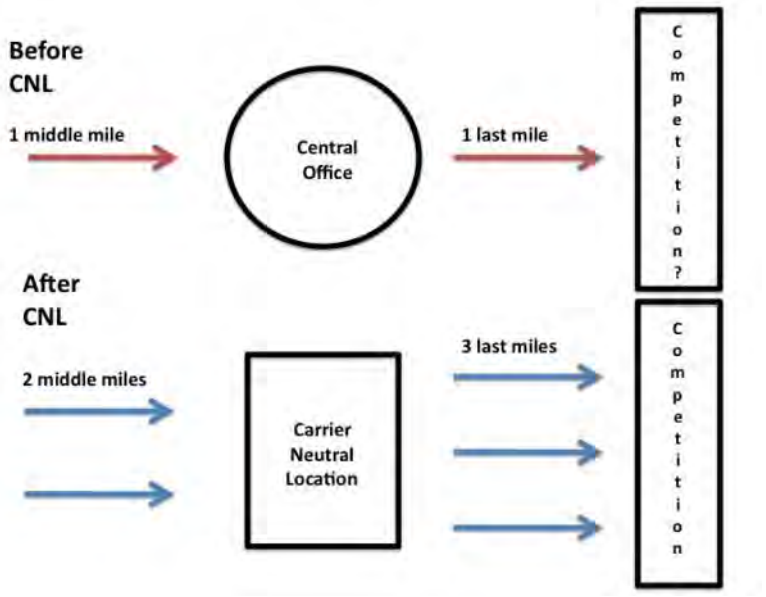


Figure 18: Carrier Neutral Location vs. Traditional Central Office

A CNL can help reduce cost and improve redundancy and reliability.

Demand aggregation by the CNL responsible agent can lead to cost savings. NCB issued a Request for Proposal (RFP) to potential middle mile service providers to build to Steamboat Springs at their cost in exchange for aggregated. The private sector responded to that RFP with offers of services that reduce cost and improve reliability.

Pre-CNL Bandwidth	Pre CNL $/Mbps/month	Post-CNL Bandwidth	Post CNL $/Mbps/month	Potential Real Savings with CNL
45 Mbps @ $5,000/month	$111.11	1 Gbps @ $5,000/mo	$5	$45,000/month or $540,000/year

Table 13: Potential Real Savings with CNL

Initially, the NCB CNL supports the set of community anchor institutions that collaborated to organize NCB with the intent of improving broadband by lowering cost and improving reliability.

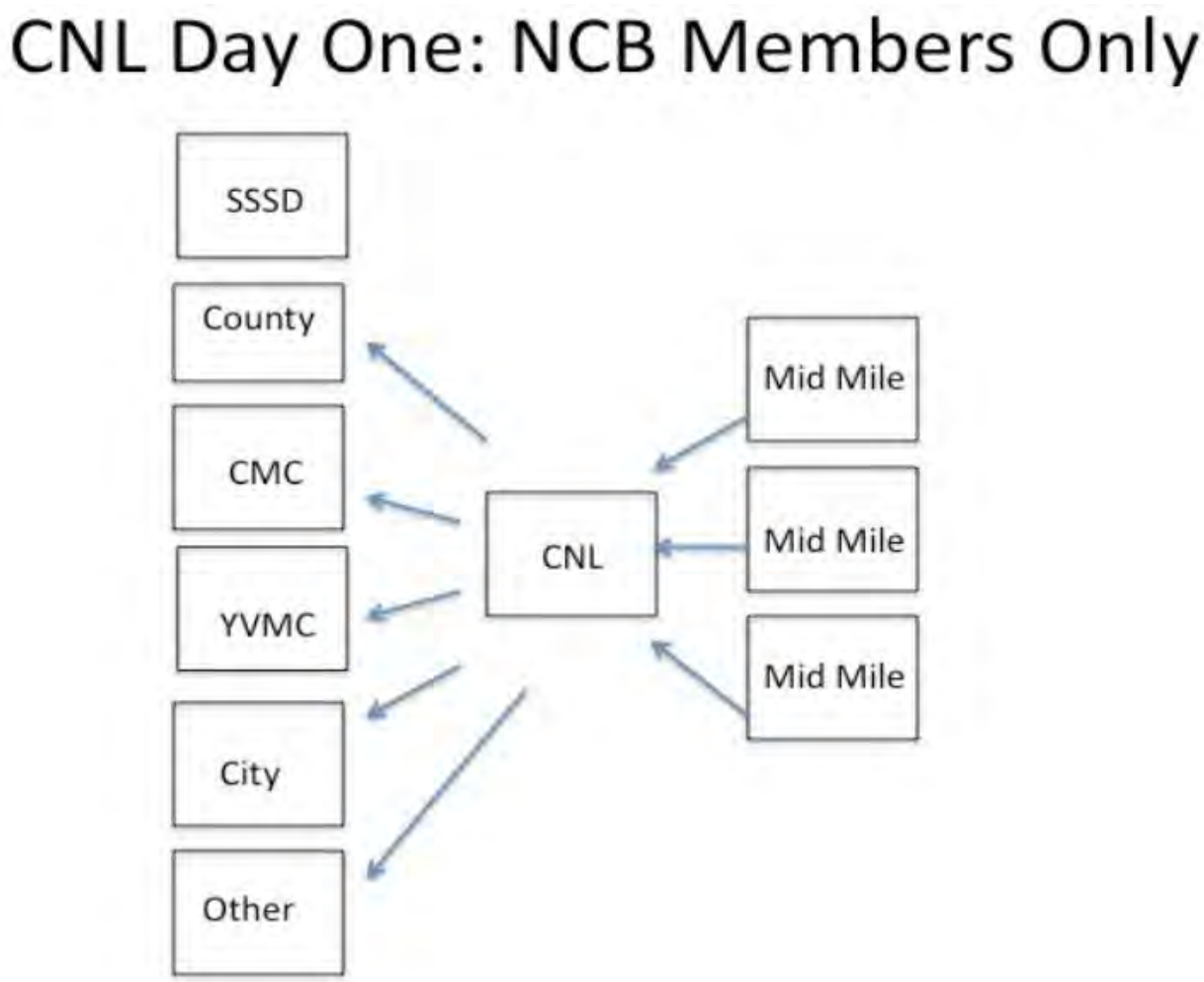


Figure 19: NCB CNL Initial Customers

With just its members participating, NCB projects the CNL will be self sustaining. NCB also recognizes that improving broadband for community anchor institutions does not contribute to economic development. NCB intends to work towards making the CNL an attractive resource to private providers who can use the facility to extend services to residents and businesses.

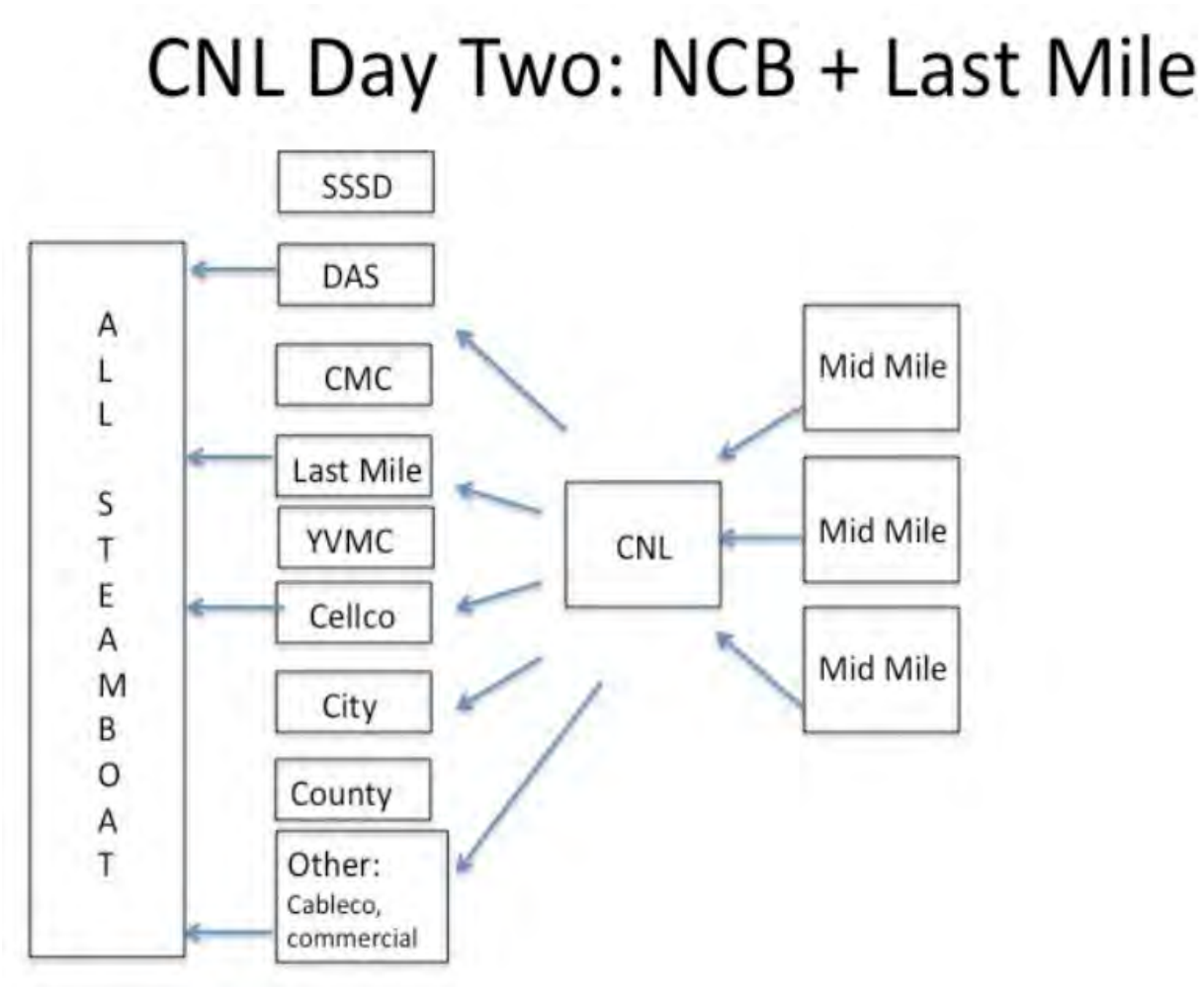


Figure 20: NCB CNL Projected Customers

4.3 POTENTIAL DEVELOPMENT PATHS

Having determined to spur economic development, improve quality of life, and enhance public safety through improving broadband by increasing capacity, improving reliability, and lowering cost, the COG faces many potential development paths. To take action effectively, the COG will need to match an appropriate organizational structure (or structures) with a selected set of actions. In the following sections, we will first introduce potential organizational models ("Ad Hoc Model" on page 79, "Jurisdictional Control Model" on page 79, "NWCCOG Control Model" on page 80, and "Telecommunications Cooperative Model" on page 80). We then look at potential solutions ("Status Quo" on page 84, "Develop Incentives and Penalties for Incumbent Providers" on page 84, "Become a "Broadband Friendly" Community" on page 87, "Regional Cooperative Planning" on page 93, and "Build Infrastructure" on page 93). We will then attempt to align potential solutions with their best fit organizational model and compare and contrast potential development paths (page 114).

4.3.1 ORGANIZATIONAL STRUCTURE

To advance broadband throughout the northwest Colorado region the Northwest Colorado Council of Governments must establish some organizational structure. Some potential organizational structures include:

- Ad Hoc Model
- Jurisdictional Control Model
- NWCCOG Control Model
- Telecommunications Cooperative Model

Of course, a hybrid or a multi-tiered model may be the most effective solution for the COG.

4.3.1.1 AD HOC MODEL

An ad hoc organizational model suggests that organizational structures are formed and disbanded as needed. The formation of the NWCCOG Broadband Steering Committee is an example of an ad hoc organization. The COG may choose to retain the Steering Committee structure in a NWCCOG control model but its initial formation was based on a need (to develop this regional broadband strategic plan).

Ad hoc committees can be established to support individual needs in the other organizational structure models but the ad hoc model is characterized by ad hoc committees forming the foundation of broadband leadership.

The ad hoc model requires the least commitment but may also result in intermittent and uneven broadband development results.

4.3.1.2 JURISDICTIONAL CONTROL MODEL

Jurisdictional control suggests that most decisions and actions affecting broadband belong in the hands of the individual jurisdictions throughout the region. Most efforts to date have been executed via a jurisdictional control model.

Self determination is an important concept and some aspects of the jurisdictional control model should always remain in place. Just as the NWCCOG is comprised of the individual jurisdictions and those individual jurisdictions control the actions of the whole, any broadband development organization should retain direct input and control from the multiple participating jurisdictions.

Relying solely on jurisdictional control may result in uneven broadband development throughout the region. Furthermore, it is difficult to manage market demand aggregation across jurisdictional boundaries in a jurisdictional control model.

4.3.1.3 NWCCOG CONTROL MODEL

For the NWCCOG to control broadband improvement in the region would suggest the COG should establish a permanent Broadband Committee. The COG could then execute projects or provide resources to individual jurisdictions for their projects.

The COG has demonstrated a willingness and ability to manage regional broadband programs. The recent direction by the COG board to pursue funding to support a broadband specialist on the COG staff demonstrates the COG's continued commitment to effective regional broadband development.

Relying on the COG as the driver behind regional broadband development may deny the COG extra-regional market aggregation opportunities and other benefits of extending beyond the COG jurisdiction.

4.3.1.4 TELECOMMUNICATIONS COOPERATIVE MODEL

It may be prudent for the region to establish a telecommunications cooperative to manage assets and improve broadband throughout the region. A telecommunications cooperative could manage infrastructure implementation and continue to provide operations and maintenance support.

A telecommunications cooperative may provide a means whereby implementation projects can happen within the constraints of Colorado law.

Development of a telecommunications cooperative entails the possible risk of diminished control of the project and the public benefits of broadband development.

4.3.2 POTENTIAL SOLUTIONS

There are many options that may lead to improved broadband in the northwest Colorado region. In project training seminars, options ranging from nothing to building infrastructure and providing services were discussed. In "Municipal Options for Fiber Deployment," the Blandin Foundation explores eleven municipal fiber deployment models ranging from enticing the private sector to invest to iterations where the municipality builds and operates a competitive network[77].

[77] Blandin Foundation (unknown). "Municipal Options for Fiber Deployment." http://www.blandinfoundation.org/_uls/resources/Municipal_Options_final.pdf.

	Considerations			
Option	**Ease of Entry**	**Financial**	**Political**	**Examples**
Municipal Utility Retail – City entity finances, constructs, operates and retails telecommunications services	Necessary to hire expertise in telecom planning, construction, operations, marketing, billing. Some municipalities leverage the facilities, financing and expertise of a municipal electric utility.	Total financial commitment, total financial control. Opportunity to gain positive cash flow to support municipal government operations.	Where local government has a positive service reputation, this can be the easiest approach. Quality private sector partner may reduce opposition from skeptics who believe technology is too sophisticated and/or dynamic.	Windom MN www.windomnet.com Burlington VT www.burlingtontelecom.net Baldwin, WI, www.baldwin-telecom.net Reedsburg, WI www.reedsburgutility.com Spencer, IA www.smunet.net Bristol TN www.btes.net
Municipal Utility providing fiber services to large customers only – government, schools, large business	Relatively simple to construct and operate. City could choose to provide Internet access or access to dark fiber.	Fiber network is often good investment for connecting public sector buildings. Depending on required build, added cost may not be significant, especially with quality planning.	This strategy provides operational savings to public sector, plus is seen as a high-level economic development strategy to lower the costs of larger employers and tech-oriented companies.	Chaska, MN www.chaskamn.com Bowling Green, KY www.bgmu.com
Joint Venture – City finances the network with a privates sector entity serving as a wholesale provider to multiple retail providers	Joint powers board sells bonds, hires wholesale operator who recruits retailers. City role is generally limited to financing.	Adequate revenues from providers required to pay bonds.	Multiple providers ensure choice. City loses marketing power of municipal utility.	UTOPIA – Utah. www.utopianet.org
Joint Venture – Network financed through capital lease with leasing company owning the network until leases are paid. Non-profit provider as operator.	Complexities in negotiating partnership agreements. City escapes need to create its own operating entity.	Reliance on partner to operate the network and sell services adequate to retire the debt and maintain / upgrade the network.	Single provider limits choice; responsibilities for service and performance are clear. Overcoming financial difficulties may be difficult w/ weak financial partner.	East Central Vermont FiberNet www.ecfiber.net

	Considerations			
Option	**Ease of Entry**	**Financial**	**Political**	**Examples**
Private Sector Entrant – Public sector entices a private sector provider to enter the market. City may provide financing incentives, ease or remove barriers such as ROW fees or permitting, or serve as anchor tenant (possibly with other entities, like schools, hospital, large business)	Collaboration between Brainerd School district CTC enabling new fiber ring for the school district and FTTP deployment by CTC. Aggressive recruiting by Wabasha and St. Charles. Fort Wayne convinced Verizon to deploy FIOS by linking economic development strategies to technology and by reducing barriers.	Brainerd Public sector financial liability is limited to school technology bond. Limited financial incentives. Atypical Verizon investment in older community at no cost to Fort Wayne.	Reduced school technology costs are a winner. Third wired provider enhances the competitive environment. Lack of public control on services offered, prices, etc. Big win for the Fort Wayne mayor and leadership in Wabasha and St. Charles.	Brainerd Baxter MN with CTC as provider www.ctctelecom.net Hiawatha Broadband in Wabasha and St. Charles www.hbci.com Fort Wayne IN www.verizon.com/fios
Municipality and major local institutions build dark fiber network which is then leased to any entity that wishes to use it-private or public	City and seven major institutions / businesses finance the initial fiber build and point of presence as founder members; dark fiber leased to public and private entities	Need a few well capitalized institutions; in South Bend these founder institutions have realized achieved large annual savings in telecom budgets by being founder members.	No ongoing public funding or liability; city paid for their portion of the network through right of ways and savings in annual telecom budget.	St Joe Valley Network, South Bend, IN www.stjoevalleymetronet.org
Municipality or Regional authority alone builds dark fiber infrastructure and leases to local business or for public interconnect	Similar to the Municipal Utility noted above, but done on a larger, regional base with specific intent toward economic development.	Regional area can spread cost among many economic opportunities.	Where strong opposition to government action exists, yet economic development is critical, this approach can serve a middle ground.	Leesburg FL – Lake County FL www.leesburgflorida.gov Development Authority of the North Country, NY www.danc.org/oatn.html

	Considerations			
Option	**Ease of Entry**	**Financial**	**Political**	**Examples**
County or regional government built fiber infrastructure for public sector uses including government and education; additional capacity may be available for private sector use.	Scott County used public funds offset by existing private carrier costs to link all municipalities and school districts. Additional fiber in conduit may be made available for public or private uses. Dakota County network built incrementally by connecting county buildings and linking with other public sector networks.	Counties are able to proceed based on county, municipal and school district costs and service needs with possible future offsets from localities and business.	County or regional governments can build fiber networks to serve public sector needs to achieve significant public sector cost savings. Policy decisions about opening this infrastructure to private sector users can be a separate discussion.	Scott County, MN (Recently built network designed for multi-sector use). www.co.scott.mn.us Dakota County, MN (expanding network, with expanded uses under consideration) www.co.dakota.mn.us
City builds infrastructure; private operator purchases electronics and operates the network for 15 years, providing all retail services	Powell has issued bonds for building a fiber infrastructure as community infrastructure; US Metronets will operate the network providing retail services to the town.	City only needs to finance the fiber outside plant construction.	City must renegotiate contract with network operator every 15 years.	Powell, Wyoming www.cityofpowell.com
Private non-profit sector begins fiber infrastructure and later adds public bodies as partners	Entry considerations involve persuasion only, initial investment is borne by non-profit sector.	City becomes anchor tenant and financial contributor later.	No City involvement initially other than organization and encouragement.	OneCommunity, Cleveland, OH www.onecleveland.org
Local government requires developers to install fiber to the home through subdivision and development ordinances. Telecommunications infrastructure is treated in the same way as sewer, water and local streets.	Developers build this cost into the price of lots and housing. City benefits from growing network. This process is most suitable to growing communities.	Little or no cost to the city as the network and community grow at the same pace. Small cost passed on to end user / home buyer.	The costs of the expanded network are paid by new users.	Loma Linda, CA www.ci.loma-linda.ca.us

Table 14: Blandin Foundation Municipal Options for Fiber Deployment

Each of the options described by Blandin may have some appeal for communities in northwest Colorado. Of course, other mechanisms besides municipal entry and other technologies besides fiber exist for improving broadband in the region. We are going to focus on five broad categories available to the COG and its member jurisdictions:

- Status Quo
- Develop Incentives and Penalties for Incumbent Providers
- Become a "Broadband Friendly" Community
- Regional Cooperative Planning
- Build Infrastructure

4.3.2.1 STATUS QUO

Broadband capacity, reliability, and price have been improving in the region through time. The COG Board should carefully consider if current progress is adequate. The COG must also consider any impact any action on the part of the COG or its member might have on the course of current progress.

In other instances where local governments have taken action to improve broadband, incumbent providers have argued that government action – whether that action is regulation or some level of government entry into the broadband marketplace or some other government action – throttles their will to innovate, represents unfair competition, discourages capital investment, and plays against free market efficiencies.

4.3.2.2 DEVELOP INCENTIVES AND PENALTIES FOR INCUMBENT PROVIDERS

Local governments are often looking for low-risk options for expanding broadband access to residents and local businesses. Aggressively courting local private incumbents will do little to alleviate the broadband monopoly/duopoly but many communities have been able to affect significant policy changes through negotiations with their existing private enterprise partners. Municipalities have various incentives available to them as they court private enterprise carriers. Local government contracts are fairly lucrative for incumbent providers – especially in smaller communities. To help encourage local providers to expand service, municipalities can pay for service to additional locations, order services that incent infrastructure upgrades that can reasonably be extended to other entities, place conditions on their contracts with their providers, or use other means of influence.

Incumbent network owner courtship involves some stark limitations. Most incumbent providers are significantly larger than any given served municipality. Very few municipalities would ever ask an incumbent to engage in money losing behavior. Nonetheless telecommunications behaviors that support public policy objectives (like ubiquitous service, extending the reach of advanced telecommunications services, creating competitive access to infrastructure, ensuring access for low income households) seldom align directly with the profit maximizing primary focus of most private network owners. If the municipality's demands function to narrow profit margins too much, providers can simply refuse. There is also some risk that incumbents will agree to the municipality's requests and then fail to fulfill their obligations or meet them in ways that do not align with the municipality's intent.

Courting the incumbents may result in service improvements, infrastructure investment, and other advances in telecommunications services but will also usually reinforce the incumbent's monopoly position in the community.

4.3.2.2.1 ALTERNATE PROVIDERS

In addition to incenting incumbent providers, the COG jurisdictions could nurture alternative providers. In particular, Colorado communities have had some success working with electric cooperatives and establishing telecommunications cooperatives.

4.3.2.2.1.1 ELECTRIC COOPERATIVES

In about 2000, the Southeast Colorado Power Association (SECPA) established a division to manage aerial fiber assets. Known as SECOM, that division built aerial fiber routes to all public schools in their footprint. Today SECOM is the Internet Service Provider (ISP) to a majority of community anchor institutions in southeast Colorado. SECOM has more than 1,500 miles of diverse and redundant fiber paths and generates over $5 million in annual revenue.

In Colorado's San Luis Valley, the San Luis Valley Rural electric Cooperative has embarked on a program to bring fiber to the home throughout their multi-county footprint.

In southeast Colorado, La Plata and Empire electric companies took a different tact and created the organization that eventually became FastTrack Communications.

Northwest Colorado has several rural electric cooperatives that may be interested in projects similar to those implemented by SECPA, San Luis Valley, Empire, and La Plata. The COG may be able to persuade them to pursue these projects.

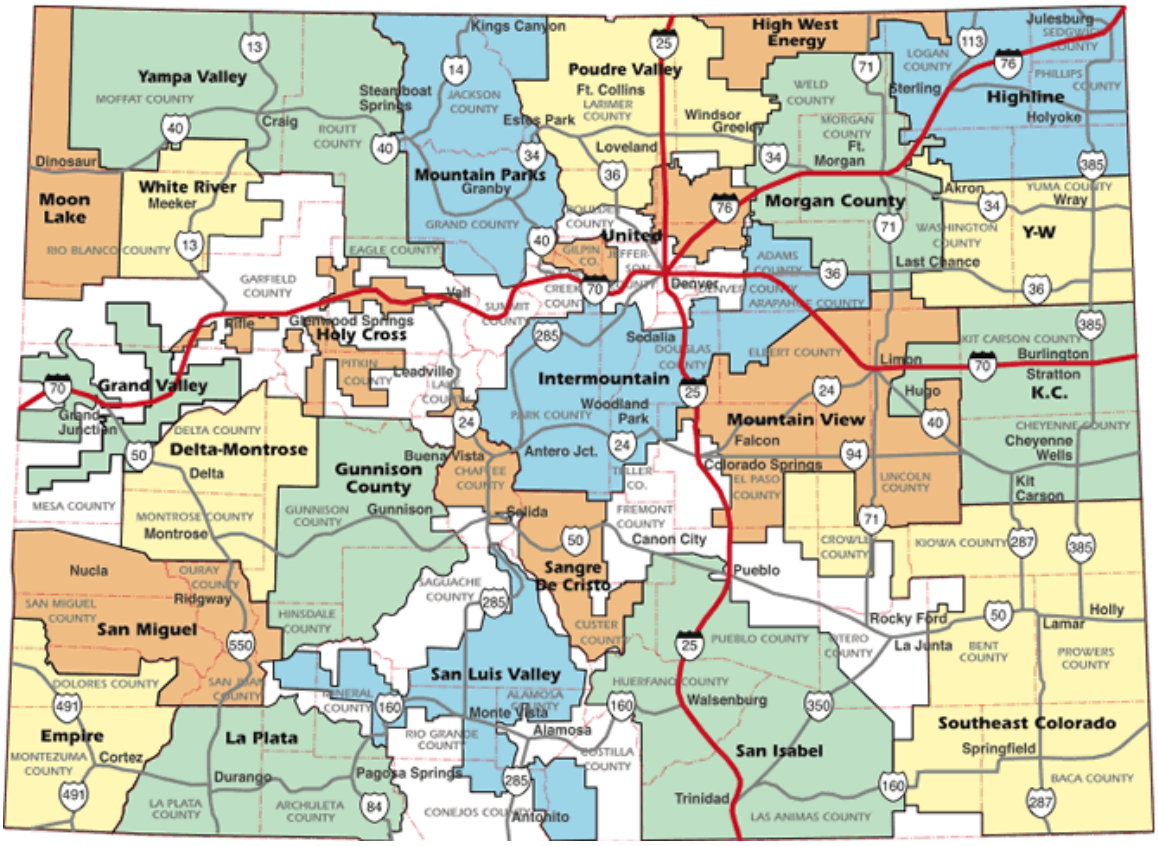


Figure 21: Colorado Electric Cooperatives

4.3.2.2.1.2 TELECOMMUNICATIONS COOPERATIVES

In Crestone and Chaffee County, communities have found success implementing telecommunications cooperatives to meet the needs of their residents.

Crestone Telecom came about through a process of local community members searching for a solution to their broadband problems. They tested various scenarios like having the town board involved, seeking a USDA grant, using a 501(c)3 organizational structure, and others. Finally they settled on a for profit limited liability company owned by community members. Local community members invested and Crestone Telecom was able to bring in middle mile access and build wireless sites.

Citizens in Chaffee County saw the success in Crestone and reached out to Crestone Telecom's founders. The Crestone team was able to duplicate their model in Chaffee County and, with some minor adjustments, Colorado Central Telecom was founded.

Crestone Telecom and Colorado Central Telecom have been able to improve broadband in their service areas by extending services and increasing reliability.

4.3.2.3 BECOME A "BROADBAND FRIENDLY" COMMUNITY

In May of 2013 the Fiber to the Home Council (http://www.ftthcouncil.org/) produced a report called "Becoming a Fiber-Friendly Community: Regulatory and Infrastructure Actions that can Drive Deployments."[78] The following discussion is based on the Fiber to the Home Council report with modifications to make it more relevant to improving broadband northwest Colorado communities.

The Fiber to the Home Council presents fourteen recommendations in four categories:

Community and Local Government Leadership and Support	•Develop a clear broadband plan. •Ensure commitment of community stakeholders, including local government personnel
Approval Requirements and Premitting	•Define an expiditiious process for on-going permitting and inspections. •Permit innovative construction techniques. •Build out requirements have been proven conterproductive.
Use of Existing Infrastructure	•Publish data about existing infrastructure. •Make all rights-of-way available on clearly defined reasonalble terms through a rapid approval process. •Make poles available on clearly defined, reasonable terms through a rapid approval process.
Ensure make-ready work is performed expeditiously	•Allow prospective attachers to perform all make-ready work themselves through contractors.
Proactively Improving Existing Infrastructure	•Provide space on all poles for new attachers. •Install ubiquitous fiber conduit. •Use building codes and community development plans to drive fiber deployments.

[78] Fiber to the Home Council (May 2013). "Becoming a Fiber-Friendly Community: Regulatory and Infrastructure Actions that can Drive Deployments." Fiber to the Home Council. http://www.ftthcouncil.org/p/bl/et/blogaid=214&source=1.

Figure 22: Becoming a Fiber-Friendly Community

Communities in northwest Colorado and across the country understand the great value of expanding broadband capacity and availability and are exploring how they can encourage infrastructure investments to support real broadband. A wide range of factors drive private network owners' decisions to invest in new broadband infrastructure, from the cost of construction and operation to demand for service. Importantly, some key factors are within the control of a community, such as accessing public rights-of-way and government owned facilities and receiving government permissions. The Federal Communications Commission (FCC) estimates these factors may amount of 20% of the total deployment cost. In other words, a community can make a real difference in whether a network gets built.

In the following, we outline a series of steps that communities should consider to clear a path for and work with a prospective broadband provider. It is not exhaustive, and some of the steps require cooperation from other private and public actors to achieve. Further, the trade-offs among competing objectives and degree of difficulty in finding solutions will vary among communities. Nonetheless, these steps have the potential to meaningfully reduce deployment costs and tip the balance in favor of new broadband network investment.

4.3.2.3.1 COMMUNITY AND LOCAL GOVERNMENT LEADERSHIP AND SUPPORT

From initial conception to contract negotiations to construction and operation of the network, community leadership – from government officials, community leaders, and business owners – can play a crucial role in the process of steering broadband improvements.

In the "Community and Local Government Leadership and Support" category, the Fiber to the Home Council has two recommendations:

1. Develop a clear broadband plan and
2. Ensure commitment of community stakeholders, including local government personnel.

4.3.2.3.1.1 DEVELOP A CLEAR BORADBAND PLAN

Improving broadband is a critical step enabling communities to participate fully in the rapidly evolving Internet economy. Like other major community infrastructure projects, broadband networks represent a major undertaking, with large costs incurred up front prior to any service being provided or revenues being generated. As such, communities need to have a clear vision about the nature of the undertaking and, once committed, develop a culture to support this effort – one that will last as community leadership changes over time and unexpected circumstances arise.

A crucial part of any community plan is to define the community's intended investment and involvement, to set realistic goals and expectations for the project, and to create measures for those goals.

The plan, for instance, should discuss how the community will directly benefit from broadband expansion, including connectivity and use of the network at public institutions. The plan may also consider how individual's use at home can improve access to and use of relevant civic services. Real benefit to the community may be hard to measure, especially in the early stages of broadband expansion. Defining the expected community benefit, measuring progress towards achieving that benefit, and advertising successes will help retain community stakeholder support.

4.3.2.3.1.2 ENSURE COMMITMENT OF COMMUNITY STAKEHOLDERS

It is essential to have key community stakeholders, especially local government decision-makers and relevant personnel, engaged with the broadband expansion project. Colorado's rural communities simply cannot afford the inefficiency inherent in each major organization pursuing its own broadband solution. By bringing the school and the fire district together with the town and county offices and working together, the community's anchor institutions can work together to improve broadband for all. Appointing a single government official as point of contact responsible for all aspects of the broadband development is one way to facilitate the process.

4.3.2.3.2 APPROVAL REQUIREMENTS AND PERMITTING

There are various permitting and approval processes required to implement new broadband infrastructure. When middle mile infrastructure investments are required to improve broadband, the state and federal government may play a more prominent role. However, counties control county processes and towns govern within their jurisdictions. Any approval process needs to have reasonable substantive requirements and be completed expeditiously. In addition, comprehensive approval for an entire project, instead of repeated approval requirements for different stages of a project, greatly reduces delays that add costs to a project.

In the "Approval Requirements and Permitting" category, the Fiber to the Home Council has three recommendations:

3. Define an expeditious process for on-going permitting and inspections,
4. Permit innovative construction techniques, and
5. Build out requirements have been proven counterproductive.

4.3.2.3.2.1 PERMITTING AND INSPECTION PROCESSES

All applications for permits should have a guaranteed response deadline – preferably no more than five business days. Along with providing a dedicated inspection team, local governments should allow providers to work with a pre-approved, third-party inspection team to review all work in a timely manner.

4.3.2.3.2.2 PERMIT INNOVATIVE CONSTRUCTION TECHNIQUES

Providers are constantly developing new technologies that speed deployment, minimize disruption to ongoing activities and reduce any costs for local governments. Microtrenching is an example of these innovations and is currently permitted in many areas. Local governments should be open to permitting expeditious use of such new techniques.

4.3.2.3.2.3 BUILD OUT REQUIREMENT RELIEF

Imposing "must build" requirements on a new entrant in a market has proven counterproductive to new builds and has been seen by federal and state agencies as anti-competitive because they end up making projects uneconomical and entrenching incumbent providers. As such, local governments should not impose these requirements on new entrants. This does not mean that communities should set aside legitimate concerns about ensuring access is provided ubiquitously. Rather, local governments should work with providers on alternative, more flexible ways to ensure access reaches customers who want service.

4.3.2.3.3 USE OF EXISTING INFRASTRUCTURE

The ability to access existing infrastructure can dramatically reduce the costs of expanding broadband. It is crucial to ensure all prospective providers can secure rapid and uninterrupted access to this infrastructure at a reasonable and predictable cost in a timely manner.

In the "Use of Existing Infrastructure" category, the Fiber to the Home Council has six recommendations:

6. Publish data about existing infrastructure,
7. Make all rights-of-way available on clearly defined, reasonable terms through a rabid approval process,
8. Make poles available on clearly defined, reasonable terms through a rapid approval process,
9. Ensure make-ready work is performed expeditiously,
10. Coordinate all pole maintenance and make-ready work with the new provider to save costs, and
11. Allow prospective attachers to perform all make-ready work themselves through contractors

Recommendations eight through eleven are pole attachment recommendations with less relevance to most of northwest Colorado's communities. We will address these in a single sub-section.

4.3.2.3.3.1 PUBLISH DATA

For providers to make use of infrastructure, they need to know what is available. To the extent consistent with public safety, welfare, and related concerns, local governments should seek to provide data to providers regarding conduit, ducts, vertical assets and other public or proprietary rights-of-way and potentially useful facilities they own or control.

4.3.2.3.3.2 RIGHTS-OF-WAY

Local governments should make available standard forms related to all rights-of-way and easements they own or control. The price for access should be commensurate with the actual additional cost imposed by the provider and incurred by the local government. Pricing and terms should be published and offered on a fair and reasonable and competitively neutral basis. As with permitting generally, any on-going approvals should occur within five business days.

4.3.2.3.3.3 POLE ATTACHMENTS

Many communities in America operate municipal power companies. With rare exceptions, this is not the case in northwest Colorado. Nonetheless, NWCCOG or its various jurisdictions can work with the various power companies to create pole attachment processes and costs that encourage new broadband infrastructure.

4.3.2.3.4 PROACTIVELY IMPROVING EXISTING INFRASTRUCTURE

Some of the more significant cost reductions can come from communities instituting forward looking programs to improve existing infrastructure. While some of these actions require investment, it will provide a more conducive environment for providers in the long run and has the added benefit of reducing the government's construction and maintenance costs.

In the "Proactively Improving Existing Infrastructure" category, the Fiber to the Home Council has three recommendations:

12. Provide space on all poles for new attachers,
13. Install ubiquitous telecommunications conduit, and
14. Use building codes and community development plans to drive fiber deployments.

One mechanism some network owners use to protect their monopolies is placing infrastructure in such a way that competitors are prevented from overbuilding. Here we see a cable operator placed pole (far left) that is too short to allow clearance for foreign attachments.

4.3.2.3.4.1 PROVIDE SPACE ON POLES

Most northwest Colorado communities do not have control over pole usage. Nonetheless, when new poles are placed, standards can be in place that ensures the new poles provide reasonable space for foreign attachments.

4.3.2.3.4.2 UBIQUITOUS TELECOMMUNICATIONS CONDUIT

By installing conduit for telecommunications with enough space for additional networks, local governments can limit the need for providers to engage new construction, further expediting broadband expansion projects.

Some communities implement a "dig once" policy that cost-effectively enables gradual deployment of infrastructure. In this model, a community implements a policy mandating installation of telecommunications conduit (or even fiber) any time a trench or road is open in public rights-of-way or when other new construction occurs. The incremental cost of adding the telecommunications conduit is minimal and the "dig once" policies can lead to a significant pool of infrastructure for use by the municipality or offered to incumbent or competitive providers to incent them to expand services.

This strategy enables deployment of infrastructure for backhaul, middle-mile, and last-mile fiber by private sector providers or that can be leased to the private sector network owners to stimulate service offerings or eventually used for a publicly owned network. It can also enable placement of conduit directly to wireless facilities sites facilitating deployment of next-generation wireless services and reducing the cost for new competitors to enter the market.

A smart "dig once" policy can provide significant benefit to a community. However, a haphazard program will result in little benefit. Some important considerations include[79]:

- The "dig-once" policy must be accompanied with rules for the use of the infrastructure.
- Ideally, the municipality will determine a telecommunications design and develop a conduit overlay for the community and then add conduit based on the design.
- The design should include construction standards and other technical specifications so that conduit laid through time is equally useful.
- The policy must be in place across all municipal departments to ensure all open trench opportunities are taken advantage of.
- If the infrastructure is not documented, locatable, and accessible it will be very difficult for anyone to take advantage of it.

[79] Andrew Cohill of Design Nine suggested most of these factors in Cohill, Andrew Michael (1 February 2012). "Community-Owned Conduit." Posted as a reply to Christopher Mitchell's article, "Smart Conduit Considerations for Forward-Looking Communities" at http://www.muninetworks.org/content/smart-conduit-considerations-forward-looking-communities.

4.3.2.3.4.3 USE BUILDING CODES AND COMMUNITY DEVELOPMENT PLANS

It is common for local governments to set basic standards regarding minimum levels of service for homes, residential planned communities and residential and commercial buildings. Local governments should require that new construction and substantial renovations for buildings and new community plans include appropriate last mile broadband infrastructure and structured wiring that allows broadband to be run easily to each room within a home or multiple dwelling unit.

4.3.2.4 REGIONAL COOPERATIVE PLANNING

Northwest Colorado simply does not have a marketplace sufficiently large to justify multiple network owners building diverse and redundant networks throughout the region. However, with limited investment, the multiple network owners could work together to use each other's networks to provide truly redundant services. The COG may be able to act in the role of mediator to bring the multiple network owners together and to help them negotiate sharing agreements that could significantly improve broadband in the region.

The COG could also help correlate the multiple public and private projects currently planned and underway. The various projects have concerns that are far more expansive than the geographic boundaries of northwest Colorado. As they should, they focus on meeting the specific requirements of their funding source. The COG could function as a resource to help them see how meeting regional needs and fulfilling funding source obligations are often in alignment.

4.3.2.5 BUILD INFRASTRUCTURE

Some areas of Northwest Colorado have access to gigabit business services and 100 Mbps or greater residential service. Other areas are limited to satellite or, in some cases, have no access to broadband at all. Some limited infrastructure investments might serve to close existing gaps and extend services to isolated areas. In other incidents, the COG's member jurisdictions may find more extensive investments to be a prudent course.

A careful study of localized infrastructure gaps and specific means to close them is beyond the scope of this regional strategic plan. Local public or public-private infrastructure investment could include:

- Carrier Neutral Locations
- Carrier Cooperative Infrastructure
- Municipal Distribution Rings
- Distributed Antenna Systems
- Limited Scope Access Level Infrastructure
- Large Scale Access Level Infrastructure

4.3.2.5.1 CARRIER NEUTRAL LOCATIONS

A carrier neutral location is a facility where multiple middle mile provider networks can meet. Last mile network owners and end subscribers can also meet at the carrier neutral location. With appropriate management, the responsible agent for the carrier neutral location can aggregate last mile demand to reduce cost and provide redundancy. We described carrier neutral locations more fully when we discussed the Northwest Colorado Broadband project (on page 75)

4.3.2.5.2 CARRIER COOPERATIVE INFRASTRUCTURE

In most instances, areas are under served or unserved because revenues generated by extending or improving service simply does not justify the capital expenditure or operations expenses required to do so. It is rare that a private company can justify a business case where the return on investment (ROI) is out past three, or at the most, five years. Some infrastructure investments may have ROIs of decades. These are investments private network owners are not likely to make. However, governmental organizations typically have more tolerance for longer term debt. In some instances, it may be reasonable for the COG or its member jurisdictions to invest in longer term ROI infrastructure and make it available to service providers at a reasonable rate.

For example, Comcast has access to very high capacity middle mile infrastructure on the south side of the railroad tracks just south of Kremmling. However, crossing the tracks to connect with their middle mile infrastructure in Kremmling has historically represented a project that Comcast estimates would have an ROI of about 40 years. It may have been prudent for Kremmling, Grand County, the COG, or some combination of organizations to invest in the infrastructure to create a model where it makes sense for Comcast to provide high speed DOCSIS 3 services in Kremmling (the only northwest Colorado Comcast service area not already upgraded)[80].

Not only could this type of effort significantly improve services in Comcast's Kremmling footprint, but it could also extend to neighboring areas. Part of the benefit extracted from Comcast could be a commitment from Comcast to provide reasonable rates to wireless and cellular carriers. This would lower the cost of deploying 3G and 4G cellular services and could make the business case for wireless broadband providers wishing to serve Kremmling and the surrounding area much better.

4.3.2.5.3 MUNICIPAL DISTRIBUTION RINGS

In 2010, the Southwest Colorado Council of Governments, with the assistance of the Region 9 Economic Development District, applied for and received a grant for the Colorado Department of Local Affairs. The premise of the grant was to create local community or intra-community distribution ring networks connecting the various CAIs in towns throughout the region in order to aggregate data traffic. The aggregated customers on the Southwest Colorado Access Network (SCAN) could then work together in a

[80] It appears Comcast has found a way to justify investment in this project see – "Comcast Kremmling Connection" on page 46.

purchasing consortium to lower data costs and improve access to advanced telecommunications services.

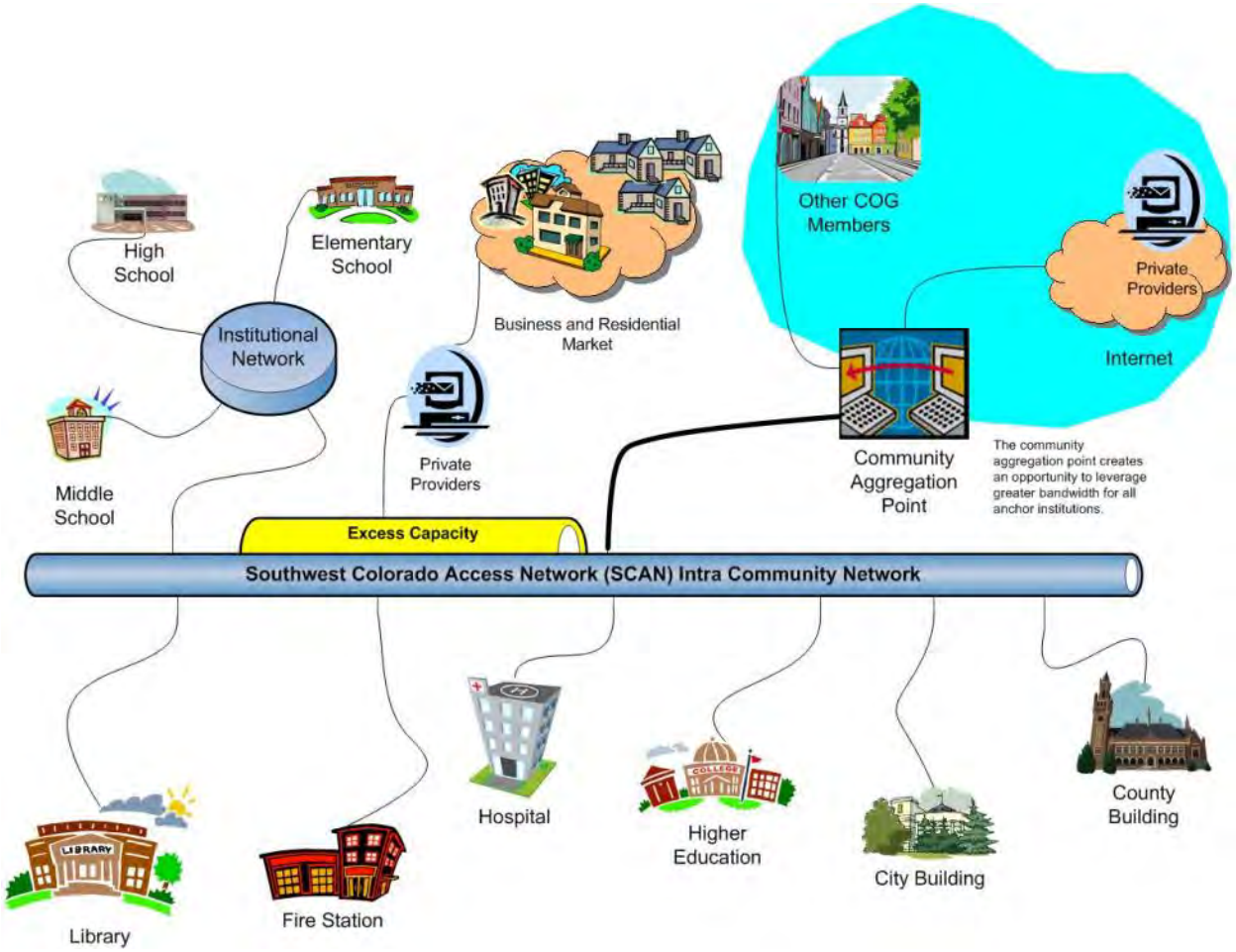


Figure 23: SCAN Community Aggregation

The SCAN network hopes to further add value to the region by capitalizing on the middle mile network EAGLE-Net intends to deploy with its federal grant and other regional middle mile carrier assets. The SCAN hopes to connect the various community aggregation points throughout the region to regional aggregation points. These regional aggregation points serve to greatly expand the purchasing consortium and significantly increase the SCAN's purchasing power.

Furthermore, the SCAN hopes to spur economic development in the region and to improve quality of life. To do this, the SCAN may make excess capacity on the SCAN network available to private providers with the hope that the additional reach the SCAN provides will entice existing private providers to offer service in new areas and may even encourage the development of new services.

The efforts of Rio Blanco County to improve the County Metropolitan Area Networks (MANs) represent investment in distribution ring infrastructure. Rio Blanco County works with the school district, fire district and other CAI locations to provide local data distribution.

4.3.2.5.4 DISTRIBUTED ANTENNA SYSTEMS

A distributed antenna system, or DAS, is a network of spatially separated antenna nodes connected to a common source via a transport medium that provides wireless service within a geographic area or structure. DAS antenna elevations are generally at or below the clutter level and node installations are compact.

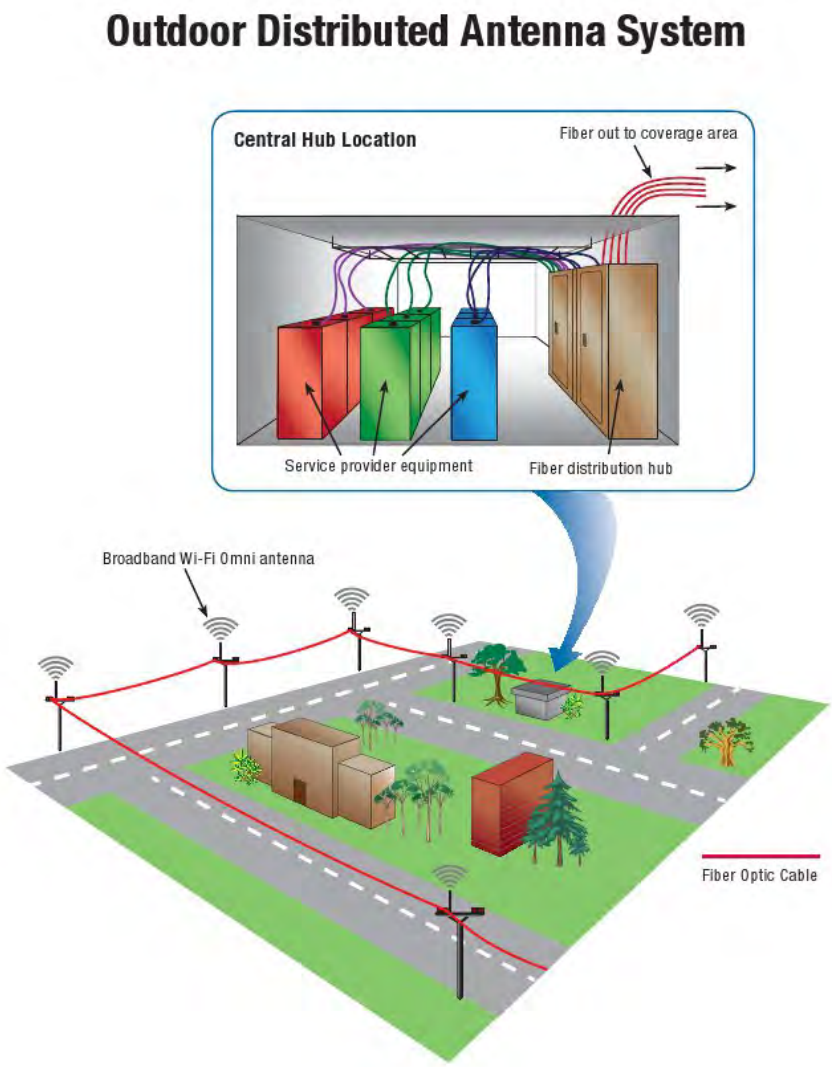


Figure 24: Distributed Antenna System Overview

As suggested in "Figure 24: Distributed Antenna System Overview", the idea is to split the transmitted power among several antenna elements, separated in space so as to provide coverage over the same area as a single antenna but with reduced total power and improved reliability. A single antenna radiating at high power is replaced by a group of low-power antennas to cover the same area.

In the mountainous territory of northwest Colorado, a DAS or other small cell cellular or wireless technology can compensate for "shadows" in service areas created by large cell systems.

4.3.2.5.5 LIMITED SCOPE ACCESS LEVEL INFRASTRUCTURE

Many communities around the country use available federal, state, and local funds to build municipal distribution rings to community anchor institutions and, as they do so, they pass and provide service to other potential revenue generating sites like cell tower sites, high data usage businesses, business districts, and others. Once positive cash flow is achieved, funds can be set aside for future expansion.

In Colorado, the Town of Cortez's network began as a municipal distribution ring. Cortez then added business districts and is now studying expanding the network further.

The Glenwood Springs Community Broadband Network began as a city-wide build but services have not been offered to residential addresses.

Communities engaged in these types of high value target programs should design and build their infrastructure with future growth in mind from the beginning. Furthermore, municipal network owners should be cautious so as to not sacrifice all available capacity to early buyers in a rush to reach positive cash flow.

Santa Monica, California has been pursuing a high value target program for years. Santa Monica's experience provides some valuable lessons for communities pursuing high value target strategies:

- It is very important to set aside the funds saved or excess revenues generated for future growth.
- It is critical to have an overarching plan from the beginning. As new opportunities arise, incremental telecommunications improvements that contribute to the overarching plan can be implemented.
- A study without a plan is of little use. Santa Monica didn't just study the opportunity to expand broadband in the community, they took the study and created a plan and then took the courageous first steps.
- High value target programs will not evolve into ubiquitous builds unless that is the plan from the beginning. Even then, high value target projects must pass through significant decision points that may delay or cancel ubiquitous build plans.
- Because of the limited scope of high value target programs, it is very hard to capitalize on network effects and economies of scale.

High value target programs may bring advanced telecommunications services to certain areas within the community but they are likely to exacerbate the digital divide and do little to promote the general welfare.

4.3.2.5.6 LARGE SCALE ACCESS LEVEL INFRASTRUCTURE

For more than 40 years, IBM dominated all aspects of the computing business. IBM maintained its dominance in part by tying application software to hardware and individual hardware components together in tightly controlled proprietary packages. In the mid-1970's, IBM misread the growing demand for smaller, more accessible computing services. A grass roots revolution to create "personal" computers with interchangeable components and application software that could run on multiple vendors' hardware platforms grew in basements and garages across the country. This "open" model was a disruptive force in the computing world and ultimately led to the marginalization of mainframe computers and of IBM as a computer manufacturer[81].

Today, a similar revolution is growing in the telecommunications industry. For decades, Bell Telephone, the "Baby Bells" and a handful of cable providers have maintained duopolistic control of telecommunications networks throughout the country leading to a marketplace modeled after the scarcity-based circuit switched telephone companies and competition averse cable monopolies. While the components to build a telecommunications network cannot easily be stored in one's garage, many municipalities, cooperatives and other organizations are recognizing the growing grass roots demand for true consumer choice on true broadband networks; the days of monopoly-like control of telecommunications service delivery over limited bandwidth platforms are coming to an end.

The federal government, through the actions of the FCC, the NTIA, and the National Broadband Plan, is pressing for open access broadband networks. Many states are following the federal government's lead and developing state-wide broadband plans with the principles of open access and bandwidth abundance as components. Local regions are pooling resources and moving forward with initiatives resulting in non-traditional network deployments. The nearly 1,100 municipalities that took the time to respond to the Google fiber RFI and the hundreds of municipal/governmental broadband stimulus applicants demonstrate a growing public frustration with the way incumbent providers meet (or don't meet) the public's broadband needs. Municipalities, counties, regional intergovernmental organizations, and states recognize that advanced telecommunications services are an essential element of their overall economic development plans and a critical aspect contributing to the quality of life residents in their jurisdictions enjoy. Many public entities are frustrated with the inadequate progress being made by the incumbent providers to upgrade services. More and more these government organizations and community groups are recognizing that in order to get world class advanced broadband services for their constituents they must take bold action to provide true choice (that is, real competition) of true broadband (that is, 100 Mbps, 1 Gbps or more). The current northwest Colorado broadband strategic planning efforts represent action on the path to broadband self reliance.

Cities, counties, states, local regions – even homeowners' associations – regularly build and maintain public infrastructure like roads and sewer systems and power lines and libraries and airports and event

[81] Charles H. Ferguson and Charles R. Morris do an excellent job of chronicling the rise and fall of IBM in their book Computer Wars (1994; Random House Times Books). Ferguson uses the example of IBM extensively in his follow on work The Broadband Problem: Anatomy of a Market Failure and Policy Dilemma (2004; Brookings Institution Press).

centers and sports stadiums. They have even built significant telecommunications networks for school, public safety, and other government use. But the world of general broadband service delivery has been generally relegated to those few incumbent providers who carefully guard their franchise or ILEC granted monopoly status. Cities have very little expertise when it comes to developing and deploying community-wide broadband solutions. Unfortunately, public entities can't turn to their local broadband experts – the incumbent providers – for guidance. In spite of federal pressure and local frustration, incumbents cling tenaciously to traditional government sponsored private monopoly business models – models that have served them so well since Congress appropriated $30,000 to construct the first telegraph line between Washington and Baltimore. In 1838 Samuel Morse opened the first government financed private monopoly commercial wireline service by tapping out, "What hath God wrought?" The answer has been nearly 200 years of monopolistic profit driven control of telecommunications in the US.

Traditional telecommunications business models are based, in part, on a perception of bandwidth scarcity that is used to control expectations and to eek as much profit out of each capital investment as possible. This traditional model leads to statements like that made by one of Qwest's (now CenturyLink) representatives to a City Council considering participating in a public telecommunications infrastructure project that would build fiber to the premises... the Qwest representative, arguing against the municipal project, suggested that the city had no need for additional bandwidth as the businesses in the town were car washes and auto repair shops. It did not seem to occur to the Qwest representative that one of the reasons the town was failing to attract knowledge worker businesses was because data dependent businesses couldn't compete from the town because Qwest didn't provide them adequate service. It did occur to the City Council members that better bandwidth would likely contribute to economic development and that Qwest was unlikely to take a lead in the effort to deploy upgraded broadband networks. The City Council voted to participate in the public fiber project and to begin a move from bandwidth scarcity to bandwidth abundance; from dependence on monopoly incumbent providers to competition on an open access network.

The monopoly philosophy underpinning traditional incumbent business models was succinctly articulated by Theodore Vail, AT&T's president in the early 20th century, as "One Policy, One System, Universal Service." Vail's true business genius was to first demonstrate that telecommunications networks represent a natural monopoly, to next accept reasonable government regulation required to protect AT&T's control of that natural monopoly, and finally to extend control of AT&T's government protected natural monopoly into the neighboring spectrum of telecommunications services. Thus, even through the trust busting of the Roosevelt, Taft, and Wilson administrations, AT&T was able to maintain and strengthen a vertically integrated monopoly under their umbrella of local infrastructure and services (in the Bell Operating Companies), long lines infrastructure and services (in AT&T), equipment manufacture and distribution (in Western Electric), and research (in Bell Labs).

Most cable television operators have not built the vertical monopolies AT&T enjoyed until the 1984 divestiture (though Comcast's acquisition of NBC has set a precedent in that direction). Nonetheless, they have worked tirelessly to protect their monopoly service areas. When possible, they establish protections through their franchise agreements. Failing that, they use other methods to impose barriers

to new entrants – rejecting unbundling, placing infrastructure in such a way that competitors cannot build in their areas, protecting content distribution rights, and otherwise strong arming their way into becoming protected monopolies.

The large multi-state cable and telephone companies should be expected to fight the loss of monopoly control and their ability to create and manage bandwidth scarcity to their profit. After all, these principles are the very foundation stones of their business models. To protect their traditional business models – the very basis of their shareholder value – they may be expected to claim government regulation throttles their will to innovate; they may argue that any effort by the government to implement telecommunications utilities represents unfair competition that discourages capital investment; they may insist that if the market demands more bandwidth or better service they will provide it. Yet, they will only innovate and make infrastructure investments and improve service if quarterly returns justify it or competition forces it. Incumbent network owners can be expected to protect their monopolies and manage bandwidth scarcity to maximize profit not because they are evil but rather because doing so is simply what the market and their shareholders demand. Because of this, even though the Internet and broadband were invented in America, America has slipped to a middling showing in worldwide broadband price, performance, and adoption. The capital improvements and innovation needed to return America to the front of the international broadband line don't reflect well on quarterly earnings reports. They are expensive. The return on investment is measured in years and decades – not quarters. Municipalities or regional organizations, like the Northwest Colorado Council of Governments, must step to the front and take action. It does no good to hope to be the fourth of 1,100 applicants to get Google fiber. It does no good to hope the federal government will fund more broadband infrastructure. It does no good to trust shareholder driven companies to manage the public good. It does no good to hope national organizations like Gig.U will solve local problems like the need for world leading broadband access in northwest Colorado.

The COG must take its broadband future into its own hands.

4.3.2.5.6.1 THE MUNICIPAL BROADBAND PROBLEM

Much like the rail systems of the late 1800's, today's advanced communications infrastructures represent a means by which communities may participate in, or find themselves left out of, the global economy[82]. Many communities are discovering that critical telecommunications needs in their business and residential markets are going unmet. Incumbent network owners consume limited public utility easement space with monopoly controlled closed networks. Traditional telecommunications business practices and market forces encourage these private companies to work towards protecting their revenue streams by extending their natural monopoly through vertical integration leading to cable companies acquiring content producers and traditional wireline telephone companies merging with

[82] In Railroaded: The Transcontintentals and the Making of Modern America, Richard White shows economic thinking in the late 1800's demanded a conversion from overbuild competition to railroad and telegraph monopolies; monopolies that could be sustained regardless of the arrogance of power, the impact of inept leadership, or the fleecing of customers.

cellular providers. Quarterly reporting requirements demand behavior that maximizes short-term profits (like delaying infrastructure upgrades) – often to the detriment of longer-term objectives or the public good. These behaviors – these infrastructure upgrade delays – serve not only to avoid capital costs but also help maintain the appearance of bandwidth scarcity. Perceived bandwidth scarcity allows companies to charge higher prices for lower quality than found in many other countries around the world. However, advanced communications infrastructures are essential for the current and future economic vitality of communities. Communities have begun to see the need to break the cycle of monopoly driven scarcity and vertical integration. In the 19th century city councils struggled with ways to entice the railroad barons to include them in transportation systems. In the 20th century cities and towns became experts at deploying critical infrastructure including, roads, electricity, and water. In the 21st century public policy demands that rather than begging and pleading with their incumbent providers or hoping to be rescued by national programs (public or private), municipalities apply their infrastructure skills to taking control of their broadband future and improving broadband availability and competition.

4.3.2.5.6.2 TRUE CHOICE ON TRUE BROADBAND

Having suggested that local governments must control their own broadband destiny, how should they tackle the problem? Let's first define some principles we can use as action selection criteria and then look at some possible public sector solutions.

4.3.2.5.6.2.1 PRINCIPLES

Like a Rubik's cube, the multitude of concerns inherent in public telecommunications projects are interrelated in a complex fashion: business modeling, financing, cash flow forecasting, legal issues, public relations, technology, maintenance, operations and other "sides" of the cube all have solutions – both short-term and long-term – that are interdependent. To simultaneously resolve each of these needs requires that they be addressed under a common set of goals or "guiding principles". Trying to solve one issue without consideration of the others – in absentia of guiding principles – may leave planners with a superficially pleasing one-sided solution while the remainder of the puzzle remains jumbled.

Careful consideration yields four key guiding principles as criteria for public broadband solution selection:

- A public solution must be open access and offer wholesale services to all qualifying service providers.
- A public solution must offer carrier class security, functionality, and reliability.
- A public solution must offer high scalable bandwidth.
- A public solution must be based on an open and independent architecture.

4.3.2.5.6.2.1.1 OPEN AND WHOLESALE

It goes without saying that monopolization is anathema to competition. We can argue that monopoly and duopoly constraints have played a large role in bringing the US telecommunications environment to where it is today. If it is responsible for much of our current state, it simply makes no sense for municipalities to trade one monopoly (the regulated private monopoly) for another (the public sector monopoly) by deploying a closed broadband infrastructure. Philosophically, cities should be averse to deploying a monopoly system and should shun the idea of delivering services themselves. Rather, they should perceive for themselves a more traditional municipal role – providing infrastructure. The actual delivery of services should be left to competing private service providers – as many as are qualified to serve the market. This model ensures that a publicly-owned infrastructure is made available to a wide variety of competing private firms for the delivery of goods and services.

While this model seems to fit logically with the traditional role of governments, it is one that is not regularly adhered to. Masha Zager, Editor of Broadband Communities Magazine, compiled a list of 135 municipal projects in the May/June 2013 issue (see http://www.bbpmag.com/2013mags/may-june/BBC_May13_MunicipalNetworks.pdf). In Zager's list, only 34 of the 135 projects are designed to support multiple competing service providers. Arguments for pursuing a vertically integrated model usually revolve around the financial implications of a wholesale/retail split. As the argument goes, price differentiation opportunities are limited in a wholesale model so the network owner has little maneuvering capability to compensate for revenue shortfalls. Further, as the argument goes, the inefficiencies associated with multiple organizations running the same business consume too much of the thin margins available. However, Anupam Banerjee and Marvin Sirbu of Carnegie Mellon University demonstrated these arguments are invalid. In their 2006 paper, "FTTP Industry Structure: Implications of a Wholesale Retail Split"

An analogy may help illustrates the concept of an open and wholesale network: When cities realize the need to build a municipal airport, they often form an airport authority. That organization exists for the sole purpose of building and operating the municipal airport. The Authority builds runways and structures, but it does not fly the airplanes. Instead, private airlines use the infrastructure and compete for retail ticket sales. Because the high cost of the airport is spread over multiple airlines using the facility, the cost to use the airport becomes much lower than if each airline had to build its own airport.

When an airline sells tickets to passengers, the cost of the ticket covers runway fees, gate fees, and other costs which the airport authority assesses airlines for use the airport. These fees operate the airport and pay the debt used to finance its construction. The airport authority does not interact directly with passengers - it does not charge the passengers fees, nor does it consider them customers. Instead, the airlines are the Authority's customers. The arrangement allows the airlines to compete against each other, not against the airport authority. This competition helps airlines focus on things like value and services rather than on maintenance of the airport. This benefits customers because airlines become innovative in their approaches to win and keep customers.

(continued)

(http://repository.cmu.edu/tepper/447), they conclude:

> *In spite of interfering with a wholesaler's ability to price discriminate, a wholesale-retail split is economically feasible. A wholesaler can recover its cost and as long as a significant number of homes do not have a zero willingness to pay for broadband data service, a wholesaler is almost as profitable as a vertically integrated entity.*

Changing the broadband delivery model from one that favors current naturally monopoly players to one that enables competition seems like an important policy objective. Implementing a model that allows for a wholesale retail split, a model that separates the natural monopoly element of broadband delivery from the competitive aspects of the services, is a core principle guiding municipal broadband selection.

Similarly, in the public open access network model, municipalities build and maintain the broadband infrastructure, but they do not engage in selling services to the end-user. Rather, they open the infrastructure to private service providers. Ideally, multiple service providers compete with each other for market share. It is they who become the customers of the municipal network owners. In this model, the private sector still owns the relationship with the end-user subscribers and, being freed from concerns about maintaining the infrastructure, they are able to focus on their service offerings. This stimulates innovation as providers seek to differentiate themselves from one another and it helps ensure that prices remain at an appropriate competition driven market level. Additionally, since government financing for the network can secure lower interest rates and longer terms than private industry can, the cost of debt service is lower than what it would be for private network infrastructure deployment. These cost savings benefit the service providers who end up paying lower access fees. Because their overhead is lower, service providers can price their services at lower retail rates or use free revenue for research and development, thus benefiting the end user.

When a community realizes they need an airport to stimulate economic development and improve quality of life, they don't call up the airline and ask them to please build runways in their town. Rather, they build an airport. When a community recognizes the need for improved broadband to achieve the same objectives, they shouldn't be forced to call the private network owners and try to get them to meet public policy objectives. Rather, they may need to build a network.

4.3.2.5.6.2.1.2 "CARRIER-CLASS"

"Carrier-class" is a fairly vague term. The PC Magazine online encyclopedia defines it as "…hardware and software used in large, high-speed networks. It implies extremely reliable, well tested and proven. Telephone companies, major ISPs and large enterprises purchase carrier-class equipment."[83] In their 2007 article "Carrier-Grade: Five Nines, the Myth and the Reality", Wedge Greene and Barbara Lancaster conclude, "Carrier-grade is actually an intangible expectation and explicit promise that the equipment vendors will provide the best equipment possible and a clear, immediate communication of issues related to equipment. And that service providers will also provide the best network possible to their customers and keep a clear and immediate communication channel open concerning service impacting situations. And lastly that the supply chain communication is two way, with feedback from the buyer going to the provider so they gauge and support continuous improvement."[84] Brocade Networks' 2009 article "What

[83] http://www.pcmag.com/encyclopedia_term/0,1237,t=carrier+class&i=39298,00.asp
[84] Greene, Wedge and Barbara Lancaster (18 March 2007). "Carrier-Grade: Five Nines, the Myth and the Reality." LTC International – published in Pipeline Magazine in April 2007.

is Carrier Grade Ethernet"[85] helps refine the overall understanding of what a carrier grade network is (Brocade Networks' focus is on Ethernet which proves to be relevant as 21st century networks tend to be packet based Ethernet or Ethernet-like networks) by defining five attributes carrier-grade Ethernet must possess: 1) standardized services, 2) scalability, 3) reliability, 4) quality of service, and 5) service management. In a 2001 white paper titled "Carrier-Class Ethernet: A Services Definition"[86], Appian Communications defines carrier-class Ethernet around the services the network can deliver – especially: a) granular, SLA-managed bandwidth guarantees, b) rapid, even on demand service activation, c) SONET/SDH resilience and manageability, d) services that span the metro and wide area, e) high-speed migration for current data services, f) a simple strategy to sell new and more services, g) integration with existing TDM services, and h) greatly reduced operating and capital costs. The fundamental driver underlying each of Appian Communications' services is the ability of service providers to increase revenues by reliably offering new packet driven services while simultaneously controlling costs.

Fundamentally, carrier-class suggests those attributes required to enable a service provider to offer customers reliable professional services. These are the attributes Wedge and Lancaster call "intangible" and that Brocade Networks and Appian Communications try to enumerate. These attributes have to do with reliability, capacity, security, flexibility, and other features expected by service providers from the network that will serve as their transport platform. Service providers require the network to perform with carrier-class attributes. From the smallest start-up to global giants with international reputations, each is willing to entrust those reputations to the network only if they are confident the network meets carrier-class expectations. From the physical design to the operational model, the network must deliver exceptional performance and offer absolute security.

So, while "carrier-class" may not be easily defined or readily measured it is an obvious guiding principle for municipal open access network projects.

This requirement, though seemingly obvious, is sustained as a guiding principle through market research. Scientifically administered surveys have been used to determine the characteristics required for municipal networks to see market success. In nearly every case, the number one or two concern for businesses and residents alike is reliability.

4.3.2.5.6.2.1.3 HIGH SCALABLE BANDWIDTH

To address the first two principles municipal networks must meet the carrier class demands of multiple service providers simultaneously. In other words, they have to be capable of reliably and securely delivering all the current services available as well as higher-bandwidth consuming future services from all service providers on the network. Thus, the system has to start out with tremendous bandwidth capacity and be able to grow larger still. In a way, this is a requirement to make the system "future proof," meaning that it is capable of adapting to new and emerging technologies that otherwise might obsolesce the investment.

[85] Brocade Communications Services (2009). "What is Carrier Grade Ethernet?" Brocade Communications Systems.
[86] Appian Communications (2001). "Carrier-Class Ethernet: A Services Definition." Appian Communications White Paper.

The value of incorporating this principle is obvious. Just as "whistle stop" communities had an advantage over those bypassed by the railroad in the old west, cities with the ability to support multiple current and future services will have economic as well as quality-of-life advantages over other communities. Further, this principle ensures that the investment made today won't become outdated. The system must be designed to scale to meet future demands.

Many incumbents argue the bandwidth they provide is more than adequate and, that as soon as the market demands it be done, they will upgrade their services. This argument sounds like the one Henry Ford made when he said of the Model-T in 1909, "Any customer can have a car painted any color that he wants so long as it is black." More germane to the current discussion is the flood of telephone styles that came to market after AT&T abandoned their telephone device monopoly. Prior to allowing competing handsets, AT&T claimed that the market did not demand anything other than the traditional black cradle phone. In the case of bandwidth, like with colors of automobiles and styles of phones, greater availability creates greater demand.

What allegorical black Model-T's and cradle phones are today's equivalents of Henry Ford and AT&T offering US broadband customers?

The OECD compares international advertised download speeds among 34 member countries. As "Figure 25: Average Advertised Broadband Download Speed by Country" shows, the OECD 2011 international broadband speed comparison puts the US, with its average advertised download speeds of 27.6 Mbps at a poor 19th place.

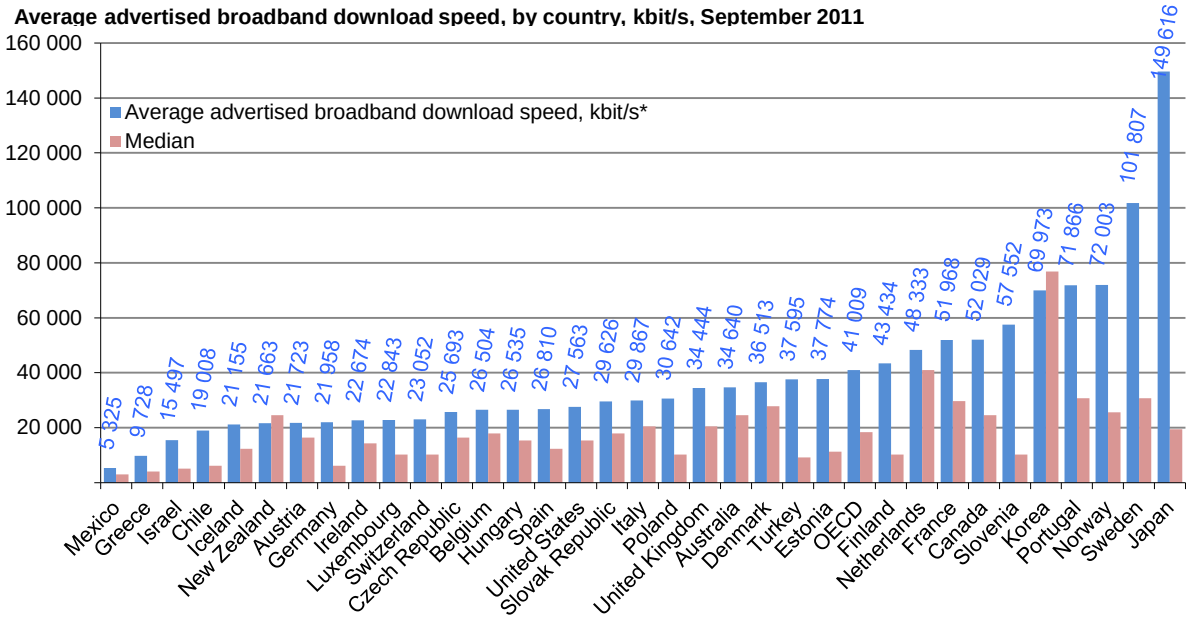


Figure 25: Average Advertised Broadband Download Speed by Country

Of course, actual speeds seldom match advertised speeds. TestMy.Net[87] compiles actual speed test data from the many self-selected speed testers around the US and the world. TestMy.Net data suggest the US has tested average download speeds of 14.4 Mbps. "Table 15: Northwest Colorado Speed Tests" suggests that northwest Colorado performs worse than the US average with an average tested download speed of only 9.76 Mbps.

County	Tests	Download	Upload
Jackson	0	N/A	N/A
Rio Blanco	73	3.20	0.61
Moffat	416	3.70	1.20
Eagle	1752	8.87	1.58
Summit	649	10.08	2.85
Pitkin	876	10.13	2.36
Grand	301	12.88	3.24
Routt	698	14.17	4.13
AVERAGE	4765	9.76	2.33

Table 15: Northwest Colorado Speed Tests

"Figure 26: TestMy.Net Download and Upload City Comparisons" shows TestMy.Net upload and download speeds for the US, northwest Colorado, the 10 fastest cities in the US, and the 10 cities around Colorado. Northwest Colorado's 9.76 Mbps average download speed puts it in about the middle of cities around Colorado; leaves the region with an average download speed that is only 9% of the speeds in the US's fastest city of Vero Beach, Florida; and only 7% of the average advertised speed of nearly 150 Mbps in Japan.

[87] TestMy.Net (http://testmy.net/) data is constantly changing. These data were collected 23 August 2013

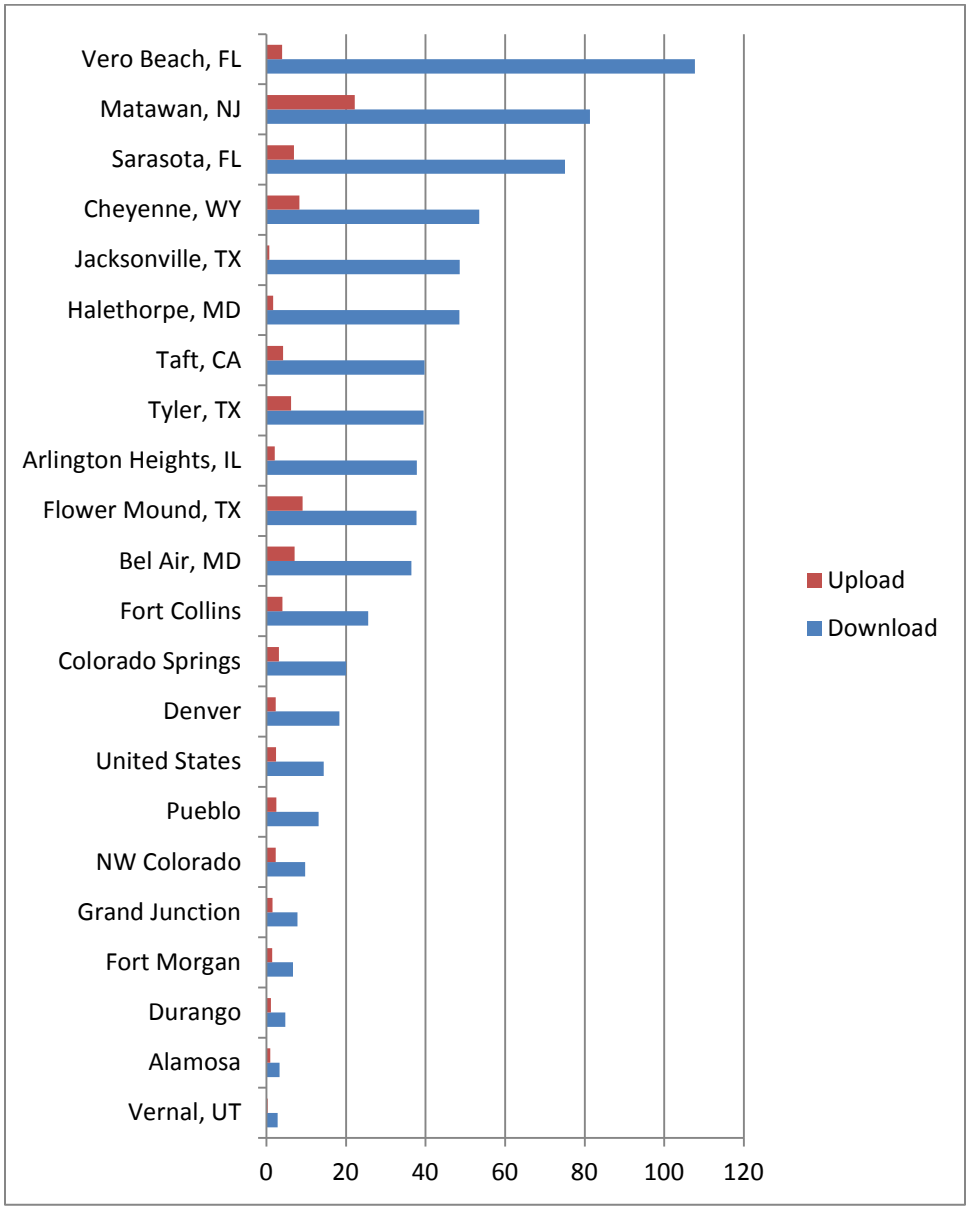


Figure 26: TestMy.Net Download and Upload City Comparisons

If these speeds truly meet northwest Colorado's bandwidth demands then the incumbent providers claim that their capital improvement plans follow and meet demand is valid. However, some evidence indicates that capacity drives demand. "Figure 27: Entropy Economics International Broadband Comparison"[88] indicates that South Korea which has substantially higher average bandwidth availability than the US has more than twice the demand for that bandwidth.

[88] The graphic is from Swanson, Bret (14 October 2010). "International Broadband Comparison, Continued." Maximum Entropy. It is based on data at Cisco Visual Networking Index (VNI); http://www.cisco.com/en/US/netsol/ns827/networking_solutions_sub_solution.html.

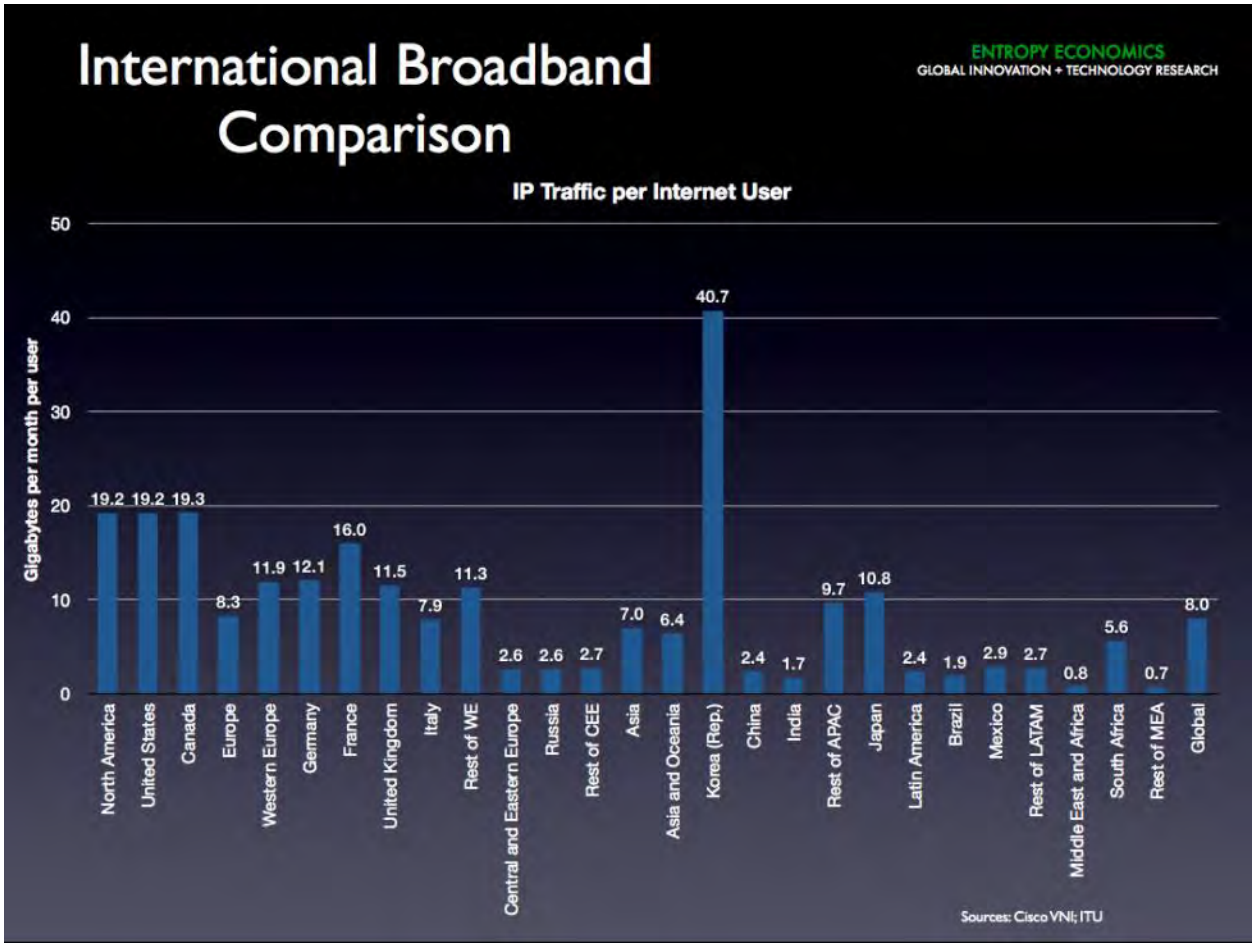


Figure 27: Entropy Economics International Broadband Comparison

Interestingly, Leonard Waverman's 2008 "The Connectivity Scorecard"[89] ranks the United States first and Korea 10th of 16 innovation driven and emerging economies. Waverman explains:

> *Korea scores well in the government and consumer components of the Scorecard, which tend to dominate other indices, but quite poorly in business usage and complementary assets and services…. Korea does not appear to be a top performer in the business arena – indeed, Korean productivity on a per worker basis is much lower than European or North American productivity…. Other sources (not used in computing index scores) confirm that in business telephony usage and spending, Korea lags well behind other Asia-Pacific Innovation driven nations like Japan and Australia in the use of business enterprise telephony solutions. (p. 21)*

The disconnect between South Korea's high Internet bandwidth and IP usage per user and their Waverman Connectivity Scorecard results begs two questions:

[89] Waverman, Leonard, Kalyan Dasgupta, and Justin Tonkin (18 January 2008). "The Connectivity Scorecard." LECG Nokia Siemens Networks.

1. What about South Korea's broadband policy is failing to extend broadband's economic development benefits to complementary sectors in Korea's economy?
   Waverman suggests Korea's failure is largely due to the major industries within their existing economy. The US, as demonstrated by its Waverman connectivity score is positioned much better to capitalize on higher bandwidth availability.
2. If the South Korea-like bandwidth were available to US businesses, how much more usage (or demand) would that create and what would that usage add to US economic development?
   This is a question we can only know the answer to if capacity is increased; if high scalable bandwidth is a central principle throughout the network (first mile, middle mile, and last mile segments).

We have already identified that many incumbents believe they deliver adequate bandwidth – therefore, relying on the incumbent providers to provide true high scalable bandwidth to drive new demand is a tenuous proposition. It is up to the public sector to lead the way towards expanded bandwidth. It is up to the public sector to abandon the notion that bandwidth is a scarce commodity and to build an environment of bandwidth abundance. It is up to the public sector to deploy the networks that will enhance economic development and quality of life. For these reasons and more, high scalable bandwidth is a guiding principle steering public broadband decisions.

4.3.2.5.6.2.1.4 OPEN AND INDEPENDENT ARCHITECTURE

While many proprietary solutions could be employed to deliver the first three principles, this fourth principle aims at ensuring that the efficiencies of the system are always maximized. By requiring solutions to be standards-based and founded on open technologies, municipal open access network owners can "shop around" for the best deals and are not beholden to any one particular company or proprietary invention. While there is sometimes benefit to a proprietary solution that can outweigh the negatives of diminished choices, the ultimate benefits usually derive from vendors who are actively competing for business and responding to competition with efficient pricing and more innovative solutions.

4.3.2.5.6.3 SOLUTIONS

We have already explored some possible solutions to the municipal broadband problem above. As we consider large scale infrastructure investment, we should consider the right type of architecture and the appropriate business model.

In order to deliver on the carrier class and high scalable bandwidth principles, a fiber to the premises network makes the most sense. We should also look at business models.

4.3.2.5.6.3.1 PUBLICLY OWNED AND OPERATED FIBER TO THE PREMISES

Some communities have elected to deploy fiber to the premises and to function as a sole provider on that new infrastructure. One of the leading publicly owned and operated fiber to the premises projects is the Bristol Virginia Utilities (BVU) OptiNet. BVU OptiNet is a nonprofit division of BVU, launched in

2001, that provides telecommunication services to approximately 9,500 customers in areas around Southwest Virginia. OptiNet is known for its pioneering work in the area of municipal broadband. BVU is acknowledged as the first municipal utility in the United States to deploy an all-fiber network offering the triple play of video, voice, and data services. Offering digital cable, telephone service and high-speed Internet from a remote-area utility provider makes BVU exceptional, even on a global level. Chattanooga, Tennessee and Lafayette, Louisiana have followed BVU's lead and now offer fairly successful utility department owned and operated fiber to the premises networks.

Not all municipal projects are self sustaining. Burlington Telecom is a municipal telecommunications department providing residents of Burlington, Vermont with triple play services over a city-wide fiber network. Conceived in the 1980's, there were a number of attempts to start the project through the 1990's but a funding source could not be found. Finally, in the early 2000's the project got started and the first stage was completed in 2003. The first stage was successful and local government officials believed the project would result in a major future public funding source. Unfortunately, in September of 2009 the City informed the Vermont Public Service Board it had used $17 million in city money to support Burlington Telecom operations over the previous year. Since then, the Burlington project has mired in controversy.

In addition to the other difficulties they face, municipally owned and operated networks, while potentially extending true broadband to their residents, do little to offer true choice – they simply function as another single provider overbuild network in a crowded public utility easement.

4.3.2.5.6.3.2 FINANCIALLY RESPONSIBLE UBIQUITOUSLY DEPLOYED PUBLICLY OWNED OPEN ACCESS GIGABIT FIBER TO THE PREMISES

The alternative that may rise up as the best suited to meet policy objectives, demands of the people, the four principles identified above (open and wholesale, carrier-class, high scalable bandwidth and open and independent architecture), and the needs of private enterprise might be one in which governments build, manage, and maintain the natural monopoly element in the telecommunications environment (that is, the physical transport mechanism) as a public utility made available to multiple private service providers who can then offer retail services. In other words, the best apparent 21st century broadband delivery solution may be financially responsible ubiquitously deployed publicly owned gigabit open access fiber to the premises.

Let's take a moment to look at each of these six characteristics: 1) financially responsible, 2) ubiquitously deployed, 3) publicly owned, 4) open access, 5) gigabit, and 6) fiber to the premises.

4.3.2.5.6.3.2.1 FINANCIALLY RESPONSIBLE

Communities considering a municipal broadband build should understand that one of the reasons private enterprise network owners have not deployed more advanced services is because the cost is too high for them to be supported by available profit margins. One of the advantages of a municipal project is the availability of long-term low interest financing for capital infrastructure projects.

The availability of favorable financing should not result in a careless fiscal environment. The municipal bonds used to back the debt must be paid. Some projects may be able to pay their operating expenses and debt service through direct project revenues. Others will need to measure tax increment benefits, cost savings, and other indirect revenues in order to show fiscal responsibility. In some cases, public policy objectives may justify network subsidies from general fund spending or through special service funds (like utility fund transfers or special assessment areas).

Mid-State and OHIvey have access to several tools to mitigate financial risk and support fiscal responsibility. Included among them are annuity based performance bonds and principal assumption and repayment programs. We will discuss these further in the Broadband Plan if we are selected for this work.

4.3.2.5.6.3.2.2 UBIQUITOUSLY DEPLOYED

One of the ways cities differ from incumbent private network owners is in the desire to make services reasonably available to all residents and businesses in an effort to overcome the digital divide and otherwise behave equitably. Incumbent private providers target implementation in areas that generate the highest returns on investment. Often certain franchise agreement stipulations or other regulation impose ubiquitous builds on the incumbents but typically only at minimum service levels. Residential areas with target demographics and certain commercial areas will usually get better service than other retail, industrial, and residential areas.

While franchise agreement requirements and other regulatory efforts help bridge the digital divide in that they require ubiquitous service deployment, they typically have little effect diminishing disparity in types of available service. Furthermore, because incumbents tend to manage their network bandwidth as a scarce resource, many services are priced out of reasonable reach of lower income households and small businesses.

4.3.2.5.6.3.2.3 PUBLICLY OWNED

Public networks can be sponsored by municipalities, counties, states, coalitions, inter-governmental agencies, or any imagined group that can be trusted with the maintenance of the public good. The role of the public owner is not to compete directly with private enterprise solutions. Rather, government institutions identify and provide “natural monopoly” services, common or public good services, and market failure services. 21st century broadband infrastructure shows characteristics of all three of these areas typically calling for government intervention. A public network allows the government to provide the natural monopoly aspect of broadband (the infrastructure itself) while opening the non-monopoly competitive aspect of providing services to multiple providers.

4.3.2.5.6.3.2.4 OPEN ACCESS

Public networks can best meet their policy objectives by adhering to principles of open access. That is, the network owner makes the physical communications medium available to multiple competing service providers. Doing so allows the forces of competition to improve services and decrease prices.

4.3.2.5.6.3.2.5 GIGABIT

Important in changing America's broadband conversation is making the move from the current environment of bandwidth scarcity to one of bandwidth abundance. When a public project undertakes to deploy new broadband infrastructure, they should ensure it is gigabit capable with the ability to upgrade connections even further.

4.3.2.5.6.3.2.6 FIBER TO THE PREMISES

Having resolved to provide a long-term gigabit enabled competitive platform for multiple simultaneous service providers, public entities contemplating a broadband solution are left with few options other than active Ethernet fiber to the premises (FTTP).

The anecdotal evidence for building fiber to the premises networks is strong. You may hear copper and wireless vendors saying something to the effect of, "It's just as good as fiber;" you will never hear a fiber network owner justifying themselves by saying their network is just as good as wireless or DSL.

This is not to suggest there is no place for wireless. Wireless networks extend and augment a fiber network providing access where fiber is yet to be built and mobility that simply cannot be replicated on a wireline type of network like fiber to the premises.

Consider the following analogy to illustrate the long term scalability of fiber: if a standard drinking straw represent dial up speeds (56K), then a pipe about a foot in diameter equals a 100 Mbps connection. Using the same scale, a Gigabit connection would roughly be a pipe 3 feet in diameter. The fastest commercial connections for a single fiber would equal a pipe about 115 feet in diameter and the theoretical capacity of a fiber would be represented by a structure over 1,600 feet in diameter – or as large as the Hoover Dam. Clearly, if we are using drinking straw capacity today, we have room to scale a network given the theoretical capacity of fiber.

The straw on the left represents the capacity of a dial-up connection; the one on the right, DSL.

Typical connections on fiber networks operate at 100 Mbps or 1 Gbps. The pipes shown illustrate those capacities relative to DSL connections.

Current technology can deliver terabits (1 million megabits) over a single strand of fiber.

The theoretical capacity of a single fiber equates to a pipe that would be the size of the Hoover Dam!

4.4 COMPARE AND CONTRAST PATHS

To compare and contrast paths, we should first look at the intersections of organizational structures and potential actions and try to determine which organizational structures and actions represent the "best fit". Then we should compare the "best fit" options.

4.4.1 ORGANIZATIONAL STRUCTURE AND POTENTIAL ACTION INTERSECTIONS

In the sections above, we introduced four potential organizational structures (ad hoc, jurisdictional control, NWCCOG control, and telecommunications cooperative) and focused on five categories of potential solutions (status quo, develop incentives and penalties for incumbent providers, become a "broadband friendly" community, regional cooperative planning, and build infrastructure). "Table 16: Organizational Structures and Potential Actions" summarizes the intersection of these organizational structures and potential solution categories.

	Ad Hoc	Jurisdictions	NWCCOG	Cooperative
Status Quo	An ad hoc organizational structure is the best fit for maintaining the status quo. Occasionally, the status quo may need regional or multi-jurisdictional guidance to keep it on course to improve broadband in the region.	Jurisdictions currently control the status quo with occasional support from ad hoc groups or from existing organizations like the COG or Club 20. The status quo can be effectively maintained through an ad hoc model supporting jurisdictional control.	Creating a mechanism within the COG to manage the status quo seems to be overkill. The status quo is best managed by ad hoc committees supporting local jurisdictions.	A telecommunications cooperative would not function to support the status quo. A telecommunications cooperative would likely find itself crosswise with incumbent providers responsible for broadband development in a status quo implementation model.

	Ad Hoc	Jurisdictions	NWCCOG	Cooperative
Incentives & Penalties	An ad hoc organizational structure is a good fit for creating incentives and penalties. As a general rule, incentives and penalties should belong to individual jurisdictions. Occasionally, multiple jurisdictions may need to come together to share best practices and create model ordinances. Multiple jurisdictions may find it useful to cooperate to add weight to their incentives and penalties.	Most available incentives and penalties belong to the local jurisdictions and the local jurisdictions should maintain control of them. Ad hoc teams can be used to share best practices and to develop model ordinances, practices, and procedures. The NWCCOG could manage the ad hoc team process. The COG may also function to aggregate incentives and penalties to add weight to them.	While the NWCCOG could provide real value managing ad hoc teams to share best practices and develop model ordinances, practices, and procedures, incentives and penalties really belong to local jurisdictions. In some instances it may be appropriate for several jurisdictions to work together to aggregate incentives or penalties.	A telecommunications cooperative may be able to support systems of incentives and penalties by taking on the role of monitoring compliance. A telecommunications cooperative may also be a good repository for best practices, and model ordinances and methods and procedures.
Broadband Friendly	An ad hoc organizational structure is an appropriate fit for developing broadband friendly communities. However, becoming a broadband friendly community is very much a jurisdictional issue. Occasionally, multiple jurisdictions may need to come together to share best practices and to create model ordinances.	Becoming a broadband friendly community rests largely on the shoulders of the local jurisdictions. Ad hoc teams may produce model ordinances and the NWCCOG may be able to facilitate coordination and cooperation between multiple jurisdictions to enhance efficiency but the responsibility truly lies with the local jurisdictions.	The NWCCOG may be able to facility cooperation between multiple jurisdictions working towards becoming broadband friendly communities.	A telecommunications cooperative could function to facilitate coordination between the multiple broadband friendly communities in the region. A cooperative may also be able to help market the efforts communities have taken to ease broadband improvements to the various network owners and service providers.

	Ad Hoc	Jurisdictions	NWCCOG	Cooperative
Regional Cooperative Planning	Regional cooperative planning can be performed with an ad hoc organizational structure. To do so, each proposed effort or tactical solution would generate the creation of an ad hoc committee to manage its development. A NWCCOG control structure will create better synergies throughout the region.	Local jurisdictions need to participate in regional cooperative planning but, because the effort is larger than any given jurisdiction, the effort truly needs to be owned and controlled by the NWCCOG or some other organization with multi-jurisdictional responsibility.	Regional cooperative planning is truly a function of the NWCCOG. Usually, the COG focuses planning efforts on governmental agencies but, in this case, the COG would be working to shape the behavior of private network owners by facilitating meetings and helping to negotiate sharing agreements and multi-vendor solutions needed to improve broadband in the region.	A telecommunications cooperative could function in the role of facilitating regional cooperative planning between multiple service providers. The fault in doing so is the risk that the incumbent providers perceive the cooperative as a competitor and, thereby, hesitate to cooperate.

	Ad Hoc	Jurisdictions	NWCCOG	Cooperative
Build Infrastructure	An ad hoc organizational structure is not well suited to building infrastructure. Most infrastructure build solutions will require some form of continuing operations and support. Ad hoc organizational structures are not well suited to continuing operations. In some cases, a straight-forward infrastructure build designed to be turned over to another organization once implementation is complete can be completed by an ad hoc organizational structure.	Individual jurisdictions can certainly build infrastructure. Glenwood Springs has built a municipal network. Many communities have distribution level infrastructure to support their multiple locations. Some have expanded access to their distribution level infrastructure to other community anchor institutions and have investigated extending capability to businesses. The public-private partnership between Steamboat Springs community anchor institutions and northwest Colorado Broadband that created the carrier neutral location in Steamboat Springs is a local jurisdiction effort.	The NWCCOG may be able to effectively manage new infrastructure implementation but it is not a good fit for managing the assets once they are in place.	New infrastructure will likely require ongoing operations and support. Establishing a telecommunications cooperative is the best way to improve broadband in the region through infrastructure deployments.

Table 16: Organizational Structures and Potential Actions

4.4.2 "BEST FITS"

As presented above, the "best fits" between organizational structures and potential actions are:

- Ad Hoc Status Quo
  Pursuing an ad hoc status quo model represents the lowest risk course of all models. It requires the least effort by the COG and its participating jurisdictions. It also involves little cost and can be easily managed.
  An ad hoc status quo model has the least probability of affecting real change to the state of broadband in northwest Colorado. Private network owners will continue to grow their capabilities as their business cases suggest they should. An ad hoc status quo course will offer the region mostly the same broadband improvement trend it has been on. Ad hoc efforts may lift the trend some but significant improvements are unlikely.
- Jurisdictional Control Incentives and Penalties

Jurisdictions creating incentive and penalty programs for incumbent network owners and service providers has historically helped communities secure ubiquitous service, create packages for low income subscribers, establish service for community anchor institutions, and achieve other public policy objectives.

Typically, larger communities with significant revenue opportunities for incumbents have better leverage when working to create incentive and penalty packages. Northwest Colorado communities may have a difficult time shaping network owner behavior – even if multiple communities cooperate to aggregate markets.

- Jurisdictional Control Broadband Friendly Community

  Taking steps to become a broadband friendly community is a fairly low risk method of enticing new service provider entrants or encouraging incumbents to improve service.

  Many communities in northwest Colorado simply cannot become friendly enough to lower barriers sufficient to make a business case for private network owners. Furthermore, broadband friendly communities may have some influence over last mile infrastructure but they do little to improve weaknesses in the middle mile layer.
- NWCCOG Control Regional Cooperative Planning

  Some of the region's network owners have already expressed some interest in participating in regional cooperative planning. Cooperative planning efforts represent the easiest and least capital intensive mechanism to create true middle mile redundancy throughout the region. The improvements that can be made to the region's middle mile networks may also improve last mile broadband services by improving middle mile reliability and lowering middle mile cost.

  There is no simple path to creating regional cooperation. Even within CenturyLink itself, regional cooperation suffers at the borders between the legacy CenturyTel and Qwest networks. Inability to seamlessly merge these networks within the same company does not bode well for the idea of getting competing network owners to work together effectively.
- Telecommunications Cooperative Infrastructure Builds

  Establishing a telecommunications cooperative potentially yields the greatest benefits but also entails the highest risk.

4.5 RECOMMENDED PRIMARY AND ALTERNATE PATHS

There is no silver bullet that will resolve northwest Colorado's broadband problem. The simple solutions have already been implemented and still the region is inadequately served. We make a series of recommendations (in the "Conclusions and Recommendations" section starting on page 144). As described above, these recommendations could be pursued in a number of ways within a number of different organizational models. In this section we summarize a "light touch" approach and a "proactive broadband development" approach.

4.5.1 LIGHT TOUCH

The underlying philosophy of a light touch approach is that the market is the most effective tool to resolve broadband issues. The role of the COG and its member jurisdictions is to help create the

environment needed for the market to succeed – i.e. to work to encourage private vendors to invest in broadband improvements throughout the region by creating aggregation and providing incentives. The light touch approach seems to be in alignment with the Club 20 "Telecommunications Principles" document which suggests that "[a]ffordable, quality, widely available access to advanced telecommunications services and broadband service is important to the present and future viability of Colorado communities, businesses and residents," and that "[t]he proper role for local government is to serve as demand aggregator and facilitator for the deployment of advanced broadband networks in partnership with the private sector" because "[c]ompetition in the free market is generally recognized as beneficial for consumers."[90]

Blair Levin, former Chief of Staff to FCC chair Reed Hundt[91] and executive director for the effort that produced the National Broadband Plan and current director of Gig.U[92], does an effective job of describing what he sees as the root of the broadband problem and of suggesting how the light touch approach can fix it[93]. First, Levin declares, "…current market forces will not drive deployment of world leading wireline networks in the United States. For the first time since the mass market Internet, there is not a national wireline carrier with plans to broadly deploy a better network than the current best available network."

This is not because we have reached a balance between network benefits and investment. Levin points out that the total benefits of high speed networks are the sum of benefits to the investor(s) in the network, content and applications, the local community, the region, and the country. However, the only benefit accrual that drives investment is the benefit to the investor. For the investor, the equation looks something like:

Costs Benefits

$$C + O > (1-r)R + SB + (-CL)$$

Figure 28: Broadband Investor Return on Investment Formula

Where:

[90] Club 20 Telecommunications Policy Committee (7 September 2012). "TE-05-1: Telecommunications Principles." Club 20. Viewed 18 November 2013 at http://www.club20.org/images/pdfs/Telecommunications%20PDFs%2007032012/TelecommunicationPrinciplesTE051.pdf.

[91] Hundt was FCC Chairman from 1993-1997.

[92] See http://www.gig-u.org/.

[93] Levin has made a similar presentation in numerous venues. The quotes, tables, and figures used here are from his 2013 presentation to the FCC Gigabit Communities Workshop. See Levin, Blair (27 March 2013). "FCC Gigabit Communities Workshop". FCC. Viewed 22 November 2013 at http://transition.fcc.gov/presentations/03272013/Blair-Levin.pptx.

- C – Capital Expenditures
- O– Operating Expenditures
- r – Risk
- R- Revenues
- SB- System Benefits *(Benefits that drive increased revenues outside the communities where the new or incremental investments are made.)*
- CL- Losses due to competition (*Note this is a negative value. Increasing a decrease in competitive losses results in a positive impact for the investor.)*

To attract new broadband investment, communities (or regions, or the nation) must "change the math by reducing costs and risks and increasing benefits.

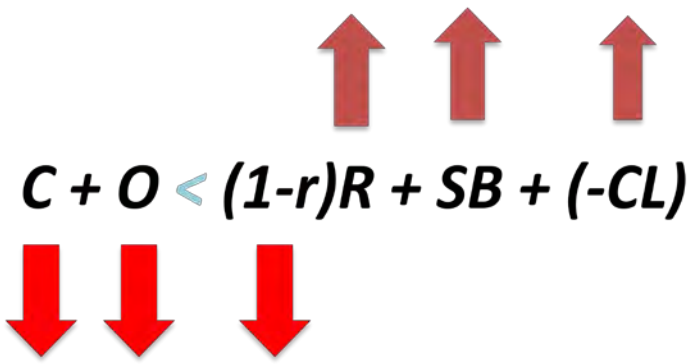


Figure 29: Change the Broadband Math

"Historically," Levin argues, "investments are made when policy – generally with federal leadership – alters [the] equation."

Sector /opportunity	Ecosystem change	CapEx	OpEx	Risk	Revenue	Comp. Losses
Telco	Grant of monopoly			Lower	Raise	
Cable	Grant of monopoly, pole attachment law, compulsory broadcast license			Lower	Raise	
Rural areas	USF	Lower	Lower			
Wireless	Limited # of licenses			Lower		
DBS	Limited # of licenses, program access			Lower	Raise	
Broadband Upgrade	Deregulation, two wire policy				Raise	Raise
Wireless Upgrade	More licenses, lowered TAC, oversight of siting authority		Lower		Raise	Raise
Broadcast Television Digital Transition	Provide 2nd channel for transmission of content	Lower		Lower	Raise	

Sector /opportunity	Ecosystem change	CapEx	OpEx	Risk	Revenue	Comp. Losses
Kansas City Google Fiber	Deals with City, State, and Utilities	Lower	Lower	Lower	Raise	Raise

Table 17: Historic Light Touch Policies

Northwest Colorado has benefited from the light touch approach leadership offered by the federal government. The Connect America Fund (CAF) is a mechanism similar to USF funding for rural areas. Through CAF and CenturyLink matching funds northwest Colorado will receive about $7.25m in broadband expansion to currently unserved addresses (see "CenturyLink Connect America Fund Projects" on page 73).

The mechanisms described by Levin ("Table 17: Historic Light Touch Policies") embody the light touch approach. From a local perspective, the light touch approach can be more fully described by policies used to define the process of becoming a broadband friendly community (see "Become a "Broadband Friendly" Community" on page 87).

4.5.2 PROACTIVE BROADBAND DEVELOPMENT

In 2010 Google fiber asked communities what they would be willing to do to make it possible for Google to deploy fiber. Nearly 1,100 communities responded offering a broad array of light touch approach enticements to Google. To date, Google has announced three respondents that meet their needs. Three of 1,100 or ¼ of 1%. Seattle, Washington and Chicago, Illinois took a different approach. Each city constructed a package of assets and policies they were willing to offer and solicited private vendors for whom the package changed the math enough to enable private investment in broadband expansion. Both cities were able to only attract limited investment in very select neighborhoods.

Communities may find that a light touch approach simply does not meet their broadband deployment expectations or the timelines their citizens demand. Most of the northwest Colorado region has pursued a light touch approach to date. While more structure around a light touch approach may result in broadband development more in line with community and public official hopes, it is likely that most northwest Colorado communities will still be underserved compared to their urban counterparts. Therefore, northwest Colorado may be better served by pursuing more proactive broadband development – deploying broadband infrastructure in targeted or more general implementations.

4.5.3 APPROACH COMPARISON

Both a light touch approach and a proactive broadband development approach have their merits and risks. Both approaches also fit within the organizational models described above and can affect solutions described above.

	Light Touch	Proactive Development

	Light Touch	Proactive Development
Philosophy	The market is the best solution to the region's broadband problem. The role of the COG and regional governments is to help create conditions for market success.	The market plays an important role in regional broadband development but cannot solve the region's broadband problem. The COG and regional jurisdictions must take a proactive role not just in creating positive market conditions but also in developing and implementing infrastructure and services.
Organizational Structures		
Ad Hoc	Ad hoc structures can be created to effectively support a light touch approach. As needed committees or organizations can form to address specific negative market conditions, create demand aggregation, or perform other market enhancing activities.	Ad hoc structures are a moderately effective tool to address proactive development. Ad hoc committees could select projects and follow them through to completion.
Jurisdictional Control	Jurisdictional control is an effective light touch organizational model. Individual jurisdictions know their market conditions best and can work to alleviate unfavorable market conditions. As needed, local jurisdictions can create regional ad hoc groups to address issues beyond the local jurisdictional scope.	Jurisdictional control is a reasonably effective proactive development organizational structure. The disadvantages of divided market aggregation and difficult regional coordination associated with jurisdictional control can be overcome and may be outweighed by the value of local self determination.
NWCCOG Control	A light touch approach could benefit significantly from some NWCCOG control. The COG can become a central repository for regional incentives. Further, the COG could take on the responsibility for attracting private sector investment. Much like economic development offices work to provide and advertise business incentives, the COG could provide and advertise regional broadband incentives.	Proactive development could be greatly enhanced through coordination and control offered by the COG. Regional projects could be more easily coordinated and market aggregation more readily accomplished. COG control may lead to project prioritization that individual jurisdictions may not agree with.
Telecommunications Cooperative	In the framework of a light touch approach, private parties would form a telecommunications cooperative as the market showed it to be a profitable venture. The Northwest Colorado Broadband effort in Steamboat Springs and Crestone Telecom and Colorado Central Telecom are examples of a telecommunications cooperative effort being born from private sources	To accomplish proactive development, it may be prudent for the COG and its member jurisdictions to help with the creation of a telecommunications cooperative and to provide it some support to ensure its success. The cooperative could serve to perform certain functions the sponsoring government entities might want to avoid because of state law or federal regulations.
Solutions		

	Light Touch	Proactive Development
Status Quo	The status quo can be characterized as a de facto light touch approach.	With few exceptions, the status quo does not lend itself to proactive broadband development.
Develop Incentives and Penalties for Incumbent Providers	Incentives and penalties for incumbent providers coupled with broadband friendly policies describe the core public function in a light touch approach.	A proactive broadband development approach does not suggest a public intent to replace incumbent providers. Rather, proactive development should strive to maximize broadband development from all quarters. Thus, incentives and penalties for incumbent providers is one tool in the proactive broadband development kit.
Become a "Broadband Friendly" Community	Becoming a "broadband friendly" community coupled with incentives and penalties for incumbent providers describe the core public function in a light touch approach.	Broadband friendly policies should be applied to support both public and private broadband development. Broadband friendly policies serve as one tool in the proactive broadband development kit.
Regional Cooperative Planning	In a light touch approach, the COG, its member jurisdiction, or both could work to create opportunities for regional vendors to meet together and maximize broadband investment efficiencies between the various providers.	Proactive broadband development suggests that the COG and its member jurisdictions will not only facilitate cooperation between regional incumbent providers by coordinating meetings and providing information but that the COG might also build infrastructure or provide electronics to achieve multi-vendor interconnectivity.
Build Infrastructure	Public construction of broadband infrastructure is the antithesis of a light touch approach. In a light touch approach, Infrastructure deployment and operation should be in the hands of the private sector. The public sector should strive to create conditions that encourage broadband investments in the region but, as a general rule, should not be making those investments.	Implementation and operation of broadband infrastructure is one of the core principles of a proactive development approach. By no means does the public sector intend to drive private providers from northwest Colorado. Rather, the public sector should build targeted infrastructure that improves broadband in the region and encourages broader competition from private providers.

	Light Touch	Proactive Development
Carrier Neutral Locations	The light touch approach to carrier neutral locations is for the COG and its member jurisdictions to aggregate demand information from multiple public and private entities and to get entities to commit to meeting at a common location. This information and these commitments could then be taken to one or more service providers or other organizations to show the value of building a carrier neutral location. The COG could also provide grant or loan funds to help offset the capital requirements and subscription commitments to bolster operational feasibility. The Northwest Colorado Broadband Carrier Neutral location in Steamboat Springs is an example of the light touch approach to developing a carrier neutral location.	The COG or its member jurisdictions would build carrier neutral locations.
Carrier Cooperative Infrastructure	In the light touch approach, the COG and its member jurisdictions would not build any carrier cooperative infrastructure. Rather, they would identify needed infrastructure and work with incumbent providers to identify the conditions required to meet return on investment requirements.	The COG and its member jurisdictions would build infrastructure, provide electronics, or take other implementation measures necessary to make it worthwhile for service providers to interconnect. EAGLE-Net is not directly targeted at deploying carrier cooperative infrastructure but serves the same function of expanding regional middle mile capacity and redundancy.
Municipal Distribution Rings	The optimal municipal distribution ring solution in the light touch approach is one in which community anchor institution commitment to subscribe to services spurs development of private sector owned and operated municipal distribution rings. Many communities throughout the nation require their cable franchisee to connect community anchor institutions as a requirement of their franchise agreement.	In a proactive development approach, the COG and its member jurisdictions would build publicly owned municipal distribution rings as needed. The Southwest Colorado Access Network is an example of proactive municipal distribution ring development.

	Light Touch	Proactive Development
Limited Scope Access Level Infrastructure	In some circumstances, ubiquitous build requirements prevent incumbent service providers from deploying or upgrading services because the burden associated with low revenue areas of the ubiquitous build area outweigh the high revenue opportunities. A light touch approach to limited scope access level infrastructure deployment would relieve incumbent providers of ubiquitous build requirements and would let the market determine where broadband improvements would happen and where they would not. Another light touch approach to achieve limited scope access level construction is to identify needed infrastructure and to create grant or loan programs to incentivize private sector deployment. CenturyLink's participation in the Connect America Fund represents a federally sponsored light touch approach. The federal government established certain criteria and CenturyLink determined where it was in the company's best interest to meet those criteria. This resulted in CenturyLink committing to build new access level infrastructure (or implement appropriate upgrades) to bring broadband to 5,572 currently unserved addresses in northwest Colorado.	The proactive development approach could extend public infrastructure into areas targeted for their underserved nature or their revenue opportunity. The municipal network Cortez, Colorado is an example of a project that has extended a municipal distribution ring into targeted neighborhoods.
Large Scale Access Level Infrastructure	The light touch approach to large scale access level infrastructure deployment involves creating a business and regulatory environment conducive to broadband deployment. Nearly all broadband services in northwest Colorado today exist because of a light touch approach to large scale access level infrastructure. With or without the specific intent of doing so, the federal, state, and local governments have created the regulatory and business conditions needed to encourage private providers to deploy large scale broadband infrastructure.	Some communities may benefit from large scale access level infrastructure public investment or in public investments in middle mile infrastructure that lead to expanded last mile capacity. The Glenwood Springs Community Broadband Network is an example of a large scale access level infrastructure investment.
Other		
COG Staff/Contractor	In a light touch approach, the COG	In a proactive development approach, the

	Light Touch	Proactive Development
Role In September of 2013, the COG Board directed COG staff to apply for grant funds to establish a COG broadband coordinator staff/contractor role for one year	broadband coordinator will: • Manage public communications. • Work with communities to develop broadband friendly policies, developing a body of best practices and helping implement them throughout the region. • Coordinate regional efforts to strengthen, expand, and take advantage of federal and state high cost broadband implementation loans and grants and operational subsidies. • Coordinate regional efforts to relieve state restrictions on municipal broadband restrictions. • Investigate the relative benefits of regional franchising vs. individual community franchising. • Continue to develop an inventory of available regional assets and work with GOIT to ensure state broadband mapping is useful to northwest Colorado communities. • Develop consumer resources to help regional consumers make educated broadband choices. • Help communities implement community education efforts to increase adoption rates. • Coordinate state and federal projects with private projects to work towards efficient broadband implementation spending in the region. • Facilitate meetings between incumbent network owners and work to improve middle mile capacity and redundancy by interconnecting existing networks. • Help communities develop and implement local broadband action plans. • Support organizations creating aggregation points. • Help private companies gather information and secure funding to expand broadband. • Identify priority needs and pursue private mechanisms to complete them.	COG broadband coordinator will: • Manage public communications/marketing. • Work with communities to develop broadband friendly policies, developing a body of best practices, managing them at the COG level, and helping implement them in member jurisdictions. • Coordinate regional efforts to strengthen, expand, and take advantage of federal and state high cost broadband implementation loans and grants and operational subsidies. • Coordinate regional efforts to relieve state restrictions on municipal broadband restrictions. • Investigate the relative benefits of regional franchising vs. individual community franchising. • Continue to develop an inventory of available regional assets and work with GOIT to ensure state broadband mapping is useful to northwest Colorado communities. Help communities use broadband mapping information to develop implementation plans. • Develop consumer resources to help regional consumers make educated broadband choices. • Lead community efforts to implement community education programs to increase adoption rates. • Coordinate public and private projects to maximize broadband implementation spending efficiency. • Facilitate meetings between incumbent network owners and work to improve middle mile capacity and redundancy by interconnecting existing networks. Identify and coordinate public spending that could enhance incumbent network owner interconnectivity. • Help communities develop and implement local broadband action plans. • Determine aggregation models. Support organizations creating

	Light Touch	Proactive Development
		aggregation points or implement public carrier neutral locations. • Propose and get approval for targeted infrastructure spending. Secure funding and manage implementation projects. • Identify priority needs and pursue implementation projects. Manage or provide management support for public infrastructure.
Summary		
Pros	Broadband Development • Places a focus on regional broadband development and helps private businesses improve capacity and reliability. Risk • Represents a low risk course of action with only as much commitment as can be made available. Finance • Can be executed with limited funding. • Probably does not incur recurring expenses. Role of Government • Avoids government entry into a market driven enterprise. Other • Avoids most potential conflicts with incumbent network owners. • Indicates a high level of trust and confidence in incumbent network owners.	Broadband Development • Brings greater control of broadband development into the hands of public officials. • Broadband development can proceed at whatever pace resources allow. • Public officials dictate broadband development priorities. Risk • Most risks can be avoided or mitigated through careful planning. Finance • May eventually generate new revenues. • May result in greater economic development opportunities. Role of Government • Creates a mechanism where government can address what some see as a natural monopoly, a public utility, and/or a market failure. Other • Broadband development can be focused on quality of life issues, public safety, and other public priorities and not just on shareholder value.

	Light Touch	Proactive Development
Cons	Broadband Development • Broadband development may be slow and erratic. • Improvements in capacity and reliability depend mostly on entities outside of public control. Risk • If broadband development is not sufficient, regional stakeholders may lose interest. Finance • Is unlikely to create direct or indirect revenue sources. • Is unlikely to generate significant economic development opportunities. Role of Government • Prevents government from taking a direct and active role in what some may perceive as a natural monopoly and a market failure essential service. • May be perceived by some as an abdication of government responsibility. Other	Broadband Development • May inspire punitive actions by incumbent network owners (e.g. they may reduce regional broadband investments). Risk • Represents a potentially high risk course of action. Finance • May require significant capital investment. • May result in recurring obligations. Role of Government • Involves government in a competitive marketplace. Other
Recommendation	The key advantage of the light touch approach is its low risk. In a risk adverse environment, we would recommend this approach. The light touch approach caters to political thought that believes free markets are the best way to resolve most consumer needs. We feel the light touch approach will result in unsatisfactory broadband development and only recommend it as a secondary course of action to be pursued if the COG feels proactive development is too risky or not well aligned with the political philosophy of the majority of its citizens.	The key advantage of proactive development is its reinforcement of local self determination. Through proactive development, the COG and its member jurisdictions take control of their broadband futures rather than primarily relying on national companies headquartered in Philadelphia, PA or Monroe, LA. The proactive development approach caters to political thought that believes in using government to resolve market failures, to provide basic utility services, and to protect consumers from natural monopolies. We recommend a proactive development approach unless the COG feels the risk is too high, not readily avoidable, and mitigation unreasonable or if the COG feels it does not align well with the political philosophy of the majority of its citizens.

Table 18: Light Touch vs. Proactive Development Approaches

5 FINANCIAL MODELING AND SUSTAINABILITY

Broadband expansion can require significant capital expenditures and, once in place, the infrastructure requires maintenance and operations. This section first looks at potential funding sources for the capital investment and then presents a high level financial summary.

5.1 POTENTIAL FUNDING SOURCES

The federal and state governments offer some potential funding sources. Local governments may also use local resources.

5.1.1 FEDERAL PROGRAMS

USDA Rural Development is chartered to help improve the economy and quality of life in rural America. USDA's financial programs support such essential public facilities and services as water and sewer systems, housing, health clinics, emergency service facilities, and electric and telephone. Rural Development promotes economic development and quality of life by supporting loan and grant programs. Rural Development administers billions in loans, loan guarantees, and grants each year.

The Economic Development Administration (EDA) was established under the Public Works and Economic Development Act of 1965 to generate jobs, help retain existing jobs, and stimulate industrial and commercial growth in economically distressed areas of the United States. EDA assistance is available to

rural and urban areas of the Nation experiencing high unemployment, low income, or other severe economic distress.

5.1.1.1 FARM BILL BROADBAND LOAN PROGRAM

The U.S. Department of Agriculture's (USDA) Farm Bill Broadband Loan Program[94] is administered by the Rural Utilities Service (RUS) of USDA Rural Development. The program funds the costs of construction, improvement, and acquisition of facilities and equipment to provide broadband service to eligible rural areas on a technology-neutral basis. Direct loans are in the form of a cost-of-money loan, a 4-percent loan, or a combination of the two.

A service area may be eligible for a broadband loan if all of the following are true:

1. The service area is completely contained within a rural area;
2. At least 25 percent of the households in the service area are underserved households;
3. No part of the service area has three or more incumbent service providers;
4. No part of the funded service area overlaps with the service area of current RUS borrowers and grantees;
5. No part of the funded service area is included in a pending application before RUS seeking funding to provide broadband service.

5.1.1.2 USDA RUS COMMUNITY CONNECT GRANTS

The Rural Utility Services Community Connect Grant program[95] serves rural communities where broadband service is least likely to be available, but where it can make a tremendous difference in the quality of life for citizens. The projects funded by these grants will help rural residents tap into the enormous potential of the Internet.

By the 2013 rules, to be eligible for a grant, the project must[96]:

- Serve a Proposed Funded Service Area (PFSA) where Broadband Service (3 Mbps) does not currently exist, to be verified by RUS prior to the award of the grant. The PFSA is defined as a contiguous geographic area within an eligible rural area.
- Offer service at the Broadband Grant Speed to all residential and business customers within the PFSA.
- Offer service at the Broadband Grant Speed, free of all charges for at least 2 years (starting from the time service becomes available) to each community anchor institution (e.g. public schools, public libraries, public medical clinics, public hospitals, community colleges, public universities, law enforcement, and fire and ambulance stations) located within the PFSA.

[94] See http://www.rurdev.usda.gov/utp_farmbill.html for more information.
[95] See http://www.rurdev.usda.gov/utp_commconnect.html for more information.
[96] See the RUS Community Oriented Connectivity Broadband Grant Program Application Guide at http://www.rurdev.usda.gov/SupportDocuments/utp2013CommConnectAppGuide.pdf.

- Provide a Community Center located in the PFSA, with at least two (2) but no more than ten (10) Computer Access Points and wireless access at the Broadband Grant Speed (5 Mbps), free of all charges, to users for at least 2 years.
- Not overlap with the service areas of current RUS borrowers and grantees.

Several communities in northwest Colorado may qualify for Community Connect Grants.

5.1.1.3 US DEPARTMENT OF COMMERCE ECONOMIC DEVELOPMENT ADMINISTRATION

The Economic Development Administration[97] is guided by the basic principle that distressed communities must be empowered to develop and implement their own economic development and revitalization strategies. EDA helps communities address both immediate (e.g. natural disasters, military installation closure, depletion of natural resources, etc.) and long-term economic distress.

EDA's economic development facilities and public works programs provide funding for construction of infrastructure in areas that are not attractive to private investment. Public works and economic development investments help support the construction or rehabilitation of essential public infrastructure and facilities necessary to generate or retain private sector jobs and investments, attract private sector capital, and promote regional competitiveness, including investments that expand and upgrade infrastructure to attract new industry, support technology-led development, redevelop brownfield sites and provide eco-industrial development. Most funding is for water and sewer infrastructure but some has been designated for communications projects.

5.1.2 COLORADO DEPARTMENT OF LOCAL AFFAIRS GRANTS

The Colorado Department of Local Affairs (DOLA) Energy/Mineral Impact Assistance Fund (EIAF) offers Administrative (grant awards up to $25,000), Tier I (grant awards up to $200,000), Tier II ($200,000 to $1,000,000), and Tier III (multi-million dollar, multi-year projects not currently available) grants. More information is available at http://www.colorado.gov/cs/Satellite/DOLA-Main/CBON/1251594715231.

5.1.3 REVENUE

Northwest Colorado communities can use indirect and direct revenues to support broadband expansion.

5.1.3.1 INDIRECT REVENUES

Many public infrastructure projects are supported by indirect revenues like taxes or licensing fees. **Northwest Colorado communities may want to investigate ways to generate indirect revenues to support broadband development. Especially since the region's resort/tourism centers must support significant broadband demand from users with low tolerance for paying for it (i.e. that is, the visitors

[97] See http://www.eda.gov/ for more information.

who expect connectivity but do not anticipate paying fees or other charges to support that connectivity).

5.1.3.2 DIRECT REVENUES

We consider direct revenues to be monies generated by the subscription, lease, sale, or other use of public broadband assets.

A light touch approach is unlikely to result in any direct revenues except from existing assets.

Proactive development is likely to result in direct revenues.

Direct revenues are discussed more fully in "Potential Direct Revenue Modeling" section under "Some Financial Stick Figures" on page 133.

5.1.4 OTHER FUNDING OPPORTUNITIES

This section has listed several potential funding sources but does not purport to be a definitive list. Working with incumbent network owners, the region can access FCC and state universal service and high cost funds. Working with schools, libraries, and medical facilities, E-Rate and other subsidy, loan, and grant funds may be available to the region.

We have not discussed bonds or other public financing instruments in this section but they are, of course, a potential funding opportunity. Furthermore, private sector for profit and not for profit organizations may pursue other capital sources.

** As the NWCCOG works to coordinate public and private regional projects all funding paths should be explored and the COG should provide what assistance it can to organizations pursuing funding not available to the COG or its member jurisdictions.

5.2 SOME FINANCIAL STICK FIGURES

Financial planning for regional broadband will depend heavily on intended actions, sources of revenue, and other unknown factors. Nonetheless, we can establish some basic assumptions to help describe financial scope and scale.

5.2.1 ORDER OF MAGNITUDE COST ESTIMATES

Order of magnitude implementation costs focus on either miles of plant deployed (a typical measure for more rural areas) or number of households passed (a typical measure for more urbanized areas).

To begin looking at order of magnitude implementation costs, it is helpful to know that CenturyLink's participation in CAF funding was based on about $1,300 per new address served to upgrade their plant in fairly rural areas. After years of mass purchases and the implementation of other scale mechanisms,

Verizon was able to lower the cost of fiber to the premises in dense urban areas to $600 to $700 per home passed[98]. More typically, fiber to the premises in areas with suburban densities (about 100 foot lot frontages) will cost about $1,100 per household passed.

In more rural areas, costs are typically measured by the mile of fiber deployed. Where aerial construction is available on existing utility poles, costs typically range around $30,000 per mile. Buried construction techniques are significantly more varied but always more expensive. If fiber can be plowed, construction costs can be as low as $60,000 per mile. If ground conditions demand other construction methodologies, construction costs can climb well above $200,000 per mile. Typically, buried construction can be roughly estimated at about $110,000 per mile.

Operations and maintenance costs will depend on the types of services offered. Public network owners may choose to transfer all operations and maintenance responsibilities to leasing entities. If not, at a minimum, the plant must be maintained. Rough estimates for outside plant maintenance are about $180 per mile per year. Operations and maintenance will increase significantly from that level as electronics are introduced, services added, and other functions contemplated.

5.2.2 POTENTIAL DIRECT REVENUE MODELING

Broadband development can result in direct revenues. Public projects can lease facilities, lease dark fiber, lease lit fiber, charge implementation fees, charge subscriber fees, solicit sponsorships, and generate revenue in other ways. Revenue projections are highly dependent on the type of models implemented over the scope of infrastructure.

[98] Ratliff, Lee (7 June 2010). "Verizon's FTTH Expansion Stoppage Takes Many by Surprise." iSuppli Market Watch. Viewed 1 December 2013 at http://www.isuppli.com/Home-and-Consumer-Electronics/MarketWatch/Pages/Verizons-FTTH-Expansion-Stoppage-Takes-Many-by-Surprise.aspx.

6 COMMUNICATION ("MARKETING") PLAN

Whether the COG pursues a light touch or proactive development approach, public involvement in broadband expansion in suggests three primary market groups:

1. Residents and businesses as both the "owners" of any projects and as potential subscribers (either directly or indirectly through a participating service provider).
2. Incumbent network owners and service providers as partners in regional broadband development, as potential customers of public infrastructure, and as potential service providers on open access infrastructure projects.
3. Public officials (elected, appointed, and staff members) as the "managers" of any public efforts and as community anchor institution subscribers and bandwidth aggregators.

Regardless of the approach or market group, we believe the COG must make one message perfectly clear: Public broadband involvement is intended for the benefit of the community. As such, public broadband expansion efforts may involve policies, education efforts, partnerships with incumbent network owners and service providers, even public infrastructure projects when they appear to be the best mechanism to improve broadband in the region or in an individual community.

The experience of other public broadband projects has shown that is important to manage the message so that the market groups understand the benefits of broadband expansion. Some projects have fallen into the trap of setting expectations around specific revenue or sustainability objectives ignoring the other reasons for broadband deployment. Most people and organizations can understand the logic of financial returns. To express the logic of economic development, quality of life, and public safety, those

responsible for broadband development in the region may need to create effective messaging campaigns.

Specific messaging to each market group will depend on whether the COG pursues a light touch or proactive development approach and on the nature of each broadband project.

7 RISK MANAGEMENT PLAN

Development of broadband in northwest Colorado comes at some risk. The COG and its member jurisdictions must work within a legal framework, must proceed in a financially sustainable fashion, and must accommodate other project risks.

7.1 THE LEGAL ENVIRONMENT

The legal environment is the first risk factor for the COG and its member jurisdictions to consider. Telecommunications regulation is a complex mix of federal, state, and local regulations. This section provides an introduction to the legal environment but does not attempt to represent itself as a thorough legal analysis. We ** strongly recommend a thorough legal review prior to any project implementation.

7.1.1 FEDERAL LEGAL ENVIRONMENT SUMMARY

Federal telecommunications regulation began in earnest with the Communications Act of 1934. The 1934 Act created the Federal Communications Commission and established interstate rules and regulations but left intrastate regulation to the states. The Telecommunications Act of 1996, recognizing the interconnected nature of telecommunications systems, established a preemption model that allowed federal regulations and rule making to preempt state actions. Preemption created an environment where most state regulatory agencies would closely model the FCC's actions.

The 1996 Act is divided into seven titles with Title I creating a fairly rigorously regulated local exchange carrier environment (traditional voice) and Title III establishing a fairly lightly regulated cable services environment.

As broadband has developed, the FCC has chosen a course of forbearance or not applying rigorous Title I voice regulations and rules to new broadband infrastructure. Forbearance has allowed incumbent local exchange carriers (historically the most tightly regulated of all telecommunications providers) to expand

broadband service (via fiber to the node and other technologies) with minimal regulation – in particular, without rate rules, carrier of last resort rules, or unbundling rules.

Federal telecommunications regulatory forbearance may result in business environments that encourage broadband investment. Forbearance may also result in areas being left behind as return on investment models simply don't work in all areas of the country and broadband deployment is relieved from carrier of last resort requirements. Forbearance may also limit broadband competition as competitive providers are excluded from incumbent network owner infrastructure previously made available to them by unbundling rules and price regulation.

7.1.2 COLORADO STATE LEGAL ENVIRONMENT SUMMARY

Generally speaking, since the telecommunications Act of 1996, state regulatory agencies have shadowed federal rules and direction. The Colorado Public Utilities Commission focuses their telecommunications rules on a variety of voice providers – largely excluding broadband from its jurisdiction except in those cases where broadband infrastructure is regulated as part of voice service delivery.

While the state pursues a largely "hands off" approach to regulating broadband providers, the state has chosen to limit public entry into broadband. The 2005 Colorado Senate Bill 152 (passed and codified as CRS 29-27) legislates that unless incumbents refuse to provide the requested broadband service, municipalities must have a referendum to offer broadband services. Relevant sections of the law are excerpted here…

Definitions.

(1) "Advanced Service" means high-speed internet access capability in excess of two hundred fifty-six kilobits per second both upstream and downstream.

(3) "Local Government" means any city, county, city and county, special district, or other political subdivision of this state.

(5) "Subscriber" means a person that lawfully receives cable television service, telecommunications service, or advanced service. A person that utilizes cable television service, telecommunications service, or advanced service provided by a local government for local governmental or intergovernmental purposes and is used by persons accessing government services is not a subscriber for purposes of this article.

(6) "Telecommunications Service" has the same meaning as set forth in Section 40-15-102, C.R.S.

29-27-103. Limitations on providing cable television, telecommunications, and advanced services.

(1) Except as provided in this article, a local government shall not:

(a) Provide to one or more subscribers cable television service, telecommunications service, or advanced service, or

(b) Purchase, lease, construct, maintain, or operate any facility for the purpose of providing cable television service, telecommunications service, or advanced service to one or more subscribers.

(2) For purposes of this article, a local government provides … service if the local government provides the … service to one or more subscribers:

(a) Directly;
(b) Indirectly by means that include but are not limited to the following:
(II) through a partnership or joint venture;
(c) By contract, including a contract whereby the local government leases, sells capacity in, or grants other similar rights to a private provider to use local governmental facilities designed or constructed to provide … service for internal local government purposes…

29-27-201. Vote – referendum.

(1) Before a local government may engage or offer to engage in providing … service, an election shall be called on whether or not the local government shall provide the proposed … service.

29-27-302. Scope of article.

(2) Nothing in this article shall be construed to apply to a local government purchasing, leasing, constructing, maintaining or operating facilities that are designed to provide … service that the local government uses for internal or intergovernmental purposes.

(3) Nothing in this article shall be construed to apply to the sale or lease by a local government to private providers of excess capacity, provided:

(a) such excess capacity is insubstantial in relation to the capacity utilized by the local government for its own purposes, and

(b) the opportunity to purchase and the opportunity to use such excess capacity is made available to any private provider in a nondiscriminatory, nonexclusive, and competitively neutral manner.

The American Legislative Exchange Council (ALEC) provides its members model legislation similar to Colorado's law designed to prohibit municipal entry into broadband services. On their web site[99] ALEC explains that they are concerned that municipal entry into broadband has "negative impacts" on "free markets and limited government." The site explains:

> *…such projects could erode consumer choice by making markets less attractive to competition because of the government's expanded role as a service provider.*
>
> *In addition, ALEC is concerned that many cities and towns are signing up for these projects before comprehensively evaluating all the issues surrounding this type of initiative. The fact that no "best practices" or standard business models have yet to emerge and many local governments have used taxpayer money to fund loosing ventures warrants the need for government officials and citizens to carefully weigh the advantages and disadvantages that exist.*

Not everyone agrees with ALEC.

In "Broadband and Economic Development: A Municipal Case Study from Florida," George S. Ford and Thomas M. Koutsky demonstrate the measurable improvement to economic activity in Lake County due to the implementation of a generally available municipal fiber network. They conclude:

[99] http://www.alec.org/task-forces/telecommunications-and-information-technology/municipal-broadband/

> *… our econometric model shows that efforts to restrict municipal broadband investment … could deny communities an important tool in promoting economic development. Municipalities build schools, roads, hospitals, parks, marinas and convention centers in order to attract businesses, jobs, and improve the quality life of their communities. Broadband investment is another form of infrastructure that could offer those and other community benefits. If further municipal investment is hindered or prohibited, the economic development boost Lake County seems to have received from its broadband investment would be denied to other communities. (p. 16)*

While the Colorado Revised Statutes certainly do not prohibit municipal broadband development, confusion about the law and the requirements of the law do hinder municipal investment. Building broadband networks and (or) providing services is not for every municipality but we feel that decision should be in the hands of the elected officials in each community and that the state's role should be to provide resources and best practices – to help communities succeed no matter how they choose to improve broadband locally. ** For this reason we recommend the COG work with other entities to reduce or remove state legal barriers to public broadband development.

P3: Working to ease state restrictions on municipal broadband projects in rural communities.

We recommend the COG work with other entities to reduce or remove state legal barriers to public broadband development.

7.2 FINANCIAL RISK MANAGEMENT

Financial risk avoidance represents one of the primary reasons private sector network owners don't deploy adequate bandwidth today. As the COG and its member jurisdictions considers infrastructure deployment targeted at spurring economic development, improving quality of life, and enhancing public safety, the participating entities must understand they do so at some financial risk but that the risk can be managed.

7.2.1 RISK LEVELS

We define project financial risk around the probability the project will generate sufficient revenues to function at operational breakeven, to service its debt, or to generate positive revenue. Broadband project financial risk falls along a spectrum from spectacular failure to unbelievable success. We define five risk profiles along that spectrum:

1. <u>Very High Risk</u>
   Very high risk projects are unlikely to produce sufficient revenue to meet operations and debt obligations and are likely to require significant subsidies indefinitely. Very high risk projects should only be undertaken with prior public disclosure of the risk and a publicly agreed upon (through a referendum or other vote process) subsidization model (e.g. a tax district, transfers from other more successful implementation efforts, voluntary contributions, etc.).

The COG may undertake to change the risk profile of a very high risk project by securing grant funds to eliminate debt service, pre-committing subscribers to bolster revenue projections, committing potential subscribers to pay a one-time fee to offset construction costs, or through other means.

2. High Risk
   High risk projects are likely to produce sufficient revenue to achieve operational breakeven but unlikely to meet debt service obligations. The COG should only undertake high risk projects with the full understanding of all key public officials that the project's debt service obligations will likely need to be met through public subsidies. Public officials may choose to seek public approval of potential public subsidies through a referendum or other public vote process.
   High risk project risk profiles can be modified by securing grant funds for implementation, pursuing financial commitments from potential beneficiaries of the project, or through other means.
3. Moderate Risk
   Moderate risk projects are likely to produce revenues sufficient to meet operations and debt obligations but unlikely to produce excess revenue to continue to grow regional broadband or to transfer to other functions.
   Moderate risk projects are reasonable for the COG to pursue.
   Moderate risk projects can be made more palatable by reducing implementation obligations through grants, subscriber implementation fees, or low interest long-term loans or by improving revenue outlooks through committed subscriptions.
4. Low Risk
   Low risk projects are likely to produce sufficient revenues to meet project obligations and to provide funds for additional regional broadband expansion.
5. Very Low Risk
   Very low risk projects are likely to produce sufficient revenues to meet project obligation, provide funds for additional regional broadband expansion, and provide funds to transfer to general funds or other funds.

As the COG considers individual projects within the context of its larger objectives, each project should be evaluated for financial risk and appropriate mitigation measures should be taken. As discussed above, some mitigation measures include seeking grant funds, securing financial commitments from potential beneficiaries in the form of installation fees or subscription commitments, implementing projects in stepped models, securing long-term low interest loans, etc. The COG may also choose to use financial tools like project performance insurance bonds or investment vehicles to mitigate project financial risk. One example of an investment vehicle is the Principal Assumption and Repayment Program (PARP) described in the "Principal Assumption and Repayment Program (PARP)" appendix.

7.3 OTHER RISKS AND RISK AVOIDANCE/MITIGATION

Public broadband projects face other risks besides financial risks. In particular, public projects face risks of negative public perception, inability to manage complex communications networks, negative incumbent response, and other project risks.

7.3.1 PUBLIC PERCEPTION

More Libertarian thinkers believe government should not be involved in enterprises like broadband. For many proponents of limited government philosophy, no amount of messaging can resolve their antipathy. While respondents did not always offer reasons, when asked what government actions would be appropriate to address northwest Colorado's broadband problem, some indicated any action would be "very bad", or "fairly bad" as depicted in "Table 19: Antipathy towards Government Broadband Action".

> **Government** should not build anything.
>
> *Grand County Survey Respondent*

Action	Very Bad	Fairly Bad	Total Bad
Do Nothing (very and fairly good vs. very and fairly bad)	6.1%	5.8%	11.9%
Incent Incumbents	3.0%	1.8%	4.8%
Broadband Friendly Policies	1.5%	0.6%	2.1%
Regional Cooperative Planning	0.6%	0.6%	1.2%
Construct to Close Gaps	1.8%	1.5%	3.4%
Construct to Compete	8.2%	3.0%	11.3%

Table 19: Antipathy towards Government Broadband Action

** It is important to work closely with incumbent private sector network owners to minimize the impact of negative public perception regarding government involvement in broadband projects.

Another perception pitfall many public broadband projects face is failure to meet public expectations. This risk starts with the setting of expectations. In Utah, the UTOPIA project set expectations around financial performance. When the project failed to meet financial objectives, no other benefits could sway public opinion away from the perceived project failure based on the project's financial performance. In southwest Colorado, the SCAN project worked from the beginning to clearly set two expectations: 1) the public provided infrastructure would not necessarily improve any individual's broadband experience and 2) while the project may generate some revenue, financial performance is not its primary objective. This expectation setting will help the SCAN project advertise its successes and draw positive public opinion.

7.3.2 COMPLEX COMMUNICATIONS NETWORK MANAGEMENT

Broadband networks can be technically complex. Many government entities do not possess the expertise needed to maintain high availability, high capacity broadband services. The COG may need to

rely on contractors to operate and maintain infrastructure and services and should ensure the costs of doing so are included in financial modeling.

Not only can the networks become complex, the business models and business management can also become very complex. The recommendations of this Regional Broadband Strategic Plan suggest walking a fine line between cooperation and competition with incumbent network owners. To maximize regional broadband development, the COG must maximize private sector investment while working to increase the consumer benefits derived from healthy competition – which may include public infrastructure and publicly provided services. To mitigate the risks associated with this complex business environment, the COG may need not only contracted technical expertise, but also contracted or internalized business expertise.

7.3.3 INCUMBENT RESPONSE

Incumbent network owners may respond to public efforts to improve broadband in a number of ways. In many instances, incumbent network owners have wielded their political clout to pass legislation prohibiting or otherwise placing barriers to public entry into broadband (see, for example, our discussion on Colorado's law in "Colorado State Legal Environment Summary" on page 137 and, for examples of other state's preemption rules, the Community Broadband Networks Community Network Map at http://muninetworks.org/communitymap).

Alternatively, incumbent network owners may choose to respond by using legal actions – filing suit within the bounds of existing law or using administrative rulings to delay or block public projects.

Incumbent service providers are likely to use marketing mechanisms to retain and grow their market share – often times to the detriment of public projects.

A key argument against public entry into broadband is that public projects are likely to discourage private investment. This argument may or may not be true – nonetheless, it represents a risk public projects must address.

Public projects should prepare for the risks represented by incumbent response by establishing early an attitude of cooperation with regional network providers. The incumbents in northwest Colorado have conceded that providing world class service in the region is difficult. Efforts should be taken to demonstrate to the incumbent network owners and service providers that public entry into provisioning broadband may represent a low cost mechanism for expanding their markets, increasing demand for their products, and improving the services they can offer. Public projects should work to establish the value of these positive outcomes as a trade-off for occasional incursion into existing markets.

We feel using this type of cooperative/trade-off approach is a much more effective methodology than fighting incumbent providers in the courts. Nonetheless, ** each project entered into should go through a legal review to identify potential legal hurdles and reduce or remove them.

7.3.4 OTHER PROJECT RISKS

Of course, depending on the nature of each proposed broadband development project, specific project risks may arise. As with categorizing financial risk and conducting legal reviews, each project should go through a project specific risk review. In some cases, sufficient risk avoidance/mitigation mechanisms will not be available and certain projects may need to be postponed or abandoned.

8 CONCLUSIONS AND RECOMMENDATIONS

For the purposes of supporting economic development, improving quality of life, and enhancing public safety, the Northwest Colorado Council of Governments will improve broadband in northwest Colorado with strategies that increase broadband capacity, improve broadband reliability, and lower broadband costs. These strategies fall into four categories (policy efforts, knowledge efforts, coordination efforts, and deployment efforts) and include:

8.1.1.1 POLICY EFFORTS

Public policy affects broadband deployment. The COG's policy strategy will be to support public policies that enhance broadband competition, lower barriers to new broadband entrants, and encourage expansion of incumbent provider service areas. Some policy effort actions may include:

P1 Assisting member jurisdictions to implement broadband friendly policies.
Broadband friendly policies (like "dig once" policies and easy access to rights of way and permitting) can significantly lower the cost of deploying and operating broadband infrastructure. Working with legal counsel, the COG should develop a set of "broadband friendly" policies or model ordinances that member jurisdictions can modify and implement.

P2 Supporting state legislation designed to extend high cost fund support to broadband development.
Colorado is in the process of reviewing its high cost fund support model and considering moving some funds to broadband service. We encourage this development but we also recognize that we

cannot expand broadband on the shoulders of diminishing telephone revenue. The high cost fund should support broadband and broadband subscribers should contribute to the fund.

P3 Working to ease state restrictions on municipal broadband projects in rural communities.
CRS 29-27 (also known as Senate Bill 152) places restrictions on government entry into broadband. We believe SB 152 causes more problems for northwest Colorado communities than it solves. In "Broadband and Economic Development: A Municipal Case Study from Florida," George S. Ford and Thomas M. Koutsky demonstrate the measurable improvement to economic activity in Lake County due to the implementation of a generally available municipal fiber network. They conclude:

> *… our econometric model shows that efforts to restrict municipal broadband investment … could deny communities an important tool in promoting economic development. Municipalities build schools, roads, hospitals, parks, marinas and convention centers in order to attract businesses, jobs, and improve the quality life of their communities. Broadband investment is another form of infrastructure that could offer those and other community benefits. If further municipal investment is hindered or prohibited, the economic development boost Lake County seems to have received from its broadband investment would be denied to other communities. (p. 16)*[100]

Western Slope counties and communities should work to modify SB 152 to incorporate a rural exemption, a lack of competition exemption, a service level exemption, or some combination of the three. Achieving this objective will likely require coordination with other regional like Club 20.

P4 Developing and supporting primary and secondary revenue generating mechanisms to fund implementation and sustaining of broadband improvements.
Primary revenue mechanisms include fees for service and other revenue that can be generated by COG of municipal owned infrastructure.
Secondary revenue generating mechanisms are efforts to shift some of the burden of broadband improvement to user classes that do not currently participate in the funding stream. For example, in the region's resort communities, significant broadband capacity and reliability is expected by visitors. Yet, these visitors do not pay for broadband service. The COG should look at mechanisms for adding room or other taxes to help fund broadband improvements.

P5 Investigating the relative benefits of regional franchising vs. individual community franchising.
Community franchising gives individual communities a regulatory tool they can use to influence the behavior of the primary broadband provider in many areas, the cable company. Unfortunately, most community officials have very little expertise when it comes to cable franchise agreements. The region's communities might benefit from "collective bargaining" of franchise agreements.

[100] Ford, George S. and Thomas M. Koutsky (April 2005). "Broadband and Economic Development: A Municipal Case Study from Florida". Applied Economic Studies: April 2005. http://www.aestudies.com/library/econdev.pdf.

8.1.1.2 KNOWLEDGE EFFORTS

Broadband adoption helps drive demand and demand helps shape private sector provider behavior. The COG should engage in developing and disseminating information regarding broadband asset availability, broadband service availability, and enhancements to quality of life that can be had through broadband adoption. Some knowledge actions may include:

K1 Working with GOIT to improve regional broadband mapping.
It is important to keep data about the state of broadband in northwest Colorado up to date. This project has produced a map data set (available in a separate Google Earth KMZ file) but rather than maintaining redundant mapping efforts it would be prudent to work with GOIT to ensure the broadband mapping application and the pending asset map meet the COG's planning and management needs.
Additionally, cellular service should be more widely surveyed. Some local jurisdictions in the region may have MobilePulse[101] licenses. We recommend continued use of the MobilePulse app and sharing of data in the region. The COG should inventory who has MobilePulse licenses and who does not and should work with jurisdictions with licenses to redistribute them throughout the region. Data collected from MobilePulse should be used to improve the information provided on the state broadband map. The COG should then work with regional cellular providers to implement infrastructure to close cellular gaps and improve service in weak signal areas.

K2 Working with GOIT and other partners to develop resources to help subscribers find the best broadband services at prices that meets their individual needs.
Information about service providers and service packages should be readily available to the public and economic development teams. If GOIT cannot expand their information resources to accommodate these reasonable needs, the COG or a COG sponsored entity should take on this task.

K3 Implementing community education efforts to increase adoption rates and increase demand.
As broadband improves in the region, demand will increase; as demand increases, broadband improvements will be required. By implementing community education efforts aimed at increasing awareness of the quality of life and business opportunities available from broadband, the COG can increase demand. The COG can then use increased demand in the region to help shape private sector provider behavior and to prioritize government sponsored improvements.

8.1.1.3 COORDINATION EFFORTS

The COG should maximize broadband capital spending efficiency in the region by coordinating public projects and working with private sector providers to encourage cooperative ventures. Some coordination effort actions may include:

C1 Coordinating existing and future projects to enhance infrastructure investment efficiencies.
In July of 2013, Colorado was one of the first five recipients of the NTIA State and Local Implementation Grant Program (SLIGP), receiving a $2.5 million grant with matching fund

[101] See http://www.mobilepulse.com/ for more information about MobilePulse.

requirements. SLIGP funding will be awarded in two phases, with the first phase focused on such activities as expanding existing governance bodies to consult with FirstNet, conducting education and outreach to relevant stakeholders, and identifying potential public safety users.

The Governor's Office of Information Technology is taking the lead on Colorado's FirstNet efforts. While FirstNet's mission is to provide a nationwide network dedicated to public safety, GOIT has recognized that the assets deployed to support FirstNet can be used for other than public safety needs. We recommend the NWCCOG work carefully with regional organizations called on to provide information and support towards the development and deployment of FirstNet. A tendency may exist to perceive public safety broadband needs separately from other broadband needs. The COG should work aggressively to overcome this tendency.

Other publicly funded projects are underway or may happen in the region. The COG should work diligently to coordinate the multiple public projects to ensure the most efficient use of public funds in the region.

Privately funded projects may be harder to influence. However, by working well with incumbent providers, the COG may be able to influence private sector broadband improvement spending and to coordinate it with public projects.

C2 Facilitating interconnectivity between regional middle mile providers to enhance middle mile redundancy throughout the region.

In aggregate, the fiber paths in the region offer good regional egress diversity. Paths exist through Vernal to Salt Lake City, through Rifle to Grand Junction, and along at least two geographically diverse routes to Denver. Taking into consideration microwave links as well, diversity will be added to Cheyenne as well. Unfortunately, route diversity is largely owned by competing network owners and the competing network owners have not come to agreements to create diversity in their disparate networks by carrying each other's traffic.

We recommend working with the various network owners in the region to help them come to agreements to carry each other's traffic. Several of the network owners in the region have expressed an interest in doing so. Failing to get service providers to enter into traffic sharing agreements, towns may pursue carrier neutral locations and create redundancy for themselves. Of course, the utility of a CNL is limited to its subscribers.

C3 Supporting development and execution of local community and county action plans.

This regional plan and its recommendations may have some direct utility for individual member jurisdictions. We believe it is prudent to drive the broadband improvement effort to the local level while providing resources and tools at the regional level. Therefore, member jurisdictions should have local broadband action plans. These plans should be coordinated with one another to ensure efficient broadband development throughout the region.

8.1.1.4 DEPLOYMENT EFFORTS

The COG should build, or cause to be built, broadband infrastructure targeted at providing relief to the greatest need areas, ensuring regional redundancy, enhancing public safety communications, and

lowering barriers preventing private sector expansion or service improvement. Some deployment effort actions may include:

D1 Establishing mechanisms to aggregate demand and by doing so improve service selection and reduce cost.

Middle mile data access prices are typically tiered with the cost per Mbps dropping dramatically as the volume of bandwidth purchased increases. However, Northwest Colorado is a rural area. The data demands an individual county or hospital put on middle mile infrastructure are limited. Disaggregated these customers seldom reach discount thresholds. Aggregating demand can serve to overcome some middle mile cost barriers.

Some demand aggregation mechanisms include carrier neutral locations and local metropolitan area networks.

D2 Prioritizing and implementing targeted infrastructure builds that lower existing barriers preventing private sector broadband companies from providing or improving services using RUS Rural Broadband loans or alternative funding.

For example, Jackson County could probably attract a fixed wireless service provider if middle mile infrastructure costs were reasonable, tower locations were in place, or other infrastructure investments were made to bring the service provider business model within return on investment bounds.

As another example, the middle mile highway infrastructure requires off-ramps in order for it to be regionally valuable. A business case may not exist to develop add/drop points but service providers may be willing to allow them if the capital expense is absorbed by the government. An example of where this might be needed is along Highway 9 between Silverthorne and Kremmling. CenturyLink fiber exists on this route but there are no add/drop points. The regional broadband cooperative might be able to invest in add/drop points and other infrastructure needed to provide cell service and broadband along this route.

The U.S. Department of Agriculture's (USDA) Rural Broadband Loan Program is administered by the Rural Utilities Service (RUS) of USDA Rural Development could be a source of loan funds for these projects. The program funds the costs of construction, improvement, and acquisition of facilities and equipment to provide broadband service to eligible rural areas on a technology-neutral basis. Direct loans are in the form of a cost-of-money loan, a 4-percent loan, or a combination of the two.

D3 Prioritizing and pursuing Community Connect Grants to extend service to currently unserved communities.

The Rural Utility Services Community Connect program serves rural communities where broadband service is least likely to be available, but where it can make a tremendous difference in the quality of life for citizens. The projects funded by these grants will help rural residents tap into the enormous potential of the Internet.

Unserved communities in the region are viable candidates for Community Connect grants. We recommend producing a preliminary cost estimate to bring service to each unserved community and then prioritizing projects based on cost per potential subscriber. As many Community Connect grants should be applied for as matching funds are available for.

8.1.1.5 STRUCTURE

Many of the actions needed to improve broadband in the region require significant effort, multi-jurisdictional coordination, or both. We recommend creating a regional broadband cooperative (a 501(c)(3) or other legal structure) to meet this task load. A regional broadband cooperative may also have the benefit of being a non-governmental agency and thus freed from the restrictions of SB 152.

9 APPENDIX

9.1 SANTA MONICA HIGH VALUE TARGET CASE STUDY

In 2011, Masha Zanger of Broadband Communities Magazine wrote about the City of Santa Monica California' high value target broadband deployment[102]. We provide Zanger's article with highlights and callout boxes to highlight important lessons.

An old joke asks, "How do you eat an elephant?" The answer, of course, is "One bite at a time." Many daunting projects become feasible once they are broken into bite-size pieces. The trick is to make sure that each step along the way produces tangible benefits and that those benefits are applied to the next step in the process.

> When beginning a high value target program, a planned end-state should be envisioned. This will allow development to proceed along a well-thought out path. Future evaluation may adjust the desired end-state but having an end goal in mind sets the context for business decisions.

This is how the city of Santa Monica, Calif., built City Net, its 10 Gbps fiber optic network. Bite by bite, over more than a decade, Santa Monica developed an asset that now provides cost savings and revenue for the city and other public agencies, offers cost savings and competitive advantages to local businesses, and serves as a powerful economic development tool.

Step 1: Planning

City Net had its origins in the Telecommunications Act of 1996, which held out the promise of telecom competition. Jory Wolf, who was then Santa Monica's information systems manager and is now the CIO, looked forward to the prospect of reducing the city's data access costs. After the act became law, he began a series of discussions with Internet service providers about offering competitive broadband services.

When these companies proved unable to offer affordable data services, the city quickly set up a task force to address the use of public assets for telecommunications, the coordination of city telecom systems and universal access to broadband. The plan was unusually ambitious, encompassing video, data, voice, cable, wireless and other services, including two-way video communications. The needs of public-safety agencies, of such municipal facilities as parks and libraries, and of the Unified Santa Monica–Malibu School District and Santa Monica College were all taken into consideration.

With help from a consultant and a community advisory group, Santa Monica's City Telecommunications Working Group assessed existing infrastructure and needs, evaluated

[102] Zanger, Masha (May 2011). "Santa Monica City Net: How to Grow a Network." Broadband Communities. http://www.bbpmag.com/2011mags/mayjune11/BBC_MayJun11_SantaMonica.pdf.

possible solutions and prepared financial models for several different approaches. In 1998, it issued a telecommunications master plan, which called for an institutional fiber network.

Step 2: Leasing an Institutional Network

When Santa Monica next renewed the franchise of the local cable TV operator, it also agreed to lease from that operator an institutional fiber network that connected 43 city buildings, along with school and college facilities. The city funded the $530,000 in construction costs and shared the operations and maintenance costs with the school district and college.

The leased institutional network went live in 2002 and immediately yielded operational cost savings. By operating the network instead of purchasing bandwidth, the city, school district and college reduced their combined telecom costs to $700,000 from $1.1 million. Within a few years, the annual savings grew to $500,000.

Step 3: Building an Institutional Network

It is important to establish measures so that you know what your savings are and then to set aside the savings for future network development.

The city used these savings to build its own 10 Gbps municipal fiber optic network, using Metro Ethernet equipment from MRV. The network made possible a variety of new, high-bandwidth municipal applications, including traffic surveillance, traffic signal synchronization, real-time parking advisories, real-time mass transit signs and security cameras.

In addition, the city upgraded its own Internet connection to 1 Gbps and installed a 10 Gbps connection to an offsite data center.

Although the original leased network was reserved for municipal use, the city-owned network had no such restrictions. The city was now free to lease excess fiber to private organizations.

Of course, neither the incumbent cable operator nor Verizon operate an open access infrastructure.

By this time, the residential sector was reasonably well served by the incumbent cable operator, and, as a result of the city's encouragement, Verizon was also building out its FiOS network in Santa Monica. (Today, FiOS service is available to about two-thirds of residences.)

However, the city's business community still had no affordable ultra-high-speed access. Bandwidth of 100 Mbps cost about $3,500 per month, and the city was concerned about making business broadband more affordable. Wolf says, "We wanted to create the concept of a 'tech coast,' so we had to do something to address the cost of broadband."

Step 4: Leasing Dark Fiber to Businesses

In 2006, the city began leasing its excess dark fiber to local businesses. Because the monthly fees were low, businesses that needed the dark fiber were willing to fund the cost of building fiber from the backbone to their buildings, thus extending the network at no cost to the city.

The city was able to attract a dozen customers to its dark-fiber offering through word of mouth alone. These customers – mainly businesses with 2,000 or more employees – needed point-to-point connections between multiple offices in Santa Monica. To connect outside the city, they partnered with third-party providers to get them to the nearest Internet point of presence.

These point-to-point connections receive no benefit from access to the carrier hotel.
Access to the carrier hotel makes more third party providers available to the businesses.

However, the dark-fiber offering was less attractive to smaller and mid-sized businesses. At the end of 2008, the city surveyed more than 3,000 businesses located within 200 feet of the backbone to find out whether they could also benefit from access to city fiber. The responses indicated that Santa Monica's businesses were not well served by private telecom companies. The great majority of survey respondents either could not afford or did not have access to the amount of bandwidth they required. Of the few that had adequate bandwidth, most were unhappy with the quality of service they received.

Despite their unmet needs, these businesses did not avail themselves of the city's dark fiber offer both because 10 Gbps service was more than they needed and because connecting to the local Internet point of presence on their own was expensive. Most of them were looking for ready-made Internet connectivity at speeds between 100 Mbps to 1 Gbps, and they requested that the city provide such service.

Step 5: Providing Internet Bandwidth

In 2009, the city decided to make an additional investment to accommodate these businesses. "We looked at lit services to provide an affordable way to multiplex broadband into the community, hook up with ISPs and get wholesale rates," Wolf explains.

To be able to provide Internet access to businesses, the city leased a fiber connection from City Net to One Wilshire, a major colocation center in Los Angeles in which about 270 Internet providers interconnect their networks. Obtaining Internet access at a major carrier hotel such as One Wilshire is much less expensive than connecting at a local point of presence.

However, leasing the 15-mile line to Los Angeles proved to be a challenge. Service providers were initially reluctant to provide transport, knowing that the city planned to make services available to local businesses – they believed they would effectively cannibalize their own commercial offerings in Santa Monica. After extensive negotiations, one company agreed to provide transport.

Step 6: Marketing Internet Services

With all these pieces in place, the city was able to begin offering Internet access to local businesses. Rather than continuing to rely only on word of mouth, it began advertising on the sides of buses, getting the word out through the Chamber of Commerce, talking with real estate brokerage companies and property management companies, and even using social networking sites such as Twitter and Facebook.

To make broadband more affordable, the city decided to keep its offerings simple – 100 Mbps, 1 Gbps or 10 Gbps, with standardized contract terms – and it dispensed with service-level agreements, counting on the inherent reliability of fiber to provide sufficient uptime. At first, the city advised customers to secure separate, secondary paths, but City Net now has enough redundant connections of its own that this is no longer necessary. (In the last several years, a number of other fiber network operators have also begun to sell business services without service-level agreements, on the grounds that a well-designed and well-run fiber network provides enough reliability for most businesses.)

Alternatively, service-level agreements can function as a revenue generating add-on product.

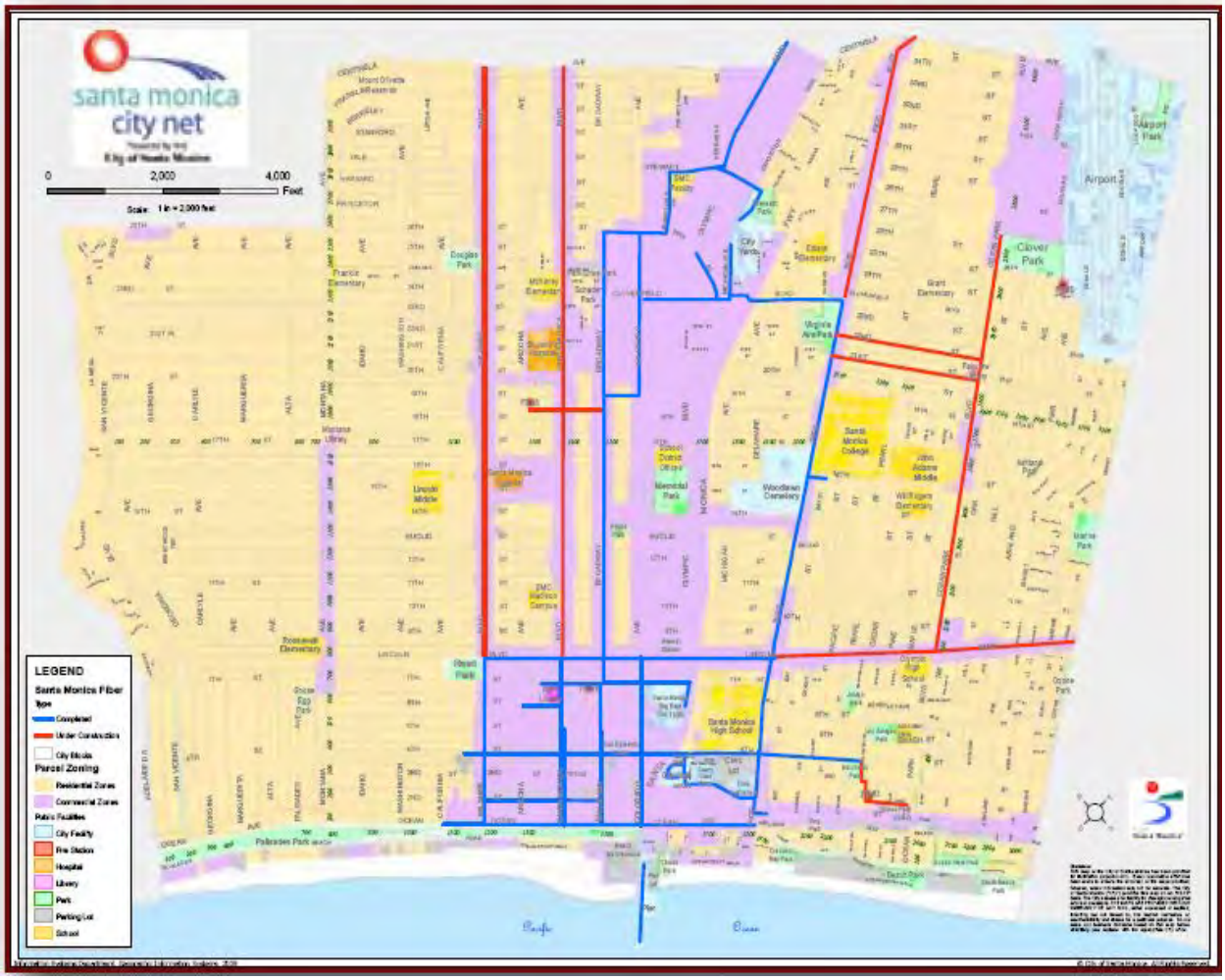


Figure 30 - Santa Monica City Net

The city's web site lists 19 on-net commercial buildings. Based on the size of the network build as depicted in "Figure 23 - Santa Monica City Net" and a review of Google Earth of Santa Monica, 19 commercial buildings is not "most"

Today, most large commercial parks and multitenant commercial buildings in Santa Monica are connected to the network. Thanks to low Internet connection costs and simple contracts, business customers of City Net typically obtain 10 times the broadband speed for about the same price they once paid for non-fiber services. The 100 Mbps connection that once cost $3,500 per month now costs about $500 per month. A measure of City Net's success is that it has had 100 percent customer retention.

Though the city provides Internet access directly, it also makes the network available to third-party providers on an open-access basis. "The incumbents have chosen not to use our assets," Wolf says, explaining that larger providers are often reluctant to operate over networks where they cannot control the user experience and that their marketing and support organizations are not geared to using other companies' networks.

However, other ISPs have shown interest in the network now that it is becoming successful. Currently, two ISPs offer services generally over the network, and other ISPs serve the Santa Monica offices of businesses that they deal with in other locations. Wolf says, "We have the opportunity to handle the business any way they prefer. … We're not an obstacle; we're an enabler. We don't see ourselves as competitors, but as filling a void."

City Net's revenue from current business customers totals about $300,000 per year, enough to fund network operations and maintenance and to support an extensive system of free Wi-Fi hot spots throughout the city. Wi-Fi is now available at parks, beaches, libraries, public buildings and other open-space areas. On any given day, about 2,000 of Santa Monica's 87,000 residents use the 27 Wi-Fi hot spots.

The city also has $190,000 of its capital funds remaining, which it uses as a revolving capital improvement project account. This account funds construction for network expansion, which is repaid by customers as the network is extended to their premises.

Lower incumbent network prices is a likely result of public broadband initiatives.

An indirect benefit of City Net is that it has forced competing networks to lower their prices. Wolf's office estimates that nonparticipating providers have lowered their bandwidth prices by 20 percent or more, making bandwidth generally more affordable throughout the city. "If that's all we had accomplished, we'd feel that we'd done what we intended," Wolf says.

Step 7: Expanding the Network

City Net's footprint today is still only about 60 percent of its planned total. Wolf says, "We're continually expanding, running fiber all through the downtown area, and lighting up the major

transit corridors and commercial corridors – every commercial corridor will have fiber. We'll have Phase 5 completed in about 10 months."

Not only do businesses pay for the fiber network to be extended and connected to their premises – which is unusual enough in the United States – but they also return these network additions to the city. Typically, a business can recoup the up-front fee in the form of lower monthly telecom costs within two to three years.

Potential business customers aren't the only entities that request City Net connections; property managers and brokers also pay to connect their buildings to the network because these connections help them market their properties. Once a commercial building is on the network, whoever paid for the connection – whether tenant or owner – can negotiate with other potential customers in the building to share the access.

Wolf explains, "I believe strongly that businesses want to know what it's going to cost them. This way they know, and they understand the differentiation between total and ongoing bandwidth costs. … It makes it more cost-effective to continue to expand to other customers."

The downside of requiring customers to pay for their own connections is that some potential customers cannot afford the up-front fee. The network would certainly grow more quickly if the city paid for the connections. In addition, some residential neighborhoods that do not have fiber access would like to connect to City Net – but again, most residents cannot pay for their own connections. Santa Monica applied for a broadband stimulus grant to enable it to pay for network expansions but did not receive it, so the policy of expanding the network based on demand will remain for the foreseeable future.

Economic Development

Making broadband access affordable is beginning to pay off in terms of economic development, as the city had hoped. As an upscale beach city, Santa Monica is an inherently desirable location, but high rents deter some businesses from operating there. By offsetting the high rents, low broadband costs make it possible for more businesses to locate in the city. [It's nice to say, but is there any evidence it is happening?]

In addition, existing businesses have found ways to compete more effectively. For example, the Fairmont Hotel Santa Monica, a historic luxury hotel on the ocean, now offers 100 Mbps broadband to guests and has repositioned itself as a tech-friendly hotel suitable for technology conventions and media production. Directors of films that are shooting in Los Angeles can stay at the Fairmont, receive daily footage via the Internet at the end of each day, review the footage and then forward approved sequences to studios and postproduction companies – a far more efficient procedure than the standard method of copying dailies to hard drives and sending the hard drives by courier to studios and by leased private jet to postproduction facilities.

A similar service is provided by Sohonet, an international private network operator that offers connectivity to film producers on an as-needed, project basis. Sohonet uses dark fiber on Santa Monica City Net to connect postproduction facilities in Santa Monica with studios and film locations worldwide.

The UCLA Santa Monica Medical Center has implemented a telemedicine initiative that involved hiring 180 software developers in Santa Monica. The medical center not only connects its main site to its data facility and satellite clinics, but also works with U.S. military services to offer telemedicine and virtual surgical procedures to troops stationed abroad. The medical center has also become 100-percent paperless for employee records, billing information and medical imaging, and it provides high-speed access to patients and their families in hospital rooms.

How Many Santa Monicas?

Santa Monica's City Net has received recognition in the local and national press and garnered prestigious awards from the Public Technology Institute and Harvard's Kennedy School of Government. Its success inspired the nearby cities of Burbank and Long Beach to launch similar projects, and the three cities are now considering developing a regional network to enable high-speed data exchange throughout the West Los Angeles region. The regional network would be used first by the city governments for collaborative IT projects and public-safety communications. Later, it would be made available to businesses to facilitate regional communications among their offices and with their customers and suppliers.

Santa Monica has also consulted with other cities that are interested in learning from its experiences. Wolf believes the model is replicable in many other cities but not everywhere. Santa Monica's business model is most likely to succeed in cities whose municipal buildings are located reasonably close to one another and that are within about 50 miles of global data centers with access to competitive broadband options.

In places where the model works, Wolf says, city governments should study it as an economic development strategy. "Businesses are community stakeholders," he points out. With a system such as City Net, "the community wins, residents win and businesses win."

9.2 PRINCIPAL ASSUMPTION AND REPAYMENT PROGRAM (PARP)

The Live Oak Group has created a life settlement contract investment model that assumes project principal payments. Following is a description of the PARP process.

Summary Contents

- Live Oak Group, LLC – who we are
- Life Settlement Contracts – what they are and what they are not
- Live Oak Principal Assumption Repayment Program – overview & example
    - Phase 1: Approval and acceptance
    - Phase 2: Irrevocable Trust established and funds distributed

- Phase 3: Administration and payments
- Phase 4: Completion of loan agreement and trust assets disbursed

Live Oak Group, LLC

Live Oak Group, LLC is a consulting firm which assists companies in achieving their acquisition of commercial loans. In the current economic environment, both lenders and borrowers have need of loan programs to be available but changes in the lending environment have made that difficult. Live Oak is not a lender, nor does it directly assist in the finding of lenders, but it facilitates the completion of loan transactions.

Live Oak Group, LLC uses Life Settlement Contracts (LSCs), a time proven life insurance product, in a new methodology to bridge the requirement gap between a lender's desire, ability and risk acceptance to fund a credit facility and the borrower's need to qualify for more cost effective large commercial loans. Live Oak offers the commercial lender a virtually risk free structured loan transaction known as the Live Oak Principal Assumption and Repayment Program (PARP). PARP is structured within an irrevocable trust for the protection of all parties.

Life Settlement Contracts

About 1990, the investment community considered the proposition that there was investment value in Life Insurance policies. It was believed that if a person has excess insurance, those insurance policies could be sold by the insured at a discount from the face amount. This opportunity might arise, for example, when policies which may have been required by a lender for credit were no longer needed or the policy holder had a need for immediate cash. The thinking of these investors was that if these policies were purchased from the insured and the policies were maintained until the death benefit was paid, a better than average return on investment could be realized. As a result, a new industry was born and this new investment product was called a Viatical Settlement. Unfortunately, as this type of investment grew in popularity, regulators became aware that unscrupulous investors were abusing the insured, especially the terminally ill and the aged. For example, many AIDS patients were taken advantage of by these criminals. Because of these abuses, the viatical business earned a well deserved bad reputation and was regulated to a standstill and is illegal in most states.

Legitimate financial institutions and investors, however, still wanted to provide a method by which insureds could liquidate their unwanted life insurance policies. Through properly regulated industry controls, the business of legitimately purchasing life insurance policies was renamed to **Life Settlement Contracts** and the participants created a set of rules to govern the industry so that the abuses of the past would not happen in the future. The industry created a very strong, self regulation, training and education association called the Life Insurance Settlement Association (www.thevoiceoftheindustry.com) to which most reputable businesses in the Life Settlement industry belong and adhere to their business practices guidelines. Some of the major players in the Life Settlement Contract industry are Berkshire Hathaway, Wells Fargo Bank and Credit Suisse.

As indicated, the Life Settlement business has grown in popularity and now includes some of the largest banks, insurance companies and investment firms in the world. The LSCs are structured to make sure the insured has a full and complete understanding of the process. Each LSC is completely documented to maintain the integrity of the instrument and make sure they are investment grade. The documents include complete information on the insured and all heirs, complete medical information including current doctor, acknowledgment from the insurance company of the transfer of ownership and other corresponding documents. Typically, a life settlement contact is a 60 to 70 page package of documents including the policy itself.

The Life Settlement Contract industry is now a healthy and thriving multi-hundred billion dollar industry that Live Oak Group is proud to be a part of.

The Principal Assumption and Repayment Program (PARP) Process

The PARP process is not a tool for capital sources to make bad loans or to qualify bad projects. As part of the loan process, each potential borrower's needs are carefully reviewed by the potential lender in the underwriting process to determine suitability of the project and the borrower's position to the loan being considered. The PARP is based upon increasing the loan approximately 50% of the net to the borrower to purchase and maintain the LSCs. Whether the borrower's financial position needs strengthening or not, PARP offers the borrower additional asset value and income to assist in completing and servicing the loan and to the lender, security that the principal will be returned.

As stated, there are significant benefits to both the lender and the borrower using the PARP. The borrower receives the added strength of LSCs to support his fund request and relieve him from the principal repayment. The lender is more protected from exposure to market fluctuations since the principal is protected by PARP and not the borrower. For example, consider the factors listed in the table below for a $67,000,000 net to the borrower transaction:

Net Proceeds to the Borrower	$63,500,000
Gross Loan Amount	$100,000,000
Loan Term	13 years
Principal Payments Paid through PARP	Monthly beginning in the 39th month
Interest Rate	6%
Total Interest Paid by Borrower	$50,526,830
Total Fees Paid by Borrower	$12,701,707
Initial Face Value of Life Settlement Contracts	$167,000,000
Trust Average Cash on Hand to Pay Principal	$12,646,239

With the implementation of PARP in structured financing, there is virtually no risk to the lender regarding return of principal. To the lender's benefit, PARP begins making monthly principal payments in the 39th month rather than a single balloon payment at the end of the term, as in typical structured financing programs. Revenue to the lender is higher since the interest is charged on the entire amount going into the trust ($100,000,000) rather than just the amount the borrower would receive

($63,500,000) in traditional funding. Additionally, funds are continuously available from PARP to make the principal payments.

The implementation and operation of PARP works alongside the Lender's normal loan program as described below:

Phase One: Approval and Acceptance

The Lender enhances its loan position by simply adding the Live Oak PARP to its loan procedure as follows:

1. A premium commercial business loan is presented to Live Oak that is at least $63,500,000, for the project. The Borrower must meet underwriting standards when PARP is used, plus the project must be able to support the interest payments and the third party administrator fees. When the Lender has completed its underwriting and has made the decision to move forward, the Lender issues to the borrower and Live Oak a commitment to fund.
2. **Live Oak Loan Accommodation Agreement**: The Borrower executes this document with Live Oak which delineates:
    a. the Borrower's desire to obtain a credit facility from a specific lender
    b. the purpose of the credit facility
    c. the net loan amount required
    d. the additional funds required to secure the PARP
    e. the general terms of the transaction including interest, accommodation fees and administration fees
    f. closing procedures
    g. fee schedule
    h. general transaction terms and conditions.
3. **Trust Agreement**: The Lender, the Borrower, Live Oak (Third Party Administrator), the Trustee (bank or trust company), the Investment Trustee (Live Oak), and the Custodian of the Assets (bank or trust company) execute the ("Name of Borrower") Irrevocable Principal Assumption and Repayment Program Trust. The purpose of this trust is to:
    a. provide for the Custodian of the Assets (bank or trust company) to take into safe keeping the Life Settlement Contracts and pay for them as well as the ability to distribute to the Lender the return of its initial contribution (gross loan amount)
    b. provide funds for use in the Borrower's business
    c. invest funds received from the Lender for principal protection and repayment
    d. establish the holding period (term), timing of distributions, termination and final distribution of the trust
    e. assign the beneficial rights
    f. create an Investment Sub-Trust
    g. establish the general method of business practices for all parties these transactions.

4. **Funding Agreement**: The Borrower, Lender, Live Oak (Administrator) and the Trustee (trust company or bank) execute the Funding Agreement. This document delineates:
    a. the identity of the Borrower, Lender, Trustee and Live Oak as parties to the agreement
    b. that the funding agreement is created pursuant to the Trust Agreement described above
    c. the appointment of an Escrow Agent
    d. the establishment of the parameters for:
    e. pre-closing Funding
    f. deposits by Lender
    g. deposits by Borrower
    h. deposits by Administrator
    i. deposits by Trustee
    j. actions of Escrow Agent
    k. release of Escrow Agent
    l. general operating conditions of the Funding Agreement.
5. Upon the receipt of a letter of commitment by the Lender, Live Oak requests from the LSC provider a detailed list of the pool of life settlement contracts for analysis. Once a reasonable determination that the listed LSCs meet the requirements of Live Oak and the Lender, no less than $160,000,000 in face value of LSCs are placed in safekeeping with a 3rd party life settlement servicing company for vetting. In this way, Live Oak and the Lender can verify for each individual LSC that:
    a. the insurance company is rated no less than "A" by A.M. Best
    b. the insured is between 76 and 84 years old as per Live Oak's specifications
    c. the ratio of male to female insureds is as Live Oak specifies
    d. all policies have been in force for at least two years
    e. the premium payments on all policies are current
    f. all policy documentation is complete and verified
    g. the policy pool averages no more than $1,500,000 face value per policy.

Phase Two: Distribution

1. Once the LSC pool is approved, verified and fully vetted, the Lender deposits the gross loan amount with the Escrow Agent.
2. The vetted LSCs are purchased by the Escrow Agent and delivered to the Custodian of the Assets.
3. The Lender is made the beneficiary of the LSCs to be held by the Custodian of the Assets.
4. The Escrow Agent distributes $63,500,000 to the borrower, less any direct fees or expenses designated in the Funding Agreement.
5. The Escrow Agent distributes the funds for broker's fees and other specific distributions as designated in the funding agreement.
6. The Escrow Agent distributes the balance of the escrowed funds into the Investment Subtrust for management by the 3rd Party Administrator.

Phase Three: Administration

1. A portion of the funds are assigned to provide for premium payments and to service the LSCs. These designated funds are not available to Live Oak for operations or other purposes until the loan has been paid off or the funds and LSCs deposited are in excess of the outstanding loan balance and there is sufficient cash on hand to secure twelve months premium payments, note payments and service the LSC's for one year.
2. The funds maintained in the Subtrust are supplemented as benefits payments are received from the Life Settlement Contracts. These funds are used as follows:
    a. pay the policy premiums as required by the individual policies
    b. beginning in the 39th month, pay monthly principal payments for the loan based on a 118 month amortization (13 year total term)
    c. purchase additional LSCs as existing LSCs mature to ensure that the minimum face value of the policies held always meets or exceeds the current principal balance.
    d. pay administrative and operational expenses.
3. The administration of the LSCs is subject to an annual independent actuarial audit and verification directed by the 3rd Party Administrator to ensure that the face value of the LSCs always is equal to or greater than the unpaid principal balance.

Phase Four: Final Distribution

Pursuant to the terms agreed to by the Lender, Borrower and Live Oak, after the lender has received 100% of its principal contribution, any remaining funds and/or assets held in the Trust or Subtrust will be distributed pursuant to the instructions of the 3rd Party Administrator and the trust is terminated.

9.3 SURVEY RESULTS

We use three surveys as data sets for development of this regional broadband strategic plan:

4. 2010-2011 Statewide School Survey
5. 2011 Grand County Survey Partial Results
6. NWCCOG Online Survey

9.3.1 2010-2011 STATEWIDE SCHOOL SURVEY

Down	Up	School	School District
2.76	2.6	Red Canyon High (Eagle)	Eagle County
8.27	6.7	Edwards Elementary	Eagle County RE50J
7.97	6.8	Edwards Elementary	Eagle County RE50J
7.81	6.8	Battle Mountain High School	Eagle County School District
7.69	5.7	Brush Creek Elementary School	Eagle County School District
4.87	7.1	Eagle Valley Elementary School	Eagle County School District
2.97	2.6	Eagle Valley High School	Eagle County School District
1.88	0.2	Eagle Valley High School	Eagle County School District

2.87	3.9	June Creek Elementary	Eagle County School District
6.52	6.6	Avon Elementary School	Eagle County Schools
11.6	7.6	Eage Valley Middle School	Eagle County Schools
5.97	5.4	GCM	Eagle County Schools
8.61	7.5	Gypsum Creek Middle	Eagle County Schools
8.62	3.9	Gypsum Elementary	Eagle County Schools
5.8	3.9	Red Sandstone Elementary	Eagle County Schools
8.06	7.6	Redhill Elementary	Eagle County Schools
34.4	7.3	3rd Street Office	Eagle County Schools RE-50
44.2	4.2	East Grand Middle School	East Grand #2
1.47	1.4	Fraser Valley Elementary	East Grand #2
21.8	4.5	Granby Elementary	East Grand #2
1.5	1.3	Grand Lake Elementary	East Grand #2
1.09	1.4	Grand Lake Elementary	East Grand #2
93	4.8	Middle Park High School	East Grand #2
97.1	20	Middle Park High School	East Grand School District
1.9	1.4	Administration Building	Garfield County 16
5.79	5.9	Meeker Elem	Meeker
19.4	8.5	Meeker Elementary	Meeker School District
9.15	4.3	Sunset Elementary	Moffat County
10.4	6.6	East Elementary	Moffat County RE1
11.3	6.7	Craig Middle School	Moffat County RE-1
7.44	4.4	East Elementary	Moffat County Sch. Dist RE 1
0.25	0.1	Maybell Elementary	Moffat County School District
5.84	3.5	Moffat County High School	Moffat County School District
6.3	4.8	Qwest	Moffat County School District
7.37	5.8	Ridgeview Elementary School	Moffat County School District RE 2
9.02	5.9	District Admin Building	Moffat County School District RE:1
0.25	0.1	Maybell Elementary School in Maybell, Colorado	Moffat School District
2.21	2.3	North Park Jr./Sr. High School	North Park
2.54	1.6	Vocational Education Building	North Park
2.03	2.8	Walden Elementary	North Park
0.96	0.8	North Park High School	North Park School District
2.89	2.5	North Park School District	North Park School District
9.84	7.3	RJSHS	RAngely Public Schools RE-4
9.6	7.9	RJSHS	Rangely School District RE-4
4.71	1.5	McKinley	RE-1
5.71	5.3	Meeker Highschool	Re-1
5.62	5.4	Meeker Middle School	RE-1
10.3	1.8	Skyline Elem.	Re-1
3.74	1.9	Admin Office	South Routt School District

3	2	Elementary	South Routt School District
4	2	High School	South Routt School District
4	2	Middle School	South Routt School District
25.6	4	District Office	Steamboat school District
25.8	4.1	admin bldg	Steamboat Springs
1.05	1.4	dillon valley elementary	summit
0.59	0.1	Summit Cove Elementary	Summit
1.21	1.3	Frisco Elementary	Summit RE 1
0.91	1.2	Silverthorne Elementary	Summit RE-1
0.96	1.4	breckenridge elem	summit school dist
1.09	1.4	Breckenridge elem	summit school dist
15.3	6.9	Summit High School	Summit School District
0.96	1.4	Upper Blue Elementary School	Summit School District
2.94	2.2	PK8	West Grand School District
10.1	**4.1**	**Average**	

Table 20: 2010-2011 Statewide School Survey Northwest Colorado Results

9.3.2 2011 GRAND COUNTY SURVEY PARTIAL RESULTS

Download Speed (Mbps)	Upload Speed (Mbps)	Comments
Fraser		
1.39	0.21	
2.81	2.1	For the staff network in the library, Mammoth aggregates two 1.5 Mbps connections. Marmot Library Network just entered a 3-year contract on our behalf for this service.
12	2	
5.43	3.49	Four 1.5 Mbps connections aggregated by Mammoth Networks for the Marmot Library Network. Just entered 3 year contract.
5.41	**1.95**	**Fraser Average**
Granby		
1.32	0.13	Would like to upgrade internet service so we could take advantage of more applications.
1.5	0.71	
1.39	0.24	
0.523	0.058	There is no cable service where we live ten miles North of Granby.
4.46	0.24	Would sure like a way to have faster internet speeds for our business and home use in the rural areas between towns in Grand County. Thanks.
4.18	4.59	

Download Speed (Mbps)	Upload Speed (Mbps)	Comments
1.3	0.74	Greater speed is needed to support our downloading of GIS generated files to and from our Wyoming office. We would welcome the availability of broadband service and greater speed.
22.77	5.27	
22.35	5.01	The monthly fee includes cable TV & internet
4.7	4.46	
29.87	8.19	
33.33	5.11	
6.09	0.45	
5.83	0.51	
3.56	0.31	
9.54	**2.40**	**Granby Average**
Grand Lake		
26.36	14.48	
0.7	0.72	I had been using a line of sight wireless for Internet connection and just had to switch to Verizon because his antenna was destroyed. I had to commit to a 1-year contract with Verizon. I would be very interested in another option for Internet connectivity. However, I cannot leave Verizon for another 11 months.
0.85	0.75	We can only get connected by radio waves.
0.86	0.27	
17.61	4.39	
1.49	0.55	This is the _only_ broadband available in this area. The issue with wireless-carrier broadband is that when people from the Front Range come up with their smart phones on the weekends (starting with Friday afternoons), service degrades severely. Download speeds drop from 1.5Mbps to as low as 26Kbps!, and my connections drop frequently. (Note that I work from home for a computer company on the Front Range, and use a VPN to connect remotely.)
7.98	**3.53**	**Grand Lake Average**
Hot Sulphur Springs		
10.45	6.1	
10.45	**6.10**	**Hot Sulphur Springs Average**
Kremmling		
0.62	0.16	Would gladly pay $100/mo for a "real" connection.
0.04	0.03	
0.02	0.03	We have fiber optic lines in place that were installed by QWEST. Someone paid for those lines to be put into the ground. It seems like a huge waste of money for the past subscribers of QWEST who paid for these unused lines.
0.63	0.24	
0.02	0.33	
0.018	0.3	crawling along in Old Park :)
3.86	0.49	
1.04	0.13	There is fiber optic cable laid by US West at the end of my driveway that runs all the way into Kremmling. I would love to see that cable lit.
0.46	0.37	We have fiber lines everywhere but they are not connected- please help.

Download Speed (Mbps)	Upload Speed (Mbps)	Comments
0.02	0.31	
2.64	0.2	
1.19	0.05	With Satellite our usage is capped at 17 G/month which is sufficient, but limiting and very expensive especially considering the limitations. We would much rather have a broadband connection that was not as limited, operated at higher speeds and not weather dependent.
5.84	0.75	
1.5	0.08	
1.94	1.88	
1.57	0.12	This internet is so slow and we have no other options. We are both taking classes online and the internet makes it near impossible.
1.38	0.75	
1.13	0.09	Very interested in acquiring broadband service. We operate a small B&B and llama trekking business, and it would be great to be able to get faster operating speeds for these LLCs.
0.256	0.128	
2,87	2.73	
0.55	0.06	I am not sure how much bandwidth or speed I am allotted each month. At the bottom of my e-mail page it says "currently using 1189 MB of your 7561MB". That may be the number the blank questions is looking for.
0	0	We do not have Internet service. We used to have WildBlue service, but their customer service was awful and we cancelled them. Currently looking for service.
0.59	0.03	
0.59	0.03	How secure would this new system be?
0.25	1.2	
0.023	0.023	we cannot get broadband up here. even if we could not get broadband, cellular would work but we need more towers.
1.05	**0.40**	**Kremmling Average**
Silverthorne		
4.01	3.21	
4.01	**3.21**	**Silverthorne Average**
Tabernash		
2.05	1.91	Our HOA is considering asking Comcast to come into the subdivision, but if there is an alternative, we would like to know about it. We desperately need faster service.
1.42	0.45	Our internet speeds are typically between 1 and 1.5 Mbps for downloading. Very slow -Manager TMWSD
1.74	**1.18**	**Tabernash Average**
Winter Park		
20.67	6.43	
20.04	3.61	
1.37	0.68	
1.61	0.72	
10.92	**2.86**	**Winter Park Average**
5.18	**1.67**	**Overall Average**

Table 21: Grand County Survey Partial Results

9.3.3 NWCCOG ONLINE SURVEY

Beginning in June of 2013, the NWCCOG conducted an online survey available at http://www.ohivey.com/test/introduction.php. The survey hoped to gather information about residential and business Internet use and satisfaction in the region as well as to collect information regarding potential broadband improvements.

Speed test results are provided below in the "TestMy.Net" section.

9.4 TESTMY.NET

TestMy.Net is an independent speed test service that uses file transfers to determine actual bandwidth.

9.4.1 TESTMY.NET SERVER DATA

An analysis of TestMy.Net data for 23 August 2013 shows tests have initiated from 250 identified Colorado localities. Of these, 149 have 25 tests or more. Aggregating these tests by county provides the following results:

		Average:	6.86	1.67
	Towns	Tests	Down Mbps	Up Mbps
Crowley	1	26	1.20	0.56
Huerfano	1	89	2.10	0.53
Conejos	1	248	2.30	0.43
Dolores	1	211	2.30	0.34
Yuma	2	82	2.55	0.28
Ouray	1	53	2.80	1.10
Bent	1	50	2.90	0.43
San Miguel	2	325	2.95	1.22
Otero	3	379	2.98	0.63
La Plata	4	3397	3.05	3.02
Alamosa	2	1293	3.20	0.73
Hinsdale	1	26	3.20	0.34
Rio Blanco	**1**	**73**	**3.20**	**0.61**
Kit Carson	2	224	3.30	0.33
Washington	1	102	3.40	0.46
Delta	3	307	3.47	1.24
Saguache	1	600	3.50	1.10
Moffat	**1**	**416**	**3.70**	**1.20**
Baca	1	65	3.80	0.89

		Average:	6.86	1.67
	Towns	Tests	Down Mbps	Up Mbps
Phillips	1	56	3.80	1.80
Gunnison	2	311	4.15	0.93
Custer	2	623	4.30	0.74
Mesa	5	981	4.40	1.26
Costilla	1	701	4.50	0.56
Archuleta	1	991	4.60	7.70
Logan	1	92	4.70	1.50
Montrose	1	417	4.70	2.70
Park	4	905	4.78	0.68
Chaffee	2	431	4.80	0.96
Morgan	2	102	5.25	1.01
Fremont	3	684	5.33	0.85
Teller	2	1556	5.35	0.93
Elbert	2	654	5.40	1.25
Rio Grande	3	243	5.83	3.47
Pueblo	2	1112	6.99	1.43
Montezuma	2	236	7.95	2.85
Lake	1	62	8.50	0.46
Eagle	**3**	**1752**	**8.87**	**1.58**
Gilpin	1	429	9.60	0.39
Las Animas	1	833	9.60	3.90
Clear Creek	2	213	9.80	2.15
Summit	**4**	**649**	**10.08**	**2.85**
Pitkin	**3**	**876**	**10.13**	**2.36**
Weld	13	4246	10.81	2.08
Larimer	8	10031	11.64	1.96
Jefferson	6	4773	12.42	2.54
Adams	6	3536	12.72	2.50
Grand	**5**	**301**	**12.88**	**3.24**
El Paso	6	17101	12.88	2.31
Douglas	5	12077	12.90	2.34
Boulder	7	12927	12.93	2.64
Denver	1	30242	13.50	2.50
Routt	**3**	**698**	**14.17**	**4.13**
Garfield	5	1323	14.54	1.92
Broomfield	1	4154	16.20	3.20
Arapahoe	2	39655	17.20	2.65

Table 22: TestMy.Net Colorado County Average Speeds

It should be noted that the location TestMy.Net detects for a given speed test is the location as reported by the Internet service provider. This may cause some tests to be reported as outside the region even though they originate within the region.

9.4.2 SURVEY SPEED TEST DATA

TestMy.Net has constructed a utility that allows the NWCCOG's data analysts to capture TestMy.Net data associated with the COG's online survey respondents. 32 service providers were detected in the testing process. "Table 23: Local Survey TestMy.Net Results by Service Provider and County" compiles download speed test data by county and service provider.

	Carbondale		Eagle		Glenwood Springs		Grand		Jackson	
	Count	Dnld	Count	Dnld	Count	Dnld	Count	Dnld	Count	Dnld
ATT	-		2	10.6	-		3	0.8	-	
Bresnan	-		-		-		-		-	
Cedar	2	54.3	-		-		-		-	
CenturyLink	6	24.7	56	6.7	1	12.0	82	3.2	12	2.6
Comcast	13	23.5	35	26.4	2	5.5	61	17.1	-	
EverWave	-		-		-		-		-	
GSCB	-		-		2	3.0	-		-	
Grand County	-		-		-		23	2.3	-	
Hughes	1	20.0	19	10.7	-		4	9.4	1	
JAB	6	5.5	-		1	4.0	1	15.0	-	
Marmot	-		-		-		5	8.0	-	
None	-		1		1		13		-	
PacketExchange	-		-		-		2	2.3	-	
Resort	-		-		-		-		-	
Roaring Fork	1	28.0	-		3	3.0	-		-	
San Isabel	-		5	6.7	-		-		-	
Sprint	-		-		-		1	1.7	-	
State	1	36.6	1	23.2	3	66.1	2	2.7	-	
Strata	-		-		-		-		-	
Tmobile	-		-		-		2	14.3	-	
Unk	5		55		3		64	3.0	2	
Vail	-		-		-		-		-	
Verizon	2	0.2	1	1.0	2	0.5	42	4.2	3	26.7
WildBlue	3	3.3	2	88.0	1	3.0	8	13.4	2	9.3
Zirkel	-		-		-		-		-	
Other	-		-		1		4	8.6	1	24.0
TOTAL	**40**	**22.3**	**177**	**13.4**	**20**	**18.1**	**317**	**8.0**	**21**	**6.5**

	Moffat		Pitkin		Rio Blanco		Routt		Summit	
	Count	Dnld	Count	Dnld	Count	Dnld	Count	Dnld	Count	Dnld
ATT	-		1	3.8	-		1	1.0	2	2.0
Bresnan	7	7.1	-		-		-		-	
Cedar	-		-		-		-		-	
CenturyLink	2	2.8	41	22.3	16	5.5	2	1.4	34	15.8
Comcast	-		40	16.8	-		5	16.6	141	25.8
EverWave	-		4	1.0	-		-		-	
GSCB	-		-		-		-		-	
Grand County	-		-		-		-		-	
Hughes	-		3	17.4	-		-		3	10.6
JAB	-		4	1.1	-		-		2	1.4
Marmot	-		2	3.7	-		-		-	
None	-		-		-		-		1	
PacketExchange	-		-		-		1	2.3	-	
Resort	-		1		-		4	6.3	6	19.1
Roaring Fork	-		2	48.0	-		-		-	
San Isabel	-		-		-		-		-	
Sprint	-		-		1	1.9	-		-	
State	-		-		-		2	7.6	2	6.6
Strata	2	13.3	-		4	7.0	-		-	
Tmobile	-		-		-		-		-	
Unk	3		28		4	1.0	5		47	17.0
Vail	-		-		-		-		5	5.0
Verizon	-		1	8.0	-		2	0.4	2	3.0
WildBlue	-		1		-		-		6	7.7
Zirkel	-		-		-		5	3.6	-	
Other	-		-		1	5.0	-		7	29.3
TOTAL	**14**	**6.8**	**128**	**18.7**	**26**	**5.3**	**27**	**6.6**	**258**	**21.7**

	Out of Region		Unknown		TOTAL	
	Count	Dnld	Count	Dnld	**Count**	**Dnld**
ATT	-		2	5.1	**11**	**3.6**
Bresnan	-		2	6.4	**9**	**6.9**
Cedar	-		-		**2**	**54.3**
CenturyLink	3	18.1	9	11.4	**264**	**10.0**
Comcast	7	29.1	16	19.0	**320**	**22.3**
EverWave	-		-		**4**	**1.0**
GSCB	-		-		**2**	**3.0**
Grand County	-		-		**23**	**2.3**

	Out of Region		Unknown		TOTAL	
	Count	Dnld	Count	Dnld	Count	Dnld
Hughes	4		-		35	11.8
JAB	1		1	4.0	16	4.5
Marmot	-		-		7	7.3
None	2		2		20	
PacketExchange	-		-		3	2.3
Resort	-		-		11	13.4
Roaring Fork	-		-		6	26.0
San Isabel	-		-		5	6.7
Sprint	-		-		2	1.8
State	3	45.0	1	61.5	15	32.6
Strata	-		1	9.5	7	8.7
Tmobile	-		-		2	14.3
Unk	5		21		242	7.0
Vail	-		-		5	5.0
Verizon	-		-		55	4.2
WildBlue	2	7.2	1		26	14.5
Zirkel	-		-		5	3.6
Other	3	8.9	-		17	19.2
TOTAL	**30**	**24.8**	**56**	**15.6**	**1114**	**14.6**

Table 23: Local Survey TestMy.Net Results by Service Provider and County

For the purpose of data analysis, we divided download speeds into three service tiers (fast, medium, and slow). "Figure 31: Service Tiers by County" compares counties by service tier and "Figure 32: Service Tiers by Service Provider" compares service providers by service tier.

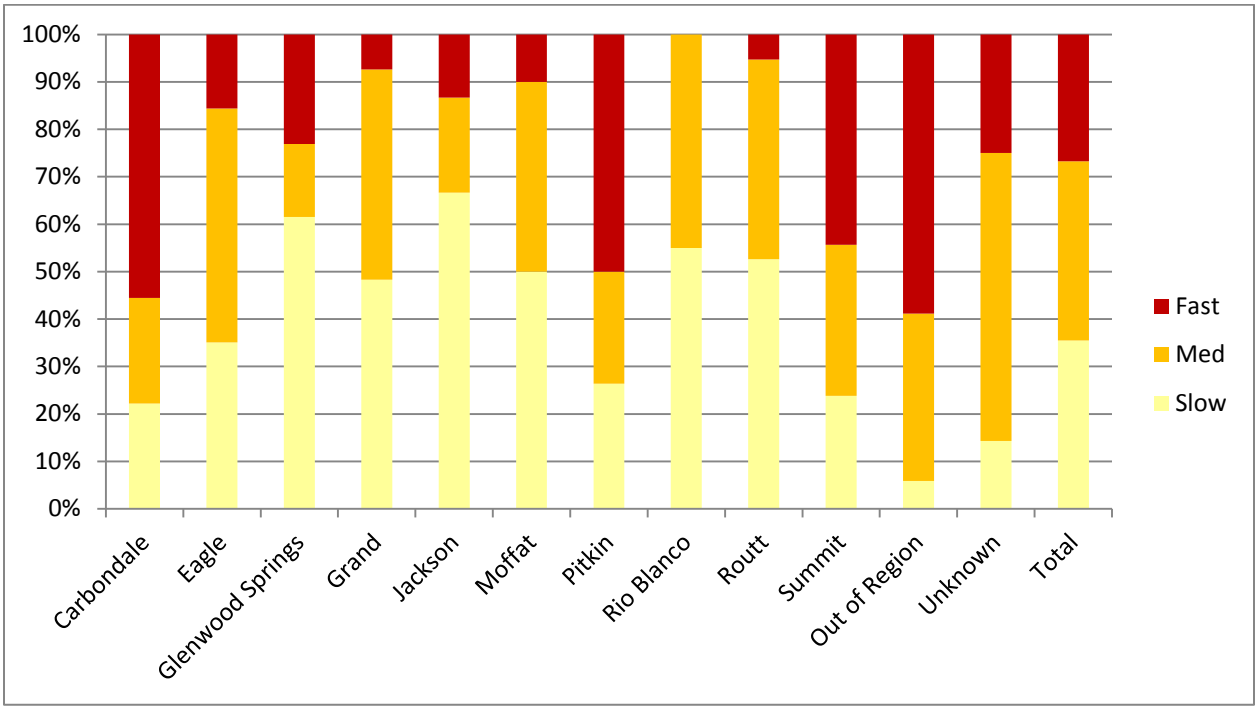


Figure 31: Service Tiers by County

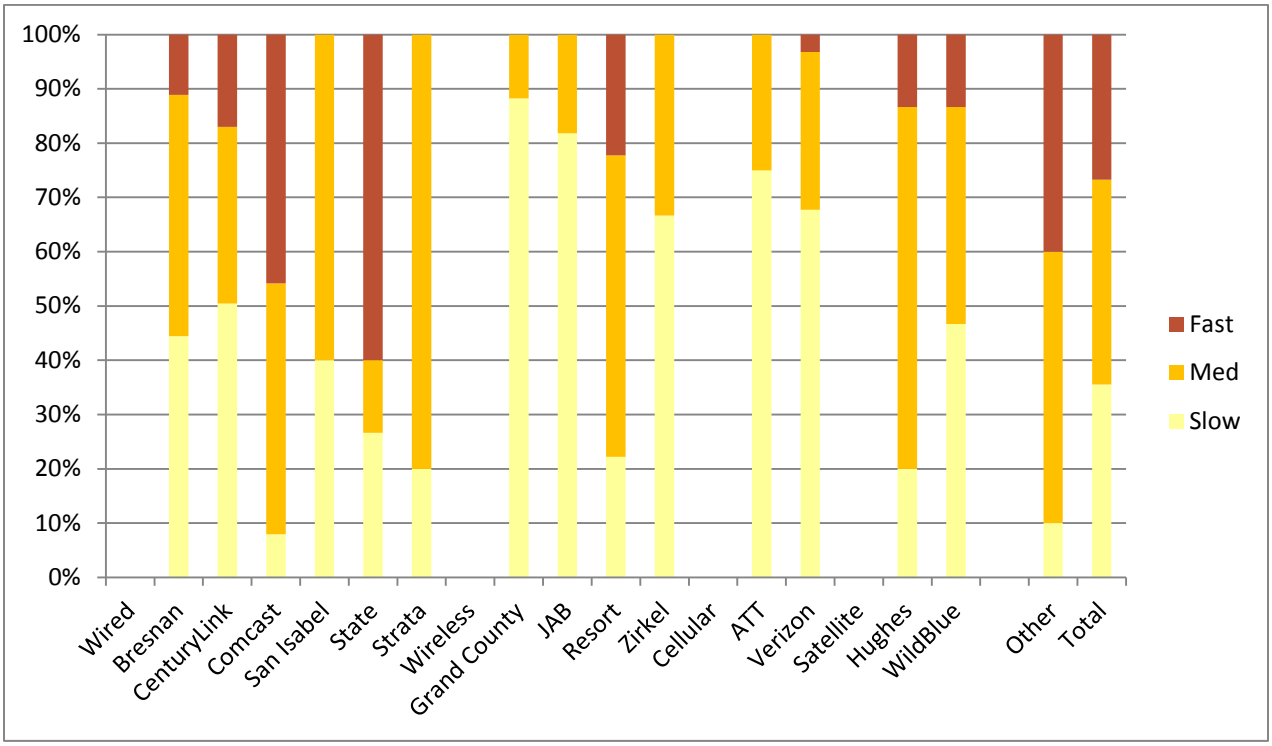


Figure 32: Service Tiers by Service Provider

The survey provided respondents with a set of priority options to evaluate. The priority options asked respondents to rate reliability, cost, speed, user friendliness, service provider choice, single billing, video

conferencing, telecommuting, access to cloud services, streaming media, and VPN services as high priority, medium priority, low priority because it's fine now, low priority because it's an unimportant characteristic, or unsure. "Figure 33: Priority Response Results" depicts priority results for the region.

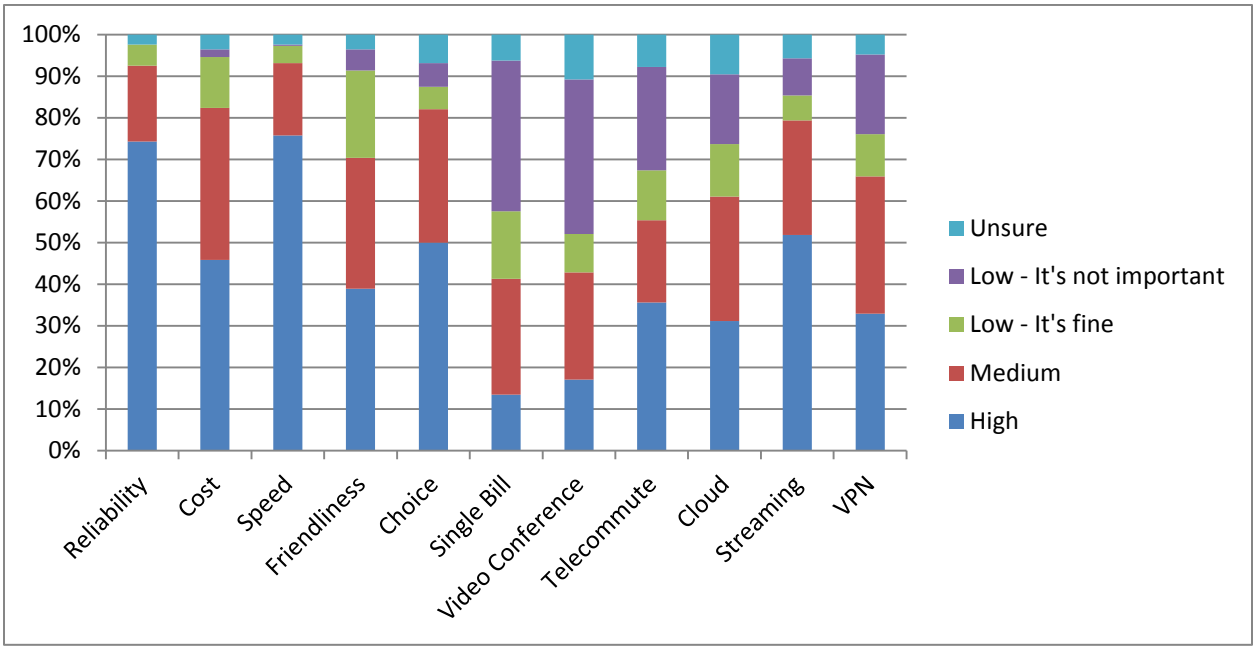


Figure 33: Priority Response Results

The survey instrument also allowed respondents to comment on priority issues. The comments received follow:

County	Comment
Carbondale	The number of choices for a provider are so limited. We would rather have the choice of paying for internet only rather than being forced to pay for basic cable, which we never wanted in the first place. We have tried the other few choices available, but they were very unreliable.
	Reliably provide the speed i am paying for.
	we dont have much of a choice of internet providers where we live which is frustrating.
Eagle	security!
	Being able to contact a service provider without having to go through a long list of buttons to push when you get their service on the telephone line.
	with good, reliable internet we would be able to avail ourselves of many other services others take for granted...cell phone booster to gain cell service, internet phone service, video chatting, streaming music, movies and tv
	satellite service in Red Cliff is intermittent and terrible for the price.
	security. privacy
	Uninterrupted service... often my computer or other device simply stops connecting for 10-20 seconds (I think), and I have to restart downloads or refresh pages or cannot download a video past a certain point.

County	Comment
	Speed is the number one problem that I have. I moved to Eagle from Vail a few years ago, and it's like I live in a different decade in terms of internet speed. I've struggled with getting equivalent service out of Centurylink that I did from Comcast in both my home in Eagle and my business in Edwards.
	Increase speed, provide cell service
	friendly polite customer service-HIGH!
	Reliability of internet goes hand in hand with power (Xcel here). Power reliability is poor. Internet has improved greatly but still not good. Real competition would be meaningful. Also we need real infrastructre for schools.
Glenwood Springs	Getting service high we live 200 feet off a major highway and we dont have access to the internet (except satelite), we run three computers, three i phones and two x boxs at any given time and the provider we have has slowed down their service because we use to much and the top monthly plan they have is $160 a month with 5g we get better service in our weekend home with TDS which is in the middle of no where delta county and in the mountains Unlimited $50 a month. We need better service so that my mother and I can work from home (right now we are unable to work form home due to slow connections) and my husband and daughter to do on line schooling. (college and high school credits. getting any service would be a god send!!
	Speaking for many neighbors here in No Name outside Glenwood Springs, many of us are frustrated by the lack of internet options as well as oftentimes speeds and reliability. There is fiber running along Interstate 70 that for us is maybe 100 yards away and for many, much closer. Also there is no DSL or cable service even though there are 60+ households in our area, not counting rental units (probably another 25-30 additional units) or the large commercial entity, Glenwood Canyon Resorts. Seems like there are opportunities here that are not being met. Also our community water system is dependent on telemetry and unfortunately our only option is copper wire which has had reliability issues.
	Our main priority is to actually get someone to provide internet service to the house.
Grand	Reliability, I have to maintain two means to access the internet. I have Verizon WiFi which is reliable but has a monthly cap that doesn't meet my needs, I have a Comcast account which is more economical but very unreliable and their tech service is very poor. They cannot maintain service when during temperature fluctuations due to there infrastructure. These are the only two options I have for access at my location.
	You've done a great job of listing the important things!
	Impacts to cable service, on-demand movies are not always displayed in good quality, especially on friady's and weekends
	Better upload speeds would alow me to bring Moore business to the valley
	I would like to have some kind of wired internet service available. At this time we do not have access to cable or DSL at all. We use a Verizon hotspot that limits the data we can use (before charging us extra). It looks like we will be able to get satellite internet soon, but that comes with limited data. It is very important to me to have a service like Comcast cable or CenturyLink DSL that does not charge more if we use more data.

County	Comment
	While i currently live in an area where getting access to a hard line internet connection is possible i didn't used to and having to use wireless broadband or satellite really wasn't much of an option because of the associated data caps placed on those services. i would like to see more hard line availability whether it be cable, dsl, whatever
	My biggest problem with Internet is using my "smart" phone (verizon). I usually have only 1 bar of 3G and often don't have 3G at all. It's very frustrating, especially given the high cost of the service. My service at home through Centurylink could be faster but at least it is reliable. If my Verizon service was up to par I wouldn't need home Internet since I have a "hot spot" box from Verizon. I needed this for work when I'm in other counties - it works great in Eagle, Summit and the Front Range.
	The reliability of free WiFi that we provide to our lodging guests is sporadic. We hwve spent over $2500 in the last 2 years to optimize it, but people still often have trouble. It sometimes means they don't stay as planned.
	currently have 2 wireless laptop connections, one ipad connection and 2 smartphone connections but this significantly reduces speed
	Bandwidth - connecting to my office requires it
	Connectivity. Get dropped a lot and have to start over.
	Just having internet would be nice.
	I am not thinking of more options either until the next big leap in technology
	We need internet service in Winter Park Highlands Colorado.
	ability to handle higher usage during weekends and holidays. I have noticed my download speeds are slower during these times.
	Non-metered (unlimited) download. We utilize Hughes Net as well as Verizon, both of which are metered and can get expensive if we do not watch the usage.
	Reliability - with satellite and mobile wireless, there are frequent outages due to weather conditions. I use a VPN connection to the office, which further constrains bandwidth. Another issue with mobile wireless is limits on number of users on the network. Would like the ability to work permanently at this location.
	Reliability and speed are most important. If we had options other than current wireless (smart phones) and satellite, they would be more competitive.
	The signal providers have great difficulty finding County Road 4605, since mapping services refer to County Roads as "City Roads", CR 46 has another name of Hughes Road, and CR 4605 has another name of Juniper Road. I can't imagine how bad it would be if I called to report an emergency at my address.
	Better connectivity and speed on weekends. Our Verizon Mifi hardly works on summer weekends. Apparently too many user with not enough broadband space!!
Jackson	none other that I can think of right now
Pitkin	Internet access, access to TV, radio and video, treaming, access to phone and texting, e-mail are all very important to general livability as well as work but should be offered at a reasonable, economical price which it is not at the moment...pehaps I should look into bundling...
	Customer service of provider.

County	Comment
	We are lucky, because we are near enough to CenturyLink's fiber optics broadband service. Before, we had to use satellite service, which was more expensive and less reliable. Lots of people in our valley can't get either, so there is a definite need for greater reliable broadband service in the Crystal River Valley.
	wireless capability where I don't have to bundle. or a very reasonable price...I'm very content with my present phone & cable, but I would like wireless.
	Slowness of service at peak hours. Correctness of telephone help about IT problems (some questions never answered).
	We need a service that can cover our entire property, at a high speed, at a cost that we can afford and don't have to charge or lodging guests
	Gaming.
	Cell phone reception is limited at our home. If we had good cell service we would not need or keep the landline. We already have cell phones just not through this plan so that would save a cost.
	Pitkin County is years behind the nation in helping to provide the most basic levels of internet communication service to Pitkin County Residents. Many third world countries have more reliable service than Pitkin County offers. The Pitkin County employees are well paid with benefit programs, Pitkin County employees have a far higher level of internet service than they are providing for the tax payers in their district.
	Stable connection, not affected by rain or snow, as are Satellite Internet services (Hughes & WildBlue, which is why we do not use one. Also Satellite Internet services have a relatively LOW amount of usage allowed, at which time they throttle it back to ridiculously slow speed for the rest of that 30 day time period.
	Lower costs with faster service.
	How about getting data transfer speeds as advertised? Wouldn't that be amazing.
	Need more option for higher quality service. Bandwidth varies greatly and is sometimes too low for sufficient service.
	Better load to support HD on Sling service
	Separate internet from other telecom/entertainment services. Don't need the bundles. High reliability, speed, and better coverage areas are the priority. Community wifi would be immensely helpful!
	1. Better mobile broadband coverage is the single most important area of focus for locals and guests. Guests who stay in a home without mobile coverage are very upset. This occurs with regularity in Snowmass Village. If this requires additional infrastructure provided by the NWCOG, I would support it. 2. Unbundling cable channels. I like bundling TV and internet billing, but it drives me crazy that I have to order 100 + channels just to get the sports package. I would like to order just the channels I want to see.
	When internet service is down or not performing properly, my providers tech support is very uneven. I have had people tell me things that were completely wrong, insist there isn't a problem, and have trouble dealing with a knowledgeable user who has already done some troubleshooting.
	Again, reliability and consistency because right now we don't have either and that is with 2 operating systems!

County	Comment
	need cell phone reception improvements and HSI higher speeds. We are a small area and the bottom line is we're not important to any service's bottom line!
	Making sure campers and families can connect through video calls. And for us to use donated money in better ways that paying for a slow, outdated T1 line.
Rio Blanco	access for rural residents in sparsely populated areas is critical in rio blanco county. my family members live outside of meeker and rely on satellite internet service provider [e.g., wildblue] at low download/upload speeds of 2-3 mb and .625 mb upload, and only fair reliability/redundancy rural residents need direct fiber connection or a microwave distributed antenna system solution or similar rf device to link to high speed fiber and microwave last mile and middle mile resources.
	I just hate how the few options we have for internet here give the companies the idea that they don't have to care about our wishes because there is no competition. I have been unhappy with my internet almost from the beginning and through a fault of CenturyLink, I do not have internet through them any longer. I have found another option that I hope will meet our needs and also through that option have changed our home telephone through a different company as well. I hope these options will not only lower my monthly cost, but that I will have less problems with internet outages and slow speeds when we need it the most.
Routt	Solid speed with more reliable service. A huge bonus would be wireless for the Steamboat Springs downtown area.
	Less buffering, faster connection.
Summit	simpler computers and less intrusive advertising
	This is sufficiently complete for the purposes of the study effort underway.
	Speed I no. 1. There is local speeds 3 to 5 times my speed of 1.5M, but century link refuses to consider upgrading me. I have pestered them over 8 times in the past 3 years about upgrading my data speed, but they refuse to consider an engineering project to do so. I would seriously consider another service provider even though I have been a continuous customer since 1961.
	A guaranteed connection with service level agreement(SLA).
	My own tech skills. I'm a real technology dud.
	We need cell service (or something similar) in the Lower Blue Valley for SAFETY. In the event of an emergency, we must be able to communicate, when we are away from our landlines. This is much more important than any of the internet uses we have been discussing here.
	Security
	viruses should be non-existent for my computer
	Price competitveness and joining accounts. I have to have 2 separate accounts, one for home, and one for business.

County	Comment
	Most people are becoming aware of the broadband speeds as a result of their ability or inability to receive online entertainment, that is available from many providers. When the Netflix movie stops in midstream to buffer, most figure out that their receive speed is the culprit. We use content from serveral providers and have just recently upgraded from 12 to 20 Mbps service to try to eliminate this problem. We see more and more cloud based services and our ability to multitask with a bunch of these at the same time is important. However, we are convinced that during our lifetime (I am currently 70)we will see personal bandwidth speeds up to a gigabyte. It is one of my favorite conversation to talk about what we may be able to do with that.
	speed speed speed
	Cell service in the Summit Cove area is very sketchy. Having a tower in our neighborhood would greatly increase our cell service
	Nothing I can think of at this time
	Consistency is a high priority and right now Comcast service is very sketchy. Extremely frustrating for business.
	quality and timely service when technician is needed
	When the service goes down, it would be good to have a way to find out 1) whether it's just my modem, or system-wide, and 2) if system-wide, approximately how long it will be down.
	Simplicity of use. I am 72 and thus very computer literate.
	streaming video isn't currently important, because the current service (century link) doesn't offer a great speed/rate for this. If the rate/speed was better, we would definitely be interested.
	Redundancy. Which is why we subscribe to multiple services.
	stronger signal throughout the house!
	Consistent speed and reliability - We seem to experience slower speeds when more persons are using the internet.
	I'm retired and many of the things that are important to working people just don't apply to me.
	Cell phone capabilities.
	Help provide competition or make it public, because either would make it better than it is now.
	having a download allowance the slows your internet when exceed your allowance
Unknown	RUNNING BUSINESS' FROM HOME. RESPONDING TO PERSONAL AND BUSINESS EMAIL. COMMUNICATION, ENTERTAINMENT, SOCIAL, EVERYTHING, USING WHAT IS AVAILABLE.
Out of Region	Constancy and reliability: depending on time of day, service may be so slow that dial-up is quicker
	Other priorities

Table 24: Priority Response Comments

The survey provided respondents with a set of potential to evaluate. The potential actions asked respondents to rate doing nothing, incenting incumbent providers, becoming broadband friendly communities, implementing regional cooperative planning, building infrastructure to close gaps, and

building infrastructure to compete with incumbents as a very good idea, fairly good idea, neutral, fairly bad idea, or very bad idea. "Figure 34: Potential Action Response Results" depicts potential action results for the region.

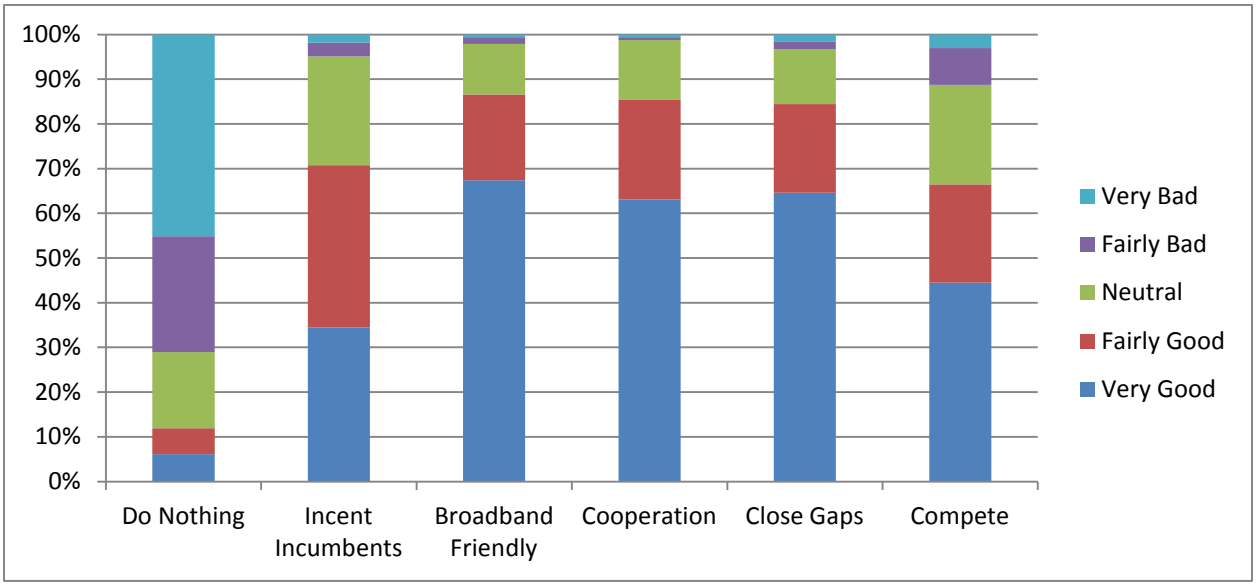


Figure 34: Potential Action Response Results

The survey instrument allowed respondents to comment on each potential action and on the survey as a whole. The comments received follow:

County	Action	Comments
Carbondale	*Do Nothing*	We have no broadband where I live. I can't even get Comcast here, they are unwilling to lay line just a few feet.
		There are people in this valley who are on dial up because they can't afford faster internet
		Fiber optic cable is buried out my front door, yet CenturyLink does nothing to connect this rural community to the fiber optic. PLEASE HELP
		need more options for internet access
		More competition is needed, Comcast is too expensive, not many choices in our valley
Carbondale	*Compete*	I don't think government should compete with business just encourage business to provide for everyone at a reasonable cost.
Carbondale	*Additional Comments*	With the recent cellular data speed increases throughout the Aspen valley from AT&T, my cell phone is now almost three times as fast as the basic cable internet offering from Comcast. This is pitiful to say the least. Comcast and other ISP's should be working to increase the speed and service regions as more and more devices are coming online. It shouldn't also be a requirement to subscribe to either telephone or TV service to have an internet speed increase. Overall there is a lot of room for improvement in regards to the internet service here in the Aspen Valley. Fight hard to get us Google fiber! Thanks.

County	Action	Comments
Eagle	*Do Nothing*	We need fast reliable service. We do NOT have that available today.
		There needs to be more choices for service providers on the Western Slope and here in the Mountains. One provider doesn't offer a lot of variety in programming.
		Communication availability on the 800 megahertz system is more important than the ability to get faster speeds on the internet. If we cannot communicate by radio then police officer lives are placed in danger.
		It is very expensive to live isolated as we are. We have few choices for providers and few services available. Internet capability is the primary hindrance to living and working in Red Cliff.
		Comcast overcharges for their broadband - which is really medium band. They will improve and drop prices only with competition. The Pitkin County Translator system should make the whole county a hot spot.
		People are not buying homes in our neighborhood due to the lack of reliable and fast internet service. This is an economic crisis for the Western Slope and will need to be fixed in order to attract workers/businesses in the future.
		We have only one option - satellite- and it's pathetically slow.
		No choices in providers, very expensive, not as fast as advertised
		I would really like to see other internet service providers in the area for the competition factor. Only having one provider available hurts.
		We want better speed
		Really depends on overall regional priorities. My internet is good; if another region has no internet - then the 21st century version of the Rural Electrification Act should happen. But it needs to be balanced with the population centers. Not really interested in spending tons of $ to get internet to a few folks in Bond if Vail is getting bogged down.
		Improved broadband is essential to our community and schools. Our school district is over 7 years behind in technology upgrades. A big part of the problem is poor access to broadband at the schools, at homes, and in communities in Eagle County where service is not available, accessible, and/or affordable.
		Encourage technology adoption in schools. Encourage (mandate) last mile in new developments, particularly business developments
Eagle	*Incent Incumbents*	We will never receive real internet or cell service at our home if this does not happen.
		To include communication upgrades
		Create incentives for developers as well as companies
Eagle	*Broadband Friendly*	If it includes communication and funding options for improved radio systems
		I would really love to have fiber in my home for the speed it provides.
		Sounds good - but there's always the reality that most of us are unaware of...where implementing one of these things means something else takes a hit.

County	Action	Comments
Eagle	*Regional Cooperation*	yes! share the easements and the wires. We're really small potatoes compared to "real" population centers. Small communities should do fine with co-ops.
Eagle	*Close Gaps*	With communication component
		To know other communities in our area are receiving upgrades to their internet and cellular infrastructure while our community has none to begin with is very frustrating. Redundancy shouldn't be a priority until every community has a reasonable basic level of service.
		This is a fabulous idea! Much-needed in rural Colorado.
		I feel the private sector should do this
		where does funding come from?
Eagle	*Compete*	When the invisible hand of the market doesn't do the job it is perfectly okay for government to step in to spur development that favors the people's agreed upon agenda. As air fares into Aspen have shown, sometimes it's appropriate for government to take a stand for the good of the community and spur competition.
		We only have one choice at our home right now -- satellite internet. It's terrible. Competition/choices would be fantastic.
		If there are places where there is very low quality service or no service the government could jump start micro broadband (neighborhood cooperatives and open source relay) initiative by providing technical expertise, consultant recommendations and endorsements, neighborhood organizing assistance etc.
Eagle	*Additional Comments*	Encouraging other providers to franchise with the communities and offer a competitive service.
		Again, more focus necessary on those communities without any/next to no service before looking at upgrades to existing infrastructure. I've heard about rural communities burying their own fiber, but I don't know where you would begin. I do know their biggest cost saving was getting land owners to allow the fiber to be buried on their land for no charge.
		Use the Pitkin County Translator system to make the whole county a hot spot and spur other counties to do the same.
		Thank you for caring about this issue! Without action, there is no financial incentive for companies to strengthen/provide service in rural Colorado. We must act to improve our service to keep residents and employers happy/productive in our increasingly digital world. If we don't, our economies will suffer.
		We live in a low density area, very little reason for a provider to run new services. There has to be government regulation or intervention or it will never happen, and we will be stuck with low speed satellite connection forever. Even affects our ability to sell our home.
		I like a lot of these concepts. I'm not a fan of franchise agreements, and I think that it generally discourages competition. I wish there were more options, but in a limited rural market, that just may not be possible, so I think that the concept of regional governments working together to improve service and availability to the area would be a good thing.

County	Action	Comments
		Initiate cell service. In town cell service is a convenience, here it could be a life saver in times of emergency since phones are far apart. Speed Test Results :::.. Internet Speed Test Result Details ..::: Download Connection Speed:: 437 Kbps or 0.4 Mbps Download Speed Test Size:: 384 kB or 393216 bytes Download Binary File Transfer Speed:: 55 kB/s Upload Connection Speed:: 170 Kbps or 0.2 Mbps Upload Speed Test Size:: 256 kB or 262144 bytes Upload Binary File Transfer Speed:: 21 kB/s Timed:: Download: 7.204 seconds | Upload: 12.331 seconds Tested At:: http://TestMy.net Version 13 Test Time:: 2013-08-27 08:32:56 Local Time Location:: Unknown US >> Destination:: Dallas, TX US Validation:: http://testmy.net/db/uiKdzD8.NFD3BKX More Stats:: http://testmy.net/compID/16887996972357 User Agent:: Mozilla/5.0 (compatible; MSIE 10.0; Windows NT 6.1; WOW64; Trident/6.0) [!]
		Thank you for taking on this project. I believe it is essential to the future of our children and community to improve broadband.
Glenwood Springs	*Do Nothing*	From our prospective not having internet sevice is costing me travel time (1 1/2 hr commute one way) and my husband and daughter will not be able to do classes that they are unable to attend during the day.
		Particularly in our neighborhood where there seems to be enough potential customers wanting improved service and where the infrastructure in the form of fiber is nearby, it would be helpful to have your assistance to investigate possible improvements and expanded options.
		We really really need a connection
		We can't get it here in No Name
Glenwood Springs	*Incent Incumbents*	Information shared, a thorough investigation, and public-private partnerships can leverage improvements and successes. Incentives yes.
Glenwood Springs	*Broadband Friendly*	Not sure what the following means: 2. 3. Relax community-wide build out requirements If means more housing or commercial growth, would not be in favor.
Glenwood Springs	*Regional Cooperation*	Especially if fiber optic installation was helped or done with public funding, need a 'hammer' to make sure is available to all and utilized to full extent.
Glenwood Springs	*Close Gaps*	Here with our 'community broadband network', oftentimes dealing with our ISP, they 'point fingers' at our municipality when things aren't fast or reliable and the city says they are not at fault.
Glenwood Springs	*Compete*	competition is good even if prices stay a little high normally service is better.
		Such might offer better responsiveness in terms of customer service, reliability, better speeds and local people who serve customers better and more timely.
		There is NO competition at our house.
Glenwood Springs	*Additional Comments*	Even more Cell towers could be good for hot spots. we also currently use a verizon hot spot because we cant get at&t service where our house is located.

County	Action	Comments
		Should increase publicity related to this survey. Had heard something on the radio news, but have seen nothing in the newspapers. Will try to share with others in our neighborhood.
Grand	*Do Nothing*	Generally I support let the market resolve itself, unfortunately I don't think they care, they know we don't have many choices and we have to have service so they don't have to try. In the big picture we don't have the strength of dollars like an urban area.
		There isn't enough competition, especially here in the our region. This should help.
		I know that many neighborhoods dont enjoy the same Internet I do, I would vote to help them as possible
		Slow up and down speeds in the county are bad for business
		There are a lot of areas of Grand County that cannot receive adequate high-speed internet, including where I am at. It limits where some people can live (I almost did not buy this house because of the lack of Internet availability).
		The lady at the Comcast office in Granby laughed when we asked if we would be able to get cable at our house. The existing service providers seem to have no plans to take care of our broadband needs.
		Qwest states they can't up the speed or add any new customers
		I was at Granby Ranch yesterday and a guy told me he and his family had planned on vacationing there for a month but he may have to leave because of the poor Internet connection - he can't do his work.
		Needs for reliable service are only going to increase.
		PLEASE HELP ME GET HI SPEED INTERNET IN MY HOME IN tABERNASH.
		DSL is our only/fastest choice and it's still painfully slow on many occasions. Given that it's 2013, there should be more options in rural areas.
		Access is choppy and expensive - cable would be great, but DSL might be more practical in eliminating the wiring and cabling issues for many 2d home owners
		We live in Eastern Grand County often refered to as the "Island in the Rockies". We have residents who have trouble receiving anything due to mountain shadowing other than hard wired service.
		I believe reliable, fast internet service and wifi are a large amenity for us due to the tourists we attract.
		I think that something should and can be done, all it takes is money and a lot of it. Because of that I'm not sure how the providers can provide a better service/product yet keep the cost to consumers down. We have outran what we can really keep up with when it comes to this.
		no competition means higher prices with no incentive for providers to improve service
		Internet service has become a requirement in order to compete in today's economy. In order to live in this community permanently, reliable Internet is a utility requirement.

County	Action	Comments
		The whole world is growing their HSD usage. The CAGR for data usage is over 50%/yr. Meanwhile we are stuck in the stone ages. Like many 2ndary airports they offer subsidies to get airlines in. How about some tax incentive to service providers to build out the networks. Usually their issue is density and cost/mile. A subsidy may help overcome this barrier. They are desperate to get more subscribers.
		Coverage is spotty, and signaling is very weak in my area
		As previously mentioned there is a huge need to expand broad band capacity.
Grand	*Incent Incumbents*	Something needs to tip the balance, the market is stuck and I believe it is affecting business development. I would be willing to pay more for service here than I would pay in a metropolitan area because I understand their cost of doing business is higher here but they seem uninterested. I actually contacted Qwest when I moved to this location to discuss the cost to have a DSL or T1 line constructed to my location knowing it would cost thousands of dollars but they were unwilling to even give me a price or discuss the possibility of it.
		Incentives yes, penalties no
		Providers are very lazy up here we should have over 7mag service up here by now
		I don't mind how or who provides the service, encourage or penalize, but just hope you can make it happen!
		I would like to see the local telecom and local cable providers expand services to this area, and believe access to several of the incentives such as access to rights of way, etc could be used to improve our services.
		The whole world is growing their HSD usage. The CAGR for data usage is over 50%/yr. Meanwhile we are stuck in the stone ages. Like many 2ndary airports they offer subsidies to get airlines in. How about some tax incentive to service providers to build out the networks. Usually their issue is density and cost/mile. A subsidy may help overcome this barrier. They are desperate to get more subscribers.
		As usual, mountain areas are at the bottom of every company's list
Grand	*Broadband Friendly*	No Government interference in market forces in our community. There are plenty of choices
		I dont want to spend a lot of public funds to get there.
		Need better service at all cost
		It seems like the only people interested in improvements are the people without broadband. Those who have it aren't willing to help us.
		I love it when traveling and stop in a town that has easy, fast broadband. Makes life much simpler.
		You cannot expand business without adequate broadband access - having it permits more people to stay longer which is good for everyone's business
Grand	*Regional Cooperation*	I feel this would be a lucrative plan for all providers to help share the costs and provide better service and pricing to their customers.
Grand	*Close Gaps*	Government should not build anything.

County	Action	Comments
		One of our problems is that we are a "remote" neighborhood and although we are a rather large neighborhood. We have a large number of part time residents who aren't involved in the local conditions. We do not fall within any town borders so we look to the county for help.
Grand	*Compete*	We need to bring more business to the area! If we had our own infrastructure we could bring high speed to business at low cost with tax breaks! Just think reversE commute to Denver
		We aren't within a town. Any infrastructure would be an improvement.
		This might make service worse or more expensive outside towns' borders.
		even cellular service is extrememly limited when it comes to coverage
		This could put towns under sever financial pressure to provide for only a few. The Fraser Valley section of Grand County is in this position right now trying to provide basic TV reception to those who cannot afford satilite service.
		The more government, the better
Grand	*Additional Comments*	I think this is a good start. I would be glad to participate in upcoming discussions on this matter and share my experiences. This is probably one of the biggest issues impacting my business right now. I made the choice to live in this region so I could have my home and business facilities on the same property and live in a rural area. I find good support for this in all areas except communications/internet access.
		I'm sure some will view this as a bad idea, saying gov't should stay out of private enterprises' way. I think this is short-sighted thinking and would love to see if this movement could provide long-term benefits to our communities!
		First of all, an inventory of all services is essential, when we know what the gaps are then the course of action will be clearer, right now who really knows?
		Understand that in our community (and other underserved areas) there are many part time residents who simply don't care if we have broadband service. The service providers see this as a reason not to provide the service. We don't have a large enough percentage of owners who would sign up for the service. Help service providers understand that we need high speed internet in resort areas and remote areas with a high percentage second homes and part time residents.
		Improve broadband significantly. It's awful here!
		Sorry. I just do not use the internet enough to be concerned with improvements at this time.
		Any thing that can be done to improve broadband is needed. It's hard having to stop at libraries and coffee shops to finish work that I should be able to do over my phone.

County	Action	Comments
		In this day and age, it is very important to keep up with technology through high speed internet connections. There are too many areas in the region where only slow connections are possible and this greatly holds back people and businesses in the community
		We are currently contemplating canceling our home phone and internet service so that we can pay for unlimited data on our cellular plan. Our cellular data (3G) is faster than the internet service that we have.
		It would be nice to have any internet at all.
		We have puzzled over this question for years and have little to show for our thinking other than suggesting fiber optic cables to virtually every home in the Eastern part of Grand County.
		living in a "town" that has no tax base or elected officials I do not see how this could extend to us
		Its important taht consideration be given to the cost of developing infrastruture as well as the on-going cost of receiving internet service. Although it may not be as significant for second homeowners, those that live here may have tp prioritize cost versus broadband enhancements; its balance.
		We have to use "wireless" because no other providers are available. I'd sign-up for Comcast or CenturyLink in a heartbeat, if it were available in our community, but it's not!!
Jackson	*Do Nothing*	There is DSL access in part of our county, but not all. We happen to be in an area where it is not available yet. We are very limited in our choices & would like to have other options!
		We need higher speeds to keep up with the rest of the world. :)
Jackson	*Incent Incumbents*	Any incentives that do not cost the taxpayers would be acceptable, penalties are not.
Jackson	*Additional Comments*	please make DSL available county wide!!!
Moffat	*Do Nothing*	Internet access at a affordable rate is importnt to economic development in our area.
Moffat	*Additional Comments*	Making sure that we meet the needs of the last mile customers and improving where we need to for the middle mile consumers.
Pitkin	*Do Nothing*	we need true high speed internet
		Without the close scrutinization by government the price will simply keep going up and up.
		The ridiculous cost of internet services pushes me out of range. I share with my neighbors connection and pay him 1/2.
		Very, very bad idea.
		I'm not sure what the question is, and the responses are confusing. I think we need more broadband options in our valley.
		if you can keep the costs down

County	Action	Comments
		Aspen is NOT a world class community with internet and wifi services. There needs to be a community wide wifi service. And, there needs to be better internet access in distant areas in Pitkin County. Millions are spent on trails, but nothing on internet access.
		While we have DSL service at our home, there is a very limited area of the Crystal River Valley covered, and no cell service
		We lose business because we don't have "modern" internet and cell service.
		How much are the tax payers paying for you to conduct this study? Pitkin County employees have been doing nothing, for years, to provide its residents sufficient communications. It is audaciously insulting for you to suggest this as an appropriate action.
		Guests coming to Aspen Snowmass need better access!
		For the large providers, rural areas like ours are less profitable than cities like Denver and Colorado Springs. As such, we get last call on their capital dollars and sometimes even get used equipment. The benefits of high speed internet to rural areas are much higher than the benefits to the providers. As such, doing nothing is a bad idea.
		Because we have such a small population, our whole area east of aspen off Hwy 82 is probably under 300 people and although we pay similar taxes, we receive almost no services, except telephone and probably fire, from Pitkin County.
		I am not sure what the broadband plan is. I have it now with cable.
		We are in the dark ages here with broadband. It is simply ridiculous to pay almost $600 per month for almost nothing.
Pitkin	*Incent Incumbents*	I think a bunch of this has been or is already being done. Almost all of the incumbent providers are or have been monopoly/oligopoly companies for most of their existence. As such, their reaction to these kinds of incentive and penalties is likely to be limited.
		Would need to know more about what this really looks like.
		since I am dial-up, I don't think I can answer this
		Need more competition to keep the rates competative.
		Would like cheaper service
Pitkin	*Broadband Friendly*	We need thie service in our area, but it needs to be competative, cost effective and reliable...broadband friendly is good as long as all possible suppliers are able to provide the appropriate services.
		We are a world class tourist destination area 1990's technology. And our visitors know it.
		too much, too soon. this is like voting for something, & all these other options are thrown in
		In our area, we have to have a land phone line for home, cell for away from home, DSL service (with limited speed) at home, satellite is only other option for internet connection, and the delay with satellite doesn't work with many of our needs. We need to do what we can to get better, faster, and more widespread coverage for our area.
		Very important to our guests who are our lifeblood.

County	Action	Comments
		It will be amazing if it actually happens, and our small community has offered to pay all or some of the costs involved in bringing other than satellite HSI to our community. Still can't get any interest!!
		Reduce cost.
Pitkin	*Regional Cooperation*	The more competition, the better...of course cooperation and coordination between supplier is important.
		The fiber optic is there, make them use it
		People in urban areas, the majority, are already well served, i.e., cable, and could not care less about rural service.
		Shared towers between Verizon and ATT
		they don't cooperate, they don't even try to coordinate digging up and placing lines at the same time. and they have no interest or incentive to do this.
Pitkin	*Close Gaps*	As with otber utilities, this is a basic need for living in general as well as businesses. Regional government has been historically involved in needed infrastructure and need to continue to be involved to keep these services viable, up to date, offered and available without monoply.
		but not everyone is interested or wants to pay
		This has to be done carefully. It can lead to wasting money on infrastructure that doesn't get used. On the other hand, in some places, this may make sense from a public safety and economic development standpoint. Clear standards on the circumstances under which this would be done and the priorities that would be used to allocate resources, as well as an agreed upon plan for acquiring/raising those resources would be required.
		mainly talk and no action
Pitkin	*Compete*	The competion will help improve the overall performance of the systems availble, help to keep a high level o performance and ultimately lower high costs of profit oriented business practices...as with deregulated fossel feuls.
		I think the county should try to develop cooperative agreements with broadband providers, and not compete with them.
		see above, but it sounds great for cheapies like me
		Why can't the region get more competition between current and new service providers? Also I would think HOA could rally on behalf of homeowners for better service and better costs.
		Which idea are you referring to in the attached answers?

County	Action	Comments
		We don't need 43 wires coming to every house. Having said that, we do need something better than the copper telephone line or shared cable line that most of us have. Creating local utilities to put in improved network neutral "last mile" wiring to businesses first, multi-family second and eventually all residences, AND offering it's services to the phone and cable companies as well as their subscribers is likely to benefit everyone. This would require infrastructure that supports 911 and works during power outages, unlike DSL. I had a T1 for 2 years before DSL came to my neighborhood, and it stayed up just like traditional telephone services does. DSL (and I assume, Cable) do not. Small towns or counties might have to contract out construction, maintenance and management of a last mile network, but it would mean that development wouldn't have to wait in line behind Colorado's larger cities...
		We could definitely use some real competition. We have no real choices because we are remote.
		Would that reduce the cost? Then I am in favor
Pitkin	*Additional Comments*	As with other utilities, the governments should be involed in the building and regulation of this industry...especially as more and more people and businesses become dependent on this technologies. Government is there for the benefit of all people and was established to benefit all. From my point of view, local government should be envolved to regulate, distribute and assure our communities this service in an effective, effecient and economical method.
		Internet access is a key to being a world class community. Aspen & Pitkin County are failing in this regards. Millions are spent on trails, but nothing on electronic trails for our citiznes.
		Once your analysis of the existing providers has been completed and the technical deficiencies of providing up to date internet services have been defined, have the providers give competitive bids to implement and operate the upgraded system.
		Broadband Internet connectivity is THE FUTURE of all communications and media... fabulously important for myriad reasons.
		I want fiber to my home.
		Last mile service & amenities for visitors and tourists will help drive development. Imagine ubiquitous cheap/free Internet access in downtown areas, think community wifi.
		Improve mobile broadband access. The mountains create many pockets of no service. I had to install a repeater in order to get cell/mobile broadband service at my home in Snowmass Village

County	Action	Comments
		Your speed test assumes a single device connected to the internet. In a house like mine with 11 devices, what a single device gets is likely to be less. After I moved to Redstone, in 2003, I traveled as a software development contractor for 5 years. 2.5 years of that were to the Front Range, and the rest was out of state. Since 2008, I've been working from home, via high speed internet. I use no more public services than an average employed resident and my employment related cash flows are almost entirely money coming into my local community (except for occasional equipment purchases). I couldn't live AND work here without reliable, high speed broadband.
		Please help us develop a forward moving cohesive plan!
		go beyond the talk stage and do something to solve the problem. Take our offer of money and help us establish a tower/wireless broadband service.
Rio Blanco	*Do Nothing*	broadband of suitable capacity and speed is virtually unavailable in rio blanco county. economic growth and development are critical needs to the survival of the economy and the community. many growth potentials would be greatly enhanced with broadband in all aspects from education, government, schools, health care, cultural and arts venues, business and much more.
		We need access and capabilities to compete with the outside marketplace.
		Doing nothing is only viable if North West Colorado wants a stagnant, declining economy.
		There is clearly a problem and internet is a very important way we can stay connected even though we live in a rural environment. To do nothing would be just as wrong as siding with the current company that we don't matter out here.
		We really need to have aother broadband available to our area. Centurylink does not care or seem to care about the kind of service they provide to us. My DSL is down alot and this causes problems when I am trying to invoice for the company I work for.
Rio Blanco	*Incent Incumbents*	private vendors tend to not be inspired to provide robust internet services in rural areas. a community owned last mile distribution system fed by a carrier neutral location permitting private vendors to be accessed by individual subscribers through the community network is a proven and reliable, low cost solution and does not make the community dependent on private vendors that may or may not remain in business as viable solutions. competitive carriers at carrier neutral locations can come and go but choices remain a viable option for subscribers.
		If and only if the contracts are issued on a bid bases and reopened for bid on a regular bases. Maybe every five years?
		more broadband services in our area will give us better service to choose from.

County	Action	Comments
Rio Blanco	*Broadband Friendly*	there are many existing fiber resources in rio blanco county that just need to be consolidated and lit up to provide robust, abundant and redundant, affordable services to all residents in this rural county and communities. by pooling resources and expertise, an optimal solution can be had at reasonable cost and be made rapidly available
		Funding for improving infrastructure is difficult for small counties and towns - would need grant funding.
		This is the most efficient, equitable, economic stimulus a region can undertake in the new economy. In addition, because "friendly, broadband service" provides communities access to markets, for goods and services, broadband provides the best return on investment for a community and individuals living within the region.
Rio Blanco	*Regional Cooperation*	government pressure along with community based coalitions can weigh in on compelling private vendors to enter into cooperative agreements and to share resources reasonably rather than being proprietarily defensive. duplication of resources is wasteful and unnecessary and delays or inhibits providing optimal high capacity redundant fiber and wireless services in the rural area. federal regulation is virtually non existent so must be handled at a local and regional level to make the system highly efficacious and economically feasible.
		I am unsure if this would lead to the same problem of not having any competition to keep pricing down if they are all working together.
Rio Blanco	*Close Gaps*	again, efforts must be combined and resources merged and consolidated wherever possible to overcome cost impediments that can be reduced with consolidation and cooperative use of available resources. government buildouts and last mile access provided by government or cooperative coalitions may be an optimal solution to make broadband available to everyone in the region regardless of their remote locations.
Rio Blanco	*Compete*	commercial providers only pay attention to the bottom line so will not traditionally provide services unless the return on investment is at a certain threshold. thus, as with the rural electrification coop program of the federal goverment in the 1930's, electricity in rural areas would not have been possible due to a high cost-low return on investment ratio. only federal/state/local subsidies made that herculean effort possible. what a huge impact electricity had on agriculture and quality of life. now in the 21st century, broadband is the next "REA" project that can have the same or greater economic and cultural spin offs to enhance the quality of life, the economy and the ability to have unlimited access to worldwide resources regardless of location.
		I thought municipalities could NOT compete with broadband providers... And again building infrastructure would require funding assistance for our small town of Rangely.

County	Action	Comments
		The hard part of government owned service projects are how they are managed. Technology is changing so rapidly the system will require continued investment. Local boards can work well, if they are broad based, transparent and responsible to all of the citizens. Some government entities have a poor history of customer service and are reluctant to move forward and adopt change. The tendency toward "empire building" can be a problem.
Rio Blanco	*Additional Comments*	public education on broadband is critical. most of the public have very little idea of how they can be benefitted by broadband so a very well designed media campaign to educate and familiarize the public with the benefits of broadband is critical. using websites, social media such as facebook and twitter, and you tube are among the many means of rapid dissemination of vital information that needs to reach the public. i am working with the governors office of information technology to help design such educational public service announcements and sound bytes to educate on broadband. newspaper articles are also effective for those who are not on the internet but potentially could be if educated and encouraged to do so, including the elderly.
		Expand current fiber services to local businesses
		From what I have heard, you have made a good start. Continue to promote local involvement.
		encourage other companies to come into our area.
Routt	*Do Nothing*	The current status quo has inhibited both business and growth for remote workers which is becoming a very important part of our economy. In addition offering quality access is vital for visitors to our community as well.
		Need better options for rural homeowners and businesses
		Generally do not believe the Government should be involved in something the private marketplace could resolve. Government should protect the borders, punish criminals, and make life easier for law-abiding citizens.
Routt	*Incent Incumbents*	This can be a slippery slope but if implemented carefully and fully it can have a very positive effect.
Routt	*Additional Comments*	Incentives are nice. Regulations stifle business. Government competition is a sure way to lose private marketplace. Government can help by providing services where it is unprofitable for the private market to facilitate.
Summit	*Do Nothing*	I think some areas need help in procuring these services.
		Need to be pro-active, to get more cell towers in our region, etc
		get the dark wires to provide cell service
		It is a good idea if you can change/improve what we get.
		Our HughesNet satellite service was remarkably improved this past year. It is still not as good as the high-speed connections elsewhere, but it is not bad. What we desperately need is CELL SERVICE.

County	Action	Comments
		We have absolutely no choice for internet, phone, cellular service. The bandwidth and reliability available through Century Link is terrible. Cellular service through AT&T is utterly atrocious, MOST of the time their signal is a very strong 5 bars but signal modulation/demodulation is completely un-usable. They apparently don't have technicians that can figure out the problem since October 2012.
		DSL bites, Comcast is a rip off
		The broadband we have today is a result of community activism during the 1990s and early 2000s. We would probably have gotten it sooner or later, but we were sucessful at acquiring some grants to accelerate competition which lead to better service faster. The next leg of this needs to be driven by the community again. We are pleased that NWCOG is engaging in this process. I would be happy to participate if yopu need someone with experience and history.
		My system is much too slow.
		Recently, at least 3 companies have completed their fiber runs into Breckenridge from the main I-70 corridor, which meant for the first time we've had competition and good pricing on full fiber connects and networks. While their could always be more competition, I believe there are currently enough providers to provide reliable and cost-effective solutions.
		We need more options, faster speeds, and lower prices, with more options being the biggest by far.
		Broadband should be universally available and free
		Cell phone improvement, more choices for internet.
		Comcast customer service is terrible. The people are nice but the system is lacking incentive.
Summit	*Incent Incumbents*	Centurylink needs to be prodded big time.
		It's not cheap to provide service in a rural area. Incentives would help.
		we don't need additional government regulators. Let the best companies survive on their own based on their performance and offerings.
		Incentives are much more effective than penalties. Almost any situation can be turned from a penalty to an incentive with a bit of creativity.
		Costs have come down and competition has increased enough recently that I don't see any benefit to incentivize existing providers.
Summit	*Broadband Friendly*	I wish we had fiber, century link 1.5MB/S does not carry enough for more than 1 user and only allows streaming OR other connections for users.

County	Action	Comments
		I've seen ideas like this fail miserably in Summit County (see: the Beanpole Project) and other rural communities. I believe, while the pace of progress can be slower in a rural community, that eventually with enough business need, that the technology available in rural areas will spread, and be available to more rural areas. I realize I sound like a libertarian here (I am not), but I don't think that creating artificial incentives and/or "councils" will help the end consumer (or even the business consumer, who I am representing in this survey) realize any benefits of better, faster service any more quickly than the private sector will make it happen naturally.
Summit	*Regional Cooperation*	I suppose getting the big network operators together would be nice, but again the interference in a market that will naturally grow isn't necessarily going to help provide better solutions.
		as long as it doesn't affect healthy competition regarding rates
		Competitive to drive better service.
Summit	*Close Gaps*	look at SB 152 may prevent this.
		It is not gap here it is a bottomless chasm.
		This should be the last resort. Government intentions can be good, but frequently get mired in beaurocracy. Hope that is spelled right.
		Depends on cost.
		Remain cost conscious
		Ski mountains are vital to us for tourist dollars. We should strive to eliminate "dead spots" on mountains, near condos, etc.
		I use Century Link because it is cheapest alternative, but it is too slow for my needs
		For the extremely rural, this is a good idea, because otherwise they will never be hooked into a fiber network.
Summit	*Compete*	I dont' think that's something most towns would want to take on if they don't alreday have services in their area.
		you may want to look at this. In 2005, the Colorado General Assembly passed SB 152, “Competition in Utility and Entertainment Services.”
		We have sort of been there, done that. We should do the planning, but pass implementation to the private sector, or perhaps some sort of a non profit.
		I've seen the government try to run their own networks. Not a good idea.
		Exactly.
Summit	*Additional Comments*	I would like to see local governments, businesses, current & potential service providers work together to build a powerful broadband capability available to all at a reasonable price!

County	Action	Comments
		The infrastructure must be mapped for me to better the problem areas. I suspect that a collaborative effort with CDOT, WAPA, EXCEL and other providers will yield a workable plan for implementation. Plesae also remember that private land owners may be amenable to access easements, et.al. for service provision, siting, etc. The local jurisdictions also have review and approval processes to site facilities. Suggest the project team integrate them into this process sooner rather than later to minimize risk of siting errors and delay implementation of the planning effort underway.
		Beat on Centurylink with all you have. I have not only been a customer for over 50 years but was an employee for 31 years starting in 1959. THX!
		Unfortunately as stated, I'm a rather tech dud.
		I understand that this is just about broadband, but please note that better cell service (which anymore includes access to the internet) is at least as important to the health of our communities- for residents and visitors alike.
		cost should come down
		Thanks for asking for my comments. I hope our access really does get better.
		Fiber to the home that will provide at-least 10MB/S. AT&T TO FIX THEIR CURRENT SERVICE TO HEENEY AND THE GREEN MOUNTAIN SERVICE AREA!
		This needs to be a group think process. There what is reasonable to expect today. But there is also a need to really invision what may be possible, because tomorrow is just around the corner and it is better to have a hand in what is happening than just to let it happen.
		please don't put the pressure on the local governments to make these improvements. It is not govt. role in my opinion. I feel proper pressure should be put on the companies to make the necessary changes.
		Having been involved in technology for a successful business over the last 10+ years (currently I am the VP of Technology for Breckenridge Grand Vacations) in a semi-rural location, I have experienced many of the issues it seems you are trying to address. I have waited patiently for network operators to realize the benefit of extending their fiber networks the mere 9 miles down from I-70 to Breckenridge and then offer these services at a reasonable price. Just this past fall, I went through an extensive RFP process with 6 different network providers all claiming that they could provide a fiber network for our 6 locations spread across Breckenridge (and 1 in Denver) so I researched the realities of the offerings and disparity of pricing and service levels. While it took many years for this day to come in Breckenridge, I would have to imagine that these companies reaching this location means that they do see the importance of expanding into rural locations, without interference from government or quasi-governmental groups. I would be happy to talk to anyone personally about my experiences or offer what little insight I may have to any committees or councils researching this issue.

County	Action	Comments
		Comcast is the worst ISP, for multiple reasons, and CenturyLink only offers up to 12Mbps, requires different modem, etc. A publicly owned infrastructure designed for competition with existing ISPs would be ideal.
		rumor has it that a Centurylink box on Hwy 9 needs upgrade to use the fiber optics installed in our area many years ago - maybe you could offer to help pay for that upgrade.
		Verizon ignores it's subscriber. I was told to buy a MiFi4G unit and that would solve my connection problems. Only problem there is no 4G service in Summit County. I have been complaining to Verizon for 3 or 4 years without them doing anything to improve capacity. Can't get on when the kids get home from school and when it's the weekend and all the visitors arrive. So I am forced to go somewhere that does have adequate service like the Rec Center. Where's the Utility Commission or your group when we need a "higher power" to help us?
		Need better cell coverage.
Unknown	*Do Nothing*	CONTACT LOCAL COOPERATIVES ALREADY ESTABLISHED THAT HAVE INFRA-STRUCTURE TO ASSIST IN PERMEATION OF SERVICES.
		DSL does not work at my house, so that just leaves me with Comcast
Unknown	*Incent Incumbents*	GOVERNMENTS ARE NOT TO BE TRUSTED. HOW EVER NOBLE THE CAUSE. PANDORA'S BOX IS HARD TO CLOSE.
Unknown	*Additional Comments*	If broadband becomes a utility, it could help. Private business' don't provide things that are not easy to do because of cost's. It is a "Super Problem" that will have unintended consequences no matter how good the idea is. Use your local media sources to apply pressure with-out regulation may be as effective and would allow competition to take care of the problem. The other option is to see how much pressure you can put on decision makers.?? Good luck, it's a very difficult job.
		Prod CenturyLink to upgrade to fiber. Since there are no new subdivisions going in, they have no incentive to improve their outside plant.
Out of Region	*Do Nothing*	I'm only responding to this survey for one reason, to help promote easy affordable access for my sister's family in Marble, CO. They currently have satellite service which is the only option available ... AND it's unreliable, expensive for what they are getting, and incredibly slow. In this day and age of technology, it's shameful. Even though I am not a resident of Colorado, these limitations impact my ability to connect with loved ones in Colorado via the internet. I urge you to make your priority to make internet access available to all colorado communities before raising the bar for those who already have reasonable service. Thank you!
Out of Region	*Broadband Friendly*	It would be great to have Grand Lake (where I have a summer home) have WiFi throughout the town.
Out of Region	*Additional Comments*	subsidize provider access if necessary!

Table 25: Action Response Comments

9.5 GLOSSARY

2G: In the world of cell phones, 2G signifies second-generation wireless digital technology. Fully digital 2G networks replaced analog 1G, which originated in the 1980s.
2G networks saw their first commercial light of day on the GSM standard. GSM stands for global system for mobile communications.

3G: Third generation of the mobile telephony standard. Analog cellular was the first generation and digital PCS the second.

4G: Abbreviation for fourth-generation wireless. Specifies a mobile broadband standard offering both mobility and very high bandwidth. Usually refers to LTE and WiMax technology.

Access Level Infrastructure: Infrastructure required to deliver services from the community cabinet or hub to the customer access point. Access level infrastructure ties to distribution rings at the community cabinet and to drop level infrastructure at the customer premises. Access level infrastructure is typically part of the local loop.

Access Portal (AP): The transceiver or media converter device that terminates a fiber network at the customer's premises. Other names for the AP include Optical Network Termination (ONT) or Ethernet Demarcation Device (EDD).

ADSL: See Asymmetric Digital Subscriber Line.

Advanced Mobile Phone Service (AMPS): A standard system for analog signal cellular telephone service in the United States and elsewhere. It is based on the initial electromagnetic radiation spectrum allocation for cellular service by the FCC in 1970 and first introduced by AT&T in 1983.

Aerial: Infrastructure placed in above ground installations.

Aggregation: See Demand Aggregation.

Aggregation Point: Aggregation point is used to describe a) a location where multiple fiber runs come together or b) a network location where multiple sites aggregate traffic.

AMPS: See Advanced Mobile Phone Service.

Analog: Relating to or using signals or information represented by a continuously variable physical quality such as spatial position or voltage.

Analog Reclamation: In a cable system, refers to repurposing spectrum previously used to carry analog channels for other uses for digital channels or high-speed data.

AP: See Access Portal.

ARPU: See Average Revenue Per User.

Asymmetric Digital Subscriber Line (ADSL): A technology that transmits a data signal over twisted-pair copper, often over facilities deployed originally to provide voice telephony. Download rates are higher than upload rates - i.e., are asymmetric. ADSL technology enables data transmission over existing copper wiring at data rates several hundred times faster than analog modems using an ANSI standard.

Name	Download	Upload
ADSL	8.0 Mbps	1.0 Mbps
ADSL (G.DMT)	12.0 Mbps	1.3 Mbps
ADSL over POTS	12.0 Mbps	1.3 Mbps
ADSL over ISDN	12.0 Mbps	1.8 Mbps
ADSL Lite (G.Lite)	1.5 Mbps	0.5 Mbps
ADSL2	12.0 Mbps	3.5 Mbps
RE-ADSL2	5.0 Mbps	0.8 Mbps
Splitterless ADSL2	1.5 Mbps	0.5 Mbps
ADSL2+	20.0 Mbps	1.1 Mbps
ADSL2+M	24.0 Mbps	3.3 Mbps

Asymmetrical: Internet connections have two components - a downstream and upstream. When the two speeds are not comparable, the connection is termed asymmetric. Typically, phone and cable companies offer

much slower upload speeds than download, in part because the Internet tended to be a download-centric system in the 90's and early 00's. However, users increasingly need faster upload connections to take full advantage of modern applications.

Asynchronous Transfer Mode (ATM): A means of digital communications that is capable of very high speeds; suitable for transmission of images or voice or video as well as data; ATM is used for both LAN and WAN.

AT&T U-Verse: An AT&T brand of triple-play telecommunications services delivered via fiber to the node.

ATM: See Asynchronous Transfer Mode.

Availability Gap: See Broadband Availability Gap or Investment Gap

Average Revenue Per User (ARPU): "Average revenue per user is calculated by dividing revenues by the subscriber base. Non-service revenues, such as equipment or other sales, are included in the calculation." From http://www.yourdictionary.com/finance/arpu.
While the accurate calculation of ARPU requires inclusion of non-service revenues, many organizations exclude them when calculating ARPU .

Backhaul: A general term for the segment of a network connecting the network to an Internet peering point.

Bandwidth: The rate at which the network can transmit information across it. Generally, higher bandwidth is desirable. The amount of bandwidth to you can determine whether you download a photo in two seconds or two minutes.

BHOL: See Busy Hour Offered Load.

BICC: See Bearer Independent Call Control.

Bit: The base unit of information in computing. For our purposes, also the base unit of measuring network speeds. 1 bit is a single piece of information – a one or zero, on or off, true or false. Network speeds tend to be measured by bits per second – using kilo (1,000), mega (1,000,000), and giga (1,000,000,000). A bit is a part of a byte – they are not synonyms. Bits are generally abbreviated with a lower case b (as in Mbps). Bits are used to measure network speeds. Bytes (abbreviated with an upper case B – as in MB) are used to measure storage space and file sizes.
That smash hit two hour long high definition movie you want to download is probably 8+ GB. If you want to download it on a standard DSL line, you better have about six hours (8 billion bytes * 8 bits = 64 billion bits / 3 million bits per second = 5.9 hours).

BPON: See Broadband Passive Optical Network.

Broadband: According to the FCC, 4 Mbps download and 1 Mbps upload. True broadband provides exponentially faster speeds and is often symmetrical.

Broadband Availability Gap: Either a) The amount of funding necessary to upgrade or extend existing infrastructure up to the level necessary to support the National Broadband Availability Target. Because this is a financial metric it is referred to as the Investment Gap. Or b) the difference in bandwidth and services available between two geographic areas, socio-economic strata, age generation, ethnic groups, or other groups.

Broadband Friendly: Policies designed to lower the costs and risks of deploying broadband in a community.

Broadband Passive Optical Network (BPON): A type of PON offering downstream capacities of up to 622 Mbps and upstream capacities of up to 155 Mbps shared among a limited number of end users.

Broadband Technology Opportunities Program (BTOP): The Department of Commerce broadband funding program.

Brownfield: Brownfield neighborhoods are neighborhoods that are already build out and typically have existing roads, sidewalks, landscaping, and other impediments to

network deployment. Brownfield neighborhoods typically have existing networks requiring new entrants to overbuild unless the incumbent is required to unbundle.

BTOP: See Broadband Technology Opportunities Program.

Burst Rate: The maximum rate or "speed" which a network is capable of delivering within a short timeframe – typically seconds or minutes. This is usually expressed as a rate in Mbps. Many network providers report their burst rate as their maximum advertised speed.

Busy Hour Offered Load (BHOL): BHOL (per subscriber) is the network capacity required by each user, averaged across all subscribers on the network during the peak utilization hours of the network. Network capacity required is the data received/transmitted by a subscriber during and hour; this can be expressed as a data rate (like Kbps) when the volume of data received/transmitted is divided by the time duration.

Byte: The base unit for file storage comprised of 8 bits. A 1 MB (megabyte) file is made of 8 million bits. Bytes generally refer to the size of storage whereas bits are used to discuss how rapidly files may be moved.

Cable Modem System: Cable television companies have offered Internet access via their cable systems since 1997. The network architecture uses a loop that connects each subscriber in a given neighborhood, meaning they all share one cable to the Internet. Because the cable network shares the last mile connection among potentially hundreds of subscribers, a few bandwidth hogs can slow everyone's experience.

Cable Television (CaTV): In its original incarnation the acronym was CATV standing for Community Antenna or Community Access Television. The CaTV acronym stands for Cable Television. In either case, cable television uses coaxial cable to deliver video signals from a single receiver to multiple homes. Cable television technologies almost always "broadcast" all available channels on the cable and rely on in home tuners to select a channel from the broadcast stream.

CAF: See Connect America Fund.

CAI: See Community Anchor Institution.

CAP: See Customer Access Point.

Capacity: Ability of telecommunications infrastructure to carry information. The measurement unit depends on the facility. A data line's capacity might be measured in bits per second while the capacity of a piece of equipment might be measured in numbers of ports.

CapEx: See Capital Expenditure.

Capital Expenditure (CapEx): Business expense to acquire or upgrade physical assets such as buildings, machinery, network infrastructure, etc. Also called capital spending or capital expense.

Carrier Neutral Location: A CNL is a local peering point location where multiple middle mile providers can meet and provide service to multiple last mile providers.

CATV: See Community Antenna Television.

CaTV: See Cable Television.

CDMA: See Code-Division Multiple Access.

Cellular: Denoting or relating to a mobile telephone system that uses a number of short-range radio stations to cover the area that it serves.

Census Block: The smallest level of geography designated by the US Census Bureau which may approximate actual city street blocks in urban areas. In rural districts census blocks may span larger geographical areas to cover a more dispersed population.

Center for Information Technology Leadership (CITL): See http://www.citl.org/.

Central Office (CO): A telephone company facility in a locality to which subscriber home and business lines are connected on what is called a local loop. The CO has switching

equipment that can switch calls locally or to long-distance carrier phone offices.

Churn: The number of subscribers who leave a service provider over a given period of time, usually expressed as a percentage of total customers.

CITL: See Center for Information Technology Leadership.

CLEC: See Competitive Local Exchange Carrier.

Cloud: Some refer to the entire Internet as a cloud – the idea being that all the information is just out there and it does not matter where. More commonly, cloud computing refers to services such as Amazon's S3 where users pay a fee to store information on Amazon's servers without ever really knowing the physical location. Cloud services may include storage, applications, and other services. As we gain access to faster Internet connections (particularly upstream speeds) cloud services may offer a more efficient means of accomplishing tasks and more reliable backup solutions.

CNL: See Carrier Neutral Location.

CO: See Central Office.

Code-Division Multiple Access (CDMA): Any of several protocols used in so-called second-generation (2G) and third-generation (3G) wireless communications.
As the term implies, CDMA is a form of multiplexing which allows numerous signals to occupy a single transmission channel optimizing the use of available bandwidth. The technology is used in ultra-high-frequency (UHF) cellular telephone systems in the 800-MHz and 1.9-GHz bands.

COG: See Council of Governments.

Colorado Telehealth Network (CTN): See http://www.cotelehealth.com/.

Community Anchor Institution (CAI): non-profit and government organizations that provide essential services to the public. Universities, colleges, community colleges, K12 schools, libraries, health care facilities, social service providers, government and municipal offices are all community anchor institutions.

Community Antenna Television (CATV): Early cable television systems were called community antenna television, or CATV, because by nature of their design they used a using antenna for multiple viewers. This was usually done to bring television signals into basins or other areas obstructed from receiving over the air signals. A single antenna would be placed on a hill or other area where signals could be received and cable would be used to distribute the signal to the homes where access was obstructed.

Community Cabinet: A remote switch location designed to support a single service area or footprint.

Community Connect Grant: The Community Connect program serves rural communities where broadband service is least likely to be available, but where it can make a tremendous difference in the quality of life for citizens. The projects funded by these grants will help rural residents tap into the enormous potential of the Internet.

Competitive Local Exchange Carrier (CLEC): The term and concept coined by the Telecommunication Act of 1996 for any new local phone company that was formed to compete with the ILEC.

Conduit: A reinforced tube through which cabling runs. Conduit is useful both to protect cables in the ground and because one can place conduit underground when convenient (like when other utility work is underway) and later blow or pull cable through the conduit.

Connect America Fund (CAF): The reformation of the USF to support broadband deployment.

Core: See Network Core.

Council of Governments (COG): Councils of governments are regional bodies typically defined to serve an area of several counties.

They address such issues as regional and municipal planning, economic and community development, cartography and GIS, hazard mitigation and emergency planning, aging services, water use, pollution control, transit administration, and transportation planning.
"The" COG refers to the Northwest Colorado Council of Governments. "A" COG refers to a generic council of governments.

Coverage: Refers to the geographic area in which one can obtain service. Sometimes referred to as a service area.

CPE: See Customer Premises Equipment.

CTN: See Colorado Telehealth Network.

Customer Access Point (CAP): The splice location where a subscriber's drop level infrastructure enters the network. May also be called a subscriber Splice Box (SSB).

Customer Drop: See Drop Level Infrastructure.

Customer Premises Equipment: The family of devices used at the customer's location to access network services. Some CPE – like the AP or cable modem – are provided by the network owner or service provider. Other CPE – like telephones and computers – are usually provided by the customer.

DAS: See Distributed Antenna System.

Data Over Cable Service Interface Specifications (DOCSIS): An international telecommunications standard that permits the addition of high-speed data transfer to an existing cable TV (CaTV) system. It is employed by many cable television operators to provide Internet access over their existing infrastructure.

Demand Aggregation: The process of combining several clients' broadband demand into a single purchase.

Dense Wave Division Multiplexing (DWDM): DWDM is a method of using a single fiber strand for multiple logical data paths.

Dig Once Policies: Broadband friendly policies that dictate communications conduit be added to any underground construction effort.

Digital Subscriber Line (DSL): A family of technologies that provide digital data transmission over the traditional copper wires of a telephone network. The common DSL technologies used in the US are Asymmetric Digital Subscriber Line (ADSL) and Very High Speed Digital Subscriber Line (VDSL).

Digital Subscriber Line Access Multiplexer (DSLAM): Technology that concentrates or aggregates traffic in DSL networks. Located in the central office or in a remote terminal.

Distributed Antenna System (DAS): A network of spatially separated antenna nodes connected to a common source via a transport medium that provides wireless service within a geographic area or structure.

DOCSIS: See Data Over Cable Service Interface Specifications.

Distribution Level Infrastructure: Telecommunications infrastructure intended to distribute signal to community cabinets.

Distribution Ring: An element of distribution level infrastructure connecting multiple community cabinets.

Download: Internet connections have two components – a downstream and upstream. Download refers to the rate at which the user's computer can receive data from the Internet.

Downstream: Generic term referring to data traffic going from the network core to the subscriber location.

Drop: See Drop Level Infrastructure.

Drop Level Infrastructure: Drop level infrastructure – often referred to as a "drop" or "customer drop" is the infrastructure that connects the subscriber's premises to the access level infrastructure. Drop level architecture is part of the local loop.

DS1: A digital signal 1 or DS1 (also known as a T1). A T-carrier signaling scheme devised by

Bell Labs. DS1 is a widely used standard in telecommunications in North America and Japan to transmit voice and data between devices. DS1 is the logical bit pattern used over a physical T1 line; however, the terms DS1 and T1 are often used interchangeable. Carries approximately 1.544 Mbps.

DS3: A copper digital signal transport with 44.736 Mbps capacity – or 28 T1 lines – or 672 voice lines.

DSL: See Digital Subscriber Line.

DSLAM: See Digital Subscriber Line Access Multiplexer.

Duopoly: A situation in which two companies own all or nearly all of the market for a given type of product or service – that is, a two company monopoly.

DWDM: See Dense Wave Division Multiplexing.

EAGLE-Net: See https://www.co-eaglenet.net/.

Earnings Before Interest, Taxes, Depreciation, and Amortization (EBITDA): An approximate measure of a company's operating cash flow based on data from the company's income statement. Calculated by looking at earnings, which are calculated by subtracting OpEx and SG&A from net revenues, before the deduction of interest expense, taxes, depreciation, and amortization. This earnings measure is of particular interest in cases where companies have large amounts of fixed assets which are subjected to large depreciation.

EBITDA: See Earnings Before Interest, Taxes, Depreciation, and Amortization.

EDD: See Ethernet Demarcation Device.

EPON: See Ethernet Passive Optical Network.

ESRI: ESRI (www.esri.com) is the global leader in geographic information systems.

Ethernet Demarcation Device (EDD): The transceiver device that terminates the optical network at the customer premises in an active Ethernet or EPON design. May also be called an access portal (AP) or optical network terminator (ONT).

Ethernet Passive Optical Network (EPON): One of the family of PON offering downstream capacities of up to 1.25 Gbps and upstream capacities of up to 1.25 Gbps shared among a limited number of end users.

EV-DO: See Evolution-Data Optimized.

Evolution-Data Optimized (EV-DO): A 3G wireless radio broadband data standard that enables faster speeds than are available in existing CDMA networks or other services such as GPRS or EDGE.

Fast Ethernet: A network transmission standard that provides a data rate of 100 Mbps.

FCC: See Federal Communications Commission.

FDMA: See Frequency Division Multiple Access.

Federal Communications Commission (FCC): Federal agency responsible for telecommunications regulation. See http://www.fcc.gov/.

Fiber Optic Splice Case (FOSC): A protective case at a fiber splicing point.

Fiber to the Building (FTTB): One of the families of fiber networks characterized by fiber delivery to a demarcation on or in the building with distribution to multiple tenants within the building through copper or wireless technologies.

Fiber to the Curb (FTTC): One of the families of fiber networks characterized by fiber delivery to the curb. Sometimes FTTC hands the curb to home connection to a copper or wireless technology. Other times, FTTC is simply a place holder with fiber continuing to the address once the address subscribes to service.

Fiber to the Home (FTTH): One of the families of fiber networks characterized by fiber delivery to the home. FTTH is sometimes used synonymously with FTTP.

Fiber to the Node (FTTN): A high-capacity bandwidth approach that uses both fiber and copper wires. Optical fiber is used for the distribution rings from the core of the telco or CaTV network to an intelligent node in the

neighborhood where copper wire is used for the local loop connection to the end user.

Fiber to the Premises (FTTP): A fiber deployment/architecture in which optical fiber extends all the way to the customer's premises. Also known as fiber to the home (FTTH) or fiber to the building (FTTB).

Fiber to the "Whatever" (FTTx): A generic term used to encompass the entire family of fiber networks.

FiOS: See Verizon Fiber Optic System.

FirstNet: The First Responder Network Authority (FirstNet) is an independent authority within NTIA chartered to provide emergency responders with the first high-speed, nationwide network dedicated to public safety.

Fisher-Pry Model: A mathematical model used to forecast technology adoption when substitution is driven by superior technology where the new product or service presents some technological advantage over the old one.

Fixed Wireless: Wireless service that uses fixed CPE in addition to (or instead of) mobile portable devices to deliver data services. Fixed wireless solutions have been deployed as a substitute for wired access technologies. For example, it is being used commercially in the US by Clearwire with WiMax and Stelera with HSPA.

FOSC: See Fiber Optic Splice Case.

Franchise: A cable company wishing to provide television service in a community historically signed a franchise agreement with the municipal government. The agreement would specify what the community would receive from the cable company in return for access to public rights of way.

FTTB: See Fiber to the Building.

FTTC: See Fiber to the Curb.

FTTH: See Fiber to the Home.

FTTN: See Fiber to the Node.

FTTP: See Fiber to the Premises.

FTTx: See Fiber to the "Whatever".

Gbps: See Gigabit per Second.

Geographic Information System: Geographic information systems are databases of spatial data. GIS systems are used to map traffic flows, contagion patterns, flood plains, and many other geography dependent features – like telecommunications outside plant.

Gig-E: See Gigabit Ethernet.

Gigabit Ethernet: A network transmission standard that provides a data rate of 1,000 megabits per second.

Gigabit Passive Optical Network (GPON): A type of PON offering downstream capacities of up to 2.5 Gbps and upstream capacities of up to 1.25 Gbps shared among a limited number of end users.

Gigabit per Second (Gbps or Gb/s): One billion bits per second. Gbps > Mbps > Kbps.
As a comparison, a high definition movie with surround sound is about 8.3 GB in size. To download this size file with different technology transmission speeds:

	Days	Or Hours	Or Minutes	Or Seconds	
Standard Dial-Up	13.72	329.3	19,761.90	1,185,714	**56 Kbps**
Fast Dial-Up	12.00	288.1	17,291.67	1,037,500	**64 Kbps**
T-1	0.51	12.2	737.78	44,266	**1.55 Mbps**
Standard DSL	0.25	6.1	368.89	22,133	**3 Mbps**
Fast DSL	0.05	1.2	73.78	4,426	**15 Mbps**
Fast Cable	0.03	0.9	55.33	3,320	**20 Mbps**
100 Mbps Fiber	0.007	0.18	11.07	664	**100 Mbps**
1 Gbps Fiber	0.0008	0.018	1.11	66	**1 Gbps**

GIS: See Geographic Information System.

Glenwood Springs Community Broadband Network (GSCBN): A municipal broadband deployment in Glenwood Springs Colorado.

Global System for Mobile Communication (GSM): A second-generation digital mobile cellular technology using a combination of frequency division multiple access (FDMA) and time division multiple access (TDMA). GSM operates in several frequency bands. The standard was jointly developed between European administrations. GSM provides a high degree of security by using subscriber identity module (SIM) cards and GSM encryption.

GOIT: See Governor's Office of Information Technology.

Gompertz Model: A mathematical model used to forecast technology adoption when substitution is driven by superior technology but purchase depends on consumer choice.

Governor's Office of Information Technology (GOIT): In Colorado, GOIT oversees technology initiatives at the state level, recommending strategies and maximizing efficiencies of service delivery in a cost-effective manner through the application of enterprise technology solutions (see http://www.colorado.gov/cs/Satellite/OIT-Main/CBON/1249667231891).

GPON: See Gigabit Passive Optical Network.

Grand Slam: A triple play with cell phone service. Sometimes called a quadruple play.

Greenfield: A plot of land that will soon become a residential or business development. Building a broadband network is cheaper in greenfield developments because roads, sidewalks, lawns, and buildings are not yet impediments to running the necessary wires and the network can be deployed in conjunction with the other utilities.

GSCBN: See Glenwood Springs Community Broadband Network

GSM: See Global System for Mobile Communication.

HFC: See Hybrid Fiber Coaxial.

High Cost Fund: In order to accomplish the goal of universal basic telephone service, the Colorado Public Utilities Commission was directed to create a system of support mechanisms to assist in the provision of basic service in high-cost areas. Specifically, the Colorado High Cost Fund (CHCF) was created under §40-15-208 C.R.S. with the Commission designated as its administrator.

High Speed Packet Access (HSPA): A family of 3G digital data services provided by cellular carriers worldwide that uses the GSM technology. HSPA service works with HSPA cell phones as well as laptops and portable devices with HSPA modems. The two established standards of HSPA are HSDPA (downlink) and HSUPA (uplink).

HSPA: See High Speed Packet Access.

ICT: See Information Communication Technologies.

ILEC: See Incumbent Local Exchange Carrier.

Incumbent: An existing network owner or service provider.

Incumbent Local Exchange Carrier (ILEC): The dominant local phone carrier within a geographical area. Section 252 of the Telecommunications Act of 1996 defines Incumbent Local Exchange Carrier as a carrier that, as of the date of enactment of the Act, provided local exchange service to a specific area. In contrast, competitive access providers and competitive local exchange carriers (CLECS) are companies that compete against the ILECs in local service areas.

Information Communication Technologies (ICT): Information and communication based technologies.

Inside Plant (ISP): Electronics, wiring, and other accouterments associated with telecommunications networks located within community cabinets, central offices, or other shelters.

Integrated Services Digital Network (ISDN): A set of CCITT/ITU standards for digital transmission over ordinary telephone copper wire as well as over other media. Home and business users who install an ISDN adapter

(in place of a telephone modem) receive Web pages at up to 128 Kbps compared with the maximum 56 Kbps rate of a modem connection.

Interconnect: The term interconnect is used in two different ways: a) to describe the connection between a service provider and the Internet – also known as backhaul and b) the logical and physical infrastructure used to connect two non-congruous service areas. In either case, interconnect is usually part of the middle mile infrastructure.

Interexchange Carrier (IXC): A telecommunications service provider authorized by the FCC to provide interstate, long distance communications services and authorized by the state to provide long distance intrastate communications services. Also known as an Interexchange Common Carrier.

Interexchange Common Carrier: See Interexchange Carrier.

International Standards Organization (ISO): The body charged with developing and advertising international standards.

Internet Exchange Point (IXP): See Peering Point.

Internet Protocol Television (IPTV): A method of delivering television services using the Internet Protocol.

Internet Service Provider (ISP): A company or organization that provides a connection to the public Internet, often owning and operating the last mile connection to the end user locations.

Investment Gap: The amount of funding necessary to upgrade or extend existing infrastructure up to the level necessary to support the National Broadband Availability Target. The investment gap is sometimes referred to as the broadband availability gap.

IP: See Internet Protocol.

IPTV: See Internet Protocol Television.

Irrevocable Right of Use (IRU): A method of leasing fiber or other existing telecommunications assets that gives the lease an irrevocable right of use for some period of time. IRU's are typically counted as capital expenses but under some circumstances can be operational expenses.

IRU: See Irrevocable Right of Use.

ISDN: See Integrated Services Digital Network.

ISO: See International Standards Organization.

ISP: See Internet Service Provider or Inside Plant.

IXC: See Interexchange Carrier.

IXP: See Internet Exchange Point.

Kbps: See Kilobits per Second.

Kilobits per Second (Kbps): A measure of transmission speed. Kbps < Mbps < Gbps. As a comparison, a high definition movie with surround sound is about 8.3 GB in size. To download this size file with different technology transmission speeds:

	Days	Or Hours	Or Minutes	Or Seconds	
Standard Dial-Up	13.72	329.3	19,761.90	1,185,714	**56 Kbps**
Fast Dial-Up	12.00	288.1	17,291.67	1,037,500	**64 Kbps**
T-1	0.51	12.2	737.78	44,266	**1.55 Mbps**
Standard DSL	0.25	6.1	368.89	22,133	**3 Mbps**
Fast DSL	0.05	1.2	73.78	4,426	**15 Mbps**
Fast Cable	0.03	0.9	55.33	3,320	**20 Mbps**
100 Mbps Fiber	0.007	0.18	11.07	664	**100 Mbps**
1 Gbps Fiber	0.0008	0.018	1.11	66	**1 Gbps**

Last Mile: Describes the final leg of a connection between a service provider and the customer and is often synonymous with the local loop. In DSL and cable systems, this is the most common bandwidth bottleneck.

LATA: See Local Access and Transport Area.

Latency: The amount of time it takes for a bit to get from point A to point B.

LEC: See Local Exchange Carrier.

Levelized: A method, often used in regulatory proceedings, to calculate the annuitized equivalent – i.e., the effective annual value of cash flows – of the costs and revenues associated with building and operating a network. A "levelized" calculation provides a steady cash-flow stream rather than trying to model or guess the timing of largely unpredictable yet sizeable real-world payouts like those for upgrading and repairing equipment. The present value of a levelized cash flow is equal to the present value of actual cash flows.

Line of Sight: Requiring an unimpeded view from one site to another.

Link Budget: A calculation involving the gain and loss factors associated with the antennas, transmitters, transmission lines and propagation environment used to determine the maximum distance at which a transmitter and receiver can successfully operate along a link.

Local Access and Transport Area (LATA): One of 196 local geographical areas in the US created by the Modified Final Judgment in which a divested Regional Bell Operating Company (RBOC) was permitted to offer local exchange telecommunications and local exchange access services.

Local Exchange Carrier (LEC): A regulatory term in telecommunications for a local telephone company.

Local Technology Planning Team (LTPT): A regional group with the purpose of planning and improving broadband.

Long Term Evolution (LTE): A high performance air interface for cellular mobile communication systems. LTE technology increases the capacity and speed of wireless networks relative to 3G deployments.

LTE: See Long Term Evolution.

LTPT: See Local Technology Planning Team.

Mbps: See Megabit per Second.

MDU: See Multiple Dwelling Unit.

Megabit per Second (Mbps): A measurement of data connectivity speed. Kbps < Mbps < Gbps.
As a comparison, a high definition movie with surround sound is about 8.3 GB in size. To download this size file with different technology transmission speeds:

	Days	Or Hours	Or Minutes	Or Seconds	
Standard Dial-Up	13.72	329.3	19,761.90	1,185,714	**56 Kbps**
Fast Dial-Up	12.00	288.1	17,291.67	1,037,500	**64 Kbps**
T-1	0.51	12.2	737.78	44,266	**1.55 Mbps**
Standard DSL	0.25	6.1	368.89	22,133	**3 Mbps**
Fast DSL	0.05	1.2	73.78	4,426	**15 Mbps**
Fast Cable	0.03	0.9	55.33	3,320	**20 Mbps**
100 Mbps Fiber	0.007	0.18	11.07	664	**100 Mbps**
1 Gbps Fiber	0.0008	0.018	1.11	66	**1 Gbps**

Metropolitan Optical Ethernet (MOE): CenturyLink's branding for fiber to the premises.

Microwave: Microwave transmission refers to the technique of transmitting information over microwave frequencies using various integrated wireless technologies. Microwaves are short wavelength high frequency signals that occupy the electromagnetic spectrum 1 GHz to roughly 300 GHz. This is above the radio frequency range and below the infrared range. Microwave transmissions can travel a long distance but must be line of sight

Middle Mile: Middle mile is a term most often referring to the network connection between the last mile and the greater Internet.

Middle mile infrastructure is sometimes referred to as backhaul.

MIMO: See Multiple Input Multiple Output.

Mobile Switching Center (MSC): The mobile switching center connects the landline public switched telephone network (PSTN) system to the wireless communications system. The MSC is typically split into a mobile switching center server and a media gateway and incorporates the bearer independent call control.

Mobile Wireless: Data connectivity from a cellular network.

MOE: See Metropolitan Optical Ethernet.

MPLS: See Multiprotocol Label Switching.

MSC: See Mobile Switching Center.

MSO: See Multi-System Operator.

MTFB: See Mean Time Between Failures.

MTU: See Multiple Tenant Unit.

Multi-System Operator (MSO): Typically refers to a firm that owns more than one cable television network infrastructure.

Multiple Dwelling Unit (MDU): A building or property with multiple individual residential addresses like an apartment building.

Multiple Input Multiple Output (MIMO): An antenna technology for wireless communications in which multiple antennas are used at both the source (transmitter) and the destination (receiver). The antennas at each end of the communications circuit are combined to minimize errors and optimize data speed.

Multiple Tenant Unit (MTU): A building or property with multiple individual business addresses like a strip mall or office building.

Multiprotocol Label Switching (MPLS): A mechanism in high-performance telecommunications networks which directs and carries data from one network node to the next. MPLS makes it easy to create "virtual links" between distant nodes. It can encapsulate packets of various network protocols.

National Association of Telecommunications Officers and Advisors (NATOA): NATOA is comprised of local government officials and employees that work on cable and broadband issues – from public access television to managing the community's rights of way.

National Broadband Availability Target: The level of service set in the National Broadband Plan that should be available to every household and business location in the U.S. The initial target is an actual download speed of at least 4 Mbps and an upload speed of at least 1 Mbps, with a proposed review and update every four years.

National Broadband Plan: A Federal Communications Commission plan to improve Internet access in the United States.

National Telecommunications and Information Administration (NTIA): A division of the Department of Commerce.

NATOA: See National Association of Telecommunications Officers and Advisors.

Natural Monopoly: A monopoly in an industry in which it is most efficient (involving the lowest long-run average cost) for production to be concentrated in a single firm.

NCB: See Northwest Colorado Broadband.

Network Management System (NMS): A combination of hardware and software used to monitor and administer a computer network or networks. Individual network elements in a network are managed by an element management system.

Network Operations and Dispatch Center (NODC): When a network operations center also has crew dispatch functions it is sometimes called a network operations and dispatch center.

Network Operations Center (NOC): The centralized location where the network is

monitored and restoration, maintenance, and operations are coordinated.

Network Owner: An organization owning (and possibly operating) telecommunications infrastructure.

NMS: See Network Management System.

NOC: See Network Operations Center.

NODC: See Network Operations and Dispatch Center.

Node: An active or passive element in a cable or telephone system where neighborhood distribution (or access level infrastructure) begins. Often a node is where fiber transitions to copper local loop infrastructure.

Node Splitting: In a cable system, adding infrastructure so that subscribers previously served by a single node are moved to multiple nodes reducing the number of subscribers per node.

Northwest Colorado Broadband (NCB): An organization in Steamboat Springs, Colorado operating a carrier neutral location.

Northwest Colorado Council of Governments (NWCCOG): See http://nwccog.org/.

NTIA: See National Telecommunications and Information Administration.

NWCCOG: See Northwest Colorado Council of Governments.

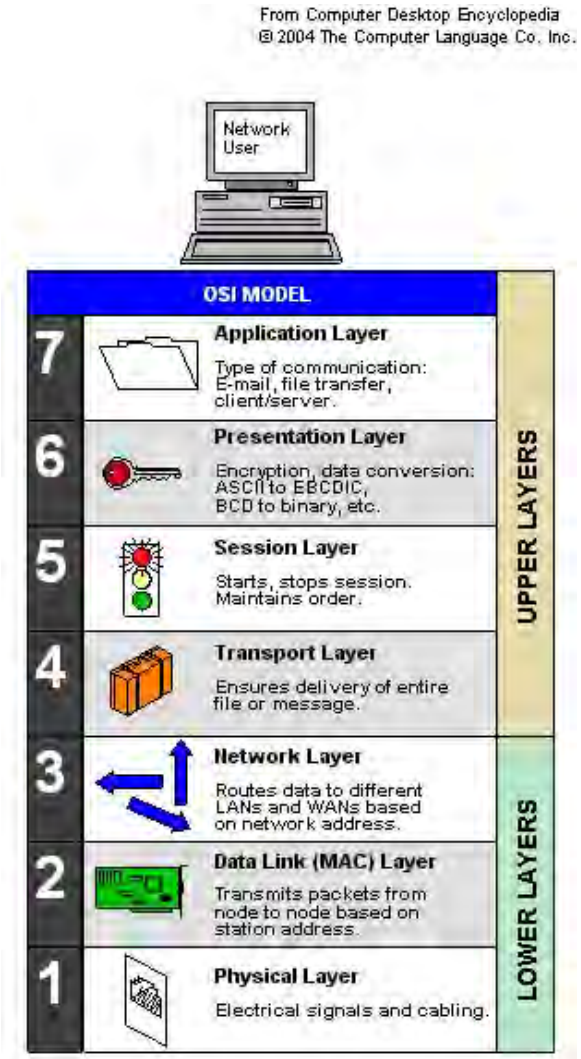
OECD: See Organization for Economic Cooperation and Development.

OFAP: See Optimal Fiber Allocation Plan.

ONT: See Optical Network Termination.

Open Access Network: A network designed and operated on the principal of a wholesale/retail split in which the network owner makes wholesale infrastructure and services available to competing service providers who provide retail services to end customers.

Open Systems Interconnect (OSI): The ISO model that defines the seven layers of activity in a data communication network.



Operational Expense (OpEx): An expense a business incurs over the course of its normal operations. Examples include product overhead, employee salaries and electric bill payments. Importantly, operating expenses on a balance sheet reflect only ordinary expenses rather than unexpected, one-time expenses. One subtracts the operating expense from operating revenue to determine the operating profit.

OpEx: See Operational Expense.

Optical Network Termination (ONT): The device in a PON architecture that terminates the optical network at the customer's premises. In many active architectures the parallel device is called an AP or EDD}

Optimal Fiber Allocation Plan (OFAP): In designing a fiber network, engineers must take into consideration the cost of aggregation points vs. the cost of the fiber plant itself. The OFAP describes the balance point where the greatest efficiency in both aggregation and fiber plant is achieved.

Organization for Economic Cooperation and Development (OECD): The mission of the OECD is to promote policies that will improve the economic and social well-being of people around the world.
The 30 member countries are: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States.

OSI: See Open Systems Interconnect.

OSP: See Outside Plant.

OTT: See Over the Top.

Outside Plant (OSP): The outside plant is that portion of the physical network that delivers services to the subscribers' homes that lies between the CO or node and the premises demarcation. Outside plant consists of conduit, fiber, cable, handholes, communications shelters, and other elements.

Outside Plant System of Record: The outside plant system of record is any system used as the definitive record of the outside plant.

Over Subscription Rate: The ratio of retail bandwidth to wholesale bandwidth used by and ISP to manage bandwidth costs.

Over the Top: Services carried over an Internet connection. For example, OTT video would include video delivered by Hulu or YouTube.

Overbuild: The process of deploying a network in an already developed area – usually where existing telecommunications networks already exist.

Overlash: The process of adding additional cable to an existing aerial route.

P2P: See Peer to Peer.

PARCC: See Partnership for Assessment of Readiness for College and Careers.

Partnership for Assessment of Readiness for College and Careers (PARCC): An organization that creates a standard set of K-12 assessments in math and English.

Passive Optical Network (PON): A fiber architecture that shares bandwidth with multiple subscribers through passive splitters.

PBX: See Private Branch Exchange.

PCS: See Personal Communications Service.

Peer to Peer: A type of network or service that allows computers to connect directly to each other rather than organizing them via hierarchical connections.

Peering: A relationship between two or more ISPs in which the ISPs create a direct link between each other and agree to forward each other's packets directly across this link.

Peering Point: A physical location where peering occurs.

PEG: See Public Access, Education, and Government.

Personal Communications Service (PCS): The FCC term used to describe a set of 2G mobile communications digital cellular technologies working over CDMA, GSM, and TDMA air interfaces

Plain Old Telephone Service (POTS): The basic single line switched access service offered by local exchange carriers to residential and business end users, using loop-start signaling.

Point of Presence (PoP): A physical location where one network hands off to another.

PON: See Passive Optical Network.

PoP: See Point of Presence.

POTS: See Plain Old Telephone Service.

Primary Revenue: Revenue created from direct charges.

Private Branch Exchange (PBX): A telephone system within an enterprise that switches calls between enterprise users on local lines while allowing all users to share a certain number of external phone lines.

PSTN: See Public Switched Telephone Network.

Public Access, Education, and Government (PEG): These are commonly programming options made available to the community by the cable company as part of its franchise agreement.

Public Switched Telephone Network (PSTN): The worldwide collection of interconnected public telephone networks that was designed primarily for voice traffic. The PSTN is a circuit-switched network, in which a dedicated circuit (also referred to as a channel) is established for the duration of a transmission, such as a telephone call. This contrasts with packet switching networks, in which messages are divided into small segments called packets and each packet is sent individually. Packet switching networks were initially designed primarily for data traffic.

QOS: See Quality of Service.

Quadruple Play: A triple play with cell phone service. Sometimes called a "Grand Slam".

Quality of Service (QOS): The ability to provide different priority to different applications, users, or data flows, or to guarantee a certain level of performance to a data flow in a data network.

Radio Frequency Over Glass (RFoG): An evolutionary technology that allows cable companies to offer an all-fiber architecture (not hybrid-fiber coax) without changing modulation schemes. RFoG is a standard in development for Point to Multipoint (P2MP) operations that has a proposed wavelength plan compatible with data PON solutions including EPON and 10G-EPON.

RBOC: See Regional Bell Operating Company.

Regional Bell Operating Company (RBOC): Local exchange carriers formed after the breakup of AT&T in 1984. The seven regional holding companies (RHCs) of roughly equal size were formed as a result of the 1982 Consent Decree AT&T signed with the US Department of Justice, stipulating that it would divest itself of its 22 wholly owned telephone operating companies. The seven RHCs were Ameritech, Bell Atlantic, BellSouth, NYNEX, Pacific Telesis, Southwestern Bell and US West. After a series of acquisitions, mergers and name changes (including one in which a combination of several RHCs reclaimed the original AT&T name), only three of the original seven remain. They are AT&T, CenturyLink, and Verizon.

Regional Tandem: A tandem switch is an intermediate switch or connection between an originating telephone call or location and the final destination of the call. These are hub facilities that interconnect telephone central office exchanges and are deployed by geographical region within a telco LATA or exchange.

RFoG: See Radio Frequency Over Glass.

Right of Way (ROW): The legal right, established by usage or grant, to pass along a specific route through grounds or property belonging to another.

ROW: See Right of Way.

Rural Utilities Service (RUS): A division of the US Department of Agriculture. RUS has a division responsible for providing low interest loans to telecommunications network owners to deploy broadband technologies in rural areas.

RUS: See Rural Utilities Service.

SB 152: See Senate Bill 152.

SCAN: See Southwest Colorado Access Network.

SDV: See Switched Digital Video.

Second Mile: Generally refers to the transport and transmission of data communications

from the first point of aggregation to the greater Internet or the peering point. Sometimes called middle mile or backhaul.

Secondary Revenue: Revenue generated through taxes or fees unrelated to the primary purpose of the assets.

Selling, General and Administrative Expense (SG&A): Corporate overhead costs, including expenses such as marketing, advertising, salaries and rent. SG&A is found on a corporate income statement as a deduction from revenues in calculating operating income.

Senate Bill 152: In Colorado, the legislation governing municipal/public telecommunications provisioning codified as CRS 29-27.

Service Area: An area served by a community cabinet.

Service Provider: An organization providing telecommunications or broadband services.

Set Top Box (STB): The device used to translate IPTV or other digital television signals to useful information to the customer's television.

SG&A: See Selling, General and Administrative Expense.

Signal to Interface plus Noise Ration (SINR): For a wireless communications device, the ratio of the received strength of the desired signal to the received strength of undesirable signals (noise and interference).

SIM: See Subscriber Identity Module.

SINR: See Signal to Interface plus Noise Ratio.

SIPA: See State Internet Portal Authority.

SLIGP: See State and Local Implementation Grant Program.

Southwest Colorado Access Network (SCAN): An effort undertaken by the Southwest Colorado Council of Governments to improve broadband by building local distribution rings.

Spectrum Allocation: The amount of spectrum dedicated (or allocated) to a specific use. In wireless, spectrum allocation is typically made in paired bands with one band for upstream and the other for downstream.

SSB: See Subscriber Splice Box.

State and Local Implementation Grant Program (SLIGP): The Middle Class Tax Relief and Job Creation Act of 2012 authorized the creation of the first nationwide broadband network for public safety, the First Responder Network Authority (FirstNet). The law also directed NTIA to develop a grant program for states to support planning, education and outreach as they consult with FirstNet on the deployment of the broadband network, which will enable first responders to better communicate during emergencies and save lives. NTIA's State and Local Implementation Grant Program gives states the resources needed to consult with FirstNet on deployment of a nationwide public safety broadband network.

State Internet Portal Authority (SIPA): See http://www.colorado.gov/sipa.

STB: See Set Top Box.

Subscriber Splice Box (SSB): The splice location where a subscriber's drop level infrastructure enters the network. May also be called a customer access point (CAP).

Switched Digital Video (SDV): A network scheme for distributing digital video via a cable more efficiently to free up bandwidth for other uses. Only channels being watched by end users in a given node are transmitted to that node.

Symmetrical: Internet connections have two components - a downstream and upstream. When the two speeds are comparable, the connection is termed symmetric. Fiber-optic networks more readily offer symmetrical connections than DSL and cable, which are inherently asymmetrical. Ultimately, purely symmetrical connections are less important than connections which offer robust

connections in both directions. However, many asymmetrical connections via DSL and cable networks offer upload speeds that are too slow to take advantage of modern applications.

T1: A mode of frequency division multiplexing that provides 1.544 Mbps or 24 voice channels. Sometimes called DS1.

TA: See Terminal Adapter.

Take Rate: Represents the number of subscribers divided by the number of potential subscribers. There are several different models for defining both subscribers and potential subscribers.

TCP/IP: See Transmission Control Protocol/Internet Protocol.

TDM: See Time Division Multiplexing.

TDMA: See Time Division Multiple Access.

Telco: *Tel*ephone *Co*mpany. A provider of telecommunications services such as voice and data services. Also called common carriers or Local Exchange Carriers.

Telecommunication Act of 1996: Current US federal law governing telecommunications regulation.

Telepresence: Refers to a variety of methods to use technology to make it seem like a person in a remote location is present. The more bandwidth available, the more realistic the telepresence.

Terminal Adapter (TA): The CPE device used to convert VOIP signals to traditional telephone signals so customers do not require specialized telephones.

Tier 1 Network: An Internet Protocol network that participates in the Internet solely via settlement-free interconnection, also known as settlement-free peering.

Tier 2 Network: An Internet service provider who engages in the practice of peering with other networks, but who still purchases IP transit to reach some portion of the Internet.

Tier 3 Network: Used to describe networks who solely purchase IP transit from other networks (typically Tier 2 networks) to reach the Internet.

Time Division Multiple Access (TDMA): Technology used in digital cellular telephone communication that divides each cellular channel into three time slots in order to increase the amount of data that can be carried. TDMA is used by Digital-American Mobile Phone Service (D-AMPS), Global System for Mobile communications (GSM), and Personal Digital Cellular (PDC). Each of these systems implements TDMA in somewhat different and potentially incompatible ways. An alternative multiplexing scheme to FDMA with TDMA is CDMA (code division multiple access), which takes the entire allocated frequency range for a given service and multiplexes information for all users across the spectrum range at the same time.

Triple Play: The three main services offered over modern broadband networks - television, phone services, and Internet access - comprise the triple play. Many consumers like to get all three from the same service provider on the same bill. Service providers frequently offer deals that will lower the cost on these packages.

UMTS: See Universal Mobile Telecommunications System.

Uninterruptable Power Supply (UPS): A batter device that continues to deliver power to connected electronics when other power fails.

United States Department of Agriculture (USDA): See http://www.usda.gov/wps/portal/usda/usdahome.

Universal Mobile Telecommunications Service (UMTS): Third-generation (3G) broadband, packet-based transmission of text, digitized voice, video and multimedia at data rates up to and possibly higher than 2 Mbps, offering a consistent set of services to mobile computer and phone users. Based on the

Global System for Mobile (GSM) communication standard.

Universal Service Fund (USF): A federal program funded by telecommunications surcharges with four programs: high cost (subsidizes the high cost of services in rural areas), low income (includes Lifeline and Link Up discounts to those in poverty), rural health care (reduced rates to rural health care providers to ensure they have access to similar services as urban counterparts), and schools and libraries (E-Rate subsidizes telecommunication services to schools and libraries).

Unserved: Those addresses without access to a broadband network capable of offering service that meets the National Broadband Availability Target.

Upload: Internet connections have two components - a download and upload. Upload refers to the rate at which the user's computer can send data to the Internet. DSL and cable networks frequently offer upload speeds at only 1/10 of the download speeds. This is one of the main reasons DSL and cable networks are insufficient for the modern Internet.

UPS: See Uninterruptable Power Supply.

Upstream: Generic term referring to traffic going from the subscriber location towards the network core.

USDA: See United States Department of Agriculture.

USF: See Universal Service Fund.

Unbundle: The process of making network elements available to competing service providers.

U-Verse: see AT&T U-Verse.

Verizon Fiber Optic System (FiOS): FiOS (Fiber Optic Service) is a "fiber to the home" (FTTH), implementation undertaken by Verizon. A typical FiOS package includes high-speed Internet access along with cable TV and basic telephone service. For consumer use, FiOS Internet access is available at downstream speeds between 15 and 300 megabits per second (Mbps) and upstream speeds between 5 and 65 Mbps.
Verizon has built its FiOS network in most of the states where it offers landline communications services.

Virtual Local Area Network (VLAN): A method of using common carrier networks to include disparate devices on the same broadcast domain.

Virtual Private Network (VPN): A set of protocols used to build and secure a private connection through a public network.

VLAN: See Virtual Local Area Network.

Voice Over Internet Protocol (VOIP): A method of delivering voice services over an IP (packet switched) network.

VOIP: See Voice Over Internet Protocol.

VPN: See Virtual Private Network.

Wholesale Retail Split: One description of the telecommunications business model wherein the network owner and the retail service provider are not the same entity.

Wi-Fi: Wi-Fi is a suite of protocols that allow wireless devices to exchange information using unlicensed frequencies. Equipment carrying the Wi-Fi brand is interoperable. Recently, a number of cities and some private companies attempted to blanket their cities with Wi-Fi but the technology is not well suited to such large scale efforts. Wi-Fi has proved tremendously successful in homes and businesses.

WiMax: Worldwide Interoperability for Microwave Access (WiMAX) is a telecommunications technology that uses radio spectrum to transmit bandwidth between digital devices. Similar to WiFi, WiMAX brings with it the ability to transmit over far greater distances and to handle much more data.

Wireless: Unwired telecommunications; either fixed wireless or mobile wireless.

Wireless Internet Service Provider (WISP): An Internet service provider that provides fixed or mobile wireless services to its customers. Using Wi-Fi or proprietary wireless methods, WISPs provide last mile access, often in rural areas and areas in and around smaller cities and towns.

WISP: See Wireless Internet Service Provider.

9.6 SOURCES

This section includes:

- References and Recommended Reading
  - Web Sites
    - Regional Providers
    - Other Web Sites
  - References and Recommended Reading
- Research Notes
  - Google Earth Notes
    - Antenna Research
    - Community Anchor Institutions
    - Fiber Path Research
    - Phone Switch Research

9.6.1 REFERENCES AND RECOMMENDED READING

This appendix provides references and recommended reading. It is divided into:

- Web Sites and
- References and Recommended Reading.

9.6.1.1 WEB SITES

Two categories of web sites are provided:

- Regional Providers and
- Other Web Sites.

9.6.1.1.1 REGIONAL PROVIDERS

- Cedar Networks. http://www.cedarnetworks.com/.
- CenturyLink. http://www.centurylink.com/.
- Comcast. http://www.comcast.com/.
- EAGLE-Net. https://www.co-eaglenet.net/.

- EAGLE-Net. EAGLE-Net Network Map. http://www.co-eaglenet.net/btop/map/. Shows existing and planned EAGLE-Net infrastructure.
- FastTrack Communications. http://www.fasttrackcomm.net/.
- Glenwood Springs Community Broadband Network. http://www.gscbn.com/.
- Google Earth. http://www.google.com/earth/index.html. Used to present mapped data.
- Grand County Internet. http://www.rkymtnhi.com/.
- Internet Colorado. http://internetcolorado.net/.
- Jab Broadband/Skybeam. http://www.skybeam.com/.
- San Isabel. http://www.sanisabel.com/index.htm.
- Slopeside Internet. http://www.slopesideinternet.com/.
- Strata Networks. http://stratacolorado.com/.
- Strata Networks Colorado fiber map. http://stratacolorado.com/fiber.php. Viewed 10 April 2013.
- Union Wireless. http://www.unionwireless.com/.
- Zirkel Wireless. http://www.zirkelwireless.com/.

9.6.1.1.2 OTHER WEB SITES

- Broadband.gov. http://www.broadband.gov/.
- Brookings Institute Broadband Policy. http://www.brookings.edu/research/topics/broadband-policy.
- CivSource. http://civsourceonline.com/.
- Colorado Broadband Data and Development Program. http://www.colorado.gov/cs/Satellite/OIT-StateInitiatives/CBON/1251575390656.
- Colorado Broadband Map. http://www.colorado.gov/cs/Satellite/OIT-StateInitiatives/CBON/1251575390656.
- Colorado Broadband Planning. http://www.colorado.gov/cs/Satellite/OIT-StateInitiatives/CBON/1251638684831.
- Columbia Institute for Tele-Information (CITI) at Columbia Business School. http://www8.gsb.columbia.edu/citi/.
- Community Broadband Networks. http://www.muninetworks.org/. Institute for Local Self-Reliance.
- Computer Desktop Encyclopedia. http://www.computerlanguage.com/. Provides definitions of information technology terms and concepts.
- Digital Communities. http://www.digitalcommunities.com/.
- Earth Point. http://www.earthpoint.us/. Used for converting Excel data to Google Earth.
- FCC Antenna Structure Registration – Registration Search. http://wireless2.fcc.gov/UlsApp/AsrSearch/asrRegistrationSearch.jsp. Provides FCC registered antenna structure data.
- FCC Degrees, Minutes, Seconds and Decimal Degrees Latitude/Longitude Conversions. http://transition.fcc.gov/mb/audio/bickel/DDDMMSS-decimal.html. Tool for converting degrees, minutes and seconds latitude and longitude to the decimal latitude and longitude needed for Google Earth.

- FCC Public Safety and Homeland Security Bureau: Broadband and Public Safety. http://transition.fcc.gov/pshs/broadband.html.
- Google Analytics: Global Broadband Performance. http://www.google.com/publicdata/explore?ds=z8ii06k9csels2_#!strail=false&bcs=d&nselm=s&ifdim=region&hl=en_US&dl=en_US&ind=false.
- Fiber to the Home Council. http://www.ftthcouncil.org/.
- HTTP Archive. http://httparchive.org/.
- Information Technology and Innovation Foundation. http://www.itif.org/.
- Institute for Local Self-Reliance: Broadband. http://www.ilsr.org/initiatives/broadband/.
- KML Circle Generator for Google Earth. http://www.thesamestory.com/kmlcircle/. Used to draw circles on Google Earth.
- Level 3 Interactive Network Map. http://maps.level3.com/default/. Map of Level 3 fiber assets.
- Missouri Broadband. http://mobroadbandnow.com/.
- MobilePulse. http://www.mobilepulse.com/.
- National Broadband Plan. http://www.broadband.gov/.
- Net Index. http://www.netindex.com/.
- NTIA: Public Safety. http://www.ntia.doc.gov/category/public-safety.
- Pew Internet and American Life Project. http://pewinternet.org/.
- Speed Matters. http://www.speedmatters.org/.
- State of Utah Broadband Project: Public Safety. http://broadband.utah.gov/resources/public-safety/.
- TelcoData.us: Telecommunications Database. http://www.telcodata.us/. Consolidates and presents significant information on telephone exchanges.
- Telecom Ramblings. http://www.telecomramblings.com/. Provides insight into the telecommunications industry.
- US Census. http://www.census.gov/.
- USDA Rural Development. http://www.rurdev.usda.gov/utp_farmbill.html.
- Your Dictionary. http://www.yourdictionary.com/. Used for some term definitions.

9.6.1.2 REFERENCES AND RECOMMENDED READING

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9.6.2 RESEARCH NOTES

The tools, sources, and methods used to collect the data for this report influence the results. The following sections list some of the tools, sources, and methods used.

The following sections summarize:

- Google Earth Notes

9.6.2.1 GOOGLE EARTH NOTES

Google Earth is a good tool for overview mapping. It is not appropriate for detailed design work or as the basis for extensive geographic database data.

We are not using Google Earth's dynamic data capabilities. All of the data we have collected is subject to change through time.

On Google Earth we are depicting:

- Antenna Research
- Community Anchor Institutions
- Fiber Path Research
- Phone Switch Research
- Selected Survey Data

- Service Provider Reported Service Areas

Most of the data mapped in Google Earth is contained in Microsoft Excel Spreadsheets. The relevant spreadsheets are listed in the following data sections. These spreadsheets were converted to Google Earth using the Earth Point Excel to KML tool at http://www.earthpoint.us/ExcelToKml.aspx. In most cases, once data points were imported, they have been reorganized and otherwise manipulated.

Circles are not a simple task in Google Earth. We used KML Circle Generator at http://www.thesamestory.com/kmlcircle/.

9.6.2.1.1 ANTENNA RESEARCH

Antenna data come from two primary sources:

1. FCC Registration Data
   The FCC antenna structure registration database can be found at http://wireless2.fcc.gov/UlsApp/AsrSearch/asrRegistrationSearch.jsp.
   We collected FCC antenna structure data 5 April 2013. We downloaded a report of all registered antennas in Colorado and then reduced the list to those in Eagle, Garfield, Grand, Jackson, Moffat, Pitkin, Rio Blanco, Routt, and Summit counties.
   FCC registration presents latitude and longitude in degrees, minutes, and seconds. Google Earth requires latitude and longitude in decimal notation. A conversion tool can be found at http://transition.fcc.gov/mb/audio/bickel/DDDMMSS-decimal.html.
2. Antenna Search Data

9.6.2.1.2 COMMUNITY ANCHOR INSTITUTIONS

Initial Community Anchor Institution, or CAI, data were derived from the work completed by the Governor's Office of Information Technology (GOIT) and provided by Megan Chadwick (megan.chadwick@state.co.us) on 1 May 2013. Ms. Chadwick provided a spreadsheet ("CAIs.xlsx") listing the CAIs GOIT had collected as of the report date.

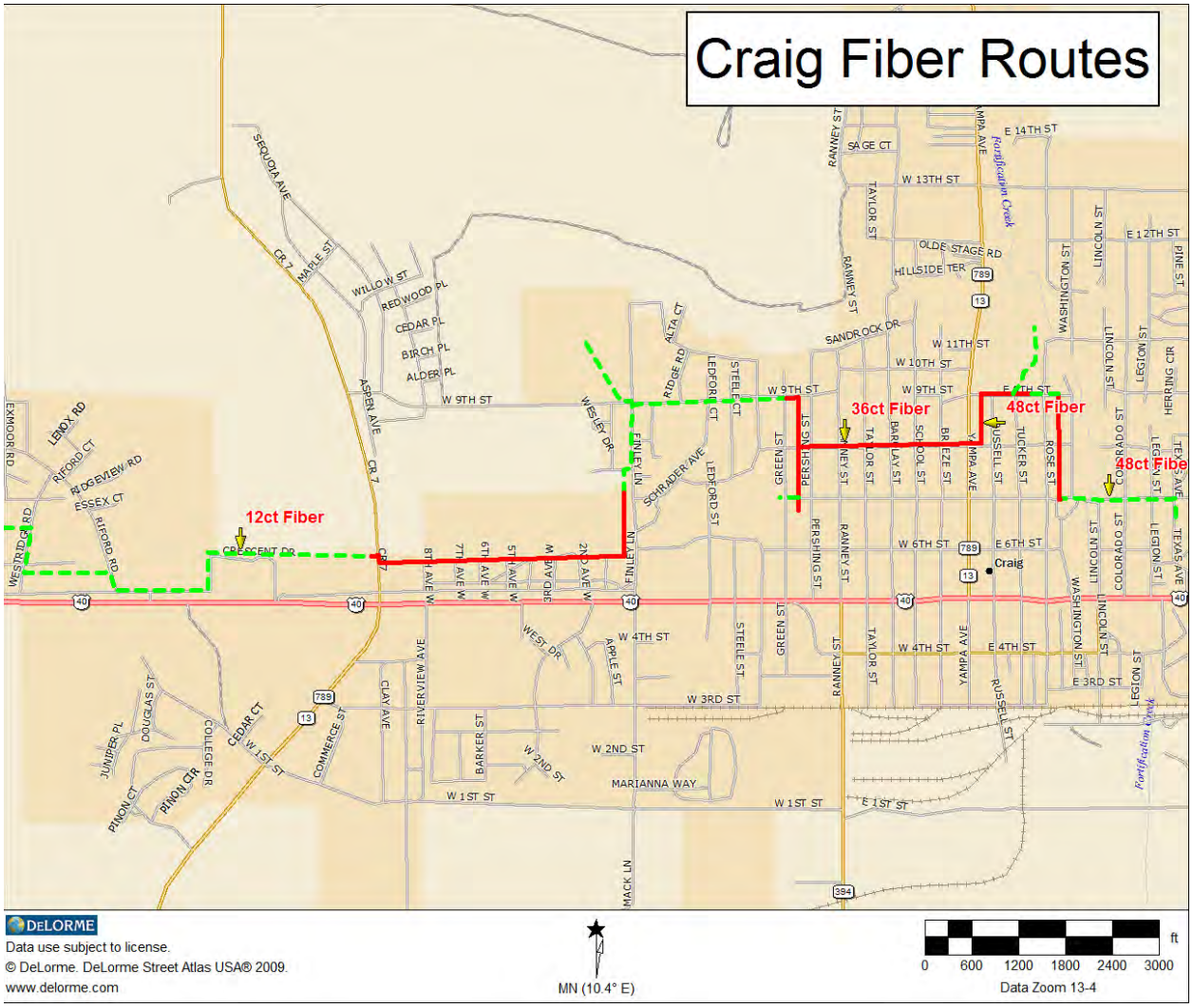
9.6.2.1.3 FIBER PATH RESEARCH

1. EAGLE-Net
   EAGLE-Net fiber paths are based on the map provided by EAGLE-Net at http://www.co-eaglenet.net/btop/map/ as of 3 May 2013.
   Some notes regarding the EAGLE-Net map:
   a. The path from Craig to Meeker to Rangely is along the same path as the former N. C. Telecom route, in part, by Strata networks. EAGLE-Net reports that they are not leasing from Strata on this path but rather from Tri-State Transmission. EAGLE-Net believes there may be fiber on both sides of the road with Strata owning one side and Tri-State Transmission the other. Some of the path was verified by confirming the presence of buried fiber markers. Field verification did not indicate two fiber paths.

b. The path from Craig to Steamboat Springs and the path from Glenwood Springs to Denver are flagged as "Under Development" on EAGLE-Net's site as of 3 May 2013.
c. The planned EAGLE-Net network does not suggest redundancy on the EAGLE-Net network north of the I-70 corridor.
d. The path on Highway 91 to Leadville is a fiber path flagged as "Future Development".
e. Walden, Oak Creek, Kremmling, Granby, and Aspen (i.e., all EAGLE-Net sites in Jackson, Grand, and Pitkin Counties) are projected to be served by microwave links flagged as "Future Development".

2. Level 3
According to the map at http://maps.level3.com/default/, Level 3 has a fiber path running along the railroad right of way from Denver to Rollinsville, Granby, Kremmling, Glenwood Springs, Rifle, and into Grand Junction and to Salt Lake City. Level 3 also has a northern route from Denver to Cheyenne and then along the I-80 Corridor to Salt Lake City.
3. Strata Networks (formerly N. C. Telecom)
Path map at http://stratacolorado.com/fiber.php (viewed 10 April 2013). Some of the path was verified by confirming the presence of buried fiber markers.

4. Unite Private Networks
At http://www.telecomramblings.com/metro-fiber-maps/the-rockies/ Telecom Ramblings provides a link to the following map of Unite Private Networks (UPN) fiber in Craig.



The UPN Site (http://upnllc.com/interactive-market-map/) does not show this asset.

The asset appears to connect school facilities.

9.6.2.1.4 PHONE SWITCH RESEARCH

The basis for our phone switch research is TelcoData.us (http://www.telcodata.us/). We first collected all the switches in the 970 area code on 11 March 2013. We then assigned each of them to Central (I-25 Corridor), NE (northeast), NWCCOG (Northwest Colorado Council of Governments study participating area), SW (Southwest Colorado not participating in Southwest Colorado Council of Governments), SWCCOG (Southwest Colorado Council of Governments participating area), W (Western Slope not in NWCCOG, SWCCOG, or SW). This resulted in "970 Switches.xlsx". Next we extracted the NWCCOG switches to add location data and other columns needed for the Earth Point Excel to KML tool giving us "GESwitch.xls".

9.6.2.1.5 SELECTED SURVEY DATA

Survey data regarding speed and service provider was geocoded using a KML generated from a mail merge based on the Excel extract of survey data.

9.6.2.1.6 SERVICE PROVIDER REPORTED SERVICE AREAS

Service provider reported service areas were collected from the National Broadband Map Broadband Provider Service Area (found for CenturyLink, for example, at http://www.broadbandmap.gov/provider/wireline/centurylink,-inc.). No extract of the shape files or a KMZ/KML is available so we simply took screenshots, modified them with Photoshop and placed them on Google Earth as photo overlays.