Region 10 Broadband Blueprint

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By

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NEO Fiber
Broadband Blueprint for Region 10

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1. Executive Summary

Introduction, Overview and Need for Better Broadband. Recognizing the impact of the lack of adequate broadband services, Region 10 members requested and received funding from the Colorado Department of Local Affairs, (herein referred to as "DOLA") to complete a broadband implementation plan. As a result, an innovative and cost-effective plan was developed to improve the broadband infrastructure within the Region.

NEO Fiber is a broadband consulting firm that was selected by Colorado Region 10 to develop an Implementation Blueprint for Broadband. NEO's mission is to assist its customers in all aspects of building and owning Last Mile FTTH and Middle Mile fiber optic networks.

According the DOLA grant submission that was submitted by Region 10, the economic health and survival of this region depends in large part on the availability and affordability of advanced telecommunication services; the region is suffering without them. The following information was compiled by Region 10 staff.[1] According to the State Demographer's office, Delta and Montrose counties are shrinking; between 2010 and 2013, they experienced the largest decreases in population in the entire region—mostly due to the outmigration for employment opportunities. Respectively, Montrose and Delta declined by 1.4 and 1.5 percent while the State of Colorado as a whole grew by 4.8 percent. These declines correlate with the higher than average unemployment rates in Montrose and Delta: 6.7 percent and 7.0 while the State of Colorado declined to 4.2 percent. At 61 percent higher unemployment in these counties compared to the whole state, the numbers are staggering and the implications reveal a grim reality.

The growth that has occurred since the downturn has and will continue to be seen in the northern Front Range along with some improvement in the Grand Junction area, according to a job growth report on Colorado Public Radio in 2014. State Demographer Elizabeth Garner has explained that, "It is taking longer for the western part of the state to recover." Even though Colorado regained its pre-recession peak in employment in May 2014, that recovery "hides a geographically lumpy recovery." Communities in the Western Slope have not recovered the jobs lost during the recession; compounding this setback is the recent $42 million dollar blow to Delta County's economy with the loss of a primary employer—a blow that impacts the entire region and the effect of which has yet to be fully realized.

[1] Region 10 grant submission to DOLA, April 1, 2015.

About 500 jobs directly related to coal-mining reductions were lost in just a little more than a year in Delta County, representing nearly 3.3 percent of the county's labor force of 15,252 as of October 2013. Coal-mining jobs, which averaged $84,000 a year in Colorado, represented some of the highest paying jobs within the community, particularly for those without a college education, well above the standard median wage of $32,684 in Delta County and $34,681 in Montrose County. It is estimated that the loss of 500 jobs at the average state wage amounted to $42 million.[2] Proportionate to population, the loss of 400 jobs compares to a similar loss of 19,000 jobs in the Denver metro area. Like any job loss, the immediate community impact is devastating but the lasting ripple effect is prolonged and extended to every other sector (education, government, and businesses) in the following months and years after families have left the community to follow jobs. For instance, the mine is one of the area's largest property taxpayers where most of the $1.2 million tax bill paid in 2013 went to local schools. In addition, both Montrose and Delta Counties' school population have decreased by about 400 students each in the prior two years.

Economic inequality between Front Range and Western Slope residents is well-documented. Median income in Montrose and Delta is approximately 25-percent lower than Colorado's. The average in Montrose and Delta counties is $43,898 while the State's is $58,433. These numbers may reflect in part citizens earning potential due to lower achievement in higher education. While the State of Colorado has a high school graduation rate of 90.2 percent, Montrose and Delta counties range between three and five percent lower. Higher education achievement rates are substantially bleaker: Montrose and Delta have between 12.5 and 19 percent less attainment than Colorado (37 percent). These economic realities and barriers to growth certainly play a part in the poverty rates for the two counties and the difference between the State's rate; Montrose is 16.4 percent; Delta is 17.5 percent. Colorado is 13.0 percent. Populations that fall into these categories are taxing on the state's economy as a whole, drawing on social support resources.

Compounding the economic disparities that exist in communities with and without broadband is the actual cost to access broadband-based services. As Diane Kruse writes in a white paper, "*Smart Infrastructure for our Future: Benefits of Advanced Networks, and Why it Matters*" which is also referenced in this document under Section 2, "The Internet and its associated technologies have impacted wealth, work, education, government, health, public safety, and education. Having equal access to advanced broadband networks bridges the digital divide and creates better equality between the haves and the have-nots." For communities without an open-access network, such as the model Region 10 proposes to establish, competition is likely non-existent with ownership to the networks limited to only a few providers. End-user pricing can be set at

[2] Delta County Economy Reels Reacts to Mine Closures, available at http://www.gjsentinel.com/news/articles/delta-county-economy-reels-reacts-to-mine-closures.

any level when competition with service providers' is unchallenged. Unfortunately, this pricing is often outside business's and residents' financial reach with more basic human needs being prioritized. These real life scenarios bring the digital inequality reality to bear where those with access to the network have greater opportunity (think, jobs and job announcements which are being pushed solely to the digital world) and those without, who do not. Creating an open-access network by linking community anchor institutions (such as a town halls, libraries community centers etc.) to a carrier neutral location that is not restricted to a single end-user provider (Internet Service Provider) helps to alleviate digital inequality issues.

An example of the demand placed on anchor institutions and where these services (when available) will directly and positively impact communities lies with the Montrose Library District. In 2014, the Library District experienced 35,000 single uses in the span of one year (approximately 100 uses a day spanned across the entire year). This demand is astounding for an institution that serves a city of approximately 20,000 residents alone, discounting the County's population of roughly 42,000. Improved service in Delta County libraries net nearly the same results, with many of the residents parked in library parking lots even after hours to gain access to internet service, due to lack of adequate services elsewhere. Whereas in many urban areas a private company will invest in the infrastructure to provide these services, it is not feasible on the Western Slope, with less financial capacity to afford the large capital outlays required. In April 2014, the City of Montrose voters approved an exemption to SB05-152 by a 3-to-1 margin. The overwhelming margin of support for the exemption is viewed as a mandate from our citizens to address local needs with local solutions. Clearly, the region has recognized the need for broadband services and asked local government to help build the infrastructure. Region 10's Broadband Implementation plan is a regional response to that demand.

Innovative municipalities across the nation are already recognizing the importance of leveraging gigabit level Internet to attract new businesses and create jobs, improve health care and education, and connect residents to new opportunities. Several of those communities, including one of Region 10's (City of Montrose), came together in formation of Next Century Cities (NCC) to further community-supported broadband services from a national level. NCC garnered the attention of the United States President[3] who included the organization in the State of the Union address out of recognition that community-supported broadband services paves the way for fast, affordable and reliable internet.

Community Outreach and Support. Region 10 and its consultant, NEO Fiber conducted community outreach meetings throughout the region. These meetings were well-

[3] Obama Wants Speed, US Broadband, available at http://thenextweb.com/insider/2015/01/14/obama-wants-speed-us-broadband/.

attended and feedback from the community confirmed the vast need for better broadband services. Seventy business people from Montrose and Delta counties attended the Delta Montrose Electric Association (DMEA) board meeting to stress the importance of broadband on their businesses and the communities within the county. Overwhelming support for this project was reinforced throughout the engagement process of putting together the broadband blueprint. Section 2 of this report provides a detailed description of the Community Outreach and Support meetings that were conducted in support of this broadband blueprint and why having access to advanced broadband services matter.

The Technology Plan. Section 5 describes the technology plan recommended for Region 10. The technology plan leverages existing fiber optic infrastructure and is a cost effective approach to improving the availability, abundance and redundancy for the communities within Region 10. In order to improve the availability, abundance and redundancy of advanced broadband within Region 10, each of the communities within the region must have fiber optic or wireless access to one of the major Internet access points or hubs located in Grand Junction, Denver, Salt Lake City or Albuquerque. This access is often referred to as Internet backhaul or transport from the Internet hubs. Because the Internet backhaul or transport fees are often assessed based upon the distance or mileage from a community to one of these locations, the monthly fees are expensive. Currently anchor tenants and service providers are paying $6,000 - $15,000 per month for 1 Gbps. The network could be built in such a way to reduce the monthly access fees and to share in the costs of these monthly fees by aggregating usage over the regional network. Targeted pricing for 1 Gbps service after the network has been implemented is $1,200 - $1,500 per month, a dramatic 75-90% less than what is currently being charged. With the ability to aggregate and allocate bandwidth, the cost for backhaul charges based upon mileage is dramatically reduced.

Network Architecture - High Capacity and Redundant, Self-Healing Rings. The network has been designed to include a ring-topology providing most of the communities within Region 10 network redundancy. Switching equipment will be deployed throughout the network to aggregate and allocate demand for bandwidth. Switching equipment will also detect outages or faults and will re-route traffic the other direction in the event of a disruption. The transport of the regional middle-mile network will be 40 Gbps. Handoffs from the network to the anchor institutions or service providers will be at either a 1 Gbps or 10 Gbps.

The management and monitoring of the network will be at a central location that is accessible from any location through a web interface, with email or text notification provided in the event of an outage or other significant event.

The Plan, Grant to Cover Capital Costs, Leverage Existing Assets. Existing fiber assets will be leveraged to keep capital costs down, to effectively use DOLA funds (i.e. not build fiber where there is existing fiber), and to allow for faster implementation of the regional network. IRUs for existing fiber from Tri-State for connectivity from Grand Junction to the Star Nelson power substation will be utilized. Additionally, DMEA will provide existing fiber connecting the communities within Delta and Montrose counties as a contribution toward the match requirement. A budget to perfect the easements for the DMEA routes is included in the capital costs. Easements for Tri-State's fiber have already been perfected on the route from Grand Junction to Starr Nelson. Other routes that are on Tri-State generation lines may need to be perfected for commercial use. New fiber will be built to extend the network from DMEA's and Tri-State's power substations to a carrier neutral location within each of the communities. Fiber will then be built from the carrier neutral location to anchor institutions. The capital costs also cover the switching equipment for both Phase 1 and Phase 2 of the plan, huts and cabinets for the carrier neutral locations and equipment that will be located at the anchor institutions. Costs for final design and engineering, project management and construction management are included in the budget.

Once this infrastructure is established and Phase 2 is underway, individual ISP's can apply for access to the network in order to deliver end-user service connections to businesses and residents. Phase 2 of the plan, which will be submitted in December, will include finishing the middle mile network and connections to anchor institutions within the remaining four counties.

Sustainable Approach, Operating and Monetizing the Network. Region 10 will monetize the network by offering Internet access and type 2 services (VLAN services) or a combination of both Internet access and VLAN service to ISPs. This is described in detail in this report under Section 7. ISPs will then provide services for the anchor institutions and ultimately to end users. The conservative financial model shows positive earnings with a five-year ramp-up serving 80% of the targeted 224 anchor institutions and providing Internet access to existing ISPs. Current pricing of $30-50 per Mbps would be dramatically reduced to $1.87 to $2.25 per Mbps with ample room for mark-up for the ISPs. ISPs could then extend this network to serve the other businesses and residents in the communities. This potential and additional revenue is not currently reflected in the financial model.

Final design, engineering, project management, program management and construction of the network would be outsourced. The network operations and management, truck rolls and repair service would also be outsourced. Sales, marketing, customer service and billing services would be provided by Region 10. A detailed financial model with assumptions, projected profit

and loss, cash-flow, balance sheet, and depreciation schedule has been provided to the Region 10 board and its members.

Aggregation of Demand. Currently the anchor institutions do not ever or rarely subscribe to Gigabit-type services as these services are presently unaffordable. Gbps Internet service pricing currently ranges between $6,000 - $15,000 per month. If the anchor institutions were connected on the Region 10 network and the aggregation of demand for Gigabit-type services were enabled, the anchor institutions would be able to receive pricing targeted at $1,800 - $2,200 per month, a dramatic improvement towards the affordability of abundant broadband.

Priorities, Plans, Recommendations and Next Steps. A list of priorities, options, recommendations and next steps are provided at the end of this report.

2. Benefits of Advanced Broadband Networks and Why This Matters, Highlights from Community Engagement and Support

Stimulate Economic Growth: Many municipalities across the country are deploying next-generation, high-bandwidth telecommunications networks as a means of stimulating economic growth and development.

Our world is changing; and it is doing so rapidly. Technology is impacting every part and parcel of our lives -- from where and how we conduct work, to whether or not we thrive economically and socially. It has impacted the way we live, our entertainment, our culture, the way government services are provided and accessed, the way healthcare is being delivered, and the way we educate our children and provide education to better improve our workforce. With the introduction and accelerated advancement of technologies, having access to affordable, redundant and abundant broadband is quickly becoming the most critical infrastructure of our time, just like electricity and transportation were in the early 1900's. Advanced broadband infrastructure has the potential to create more jobs, increase the community's competitive ability globally, create new technologies, increase opportunities for the region's companies, enhance public safety, provide better and less expensive healthcare, and provide greater educational opportunities throughout our community. In a recent meeting/webinar and report produced by Brookings in May of this year, fiber was added as a critical infrastructure.[4]

Advanced broadband networks are creating seismic changes in local, state, national and global societies, as well as markets, business and in institutions around the world. Access to social media and the Internet, has shifted governments, threatened national and local boundaries, inspired revolutions, and has changed us culturally. The Internet and its associated technologies have impacted wealth, work, education, government, health, public safety, and education. Having equal access to advanced broadband networks bridges the digital divide and creates better equality between the haves and the have-nots.

Like the introduction of electricity, advanced broadband networks are fundamentally changing our world in ways that were not expected or anticipated. Much like electricity, advanced broadband networks are the enabling technology in which all things are impacted. Electricity

[4] Joseph Kane and Robert Puentes, "Beyond Shovel Ready: The Extent and Impact of U.S. Infrastructure Jobs," Brookings Institution, (May, 2014) available at http://www.brookings.edu/research/interactives/2014/infrastructure-jobs#/M10420

was invented to turn on the lights, but empowered – literally, the transformation to an industrial society. Advanced broadband networks are now the enabling technology to transform us yet again, to a global technology and information society; the new Knowledge Economy. (See *Captive Audience* by Susan Crawford).

Just as it was impossible to know in advance the impact that electrification would provide the critical infrastructure to power all of our modern appliances, computers, health monitoring systems, manufacturing facilities, computers, radio and television, and financial markets; so too, is it impossible to predict the impact and reach of advanced broadband networks. We do not yet know the far reaching impacts that the Internet will have on our lives and on generations to come. However, it is certain that NOT having access to advanced broadband networks would be equivalent to being in the dark without electricity!

The incumbent providers of phone service, Internet and cable TV services are not building best-in-class broadband networks fast enough. The model by which these services are being provided needs to shift dramatically to enable faster deployment of advanced services, affordable broadband and abundant capacity to support our current and future needs for bandwidth.

Speed Matters. Global network traffic has quadrupled from 2009 to 2014. Both commercial and residential Internet bandwidth consumption are doubling every year.

Bandwidth refers to the capacity, or speed of the networks to carry traffic. The question is often presented, "How fast is fast enough?" and "What should be the definition of broadband?" The Federal Communications Commission (FCC), as part of its 2015 Broadband Progress Report, voted to change the definition of broadband by raising the minimum download speeds needed from 4Mbps to 25Mbps, and the minimum upload speed from 1Mbps to 3Mbps, This new definition of 25 Mbps download and 3 Mbps upload tripled the number of US households without adequate broadband access. Given the growth trends in bandwidth needs and network traffic, this definition is conservative and barely meets the minimum needs for bandwidth consumption today and certainly does not address the needs that are forthcoming.

In the early days of the Internet, text messaging, email and web sites were not data-rich or bandwidth intensive and the average consumer did not need more than 7 Mbps of bandwidth. When YouTube burst upon the scene in 2005, this dramatically changed things. One video download was the equivalent of downloading 30,000 web pages. Since that time, videos and picture-rich content have been downloaded and uploaded on a regular basis by the masses. The applications we use on the Internet are becoming much more feature-rich and bandwidth intensive and our existing networks cannot keep up with the demand for networks that support these applications.

The Fiber to the Home Council (FTTH) stated its position clearly in a brief to the FCC. "Even today, with most users still operating on last-generation broadband technologies, the capabilities of advanced video, cloud-based services, and other bandwidth-intensive applications are growing at a pace beyond what our existing networks are capable. Cisco and other scientific companies talk about the network in terms of "terabytes" of capacity in the network center, or "core."[5] According to the Cisco 2012 Zettabyte Report, businesses today routinely require symmetrical gigabit service between their locations."[6]

Also referenced in the Cisco 2012 Zettabyte Report, global Internet traffic grew 45 percent during 2009 alone and has doubled every year since then. Both commercial and residential Internet bandwidth consumption are doubling every year, as video, cloud computing, advanced storage solutions, telemedicine, telecommuting, video conferencing, etc., are becoming more prevalent from end users. Applications are becoming more bandwidth intensive and as more devices – tablets, Smartphones, computers, appliances – are being used both in the home and for business applications. ***Research conducted by Cisco states by 2016, there will be nearly three Internet Protocol or IP-connected devices per person.*** Internet-connected televisions, radios, set-top boxes, Blu-ray players, Netflix, cameras and picture frames now receive or deliver movies, TV and photos through the Internet.

According to FTTH's brief to the FCC referenced above, "the average monthly traffic in 2014 on the Internet has been equivalent to 32 million people streaming Avatar in 3D, continuously for the entire month." In 2014, video downloads and uploads comprised 50 percent of all Internet traffic. In the coming years, the sum of all forms of Internet Protocol (IP) video (Internet video, video on demand, video files exchanged through file sharing, video-streamed gaming, and videoconferencing) will reach 86 percent of the total Internet traffic. Applications supported by cloud-based services through multiple devices have created the need for always-on connectivity and advanced broadband network bandwidth.

[5] Fiber to the Home Council, "America's Petition to the Federal Communications Commission for Rulemaking to Establish a Gigabit Communities Race-to-the-Top Program," July 23, 2013.
[6] Cisco, "*The Zettabyte Era*" (May 30, 2012).

Application	Rate
Personal communications	300 to 9,600 bits/sec or higher
E-mail transmissions	2,400 to 9,600 bits/sec or higher
Remote control programs	9,600 bits/sec to 56 Kbits/sec
Digitized voice phone call	64,000 bits/sec
Database text query	Up to 1 Mbit/sec
Digital audio	1 to 2 Mbits/sec
Access images	1 to 8 Mbits/sec
Compressed video	2 to 10 Mbits/sec
Medical transmissions	Up to 50 Mbits/sec
Document imaging	10 to 100 Mbits/sec
Scientific imaging	Up to 1 Gbit/sec
Full-motion video	1 to 2 Gbits/sec

Service	Bandwidth	Number of Devices	Bandwidth Home Area Network	Bandwidth Residential Gateway to Network
TV	2 to 20 Mbps	3.5	2 to 70 Mbps	2 to 70 Mbps
DVR	2 to 20 Mbps	2	2 to 40 Mbps	0
Home Theater	1 to 6 Mbps	1	1 to 6 Mbps	0
Internet Browsing	1 to 20 Mbps	1 to 5	1 to 100 Mbps	1 to 10 MBPS
Printer	.5 to 1 Mbps	1 to 5	.5 to 5 Mbps	0
Digital imaging	1 to 20 Mbps	1 to 3	1 to 60 Mbps	0
On-line Gaming	.2 to 1 Mbps	1 to 3	.2 to 3 Mbps	.2 to 1 Mbps
Video Capture	.1 to 1 Mbps	1 to 10	.1 to 10 Mbps	.2 to 3 Mbps
Portable Audio	.1 to 20 Mbps	1 to 3	.1 to 60 Mbps	0
Total	**70 to 100 Mbps**		**12.5 to 354 Mbps +**	**4 to 84 Mbps +**

New Tools Enable Innovation

Table 1 Changing Patterns of Technology Adoption

While Internet bandwidth use is doubling, cellular networks are also greatly overextended.

In addition to explosive growth in Internet consumption from homes and businesses, mobile Internet use has also advanced dramatically. Smartphone applications are spurring higher consumption of multimedia services. With tablet computers and smartphones having easy access to games, e-books, TV programs, email, shopping, banking and social media sites, wireless service providers have been scrambling to upgrade their networks.

The need for advanced broadband connectivity must include both a consideration for fiber, connecting our businesses, offices and establishments, homes; as well as wireless and cellular, allowing for mobile and portable access as we travel, move about and commute.

Community Outreach and Support. All-Fiber networks are imperative, critical and necessary to stimulate economic development and growth. Municipalities, communities and regions that want to impact economic development must build 21st Century infrastructure.

NEO Fiber and Region 10 staff and members conducted community outreach meetings in Delta, Montrose, Paonia, Hotchkiss, Cedaredge, Gunnison, Telluride, the West End and Ouray. Additionally, NEO met with service providers throughout the Region to discuss how Region 10 could help promote more broadband services working in collaboration with the service providers.

Communities that do not have adequate bandwidth do not support this growth, in fact; people are leaving the communities in the Region because there is not adequate broadband infrastructure available. Simple applications such as webinars, online education, accessing web-based applications and databases cannot be conducted in our communities because the Internet available is too slow. Below are statements pulled from the community outreach meetings.

From Chris Yates, founder of The Hive in Paonia:
"Since opening the Hive co-working space earlier this year we have learned the critical importance of having broadband access in our community. While local residents have grown used to slow connection speeds, visitors to the Hive consistently express their disappointment at the slow or inconsistent bandwidth in the local area to the extent that they literally have to leave town to get work done. I have given tours to numerous visitors through our facility who are considering a move to our community, all of whom are either contract workers, self-employed, or the founders of small companies or start-ups. Most of them who decide not to move here make the decision because our bandwidth is too poor for them to conduct business. I can think of several people in the last few months who would have brought jobs and new services to our valley including a government contractor doing GIS mapping work, a video producer, a small business that manufactures a product and sells it exclusively online, and several others. None of these people are here now, and all mainly due to the lack of broadband. I believe that broadband access throughout our region is the single most important next step we could take to improving the local economy and our overall quality of life."

From Carrie Silvernail with Remax Mountain West in Cedaredge:
"....the current level of Internet is not sufficient. Webinars stall out while "buffering" and sometimes we get kicked off of the application we are using online because the service is too slow. Many web-based applications are utilized all day long, sometimes speed slows down or we have to re-boot our router and all work is lost. If broadband services were improved, we could provide online education and training, provide our real estate contracts online, obtain e-signatures and provide better contract management. My agents and clients would not have to drive in to an office location to connect to webinars."

Carrie Andrew, the Director of the Norwood Public Library writes:
"If we had better Internet service, we could use the Internet for all material circulation needs as our databases are hosted offsite as part of a statewide consortium. We, the staff, would use it for webinars and streaming video for educational purposes. If we had advanced broadband

service, we could offer distance learning classes, video conferencing and other features that require larger bandwidth."

From Beuford Durmon, Lake City Medical Center:
"The current level of service is inconsistent and slow. We use the Internet for reference to medical applications, transmission of large x-ray files. We need it for inter-facility communications and referrals, online education, telemedicine, education webinars and teleconferencing. If we had better Internet, our patient portal work better, we would have better patient communication."

Dan with Lake City Community School says:
"The service we have is not sufficient. We have about 75 devices using these two DSL connections during the day. We require students to use our proxy 24/7. If Internet service was improved we would use it for remote backup services, government reporting, device management and class room management

Communities meetings conducted by NEO Fiber throughout the region were well attended. Community members throughout the region stated they are unable to conduct their business properly because of slow Internet services. ***In Delta and Montrose counties, over 70 business people attended the Delta Montrose Electric Association's board meeting to show their support for having DMEA facilitate broadband deployment through use of DMEA's existing fiber network.***

Municipalities, communities and regions that have deployed all-fiber networks have already seen the tremendous economic impact of building symmetrical gigabit networks. These communities have fostered an environment of innovation, economic development and growth, collaboration, and creative activities. ***According to a 2012 survey of economic development professionals, 60 percent said that 1 Gigabit of service had a "definite impact" on new businesses that moved to an area (see Table 2).*** As having access to advanced broadband services is the number one priority for large businesses as they are looking for commercial real estate, the communities that have built gigabit-enabled fiber networks have already benefited economically by attracting businesses and industries to re-locate to their communities.

	Definite Impact	Indirect impact	Too soon to tell	No Impact	Difficult to measure	Total
New businesses moved to your area	60.35% 137	16.30% 37	14.98% 34	3.52% 8	4.85% 11	227
Revived depressed communities	26.22% 59	22.67% 51	29.33% 66	11.11% 25	10.67% 24	225
Individuals' income earning increases	24.23% 55	22.03% 50	29.96% 68	6.61% 15	17.18% 39	227
Revived depressed business districts	26.87% 61	22.03% 50	29.52% 67	13.66% 31	7.93% 18	227
Local companies more profitable, competitive	36.12% 82	33.04% 75	20.26% 46	5.29% 12	5.29% 12	227
Increase in home-based businesses	53.95% 123	15.35% 35	19.30% 44	3.51% 8	7.89% 18	228

Table 2 Fiber's direct impact on attracting new businesses to a community.[7]

After Chattanooga deployed their Gigabit network, the city attracted numerous high-tech firms, and entrepreneurs to relocate their company facilities, including Amazon, Alstom, and Volkswagen amongst others. Several venture capital firms were established in Chattanooga after their Fiber to the Home network was built because this fostered a business climate that was perfect for innovation and creativity. When surveyed, 42 percent of economic development professionals claimed that 1 Gigabit of service actually attracts new businesses to an area (see Table 3). Since building its gigabit network, Chattanooga has created over 7,000 new jobs and attracted billions of dollars in capital investment in a city once referred to as the "dirtiest city in America."[8]

[7] Craig Settles, *Building the Gigabit City*, (e-book). Available at http://portal.calix.com/portal/calixdocs/mktg/w/gig/Building_the_Gigabit_City.pdf

[8] Chatanooga's "GigTank" website, available at http://www.thegigcity.com/gigtank/

	2–4 megabits per second (Mbps)	10–12 Mbps	20–25 Mbps	100–120 Mbps	500 Mbps	1 Gigabit	Total
Attract new businesses to your area	3.10% 7	4.87% 11	9.73% 22	26.55% 60	13.27% 30	42.48% 96	226
Help local companies grow	4.87% 11	7.52% 17	20.35% 46	29.20% 66	9.29% 21	28.76% 65	226
Increase home-based businesses	5.80% 13	13.84% 31	26.79% 60	25.89% 58	12.95% 29	14.73% 33	224
Individuals' income earning increases	8.64% 19	16.82% 37	23.18% 51	25.91% 57	11.36% 25	14.09% 31	220
Revive depressed business districts	6.31% 14	11.71% 26	18.92% 42	27.48% 61	12.61% 28	22.97% 51	222
Revive depressed communities	7.14% 16	16.52% 37	17.86% 40	27.23% 61	12.95% 29	18.30% 41	224

Table 3 Broadband's impact on economic outcomes from the perspective of speed.[9]

In 2012, the Chattanooga Electric Power Board (EPB) established GigTank, an application-incubation facility. The goal of GigTank is to build applications to utilize the capabilities of gigabit networks. According to its website, "GigTank is a startup accelerator connected to a living, metro-wide fiber optic network. Hosted by the Company Lab, this annual program attracts entrepreneurs from across the globe to Chattanooga, the home of America's first widely-available gigabit Internet service. With Internet speeds that run 100x faster than the national average, Chattanooga offers entrepreneurs the opportunity to innovate on the broadband platform of the future." This year, GigTank is focusing on three start-up tracks accelerating seed stage startups in the additive manufacturing (3D printing), smart grid and healthcare industries by connecting these new companies with the tools, capital and connections to go to market.

Chattanooga itself has experienced great success with its smart grid system that is running on the city's all-fiber network. The smart-grid system promotes energy efficiency throughout the city, remotely monitoring the system's power consumption, load balancing and power substations. It allows the electric system to re-route around failures and downed power lines in storms and outages, restoring services within minutes. Prior to the smart-grid system

[9] Settles, *Building the Gigabit City*.

implementation, typical outages may have lasted four to five hours and many neighborhoods may not have had services restored until residents notified Chatanooga's EPB of the outage. Today, with the new smart-grid system in place over the all-fiber network, EPB can restore service in minutes. Savings realized by better management of the city's power system and improved operations has paid for the cost of deploying the Fiber to the entire community system.[10]

Similar to Chattanooga's GigTank program, entrepreneurs have developed gigabit-ready applications through the US Ignite Partnership.[11] US Ignite is a non-profit, public-private organization that is supported by the White House Office of Science and Technology and the National Science Foundation. US Ignite is focusing on creating applications in the following disciplines of national priority:

- Education and Workforce
- Energy
- Health
- Public Safety
- Transportation
- Advanced Manufacturing

In addition to creating transformative applications, US Ignite connects people and resources, coordinates test beds, provides efforts towards scalability and providing these applications to the masses, informs the public and takes these applications to market. One cutting-edge application being developed by researchers at the University of Massachusetts, and supported by US Ignite, is the Collaborative Adaptive Sensing of the Atmosphere ("CASA") program. CASA uses predictive storm-tracking technology and "data 5 to 10 times more detailed than current radar systems" to provide citizens with advanced notification of severe weather events. These applications, as well as all of the other applications developed by US Ignite, are only possible with having access to a minimum of 100 Mbps of bandwidth. US Ignite is participating with municipalities and communities that have built out fiber networks and are offering this type of bandwidth to their constituents.

Kansas City offers another example. When Google issued a Request for Proposal for the "Think Big with a Gig" program to host gigabit test-beds and have Google build within their city, over one thousand communities across the country submitted applications.[12] Google selected the bi-state Kansas City metropolitan region. Kansas City has already seen an uptake in new high-tech start-ups due mostly to Google's FTTH efforts. Through Homes for Hackers and the Kansas City Startup Village, entrepreneurs have built a community of innovators enticed by the

[10] Mike Smalley, "Broadband and the Smart Grid," (2008) available at http://www.carinatek.com/PDFs/BBP_AugSep08_SmartGrid.pdf

[11] US Ignite, available at https://us-ignite.org/about/what-is-us-ignite/

[12] Topeka, Kansas, even changed their name to Google in hopes of being selected as the test-bed.

possibilities presented by the Google Fiber network.[13] A prominent venture capitalist has even purchased a home in a Kansas City "fiberhood" to allow entrepreneurs to live for free in Kansas City and build gigabit-ready applications. High-tech companies recognize the benefits of these networks and are willing to relocate just to have access to them.

Since Google's roll-out of gigabit services in Kansas City, it has made plans to build Fiber to the Home in Austin and has recently purchased an existing system in Provo, Utah. Google last year announced plans to build FTTH in 34 municipalities across the country upon cooperation and attainment of a checklist put out by Google.

Other communities that have built fiber networks have shown economic growth by attracting manufacturing, high-tech and technology companies in large part because of their investment in all-fiber networks. These include:

Municipal FTTH Networks	New Companies, due in part, to All Fiber Infrastructure
Auburn, IN	Cooper Tire Expansion
Bristol, TN	Media General
Bristol, VA	Northup Grumman
	CGI
Chelan County, WA	Yahoo
Douglas County, WA	Sabey Corporation
Grant County, WA	MSN (Microsoft)
	Ask Jeeves
	Intuit
Independence, OR	Metal fabrication companies
Kutztown, PA	Film production companies
LENOSIWSCO, VA	Data Centers
Mason County, WA	Louisville Slugger
	Sims
	Technology companies
	Online engineering firms
Morristown, TN	Cogate Palmolive
	Alpine Access Virtual Call
Powell, WY	Center

[13] Kansas City Startup Village, available at http://www.kcstartupvillage.org; and Homes for Hackers, available at http://homesforhackers.com.

These communities understand that symmetrical gigabit networks are essential for economic development and innovation.

Telecommuting Opportunities

The number of people working from home or telecommuting has increased enormously in the past few years and will increase exponentially in the future. According to a study conducted by the Global Workplace Analytics[14], telework grew nearly 80% from 2005 to 2012. In 2010, based on its own limited survey, *WorldatWork* estimated that 16 million employees worked at home at least one day a month, a number that increased almost 62% between 2005 and 2010. Extrapolating from 2010 to 2014 would put the current number of those who telecommute at least one day a month at approximately 25 million.

According to the study, in twenty-five percent of the nation's 20 largest metro areas, more people now telecommute than use public transportation as their principal means of transportation to work. More importantly, according to Global Workplace Analytics, the estimated based upon the current labor force composition is that 64 million U.S. employees hold a job that is compatible with at least part-time telework (50% of the total workforce). 79% of U.S. workers say they would like to work from home at least part of the time (WorldatWork Telework Trendlines 2009) and 87% of federal employees say they want to work from home (2013 Federal Viewpoint Survey).

There are significant economic benefits from telecommuting and working from home. According to the Global Workplace Analytics website, "If those with compatible jobs and a desire to work from home did so just half the time (roughly the national average for those who do so regularly) the national savings would total over $700 Billion a year." Other data points from the website are:

- A typical business would save $11,000 per person per year
- The telecommuters would save between $2,000 and $7,000 a year
- The oil savings would equate to over 37% of our Persian Gulf imports
- The greenhouse gas reduction would be the equivalent of taking the entire New York State workforce permanently off the road.
- The Congressional Budget Office's estimate of the entire five-year cost of implementing telework throughout government ($30 million) is less than a third of the cost of lost productivity from a single day shut-down of federal offices in Washington DC due to snow ($100 million).

According to the Aspen Institute's Communications and Society Program's recent publication, "The Future of Work", (2011) work is no longer confined to a specific time and place. Open systems, open platforms, shared folders and databases, "crowdsourcing," and collaboration

[14] Global Workplace Analytics Recent Statistics on Telecommuting available at http://www.globalworkplaceanalytics.com/telecommuting-statistics

between employees, contractors, vendors and suppliers happens "in the cloud" facilitating the ability to work anywhere there is a high-speed Internet connection, at any time.[15]

Providing the ability for people to work from home or from Internet meeting rooms – i.e. the local coffee shops, libraries, community centers, co-working spaces, incubator locations or virtual offices -- requires access to advanced broadband services. For example, the City of Montrose is opening a co-working space in July 2015 that will need Gigabit access for workers. A co-working space in Paonia called the Hive, requires this type of bandwidth as well. The benefits and cost savings of telecommuting can only be realized when workers have access to abundant broadband. If work is portable, people will choose communities that are rich in culture, art, entertainment, recreation, educational opportunities for kids and adults and are affordable. Work is no longer tied to place. Communities need to change to attract and maintain this new *portable* workforce.

Every "Thing" will be Connected to the Internet -- Medical Devices, Health Monitoring Systems, Our Cars, Our Clothes, Household Systems, Appliances, Energy Controls – the "Internet of Things."

Every good thing out there is connected to the Internet; the new "Internet of Things." These things include household systems that monitor security systems, locks, energy use, temperature, and water control. It includes appliances that call automatically for maintenance; make shopping lists, schedule events, order parts, and schedule repair -- all without the need for human intervention or oversight.

The Internet of Things includes medical devices that monitor our health, detect and alarm us when medical issues are present, clothes that detect glucose levels or heart conditions, and hats that monitor our brain activity. Cars are now connected to the Internet, monitoring the car's status and performance, notifying drivers of traffic delays, alternative routes, hazardous conditions and mechanical issues. Soon cars will drive themselves. Internet-connected cars will provide anti-collision technology, automatically braking and steering clear of accidents or potential accidents. Our coming and going, our location, customer information and applications will all be collected, stored and monitored. Some of this sounds a bit invasive and creepy; however, the reality of all of this is here. Devices are all Internet-enabled. Although we as individuals will need to determine how far and how much data we want to have shared and collected, it is clear that the Internet of Things is only enabled with advanced broadband capacity.

[15] David Bollier, *"The Future of Work, What it Means for Individuals, Markets, and Governments,"* Aspen Institute's Communications and Society Publication, (2011).

Affordable Healthcare: The growing Baby Boomer population and the implementation of the Patient Protection & Affordable Care Act will create new challenges for our healthcare system.

The baby boomers are getting older; the largest portion of our population is aging. Concerns of increased healthcare costs with our aging society will need to be curbed by providing better, smarter, more cost-effective healthcare. Implementation of the Patient Protection and Affordable Care Act is placing new demands on the medical industry to become more efficient, cost effective and nimble, demanding that physicians interact with more patients.

Telemedicine is the use of information technology including the telephone, the Internet and personal computers, for diagnosing, treating and monitoring patients. Telemedicine is adding a new dimension to modern health care. These advances are not only making care more accessible and convenient, they are lowering the costs of medical care, while not sacrificing the quality of care, and in many studies, improving the quality of care. Physicians can consult with more patients, and patients can meet with their physicians in a shorter time period. Less time is spent checking the patient in and leading the patient to the exam room. In terms of economic advantages, telemedicine can save a great deal of time for patients who otherwise would have to leave work. Telemedicine can also eliminate many ER visits, which are often the most costly means of providing healthcare services.

According to the Wellness Councils of America (WELCOA), as many as 70 percent of primary care visits, and 40 percent of emergency room visits to treat acute medical conditions could have been diagnosed and prescribed medication all over the phone.[16] The methodology of providing care has not changed; however, the medium for providing care has. The physician can perform diagnostic testing, interview the patient, check vital signs, etc. remotely using videoconferencing and remote monitoring equipment, and the telephone or internet; instead of providing these services in person.

The American Telemedicine Association highlights various reports on the efficacy, cost savings, improved healthcare and patient benefits of telemedicine.[17] One report highlights the experience of UPMC Health Plan, an integrated delivery and financing system headquartered in Pittsburgh, Pennsylvania, in its efforts to support primary care practices as they converted to patient-centered medical homes. From 2008 through 2010, sites participating in the UPMC pilot achieved lower medical and pharmacy costs; more efficient service delivery, such as lower hospital admissions and readmissions and less use of hospital emergency departments; and a 160 percent return on the plan's investment when compared with nonparticipating sites.

[16] Wellness Council of America, "Collecting Data to Drive Health Efforts," available at https://www.welcoa.org/resources/collecting-data-drive-health-efforts-classic-edition/

[17] American Telemedicine Association, numerous case studies available at http://www.americantelemed.org/about-telemedicine/telemedicine-case-studies

Presbyterian Healthcare Services based in Albuquerque, New Mexico, adapted the Hospital at Home® model developed by the Johns Hopkins University Schools of Medicine and Public Health to provide acute hospital–level care within patients' homes. In this program, patients show comparable or better clinical outcomes compared with similar inpatients, and they show higher satisfaction levels. Available to Medicare Advantage and Medicaid patients with common acute care diagnoses, this program achieved savings of 19 percent over costs for similar inpatients. These savings were predominantly derived from lower average length-of-stay and use of fewer lab and diagnostic tests compared with similar patients in hospital acute care.

Additionally, patients that are participating in a home health program or telemedicine program experience higher satisfaction as they receive more personal one-on-one care, without taking time from work to travel to a medical clinic and wait for their appointment with the doctor. The source of satisfaction for most patients is the ability to see a specialist trained in the area most closely related to the patient's condition, the feeling of getting personalized care from a provider who has the patient's interest in mind, and the ability to communicate with the provider in a very personal and intimate manner over the telecommunications technologies.

With the Internet of Things for Medical Devices, it is now possible to remotely monitor a patient's health with the use sensors, detectors, actuators and the Internet. Medical remote monitoring devices are connected to the Internet where a patient's vital statistics get transmitted via a gateway onto secure cloud-based platforms where the data is collected, stored, monitored and analyzed. These devices can monitor and alert physicians or loved ones if a patient's vitals fall outside a healthy range. Scanners can monitor inventory levels for pharmaceuticals before a medication runs out and order supplies and inventory ensuring that hospitals and clinics have the needed supplies.

Other medical applications enabled with advanced broadband include medical training and consultation with other physicians and providers, electronic health records, and the ability to log-in and read patient charts, MRIs and X-rays.

Education and Distance Learning: Our workforce must continue to evolve through workforce training and education. The manner in which we provide education to our kids and to adults is changing, requiring us to access information and education through distance learning and reverse classroom experiences.

The concept of working for a single company or within a single industry for thirty years until retirement is no longer an economic reality. Workers will change careers an average of seven times during their lifetime. Workers cannot expect to enjoy a "steady job" with a lifelong employer, nor expect that employer to provide the training and skills needed as the work changes. Workers will require on-going training, education and mentorship. Many of these resources for further education and mentoring are now mostly available on-line and virtual. Educational institutions, workforce training, universities, and corporations must provide education when people can use it, rather than at a specific place and time, working around lifestyle, schedules and work/home priorities and pressures.

Homework assignments, testing and accessing educational videos are all on-line. The methodology by which education is happening is changing. Schools are providing the reverse classroom, or flip education; a concept that includes providing a video of the lesson online. Students download the lesson remotely while at home, watch the lecture, can pause, reflect, rewind and watch again. The classroom time is then used for more in-depth study, homework, questions and interaction between the students and teachers.

Public Safety: Our first responders need reliable, ubiquitous coverage, higher standards than what our commercial networks currently have, interoperability between networks and priority access to information and databases.

Emergency response teams have unique needs and higher standards for broadband and communications. Our first responders need networks that are reliable, always on, secure, provide ubiquitous coverage, interoperability between network and priority access to information and databases. Their devices need to be small, lightweight, versatile and autonomous, wearable and portable. The devices need to be capable of sensing the environment, of tracing and tracking resources and able to convey a wealth of information to other responders, civil protection authorities and to crisis management centers. Sensor-nets can provide for situational awareness for disasters, fires, emergencies, car wrecks and other events, but these sensors require access to high bandwidth and the current wireless networks do not currently support these applications adequately.

Police officers are ready to trade in their handheld radios for use of their iPhones, iPads, and Android devices while on the job. Until recently, this has created a problem for law enforcement agencies as smartphones and tablets haven't been able to connect to conventional Land-Mobile Radio (LMR) networks. U.S. public safety agencies will soon be able to use the FirstNet network that provides priority access for law enforcement, first responder and public safety agencies. This is critical during disasters when cell phone networks can become congested, as FirstNet is a network that will have spectrum dedicated exclusively for public safety entities.

Additionally, most devices for law enforcement include video applications – camera-equipped police and camera-equipped cars, cameras on traffic stops and enforcement of speed sensors and speeding tickets, and live ambulance video-links to hospitals. The existing wireless networks cannot support the applications that are in use today. The 911 system cannot process videos from citizens, but as we are finding during emergencies, the public is often the "eyes and ears" during these crises as citizens are videotaping events as they happen. Having the public be able to record events and send the information to first responders allows for better transparency, honesty and less mistakes.

Digital Inclusion and Civic Engagement; The Great Equalizer between the Haves and the Have-nots.....or Not?

Broadband must be ubiquitous or it will further create a digital divide between the haves and the have-nots. When broadband is ubiquitous it can be the great equalizer between different economic classes. In 2014, the International Economic Development Council asked economic development professionals if broadband service could "encourage individual entrepreneurship among under-served constituents," and 35 percent said that it is quite likely and 14 percent said that they had seen it firsthand (see Table 4). Ubiquitous broadband access can help create social equality. However, not having advanced broadband access available to everyone can create further inequalities of wealth and potentially can create further gaps in education, social institutions and government resources. Broadband must be abundant, redundant and available to everyone.

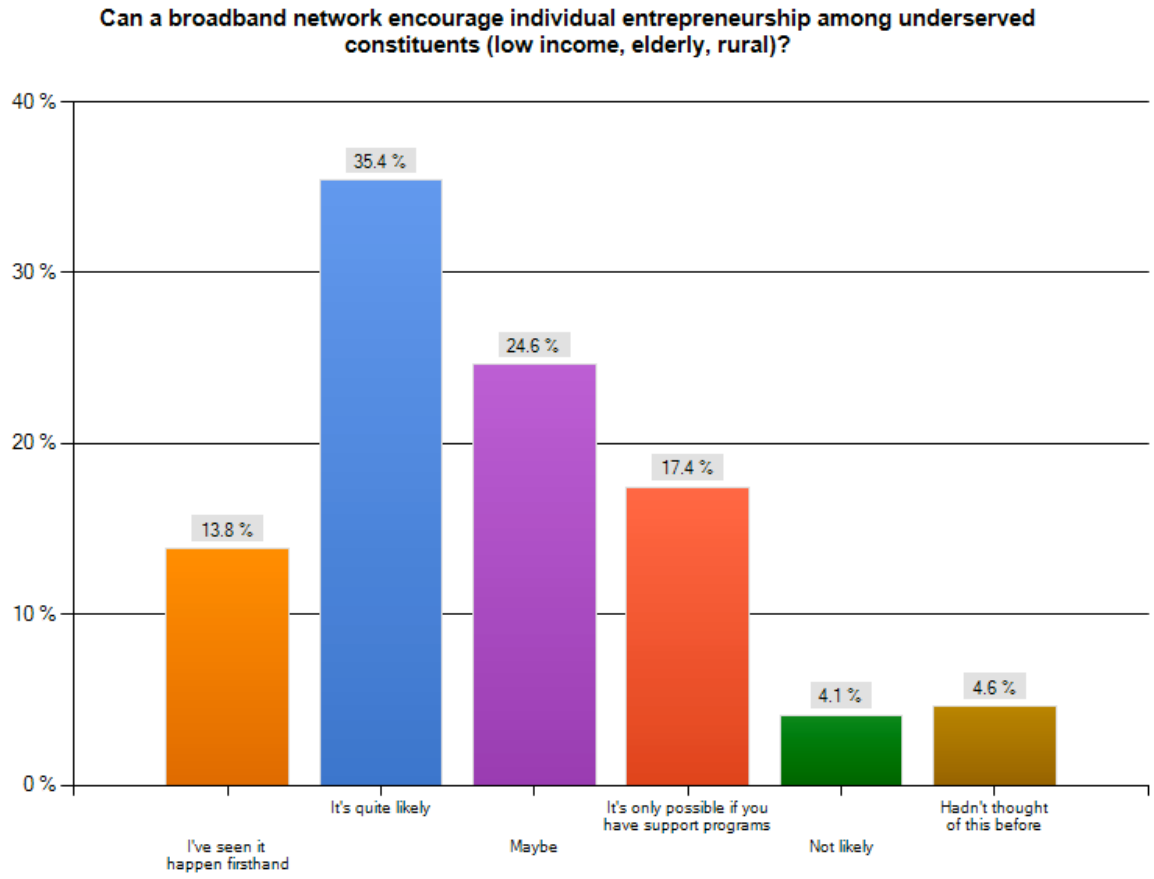


Table 4 Entrepreneurship among underserved constituents.[18]

Civic Engagement, Transparency, Access to Government Resources.

Advanced Broadband Networks can transform civic engagement, access to government resources and transparency of government. All government documents, including GIS data, applications, information on initiatives, information on financial contributions etc. are now available on-line. Documents must be able to be in a standardized format, searchable and available where data can be edited and used by other programs. Providing citizens access to this data provides further transparency, community engagement, public input, and public impact on government.

Higher Home Values

Finally, statistics from the FTTH Council state that real estate developments communities that have deployed FTTH networks have instantly improved home sales values by $7,000 - $10,000 per home.

[18] International Economic Development Council, "The Broadband-Driven Economy."

3. Exploration of Ownership Structure, Who Should "Own this Network?"

The purpose of this section of the broadband blueprint is to discuss what type of entity could potentially own and operate a broadband system within Region 10 and what the pros and cons of each option include. The next section, Section 4, deals with how services can be delivered on the network and the various business models for consideration.

There are a number of considerations to what type of entity would own the network. The first primary consideration regarding who should own the network is the regulatory environment. Another consideration for network ownership is the funding options available and to whom these funding and grant programs are available. Finally, another consideration is the balance or tension that must be addressed between control (ownership), risks of that ownership and the rewards of owning a network that will potentially have on the constituents within the Region.

Regulatory Environment. The first consideration in determining the appropriate model for ownership and operations structure is to consider the regulatory environment in Colorado and specifically, within Region 10.

In 2005, the State of Colorado passed a bill that limits municipalities from building telecommunications infrastructure for end users (§ 29-27-101 to 304, C.R.S., commonly referred to as "SB-152".) This legislation is the biggest barrier for the communities within Region 10 in improving broadband capabilities and it dictates the options for ownership and service delivery options available to Region 10 as its members are municipalities, counties and local governments.

The law generally requires an election before a local government may take various actions to provide Internet access service, cable television service, or telecommunications service to the public. The statute also requires "regulatory parity" between public and private providers of such services. Much of the statute concerns various exemptions from this requirement. For example, SB-152 provides that the law does not limit the authority of local governments to enter into agreements permitting private telecommunication service providers to lease space on government property for the placement of telecommunications equipment. Arrangements between municipalities and private telecommunication providers for placement of equipment such as cell phone antenna arrays are common. With this provision, no election is required in connection with such agreements. The statute also does not apply to government provision of various telecommunication service to citizens for governmental or intergovernmental purposes, including for use by persons "accessing government services." Governments commonly provide a variety of telecommunication services to citizens using its buildings and facilities; no

election is required for this to continue. Furthermore, SB-152 makes clear that no election is required in order for governments to operate internal communications networks and to utilize such networks in cooperation with other governmental entities. Should local governments wish to sell insubstantial amounts of "excess capacity" on their networks, they may do so without an election, provided that the sale and use is made on an evenhanded, "competitively neutral" and "nondiscriminatory" basis.[19]

NEO Fiber engaged Ken Fellman, a Colorado-based attorney with Kissenger & Fellman to provide feedback on the impact of SB-152 on a number of issues within Region 10. An opinion letter was provided by Fellman discussing various questions regarding subscriber definition, limitations, ballot questions and service delivery models. Below are a few highlights of Fellman's findings.

Under SB-152 the prohibition of providing services specifically noted as the provision of services to "subscribers." In the statutory definition, there is a specific exclusion which indicates that a government's provision of services to other governments is not considered as providing service to a "subscriber." The specific statutory language reads as follows:

> (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.*** (emphasis added) C.R.S. § 29-27-102.

Therefore, a government network may provide services to other governmental and quasi-governmental entities, without seeking voter approval, as it would have to do if it wished to provide services to non-governmental entities.

> CRS § 29-27-102(1) defines "advanced service" as "high-speed internet access capability in excess of two hundred fifty-six kilobits per second both upstream and downstream." This definition is out of date, and not reflective of today's technology. Any service that can deliver data speeds over 256 kbps would, in Fellman's opinion, be considered "advanced service" under SB-152.

A local government can build any kind of a communications network, and can, without other authority, provide all of the services identified in this plan, but only to itself or other governmental/quasi-governmental entities. All of the services mentioned within this broadband blueprint would be considered advanced services if they are delivered at speeds in excess of 256

[19] Geoff Wilson, Colorado Municipal League General Council brief of SB-152.

kbps. A government that has built a government network cannot expand and provide service directly to subscribers (as that term is defined in the statute) without voter approval, unless it comes under one of the limited statutory exceptions. One of the exceptions states that:

> *Nothing in this article shall be construed to apply to the sale or lease by a local government to private providers of excess capacity, if:*
>
> *(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.*
>
> CRS § 29-27-302(3).

San Miguel County and the City of Montrose have passed a public vote to opt-out of the restrictions placed upon municipalities and local governments. Therefore, they can offer services directly to the public or end users, but all of the other local governments may not offer services directly to the public or end users without a favorable public vote to opt-out of SB-152. This broadband blueprint will take into consideration what is possible for service delivery options for the majority of the communities within Region 10.

Financing Options. Other considerations for choosing an ownership model include the ability to receive financing and funding to pay for the capital costs of the network construction. Certain financing and funding programs restrict who is eligible to apply for and receive funding. The federal grant and loan programs available for funding broadband construction include the following:

	State-Level	Federal Level				
Grants	**DOLA**	**Rural Broadband Experiments, Connect America**	**Community Connect Grants**	**Distance Learning and Telemedicine Grant Program**	**Health Connect, Rural Healthcare Program**	**E-rate**
Eligibility						
Regional Council of Governments	Yes	-	-	-	-	-
Local Government, Tribes	Yes	Yes	Yes	Yes	-	-
Non-profit	-	Yes	Yes	Yes	-	-
Corporations	-	Yes	Yes	Yes	-	-
Cooperatives	-	Yes	Yes	Yes	-	-
Education	-	-	-	Yes	-	Yes
Medical Providers	-	-	-	Yes	Yes	-
Eligible Telecommunications Carrier	-	Required	-	-	-	-
Timing	Ongoing	November 7, 2014; Phase II in 2015	Grant cycle is in early part of year.			
How much?		$100M total, grant amounts dependent upon technology/bandwidth		Grants available for Equipment, inside wiring and "other facilities"		

The Colorado Department of Local Affairs (DOLA) has announced a $20 Million grant program for regional councils of governments and municipalities. In 2015, DOLA will have three rounds of financing applications with deadlines for grant submission being April 1st, August 1st and December 1st. Region 10 applied for DOLA funding for phase 1 of this project implementation for network expansion and funding for Delta and Montrose counties. Region 10 will prepare a second grant application targeted for the December 1st deadline to address the remaining counties within the Region. DOLA's funding is available for municipalities and regional councils of government; and therefore, this informs the type of organization that should own this network – i.e. a regional council of government; - Region 10.

The Rural Broadband Experiments and Connect America program are available to unserved areas; the definition for eligibility is 3 Mbps combined upload and download. As the FCC in 2015 raised the definition of served to 25 Mbps download and 3 Mbps in upload speeds, there may be funds available through the Connect America to a wider group of communities. One caveat currently of the Connect America program is that it is available for Eligible Telecommunication Carriers.

The Telecommunications Infrastructure Loan Program available through the USDA "makes long-term direct and guaranteed loans to qualified organizations for the purpose of financing the improvement, expansion, construction, acquisition, and operation of telephone lines, facilities, or systems to furnish and improve Telecommunications service in rural areas. The definition for "rural area" is within the boundaries of any incorporated or unincorporated city, village, or borough having a population exceeding 5,000 inhabitants."[20]

The Rural Broadband Loan Program, which is part of the Farm Bill, "is designed to provide loans for funding, on a technology neutral basis, for the costs of construction, improvement, and acquisition of facilities and equipment to provide broadband service to eligible rural communities."[21] Again, the definition of rural includes communities with a population less than 5,000 inhabitants.

Other sources of funding should also be considered. These include internal loans, bonds, TIF and revenue funds, economic development financing programs, and crowd sourcing.

[20] US Department of Agriculture Rural Development, About Telecom Infrastructure Loans, available at http://www.rurdev.usda.gov/utp_infrastructure.html

[21] US Department of Agriculture Rural Development, About the Farm Bill Loan Program, available at http://www.rurdev.usda.gov/utp_farmbill.html

E-rate is available for schools and in the past was used to as a reimbursement or supplement for Internet access services. The E-rate program has had a number of changes recently; one significant change is the ability to reimburse for construction of facilities (i.e. fiber optic cable) to serve the school.

There are grant programs that are available for Telemedicine and Distance Learning as well as program targeted specifically for Rural Health.

There are a number of other financing options some of which include; New Market tax credits, for which allocations would have to be secured; economic development retail sales tax funds, and bond financing through a number of different structures and types of bonds.

Control, Risk and Reward. Other considerations for selecting the most appropriate ownership model include balancing the tension between control, risk and rewards. Control considerations include who owns the network and makes decisions regarding how the network is used, coupled with who maintains the network and the types and levels of services offered. Many proponents of community broadband networks are in favor of having a local entity own the network. This local entity may be a public utility, the municipality, a local community non-profit, collaboration of entities, or in some cases, a locally-owned service provider. Local ownership could also be in the form of a public-private partnership.

Local ownership implies having a vested interest in the economic outcomes for the community. Networks are built to spur economic development and are built to key anchor institutions that require high availability of bandwidth.

A local entity may own the network, but the impact of the cost of building the network must be weighed against the risks of doing so. Fiber networks are capital intensive. Consideration of bearing the financial risk must be weighed against the rewards that the network could potentially bring to the community. Rewards of local ownership of the network may include more abundant broadband, higher bandwidth speeds available, and lower costs to end users. These attributes may also entice companies, research facilities, education centers and entrepreneurs to re-locate to the community. The network infrastructure then becomes a catalyst for economic development.

Owning the network can give the local entity more control over the services being offered. For example, if the network owner provides services directly to the end user using a retail model, the network owner sets pricing and service offerings. In a wholesale model environment, the network owner should take care to still control the level of services offered and pricing. Utopia is an all-fiber network that was built for sixteen municipalities in Utah. The law in Utah prohibits Utopia from offering retail services; the consortium could only offer services using a

wholesale platform. The service providers that initially used the Utopia network offered services that were the same as other competitors in the market that were not using the Utopia network. There was no compelling reason to change providers; no greater offering of bandwidth speeds and no better pricing options. This resulted in Utopia not meeting its revenue or take-rate targets. Utopia had accumulated over $200 Million in debt and had only $3 Million in annual revenues. A rescue-plan needed to be put in place this past year to ensure the long-term viability of the project. In order to avoid this type of scenario, the network owner must ensure there is a minimum threshold of services offered and must maintain some control over pricing.

There are other considerations for dealing with control issues. For example, the network owner may own the network, but outsource the operation and maintenance of the network to another entity. Often local entities such as a local public power company or the municipality may have many desirable and already established operational skills and systems in place. These may include an established customer call center and/or a billing system. Power companies that already maintain electric infrastructure may own bucket trucks and have outside plant engineers that maintain power lines and equipment. The skills needed to maintain a fiber network may be taught to existing electric department employees that are already familiar with maintaining outside plant. If the local entity does not have these systems in place, then it may make better sense to outsource these areas to a service provider or other entity.

The pros and cons of the following organizational structures are included below:

- Public utility
- Public or City Government Department
- Community Non-Profit
- Collaboration
- Service Provider or Privately-Owned

Public Utility. Many of the community broadband networks that are in place today have been initiated by a public utility, either as a municipality that provides electric services to its constituents or from an electric cooperative. Many of these fiber networks were initially built to better manage utility systems, connecting the power stations with a Supervisory Control and Data Acquisition or "SCADA" systems. These fiber networks were then leveraged to build out to anchor institutions and then in some cases, to all of the residents and businesses within the area.

Examples of public utilities that have built community broadband networks include:

WHOLESALE MODEL (OPEN ACCESS MODEL)

- Danville,VA
- Leverett, MA
- Chelan PUD, WA
- Sho-Me Technologies, MO
- Grant County PUD, WA

RETAIL MODEL

- Chattanooga, TN EPB
- Kit Carson Electric Coop., NMUnited Electric, MO
- Opelika Light and Power, AL
- Clarksville Department of Electricity, TN
- St. Louis Park, MN
- Bristol, VA
- Bristol, TN
- Chaska, MN
- Cloud, FL
- Benton Public Utility District – Kennewick, WA
- Longmont, CO

As these public utilities are locally controlled, they have a vested interest in the community's success. There is a high level of local control over network funding and priorities. This established organizational structure provides local oversight. These public utilities have a board of directors to guide their activities and oversight already established by a city council or other governing body. This community model creates customer loyalty.

A chart illustrating the benefits of this organizational model, along with the potential pitfalls is shown on the following page.

Pros and cons for a PUBLIC UTILITY

* High level of **local control** over network funding and priorities.
* **Public good** often overrides profit motives.
* Already have **experience** in managing infrastructure.
* Public utilities often own repair trucks and employ field engineers who can perform installation and provide maintenance
* Have customer service experience, managing individual accounts, staffing call centers, established billing practices, etc..
* Community model creates **loyalty.**
* Incorporate SCADA management systems into the fiber design; power company becomes a key anchor tenant.
* Established structure to provide **local oversight**.
* Have board of directors to guide their activities and oversight by a city council or other governing body

* Usually a **new line of business**
* Organization must build or acquire operational experience in broadband.
* Public utility must develop and manage marketing, sales, and compete with other community network providers.
* **Transparency** requirements in business practices can cause competitive conflict.

The potential disadvantages of this model are that city politics can sometimes play a role in the process and may make decision-making a difficult process. Often business decisions must be made quickly in order to respond to competitive pressures, and the decision making process within a city can sometimes be a slower process. Also, the required expertise and experience to operate a telecommunications network may not be present with the city's organization and this experience either needs to be built, established or acquired.

City Department. In other cases, the municipality that does not own a public utility has established a community broadband network and has run it through a city department. This organizational model has many of the positive attributes of a public utility as it is locally-owned and has the community's best interest in mind. The impetus for creating a community broadband network owned by the city is based upon economic development initiatives. Many of the elements discussed here can be used in combination with other models discussed within to create the best practices in delivering the best service for the value.

A municipality may have sources of funding that may not be available to a private company and can be used in a public private partnership. Municipal securities are issued to finance public-purpose projects for infrastructure such as roads, airports, hospitals, school, water and sewer systems and telecommunication networks. Generally, municipal bonds fall into one of two categories – general obligation bonds or revenue bonds. Interest income is generally federally tax exempt; although there are several types of general obligation and revenue bonds and it should not be assumed that all bonds are tax exempt. General obligation bonds are backed by the full faith and credit of the governmental entity, and taxes can be issued to pay back the loan. Revenue bonds are secured by revenues generated by the issuer or by certain taxes such as sales, fuel or hotel occupancy taxes. As community broadband networks are considered infrastructure that serves the public purpose, municipalities can use bonds to finance the construction costs.

A municipality may also have the ability to implement favorable policies and ordinances to facilitate community broadband network construction. For example, the city may have a "Dig Once Policy" that requires all public works, utility and/or road improvement projects to install additional conduit for the city while there is an open trench. The city may also have an ordinance whereby any abandoned fiber located within the city limits reverts to the city's ownership after a period of time. A municipality may consider these policies whether it decides to own the network or not. Having these policies in place allows the city to have access to conduit and fiber that could be used by another entity to build infrastructure. Either way, much of the capital costs of opening a trench and installing conduit are greatly reduced by having these policies in place. It is our recommendation that these polices be put in place within Region 10 at the earliest opportunity, no matter what model is used.

In many cases, having the municipality own the network infrastructure allows for more choices in collaborative efforts. The municipality may be a neutral party to collaborate with numerous service providers in an open-access approach. The municipality may more easily leverage their assets and policies to collaborate with other public-private ventures and with community leaders and non-profits. On the following page is an outline of the pros and cons of the municipal-owned or city department organizational structure.

Pros and cons for a CITY DEPARTMENT

* High level of **local control** over network funding and priorities.
* **Public good** often overrides profit motives.
* Can encourage build out of "middle mile" across a region, collaborate with local service providers to increase competition.
* Sometimes easier for government to leverage assets, participate in collaborative ventures, and partner with non-profits
* **"Dig once" policies** leverage other infrastructure projects
* Can build incrementally and organically to reduce capital risk
* Community model creates **loyalty.**
* Can leverage bonds to fund infrastructure projects.
* Have a vested interest in the community's success; i.e. economic development prospects.
* Established structure to provide **local oversight**.
* Have city councils to guide their activities and oversight by a city council or other governing body

* Usually a **new line of business**
* Organization must build or acquire operational experience in broadband.
* Municipality must develop and manage marketing, sales, and compete with other community network providers.
* **Transparency** requirements in business practices can cause competitive conflict.
* Turnover of city council members may be an issue

Examples of community broadband networks owned by a city department include:

- Santa Monica, CA
- Farmington, NM
- Windom, MN
- Corpus Christi, TX
- Provo, UT
- Seattle, WA
- Centennial, CO

In both of the public utility model and the city department model, transparency can be a barrier or a competitive threat. Measures must be taken to allow the entity to remain competitive and nimble, with the ability to react quickly to changing market environments.

Community Non-Profit Organizations. Another organizational model to consider is a community non-profit organization. Control is still maintained locally, and all of the benefits of local control can be realized. Additionally, non-profit organizations may have yet another source of funding available through charitable giving and foundational funds. The non-profit organization may not be under the same transparency requirements of a city department or public utility and may be able to operate more effectively.

The potential downsides of a non-profit organization may be that the governance structure and funding may be difficult and therefore, considerations should be in place to mitigate this risk.

Examples of community broadband networks that are using the non-profit organizational model include:

- UC2B, Urbana Champaign, IL
- One Community, Ohio
- Cape Cod, MA
- Rhode Island, RI

The benefits and potential disadvantages are listed on the following page.

Pros and Cons of Community Non-Profit Organizations

*Non-profit mission is directed by the selected governance model and mandates

* Can have a social mandate that focuses on community needs and **operates independently from other city business.**

High level of **local control** over network funding and priorities.

* **Public good** often overrides profit motives.

* Can encourage build out of "middle mile" across a region, collaborate with local service providers to increase competition.

* More funding sources? Can leverage charitable contributions

* Can enable charitable giving and provides shelter for assets.

* Can lesson the burden of government while addressing the social and community needs.

* Can build incrementally and organically to reduce capital risk

* Community model creates **loyalty.**

* * Have a vested interest in the community's success; i.e. economic development prospects.

* Established structure to provide **local oversight**.

* Usually a **new line of business**

* Organization must build or acquire operational experience in broadband.

* Must develop and manage marketing, sales, and compete with other community network providers.

* Start-up structure and funding may be complex or difficult.

Consortium. Another organizational structure to consider is one of a consortium. A consortium could be a non-profit organization or a public-private initiative or both. Many municipalities and counties have formed a collaborative effort or consortium to address broadband needs as a region. In these cases, there was power in numbers; either as in buying or purchasing power or in sharing costs.

By aggregating demand, a regional approach may reduce overall capital costs of a community broadband project. Many of the funding sources encourage a regional collaboration versus a one-municipality or one-jurisdiction approach for this reason. Most of the Stimulus projects funded under the ARRA BTOP program were indeed consortiums. These consortium pooled resources and established large projects that could effectively compete for grant funding.

Examples of consortium-type community broadband organizations include:

- Ohio Middle Mile Consortium (OMMC)
- Wireless Silicon Valley
- Colorado Region 9 Council of Governments
- Utopia, UT
- Florida Rural Broadband Alliance
- Numerous BTOP Projects, Middle Mile projects

Consortiums

Buying Power

Aggregate Demand, Share in Costs

High level of **local control** over network funding and priorities.

* **Public good** often overrides profit motives.

* Can encourage build out of "middle mile" across a region, collaborate with local service providers to increase competition.

* Sometimes easier for government to leverage assets, participate in collaborative ventures, and partner with non-profits

* **"Dig once" policies** leverage other infrastructure projects

* Can build incrementally and organically to reduce capital risk

* Community model creates **loyalty.**

* Can leverage bonds to fund infrastructure projects.

* Have a vested interest in the community's success; i.e. economic development prospects.

* Established structure to provide **local oversight**.

* Have city councils to guide their activities and oversight by a city council or other governing body

* Usually a **new line of business**

* Organization must build or acquire operational experience in broadband.

* Must develop and manage marketing, sales, and compete with other community network providers.

*Varied interests and needs

* Decision making process can be blurred.

Service Provider Owned Organizational Model. Finally, another model for consideration is one in which the service provider or multiple service providers own the network. This strategy seems to promote the status quo. Service providers own their networks today. Using this strategy gives up the components of control, risk and reward. The municipality or the community must rely on the service providers to upgrade their networks to offer gigabit-enabled services. This appears to be the least attractive option for Region 10 as there are no providers currently that are planning to offer gigabit-flavored services to the community. Region 10 would have no control over where the network is built, when it is built or what services would be offered and at what price level.

Region 10 could try to promote pro-build policies – Dig Once Policies, and sharing of existing assets, but without some measure of control, the potential rewards that could be realized with a community broadband network are left to the service providers to implement. There is no incentive or penalty for the service provider to improve the service.

Public/Private Partnerships. It should also be noted that a Public/Private Partnership ("PPP") model could be set up to reduce the operational risks potentially for a municipality, and yet provide all of the benefits that are associated with local ownership and patient funding. A PPP is a negotiated contract between a public and private entity to fulfill certain requirements and obligations to build out telecommunications or broadband infrastructure and provide services.

PPPs can leverage public assets, such as fiber optic cable, conduit, poles and land with private service providers' assets. These assets can be combined or shared or used to facilitate better and more available access to high speed broadband services. As a PPP can take on several shapes and forms, we will discuss how PPPs can help address risks in various service delivery models. Typically the questions to be addressed when setting up a PPP includes the following list:

- Who will own the network?
- Who will pay for the network to be built? Will the costs of building the network be shared?
- What are the parameters, priorities and boundaries for build-out?
- What assets will be provided for use by the municipality? At what cost? What is the value of these assets?
- What assets will be provided by the service provider? At what cost? What is the value of these assets?
- What policies can be put in place to further incentivize build-out? For example, permitting timelines can be streamlined through bulk/blanket permits or permitting fees could be waived or reduced. Another possibility could be allowing for lower cost construction methods (i.e. aerial construction or microtrenching)

- Is this partnership exclusive? Open to many service providers?
- Who will provide services to end users? Which end users?
- What services will be provided?
- What minimum level of service is required?
- What pricing will be offered?
- Who will provide network management and operations?
- How will the partnership be managed?
- What happens if either party falls short of its obligations?
- How will the performance and progress be measured?

Region 10 could engage in either an Invitation to Negotiate (ITN) or a Request for Proposal process with service providers to allow providers the opportunity to submit a PPP proposal for consideration. This could be in an open and non-discriminatory process by which one or more service providers could be selected to enter into a PPP with Region 10.

The ITN would specify what assets could be available for use and at what cost. Region 10 could also provide a streamlined permitting process for use of poles and opening trenches for further build-out.

There are certain conditions that the ITN would require of service providers. These conditions could be the following:

- Region 10 could reserve the right to provide services directly to the schools, hospitals and government offices within the community.
- Specific price targets for specific tiers of service offerings for residential and business customers
- Provide a minimum level of service to residential and business customers. For example, many municipalities are requiring a minimum service level of 100 Mbps or even 1 Gbps.
- Joint marketing opportunities. For example, the community can market the connectedness of the community and promote this for economic development purposes and to recruit new businesses and industries to the community. The service provider can market its selection as the preferred provider within the community.
- Free wi-fi in specific areas of the community, such as parks, downtown areas, tourist areas or other designated places within the community.
- Service level agreements guaranteeing availability, reliability, redundancy and performance.
- The ability to have the municipality provide oversight, management of performance and progress

The PPP model could then assume that the service provider would then further build-out the infrastructure to the community using or leveraging the municipality's assets or that the cost of further build-out could be shared.

In Conclusion. Region 10 has the opportunity to have this network be in part, funded by DOLA's grant program. It is NEO's recommendation for Region 10 to submit the grant application to DOLA, own the network and enter into Memorandums of Understanding with the various member organizations that will support and provide additional funding for this grant application. Region 10 can then enter into agreements with service providers to provide services to the end users. Region 10 can also outsource various functions for operations of the network, such as network monitoring, maintenance of the network, truck rolls and repair services and perhaps even customer service functions. These operating considerations are further discussed in detail under Section 6, Operational Considerations.

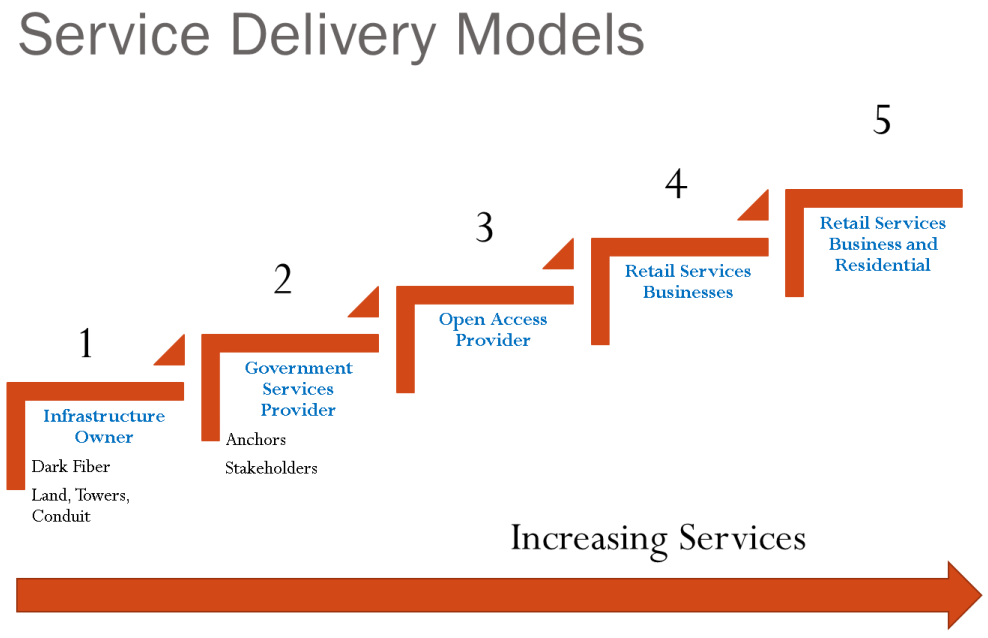
Region 10 is a non-profit organization that is made up for local governments as member organizations. The pros and cons of non-profits and local government agency ownership are addressed above and therefore, steps should be taken to mitigate the downsides of these organizational structures. Consequently, the benefits of local support, having access to specific funding available to local government agencies, and the ability for the local government to control its own destiny and economic vitality, should be leveraged as much as possible.

The service delivery options available to provide services on the network by Region 10 will be addressed under the following section, Section 4, Service Delivery Models.

4. Service Delivery Models to Consider, Wholesale Strategies vs. Retail Strategies

In all of the organizational models discussed above, with the exception of the Service Provider Owned Organizational Model, the network owner could offer service in a retail or wholesale manner. In other words, the municipality or local government – or Region 10 could decide to build a Regional Middle Mile Network connecting the various communities throughout the Region and each of the communities' anchor institutions. Then, after the network is built, there would be several service delivery models that could then be contemplated.

Here are the various forms of service delivery for a Community Broadband Network or Regional Middle Mile Network.



As discussed in Section 3, Exploration of Ownership Structures, SB-152 limits Region 10's options for service delivery. Under the existing law, Region 10 and its member organizations could offer services by being the Infrastructure Provider (1) and by being the Government Services Provider (2) either in a retail manner or in a wholesale service manner. Region 10

would NOT be able to offer services as an Open Access Provider (3), as a Retail Services Provider for Businesses (4), or as a Retail Services Provider for Businesses and Residential Users (5). SB-152 allows Region 10 to offer services to other government agencies and quasi-government agencies within the Region (i.e. the anchor institutions) and to sell access to the network or services on the network to service providers to then provide services to end users. NEO recommends that the local governments within the Region ultimately plan to opt-out of SB-152 to enable further service delivery options to the end users.

A description of each of these service delivery models are provided below.

Infrastructure Provider. The municipalities or local government agencies, or Region 10 could sell conduit, dark fiber, use of poles, towers, land, and property to service providers to use. This can dramatically improve the ability for service providers to build out within the community. For example, having access to conduit can reduce the capital costs of deployment by 60-80% as most of the capital cost for building a fiber optic network is in the labor to open a trench, lay conduit and then place fiber.

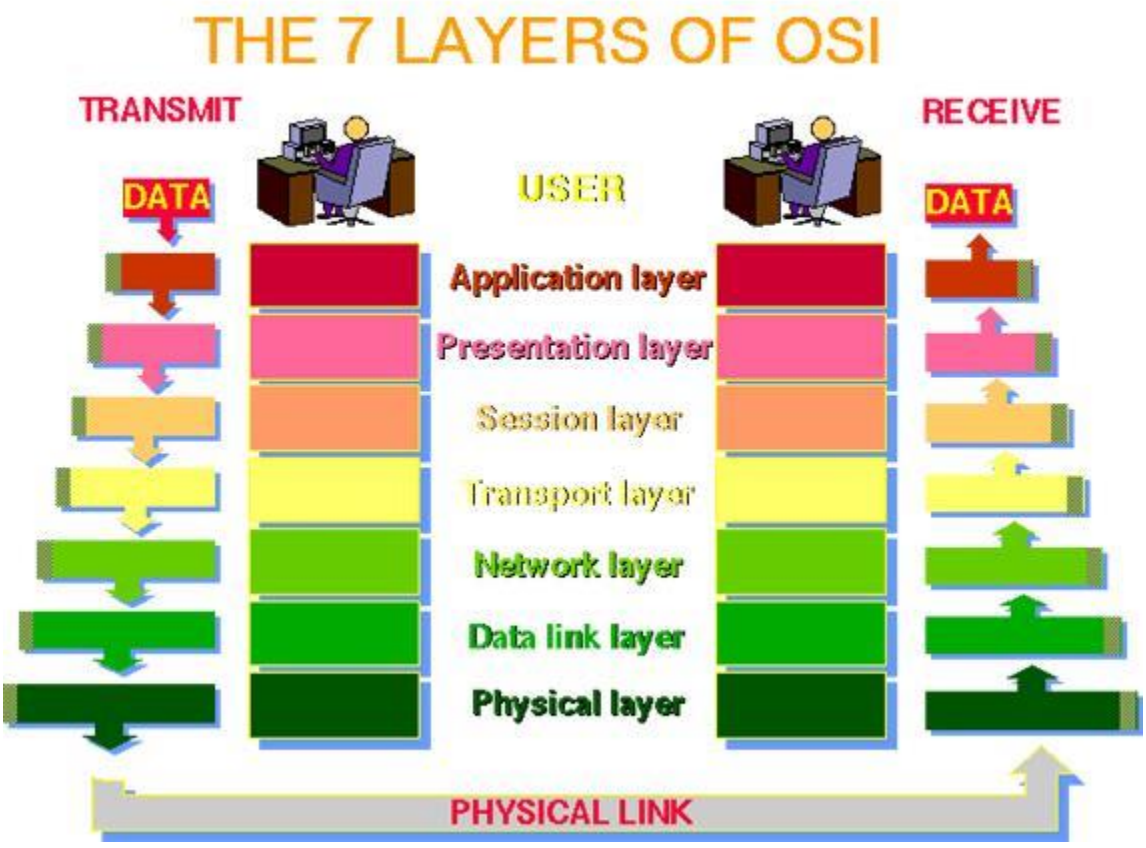
Government Services Provider. In this service delivery model, the municipality or local government agency or Region 10 could build fiber to and provides services for anchor tenants, government offices, public safety, schools, universities, and medical establishments. In addition to providing more abundant broadband at an affordable price to these stakeholders, other services such as IT support, videoconferencing, software updates, etc. can be provided and shared amongst governments to reduce costs and provide better e-government applications. ***This is the recommended service delivery option for Region 10 given the regulatory constraints of SB-152.***

Open Access Provider. An open access network is one in which the physical access to the network is separate from the services that are offered on the network. In its truest sense, the infrastructure owner does not supply services for the network; these services are provided by the service provider. There is clear delineation of separation of network ownership and service providers (i.e. wholesale only services). In many open access networks, the network owner may also be the retail service provider (for example, offer retail Internet services directly to end users) AND offer wholesale service is an open-access environment or perhaps the municipality retains the ability to serve anchor institutions and/or government agencies.

The access is open if it is sufficiently available on a non-discriminatory basis so that all competitors can access the infrastructure under equivalent cost and quality terms. In some sense, selling services to anchor institutions could be provided on an open access basis, and

therefore, there is a component of providing an open access network – albeit, only to the anchor institutions on the network, to NEO's recommendation for Region 10.

There are a number of "flavors" of open access networks. These variations of the model are determined based upon technical design aspects of the network and how "deep" the infrastructure owner's network exists. These technical components are referred to as layers on the Open Systems Interconnection ("OSI") model. The OSI model is a conceptual model that defines and standardized the internal functions, protocols and languages of a communication system by partitioning it into abstraction layers. The lower the layer on the OSI, the less involved, or less functions are provided by the infrastructure owner. As one moves up the layers, the infrastructure owner is providing an increasingly robust and sophisticated set of functions.



This graphic is taken from The Abdus Salam International Centre for Theoretical Physics.

For example, if the municipality or local government – or Region 10 in this case, were to offer conduit only and collocation space, this is a basic level of functionality, or sometimes referred to as "Layer 0." Service providers use the collocation space to house and terminate their own equipment and pull fiber through the existing conduit. This approach minimizes the local

government's role and its investment and allows service providers the greatest degree of flexibility in the broadband access network they implement. This approach also increases the costs required to become a service provider and minimizes the extent to which infrastructure is shared. Nonetheless, opening a trench and laying conduit is often the most expensive part of the outside plant costs and a local government can provide conduit to entice the service provider to offer more robust services. This was discussed previously under the Infrastructure Provider Model.

At a higher level of investment, the municipality or local government or Region 10 could deploy fiber through conduit or in an aerial fashion and sell dark fiber leases or long-term IRUs of the dark fiber to recover its investment costs ("Layer 1"). The network owner provides the physical layer (conduit and fiber), but leaves the service provider with lighting the fiber with its own electronics and provisioning of services. This works when there is a large amount of fiber counts available from the network owner.

The IRU pricing is dependent upon the number of fibers acquired. It may be cost prohibitive to purchase a large strand count of fiber and most IRU agreements restrict the further resale of the acquired strands. ***Region 10 is planning to acquire a limited amount of fibers from Tri-State and/or DMEA. As the network backbone will have limited number of fibers, offering Layer 1 services; i.e. dark fiber to service providers, does not work efficiently. If Region 10 had more fibers available on its fiber network, then it could more easily sell dark fiber leases or IRUs to other service providers, but this is not the case.***

Another hand-off to the service provider could be at a lambda or a wavelength. Lambda switching (sometimes called *photonic* switching, or *wavelength* switching) is the technology used in optical networking to switch individual wavelengths of light onto separate paths for specific routing of information. In a simplistic sense, a wavelength could be thought of as a different color of light. Technologies such as Dense Wavelength Division Multiplexing (DWDM) enable 80 or more separate wavelengths to be transmitted on a single optical fiber. Handing off at a lambda to the service provider allows a light path to behave like a virtual circuit.[22]

The most often used form of open access for community broadband networks is the Data Link layer, or "Layer 2". In this case, the infrastructure provider deploys both the fiber and the link layer electronics at either end. Many local governments are deploying this level of service and often this is referred to as the Open Access Model. As there are different meanings assigned to

[22]Tech Target, Lambda Switching, definition available at http://searchnetworking.techtarget.com/definition/lambda-switching

this term in the industry, it is appropriate to further define which Open Access Model and strategy is being provided.

Service providers are offered a basic network service which they can use as a platform for delivering a bundle of retail-level services to the end users. The handoff from the network owner to the service provider might be an Ethernet port to support Virtual Local Area Network (VLAN) service. The Ethernet port handoff could be 100 Mbps, 1 Gbps or 10 Gbps. This level of service could then be available to any location that is fiber-fed. Pricing for this type of service could be a port charge or access fee per location.

If the network infrastructure owner is providing a link layer service based on Asynchronous Transfer Mode (ATM), then customers are assigned separate Permanent Virtual Circuits (PVCs) which are switched to the designated service provider. While providing the electronics for lighting the fiber, the infrastructure owner might also provide what is normally viewed as a Layer 1 service: point-to-point circuits, for example using Synchronous Optical Network (SONET) Add/Drop Multiplexors (ADMs).

Finally, open access can occur at the network layer ("Layer 3"). Once again, this may be implemented in a number of ways. Policy based routers, or Multi-Protocol Label Switching (MPLS)-based Virtual Private Networks (VPNs) are used to separate traffic going to competing service providers or ISPs. Pricing for this type of service could be a revenue share or a fixed monthly fee per customer per service.

The term “open access” can be generally used to mean that the network is available on a non-exclusive basis, and for any qualified service provider to utilize in order to connect their customers. Qualified service providers would be able to serve any business or residence that is connected to the network.

Retail Service Provider Model, Businesses. In this model, the municipality, local government or Region 10 builds the fiber network, installs electronics to light the network and provides services directly to the end users. Most often, the local government provides voice and Internet services to local businesses. In this model, the network owner competes directly with the service providers. SB-152 restricts local governments from offering this type of service delivery model without a favorable public vote to opt-out.

Retail Service Provider Model, Businesses and Residences. In this model, the network owner provides voice, data, Internet and cable TV services to the businesses and residences within the community. Again, SB-152 restricts local governments from offering this type of service delivery model without a favorable public vote to opt-out.

Triple Play Services? Until recently, most municipal or community broadband networks offered voice, data and cable TV services. This offering of the three services was often referred to as triple play services. As things are changing rapidly in the telecommunications and cable TV industry, some municipalities or local governments are only providing data and Internet services and are deciding not to provide voice services and cable TV services. With enhancements being made to cellular phones and the increasing mobility needs of customers today, more customers are opting for cell phone services over their landline phones. 90% of adult Americans have a cellular phone. The number of adult Americans with a smartphone rose from 35% in April 2011 to 58% in January 2014. Smartphones have more advanced computing ability and connectivity than landline phones. Smartphones are now cameras, media players, video cameras, GPS navigation units, web browsers, and personal digital assistants.

Landline phone service (i.e. dial-tone phone service) is a product in decline. The number of households in the United States that have only wireless phone service has jumped from about 18% in 2008 to almost 35% in 2011, now at 70%. It is predicted that only 30% of homes will retain their landline phones by the end of 2015. The FCC is recommending changing the Universal Service Fund, which helped subsidize the installation of networks to build landline phones; to subsidizing BROADBAND services. The Universal Service Fund would no longer subsidize landline phone service, but would instead subsidize broadband or Internet services.

IPTV: Video and cable TV usage is dramatically changing too. The top 12 cable companies have all seen a dramatic decline in cable TV subscribers in the past twenty-four months. Former pay-TV subscribers are opting for lower-priced Internet streaming solutions, such as Netflix, Hulu and Amazon. The big three channels (ABC, NBC and CBS), as well as most cable TV content is now offered online at no or very low cost depending upon the programming. As customers are becoming more Internet-savvy, more content is now offered online for free, and given the current context of the tough economic climate, when given a choice, customers are discontinuing their cable TV subscriptions in favor of Internet entertainment options.

The customer's experience in the world of TV is well established and expectations are deep-seated. Customers do not want to experience channel delay or service disruptions, which have been typical in most IPTV service roll-outs. Initiating an IPTV service must meet or exceed previous customer experience from cable or satellite companies. Market research shows that if these experiences are not impeccable, the customer is already predisposed to changing services should their expectations (or anybody else's in the household, for that matter) not be met.

Offering IPTV services is challenging and complex. Even for existing service providers or other utility providers that already have an operational team and systems in place, launching IPTV service is unlike providing any other service offering in the past. The complexity of the last-mile network infrastructure, i.e. the fiber from the curb to the premise, the Customer Premise Equipment configurations, the difficulties in establishing programming and distribution rights, competition among Fortune 500 companies, the complexity of the service offerings, coupled with the customer's established TV viewing expectations make offering IPTV services difficult at best.

Given these changes in phone and cable TV use, NEO does not recommend offering dial-tone phone services or cable TV services and is recommending that Region 10 provide provision of Internet or data-type services to anchor institutions and to service providers.

5. Technology Plan, Leveraging Existing Assets and Capital Costs Projections

Before discussing possible assets and how these assets may be used or acquired, it is appropriate to have a basic understanding of the terms used in the telecommunications and fiber optic industry regarding use and acquisition of existing fiber assets. Dark Fiber is optical fiber infrastructure that is currently in place, or has been constructed; but is not being used. Optical fiber conveys information in the form of light pulses so the term "dark" means no light pulses are being sent. To the extent that these installations are unused, they are described as dark. Another way of describing dark fiber is the fiber is not "lit" with equipment on each end point. Equipment or data switches "light" or activate the fiber connection. The cost of the equipment to light the fiber is not included in the monthly Dark Fiber lease.

A Dark Fiber lease is typically an arrangement between the Grantor, the owner of the network- and the Grantee in the form of is a monthly lease price for a given term.

An Indefeasible Right of Use (IRU) is the effective long-term lease (or often thought of as temporary ownership) of a portion of the capacity of a fiber optic cable.
In structuring the IRU agreement, the owner of the network is the Grantor. The Grantor pays for the construction of the network, has submitted permits and the use of the rights of way, and may have established franchise agreements and fees to the jurisdiction. The Grantor then assigns parts of the constructed network to the Grantee for use of the dark fiber, and a select amount of bandwidth or capacity on the network between termination points or routes along the constructed network.

An IRU combines features of a sale, a lease, and a service contract. Every IRU is unique, but typically the agreement confers exclusive usage rights to Grantee, but title and control remain with the Grantor. IRUs are specified in terms of a certain number of fiber counts for a given segment of a fiber optic network. In most cases, the IRU is a 20- to 25-year agreement to use the fiber count for a segment. Payment for the IRU is typically an upfront fee based upon the fiber count miles. The fiber count miles are the number of miles of the segment times the number of fibers used.

The per route mile fee can range anywhere between $1,500 to $6,500 per fiber count. These numbers are based upon national statistics, but IRUs are unregulated and pricing varies dramatically across the country. For very short routes, the per route mile fee can be up to $25,000 per route mile. This large range in pricing is due to a number of factors – demand for fiber, location of the fiber, whether it is a long-haul or a short distance, etc.

An example of the pricing methodology for the up-front payment is shown below. For example, ABC Company wants a 20-year IRU agreement for a (6) count fiber cable from Location 1 to

Location 2. The distance on the network between Location 1 and Location 2 is 100 miles. ABC Company will pay $2,200 per mile. The upfront payment would be:

(6) counts of fiber * $2,200 per mile * 100 route miles = $1.32 Million

There is usually an annual or monthly maintenance fee in addition to the up-front payment. Maintenance fees are typically anywhere from $200 to $350 per mile. In some cases, the maintenance fee is included in the up-front payment as it is treated as a capital expense from the buyer. In other cases, the maintenance fee is paid monthly or annually for the term of the agreement.

Standard maintenance fees may include day-to-day routine maintenance of the network. Additional maintenance and repair fees may be included for emergency, after hours or cable relocation. Network providers may also charge for collocation space, rackspace, power, and cross connect fees.

Managed services implies that the fiber is lit, meaning the service provider has installed and is using telecommunications equipment to light the fiber and provide a service to the end user. Managed services typically include a non-recurring installation charge and a monthly reoccurring charge based upon the length of the agreement and the bandwidth provided in the service offering between two or more locations. It is an operating expense, rather than a capital expense. Each of the service providers have varied options available for managed services; they range from offering point-to-point services, virtual LAN service and point-to-multipoint services.

Internet access services involve paying a non-recurring installation charge and a monthly reoccurring charge based upon the bandwidth of the access to the Internet. Included in the Internet access service monthly fee is the transport or backhaul costs which are based upon mileage from the customer location to the Internet hub.

The Technology Plan, How to Best Improve Broadband Abundance, Availability and Redundancy.

In order to improve the availability, abundance and redundancy of advanced broadband within Region 10, each of the communities within the region must have fiber optic or wireless access to one of the major Internet access points or hubs. In many of our meetings discussing this issue, we referred to this as "supply". This access is often referred to as Internet backhaul or transport. It refers to the fiber optic line or leased circuit to a main Internet hub. The Internet hubs for this region are located in Grand Junction, Denver, Salt Lake City or Albuquerque. Because the Internet backhaul or transport fees are often assessed based upon the distance or mileage from a community to one of these locations, the monthly fees are expensive. If a service provider or an anchor tenant does not have a physical connection, a fiber optic line or a

microwave connection directly into one of the Internet hubs, then the entity pays monthly access charges based upon mileage or distance to the Internet hub. In the case of Region 10, all of the communities within the region are a fair distance to one of the Internet hubs. Therefore anchor tenants pay a large monthly fee for internet access and so do the service providers that do not have a physical connection to Grand Junction, Denver, Salt Lake City or Albuquerque.

The service providers cannot offer better services to each community until better bandwidth is available from these Internet access points and their costs for backhaul and transport are reduced. The service providers often stated during NEO's meetings that the large expenses of transport and backhaul costs prohibit them from offering better service speeds. In order to provide more abundant bandwidth to the communities, this issue needs to be resolved. One way to resolve this issue is to build a regional network connecting all of the communities to one or more Internet access hubs. The network could be built in such a way to reduce the monthly access fees and to share in the costs of these monthly fees by aggregating usage over the regional network.

Inventory of Existing Fiber. There are many assets in place within the region that would allow advanced broadband services to be brought to each of the communities. These assets, meaning existing fiber optic cable and/or conduit or existing wireless towers, are in place and are owned by a number of companies. Fiber optic assets located between many of the communities within Region 10 are owned by the following entities:

- Tri-State Generation and Power
- Western Area Power Administration (WAPA)
- Delta Montrose Electric Association (DMEA)
- FastTrack (formed and owned by Empire Electric and La Plata Electric)
- San Miguel Power Association (SMPA)
- EAGLE-Net Alliance
- Century-Link
- Nucla Naturita Telephone Company
- Charter Communications

There is also existing fiber and/or conduit within the communities from the local ISPs that serve some of the communities. Additionally, there is conduit between Crested Butte and Mt. Crested Butte that is owned by Gunnison County.

There is also fiber that is owned by CenturyLink throughout the six county region. NEO's team met with CenturyLink in face-to-face meetings and via conference calls on several occasions. NEO's team requested CenturyLink to provide pricing for use of their fiber either through an IRU or a dark fiber lease. CenturyLink did not provide pricing nor did they agree to leasing or use of their fiber throughout the region.

A map of these assets has been provided to Region 10 and its members.

Network Architecture - High Capacity and Redundant, Self-Healing Rings.

Toplogy. The network has been designed to include a ring-topology providing most of the communities within Region 10 network redundancy.

Edge. The edge component of this network will consist of a router at each IP drain handoff location. The solution will be robust and scalable to adapt to nearly any demands. The handoff will be a Border Gateway Protocol "BGP" peering session to the neighboring carrier. There will be an edge device at two physically disparate locations on the network. Traffic will run in a fault tolerant mode where traffic will flow to the alternate handoff in the event of an outage at the primary carrier. The edge router will be a dedicated device that has either a 40G or 10G connection to the adjacent transport switch.

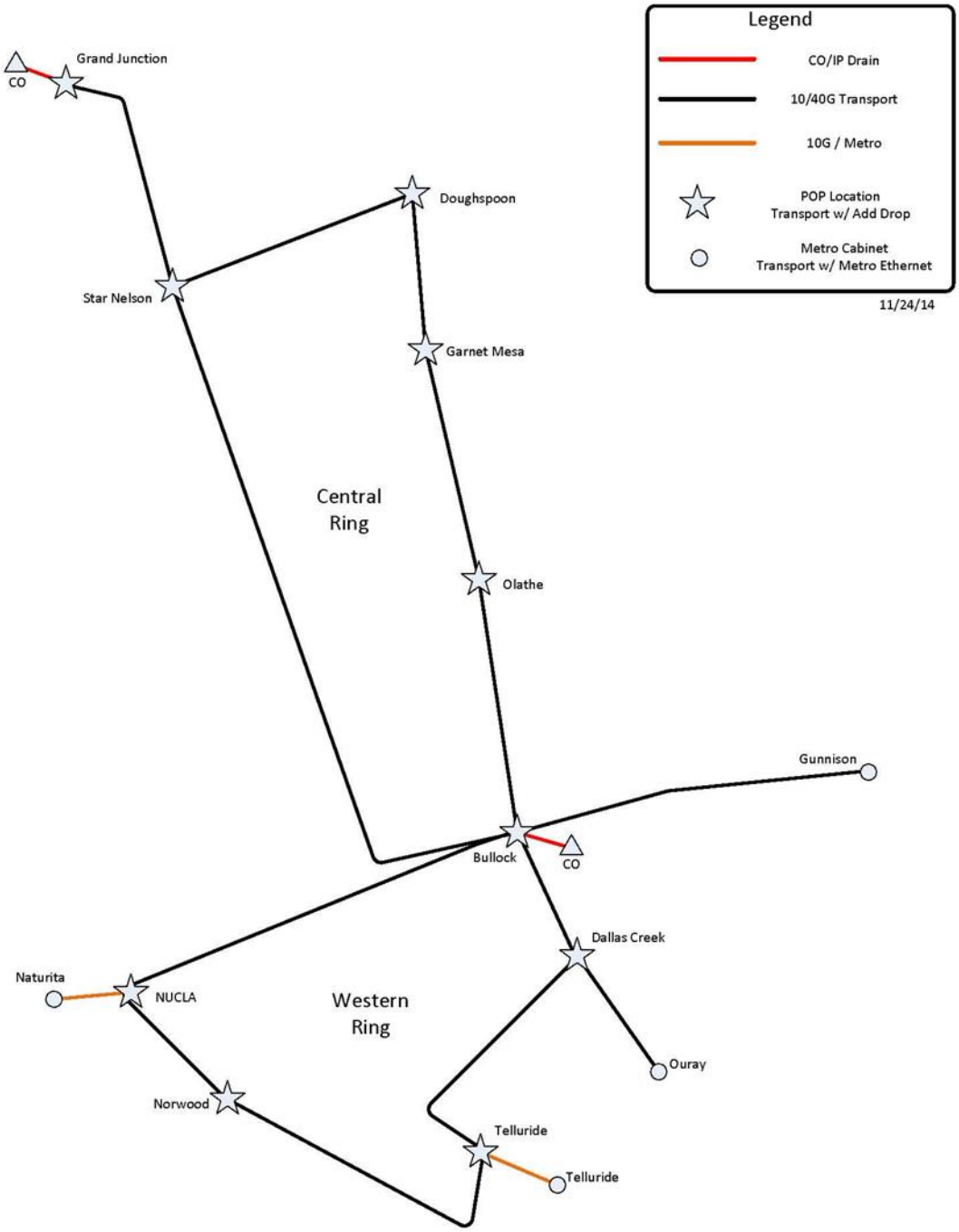
Transport. The transport or distribution layer of the network will be a series of Ethernet devices strategically placed throughout the territory to provide aggregation of end client devices. The transport network will be placed in multiple fault tolerant rings with zero impact failover between paths in the instance of a network interruption. The ring will operate at a 10G speed with the ability to aggregate to higher speeds where a fiber asset is available.

Customer Premise Equipment. The customer premise equipment will be an Ethernet handoff at the customer property. The equipment will be robust and solid state. The device will allow for multi-tenancy scenarios and centrally managed data throttling. Multiple service types will be handed off to the customer through this device depending on the service subscription. The uplink to the transport network can be up to 10G and a customer handoff of up to 1G.

Management/Monitoring. The management and monitoring solution will be a centrally placed component that is accessible from any location through any web interface. There will be email or text distribution group in the event of an outage or other significant event. Options such as SNMP traps for device detection and sflow for bandwidth link utilization are used in this solution. The bandwidth throttle based on subscription will be adjusted and managed in this solution.

Below is a conceptual design of the high capacity, redundant and self-healing network.

Region 10 Fiber Network



Levering Existing Assets through IRUs

As described above, existing fiber assets can be acquired through a long-term Indefeasible Right of Use or IRU. The benefits to acquiring an IRU versus building new fiber are many. First, it is typically much less expensive to acquire an IRU than to build the fiber route. Second, the IRU fiber is already constructed and in place. Therefore, the time to implement is shorter. The time to implement is contingent upon a contract being negotiated, rather than the time to engineer the route, pull permits and construct the network. And finally, another benefit to acquiring an IRU is that maintenance on the fiber route is often borne by the Grantor or fiber network owner.

The following segments can be acquired through an IRU and cost estimates for this are included below. If the following segments were to be built, the capital costs would be well over $60 Million.

Grand Junction to Albuquerque Route, or Grand Junction to the Montrose/San Miguel County Line

As mentioned above, Internet access hubs are located at the CenturyLink Central Office in Grand Junction and in Albuquerque. There is an existing fiber route between Grand Junction and Albuquerque that is co-owned by multiple companies or entities. These include Tri-State, DMEA, San Miguel Power and FastTrack. Additionally, a few wireless providers have capacity on this route.

For purposes of this network design, the entire route would NOT need to be acquired. NEO priced out an IRU using Tri-State's recommended pricing for Grand Junction to the Montrose/San Miguel County Line.

As Region 10 is planning to initially apply for grant funding through DOLA for Montrose and Delta counties, a smaller portion of this route will initially be acquired through Tri-State. The route that will initially be acquired is from Grand Junction to Starr Nelson's substation. Phase 2 of the DOLA grant may include extending this route from the Starr Nelson substation to the county line between Montrose and San Miguel Counties.

The easements along this route have been perfected and no additional costs would be included along this route. Also, regeneration sites have already been established on this route. However, there are other fiber routes that are owned by Tri-State in which additional regeneration sites would need to be established and the easements would need to be perfected for commercial use.

For many grant programs that fund advanced broadband networks, annual maintenance fees could be capitalized and paid up-front. When annual maintenance and operation fees are paid up-front, there is typically a time value of money or net present value calculation that is applied.

NEO is not recommending that this entire route be built. As Tri-State has already stated that an IRU for this route can be purchased, and there is an option to use the DMEA fibers, NEO did not assume that this route would be built. Additional options to explore for this route would be to obtain a leased circuit and Internet access from FastTrack, who also co-owns this route and/or to explore options with San Miguel Power who also owns (2.25) fibers. A detailed breakdown of the costs for the IRU through Tri-State has been provided to Region 10.

Extending the route from the Starr Nelson substation to the county line between Montrose and San Miguel Counties is of interest to the entire region because it provides redundancy for a number of the communities. It also provides a path to serve the West End in Montrose County and it connects to Tri-State fiber from the county line toward the Sunshine Substation in San Miguel County. This route could possibly be of interest to Region 9, as they are currently receiving internet access through Albuquerque. Having access to the extended route from Starr Nelson to the county line would give Region 9 with the ability to purchase bandwidth from Grand Junction, giving them added redundancy in and out of their region. Region 9 has expressed interest in this route as they too have a need for redundancy, with the ability to subscribe to Internet access from Grand Junction and from Albuquerque.

DMEA Fiber

DMEA has installed and is in the process of installing fiber within its Delta and Montrose county footprint. The network will connect their various power substations to their headquarters location in Montrose.

DMEA hired a consulting firm approximately a year ago to research how to best leverage and use its existing fiber network. One of the obstacles to leveraging its network to offer broadband services is allowing expanded use of the easement or right-of-way for commercial purposes. Easements that are currently in place on these routes are for installation of fiber optic cable for monitoring of the power system. The perfection of this easement will need to be done in order for any entity to use the fiber for commercial communication purposes.

DMEA has easements to cross these properties to provide management of its power system; however as noted above, the easements need to be perfected in order to allow for an expanded use of their network; i.e. to allow the network to be used for broadband services. This unknown liability is seen as a risk within the Board of Directors of DMEA and therefore, rightfully so, the Board has been hesitant to go forward with any plans for offering broadband services. The Board has stated its fiduciary obligation to the cooperative and its members, to ensure that additional costs incurred in allowing public access to DMEA's fiber network does not increase the rates charges for electric service.

The study recommended that the best strategy for DMEA that offered the least financial risk to the cooperative was the lease of dark fiber. The largest hurdle of perfecting the easements is being evaluated by a committee formed by the DMEA Board along with appropriate legal counsel, subject matter experts from the fiber industry, and other regional cooperatives that

have experience in commercial communication in regards to right of way perfection. DMEA has stated in its position paper regarding broadband services that it welcomes discussions on how to best mitigate this risk.

Virgil Turner and NEO's Diane Kruse met with the CEO and team members of DMEA on December 10th to discuss options in working together. Virgil Turner put together a white paper on perfecting the easements to advance broadband deployment in Montrose and Delta counties. Additionally, Michelle Haynes and Diane Kruse with NEO had several conversations and email exchanges with DMEA staff. DMEA has agreed to provide an IRU for (6) strands of fiber on the routes that it is currently building, in exchange for Region 10 providing an IRU for (6) strands of fiber on the routes between DMEA's power substations and the Carrier Neutral Locations (CNLs) within Delta and Montrose Counties and sharing in the costs of the perfection of easements along these routes. In Phase 1 of the grant application for DOLA, Region 10 is providing for $500,000 for perfection of easements on these DMEA routes.

With DMEA providing an IRU for the use of their fiber to Region 10, $6 Million in capital costs are saved, as Region 10 will not need to build these routes. As DMEA has already or is in the process of building these routes, these costs are sunk costs for DMEA. However, for purposes of the in-kind contribution, an amount between $1.9 Million and $6 Million could be used as the in-kind contribution number.

The following communities could be connected with fiber with this strategy:

- Olathe
- Montrose
- Delta
- Hotchkiss
- Cedaredge
- Paonia
- Crawford
- Orchard City

Region 10 would need to extend or build fiber between the DMEA power substations to a CNL within each community.

TDS in DELTA COUNTY

TDS did not share with NEO where they have fiber optic facilities. It is known that TDS serves the following markets and therefore, most likely has fiber to these communities. TDS did state that they do not have excess capacity on their fiber networks and that they are interested in upgrading their equipment to allow for faster speeds to the communities that they serve.

- Eckert
- Grand Mesa
- Cedaredge
- Hotchkiss
- Paonia
- Somerset
- Crawford

The DMEA fiber is the best option available to Region 10 as DMEA will also have fiber to most of these communities. Additionally, TDS stated that they would not be interested in providing an IRU to Region 10; however, they would be interested in speaking with Region 10 regarding lowering their transport and backhaul fees (i.e. Internet access in Grand Junction or Albuquerque) and would be interested in additional fiber facilities to Delta.

EAGLE-Net and Tri-State, Montrose to Ouray

EAGLE-Net Alliance ("EAGLE-Net") is a Colorado intergovernmental entity and the recipient of a BTOP grant award administered through NTIA and ARRA (i.e. "The Stimulus Program").

EAGLE-Net started with a vision to bring high-speed Internet to every public school in Colorado through public-private partnerships to build a comprehensive, statewide network. 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 EAGLE-Net Alliance applied for and was awarded a $100.6 million grant from BTOP in September 2010.

EAGLE-Net has fiber network facilities to Ouray and Ridgway. They are leasing this route or have acquired an IRU for this route through Tri-State. Upon initial discussions with EAGLE-Net, they stated that they would most likely not be able to sell IRU's of their fiber, but would rather sell dark fiber leases for use of their fiber. We also know from personal experience, that EAGLE-Net may be interested in fiber swaps, i.e. the use of their fiber with the ability to use another entity's fiber.

An estimate of the IRU acquisition costs was provided to Region 10 and its member organizations. Ridgway and Ouray would be served by this route. Additional research must be done along this route to determine whether or not there is excess capacity or fiber available through Tri-State. Initial discussions with Tri-State indicated that most of the fiber has been acquired either through Eagle-Net or CenturyLink on this route.

If this route cannot be acquired through either Tri-State or EAGLE-Net, there is an option to lease a 1 Gbps or a 10 Gbps circuit through Mammoth Networks. See information on Mammoth Networks provided below.

Tri-State, Montrose/San Miguel County Line to Sunshine Substation, near Telluride

Tri-State also owns fiber from the Montrose/San Miguel County Line to the Sunshine Substation near Telluride. NEO designed the network to include acquisition of 6-counts of fiber for this route for the entire six counties.

There is a non-profit organization that is working with San Miguel County that has acquired or is in the process of acquiring fiber strands on this route. There is potential to work together with this non-profit organization in order to not duplicate capital expenses. For purposes of the budget, NEO included the costs for this route.

WAPA and Tri-State, Montrose to Gunnison

Western Area Power Administration (WAPA) has fiber between Montrose and Gunnison, following their transmission power lines along this route. Tri-State leases fiber from WAPA on this route. Additionally, CenturyLink has fiber within the CDOT right of way along state Highway 50.

WAPA expressed concern over providing an IRU on this route, stating restrictions imposed by the Department of Energy and its existing charter. The existing WAPA charter states that

WAPA can work with other entities such as water and power companies (such as Tri-State), but would not lease their fiber to private organizations or companies for commercial use. This needs to be further investigated as the Town of Estes Park is using WAPA transmission lines for fiber that it owns into Estes Park. WAPA and Estes Park are still in negotiations upon whether or not it will be permissible for Estes Park to continue to use the fiber along these transmission lines. It will be of great interest to Region 10 to see how this is resolved. Political pressure may be put upon WAPA for Estes Park to continue to use this fiber and depending upon how this is resolved, Region 10 may be able to convince WAPA to share in its use of fiber from Montrose to Gunnison.

NEO reached out to Tri-State regarding this route to see if there was a workable solution. WAPA must give written authority to Tri-State to lease their fiber to Region 10. NEO's team has sent out emails to WAPA asking for their permission to have Tri-State lease their fiber to Region 10.

Additionally, with the FCC's February 26, 2015 decision of defining broadband services as a utility, and under the definition of Title II services under the Communications Act, there may be further ground to gain with WAPA. Having broadband defined as a utility seems to allow use of this fiber under WAPA's existing charter. Further, there is the ability to use power and transmission lines under the Communications Act.

As these considerations need to be further explored with WAPA, this route is projected to be included in Phase 2 of the DOLA grant application. Another consideration is to partner with DMEA on this route as DMEA expressed interest in having fiber built to serve the Cimarron power substation. Cimarron is located approximately halfway between Montrose and Gunnison.

An estimate of the IRU costs was provided to Region 10 and its members. Easements will need to be perfected for many of the Tri-State routes.

New Fiber to be Built

Leveraging these existing fiber routes, there would be fiber optic cable that would need to be built to serve the remaining communities and/or to extend the fiber from a power substation to a carrier-neutral facility within a community.

Region 10 is planning to build the following routes for Phase 1 of the DOLA grant application, within Delta and Montrose Counties:

To	**From**
Doughspoon	Delta CNL

Hotchkiss Sub	Hotchkiss CNL
Crawford Sub	Crawford CNL
Olathe Sub	Olathe CNL
Cedaredge Sub	Cedaredge CNL
GARNET MESA	Delta CNL
Paonia Sub	Paonia CNL
Cedaredge	Orchard City

The following routes are considered for new build for Phase 2 of the DOLA grant application. Estimated costs to build these new routes for both Phase 1 and Phase 2 were provided to Region 10 and its member organizations.

To	**From**
Gunnison	Crested Butte
Ridgway	Sawpit
Sawpit	145/Telluride
Roundabout at 145/Telluride	Telluride
SMPA Telluride Substation	Sunshine Substation
SMPA Telluride Substation	Roundabout at 145/Telluride
Sunshine Substation	Ames Substation
Ames Substation	Ophir
Ophir	Silverton
Blue Mesa Substation (between Montrose and Gunnison)	Lake City
WAPA substation near Gunnison	Gunnison
Ouray Sub	Ouray
Norwood Sub	Norwood

An additional route from the Blue Mesa Substation, located between Montrose and Gunnison was added, using Tri-State transmission lines. Also, another route from Ophir to Silverton was added as Tri-State mentioned this route was of importance to them and that, as a potential partner with Region 10 for the Phase 2 grant submission, there may be in-kind contributions that could be made and/or costs for the new routes that may be built may be borne by Tri-State. Easements will need to be perfected on the two additional routes.

Another route was added from the Gunnison Substation to a carrier-neutral location as a place-holder. As noted earlier, clarification must be done to determine where WAPA's fiber terminates near Gunnison.

San Miguel Power Association, Fiber to the Built

NEO held several conference calls with San Miguel Power Association and Tri-State regarding their plans to build fiber throughout San Miguel County. San Miguel Power and Tri-State are currently planning to build fiber which would connect from the Sunshine Substation to Telluride. San Miguel County and NEO Fiber have expressed interest in acquiring an IRU for these routes once the San Miguel Power/Tri-State Build has been completed. An estimated cost for the IRU has been provided to Region 10 and its members.

NEO had several discussions with Tri-State in reference to partnering on the potential fiber build which would serve Ophir and had discussion in regards to sharing in the costs of this build. Tri-State expressed interest in this route as it serves the Ames substation and could be potentially extended to the fiber that is located in Silverton, providing further redundancy for their power substations. Follow up with Tri-State and San Miguel Power Association is strongly encouraged to share in these costs.

CenturyLink Fiber, IRU or Leased Circuit, Dark Fiber

NEO's team has reached out the CenturyLink and CenturyTel several times to determine whether either or both companies would be willing to sell an IRU for segments of their fiber throughout the region. Specifically, CenturyTel and CenturyLink seem to be the only companies that have fiber in or near Hinsdale County and Lake City. Other routes owned by CenturyLink that are of interest to Region 10 include:

1. Montrose to Gunnison. It is understood that CenturyLink's fiber is located along Highway 50 in the CDOT right of way.
2. Gunnison to Crested Butte.
3. Cimmaron to Lake City. It is not clear as to CenturyLink's route or location, but apparently CenturyLink has a fiber route into Lake City.
4. Ridgway to Sawpit.
5. Sawpit to 145/Telluride.

Additionally, as there may be limited capacity on the Tri-State route from Montrose to Ouray, and as it has been confirmed that CenturyLink has purchased an IRU from Tri-State on this route, it would be beneficial to the region if CenturyLink would offer use or a dark fiber lease or a leased circuit from Montrose to Ouray in addition to the routes listed above. If CenturyLink is not willing to provide an IRU for these routes, which based upon their lack of response to our inquiries on this topic, it is highly likely – leased circuits could be obtained from CenturyLink to provide connectivity to these locations.

NEO did not get a response on several of its requests for pricing through CenturyLink. However, NEO did receive pricing from Mammoth Networks to lease dark fiber for a few of the locations. This pricing has been provided to Region 10 and its members.

Mammoth was not able to provide a dark fiber circuit from Montrose to Ouray as CenturyLink is most likely leasing an IRU from Tri-State on this route and does not have excess capacity. Mammoth stated that it could possible provide lit services; i.e. a 10 Gbps circuit between Montrose and Ouray for a monthly recurring charge. Additional follow should be done with Mammoth to explore this connectivity option for serving Ouray and Ridgway.

Wireless Services

In most cases, NEO's team specified fiber to be built to serve the various communities throughout the region. In the case with Lake City, the cost to build fiber is excessive. NEO specified a wireless tower to serve Lake City. Wireless is a good option because it is less costly than building fiber and if licensed spectrum can be acquired, wireless bandwidth could potentially be up to 50 Mbps. If Region 10 were able to get a 5Mhz licensed spectrum, this would provide approximately 15-16 Mbps. The 10-15 Mhz options support 50 Mbps.

NEO's team assembled a list of companies that own licensed spectrum in the region. The information prepared by NEO includes the company contact information, the area in which the license is held and what spectrum is owned. This information has been forwarded on to Region 10.

Some of these license holders may be operating in another part of the country, but also hold the license within Region 10. These companies might not be using their license within the Region 10 geographic area.

If licensed spectrum can be acquired, the throughput and performance attributes are much more favorable. For example, line of sight may not be needed with licensed spectrum and distances supported may be greater. Wireless equipment could be placed on poles or on buildings to support a wireless overlay network. This network could be used to provide wireless capabilities to outlying areas within a county to within communities to provide Internet access.

Building to the Anchor Institutions

NEO's engineering team also put together network routes and preliminary capital costs of building to most of the anchor institutions within each community. A list of community anchor institutions served on the network has been provided, as has a list of locations that are not currently served with fiber.

These cost projections are again, preliminary as there may be fiber assets within each community that can be leveraged or perhaps some of the anchor institutions within the community are already being adequately served. Input and feedback from Region 10 and from the communities are needed to further validate the locations to be served.

Some grant programs will not pay for customer premise equipment; i.e. equipment that the customer owns. However, if the network owner or Region 10 maintains ownership of the equipment that is placed at the customer anchor institution, there would be the opportunity to have the grant pay for the equipment.

Once fiber is built within a community, it is much easier to continue to build out further into the community. The networks within each community have been designed so that either the ISPs can further build out within the community or the cities or towns themselves can build further into the community. Equipment at each of the anchor institutions would also need to be purchased to light the fiber. These costs are included in the Phase 1 of the DOLA grant submission.

As Lake City is being contemplated to be served with a wireless tower, there are no costs associated with building to the anchor institutions; however, there would be a cost for equipment that would be included.

A list of anchor tenants that are contemplated being served was provided to the members of Region 10. Cost estimates for these builds, maps of the proposed network builds and equipment estimates have been provided to Region 10 and its members.

Regeneration/Switching Equipment and Carrier Neutral Location Facilities

There would be switching equipment that would aggregate and allocate the bandwidth amongst all users on the network and costs for equipment, racking and building costs for new huts and cabinets for the Carrier Neutral Locations. The location of the Carrier Neutral Locations information, specifications regarding huts and cabinets and associated costs for site preparation and equipment have been provided to Region 10 and its members.

Project Management, Design, Engineering Costs

Project management costs and design and engineering costs projected for the new build routes and the anchor institution routes that will be built are included in the total capital cost summary.

Putting it Together

A summary of all of the capital costs have been provided to Region 10 and its member organizations. Alternate provisions for services, including purchase of lit fiber and additional partnerships could reduce the initial capital costs of building some of the routes.

NEO would suggest to also considering adding back in the IRU from Tri-State between Starr Nelson substation and the Montrose/San Miguel County Line for either Phase 2 or for Phase 3 submission with Region 9. These costs could be shared amongst Region 9, San Miguel County and Montrose County.

Assumptions for operations, revenue and pricing strategies and various service delivery models are included in the next section. Detailed financial models have been provided to Region 10 and its member organizations.

6. Operational Considerations, Revenue Projections, Operating Expenses, Financial Plan

Operational considerations for this network are discussed below. If Region 10 or a combination of various jurisdictions embarked upon this project or a portion of this project to build a regional fiber network, there are several operational issues to be considered. These considerations include addressing the following questions:

- How would the entity produce revenue?
- What operational costs would be realized?
- Who could provide operations and maintenance for the network?
- Who would provide operational support for various customer service functions, i.e. billing, customer service, trouble resolution
- Who would provide marketing support?

Business Models for Middle-Mile

It is important to note what the Region 10 network is, and perhaps what it isn't in order to establish revenue and pricing strategies and to make decisions regarding business models.

Region 10's network is considered a "Middle Mile" Network. A Middle Mile broadband network does not predominantly provide broadband service to end users or to end-user devices. In other words, the Middle Mile network is an extension of the Internet backbone that connects Last Mile providers (Internet Service Providers) who ultimately serve the residents, and businesses in the region, and possibly the anchor institutions. Region 10, under the current Senate Bill 152 could serve the anchor institutions directly if it so chose. The Middle Mile network is typically connected to multiple "access points" along the Internet backbone routes. These access points could be the regeneration sites along the network or the carrier neutral locations within the communities. Either way, the service providers could connect to the network via these access points and then in turn, provide services to the end-users within a community.

Region 10's network is not considered a "Last Mile" network. Last Mile refers to the connection between the Middle Mile network and the end-user. Entities such as Google Fiber or Chattanooga are considered Last Mile, Fiber to the Home providers. One of the outcomes of this project is to try and provide a platform by which the service providers can use the regional Middle Mile network to in turn offer services to the community. Google Fiber's and Chattanooga's pricing model for offering a 1 Gbps connection to an end user should be considered in Region 10's pricing strategy, as it is desired to provide a platform by which the service providers can offer much better services to end users at an affordable price.

The services that will be offered under the Region 10 business model will be "lit" services, as opposed to dark fiber leases. Most of the network that will be in place for Region 10 will be acquired under an IRU agreement. The IRUs will acquire (6) counts of fiber throughout the network. Additional fiber will be built to extend these IRUs from the power substation into a Carrier Neutral Facility. Additional fiber will then be built to the community anchor institutions. There is not a great amount of excess fiber to sell further IRUs and/or to lease dark fiber strands to other entities. The model therefore, will be to provide "lit" services to anchor institutions and/or service providers.

Providing lit services assumes that Region 10 would offer services under an open access business model. Open access allows Region 10 or its associated municipalities to deploy switching equipment throughout the network to "light" the network and to establish a "transport service" or circuit to the various service providers. Service providers would connect to the various carrier neutral facilities throughout the region and would have access or could serve all customers connected to the network. Open access refers to a network that is available for any qualified service provider to use on a level-playing field basis. This fosters an environment of competition amongst the service providers and provides a platform in which Region 10 can require service level agreements with the service providers to provide a minimum level of service at an affordable rate to end users.

There are a few options to consider regarding the level of services to be offered by Region 10 under an open access business model. These options and their associated financial models are provided below. Here is an overview of each option.

1. Internet Access to Service Providers Only. As Region 10 will be deploying switching equipment throughout the network that will aggregate and allocate bandwidth across the entire network, service providers can benefit from this shared aggregation and shared cost of Internet access. Service providers can pay Region 10 for Internet Access, reducing their transport and backhaul costs for Internet "supply."

2. Wholesale Internet Access to Anchor Institutions, Services Provided by the Service Provider. Region 10 can provide Internet access and transport to the anchor institution over the fiber network and the actual service is billed and supported by the service provider.

3. Retail Internet Access to Anchor Institutions. Region 10 would provide both internet access and transport to the anchor institution. Region 10 would bill the anchor institution for service.

4. Transport Only or VLAN Services. The service provider would be required to obtain its own Internet access but would utilize the Region 10 network within a community to access the anchor institution. The service provider would be charged a port charge to connect to the anchor institution.

Under each of the scenarios above, the service providers will pay a monthly fee to Region 10 for the connection to the anchor institution based upon the amount of bandwidth and the type of service (Internet, or transport only).

Region 10 would offer two types of Internet service, a shared service and a dedicated service. Shared service would be available for anchor institutions that do not require a guaranteed amount of bandwidth at all times. Bandwidth demand can fluctuate with the total number of subscribers on the network at one time. Dedicated service would also be available to large anchor institutions that require an "always on" or guaranteed amount of bandwidth specifically for their organization's needs. Dedicated service might be required by a hospital on the network or perhaps a service provider.

With transport only services, Region 10 would provide a virtual connection to the anchor institution, which is sometimes referred to as VLAN service, but would not provide any Internet services associated with that connection. With this service, service providers would be responsible for providing their internet services and Region 10 would charge a monthly port charge or transport fee to the service provider.

Pricing Considerations

Currently anchor institutions and service providers are paying a range of $6,500 - $10,000 per month for Gigabit access. Only a handful of anchor institutions are subscribing to this level of service because it is not affordable. Most of the attendees in the community meetings, according to the questionnaire, are paying $50 - $100 per month for 1.5 Mbps. The goal of this project is to disrupt and transform this model of pricing dramatically. The question is, what level of service is appropriate and at what price?

In order to answer that question, it is helpful to understand what is being offered in other cities across the U.S. and the world, and what price points are offered as well. According to the Open Technology Institute's 2014 Cost of Connectivity Report[23], the best-in-class or speed leaders around the world have the following service levels and pricing:

[23] See http://www.newamerica.org/downloads/OTI_The_Cost_of_Connectivity_2014.pdf New America

Rank	City	ISP	Download Speed	Upload Speed	Price	Price per Mbps
1(tie)	Seoul	HelloVision	1000	1000	$ 30.30	$ 0.03
1(tie)	HongKong	Hong Kong Broadband Netv	1000	1000	$ 37.41	$ 0.04
1(tie)	Tokyo	KDDI	1000	1000	$ 39.15	$ 0.04
1(tie)	Chattanooga, TN	EPB	1000	1000	$ 69.99	$ 0.07
1(tie)	Kansas City, KS	Google Fiber	1000	1000	$ 70.00	$ 0.07
1(tie)	Kansas City, MO	Google Fiber	1000	1000	$ 70.00	$ 0.07
1(tie)	Lafayette, LA	LUS	1000	1000	$ 109.95	$ 0.11
8	Zurich	Swisscom	1000	100	$ 157.55	$ 0.16
9	Bristol, VA	BVU	1000	50	$ 319.95	$ 0.32
10	Bucharest	RCS & RDS	1000	30	$ 32.35	$ 0.03
11	Paris	Free	1000	.	$ 35.28	$ 0.04
12(tie)	Amsterdam	XS4ALL	500	500	$ 72.29	$ 0.14
12(tie)	Copenhagen	SES-NVE	500	500	$ 129.24	$ 0.26
12(tie)	Riga	Baltcom	500	500	$ 142.29	$ 0.28
12(tie)	Los Angeles, CA	Verizon	500	500	$ 299.99	$ 0.60
12(tie)	New York, NY	Verizon	500	500	$ 299.99	$ 0.60
12(tie)	Washington, DC	Verizon	500	500	$ 299.99	$ 0.60
18	Toronto	Rogers	350	350	$ 182.25	$ 0.52
19	Prague	UPC	240	20	$ 83.63	$ 0.35
20(tie)	San Francisco, CA	Webpass	200	200	$ 30.00	$ 0.15
20(tie)	Mexico City	Axtel	200	200	$ 156.32	$ 0.78
22	Berlin	Deutsche Telekom	200	100	$ 57.63	$ 0.29
23	Dublin	UPC	200	10	$ 63.41	$ 0.32
24	London	Virgin	150	0	$ 55.71	$ 0.37

The U.S. cities are highlighted. The price per Mbps ranges from .32/Mbps to .07/Mbps.

Since 2012, almost every city in the ranking above has increased the top speed offering and has dramatically lowered their pricing. For example, Lafayette, LA charged $999.95 per month for its gigabit service in 2013 and dropped that price to $109.95 per month in 2014. In Mexico City, a 200 Mbps package was available for nearly $100 less than the price offered for that speed by a different provider in 2013.

Per the report, the average download speed of plans in this ranking increased from 233 Mbps in 2012 to around 500 in 2013, and almost 650 Mbps in 2014. Nearly half of all cities in this ranking offer Gigabit speeds, and more than two-thirds of all cities offer service over 500 Mbps.

Per the rankings, Chattanooga, TN; Bristol, VA; and Lafayette, LA, now offer some of the fastest and most affordable high-speed residential products available in the country despite the fact that they have some of the lowest population densities among the cities that are surveyed. All

three cities offer gigabit speeds that place them on par with Hong Kong, Seoul, Tokyo, and Zürich. All three of these examples are city- or utility-owned entities, rather than a private sector ISP.

In fact, the only other provider that offers gigabit speeds in the cities we surveyed is Google Fiber, which sells 1 Gbps service in Kansas City, KS, and Kansas City, MO, for the same price as EPB in Chattanooga, TN.

By contrast, Verizon's top tier is a 500 Mbps symmetrical connection that is available to some residents of New York, NY; Washington, DC; and Los Angeles, CA for about $300/month, which is significantly more than the cost of a gigabit in Chattanooga, TN (around $70/month) or Lafayette, LA (around $110/month) and comparable to the price of the gigabit package in Bristol, VA (around $320/month) but only half the speed.

Also to note from the report, rural areas with low population density have historically struggled to attract adequate private sector infrastructure investment, similar to what has been the case in Region 10. More recently, many of these local communities have similarly taken broadband investment into their own hands and now provide residential service through a publicly-owned network or utility company. Although there are many examples of successful locally-owned networks, In general, the research shows that these locally-owned networks tend to deliver better value to their customers when compared on a price-per-megabit basis to competing cable and telecom providers in their own cities.

Business customers for Google Fiber and Chattanooga do offer higher prices for Gigabit service. Here is a summary of the services available in each of these cities:

Google Fiber	**Monthly Fee**
Residential Gbps service	$ 70.00
Residential Gbps service plus TV	$ 120.00
Business Gpbs service	$ 100.00
Chattanooga EPB	**Monthly Fee**
Residential Gbps service	$ 70.00
Residential 100 Mbps service	$ 57.99
Business Gpbs service	$ 299.99

Another relevant data point is setting pricing for Region 10 is to understand on ***average***, what is being offered within the U.S. According to a broadband report by Point Topic[24] which was conducted in the first quarter of 2014, the average monthly combined stand-alone and bundled residential broadband subscription for copper networks in North American came in at $8.54, that for cable at $2.03 and that for fiber at $1.45. Point Topic found the global average monthly charge for residential broadband services was $76.61. The average bandwidth provided by residential services was 55 Mbps, meaning the global average cost per megabit was $1.39.

According to the report, The U.S. ranked 43rd of the 90 countries surveyed in Point Topic's market research and analysis, ranking just behind Colombia and one place ahead of Greece. Monthly U.S. broadband subscription rates did fall below the global average of $76.61, however. Access to actual U.S. average broadband pricing data requires a subscription to Point Topic, but it's estimated to be in the $60 – $65 price range.

These pricing examples can serve as a benchmark for Region 10's service providers as a standard or goal for providing Gigabit service to the end-users. The current price per Mbps in Region 10 is $35-50.

Revenue Targets, Recommended Pricing

There are 224 anchor institutions that have been identified throughout Region 10 that could be served directly with a fiber connection for all six counties.

As the initial grant application is assuming that Delta, Montrose and Ouray counties would apply for funding, the business model was run based upon 146 anchor institutions initially to be served. For purposes of projecting revenue, NEO assumed an 80% take rate for the anchor institutions, over a 5-year period of time.

This is the projected number of anchor institutions taking services:

Total Number of Customers (End-of-Year) Subscribers	Year 1	Year 2	Year 3	Year 4	Year 5
Anchor Institutions, Retail Services	-	-	-	-	-
Anchor Institutions and Service Providers, Wholesale Services	-	44	73	102	117
Total	-	44	73	102	117

Suggested pricing has been provided to Region 10 and its members.

[24] See http://www.telecompetitor.com/report-average-u-s-broadband-prices-are-below-world-average-of-76-61/

It is also likely that the service providers will obtain Internet access on their own and want to connect with the Region 10 network through a Virtual Local Area Network (VLAN) connection. In this case, Region 10 is providing a connection to the anchor institution, but is not providing Internet access with that connection.

Several various detailed financial models have been run with these revenue assumptions and their associated service delivery models.

Operational Expenses

The following operating expenses are projected.

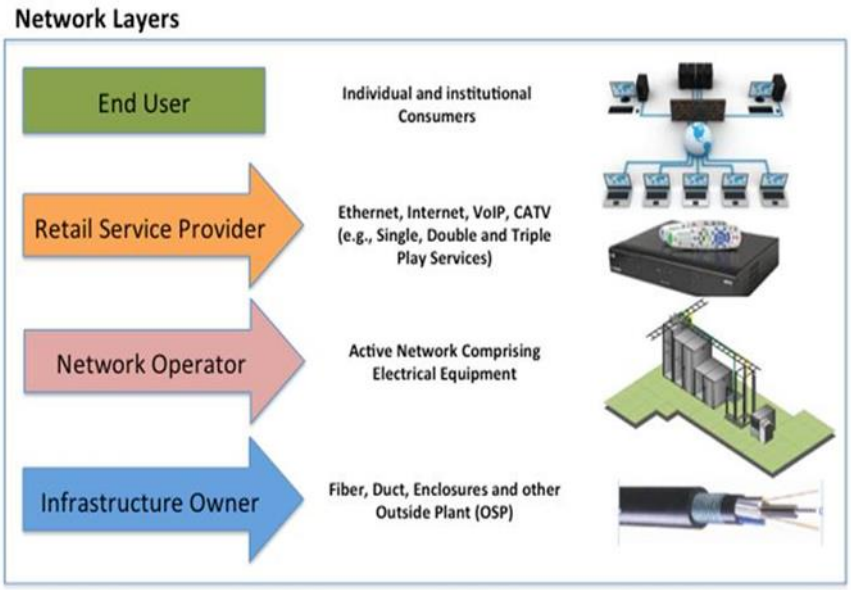
Internet Access. The largest operating expense for Region 10 will be Internet Access monthly fees. These fees are dramatically reduced from current fees because there are no distance-based backhaul costs. The backhaul costs are non-existent because the Region 10 network will terminate directly to the CenturyLink Central Office in Grand Junction.

If Region 10 offers a 1 Gbps service to the anchor institutions and to the service providers, Region 10 will most likely need to have a 10 Gbps or a number of 10 Gbps Internet access service circuits to support all of the users on the network. Internet access can be oversubscribed because not all users are on the network at the same time, nor is a Gigabit worth of data used for every connection. Most users will subscribe to a shared Internet access service. Oversubscription is a widely practiced concept in the industry. The business model calculates the number of Internet access bandwidth needed each year as additional anchor institutions are added.

Network Operations. Operations, Maintenance and Trouble Resolution on the Network, Who would be Responsible for What?
In order to understand what is required of Region 10 from a network operations standpoint, a good understanding of a fiber network and its associated layers is helpful. A fiber network can be considered to have four layers:

1. the passive infrastructure comprising the fiber, duct, enclosures and other outside plant;
2. the active network comprising the electrical equipment;
3. retail services, which provides connectivity to the services (e.g., Ethernet, internet, VoIP, IPTV, Sensors);
4. and of course the end-users.

Some people also visualize an additional layer, the content layer, lying above the retail services layer, which may also be exploited commercially. This technological structure has implications for the way that a fiber network is organized and operated.



The overall business model and service offering decisions guide the resources needed for operations and equipment investment decisions, as well as marketing, sales and support activities. The three primary technology structures are:

Passive infrastructure - Physical Network

The passive infrastructure layer comprises all the physical elements needed to build the fiber network. This includes the physical components such as the optical fiber, the trenches, ducts and poles on which it is deployed, fiber enclosures, optical distribution frames, patch panels, splicing shelves and so on. The organization in charge of this layer will normally be responsible for network route planning, right-of-way negotiations, and the civil works to install the fiber. This is the layer where the network topology is implemented.

The primary functions for this layer are:

1. Construction Activities, Backbone or Middle Mile Network. As NEO was able to identify existing fiber assets that would be acquired via an IRU, the construction activities for the middle mile or transport will be minimal. If the Region 10 network expands into further phases to build some of these routes (i.e. between Ridgway and Telluride) there would be construction activities for the middle mile that would most likely be outsourced to a fiber optic construction company to build.

2. Construction Activities, Drop Cable, Laterals from Substations to the Carrier Neutral Facilities and to the Anchor Institutions. A Request for Proposal will be sent to fiber optic construction companies to outsource the building of the new routes extending the fiber acquired by the IRUs from the power substations to the carrier neutral facilities and then to the anchor institutions within the communities. The RFP could also cover final

design, engineering and construction management, as well as the construction of the network.

3. Monitoring of the Network. A proposal was received for monitoring the network, provisioning services and for trouble ticket tracking. The proposal included the following tasks associated with monitoring and maintenance of the network:

    - Programming of all network equipment
    - Provisioning of service for new connections to the network
    - Scheduled backups of all network configurations
    - Active monitoring on all equipment
    - Out of band management (requires secondary circuit to each location)
    - 24/7 Network Operations Support (NOC) Support
    - Dedicated line to Tier II Ethernet technicians 8am – 5pm weekdays
    - Coordination and dispatch of remote hands and/or field technicians (On-site labor is not included in this pricing, this would need to be contracted with local service providers)
    - IP management and allocation tracking
    - Ticketing system
    - Outage notifications and alerts
    - Utilization reporting and graphing

4. Maintenance of the Network. An entity that has trucks, people certified and trained to splice fiber, fiber optic testing equipment and the like should be hired to maintain and repair the network. These services will be done when in monitoring the network, it is determined that a truck roll or on-site service call must be done. Possible organizations for this function include service providers, DMEA, Tri-State and local fiber optic construction firms.

Active Network – Electronics

The active network layer refers to the electronic network equipment needed to bring the passive infrastructure alive, as well as the operational support systems required to commercialize the fiber connectivity. The network operator in charge of this layer will design, build and operate the active equipment part of the network. This is the first layer where active services such as coarse wave or dense wave division multiplexing (C/DWDM), Gigabit Passive Optical Networking (GPON), and Ethernet (Active Ethernet) services are provided.

The primary functions for this layer are:

1. Installation of the Active Equipment.
2. Maintenance of the Active Equipment.
    - Provisioning Customers on Network Core
    - Configuring and Maintaining the Network Core Equipment

- Repair of ONTs

The proposal discussed above under Monitoring the Network includes provisioning customers on the network core, and configuring and maintaining the network core equipment. The installation of active equipment and the repaid of ONTs could be outsourced to a company that would perform truck rolls.

Retail Services –
Once the passive and active layers are in place, retail services come into play. This is the layer where the Internet, voice, video or other network service connectivity are packaged as a service for consumers and businesses. Besides enabling those services technically, the company responsible for this layer is also in charge of customer acquisition, go-to-market strategies, and customer service. The retail service provider may also decide to offer premium services from the content layer, such as IPTV.

The primary functions for this layer are:

- Sales and Marketing
- Order Entry, Provisioning
- Customer Service
- Trouble Resolution
- Billing
- Vertical Management of Customer Groups, i.e. Wholesale Customers, Anchor Institutions, Business and Commercial Customers, Residential Customers

The business models contemplated are to provide wholesale services primarily to the service providers. The service providers would perform the functions of sales, marketing, order entry, customer service, trouble resolution and billing. There would be limited provisioning of new customers that will be "pointed" to the service providers, and these costs are included in the network monitoring proposal. There is one financial model of providing retail services to the anchor institutions.

The ability to truly succeed under the wholesale business models relies on strong relationships with the service providers and delivery provider partners to effectively market and manage services and customer relationships.

Financial Results

In all of the service delivery models, the financial results are EBITDA positive throughout the initial grant period and the remaining years. Several detailed Financial Models were run by NEO Fiber's team and in all of the models, the network is sustainable and in some cases, very profitable.

Financial models were run for the initial Phase 1 grant application for DOLA assuming Delta and Montrose Counties only, and models were run with the rest of the counties coming on board in Phase 2.

7. Collaboration and Aggregation of Demand and Associated Cost Savings/Benefits

The benefits that can be realized from this middle mile network are far reaching. The current model of broadband scarcity would be dramatically disrupted and transformed as this network would provide an abundant amount of broadband capacity to each community and to the anchor institutions on the network. Each anchor institution could receive 1 or 10 Gbps of service. As mentioned earlier in the report, if an anchor institution subscribed to Gbps service today, the price for this service ranges from $6,000 - $15,000 per month. Most of the anchor institutions today are not subscribing to this level of service because it simply is not affordable. Pricing being contemplated for the anchor institutions would be dramatically reduced to allow the anchor institutions to have the ability to subscribe to a Gigabit worth of service for an affordable price.

8. Priorities, Plans, Recommendations and Next Steps

To summarize, much work was put into this broadband blueprint to leverage existing assets that are already in place and to build a network that is future-proof, redundant, abundant, affordable and transformative. The intention of this plan was to provide several options for connectivity and redundancy for the communities. There are many options that can be further explored. These options need to be weighed against need, feasibility and the ability to finance, coupled with ability to implement and the ability to have a sustainable plan.

Much effort was given to engaging the communities and its respective members and citizens in this process and to begin breaking down silos that exist between government agencies, the medical community, schools and education establishments, power and electric companies, the business community and the residential citizens. The purpose of this community outreach was to begin the conversation of what is possible and to engage support – financial, political and community support for this project. We believe these goals were met.

As SB-152 limits municipalities to build telecommunications infrastructure to directly serve non-government and non-quasigovernment entities without a favorable public vote to opt-out, this blueprint provides for a regional middle mile network that will connect anchor institutions and government agencies throughout the region. SB-152 allows the network to be used by service providers to provide services directly to the end users. Therefore, further work should be done to collaborate with the service providers to invest in middle mile infrastructure that will in turn improve their services, pricing and affordability, redundancy and capacity. Additionally collaboration with the service providers can be done to allow them to extend last mile services, using portions of the Region 10 network to serve the end-users and general public.

While work is being done to construct the Region 10 community networks, further collaboration can take place with the service providers to provide an open trench or joint trench to reduce costs of building infrastructure for all parties.

The following recommendations and priorities are recommended by NEO Fiber. Region 10 is currently already implementing many of the recommendations put forward in this process. Here is a list of next steps:

1. Apply for grant funding through DOLA for Phase 1, Delta and Montrose Counties. (In process.)
2. Apply for grant funding through DOLA for Phase 2, Gunnison, Ouray, Hinsdale and San Miguel Counties.
3. Consider opting out of SB-152 for all or as many communities within the Region as possible. Opting out of SB-152 will allow for more options to further serve the end users

within the communities. This project is currently able to meet the needs of the government users and quasi-government use. The project can currently allow ISPs to use this network to expand further into the community. However, opting out of SB-152 will allow this network to be leveraged even further to build to end users, whether this is done by the ISPs or by Region 10 or by Region 10 members.

4. Implement network build-friendly policies in all of the communities. This includes dig-once policies, abandoned conduit and fiber ordinances and simplified permitting and pole attachment policies.
5. Acquire access to licensed wireless spectrum. Wireless connectivity can serve as an interim solution where building fiber is not yet possible or feasible. If licensed spectrum can be acquired, the throughput and performance attributes are much more favorable than unlicensed spectrum. As stated earlier, line of sight may not be needed with licensed spectrum and distances supported with licensed spectrum may be greater than with unlicensed spectrum. Wireless equipment could be placed on poles or on buildings to support a wireless overlay network. This network could be used to provide wireless capabilities to outlying areas within a county to within communities to provide Internet access. This network could also serve the mobile, portable, tourist and public safety applications for users. This could be done in partnership with the existing wireless providers in each of the communities or could be done independently.
6. Document placement of conduit, fiber facilities. As this network and any other assets are built, acquired or discovered, document the location of these assets in a GIS-based system. Continue to document these assets are they are leveraged and built out further either by Region 10 and its members or by the service providers, power companies and other infrastructure companies.
7. Continue to perfect easements for commercial and broadband purposes.
8. Continue to work with Tri-State, DMEA, San Miguel Power, WAPA, EAGLE-Net and other infrastructure owners in regards to swapping fiber, leasing dark fiber and IRUs, joint builds and sharing of resources for future builds.
9. Engage in outsourcing various functions of network operations. Requests for Proposals can be written and sent out to companies.