Southwest Colorado Council of Governments Strategic Broadband Plan

January 2017

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Introduction and Executive Summary

This project was made possible by the Colorado Department of Local Affairs, Colorado Department of Transportation, La Plata Economic Development Alliance, Region 9 Economic Development District, and the Southwest Colorado Council of Governments.

In the fall of 2015, the Southwest Colorado Council of Government (SWCCOG) engaged NEO Connect (NEO) to prepare a strategic broadband plan for Southwest Colorado Regional Broadband Plan for an area encompassing thirteen local government jurisdictions, consisting of Archuleta, Dolores, La Plata, and San Juan Counties as well as the municipalities of Bayfield, Cortez, Dolores, Durango, Ignacio, Mancos, Pagosa Springs, Rico, and Silverton. The project was supported in part by an Energy and Mineral Impact Assistance Fund (EIAF) grant awarded through the Colorado Department of Local Affairs (DOLA). The scope of work also included making recommendations to put together a sustainable financial plan for the existing Southwest Colorado Access Network (SCAN) project. This report will address both aspects. It will provide a strategic broadband plan for the SWCCOG and its members to consider which will improve broadband services in the area, as well as provide recommendations for creating a sustainable financial model for the existing SCAN project without further expansion.

In October of 2016, the service area was amended to also include the Ute Mountain Ute tribal community in the study area. An add-on companion report will be provided to this plan that will address the Ute Mountain Ute tribal community's recommendations for improving broadband services.

The shared goal of members of the SWCCOG is to provide abundant, redundant and affordable Internet service to citizens, businesses and visitors. There are a number of options and strategies for improving broadband services throughout region. Some of these options may be considered in the short term and others may best be part of a longer-term plan. For example, in the short-term, the SWCCOG and its members may decide to collaborate with the service providers to share in the costs of leased Internet transport, backhaul and access costs. In the long-term, a strategy to construct fiber facilities between the communities in collaboration with CDOT and the Rural Healthcare Grant Program may be implemented. Another short-term strategy may be to implement broadband policies and ordinances and to build to anchor institutions, while the long-term strategy of implementing public private partnerships for last mile connectivity may be further developed. Another example may be to consider use of existing structures and towers for wireless implementation as a short-term strategy while developing additional tower locations for long-term implementation. This plan will provide a road map of both short-term and longer-term strategies for consideration.

Background of the SCAN project

In 2010, the SWCCOG was awarded a $3 million Department of Local Affairs grant to implement a high capacity network for the regional governments. This network, known as the Southwest Colorado Access Network (SCAN), was the SWCCOG's first large scale endeavor. The total project, including local matching funds, was over $4 million.

The primary driver for this initiative was the lack of affordable broadband options and in some cases, complete absence of broadband capabilities in the region. The SCAN project built fiber between some of the key anchor institutions within each of the communities. This fiber is now being used by many service providers to provide more abundant broadband services to these anchor institutions, in some communities. Further, some of the communities built out additional fiber and conduit throughout their respective cities and towns to connect more government, schools, healthcare and libraries.

A list of anchor institutions was compiled initially by the State of Colorado's OIT department. NEO met with city and county officials and scoured the community anchor institution list to identify locations that are currently connected to the SCAN network, locations where the Municipality or the County built fiber, and those anchor institution locations that are not yet connected to fiber. Based upon these meetings, NEO and the SWCCOG member communities and counties identified approximately 116 locations that were currently connected to the SCAN network and approximately 193 locations that were not yet connected to the SCAN project or to further build out from the Municipality and/or County.

Location	Other Anchor Institutions, Connected to SCAN	Other Anchor Institutions not yet connected	Schools and Libraries, Connected to SCAN	Schools and Libraries, not yet connected	Healthcare, Connected to SCAN	Healthcare, Not Connected	Totals
Bayfield	10	10	0	6	0	0	
Cortez	22	0	12	6	1	2	
Dolores	1	9	0	8	0	0	
Dove Creek	4	8	6	6	0	2	
Durango	25	30	5	11	2	9	
Ignacio	3	12	5	1	0	0	
Mancos	0	14	0	13	0	1	
Pagosa Springs	14	14	6	2	0	1	
Rico	0	3	0	3	0	0	
Silverton	0	12	0	6	0	1	
Towaoc	0	2	0	0	0	1	
Totals	79	114	34	62	3	17	309
SCAN	79		34		3		116
To be Connected		114		62		17	193

A detailed list of the anchor institutions, their addresses and whether they are connected to SCAN, a City and/or County network, or not yet connected was provided to SWCCOG and its member communities.

SCAN includes two hub locations in the cities of Cortez and Durango. The two regional hubs were originally to be connected via a 50 Mbps backbone; however, fiber optic facilities were not built for the SCAN project between these two locations. Instead, the two communities are connected via leased dark fiber with service of 10 Mbps from a local service provider. Leasing services with a larger bandwidth capability is currently cost-prohibitive; and therefore, the two data centers are connected with a leased line with a much smaller bandwidth capacity. The option to share data, store data and better leverage the ability for back up facilities between these two locations is lost as there isn't sufficient bandwidth connecting these two locations.

NEO conducted an assessment of the current SCAN project's Strengths, Weaknesses, Opportunities and Threats (SWOT) and found the following:

Strengths:

- The SCAN project has provided a foundation of connecting many of the anchor institutions within each community. Additionally, many of the communities have built their own fiber networks to further expand broadband connectivity within many of the cities. The City of Durango has built a substantial fiber network throughout the entire community and the City of Cortez is currently building out a Fiber to the Business network within its community.
- Service providers are using the SCAN network through dark fiber leases to provide Internet and data services to many of the anchor institutions, residents, and businesses in the Cities of Cortez and Durango.

- Approximately 116 anchor institutions are connected to the SCAN network.

Weaknesses:

- The current SCAN operations is supported by two sources of cash: community and member contributions and operational revenue received from Internet access and dark fiber leases. The operational revenue received through dark fiber leases does not support the current operations on its own; member communities need to provide funding for the SCAN network's operations, which is done through general dues. Additionally, the current staff levels that are operating the SCAN network are limited. Operations should be expanded to better operate and level the network's capabilities. For example, operations should support fulltime resources for administrative, management, marketing and technical support. The current revenue model does not provide for an independently run, self-sustaining organization. SCAN needs to be financially viable or sustainable without annual member contributions.
- Current levels of pricing for SCAN members are at $8 per Mbps. In other words, to receive a 100 Mbps Internet service, the monthly cost is $800. A Gigabit or 1,000 Mbps would cost $8,000 per month. This is expensive and therefore, member communities are not subscribing to a higher service levels. Current levels of services are at what communities can afford; 10-30 Mbps. Given this, the network is underutilized.

Opportunities:

- The global average cost for bandwidth is $1.39 per Mbps. According to a broadband report by Point Topic[1] 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. In the SWCCOG region, the cost for bandwidth is $8 per Mbps. There is an opportunity to drive down the cost for Internet services by either building more network connectivity or by renegotiating pricing for the SWCCOG members.
- In cities that are implementing a Gigabit of service to homes and businesses, the pricing standard is .07 - .09 per Mbps for residential service ($70 – 90/month for Gigabit Internet) and (.30 - .80 per Mbps for businesses or commercial service ($300 - $800 for businesses for Gigabit Internet).[2] The gap from the SCAN project current pricing level at $8 per Mbps vs. the global average at $1.35 per Mbps can be dramatically improved.

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

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

- Revenue share models for public private partnerships with service providers are typically at a minimum of 50-50% revenue shared. Revenue shares with a 75/25% split are more appropriate in favor of infrastructure owner where the infrastructure owner has contributed most of the capital costs.
- The current pricing for dark fiber leases could be increased slightly to allow for a more sustainable revenue model. The service providers that are currently using dark fiber at the current pricing levels may push back; although when this suggestion was made at the community meeting with the service providers, there was a general sense that the current dark fiber pricing could be increased and the service providers could still benefit from the fiber infrastructure. We believe there is room to increase the pricing and still allow sufficient margins for the service providers.
- With 116 anchor institutions currently connected to the SCAN network, the SWCCOG could implement a more favorable revenue model by providing services either directly or indirectly to the anchor institutions. These locations could be connected to each other through connections between the various communities, by either leasing or building fiber facilities. With this approach, true aggregation of demand could be realized and the SWCCOG could implement a more favorable revenue share on Internet and data communication services.
- At the two hub locations, in Durango and in Cortez, there is switching equipment that could be better leveraged and utilized. The original plan was to connect these two hubs to each other via high-bandwidth leased services and to connect to the other communities within the region. This did not occur, again, because the leased circuits to connect the hubs and the communities are expensive. There is an opportunity to build a regional network that will truly aggregate demand for Internet services and reduce the overall cost for all anchor institutions. Currently each anchor institution subscribes separately for Internet service. Connecting them will allow for better aggregation and for sharing in the Internet access and backhaul charges.
- Throughout this process, NEO and the SWCCOG staff and members have engaged many key stakeholders and potential partners in improving broadband services throughout the region. There is an opportunity to work together to either share in the cost of leased circuits and/or leverage grant and funding opportunities and partnerships to build fiber connectivity between the communities and to more anchor institutions. This will be discussed in detail under Section 6. Building a middle mile network between communities achieves a number of benefits. The primary benefits include better redundancy, lower leased access costs, true aggregation of demand of anchor institutions, potential shared services between government agencies, collaboration opportunities amongst all stakeholders, and reduced backhaul and transport costs for the anchor institutions. Additionally, access to this infrastructure provides better redundancy and lower access costs for the service providers.
- NEO and SWCCOG issued a Request for Proposal for a Public Private Partnership for helping to improve last mile options within the region. Eleven responses were received from service providers, financing companies, and operational companies to potentially

partner with the member communities on last mile broadband options. This will be discussed in detail under Section 7, Last Mile Options.

Threats

- Perhaps the greatest threat is doing nothing and keeping the SCAN as it is, without a sustainable plan. The SCAN can be leveraged further to connect more of the anchor institutions within each community, and to provide redundancy in and out of each of the communities. The SCAN project could also be expanded to include building fiber, wireless or other connectivity between the communities. This expansion would better leverage the previous work of the SCAN project, allowing more anchor institutions to receive better broadband services and can potentially provide a path forward to financial sustainability for the SCAN project.

Why Expanding Broadband Services Matters, Broadband Infrastructure is Critical to our Communities' Economic Vitality

Our world is rapidly changing. 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. The Internet has impacted the way we work and live including 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.

The importance of broadband was reflected in the recent Federal Communications Commission's (FCC) determination that broadband internet access is a utility, as necessary to contemporary life as electricity, roads, and water systems. 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 communities.

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 political boundaries and changed us culturally. 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 was invented to turn on the lights, but empowered – literally, the transformation to an industrial society.

Just as it was impossible to predict the impact that electricity would have to power 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.

Identify the Projected Capital Costs for the Development of (at least) Gigabyte Speeds to the County Seats, Middle Mile Infrastructure

The scope of work required a number of strategies for the development of at least a Gigabit of Internet and broadband speeds to the four County seats in this project. The four County seats are:

Archuleta County: Pagosa Springs

Dolores County: Dove Creek

La Plata County: Durango

Montezuma County: Cortez

San Juan County: Silverton

NEO identified strategies for providing development of at least a Gigabit of Internet speed to each of the county seats per the scope of work, and also identified strategies for providing this level of service at a minimum to the remaining communities within the study area and to the unincorporated areas of each of the Counties:

Archuleta County: Pagosa Springs, noted above

Dolores County: Dove Creek, noted above and Rico

La Plata County: Bayfield, Ignacio, and Durango, noted above

Montezuma County: Cortez, noted above, Dolores, Mancos and Towaoc

San Juan County: Silverton, noted above

Bringing capacity into these communities is often referred to as "Middle Mile Infrastructure." Most of the existing middle mile infrastructure is CenturyLink. EagleNet, TriState, FastTrack, and CDOT have existing fiber located between communities.

Broadband networks require access to an Internet "supply" – locations where there is an Internet hub, backhaul or transport point, located in population centers. These Internet hubs can either be accessed by building fiber directly to the location, utilizing a point-to-point digital microwave link or leasing existing infrastructure. The costs for leasing existing facilities or backhaul are often based upon mileage. In either of these options, the costs to build directly from the Internet "supply" to rural areas are extremely capital intensive and/or the monthly access charges for leasing infrastructure are too high.

In rural areas, incumbent providers – primarily CenturyLink in southwest Colorado - has infrastructure to link fiber back to these internet hubs. The internet hubs for this region are based in Albuquerque, Farmington, Denver or Grand Junction. However, CenturyLink to date has not allowed other entities or local governments to "tap into their fiber" to extend a network, as is common for new homes to tap into a main waterline. CenturyLink has recently allowed other ISPs to lease dark fiber for connectivity to the various communities, but their excess fiber is limited and they, in most cases, are the only company that has fiber in the region and therefore, the lack of competition still does not drive down backhaul costs. The only option to access the existing fiber infrastructure it to lease fiber and pay for the backhaul and transport fees to the Internet hubs. Since these costs are based upon mileage back to the Internet hubs, the monthly access fees and dark fiber lease fees are high. The only realistic options are to subscribe to the high monthly service fees or build back the long distance to the internet supply.

These high monthly backhaul charges or capital costs to connect to Internet hubs are difficult to finance since most rural areas do not have the population to support an adequate return on investment for any providers to upgrade their networks. This issue was raised with other providers serving the area. Service providers discussed partnering with SWCCOG on the connections between the communities to allow for improvement of services throughout the region and to provide redundancy through another route that is an alternative to using CenturyLink's network. These fiber optic connections between communities and to the Internet hub are often referred to as "middle mile."

In addition to needing alternative routes in and out of the region for redundancy, having access to faster, more affordable broadband services are also needed. All of these variables are interrelated. Having more options to serve the market in terms of network facilities in and out of the region would not only impact the lack of redundancy options available, but also, having other alternatives to serve the region would greatly lower the costs for the current service providers providing services.

NEO Connect identified potential partnerships that could potentially be leveraged to reduce the capital costs of building new fiber along these routes. CDOT has fiber and is interested in building fiber along many of the state highways in support of reducing their operating expenses and allowing for better traffic management, reporting, vehicle locator services and other operating initiatives. Partnering with CDOT, along with leveraging Rural Healthcare Grant opportunities may allow most of these middle mile routes between the communities to be built and paid for with grant monies. This may serve as a longer-term strategy to improve middle mile connectivity for the region.

Additionally, there is a short-term opportunity to lease CenturyLink fiber through working with Mammoth Networks and partnering with the other service providers in the area to share in the monthly lease costs.

The options will be discussed in detail in Section 6 of this report.

Solving the "Last Mile" of Connectivity

Although building fiber between the communities may improve cost of backhaul and transport fees for the existing service providers and provide more bandwidth capability to the communities, this build will not completely solve the "last mile" issues that are prevalent within the region. "Last mile" refers to the broadband connection at homes and businesses.

In order to have a local government play a role in solving last mile issues for broadband, the local government entity must opt out of a current law in Colorado, Senate Bill 05-152 ("SB-152.") Most of the communities within the region have already held an election to opt out of SB-152, but there are a few communities within the region that have not yet opted out, but are planning to do so. Without opting out of Senate Bill 152, there are limited options available to government entities in actively solving the last mile connectivity within the region.

Although the local service providers have invested in limited fiber optic infrastructure to key businesses and anchor tenants, the existing providers' networks are primarily based upon cable modem, Digital Subscriber Line (DSL), satellite and wireless technologies for the last mile. Below is a brief description of the various technologies:

DSL (Digital Subscriber Line) uses existing copper phone lines to deliver download and upload broadband speeds typically of 1.5 Mbps to 7 Mbps. DSL speeds diminishes as distance increases from the telephone company's central office. Homes or businesses located more than three miles from the central office will not receive as fast of speeds. There have been many improvements to DSL technologies to improve the speed available. In general, most forms of DSL service improvements support up to 10 Mbps. VDSL (Very High Bit Rate Digital Subscriber Line) can support up to 30 Mbps, but most Internet service providers do not support this type of service, including providers in the region.

Cable modem service uses coaxial cables already installed by the cable TV operators to provide broadband service. Most cable networks support speeds comparable to DSL. Cable operators are upgrading their cable networks by installing fiber optic cable closer to neighborhoods. These network improvements allow cable modem service to be able to support up to 30 Mbps. This connection type is a shared service, meaning, as more people are on the network within a neighborhood, the speed available to each customer diminishes.

Fiber optic technology converts electrical signals carrying data to light and sends the light through glass fibers about the diameter of a human hair. Fiber transmits data at speeds far exceeding current DSL or cable modem speeds, typically by tens or even hundreds of Mbps. Fiber is the best way to provide abundant broadband, but it often is the most capital-intensive to build. As fiber optic technology transmit pulses of light, more bandwidth can be delivered on a fiber optic network by adding various colors of light or additional spectrum. Fiber is unique because it can carry high bandwidth signals over long distances without signal or bandwidth degradation and it can provide that capacity in both directions – for both upload and downloading information.

Wireless broadband connects a home or business to the Internet using a radio link between the customer's location and the service provider's facility. Wireless technologies using longer-range directional equipment provide broadband service in remote or sparsely populated areas where DSL or cable modem service would be costly to provide or fiber network installations may be too capital intensive.

Wireless broadband can be mobile or fixed. Wireless speeds are generally comparable to DSL and cable modem. Wireless services can be offered using both licensed spectrum and unlicensed devices. Wi-Fi networks typically use unlicensed spectrum. Wi-Fi networks use wireless technology from a fixed point and often require direct line-of-sight between the wireless transmitter and receiver. Wi-Fi networks can be designed for private access within a home or business, or be used for public Internet access at "hot spots" such as restaurants, coffee

shops, hotels, airports, convention centers, and city parks. Using licensed spectrum, greater amounts of bandwidth can be delivered and often do not require direct line-of-sight.

In some communities, especially sparse, geographically diverse rural communities, small providers build out a wireless solution since wireless infrastructure is not as capital-intensive as building out a fiber optic infrastructure. While wireless technology does have its limitations, needing to be designed to get around "line of sight' requirements as well as to support "shared" bandwidth on the network, smart engineering can deliver good connectivity.

Cellular 4G and LTE. Cellular service is often referred to as wireless service and it can be confused with Wi-Fi. Cellular and Wi-Fi are both wireless systems, meaning both use radio frequencies to transmit and receive data. But Wi-Fi has a radio transmitter and receiver that operates only at a range of 200 feet or so. The range of cellular is measured in miles. Wi-Fi's transmitter and receiver is called an access point. It is mounted in the corner of a room, or on a lamp post, or in a hotel lobby. Cellular's transmitter and receiver is called a cell site, or a base station and can transmit for miles.

"4G" refers to the fourth and latest generation technology for data transmission over a cellular network. It can support greater data speeds than most public Wi-Fi networks and is used primarily when a customer is out of the range of a Wi-Fi network. LTE, which stands for "Long Term Evolution," is the fastest, most consistent variety of 4G.

To date, the cellular companies have charged for data usage either by the amount of data used or with a flat fee for unlimited data use.

Wireless Local Area Networks (WLANs) provide wireless broadband access over shorter distances and are often used to extend the reach of a "last-mile" wireline or fixed wireless broadband connection within a home, building, or campus environment. An in-home Wi-Fi network is a WLAN – it does not use spectrum, rather it sends radio waves at a limited range. Mobile wireless broadband services are also becoming available from mobile telephone service providers. These services are generally appropriate for highly-mobile customers and require a special wireless card with a built-in antenna that plugs into a user's laptop computer. Generally, they provide lower speeds, in the range of several hundred Kbps.

Satellite broadband is another form of wireless broadband, and is also useful for serving remote or sparsely populated areas. Typically, a consumer can expect to receive (download) at a speed of about 500 Kbps and send (upload) at a speed of about 80 Kbps. These speeds are slower than DSL and cable modem, but they are about 10 times faster than the download speed with dial-up Internet access. Service can be disrupted in extreme weather conditions and are typically oversubscribed.

The "gold standard" in solving the last mile connectivity is in building more fiber out to homes and businesses. This is referred to in the industry as "Fiber to the Premise," or "Fiber to the Home," or "Fiber to the Business." This methodology is currently the only reliable way of providing Gigabit or 1,000 Mbps of broadband services to end users. There have been dramatic improvements in wireless technologies and although we are now seeing the ability for wireless to support Gigabit speeds, the wireless access points need to be fed with fiber and have a Gigabit reach of less than 500 feet. Gigabit players, Google Fiber and AT&T have announced plans to trial Gigabit wireless services for serving homes and businesses, but are not yet commercially available. Siklu is a company that is currently providing wireless equipment that supports Gigabit capacity; again, wireless access points need to be fed with fiber.

Most of the SWCCOG communities, with the exception of Cortez, have not yet committed to a Fiber to the Premise strategy, although some of the communities have started negotiations with various service providers to improve services. During the planning process, NEO and the SWCCOG issued a Request for Information for a Public Private Partnership to engage the existing and other service providers in an initial dialogue of interest to collaborate on last mile strategies. This is further discussed in Section 7 of this deliverable.

NEO's Recommendations

With this brief introduction of the issues, obstacles, and potential outcomes, NEO recommends the following strategies for the SWCCOG. These strategies will be addressed in detail after this section.

1. Change the current revenue model for dark fiber leases to improve SWCCOG's current financial position and create a path toward financial stability for the SCAN network.
2. Acquire an IRU between Durango and Cortez and implement an aggregation strategy for existing anchor institutions already connected on SCAN. This dramatically improves the connectivity between the two existing switch/router locations. This also dramatically improves the financial model for the SCAN project.
3. Consider implementing this aggregation strategy throughout the region to all existing SCAN-connected facilities.
4. Hold an election to opt out of SB-152 for those communities that have not yet done so.
5. Implement broadband-friendly policies and ordinances in each of the cities, towns and counties to help reduce the cost of broadband expansion.
6. Work with La Plata Electric, Empire Electric and San Miguel Power Administration to streamline the permitting process for access to their utility poles.
7. Follow up on discussion with the service providers for collaboration. Conversations regarding joint trenching, joint builds and implementation of a pre-committed fund for set asides for shadow conduit and broadband builds were initially discussed with the existing

providers in the region. Additional collaboration may be in sharing very high-speed Internet access, transport and backhaul monthly fees.

8. Partner with CDOT, TriState, La Plata Electric, Empire Electric, San Miguel Power Administration, local providers and Region 10 to build key middle mile routes throughout the region.
9. Leverage grant funding – namely, the Department of Local Affairs (DOLA), the Rural Healthcare Grant, E-rate and others to pay for a significant part of these builds. These grant programs will pay for 50-65% of the capital costs to connect government entities, schools and the medical establishments. Many of these grants will also pay for the middle mile portion of these builds to connect various government and quasi-government locations. Each of the grant programs can be further leveraged to maximize the grant funding available.
10. Expand the SCAN project to more anchor institutions.
11. Establish a working group to spearhead and implement cooperation amongst all member communities for shared services, shared data centers, buying and negotiating power for potential public private partnerships as well as other common member interests.
12. Allow member communities to opt in to collaboration of last mile services or to work on solving last mile broadband opportunities on their own. Smaller communities and counties may want to collaborate together to solve last mile issues while other communities may want to work on their own.
13. Protect the revenue model for the SCAN network by delineating middle mile connectivity and its associated revenue to be managed by the SWCCOG and last mile connectivity and its associated revenue can be implemented either by opting in and collaborating amongst the member communities or not. Either way, member communities agree that having a financially stable and self-sustaining business model for middle mile connectivity helps the entire region and therefore, all members benefit.
14. Allow service providers to participate in joint builds and to install wireless access points and/or use the fiber to extend their services to homes and businesses.

Section 1 – Strategies for Improving Existing Operations and Sustainability of the SCAN Project

Currently the SCAN network is operating at a loss, and is not self-sustaining financially. Members of the SWCCOG contribute financially to cover operational expenses and grant funding is used to fund portions of the operations. One of the goals of this project is for the SCAN network to have sufficient revenues to support its operations.

NEO recommends the following strategies for improving the current SCAN operations:

1. Near Short Term, i.e. next twelve months: Change the pricing and policies of existing dark fiber lease rates.

2. Within one year: Acquire an IRU of (2) strands of fiber between Durango and Cortez and implement an aggregation strategy of anchor institutions connected to the existing SCAN network.

3. Within one to two years: Evaluate implementing an aggregation strategy – switches and routers for true aggregation between all of the community anchor institutions and connections between all of the communities.

4. Within one to three years: Evaluate implementing an aggregation strategy with expansion of the number of anchor institutions served.

Dark Fiber Leases

NEO recommended that the financial model could be improved if dark fiber lease rates and the revenue share between the SWCCOG and its members were changed. Current dark fiber rates could be increased from the current rate of $60/mile/fiber/month to $110/mile/fiber/month. It was recommended to sell a minimum of 6 fibers with a 1-mile minimum. It was also recommended to require entire segments of dark fiber routes be leased rather than "chopping-up" the route. This makes for more effective network management and use of existing fiber.

The following financial projection includes SWCCOG's current operating projections for 2016 in regards to the SCAN project only. The SWCCOG's total salaries, benefits, allowances and

payroll taxes are $214,225.48. It was assumed that the SCAN project accounts for 10% of all salaries, benefits and payroll taxes paid.

	Projected P&L, 2016	Notes
REVENUES		
4001 · Fiber Equipment Replacement Fund	$ 15,000.00	Community and Member Contributions
4005 · E-tics	$ 8,400.00	Community and Member Contributions
4008 · Telecom Services Revenue	$ 8,280.00	SCAN Operational Revenue, Generated from Network
4009 · Fiber Lease Revenue	$ 20,560.00	SCAN Operational Revenue, Generated from Network
TOTAL REVENUES	**$ 52,240.00**	
EXPENDITURES		
5401 · Software Maintenance (E-Tic)	$ 8,400.00	SCAN Expense
5403 · Fiber Leasing Expe.	$ 15,420.00	SCAN Expense, tied to Revenue, Cost of Goods Sold
5526 · Internet Connectivity (100 Mb)	$ 10,800.00	SCAN Expense, Internet Access
5530 · Fiber Equipment Replacement Fund	$ 15,000.00	SCAN Expense
5580 · Salary & Wages	$ 21,422.00	SWCCOG Expense, $214,225.48 is the total for salaries, benefits, payroll taxes and allowances. It was assumed that the SCAN project uses 10% of staff time.
TOTAL EXPENDITURES	**$ 71,042.00**	
PROJECTED PROFIT (LOSS)	**$ (18,802.00)**	

Items highlighted in blue represent SCAN operating revenue and SCAN-related expenses. As noted above, there is a drain on cashflows from the current SCAN operations. The SWCCOG supplements this loss through other grants, member contributions and absorbing the operating expenses into its other operations. As a stand-alone entity, the SCAN project loses $18,800 per year.

With NEO's recommendation for changing the dark fiber model, the following cashflow projections would apply:

	Projected P&L, 2016	Notes
REVENUES		
4001 · Fiber Equipment Replacement Fund	$ 15,000.00	Community and Member Contributions
4005 · E-tics	$ 8,400.00	Community and Member Contributions
4008 · Telecom Services Revenue	$ 8,280.00	SCAN Operational Revenue, Generated from Network
4009 · Fiber Lease Revenue	$ 61,175.00	SCAN Operational Revenue, Generated from Network
TOTAL REVENUES	**$ 92,855.00**	
EXPENDITURES		
5401 · Software Maintenance (E-Tic)	$ 8,400.00	SCAN Expense
5403 · Fiber Leasing Expe.	$ 15,420.00	SCAN Expense, tied to Revenue, Cost of Goods Sold
5526 · Internet Connectivity (100 Mb)	$ 10,800.00	SCAN Expense, Internet Access
5530 · Fiber Equipment Replacement Fund	$ 15,000.00	SCAN Expense
5580 · Salary & Wages	$ 21,422.00	SWCCOG Expense, $214,225.48 is the total for salaries, benefits, payroll taxes and allowances. It was assumed that the SCAN project uses 10% of staff time.
TOTAL EXPENDITURES	**$ 71,042.00**	
PROJECTED PROFIT (LOSS)	**$ 21,813.00**	

Although this does not yet solve the SCAN's ability to be self-sustaining financially, this minor change in the financial model, without expansion of any additional services from SCAN improves the financial model in the following way:

Impact of the Dark Fiber Lease Pricing Changes
Took Revenues from $52,240 to $92,855
Fiber Lease Revenues from $20,560 to $61,175
Increased profit from ($18,802) in loss to $21,813 in profit.

This recommendation for changing the dark fiber lease pricing is suggested as a short-term approach to improve the SCAN operations, and if all voting members of the SWCCOG can agree on this approach, it can be implemented immediately.

Aggregation Strategy for Existing Anchor Institutions Connected to SCAN, - Cortez and Durango Only

A dark fiber lease model is difficult for any organization to make work. The SCAN's revenue model could be improved by implementing an aggregation strategy for its existing anchor institutions. This involves purchasing and installing switching equipment in each community at an existing facility and connecting all of the anchor institutions. Currently many of the anchor institutions are connected within a community, but there is no connectivity between the communities. Additionally, the internet service providers provide services directly to the

anchor institutions and the SWCCOG does not receive a revenue share of this, other than through dark fiber leases.

Switches and routers are currently in place in Durango and in Cortez. As stated previously, there is a 10 Mbps leased circuit from FastTrack between Durango and Cortez.

TriState, FastTrack, and Eagle-Net seem to have fiber along this route. SWCCOG could potentially acquire a (2) strand, 20-year IRU from TriState for approximately $180,000. Estimated mileage of the route, pricing and availability of fiber need to be verified with TriState. This would give an unlimited connectivity option between Cortez and Durango, with the capability to offer end users the option of 1 Gigabit or at 10 Gigabit connections (1,000 – 10,000 Mbps vs. 10 Mbps currently in place). It is assumed that the current switching equipment and routers located in Cortez and Durango would be able to accommodate this fiber connection, VLAN routing and aggregation of demand.

TriState IRU Pricing, Need to Verify Mileage Estimates						
From	**To**	**Estimated Feet**	**Estimated Mileage**	**# of Fiber Strands**	**Cost per Fiber Strand Mile**	**IRU Costs**
TriState HH Splice point outside Cortez	Empire Substation	65,160	12.34	2	$ 1,500	$ 37,023
Empire Substation	Lost Canyon	46,372	8.78	2	$ 1,500	$ 26,348
Lost Canyon	Durango	204,274	38.69	2	$ 1,500	$ 116,065
			59.81		Total	**$ 179,435**

It was assumed that all operating expenses would remain the same for the SWCCOG, with the addition of $60,000 per year for equipment monitoring, network monitoring and technical support starting in the 2nd year. A 10 Gigabit Dedicated Internet Access service would be put in place in Durango or Cortez. The assumption for costs for this is $7,500 per month.

In terms of the revenue model, the goal is to transform or disrupt the pricing and bandwidth model available today and offer much more bandwidth at a lower price. This strategy will allow more of the anchor institutions to use the SCAN as most do not use it because services are too expensive. In Bayfield, for example, current pricing is $300 per month for a 50 Mbps Internet connection. Others are paying $8/Mbps; or $800 for 100 Mbps. The revenue model proposed will be $100 per month for a 100 Mbps connection and $600 per month for a 1 Gbps. A summary of the current and proposed offering is shown below.

Internet Services	**Current Pricing**	**Proposed Pricing**	**% of Anchors to Subscribe**
50 Mbps	$300		
100 Mbps	$800	$200	50%
1,000 Mbps or 1 Gbps	$8,000	$800	50%

It cannot be assumed that every location that is currently connected to the SCAN would use the 1,000 Mbps (1 Gbps) service offering; it was assumed that 50% of the current anchor institutions would subscribe to this level of service. For purposes of the revenue model, it was assumed that the remaining 50% of the locations currently connected to the SCAN would subscribe at the 100 Mbps offering at $200 per month.

In addition to Internet access services, the SCAN could support data services between locations connected to the network. These data services provide a very high-speed connection between two or more locations on the network, without going to the public Internet for Internet services. The data connections can support a number of functions for the anchor institutions. Although this does not list all of the many possibilities, here are a few examples of functions that can be supported over a very high-speed data connection:

- Centralized Voice over IP Services. Locations can make voice calls between offices, allowing for extension dialing between locations. A centralized phone system can support all locations connected to the network. Long distance charges between locations would be eliminated and locations could reduce the number of telephone lines at each of the offices.
- Video arraignments. Instead of driving between communities for an on-site arraignment, a video conference could be set up for this purpose. On-site arraignments require 1-2 police officers attending, and with travel time, this can sometimes consume an entire day of driving back and forth between communities. A video arraignment would save time and money.
- Shared operational functions such as shared help desk, GIS, software support. Smaller communities that cannot afford full-time staff for these positions could potentially contract with the larger communities for these functions.
- Enhanced public safety options. Having a fiber connection between, for example, a school and law enforcement can provide critical information during an emergency. Security cameras can be installed with gunshot detection, allowing law enforcement to receive instant camera and video feeds if a gunshot is fired within a school. First responders can pinpoint who, where and how many shooters are present prior to arriving at the scene.

Again, it cannot be assumed that all anchor institutions will subscribe to this type of service; for purposes of the model, it was assumed that 30% of the current locations connected to SCAN would subscribe. Of the 30%, half would choose the 100 Mbps level and half would choose the 1,000 Mbps (1 Gbps) data connection port. The following pricing is considered for Data Services:

Data Service, per Port	Proposed Pricing	% of Anchors to Subscribe
100 Mbps	$100	15%
1,000 Mbps or 1 Gbps	$600	15%
Total		30%

Cortez has 35 anchor institutions connected to the SCAN network and Durango has 32 locations connected to the SCAN network. The model assumes a twelve month ramp up period, meaning, not all anchor institutions would subscribe starting on the first month. Anchor institutions would subscribe over a twelve month ramp up period.

On the operational expenses, one of the primary issues for operating the SCAN project is that full time staff is actually needed to support the operations. As noted above, in the dark fiber lease improvement, only 10% of the SWCCOG staff's wages, benefits, allowance and payroll taxes were assumed. For the projected model below, it was assumed that 100% of the staff's salaries and wages were supported by the SCAN project.

Additionally, there is additional provisions for marketing and general administration expenses. If we assumed just the Durango and Cortez markets, and a demand aggregation strategy was put in place, with these assumptions, the following projections would apply:

Income Statement

Durango and Cortez Existing Anchors Institutions Currently Connected to SCAN	2017	2018	2019	2020	2021
	Forecast Project Period				
	Year 1	Year 2	Year 3	Year 4	Year 5
Revenues					
Total Revenues	**$ 285,300**	**$ 456,400**	**$ 456,400**	**$ 456,400**	**$ 456,400**
Expenses					
10 Gigabit Dedicated Internet Access	$ 90,000	$ 90,000	$ 90,000	$ 90,000	$ 90,000
Cost of Additional Backhaul per Gbps	$ -	$ -	$ -	$ -	$ -
Dark Fiber or Monthly Subscription Fees	$ -	$ -	$ -	$ -	$ -
Software Maintenance	$ 8,400	$ 8,400	$ 8,400	$ 8,400	$ 8,400
Network Equipment Monitoring and Maintenance	$ -	$ 60,000	$ 60,000	$ 60,000	$ 60,000
Fiber Equipment Replacement Fund	$ 15,000	$ 15,000	$ 15,000	$ 15,000	$ 15,000
Salary and Wages, Existing Employees (includes Payroll Taxes and Benefits)	$ 214,225	$ 214,225	$ 214,225	$ 214,225	$ 214,225
Marketing and Sales Expense, percent of Total Revenue	$ 14,265	$ 22,820	$ 22,820	$ 22,820	$ 22,820
General and Administrative Overhead, % of Revenue	$ 14,265	$ 22,820	$ 22,820	$ 22,820	$ 22,820
Total Expenses	$ 356,155	$ 433,265	$ 433,265	$ 433,265	$ 433,265
EBITDA	**$ (70,855)**	**$ 23,135**	**$ 23,135**	**$ 23,135**	**$ 23,135**

EBITDA stands for Earnings before Interest, Taxes, Depreciation and Amortization. It is essentially the projected profit from operations.

This recommendation dramatically improves the financial model, operations and Internet options in the following ways:

- Stand-alone operations go from a loss of $18,800 to stabilized profit of $23,135.
- Additional support or 100% of the existing SWCCOG can be supported with SCAN. Additional support can be put in place to manage the network.
- Member entities do not need to further contribute annually and grant monies do not need to be secured.
- This solution leverages the existing equipment in Cortez and in Durango
- This improves the connection between the two locations by 1,000-fold (from 10 Mbps to 10,000 Mbps)
- It offers higher speeds to all anchor institutions currently connected to the SCAN.
- It also reduces the cost for Internet connectivity for existing anchor institutions and allows for the opportunity to support very high-speed data connections between any and all locations connected.
- If TriState does have excess fiber capacity, this solution could be implemented in the short-term (within one year).

- As FastTrack and Eagle-Net seem to also be using this fiber route with TriState, it is assumed that easements have been perfected for commercial use.

DOLA funds could potentially be targeted to pay for the IRU. DOLA will pay for 50% of the capital costs.

Aggregation Strategy including all Anchor Institutions in All Communities

This strategy could be rolled out to all of the anchor institutions and to all of the communities. This would require fiber connectivity between all of the communities and it would require additional switching and routing equipment for the other communities.

Obtaining connectivity between the communities may prove to be a bit more challenging; however, existing assets are in place. Eagle-Net and FastTrack networks have connections from the TriState fiber into Dolores and into Mancos. FastTrack's network extends from Durango into Ignacio and from Durango to Bayfield. Skyworx has a 10G wireless wave from Durango to Pagosa Springs. Assuming that either an IRU could be acquired, here are the projected results with adding all communities that are currently connected to SCAN.

Income Statement

Existing Anchors Institutions Currently Connected to SCAN	2017	2018	2019	2020	2021
	Forecast Project Period				
	Year 1	Year 2	Year 3	Year 4	Year 5
Revenues					
Total Revenues	**$ 481,400**	**$ 770,400**	**$ 770,400**	**$ 770,400**	**$ 770,400**
Expenses					
10 Gigabit Dedicated Internet Access	$ 90,000	$ 90,000	$ 90,000	$ 90,000	$ 90,000
Cost of Additional Backhaul per Gbps	$ -	$ -	$ -	$ -	$ -
Dark Fiber or Monthly Subscription Fees	$ -	$ -	$ -	$ -	$ -
Software Maintenance	$ 8,400	$ 8,400	$ 8,400	$ 8,400	$ 8,400
Network Equipment Monitoring and Maintenance	$ -	$ 60,000	$ 60,000	$ 60,000	$ 60,000
Fiber Equipment Replacement Fund	$ 15,000	$ 15,000	$ 15,000	$ 15,000	$ 15,000
Salary and Wages, Existing Employees (includes Payroll Taxes and Benefits)	$ 214,225	$ 214,225	$ 214,225	$ 214,225	$ 214,225
Marketing and Sales Expense, percent of Total Revenue	$ 24,070	$ 38,520	$ 38,520	$ 38,520	$ 38,520
General and Administrative Overhead, % of Revenue	$ 24,070	$ 38,520	$ 38,520	$ 38,520	$ 38,520
Total Expenses	$ 375,765	$ 464,665	$ 464,665	$ 464,665	$ 464,665
EBITDA	**$ 105,635**	**$ 305,735**	**$ 305,735**	**$ 305,735**	**$ 305,735**

If IRU agreements cannot be reached between these locations, a strategy to lease fiber or lease 10 Gigabit waves may still be financially viable. Leasing fiber or services requires a monthly fee. Quotes for monthly services can be obtained from the providers that have facilities currently in place. In addition to the companies noted above and their respective assets, CenturyLink most likely also has fiber assets. Mammoth Networks is a wholesale provider of CenturyLink and can provide monthly lease fees for dark fiber service available from CenturyLink.

Projected capital costs for building fiber between all of the locations is provided under the Section 6, the section regarding Middle Mile Connectivity.

Aggregation Strategy, Build to More Anchor Institutions, Expand the SCAN Project

And finally, the scan network could be expanded to more anchor institutions. NEO identified additional anchor institutions throughout the region.

Location	Other Anchor Institutions, Connected to SCAN	Other Anchor Institutions not yet connected	Schools and Libraries, Connected to SCAN	Schools and Libraries, not yet connected	Healthcare, Connected to SCAN	Healthcare, Not Connected	Totals
Bayfield	10	10	0	6	0	0	
Cortez	22	0	12	6	1	2	
Dolores	1	9	0	8	0	0	
Dove Creek	4	8	6	6	0	2	
Durango	25	30	5	11	2	9	
Ignacio	3	12	5	1	0	0	
Mancos	0	14	0	13	0	1	
Pagosa Springs	14	14	6	2	0	1	
Rico	0	3	0	3	0	0	
Silverton	0	12	0	6	0	1	
Towaoc	0	2	0	0	0	1	
Totals	79	114	34	62	3	17	309
SCAN	79		34		3		116
To be Connected		114		62		17	193

Capital cost projections were put together to expand to all 193 of the anchor institutions that are not yet connected to the SCAN project. The capital costs to build fiber to these locations are detailed under Section 6 of this deliverable.

This expansion of the network would most likely require more staff. The following assumptions were used for additional staffing, technicians, technical managers, GIS support, etc.

Salaries, Expanding SCAN to More Anchor Institutions	
Existing SWCCOG staff	$ 214,225
Technical Manager	$ 120,000
Addl Staff/Admin	$ 50,000
Addl Staff/Billing	$ 50,000
Support/Shared Services	$ 75,000
GIS Support	$ 75,000
Technical Support (3) Technicians at $75,000 each	$ 225,000
Total Salaries, etc.	**$ 809,225**

Power and utilities annual budget of $50,000, increasing the fiber management fund from $15,000 to $100,000 and (2) Dedicated 10 Gigabit Internet access charges were assumed. Assumptions for network monitoring were doubled from $60,000 to $120,000 annually.

This expansion and revenue model provides the following projections:

Income Statement

Expand SCAN to all Anchor Institutions	2017	2018	2019	2020	2021
	Forecast Project Period				
	Year 1	Year 2	Year 3	Year 4	Year 5
Revenues					
Total Revenues	**$ 1,183,600**	**$ 1,893,200**	**$ 1,893,200**	**$ 1,893,200**	**$ 1,893,200**
Expenses					
10 Gigabit Dedicated Internet Access	$ 180,000	$ 180,000	$ 180,000	$ 180,000	$ 180,000
Cost of Additional Backhaul per Gbps	$ -	$ -	$ -	$ -	$ -
Dark Fiber or Monthly Subscription Fees	$ -	$ -	$ -	$ -	$ -
Software Maintenance	$ 8,400	$ 8,400	$ 8,400	$ 8,400	$ 8,400
Network Equipment Monitoring and Maintenance	$ -	$ 120,000	$ 120,000	$ 120,000	$ 120,000
Fiber Equipment Replacement Fund	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000
Salary and Wages, Existing Employees (includes Payroll Taxes and Benefits)	$ 809,225	$ 809,225	$ 809,225	$ 809,225	$ 809,225
Marketing and Sales Expense, percent of Total Revenue	$ 59,180	$ 94,660	$ 94,660	$ 94,660	$ 94,660
General and Administrative Overhead, % of Revenue	$ 59,180	$ 94,660	$ 94,660	$ 94,660	$ 94,660
Total Expenses	$ 1,215,985	$ 1,456,945	$ 1,456,945	$ 1,456,945	$ 1,456,945
EBITDA	**$ (32,385)**	**$ 436,255**	**$ 436,255**	**$ 436,255**	**$ 436,255**

There is ample room in the budget to add additional staff to support other functions and initiatives. This strategy may realistically take 2 to 3 years to implement.

The Downside

The aggregation strategy will most likely not be supported by the existing local service providers. They will see this potentially as taking the highest revenue clients from their existing revenue base. Additionally, this strategy needs to be supported by the SWCCOG member communities. Push back might occur from the communities that are already looking to build out to more community anchor institutions or are planning for a Fiber to the Premise strategy.

Given the potential push back, perhaps a blended strategy could be implemented that would benefit all parties. A blended strategy could be working through a model to share or assign potential revenue sources. For example, a model could be that the exiting service providers or the various communities could provide Internet access service to the anchor institutions, while the SWCCOG provides data services only.

The purpose of showing these projections is primarily illustrative. It is meant to show a path forward for sustainability for the SWCCOG. Operating expense assumptions can be changed, participation amongst the various members can be changed and revenue assumptions can be changed. The primary objective is to show a reasonable approach to better leverage the existing assets or to further build out to more anchor institutions.

Establish a Working Group for Shared Services and Collaboration

As shared services and high speed data services connectivity between all anchor institutions is a concept that has been discussed for many years, but not yet implemented, NEO recommends that a working group be established to spearhead and implement cooperation amongst all member communities. This could include collaboration and cooperation for shared services, shared data centers, and/or buying and negotiating power for potential public private partnerships. This working group could be tasked with identifying common software applications amongst the communities and counties, shared applications and opportunities for cost reduction and greater efficiencies.

In Summary

Regardless of the approach, or which communities participate in the aggregation model, or the assignment of revenue sources, there needs to be a financial model implemented for the SCAN network to be financially viable. Ideally, the member communities should agree that having a financially stable and self-sustaining business model for SCAN helps the entire region and therefore, all members benefit.

Section 2 - Community Engagement, Market Assessment, Speed Tests and Existing Services and Pricing

NEO, in conjunction with SWCCOG staff, organized community engagement meetings that provided an open forum for community-wide discussions about regional broadband. These meetings were divided according community and industry and took place in Pagosa Springs, Durango, Cortez and Silverton. Industry segments included business/professional, healthcare, education and libraries, and government services. Each day concluded with an hour-long session for the general public to ask questions and provide comment.

These meetings were well attended with attendees representing six service providers: ForeThought.net, Cedar Networks, Skywerx, AlignTec, Fast Track Communications and Century Link. Additionally, several industry experts and a number of private citizens engaged in the dialogue as well. Discussion topics included broadband friendly policies, partnership and collaboration opportunities and common challenges faced by the industry.

All attendees agreed on the value of the broadband friendly policies set forward. There was much discussion surrounding the practices of dig-once/open trench, shadow conduit installs, joint build efforts and streamlining of the permit process. Much of the ***trenching and conduit*** conversation focused on the idea of creating a conduit sharing/leasing process. This could potentially look very similar to a fiber IRU agreement with interested parties gaining exclusive access to specific, shadow conduit space at the time of construction. Another possible model that was discussed and needs further evaluation was to create a pre-commitment fund to pay for shared trench and shared build costs amongst all of the service providers. Service providers would be willing to pre-commit to sharing in the costs of conduit being placed and costs for shadow conduit could be shared amongst all participating parties.

The permitting process was discussed at length as well during this meeting. All providers were in agreement that g*etting access to county and city owned facilities, electric utility poles and municipal*

rights of way can often be incredibly costly in time and effort. Frustration was expressed with permitting processes that lengthened turn-around times.

A number of providers described their extreme dissatisfaction with the permitting process of the U.S. Forest Service in gaining access to land or existing towers for placement of wireless access equipment. This process can, and often does take as long as two years to complete. This was described as egregious when compared with other federal and state agencies. Moreover, everyone agreed that impact and usage fees continue to rise and are quickly becoming a central issue in network expansion plans.

Additional common challenges expressed by service providers included pole access throughout the region, a shortage of quality fiber optic construction companies and the need for a local, long-term data storage center. Local utility providers, including La Plata Electric Association, Empire Electric, and San Miguel Power Association currently have highly complicated and time intensive application processes. Many of the service providers characterized their willingness to deploy fiber to the home services in the region, but expressed relying on access to LPEA utility pole access as a critical step towards implementation.

Local Service Provider Capabilities

In addition to community outreach meetings, NEO conducted individual interviews with the local service providers currently providing Internet services in the community.

According to Broadband Map USA[3], CenturyLink provides Asymmetric xDSL broadband technologies to 75% of the population in region. The most common advertised download speed is 768 – 1.5 Mbps. The most common advertised upload speed is 200 – 768 kbps. This is well below the FCC's standard definition of 25 Mbps download and 3 Mbps upload speeds.

CenturyLink was awarded $26 Million in annual grant funding per year for six years in Colorado through the federal high-cost program. The federal universal service high-cost program (also known as the Connect America Fund) is designed to ensure that consumers in rural, insular, and high-cost areas have access to modern communications networks capable of providing voice and broadband service, both fixed and mobile, at rates that are reasonably comparable to those in urban areas. The program fulfills this universal service goal by allowing eligible carriers who serve these areas to recover some of their costs from the federal Universal Service Fund.[4]. Of the $26 Million annually, from the federal Connect America Fund II, $3.7 Million is allocated annually for six years for the counties in the SWCCOG region.

[3] See http://www.broadbandmap.gov/

[4] See https://www.fcc.gov/general/universal-service-high-cost-areas-connect-america-fund

Federal Communications Commission			
Connect America Fund II - CenturyLink Funding by County			
August, 2015			
County Name	Homes and Businesses Supported	County Carrier Total Support	6 years Support
Archuleta, CO	2,235	$ 1,080,202	$ 6,481,212
Dolores, CO	404	$ 264,251	$ 1,585,506
La Plata, CO	4,320	$ 1,559,150	$ 9,354,900
Montezuma, CO	2,088	$ 821,533	$ 4,929,198
San Juan, CO	116	$ 69,594	$ 417,564
	Total	**$ 3,794,730**	**$ 22,768,380**

The goal of the Connect America Funding is to make infrastructure improvements to bring unserved and underserved areas to 10 Mbps in download availability and 1 Mbps in upload availability. Although this program will help some areas within the region, this program is more of a stop-gap measure than a good long-term plan.

CenturyLink has invested in fiber optic infrastructure to key businesses and anchor tenants within the communities and has fiber throughout the area. The incumbent provider's networks are based upon cable modem and Digital Subscriber Line (DSL). DSL service is provided by copper telecommunication lines and can carry high bandwidth signals only for a short distance – a few hundred yards; after which the signal is degraded and bandwidth diminishes. While cable modems generally provide transmission speeds of anywhere between five and 50 megabits per second on the download (and are generally much slower when uploading), this technology is shared and therefore, all users on the network share this bandwidth. For example, if there are 100 users sharing 50 Mbps, each user receives 0.5 Mbps of service.

Skyworx has invested in fiber and in wireless technology in the region. Skyworx has built a very robust wireless network between many of the communities and within the communities. Farmer's, Rico Telephone, AlignTech and Forethought/Brainstorm have also invested in infrastructure within the region.

Cedar Networks, FastTrack and Forethought are investing in fiber and Fiber to the Premise technology in parts of the region. Fiber is 1,000 times to 10,000 times faster than DSL, wireless and cable modem networks. The speed tests that were conducted in the region showed the fastest results amongst these three providers. Additionally, the carrying capacity of fiber is unlimited. As fiber optic technology transmit pulses of light, more bandwidth can be delivered on a fiber optic network by adding various colors of light or additional spectrum. Fiber is

unique because it can carry high bandwidth signals over long distances without signal or bandwidth degradation and it can provide that capacity in both directions – for both upload and downloading information. Again, the fact that these providers are investing in build out of more fiber in the region, their speed test results validated the efforts made by these companies.

Speed Test Results

Throughout the planning process, NEO, the SWCCOG, and partners, encouraged homeowners, citizens and businesses to participate in an Internet speed test to determine actual speed test results. In partnership with the Colorado State OIT Department, who gathered speed test data, over 1,294 test results were compiled for the SWCCOG region. NEO analyzed the speed test data results and found the following:

- The average download speeds overall were 16.8 Mbps
- The average upload speeds overall were 13.6 Mbps

The averages are somewhat skewed because of high bandwidth results from Cedar Networks, Forethought and FastTrack for 100 of the 1,294 results. Most likely these results are from businesses that have a fiber connection or from areas where these companies are providing a direct fiber connection as discussed in the previous section. If these results are taken out of speed test results from these providers, the averages are:

- The average download speeds are 12.243 Mbps
- The average upload speeds are 9.046 Mbps

CenturyLink's average results were 10 Mbps and 6 Mbps in average download and upload speeds. Again, the results are below the FCC's standard definition of 25 Mbps in download speeds, but upload speed averages were higher than the FCC's standard definition of 3 Mbps upload speeds. The complete results of the speed tests were provided to SWCCOG and its members.

Section 3 – Identification of Existing Key Assets and Other Potential Partners

NEO identified and mapped assets in the region and identified gaps in services. This analysis included creation of a comprehensive broadband asset inventory list and infrastructure map. The map includes assets from existing service providers and from other potential partners. Information collected includes topological data, identification of current underground and overhead infrastructure, fiber lines, conduit, pole access, tower access and view-shed data. Maps of the existing assets were provided to SWCCOG as a deliverable of this project.

Key anchor institutions were identified that are eligible for the rural healthcare grant program. From this information, NEO's team provided preliminary design and projected capital costs for build-out of a middle-mile network.

In addition to meeting with the primary service providers within the region, NEO also reached out to other entities that might have assets in place today or may be potential partners for fiber expansion projects in the future. Key potential partners identified in this process are CDOT, La Plata Electric, Empire Electric, Region 10 and its member communities and TriState.

CDOT's Initiatives

CDOT is investing in fiber optic facilities, per their website, to "facilitate the use of technology to quickly detect and verify traffic incidents, allowing CDOT to work with law enforcement and emergency responders to ensure fast, appropriate levels of response to incidents, thereby increasing the ability to save lives. Building out this technology will also allow the department to monitor and detect rapidly changing weather conditions and quickly relay this information to travelers." Investments in telecommunications backbone or fiber facilities are connected to the CDOT Transportation Management Center in Golden. This center is responsible for disseminating statewide traveler information, including weather, traffic congestion, and travel route information. Information is disseminated to travelers via message boards, phone apps, and other means. CDOT also uses information from the backbone to make operational decisions such as when and how to initiate road maintenance projects.

CDOT is also implementing infrastructure to support its "Connected Vehicles" applications. These applications include vehicle-to-vehicle and vehicle-to-infrastructure communications, which is part of a federal traffic management initiative that envisions facilitating

communication between vehicles and infrastructure to increase safety and mobility and decrease the environmental impact of driving. Through communications interconnection, the traffic management infrastructure will help vehicles to avoid crashes while reducing traffic congestion and associated fuel use. A reliable, high-speed communications network is required to implement Connected Vehicles technology.

CDOT also uses this infrastructure to connect its network to the Nationwide Public Safety Broadband Network, and create a platform to work with neighboring states to provide levels of transportation services that travelers expect.

CDOT has implemented these strategies through deployment of their RoadX project. Again, according to the CDOT website, "The RoadX program will employ a multi-pronged DO-IT (deployment, operations, innovation, technology) approach with the objective of being the most efficient, agile, and flexible system for bringing transportation technology to market. The RoadX program will implement several efforts along the DO-IT spectrum in 2016–18. CDOT plans to partner with private industry and others to deploy advanced technology to reduce the cost of transporting goods by 25%; to turn a rural state highway into a zero-death road; and to improve congestion on Colorado's critical corridors."[5]

Electric Companies as Potential Partners

La Plata Electric and Empire Electric have deployed fiber between some of their substations and has expressed an interest in collaborating with regional communities to improve broadband services with use of their existing fiber or use of their utility poles. TriState has been a valuable partner in helping to bring better broadband services throughout the state and has also expressed interest in providing access to its fiber whenever possible. One of the challenges with use of fiber deployed either by La Plata, Empire Electric or with TriState, is the need to perfect easements for commercial use. Perfecting easements can be a time-consuming and uncertain endeavor, as not knowing how long it will take or how much it may cost can be concerning; however, there is much precedent that has been set across the state in gaining success throughout this process.

Other Regional Partners

Region 10, a council of governments made of the six-county region adjacent to the SWCCOG's region, is also identified as a potential partner for the SWCCOG's efforts. Region 10 includes the counties of Delta, Montrose, San Miguel, Hinsdale, Gunnison and Ouray Counties. Region 10 is currently building a middle mile network connecting its member communities and

[5] See https://www.codot.gov/programs/roadx

counties. Many of these communities are adjacent to the SWCCOG's region and use of Region 10's network may provide added redundancy in and out of the SWCCOG's region.

Section 4 – Most of the Communities and Counties Have Opted Out of Senate Bill 05-152

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 a barrier for Colorado communities in improving broadband capabilities and it limits the options for ownership and service delivery by municipalities, counties, and other local governments. Most of the communities within the region have already opted out of SB-152. These include the Town of Bayfield, the City of Cortez, the City of Durango, the Town of Ignacio, the Town of Mancos, the Town of Pagosa Springs and the Town of Silverton. Additionally, Archuleta, La Plata and San Juan Counties have all opted out of SB-152. The remaining communities and counties that need to opt out include the Town of Dolores, Dolores County and Rico.

SB-152 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.[6]

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 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), or enter into a public-private partnership without voter approval, unless it comes under one of the limited statutory exceptions.

Local governments can obtain exemption through a local ballot initiative to opt-out of SB-152. As of April 2016, approximately 60 municipalities, counties and school districts have held public elections to opt out of SB-152. All of the favorable opt outs have passed overwhelmingly. Some communities (Estes Park, Durango and Telluride) passed with over 90% voting in favor of opting out of this restrictive bill, giving local governments the authority to solve broadband infrastructure gaps within their communities.

The fact that SB-152 was written into law in 2005 is evident in in that it defines high-speed Internet as 256 kbps, versus current standards defining broadband as 25 Mbps download speed and 3 Mbps upload speed. The good news is that municipalities can indeed offer free Internet service in city libraries, parks and community centers without opting out of SB152. The bad news is that it cannot exceed service speeds of 256 kbps.

The bigger issue with the 2005 legislation is that it assumes that the private sector will provide adequate service – services that are good enough for businesses to compete and its citizens to thrive. As economic development is typically not a top priority for private carriers or part of their own business case, many municipalities and counties are under- or unserved, requiring local governments to build (or partner to build) modern infrastructure.

A simple yes or no referendum to secure voter approval allows a Colorado, town, city, county, and other local governments. to move forward with their broadband aspirations. This includes investing in infrastructure as well as forging partnerships to deliver alternative broadband service. The good news is that most of the municipalities and counties have already opted out of this law. NEO recommends that the other SWCCOG Members – The Town of Dolores, the Town of Rico and Dolores County do the same.

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

Section 5 – Broadband Friendly Policies and Ordinances

NEO recommends putting in place broadband friendly policies and ordinances to encourage further broadband infrastructure deployment by helping to reduce the capital costs of fiber builds. These policies also encourage the following:

1. Reduce the cost of construction for broadband networks. 60-80% of a fiber optic network's capital costs are in opening a trench or in burying conduit that will house fiber optic cable. Policies that encourage placement of fiber in coordination with other government capital projects (sidewalks, trails, lighting, and road projects) and coordination with other utility projects by others - may all be opportunities to install conduit.

NEO recommends implementation of a ***Dig Once Policy*** that has the following components:

All public works or installation of other telecom, cable or utility infrastructure allows for conduit to be placed on behalf of the City and any other entities that want to participate. If there is an open trench, the policy provides for coordination of street cuts and excavations with utilities, public works, developers and other interested parties to maximize the opportunity for broadband conduit installation, and to minimize cost, disruption and damage.

Allows for a notice period informing other entities that an open trench will be available for placement of their conduit and/or fiber optic facilities

Allows for shadow conduit to be placed for the Town, City or County. Installation of empty and/or space conduit by a public agency when excavations occur in the public right of way, with agency (Town, City or County) costs limited to incremental costs.

Additionally, NEO recommends that the various government agencies establish ***Joint Trench Agreements*** and ***Joint Build Agreement***s with other telecommunications, cable or utility providers. Cost for placement of conduit or fiber will be shared amongst all entities, allowing each entity to take advantage of trenches that have been opened through each other projects and allows for sharing of capital costs for any conduit and/or fiber builds. Standardization of these agreements across all potential owners of underground infrastructure can be established to ensure all parties are aware of the joint trenching opportunities as they become available.

NEO also recommends a ***Streamlined Permitting Process*** – placing responsibility for approval of broadband infrastructure projects solely in the public works department via encroachment permit processes. An ***Abandoned Fiber and Conduit Policy*** can be put in place if any abandoned

fiber and/or conduit that are not claimed by the owner within a reasonable time period, the ownership of that conduit and/or fiber would revert to the local government agency.

2. Encourage standards for placement of conduit and/or fiber in new developments. Integrating broadband "utility" codes into land development policies and ordinances to ensure that new real estate developments incorporate a standard placement of conduit and/or fiber optic facilities. The land development codes could require new land developments, new real estate developments and/or newly built homes and office buildings to install fiber optic infrastructure. New building codes could describe specific compatible communications components and architectures into each new building, and could describe development and use of municipal/county right-of-ways for communications connectivity, and could specify standardized specific wiring requirements for new buildings.

3. Set up funding mechanisms to allow for adoption of these policies. Conduit is not expensive. However, if the funding mechanism does not exist to place conduit, often opportunities to take advantage of open trenches or joint builds do not occur. A funding set-aside or budget process must be put in place to allow for adoption of these policies. The funding mechanism will allocate monies to build broadband infrastructure when opportunities arise and the fund would maintain a reserve or set-aside for unanticipated projects.

4. Keep a GIS database of all infrastructure, and provide for a process to submit plans. Any permit for work done within the right-of-way or for new developments would require as-built drawings to be submitted to routinely document conduit and other broadband asset data into a geographic information system. The policy could establish a requirement that plans and as-built drawings and other information be submitted by utilities, developers, contractors and others in an appropriate GIS format.

NEO provided sample policy and ordinance language that other communities have implemented for all of the above policy recommendations. NEO also provided information regarding compliance with the FCC Order on Mandatory Wireless Facilities Collocation.

Section 6 – Gigabit Access to the County Seats, Strategies for Middle Mile Connectivity

This section lays the groundwork for the implementation plan, NEO's methodology for the preliminary design and projected capital costs, and information regarding partnership and grant funding.

Providing Redundancy and Options for Service Providers, Middle Mile Transport Between Communities and to Internet "Supply"

NEO put together a preliminary design and capital cost estimates for connecting the communities. Bringing fiber to the communities aggregates demand and reduces costs for broadband services, as the costs for the services are shared amongst all of the users. Also, once fiber is brought to a community, it is relatively inexpensive to expand this fiber within the community to other key locations and anchor institutions.

Connecting Anchor Institutions

NEO updated the Community Anchor Institution list provided by the Colorado State OIT Department. This list includes schools, municipal and county locations, medical facilities and clinics, and libraries. Updates included connectivity status (whether or not the location is connected via SCAN, another Municipal/County network or by a service provider,) location and contact verification, and qualification of Universal Service Administration Company (USAC) grant-funding eligible locations.

USAC has two sister programs – the E-rate and Rural Healthcare Grant Programs. These two programs can be leveraged to pay for many of the capital costs associated with building to schools and libraries (E-rate) and to medical facilities and hospitals (the Rural Healthcare Grant program). NEO worked with Colorado Telehealth Network (CTN) to identify anchor institutions (medical facilities and hospitals) that would be eligible for the Rural Healthcare grant program.

The Rural Healthcare Grant fund is available for the following eligible entities:

(1) post-secondary educational institutions offering health care instruction, teaching hospitals, and medical schools;
(2) community health centers or health centers providing health care to migrants;
(3) local health departments or agencies;
(4) community mental health centers;

(5) not-for-profit hospitals;
(6) rural health clinics; and
(7) consortia of one or more of such entities.

The grant program would potentially fund 65% of the capital costs to connect these medical establishments, including the middle mile portions of the fiber build between the communities. Targeting this grant, and building to the medical establishments "first" would allow for much of the desired routes to be built.

NEO met with CDOT management, locally, regionally, and at the State-level, to develop a potential partnership to leverage grant funding and collaborate on joint builds, especially for the middle mile connections between the various communities within the region. Many of the segments between the communities are "priority 1" routes for CDOT's RoadX and traffic management system. NEO met with CDOT management and staff to determine their requirement, construction options and requirements.

Capital costs were identified to build fiber between these communities to a Carrier Neutral Location (CNL) in each community. CDOT provided a list of maintenance and operational facilities to NEO's team. NEO then mapped routes from the CNL to the various CDOT facilities and provided an estimated capital cost projection for these builds. NEO also mapped routes and identified capital cost estimates for building to the schools and libraries and to the eligible entities that qualify for the Rural Healthcare Grant program.

Further research and validation needs to occur with use of excess fiber for projects built with E-rate and Rural Healthcare Grant funds. The ability to fund capital costs of fiber builds is a fairly new add-on to these existing grant programs. In the past, these programs have provided a subsidy for monthly access fees and funded customer premise equipment primarily. New rules for funding were introduced within the past three years, including construction for fiber as an eligible expense. These programs limit how excess fiber is used and have rules regarding revenues generated on networks funded through these programs. NEO brought in staff members from DOLA and from the Colorado State OIT department to help facilitate collaborative and more comprehensive use of these programs.

And finally, NEO estimated capital costs to build out to the remaining anchor instutions identified throughout this process. Estimated capital costs are described in detail below.

Capital Costs Identified

As mentioned earlier within this deliverable, CDOT is planning to build fiber on most of the state highways within the region. CDOT requires 100% of the build to be underground, rather than using transmission or power utility lines for aerial construction. If 100% of the build is underground, the following represent projected capital costs to build between all of the communities within the region.

CDOT Build Routes							
Segment	**From**	**To**	**New (Miles)**	**Existing (Miles)**	**Type**	**Fiber Ct**	**Build Cost $$**
1	Dolorez	Cortez	10.08	1.19	100%U	144	$ 2,325,734.53
2	Cortez	Mancos	15.14	2.54	100%U	144	$ 3,458,654.64
3	Mancos	Durango	27.66	0.45	100%U	144	$ 6,261,983.06
4	Cascade	Silverton	0.00	19.94	100%U	145	$ 68,000.00
5	Durango	Cascade	27.08	0.00	100%U	146	$ 6,134,124.85
6	Durango	NM State Line	12.44	5.06	100%U	144	$ 2,853,484.27
7	Durango	Bayfield	12.60	7.23	100%U	144	$ 2,889,340.35
8	Bayfield	Pagosa Springs	39.42	2.29	100%U	144	$ 8,897,697.45
9	Bayfield	Ignacio	8.11	0.76	100%U	144	$ 1,884,231.09
10	Pagosa Springs	North toward South Fork	10.39	0.00	100%U	144	$ 2,395,546.36
11	Dolorez	Rico	37.77	0.15	100%U	144	$ 8,527,502.11
12	Dove Creek	Cortez	32.55	7.71	100%U	144	$ 7,358,345.58
						Total	**$ 53,054,644.30**

A rural healthcare grant could potentially be sought to pay for 65% of the capital costs of this build and CDOT may consider paying for the remainder of the capital costs. The SWCCOG may consider partnership with the rural healthcare grant program and CDOT to allow for fiber to be built within the communities. This strategy represents a two- to five-year implementation. In the short term, the SWCCOG may consider leasing dark fiber or lit services from CenturyLink or Mammoth Networks to provide connectivity

between the communities. The various service providers may be willing to share in the monthly service fees for this strategy. DOLA has expressed interest in working with the SWCCOG to help offset the monthly service fees. This strategy may be a good short-term solution to consider for implementation as agreements are put in place with CDOT and the rural healthcare grant program. If funding can be secured by these entities, the dark fiber and/or lit services strategy may serve as a short-term strategy as fiber is being built.

These estimates represent capital costs of building fiber between the various communities from a Carrier Neutral Location in the first community to a Carrier Neutral Location within the second community.

From the Carrier Neutral Location within each community, the following estimates would be considered to extend fiber to the healthcare facilities within each community that qualify for the rural healthcare grant.

Rural Healthcare Anchor Builds within each community

Segment	New (FT)	Existing (FT)	Fiber Cnt	Aerial	Underground	Build Cost $$	County	# of Healthcare Facilities
Cortez	73,347	15,213	48	66,012	7,335	$ 1,793,125.31	Montezuma	5
Rico	-	-		-	-	$ -	Dolores	0
Durango	21,106	52,252	48	18,996	2,111	$ 559,923.37	La Plata	13
Mancos	-	-		-	-	$ 3,800.00	Montezuma	1
Pagosa Springs	10,726	10,703	48	9,653	1,073	$ 289,844.55	Archuleta	8
Bayfield	-	-		-	-	$ -	La Plata	0
Dove Creek	3,009	-	48	2,708	301	$ 80,375.72	Dolores	2
Dolores	-	243		-	-	$ 3,800.00	Montezuma	1
Silverton	-	2,038		-	-	$ 3,800.00	San Juan	1
							Total	31

A list of the locations that qualify for the rural healthcare grant program was provided to the SWCCOG and it members as a deliverable for this project.

From the Carrier Neutral Location, the following represents the costs to build fiber to the various CDOT maintenance and other facilities within the region.

CDOT Anchor Builds within each community

Segment	New (FT)	Existing (FT)	Fiber Cnt	Aerial	Underground	Build Cost $$	County	# of CDOT Facilities
Cortez	-	21,731		0	-	$ 79,800.00	Montezuma	21
Rico	-	-		0	-	$ 15,200.00	Dolores	4
Durango	-	37,353		0	-	$ 114,000.00	La Plata	30
Mancos	1,295	5,805	48	0	1,295	$ 69,489.54	Montezuma	5
Pagosa Springs	1,670	1,558	48	0	1,670	$ 87,904.69	Archuleta	6
Bayfield	-	3,039		0	-	$ 22,800.00	La Plata	6
Dove Creek	1,621	-	48	0	1,621	$ 74,594.51	Dolores	3
Dolores	-	-		0	-	$ 15,200.00	Montezuma	4
Ignacio	7,885	-	48	0	7,885	$ 322,515.88	La Plata	4
							Total	83

CDOT provided a list of their addresses within each community that they would like to have connected.

NEO's team also identified building to the various schools and libraries within the region. The capital costs from the Carrier Neutral Location to the schools and libraries that are not yet connected with fiber are shown below. These locations are eligible for E-rate funding to help pay for much of the capital costs. It was assumed that the City of Cortez has included building to their schools and libraries within their Fiber to the Premise strategy, and therefore, are not included below. Additionally, Montezuma County has

stated that their plans are to build to all of the schools and libraries within their County, and therefore, are not included below. In the other communities, fiber is already in place at the schools and libraries from another provider.

E-rate Anchor Builds within each community								
Segment	New (FT)	Existing (FT)	Fiber Cnt	Aer	UG	Build Cost $$	County	# of E-rate Facilities
Cortez	0	0		-	-	$ -	Montezuma	0
Rico	0	0		-	-	$ -	Dolores	0
Durango	70012	2607	48	63,011	7,001	$ 1,701,065.82	La Plata	2
Mancos	0	0		-	-	$ -	Montezuma	0
Pagosa Springs	1929	6706	48	1,736	193	$ 65,653.49	Archuleta	5
Bayfield	0	0		-	-	$ -	La Plata	0
Dove Creek	0	0		-	-	$ -	Dolores	0
Dolores	0	0		-	-	$ -	Montezuma	0
								7

To add on building fiber to the other remaining anchor institutions within all of the communities, the following projections apply:

Other Anchor Institutions						
Segment	New (FT)	New (Miles)	Fiber Cnt	Build Cost $$	County	# of Other Facilities
Cortez	135086	25.58	96	$ 3,525,897.05	Montezuma	68
Rico	0	0.00		$ 11,400.00	Dolores	3
Durango	178688	33.84	96	$ 4,618,540.45	La Plata	78
Mancos	108624	20.57	48	$ 2,733,827.82	Montezuma	28
Pagosa Springs	188068	35.62	48	$ 4,682,037.64	Archuleta	35
Bayfield	142049	26.90	48	$ 3,519,507.28	La Plata	22
Dove Creek	2925	0.55	48	$ 139,157.23	Dolores	18
Dolores	48444	9.18	48	$ 1,240,185.53	Montezuma	18
Ignacio	124735	23.62	48	$ 3,096,933.76	La Plata	21
Silverton	2430	0.46	48	$ 134,772.12	San Juan	20
			Total	$ 23,702,258.88		311

Again, a detailed list of anchor institutions that are included within these assumptions was provided to the SWCCOG and its members as a deliverable of this project.

Additionally, detailed capital costs with assumptions for design, engineering, permitting, aerial and underground fiber construction labor, materials and overall costs were provided.

Potential to Include in a Last Mile Strategy and Public Private Partnership

These are significant capital costs. The SWCCOG could potentially build out to more anchor institutions or could also consider including fiber builds to the other anchor institutions as part of the negotiations of a Public Private Partnership ("PPP") with various service providers under a last mile strategy. Each community could negotiate a PPP for last mile connectivity or communities could come together and negotiate a partnership. Strategies for last mile connectivity are addressed in the following Section 7.

Paying for Capital Costs: Funding Opportunities

Strategies to pursue E-rate and the Rural Healthcare Grant program, coupled with collaboration with CDOT, Region 10, and the electric and power companies identified, as well as the service providers in the region should be pursued.

In addition to this strategy, there are other grant and loan programs that are also available for broadband build-out. Certain financing and funding programs restrict who is eligible to apply for and receive funding. A few of the state and federal grant and loan programs available for funding broadband construction are provided below.

The Colorado Department of Local Affairs (DOLA) in 2015 announced a $20 Million broadband implementation grant program for regional councils of governments and municipalities. In 2015, DOLA had three rounds of financing applications with deadlines for grant submission being April 1st, August 1st and December 1st. DOLA has not yet announced funding availability for 2016 or 2017 specifically for broadband implementation; however, applicants are encouraged to apply for funding through the Energy and Mineral Impact Fund.

The Rural Broadband Experiments and Connect America programs 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 less than 5,000 inhabitants."

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." Again, the definition of rural includes communities with a population less than 5,000 inhabitants.

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

A report written by NTIA referencing all federal programs available for broadband financing has been provided to the SWCCOG and its members as a deliverable of this project.

Tabor Laws

Financing of a broadband network, just like the financing of any other public project, is governed by state law, and primarily by the Constitutional Amendment known as the Taxpayer's Bill of Rights (TABOR). Colorado Constitution, Article X, Section 20. With respect to incurring debt, Section 20 (4)(b) of TABOR requires an election prior to "creation of any multiple-fiscal year direct or indirect district debt or other financial obligation whatsoever without adequate present cash reserves pledged irrevocably and held for payments in all future fiscal years." To the extent that the financing of a broadband network, or any components of a network would require the issuance of debt, the various municipalities and counties would be required by TABOR to seek a vote of the registered electors. To the extent that the municipalities or counties own or control existing network facilities that it wishes to use in a network, or has the financial resources to pay for new facilities, it may do so without an election.

Statutory municipalities are granted their authority in Title 31 of the Colorado Revised Statutes. Among the powers of statutory municipalities are the power to enter into contracts and the power to acquire, hold, lease, and dispose of both real and personal property. C.R.S. 31-15-1(b) and (c). The municipality also has the power to contract indebtedness (subject to TABOR) by borrowing money or issuing the bonds of the municipality "for *any public purpose* of the municipality, including *but not limited to* the following purposes: Supplying water, gas, heating and cooling, and electricity; purchasing land; and purchasing, constructing, extending, and improving public streets, buildings, facilities, and equipment…" C.R.S. 31-15-302(1)(d)(I). While this section of the statute does not specify telecommunications, the authority granted to the municipality is specifically not limited to the examples stated, and the broadband facilities the municipality is considered would, according to Denver-based attorney, Ken Fellman, be deemed a public purpose, and therefore permitted. That being said, the total amount of the municipality indebtedness for all authorized purposes may not exceed three percent of the actual value, as determined by the assessor, of the taxable property in the municipality. C.R.S. 31-15-302(1)(d)(II).

Section 7 – Last Mile Strategies, Potential Public Private Partnerships and Funding/Financing Opportunities

During the broadband planning process, NEO and the SWCCOG issued a formal Request for Information (RFI) for a Public Private Partnership (PPP). The RFI was broad and open-ended, allowing for a number of responses. The purpose of the RFI was to extend an invitation to partner with the SWCCOG and it member communities and counties in improving broadband services for the entire region. The primary questions posed within this RFI were – "If key investments in middle mile connectivity are made from government entities, grants and potential other partners, what would your company provide for Last Mile Internet Services?" and, "What Public Private Partnership arrangements and structure would facilitate more investment in Last Mile Internet Services?"

The SWCCOG RFI sought input from potential partners regarding the terms and conditions under which partners would collaborate in offering a high-speed broadband data network to residents and businesses in each of the communities and counties within the region. Possible options that were included were:

1. Responses to design, build, own, operate and finance a high-speed Internet network.
2. Responses to jointly finance a high-speed Internet network in collaboration with the SWCCOG.
3. Responses to operate and maintain a high-speed Internet network on behalf of the SWCCOG. The network would be owned by the SWCCOG. Operations and maintenance activities must be defined by the respondent.
4. Responses to provide high speed Internet services to end users on a network that is owned by the SWCCOG or its member communities/counties and available on an open access basis to multiple service providers. The RFI discussed the City of Cortez and Montezuma County plans to build a Fiber to the Home/Business network with the option to evaluate an open access strategy. It asked respondents to discuss their product offering and pricing and willingness to provide services on an open access Fiber to the Home/Business network.

5. Responses to provide either dark fiber leases or Indefeasible Rights of Use (IRU) for the SWCCOG to acquire from the Offeror for fiber and/or conduit.
6. Other responses that were not described above.

Responses

The SWCCOG received ten responses from various incumbent, national and local providers. Although much of the content of the RFI is proprietary, the types of responses included:

Services, 1 Gig: CenturyLink, Cedar Networks, Allo, FastTrack

Finance: Macquarie Capital

Partial Finance: CenturyLink, Cedar Networks, Allo, FastTrack

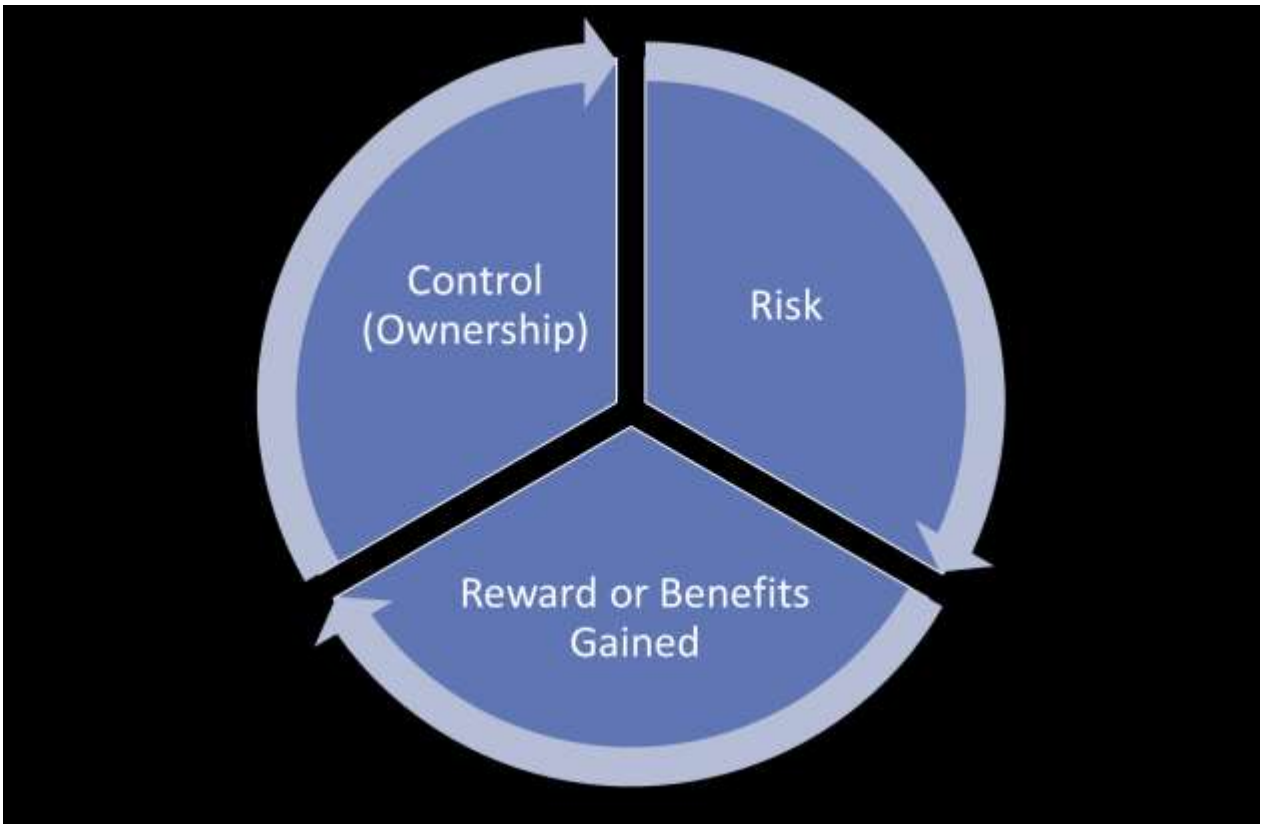
Manage/Operations: EntryPoint, Data Safe, Wide Open Networks

Other: Charter

Balancing Control, Risk and Reward

There are many PPP models that are recently being developed in the municipal broadband industry. Municipalities and counties are exploring ways to share in the capital risks of development and implementation of last mile infrastructure and consequently, share in the rewards and benefits that advanced broadband networks provide to a community's residences and businesses.

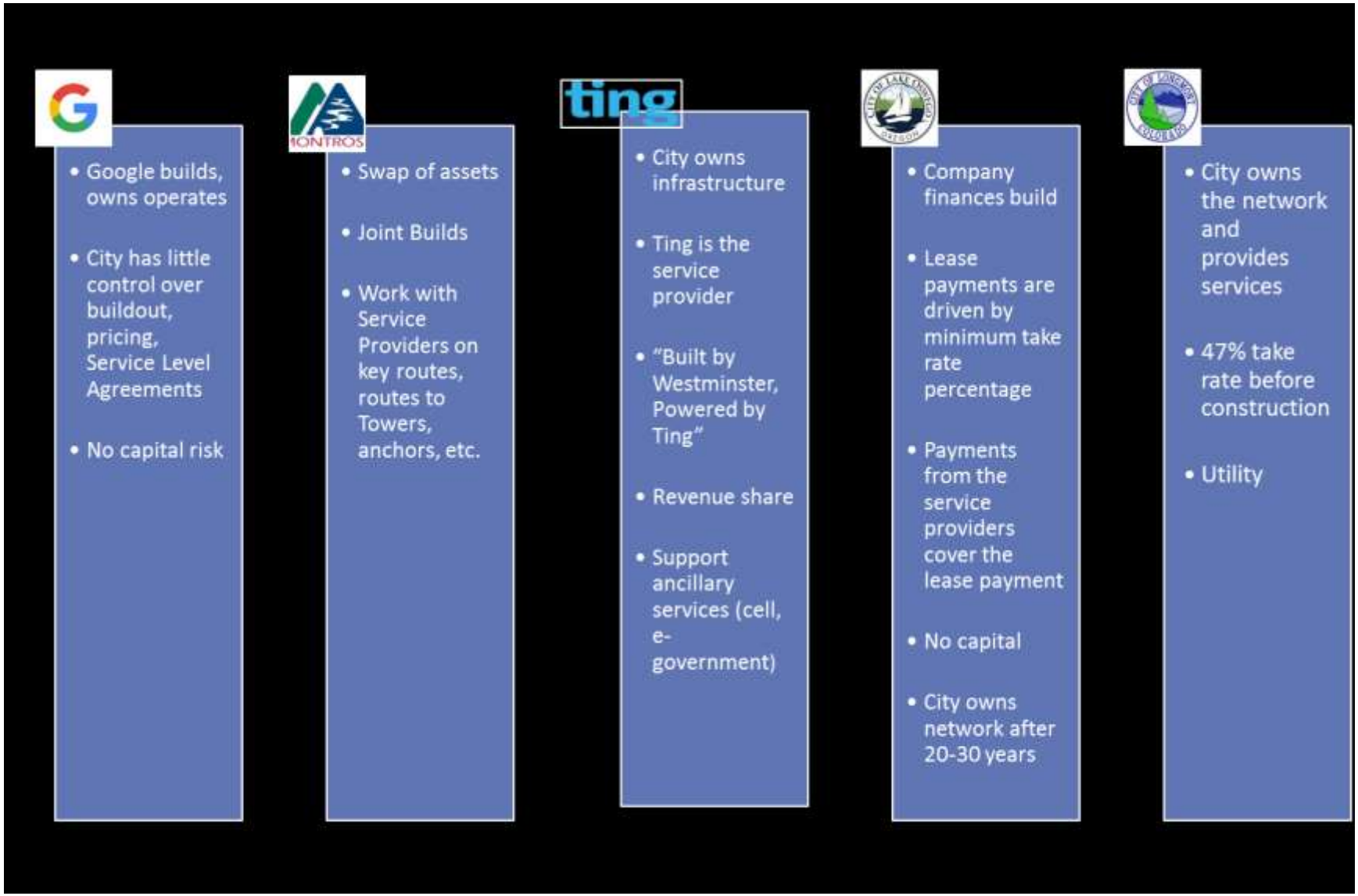
As potential PPP models are further explored, whether they are developed by the municipalities on their own or with many communities coming together in collaboration, considerations should include and consider the opportunities and potential risks of the tension between these three concepts:



Control often means ownership of the network and in many cases, also requires assuming a portion or all of the capital costs of the network. Risk includes capital, financial, operational and execution risk. Rewards or benefits gained refers to the outcome of the PPP; in most cases, the goal to provide abundant, affordable and reliable very high-speed broadband services. In other cases, rewards or benefits could also include the economic vitality of a community because this critical infrastructure is in place.

Types of PPP Models

There are several types of models that are emerging. Below is a summary:



Many commuities are familiar with Google Fiber's work with various municipalities across the county. Google has invested in building Fiber to the Premise (FTTP) networks in Kansas City, (Kansas and Missouri), Austin and in Provo, Utah. Google has announced plans to work with up to thirty-five municipalities in development of this strategy. Google Fiber's model includes no capital risk or investment from the municipalities, as Google Fiber assumes all of the financial risk for deployment. The municipalities provide streamlined permitting processes to Google Fiber to help speed along their network construction and to create an efficient deployment of network facilities. In some cases, municipalites also offer access to existing conduit, fiber, data centers, and public land for placement of telecommunication huts.

Another strategy to further incent investment that municipalities and counties can consider is giving access to information. Sharing of information could be in the form of provider access to Geographic Information Systems (GIS) or other databases that provide information such as streets, right of way, parcel data and information, demographics, survey results, locations and details of other existing utilities, and existing infrastructure. Sharing this information can be extremely helpful for a locality's own broadband planning, potential public–private partnerships, or a network service provider that is evaluating the deployment of new infrastructure in a community. Access to this information may attract and speed new construction by private partners, while enabling the community to meet its goals for new, better broadband networks—and potentially to realize revenues for use of the assets.

In Montrose, Colorado, the city government is working with its existing service providers to help facilitate building out more infrastructure. The City works with the private sector on sharing in the costs of joint fiber builds, conduit and fiber swaps, and coordination of the various service providers to help build key routes within the community.

Another model is one in which there is substantial public investment in the fiber optic network and the municipality pays for the capital costs of the network to be built. In some cases, this includes the fiber distribution throughout the community and in other instances, it may also include fiber to the residences and businesses. The service provider then pays for the optical equipment to light the network and assumes the operational and implementation risk of offering services. This model was deployed in Westminster, Maryland where the city was responsible for building the fiber network and Ting Internet assumed the capital costs of the electronics to provide services. Ting also provides services to the end users and provides a revenue share to the City of Westminster for use of the network. The capital risk is shared and the revenue is also shared. The SWCCOG RFI received several proposals from service providers that were interested in further developing this type of model.

Another model is one in which the private sector provides a combination of funding, design, engineering, construction and operations. Funding is provided through a 20-30-year lease with the option of owning the network after the lease agreement term. Municipalities share in the risk by paying monthly lease payments that are tied to sharing in the take-rate or market share risk of the project. While this type of model is constantly changing, there are three companies in the industry that have fully developed business models and propositions for consideration. These companies include Macquarie Capital, SiFi Networks, and Symmetrical Networks.

Macquarie Capital submitted a response to the SWCCOG RFI. Macquarie Capital will provide financing, construction, operations, and service delivery over the network. To fund all this activity and investment, the locality or SWCCOG will pay Macquarie on an ongoing basis by placing a monthly fee on all local property owners' utility bills or by assuming some of the take-rate risk. Macquarie has offered this type of arrangement with the State of Kentucky and with the Utopia project in Utah. In both of these projects, Macquarie intends that multiple ISPs will compete over the network, giving consumers a choice of providers and the benefits of competition. As service revenues generated by the ISPs increase, Macquarie then commits to sharing some of its revenues with the locality. Lake Oswego was also considering this type of arrangement with a private firm.

Fiber to the Premise Capital Costs

As mentioned in the previous section 6, SWCCOG could consider developing a PPP to build to the anchor institutions and may consider also incorporating the possibility of partnership with the private sector to build FTTP.

NEO's team put together a preliminary cost estimate of building FTTP within the communities and counties of the study area. Below are the projected capital cost considerations.

FTTH estimates within each community						
Community	Households (Estimate)	OSP Cost/HHP	OSP Build Cost	Electronics Cost/HHP	Electronics Build Cost	Total Build Cost
Bayfield	958	$ 2,330	$ 2,232,140	$ 4,194	$ 4,017,852	$ 6,249,992
Cortez	3,725	$ 1,399	$ 5,211,275	$ 1,889	$ 7,035,221	$ 12,246,496
Durango	7,980	$ 950	$ 7,581,000	$ 855	$ 6,822,900	$ 14,403,900
Dove Creek	300	$ 3,540	$ 1,062,000	$ 9,558	$ 2,867,400	$ 3,929,400
Dolores	449	$ 3,540	$ 1,589,460	$ 9,558	$ 4,291,542	$ 5,881,002
Pagaso Springs	633	$ 3,540	$ 2,240,820	$ 9,558	$ 6,050,214	$ 8,291,034
Mancos	591	$ 2,890	$ 1,707,990	$ 6,503	$ 3,842,978	$ 5,550,968
Rico	217	$ 3,540	$ 767,118	$ 9,558	$ 2,071,219	$ 2,838,337
Silverton	279	$ 3,540	$ 986,952	$ 7,965	$ 2,220,642	$ 3,207,594
Ignacio	319	$ 2,890	$ 920,465	$ 6,503	$ 2,071,046	$ 2,991,511
		Total	$ 24,299,220	$ 66,140	$ 41,291,014	$ 65,590,234
** The above numbers include real estate developments contiguous to the town/city.						

FTTH estimates within each County						
Community	Households (Estimate)	OSP Cost/HHP	OSP Build Cost	Electronics Cost/HHP	Electronics Build Cost	Total Build Cost
Archuleta	4,940	$ 3,540	$ 17,486,747	$ 10,620	$ 52,460,241	$ 69,946,988
Dolores	794	$ 4,336	$ 3,444,421	$ 15,176	$ 12,055,473	$ 15,499,894
La Plata	21,963	$ 2,890	$ 63,473,221	$ 7,225	$ 158,683,052	$ 222,156,273
Montezuma	10,509	$ 3,540	$ 37,202,699	$ 10,620	$ 111,608,096	$ 148,810,795
San Juan	282	$ 4,336	$ 1,220,697	$ 15,176	$ 4,272,440	$ 5,493,137
		Total	$ 122,827,785	$ 58,817	$ 339,079,303	$ 461,907,088

This information was provided to establish a foundation of understanding the projected capital costs involved in a FTTP build.

Section 8 - Benefits of Advanced Broadband Networks

The following section is taken from a white paper written by NEO Connect in 2015. The information is relative to this project in understanding the applications and trends in broadband services. This section discusses the community benefits of advanced broadband networks and provides the context of why building Gigabit-enabled networks are important.

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.[7]

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 helps creates economic and educational equality.

[7] 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

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 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, 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 FCC ruled in 2015 that the definition of broadband should be 25 Mbps in download speeds and 3 Mbps in upload speeds. 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 Council) 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."[8] According to the Cisco 2012 Zettabyte Report, businesses today routinely require symmetrical gigabit service between their locations."[9]

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. 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 Council'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.

[8] 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.
[9] Cisco, "*The Zettabyte Era*" (May 30, 2012).

Table 1, Applications and their Needed Bandwidth

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

In addition to explosive growth in Internet consumption from homes, businesses, and mobile Internet use has also advanced dramatically. Smartphone applications are spurring higher consumption of multimedia services. With tablets 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.

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. 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.

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."[10]

In 2012, the Chattanooga Electric Power Board (EPB) established Gig Tank, an application-incubation facility. The goal of Gig Tank is to build applications to utilize the capabilities of gigabit networks. According to its website, "Gig Tank 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, Gig Tank 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

[10] Chattanooga's "Gig Tank" website, available at http://www.thegigcity.com/gigtank/

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 implementation, typical outages may have lasted four to five hours and many neighborhoods may not have had services restored until residents notified Chattanooga'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.[11]

Similar to Chattanooga's Gig Tank program, entrepreneurs have developed gigabit-ready applications through the US Ignite Partnership.[12] 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

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

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

one thousand communities across the country submitted applications.[13] 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 possibilities presented by the Google Fiber network.[14] 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.

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[15], 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

[13] Topeka, Kansas, even changed their name to Google in hopes of being selected as the test-bed.
[14] Kansas City Startup Village, available at http://www.kcstartupvillage.org; and Homes for Hackers, available at http://homesforhackers.com.
[15] Global Workplace Analytics Recent Statistics on Telecommuting available at http://www.globalworkplaceanalytics.com/telecommuting-statistics

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 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 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.[16]

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. 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.

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

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. The Federal Highway Administration and CDOT have adopted rules recently about self-driving cars. Uber is testing them and Tesla is developing them. 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 uncomfortable; 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.

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 an 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 travel to medical facilities. Telemedicine can also eliminate many ER visits, which are often the costliest 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.[17] 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.[18] 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.

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

[17] Wellness Council of America, "Collecting Data to Drive Health Efforts," available at https://www.welcoa.org/resources/collecting-data-drive-health-efforts-classic-edition/
[18] American Telemedicine Association, numerous case studies available at http://www.americantelemed.org/about-telemedicine/telemedicine-case-studies

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 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 rapidly moving online. Schools are beginning to provide a 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?

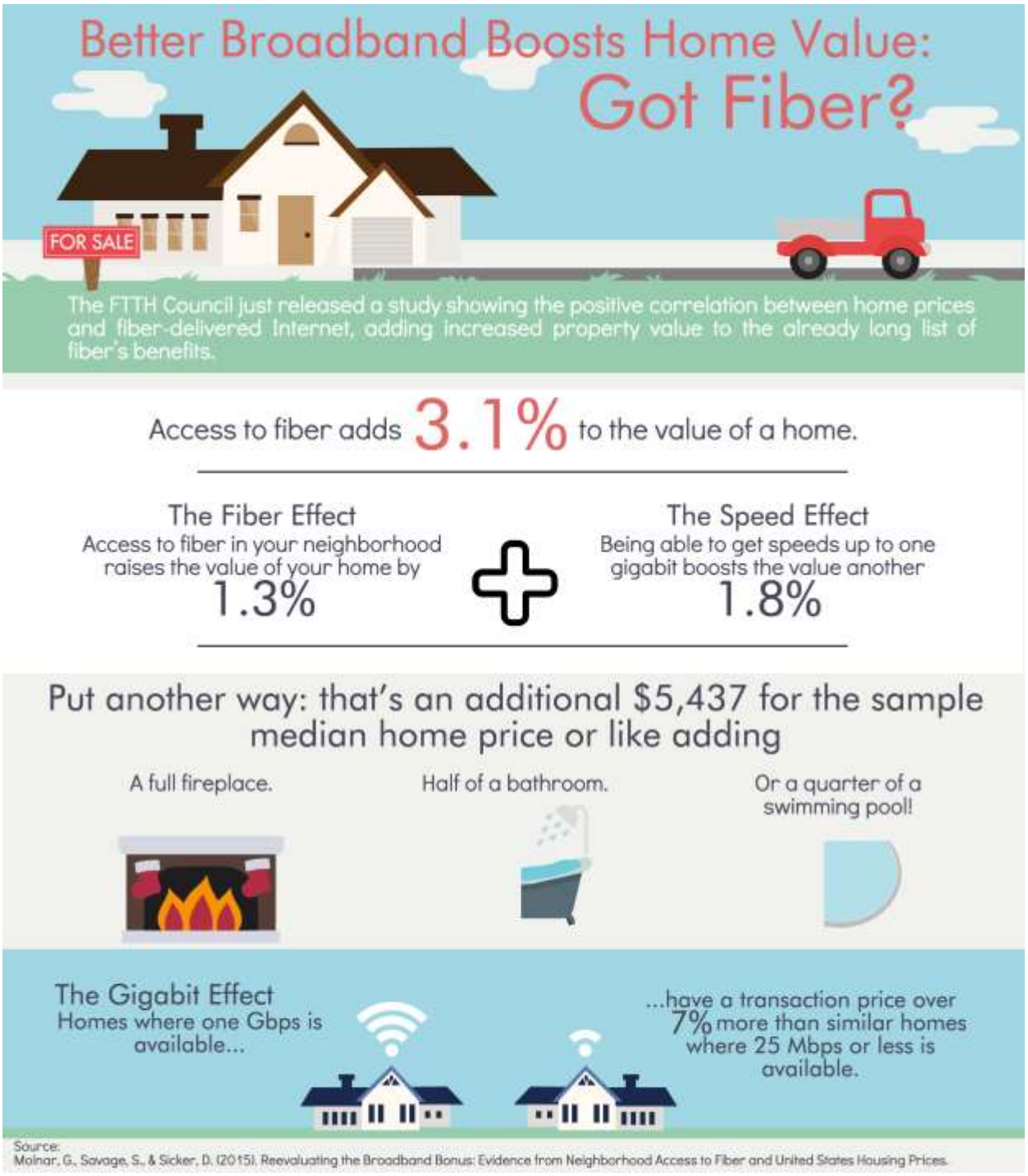
Broadband must be ubiquitous or it will further create a digital divide. When broadband is ubiquitous it can be the great equalizer between different economic classes. In 2014, the International Economic Development Council asked economic development professionals if broadband service could "encourage 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. Ubiquitous broadband access can help create social and economic equality. However, not having advanced broadband access available to everyone can create further inequalities of wealth, education access, social institutions, and government resources. Broadband must be abundant, redundant and available to everyone.

Civic Engagement, Transparency, Access to Government Resources.

Advanced Broadband Networks can transform civic engagement, access to government resources and transparency of government. Government documents, including GIS data, applications, information on initiatives, information on financial contributions etc. can now be available online. 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. According to the FTTH Council, access to fiber adds 3.1% to the value of a home and having a Gigabit available increases home values by 7% over homes that have access to 25 Mbps or less.


Better Broadband Boosts Home Value:
Got Fiber?
FOR SALE
The FTTH Council just released a study showing the positive correlation between home prices and fiber-delivered Internet, adding increased property value to the already long list of fiber's benefits.
Access to fiber adds 3.1% to the value of a home.
The Fiber Effect
Access to fiber in your neighborhood raises the value of your home by
1.3%
The Speed Effect
Being able to get speeds up to one gigabit boosts the value another
1.8%
Put another way: that's an additional $5,437 for the sample median home price or like adding
A full fireplace.
Half of a bathroom.
Or a quarter of a swimming pool!
The Gigabit Effect
Homes where one Gbps is available...
...have a transaction price over 7% more than similar homes where 25 Mbps or less is available.
Source:
Molnar, G., Savage, S., & Sicker, D. (2015). Reevaluating the Broadband Bonus: Evidence from Neighborhood Access to Fiber and United States Housing Prices.