Broadband Planning Primer and Toolkit – August 2016

Prepared by:

Jane Smith Patterson

Deborah T. Watts

Brian Rathbone

Stephanie Jane Edwards

*In partnership with the **North Carolina Broadband Infrastructure Office***

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Chapter 1: Introduction to the Broadband Ecosystem

Foreword

"Appalachia is a region of great opportunity that will achieve socioeconomic parity with the nation."

The Appalachian Regional Commission (ARC) has recently completed a five-year strategic plan of action that advances strategic goals to advance its vision of a more prosperous future for Appalachia.[1] These priorities include:

- *Economic opportunities increased by investing in entrepreneurial and business development*
- *Ready workforce supported by increasing educational attainment, skills, and health of citizens*
- *Critical infrastructure investments- broadband, transportation, and water/wastewater systems*
- *Natural and cultural resources leveraged to increase community and economic potential*
- *Leadership and community capacity*

These goals are distinct, yet interdependent, with progress in one often requiring investment in another. This is especially true of broadband, where ARC's previous investments have brought the Internet to more Appalachian communities to help reduce the region's isolation, support economic activity, move awareness of its cultural riches to a global stage, and improve the region's public health and safety. Progress to date was hard won, but the job is not complete; the virtuous cycle of ever more valuable and cross-cutting applications coupled with technology evolutions are setting new standards for competitive speeds and bandwidth. Broadband plans will need to be comprehensive, compelling, constituent driven, and collaborative. ARC offers this toolkit as a guide and stands ready to assist you as you undertake this important challenge.

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[1] Appalachian Regional Commission. (November 2015). *Investing in Appalachians' Future*: *The Appalachian Regional Commission's Five-Year Strategic Plan for Capitalizing on Appalachia's Opportunities, 2016-2020*. [PDF] Retrieved from: http://www.arc.gov/images/newsroom/publications/sp/InvestinginAppalachiasFutureARCs2016-2020StrategicPlan.pdf

What is Broadband?

The U.S. Federal Communications Commission (FCC) defines broadband as data transmission technologies that are always on and capable of simultaneously transporting multiple signals and traffic types between the Internet and end users. In January 2015, the FCC upgraded the definition of broadband speeds for downloading content from 4 Mbps (Megabytes per second) to 25 Mbps and for uploading content from the previous rate of 1 Mbps to a new standard of 3 Mbps. The FCC notes that with the revised standard, 13.1 percent of households do not have access to broadband. Why does that matter?

Broadband Internet and the broadly available devices that facilitate its use are emerging as the rarest of innovations – a true General Purpose Technology (GPT).[2] GPTs enable new and different opportunities across an entire economy, fundamentally changing how and where economic activity is organized. Historical examples illustrate the concept of analogous developments that reshaped the economy and boosted productivity across all sectors and industries: electricity, internal combustion engines, and railways. GPTs often require wholesale remaking of infrastructure environments, of business models, and of cultural norms. Try to imagine communities that never developed roads and electricity and you will understand the dismal prospects that confront unconnected communities.

Speed characterizes broadband on many different levels. Rapid innovation has ratcheted up the very definition of what data transmission speed qualifies as 'broadband' even as the uptake of smart phones and other broadband access devices set new records for technology diffusion (see Figure 1). The pace of change and the consequences for not being part of the transformations that are underway mean that communities that are not working to be active participants in the digital economy are at risk on many levels.

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[2] Unknown. (April 13, 2012). The revolution to come. *The Economist*. Retrieved from:
http://www.economist.com/blogs/freeexchange/2012/04/general-purpose-technologies

Fastest Growing Consumer Technologies
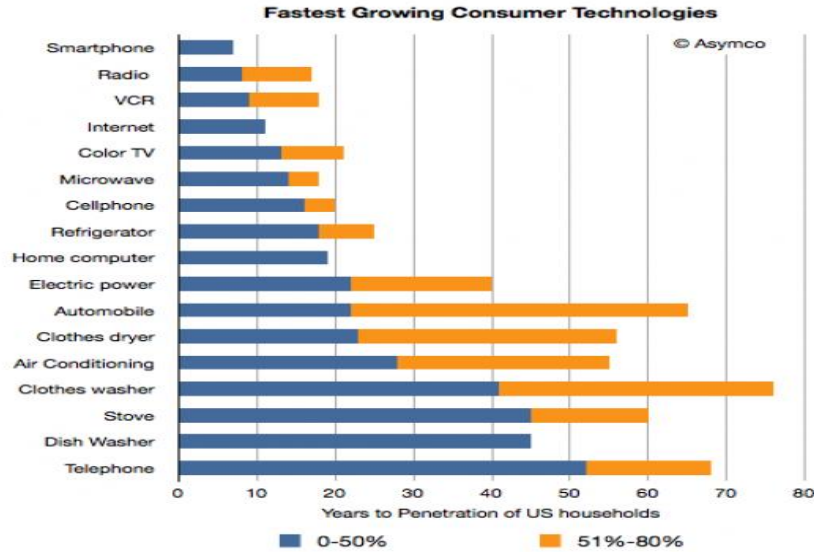
Figure 1
Source: Unknown. (April 13, 2012). The revolution to come. *The Economist*. Retrieved from:
http://www.economist.com/blogs/freeexchange/2012/04/general-purpose-technologies

The scale and interrelatedness of impact emphasize the need for comprehensive approaches to broadband planning that include considering the full set of technologies, devices, applications, and end users that comprise the broadband ecosystem.[3] Broadband networks are defined by level: Backbone (or central hub); Middle Mile (which enables connectivity to Internet service providers); and Last Mile (over which providers deliver services to end users such as households, businesses, and community anchor institutions). Broadband communication networks can take multiple forms: wired or wireless, fixed or mobile, terrestrial or satellite. Different types of networks have different capabilities, benefits, and costs; these options will be examined at length in Chapter 5: Models of Broadband Deployment.

Applications and content include: e-mail, search, news, maps, sales and marketing applications used by businesses, user-generated video, and hundreds of thousands of more specialized uses, the value of which determines the interest and uptake of end users. Even as demand for e-commerce and entertainment offerings explodes, equally rich content and interactions supported by specialized uses in education, healthcare, and public safety are driving exponential demand for more and faster bandwidth. Applications run on devices that connect to

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[3] National Telecommunications and Information Administration. (March 2010). *National Broadband Plan*. Chapter 3. Retrieved from https://www.fcc.gov/general/national-broadband-plan

the Internet.

Devices, including computers, smartphones, set-top boxes, e-book readers, sensors, private branch exchanges (PBX), local area network routers, modems, and an ever-growing list of other devices connect the end users to the content and tools delivered by the applications. New devices mean new opportunities for applications and content.

As visualized in the National Broadband Plan, the networks, devices, and applications that comprise this ecosystem drive each other in a virtuous cycle. Availability is a critical factor in the strength of this ecosystem: robust infrastructure—fiber, wireline, wireless, satellite, or some combination of these technology platforms, and a service provider enabling affordable connection to the Internet has to be the starting point for a healthy ecosystem. Fast, reliable, and widely available networks will incentivize: 1) companies to produce more powerful and capable devices to connect to those networks, and 2) innovators and entrepreneurs to develop exciting applications and content. These new applications draw interest among end users, bring new users online, and increase use among those who already subscribe to broadband services. As one sector utilizes the benefits of broadband, it creates a ripple effect impacting other sectors and the system as a whole.

Figure 2: Broadband Ecosystem 1
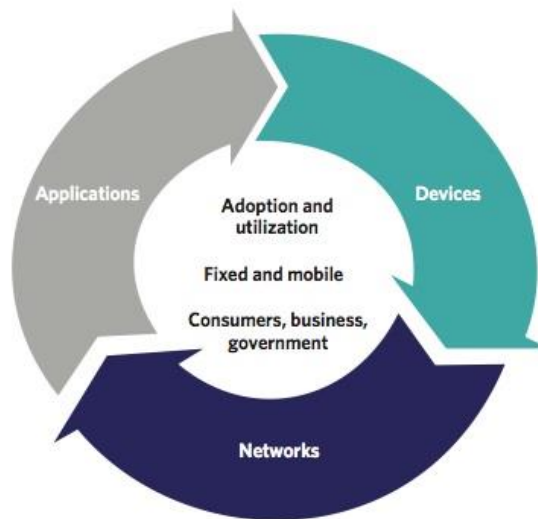
Source: National Telecommunications and Information Administration. (March 2010). *National Broadband Plan.*

Broadband Internet's highest value proposition comes from maximizing the number of people and businesses that choose to adopt broadband and make full use of the applications and devices that the network supports. Foremost among the factors found to affect the adoption

decision are: availability of broadband, affordability of broadband service or the computer/device needed for access, digital literacy, and perceived usefulness/relevance of broadband Internet. These factors become the most promising targets for action for improving the broadband profile of the community. The remainder of this toolkit provides information, strategies and tools for:

- *Evaluating current broadband access and identifying options for improving availability*
- *Characterizing and quantifying demand*
- *Identifying availability and gaps in resources to identify levers for improving the absorptive capacity of the community and to increase interest and uptake.*

Why is Broadband Important?

In the previous section, we introduced broadband as a general-purpose technology, meaning that its economic effects spread through the economy on multiple levels and at multiple rates. In the short term, post-deployment broadband has positive effects on employment, productivity, income, and behavior. Indirect effects are medium-term multiplier effects which occur due to increases in productivity of firms in the broader information and communication technologies (ICT) supply-chain cluster. The longer-term transformative effects induced by broadband are the creation of new industries, clusters, and ways of working, as well as the realization of the removal of time and distance as a constraint in markets and relationships. For ARC communities that have too long struggled against the constraints of isolation and distance to markets and critical health and education resources, this can be an especially exciting period, as long as they can get connected.

Anecdotal evidence that broadband is transforming the economy abounds even as rigorous quantitative assessments are only starting to appear on a scale that supports conclusions. Recently released evaluations at the macroeconomic (national and state) and microeconomic (household) levels are providing broader and more longitudinal evidence of the positive impacts of high-speed broadband access.

Key findings include[4]:

At the macro level:

- *Increasing broadband access 10 percentage points increases Gross Domestic Product 1 percent*
- *Doubling broadband speeds for an economy can add 0.3 percent to GDP growth[5]*
- *80 new jobs are created for every additional broadband 1,000 users*
- *The benefits of faster broadband can be categorized as:*
    - *Economic effects, including increased innovation and productivity in business*
    - *Social effects, including better access to services and improved healthcare*
    - *Environmental effects, including more efficient energy consumption.*

At the household level:

- *Broadband access affects development: Gaining 4 Mbps of broadband increases household income by $2,100 per year*
- *Broadband speed upgrades affect development: Upgrading from 0.5 Mbps to 4 Mbps increases income by around $322 per month*
- *Online job searches result in re-employment 25 percent faster than traditional searches[6]*
- *Broadband is associated with higher employment rates in rural counties.[7]*

Possible reasons for the links found between access to fast broadband networks and economic improvements include:

- *Personal productivity: A faster broadband speed boosts personal productivity, in part by supporting more flexible work arrangements.*
- *Income enhancement: A higher speed connection enables more advanced home-based businesses as a replacement, or complement to, an ordinary job.*
- *More knowledge: Broadband speed enables people to be more informed, better educated and socially and culturally enriched – fueling a faster career path.*

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[4] Ericsson, Arthur D. Little, & Chalmers University of Technology. (September 2013). *Socioeconomic Effects of Broadband Speed*.. [PDF] Retrieved from: http://www.unh.edu/broadband/sites/www.unh.edu.broadband/files/media/kb-reports/ericsson-broadband-final-071013.pdf

[5] Based on 2008 base year

[6] Kuhn, P and Mansour, H. (2013). Is the Internet job search still ineffective? [PDF] Retrieved from www.econ.ucsb.edu/~pjkuhn/Research Papers/NLS_NetSearch.pdf

[7] Atasoy, H. (2013) The effects of broadband Internet expansion on labor market outcomes. *Industrial and Labor Relations Review 66*(2) 315-345.

On the question of whether it is better to invest in addressing unserved versus underserved areas, data suggest extending service to unserved areas will yield greater returns on investment; speed matters but not as much as having service at all.[8]

The Economics of Broadband

The economics of broadband are complex and far-reaching, crossing multiple industry segments, some of which are regulated as public utilities and others that are not. The physical infrastructure used to deliver broadband is as diverse as the companies who sell Internet service to consumers.

One of the primary constraints is the physical cost of the infrastructure. Fiber optics are at the core of broadband infrastructure across nearly all providers. Copper, coaxial cable, and towers have traditionally used existing infrastructure that was deployed long before the need to provide broadband Internet services. Having existing copper infrastructure on the premises for nearly all residential structures dramatically reduces the investment of deploying broadband service, such as AT&T's U-Verse, that brings fiber to the pole and hands off to copper to the home.) Fiber, such as that provided by Google and Verizon, has no copper or coax used on the provider side; instead, the provider uses a true "optical hand-off," whereby fiber optics are brought all the way to the customer's premises. The cost of deploying true fiber to the home is significant and gets higher in the low-density and terrain-challenged environments characteristic of much of Appalachia.

It is seldom recognized that many of the things that make a place beautiful also increase the cost of deploying broadband infrastructure. Trees, mountains, rivers, estuaries, and wildlife preserves increase the cost of deploying infrastructure. Areas cut off from nearby metropolitan areas by mountain ranges or rivers are less likely to have access to robust broadband because the cost of traversing bridges, waterways, mountain peaks, and even just lining mountain roads or long rural driveways with telephone or co-axial cables is so much higher. Add in low densities, and the cost of deploying them far exceeds the revenue generated within the industry standard

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[8] Meek, K., Broughton, T, Thanki, R, & Corn, E. (2010). Optimal investment in broadband: The trade-off between coverage & network capability. [PDF]
https://www.vodafone.com/content/dam/vodafone/about/public_policy/policy_papers/public_policy_series_10.pdf

payback period of two years. Delayed returns underlie the conclusion by many private, for-profit providers that there is no business case to deploy broadband in such locations.

In the case of wireless service, trees, mountains, and other structures can effectively block a wireless signal. A wireless provider's ability to deal with foliage depends largely on the frequencies they use, the regulated output power at which they can operate, and the location of their radio transmitters. All wireless frequencies tend to perform well in unobstructed sites with clear line-of-sight transmission. The heavy foliage that characterizes much of Appalachia dramatically limits the number of frequencies that effectively penetrate foliage. Wireless service providers who use unlicensed spectrum, generally referred to as WISPs, are limited to a few low-frequency, foliage penetration strategies. This increases the cost of the hardware and reduces the speeds the provider can offer. Self-interference and interference from other users of the same unlicensed spectrum further reduce the range and foliage penetration capabilities of these networks. Emerging technologies like TV White Space offer some promise in this regard but have yet to see widespread use. An example of an organization using this in the field is Declaration Networks in Garrett County Maryland.

Wireless operators using licensed spectrum are an entirely different matter. Licensed spectrum is dedicated to the licensee and, thus, should be theoretically free from interference from third parties. Most of the providers operating with licensed spectrum are cellular phone service and wireless Internet providers. These companies have often spent billions of dollars for access to their radio spectrum and have equally large investments in their fiber infrastructure, which interconnects their towers and radio area network to the main backbone of their networks. As 4G wireless Internet and beyond have proliferated, more and more cell towers have needed to be connected directly to fiber in order to provide the speeds consumers seek. For all these reasons, the use of these networks can come at a premium. Consumers are charged for every data bit they transfer at a rate of fifteen times or more higher than their landline or unlicensed, fixed wireless counterparts. Data caps and throttling (deliberately slowing the transmission speeds) have become commonly understood terms as consumers manage their data consumption.

The economics of wireless broadband become even more complex because our cellular communications infrastructure has become integral to the operation of our public safety agencies. Though all types of broadband Internet are used heavily for public safety purposes, wireless Internet is especially important for law enforcement, fire fighters, and other first

responders. Previous national tragedies taught us that ubiquitous and interoperable communications across all first responders was something we lacked. As a result, the FIRSTNET initiative was formed. Tasked with creating a nationwide interoperable and mobile data network, this initiative continues to move toward utilizing and expanding the nation's existing 4G LTE (Long-Term Evolution) wireless infrastructure. Because of this, major providers of LTE service are potentially eligible for substantial subsidies to expand and harden their networks. It is important to note that even subsidies are far from free money and come with a cost. Organizations can spend millions applying for funds with no guarantee they will be awarded those funds. It must also be said that the regulatory and reporting burdens placed on those receiving subsidies can be onerous and costly, which further limits the efficacy of subsidy dollars.

Another economic constraint on broadband deployment is the chicken or egg conundrum that surrounds demand and uptake. Areas that have traditionally not had access to broadband Internet, such as rural and farming communities, often have less demand for broadband than areas where connectivity is more prevalent. In general, environmental factors aside, when there are fewer than ten households per mile, demand plays an outsized role in supporting deployment.

The economics of broadband deployment are not static, though, and levers exist to shift the cost equation. When projects are not able to meet the two-year payback goal, it becomes important to look at ways to alter the other factors in the cost equation. For example, communities often own assets that can be utilized to lower the cost of deploying new infrastructure. Community owned towers, water towers, conduit, rights-of-way, and telephone poles are all examples of assets that can dramatically lower the cost of deployment. This is covered in greater detail in the Opportunities to Leverage Existing Assets to Reduce Costs section of this toolkit.

Broadband as a Moving Target

Broadband does not have fixed definition; rather, it is a moving target as innovations elevate its platform technologies to ever-greater speeds and bandwidth capacity to transmit data to and from the Internet and end users or devices. Growth in the absolute number of users and the amount of bandwidth required by an exploding number of data-rich applications requiring strong real-time quality of service are driving constant improvement in functionality and speed.

Figure 3 shows changes in the relative use of different access technologies over time as the capacity of transmission technologies and the definition of broadband evolved. Note that the drop in households with broadband declined in 2015 as a result of changes in the definition and not from a decline in the absolute number of households with Internet access.

Figure: 3 U.S. Household Internet Access Speeds (Millions)[9]
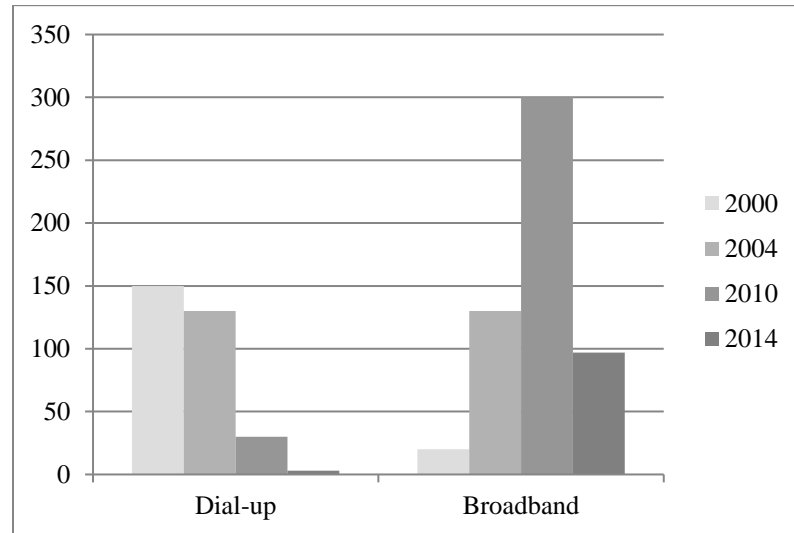
The needs of the nation are ever evolving, and the minimum level of broadband Internet connectivity required to participate in the digital economy has always been a hotly debated matter. Different agencies have provided different speed thresholds on the uplink and downlink speeds when defining broadband. At its core, broadband describes the capacity, or bandwidth, of a digital communication channel that is larger than traditional dial-up technology, allowing transmission of more information at a faster rate. If we use the highway analogy, bandwidth refers to how many lanes there are in each direction: the more lanes, the broader the communications channel—thus, the term broadband. But how many lanes equal a broad communications channel? The number can only go up as innovations—such as interactive applications, real-time monitoring and virtual reality—drive the demand for bandwidth to ever-higher levels.

A familiar example, camera phones, illustrates just how innovations can become the new standard and drive the need for bandwidth. Only four years after introduction in 2000, camera phones became a standard feature on more than 75 percent of mobile phones. Improvements in mobile phone technologies—such as, resolution from the initial 0.35 to today's 40 megapixels, along with video, wide-angle lens, filters, and touchscreen controls—has had cascading effects on bandwidth usage.

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[9] FCC (February 2, 2015) 15th Broadband progress report. Retrieved from https://www.fcc.gov/reports-research/reports/broadband-progress-reports/2015-broadband-progress-report

Those effects have been compounded by rapid evolution of the essential consumer services mobile phones provide, such as capturing goods in transit, and use with smart appliances. Indeed, a seemingly endless stream of innovations in mobile services and technologies are driving the demand for more and better Internet access and a redefinition of what it means to be part of the connected economy.[10]

Migration of Infrastructure

One of the challenges facing incumbent providers in Appalachia is their existing legacy infrastructure. Moving to fixed and mobile wireless as the default infrastructure could come at the cost of losing critical infrastructure and its functionality. Landline voice service and traditional 911 emergency services are perfect examples. When someone calls 911 from a landline connection that utilizes Time Division Multiplexing (TDM) to send multiple discreet signals across a single communications channel, we know that responders will get the message and be able to find the caller, even if the power is no longer on. Copper infrastructure, along with the incumbent provider's generators and battery backups, can provide the power that the telephone service requires. This provides life-saving voice service. Fiber-to-the-Home deployment, which uses Internet protocol (IP) to enable telephone calls, does not share those capabilities. There must be battery backups at every premise. Next-generation 911 services have not been fully defined and implemented. There is, therefore, resistance to enabling incumbent providers to migrate from legacy TDM-based systems to IP-based fiber or wireless replacements.

Cable providers are faced with aging infrastructure that was designed for one-way television transmission and has been retrofitted to provide modern, two-way Internet service. Provision of the latest technologies over existing infrastructure involves costly network upgrades that do not automatically upgrade the entire network. Some cable providers still have portions of their networks incapable of provision of broadband Internet access.

Future of Networks and Fiber Deployment

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[10] Organisation for Economic Co-Operation and Development (OECD). (June 2011). The future of the Internet economy: a statistical profile. [PDF] Retrieved from: http://www.oecd.org/internet/ieconomy/48255770.pdf

The National Telecommunications and Information Administration (NTIA) encourages future-proofing the networks by deploying more fiber. Future-proofing can bring extra capacity, and that offers advantages because data demand can only grow. Second, the marginal cost of installing extra fiber is minimal relative to deployment cost because fiber is upgraded by changing the electronics that create and receive the light pulses, not by replacing the cable itself. Third, extra capacity will be a cost-effective way to acquire bandwidth from providers through fiber swaps or trades, rather than having to pay cash or build new infrastructure. This extra capacity becomes a critical asset when investment partners can leverage new partners or can develop new business models to achieve the targeted objectives.[11]

Lessons from the History of Telecommunications Deployment

"Nothing is permanent but change!"
Heraclitus 4th Century BC[12]

Throughout the history of telecommunications—from telegraph (1860s) to landline telephones (early 1900s) to cable television (late (1940s) to satellite television (1979) to wireless phones (late 1990s) to the Internet (mid-1990s) via cable, microwave, and telephone lines to communications networks enabled by copper, wireless, fiber, and satellite (2000 to today)—the companies that provide these various technology networks have emerged, been acquired, and sometimes re-emerged as combined entities. They have done so through a repeated series of innovations and investments enabled by funding from the private marketplace, government, and industry and driven by the need for business and the military to operate in an increasingly global world.

Intertwined developments in two sectors, aviation and telecommunications, enabled the emergence of today's global economy, which has made distance less of an impediment to the near real-time movement of goods, services, and people around the world. The communications technology revolution was an essential development allowing airline companies to track fuel use and aircraft locations and to support the development of enhanced security systems employed in airports today.

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[11]Broadband Communities. (Fall 2013). What fiber broadband can do for your community. [PDF] Retrieved from: www.bbcmag.com/Primers/BBC_Aug13_Primer.pdf
[12] *Encyclopedia of Ancient Greece* Page 347. Retrieved from: https://books.google.com/books/about/Encyclopedia_of_Ancient_Greece.html?id=8pXhAQAAQBAJ

A History of Public and Private Support

Transformations often begin with radical innovations; the digital age that is transforming how we live, work, and interact has the creation of the Internet as its starting point. ARPANET, a division of the U.S. Department of Defense, created and nurtured the Internet to support better communications. Early use was restricted to university and government researchers until a more user-friendly platform for interacting with the Internet was developed in 1989 by Tim Berners-Lee, a computer scientist working at the European Organization for Nuclear Research (CERN) in Switzerland. With the subsequent development of a graphical browser (Mosaic) in 1993 by Marc Andreessen, followed by increasingly more user-friendly options by Netscape, Microsoft, and others, the use of the Internet and the World Wide Web exploded.[13]

Originally, the United States favored private-sector versus public provision of broadband networks. In the mid-1990s, the federal government privatized, and thus enabled, commercialization of the Internet backbone. It did so with the expectations that privatization would spark more innovations and result in faster and broader deployment of the Internet. The Clinton-Gore administration (1994) created the National Information Infrastructure Advisory Council and began to encourage the private and educational sectors to create more access to the network and to develop applications in education, health, government, intellectual property, security, and network operations that would catalyze demand.[14]

The U.S. Department of Commerce took advantage of the NTIA-created Technology Opportunities Program (TOP) to encourage the development of applications across the United States through the provision of grants to local and state government and educational entities. In the early 1990s, the Rural Utilities Service (RUS) of the U.S Department of Agriculture (USDA) initiated a modestly funded grants program for broadband.

The American Reinvestment and Recovery Act of the mid-2000s tangibly recognized the importance of broadband infrastructure with the allocation of $7 billion for broadband-related grants and loans through the NTIA's Broadband Technology Opportunities Program (BTOP) and State Broadband Data Development (SBDD) program and the USDA's Broadband Investment

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[13] Howe, W. (March 28, 2016). A brief history of the Internet. Retrieved from http://www.walthowe.com/navnet/history.html
[14] Pesner, J. (Dec. 5, 2013). We've seen this before: the National Information Infrastructure deconstructed. Retrieved from http://fedscoop.com/guest-column-national-information-infrastructure-deconstructed

Program (BIP). Concurrent development of the first National Broadband Plan by the FCC in 2010 provided guidance to strategic investments at the federal, state, and local levels.

Over time, existing programs have been amended and new ones established to take advantage of the Internet's capacity to support public purposes. In 1996, Congress passed an E-rate law, and in 1997, the FCC implemented the e-Rate program as a means of funding the wiring of schools for Internet. Since then, E-Rate has been expanded to provide funds to schools and libraries for Internet access and for infrastructure equipment and services.[15] The FCC has implemented other programs, including the HealthCare Connect Fund in 2012, to provide funding for high-capacity broadband networks to health care eligible entities.[16]

Dynamic change as it relates to telecommunications is not restricted to the public sector. The telecommunications industry can be fairly characterized as turbulent since the 1982 decision by Judge Joe Green to split the dominant Bell Telephone in to seven separate "Baby Bell" operating companies. Until 1984, the Bells operated independently, but soon thereafter, new companies emerged that combined some of the Bells with other companies. New company names emerged as partnerships formed and dissolved with increasing tempo: U.S. West was purchased by Quest, and then Century Link purchased Quest. Southwestern Bell began to purchase other Bell companies, and now Southwestern Bell has become AT&T. Bell Atlantic became Verizon. Verizon then sold off GTE landlines around the country to other providers (Frontier) and became a wireless company that also offered landline fiber (FIOS). AT&T is following a similar path as it increasingly concentrates on deploying fiber in its more urban districts and wireless overall. Google has begun to develop Google fiber networks in more populated areas. To successfully service their customers, some of these new entrants are wireless companies that ultimately will have to purchase access to other companies' towers or construct their own towers.

In contrast to the global spread of leading-edge communications technologies, too many rural and urban populations have not been able to have ubiquitous access to the Internet. As online applications deliver more and more critical resources, products, and services from education, health care, agriculture, commerce, and government, the Appalachian Region needs

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[15] Federal Communications Commission. (n.d.). FAQs on E-Rate program for schools and libraries. Retrieved from https://www.fcc.gov/consumers/guides/universal-service-program-schools-and-libraries-e-rate

[16] Federal Communications Commission. (March 2013) Healthcare Connect Fund – frequently asked questions. Retrieved from https://www.fcc.gov/general/healthcare-connect-fund-frequently-asked-questions

its citizens to have access to the highest possible network bandwidth speeds at their homes, workplaces, and public spaces. There are major lessons to be learned from the history of technology and expansion of other infrastructures. High-speed Internet access must be available to all citizens in all areas of the country if these regions are to remain competitive and sustainable. Lacking ubiquitous access to high-quality, high-speed broadband Internet, ARC communities cannot be full players in today's economy.

There are relevant lessons in the development of other forms of infrastructure. Historically, the same economics that challenge expansion of broadband connectivity delayed the delivery of electricity and telephone service to topographically challenged and low-population-density areas. The creation of rural electric and rural telephone cooperatives, with grant and loan funding from the federal government, emerged as a mechanism to bring critical infrastructure to underserved areas. Broadband funding from the American Recovery and Reinvestment Act of 2009 (ARRA), provided in the form of loans and/or grants to utility cooperatives, has successfully applied the cooperative model in the broadband arena with expansion of infrastructure by utility cooperatives into previously unserved and underserved communities, many of them in Appalachia. Other ARRA funding initiatives included creation of a broadband mobility fund[17] to address gaps in mobile service and to undergird middle-mile-transit support where there were higher costs for wireless deployment. Adoption challenges resulting from affordability, digital literacy, and relevance issues among low-income households and non- and low-adopter communities were the focus of other ARRA broadband initiatives.

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[17] Levin, B. (October 2, 2010). Universal broadband: targeting investments to deliver broadband services to all Americans. [PDF]. Retrieved from: http://www.aspeninstitute.org/publications/universal-broadband-targeting-investments-deliver-broadband-services-all-americans

Chapter 2: The Context of Broadband in Appalachia

Infrastructure

Broadband maps included in this toolkit show Federal Communications Commission (FCC) Form 477 data collected from telecommunications providers. These data are collected at the census block level and inherently overstate coverage as a result. A single customer served within a census block marks that block as served. While not accurate at the address level, these data are useful for highlighting census blocks that are entirely unserved for any given technology type, as well as illustrating the disparity between technology footprints relative to one another. These maps are for estimation purposes only. Additional, citizen-sourced data are recommended to complement this information.

Wireless

Wireless as an Overlay to Fiber
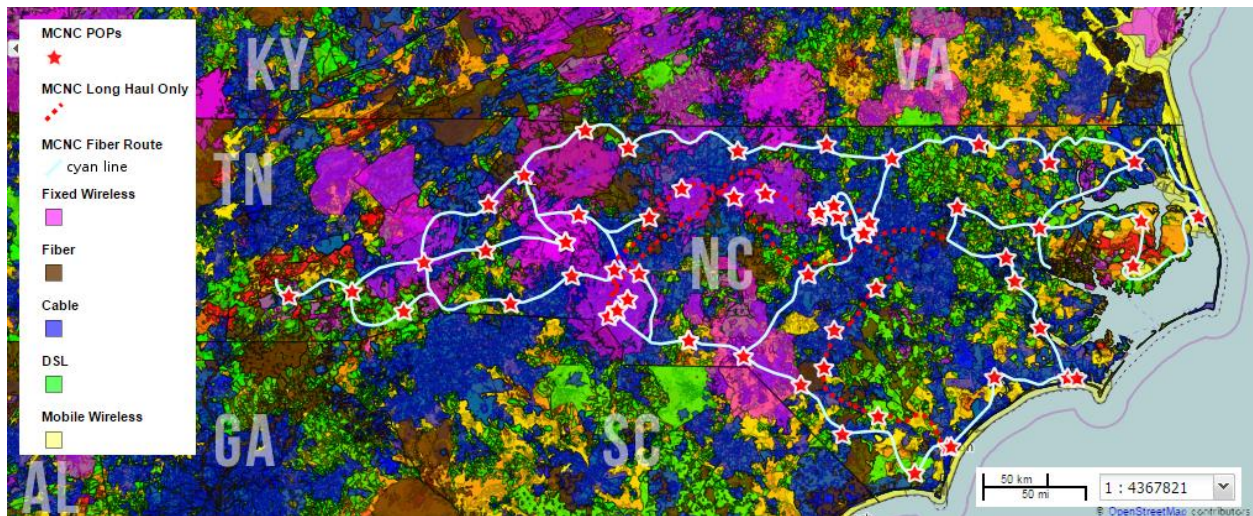
Map Source: Broadband Catalysts – Visualization of FCC Form 477 Data. Fixed June 30th 2015. Mobile December 14th 2014. MCNC fiber routes provided by MCNC. Base map provided by OpenStreetMap

In an increasingly wireless and mobile world, it is easy to forget that almost all wireless communication travels via wireless for as short a distance as possible. The greater the distance between the end user and wire-line connectivity, the slower and less reliable the service will be. Therefore, the most robust, accessible, and available wireless network is one built directly on top of a robust wire-line infrastructure.

While many providers still utilize copper facilities to feed wireless deployments, the future lies in fiber-optic-fed wireless deployments. The more wide-reaching the fiber network, the smaller and closer together the wireless transmitters can be. This makes for more efficient

use of radio spectrum, which is a finite resource. By making cells smaller and reusing frequencies in non-adjacent cells, we can make far greater use of the available spectrum.

In addition to providing voice and data for mobile end users, a robust wireless network will provide alternate routes for existing wire-line routes for additional capacity and redundancy.

Geosynchronous Satellite

The current satellite Internet access commercially available consists of geosynchronous satellites, which remain stationary in the sky in relation to Earth. In order to maintain this synchronous orbit, the satellites must be located approximately 22,000 miles from earth. This distance introduces satellite Internet's most well-known characteristic, and that is latency. Even under the best conditions, it takes data more than 250 milliseconds to make the round trip between the satellite and Earth. In practice, this number can grow much higher, especially as satellites are oversold. Since these are very expensive pieces of equipment to create, launch, and fly, and there are only so many of them in space, the more users a provider can have subscribed off a single satellite, the more profitable that asset becomes. For this and several other reasons, newer satellites often offer better service than those with large user bases.

Newer satellites also can offer greater speeds than their predecessors, but that speed often comes at a price. Like mobile wireless Internet service providers, satellite providers place a premium on usage. Data caps as low as 10 gigabytes of transfer a month can cost as high as $15 per gigabyte of transfer and are factors that relegate geosynchronous-satellite-based Internet access service as a last resort. In some areas of Appalachia, this is currently the only option for broadband.

Low Earth Orbit Satellite

While it has been proven that flying a constellation of high-speed, low-Earth-orbit satellites can provide Internet service without the inherent latency, there is no affordable commercial service available to consumers at the time of this writing. The cost of flying dozens of satellites will likely keep this technology out of reach for some time.

Licensed Versus Unlicensed Wireless
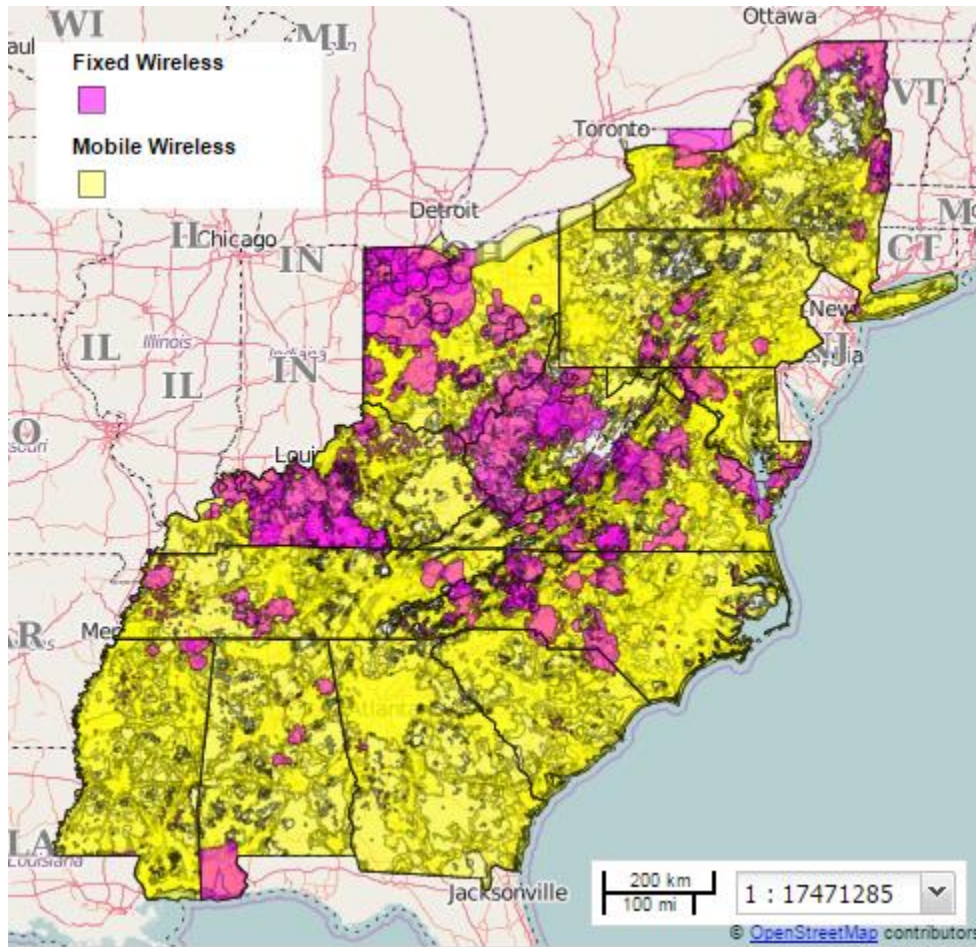
Map Source: Broadband Catalysts – Visualization of FCC Form 477 Data. Fixed June 30th 2015. Mobile December 14th 2014.
Base map provided by OpenStreetMap

Wireless spectrum is a finite resource that is very carefully regulated and allocated. Every wireless device is communicating on specific sets of frequencies, some of which are licensed, others that are unlicensed, and yet others that are pseudo-licensed.

A smart phone is a good example of a device that uses both licensed and unlicensed spectrum. When someone makes a regular cellphone call on a smart phone, the phone uses licensed frequencies that the cellphone provider paid for exclusive use costing as much as a billion dollars or more. This is part of the reason one provider's service will work better in any given area than will another provider's service. If a user connects a smart phone to Wi-Fi, then the phone is using unlicensed spectrum, which is freely available for everyone to use, but there is nothing preventing someone else's Wi-Fi connection from using those same frequencies and potentially degrading performance for nearby Wi-Fi users.

The frequencies used by Wi-Fi are not the only ones available as unlicensed spectrum,

and Fixed Wireless Internet Service Providers (WISPs) are an entire industry that uses mostly unlicensed spectrum. WISPs often use the same frequencies used by Wi-Fi, as well as other unlicensed frequencies like 900 MHz, to provide Internet access. There are rules in place that prevent providers from using very high output power in order to prevent any single provider from drowning out everyone else trying to use a public resource. Because of this, WISPs often struggle to penetrate thick foliage, though they have the advantage of a larger, higher power at the customer level than mobile wireless providers.

Mobile wireless providers are well-positioned to move into fixed wireless service, and some already have in certain markets. By having a higher-powered and static antenna at the customer's premises, mobile wireless providers will be able to provision even greater levels of service, even to customers in more remote areas.

Since unlicensed spectrum is a public resource, it can quickly become over crowded. The 900 MHz unlicensed frequencies are an example of spectrum that was widely used in consumer electronics and which experienced a high level of interference from other devices. In order to protect certain spectrum from this, the concept of managed unlicensed or pseudo-licensed spectrum arose. In this case, frequencies are available on a first-come, first-served basis for a specific geographic area. If someone is the first customer to establish a connection covering a specific area, no one else would be given permission to establish a transmitter that would interfere with that existing connection. This concept has been taken one step further with the implementation of automatic unlicensed frequency management used in TV Whitespace equipment. With each device enabled with GPS, TV Whitespace transmitters are allocated frequencies automatically after looking up their location in a third-party database that maintains and allocates available frequencies on demand. While this technology has yet to be perfected, it is a pathway toward more efficient unlicensed frequency use and reuse.

Wireline
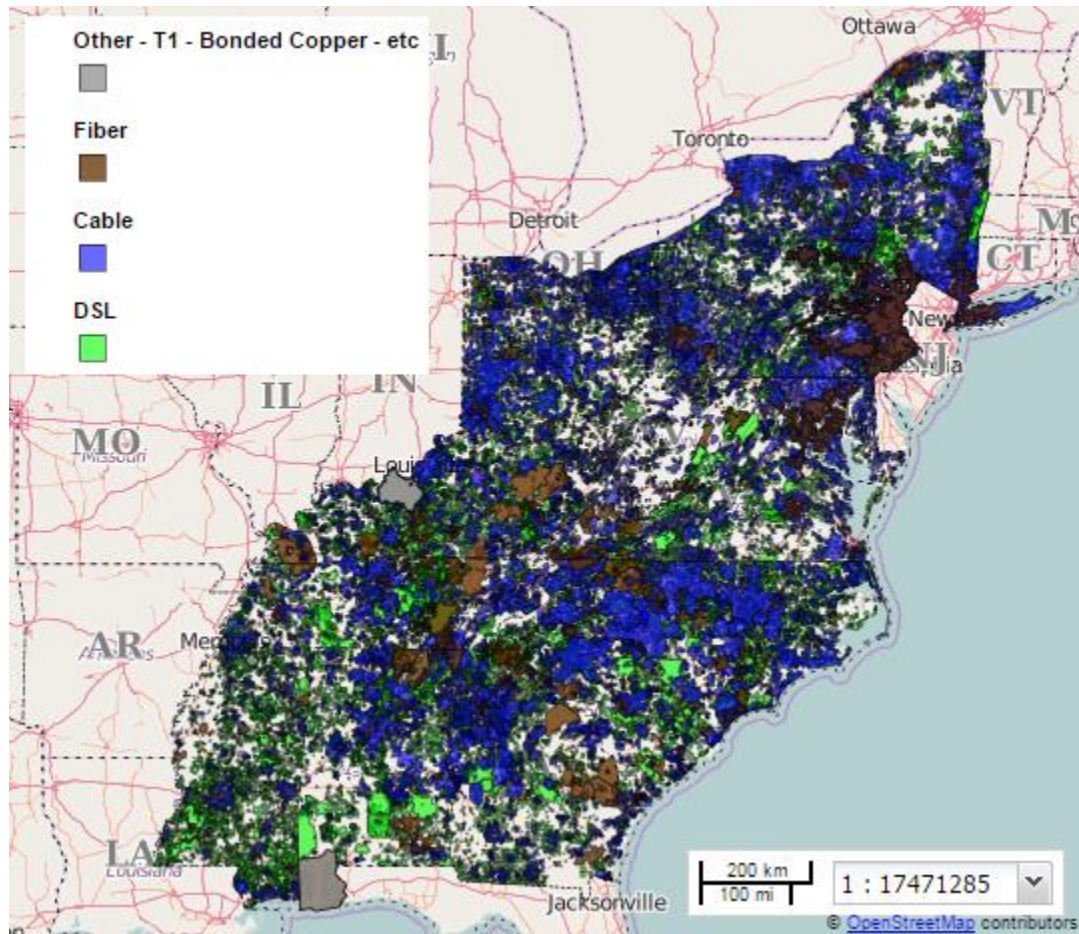
Map Source: Broadband Catalysts – Visualization of FCC Form 477 Data. Fixed June 30th 2015. Mobile December 14th 2014. Base map provided by OpenStreetMap

The State of Copper Infrastructure

Although copper communications infrastructure in the United States may at first seem ubiquitous, the state and nature of that infrastructure varies wildly from location to location. There is a natural tendency for the copper infrastructure in rural areas to be less robust on a per-household basis for many of the same reasons that broadband Internet access is not more readily available in those same areas: profitability. Had the nation left telephone infrastructure expansion purely in the control of private industry, the infrastructure would reach only into areas where a return could be generated on the investment. In an age where Wall Street investors demand a return on investment within two years, many areas are left out in the cold with regards to broadband and would have been similarly without landline telephone service had the nation not

decided the infrastructure was critical to all citizens.

Even today, as communications carriers move away from copper-based Time Division Multiplexing (TDM) equipment to modern fiber and Transmission Control Protocol/Internet Protocol-based systems (TCP/IP), there are concerns regarding basic levels of service provided by the nation's critical copper infrastructure. Emergency communications such as next generation NG-911 have yet to become fully adopted and accepted. The FCC offers an excellent discussion of migration from our copper infrastructure.[18]

The copper infrastructure will continue to play a role in delivering broadband Internet for the foreseeable future. The shorter the distance over which copper connectivity is used will impact the speed and quality of the connections. AT&T's U-Verse product, for example, uses multiple pairs of copper over a short distance from the house to the central office or remote; after that, the communications travel on fiber optics. Digital Subscriber Line or Loop, (DSL) subscribers can traverse two and a half miles or more on copper before terminating at a central office or remote. In locations where fiber is absent, copper facilities can be used to provide T1 backhaul, which means copper is used to get all the way back to the central office.

In areas where DSL service is not available, a number of factors can conspire to make the infrastructure inappropriate or insufficient to support new deployments. In some areas where homes are more than two and half miles or so from the central office or are remote, the distances are simply too great for DSL to be deployed. While DSL can potentially traverse copper for 15,000 feet, the quality and thickness of that copper often restricts providers to serving homes within 10,000 feet of their facilities. There are also instances in which copper has been overleveraged or shared between multiple customers using things like multiplexers, which can use a single pair of copper to carry multiple voice signals. The very measures that once allowed for economical deployment of voice service now stand in the way of deploying DSL service. This leaves some rural providers in the unenviable position of deploying new copper into rural areas.

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[18] Intergovernmental Advisory Committee to the FCC. (2013). Policy recommendation 2013-3: regarding technological transition from legacy copper wire infrastructure to new technologies. [PDF] Retrieved from: https://transition.fcc.gov/statelocal/recommendation2013-03.pdf

Cable Infrastructure

Cable television service has proliferated in areas where household density is in excess of 10-15 households per mile. There are areas where the cable infrastructure penetrates areas of lower population density, but they often involve special circumstances and/or subsidy. The reasons for this are similar to the reasons preventing broadband expansion into rural areas in general. When the cost of deploying the infrastructure exceeds what can be recouped off of that infrastructure within two or three years, deployment stops.

Many people in rural areas are disconnected from the cable infrastructure even though the cable infrastructure passes their residence. Many farms and homes in rural areas are hundreds if not thousands of feet from the roadway, and the cost of bringing the cable up their driveways is in the thousands of dollars, which often prevents them from becoming customers.

While the coaxial cable used to deploy cable television is relatively easy to spot on telephone poles, the presence of coaxial cable does not guarantee the availability of cable Internet service. Existing one-way cable networks must be upgraded for two-way communication and kept current with the latest Data Over Cable Service Interface Specification (DOCSIS) revisions and hardware in order to provide the fastest speeds.

As with copper networks, the closer the fiber is to the end user, the better connectivity tends to be. Cable network owners are deploying large amount of fiber-optic cable alongside and in addition to their existing coaxial-cable footprints. Cable operators can continue to use that very expensive resource, which is coaxial cable running to many existing structures, and provide blazing fast speeds by pulling fiber into each neighborhood. Cable operators are well-positioned for incremental upgrades to their networks that may, in the end, provide end-to-end, fiber-optic connectivity.

In the past, fiber optics have been the backbone of our communications infrastructure, providing high-capacity, low-latency backhaul for our existing copper, coaxial, and wireless networks. As the demand for higher speeds to the end user increase, the fiber infrastructure will need to move ever closer to the end user. The end game for the foreseeable future of fiber deployment is connecting all residences and structures directly to the fiber infrastructure, as well as providing fiber access directly to all cell towers and transmission points, which will facilitate ubiquitous access to high-speed wireless communications for voice, data, and public safety purposes.

The Future of Fiber Deployment
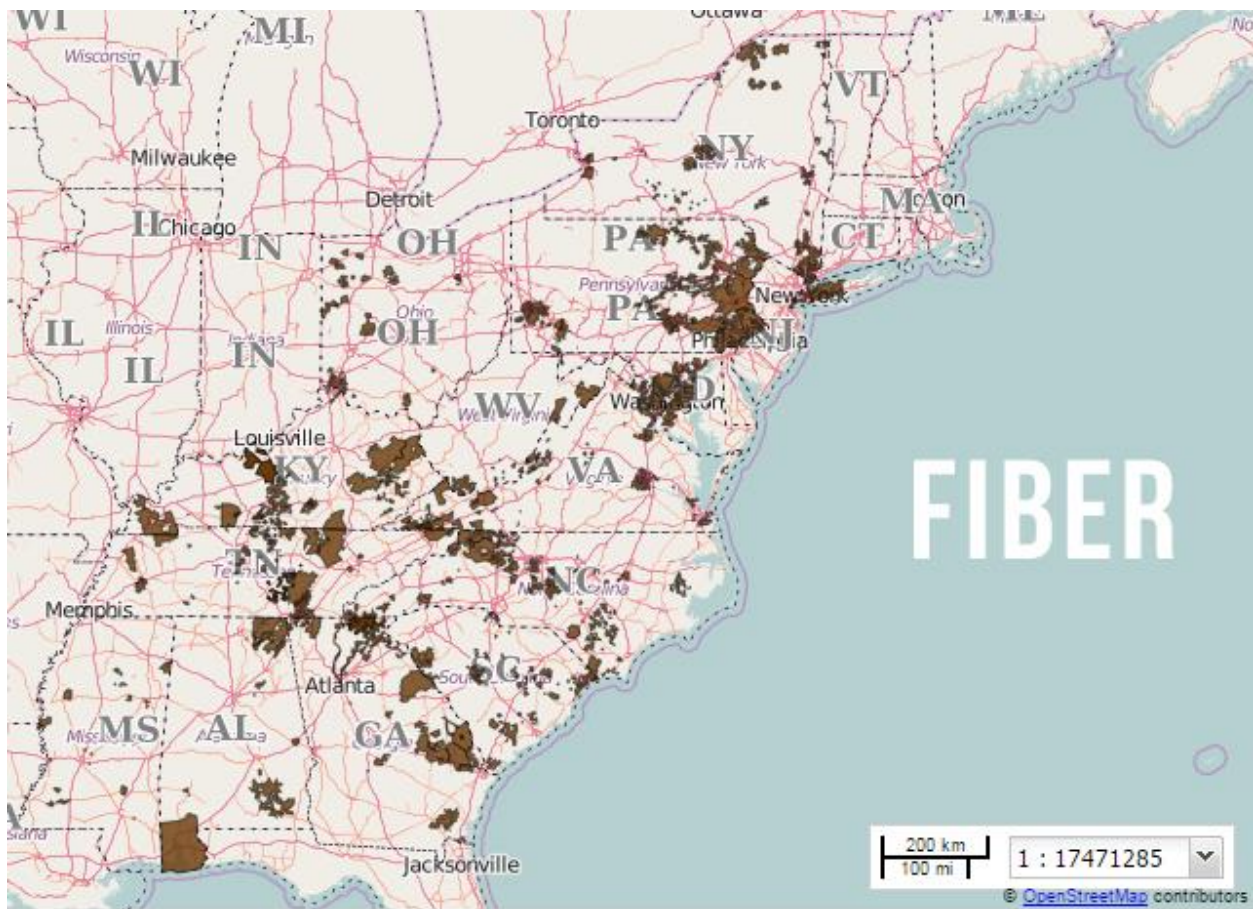
Map Source: Broadband Catalysts – Visualization of FCC Form 477 Data. Fixed June 30th 2015. Mobile December 14th 2014.
Base map provided by OpenStreetMap

The NTIA encourages the deployment of excess capacity to future-proof networks. A network built with extra capacity offers many advantages. First, it "future-proofs" the network against a data demand that will very likely continue to grow. Second, in the case of a fiber network, the marginal cost of installing extra fiber is minimal relative to the deployment cost. Third, the extra capacity can serve as a cost-effective way to acquire bandwidth from providers through fiber swaps or trades, for example, rather than having to pay cash or build new infrastructure. Finally, extra capacity becomes a critical asset that the investment partners can leverage to attract new partners or to develop new business models if the original model fails to achieve the targeted objectives.

Terrain and Environmental Challenges

Terrain and the environment play key roles in determining the cost and efficacy of deploying infrastructure in different areas. This issue is especially acute in the ARC region, where mountains, waterways, parks, and reserves all present barriers to broadband deployment. Boring through rocky areas can be impossible and make blasting a necessity just to deploy telephone poles, and mountain peaks block wireless signal better than just about anything else. At the same time, mountaintops that happen to have power and fiber optics can make excellent places from which to transmit wireless Internet.

Living in Appalachia's flatlands or even rolling hills is not without challenges. In many places that are flat, the only things that poke above the tree line tend to be very expensive towers. In this case, it is expensive for providers to locate there, and they still have to manage to punch through trees surrounding most residences, which dramatically reduces the range of their transmitters and the speeds they can provide.

While coastal challenges do not usually impact broadband efforts in ARC counties (unless they are part of a regional or state-wide broadband-enhancement effort), there may be lessons to learn from their deployment projects. Deployment costs escalate in coastal areas due to the cost of traversing bridges waterways, and estuaries, as well as low population densities dispersed around wetland areas and the threat of hurricane-force winds and flooding that often restricts the number of towers permitted. Point-to-point wireless transmitters can bridge the gaps between areas where the cost to deploy fiber is simply too high, but even those measures can prove expensive and problematic.

Beauty comes at a price: it is exactly the case that many of the features making Appalachia so breathtakingly gorgeous make broadband deployment cost-prohibitive. Trees, mountains, rivers, estuaries, and wildlife preservations abound in Appalachian communities, but every one of these things increases the cost of deploying infrastructure. Areas cut off from nearby metropolitan areas by mountain ranges or rivers are far more unlikely to have access to robust broadband because the cost of traversing bridges, waterways, mountain peaks, and even just lining mountain roads with telephone poles is so much higher. In these same areas, homes and businesses tend to be more widely dispersed and are often farther from the main transportation arteries. Combined, these factors can raise the deployment cost beyond the range

permitted by the capital-expenditure models typifying the two-year payback goals of for-profit Internet providers; the business case is not there.

When evaluating options for broadband expansion in a community, terrain and environmental issues are among the most important to understand. When trying to deploy service in areas where these challenges appear insurmountable, look toward the infrastructure used to bring electricity to the area and see if there aren't existing facilities that might be used to bridge costly gaps. The State of Maine may provide guidance on policies that support broadband deployment in geographically-challenged locations—for example, through dig-once policies that mandate installation of conduit on all bridge-construction projects.

Demographics

Successful broadband planning efforts build on a thorough understanding of a community's demographic profile to tailor adoption programs that are specific to the needs, interests, and stage of digital capacity of its constituent population. Just as the best infrastructure choices are strongly influenced by the physical landscape, efforts to boost adoption and utilization need to reflect the needs, wants, and digital preparedness of the plan's targeted constituency.

The Pew Research Center has tracked the evolution of the broadband economy and its adoption for decades, providing an excellent source of current and historical information on how the Internet is being used, as well as who does not use it and why.[19] Recent studies examining progress over 50 years in the ARC Region and, more specifically, the outcomes of broadband and technology investments between 2004 -2010 provide additional insights that can inform many aspects of a planning effort.[20]

Internet use is positively correlated with youth, higher incomes, educational attainment, and population density. Appalachia as a region does not resemble this profile, and therein lies much of the explanation for the relatively slow progress made in expanding broadband availability and uptake. While there may be significant variability among its counties, relative to the country overall, the ARC Region is:

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[19] Pew Research Center. Internet & Tech. See: http://www.pewinternet.org/
[20] Appalachian Regional Commission. (November 2015). Program evaluation of the Appalachian Regional Commission telecommunications technology projects FY2004-FY 2010. Retrieved from http://www.arc.gov/research/researchreportdetails.asp?REPORT_ID=120

Rural

The ARC Region is heavily rural, with 42 percent of the population living in non-metro communities compared with 20 percent for the United States overall. Low population density and especially onerous terrain and environmental challenges are real barriers to conventional broadband deployment efforts. One of the greatest benefits broadband brings to Appalachia is the capacity to overcome the physical, economic, and cultural isolation that has limited the prospects of its residents and businesses. It is vital that a planning group be open to creative ideas and collaborations.

Growing More Slowly

Population in the United States increased 9.7 percent over 2000-2010, compared with 6.8 percent for the ARC Region, which has current levels of just over 25 million people scattered across 13 states, 420 counties, and more than 200,000 square miles. Distressed counties barely held steady, with growth rates of only 0.3 percent. Between 2000 and 2010, Appalachia's 6.6 percent growth rate was only half of the 13 percent increase for the United States overall.

Youth Are Exiting

Since 1993 the Appalachian Region has experience a pronounced and steady decline in the population share that is under 20 years of age. At 25 percent, the share held by this age group has declined 30 percentage points in the last 50 years. In the context of broadband, this means the region is in short supply of the "digital native" cohort whose life has been permeated at many levels with the Internet.

Appalachia Is Older

Exceeding the national trend, more than 15 percent of the population in Appalachia in 2010 was older than 65 years of age, compared with 13 percent of the United States' population.[21] The planning consequence needs extra efforts to engage older citizens in the

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[21] The United States Census Bureau, See: Quick facts http://www.census.gov/quickfacts/table/PST045215/00

planning and implementation process and to seek out best- practice adoption- and awareness-building programs targeting this older age group—for example, by co-locating public access facilities in senior centers and by tailoring digital literacy classes.

Educational Attainment

High educational attainment raises productivity, increases lifetime earning capacity, reduces poverty risk, and is highly correlated with a variety of measures of well-being. A region's educational attainment rate is one of the best long-term predictors of economic growth. The proportion of adults age 25 or over in Appalachia with a college degree is about three-quarters the national average, and the gap is widening. This phenomenon is partly due to college-educated young adults not returning to or settling in the Region, and partly due to a lower college-going rate among high-school graduates in Appalachia. The relatively lower educational attainment in the ARC Region challenges efforts to expand broadband adoption and use. While exhibiting near parity at the high-school graduation level (85.1% ARC–versus 86.0% U.S.), the proportion of Appalachian citizens with at least a Bachelor's degree trails the national average by more than seven percentage points (22.3% ARC-versus-29.3% U.S.).[22] Broadband can be an extraordinarily powerful tool to deliver innovative content and support educational opportunities in the community at every level. It is important that creative educational leaders are active in all aspects of broadband planning.

Personal Economics

The ARC Region underperforms the national average on three important metrics of personal economics: poverty, income, and unemployment. The numbers vary within the Region, but the pattern overall is the same; in 2010, the ARC's poverty rate of 17.2 percent was 110.2 percent of the national average; per-capita income in ARC was 80.9 percent, down from 81.7% in 2000; and unemployment of 6.5 percent was 105.3 percent of the national average. Broadband can deliver training and skills development, support home-based and heritage enterprises, and expand the market access for local businesses, so it is imperative to include representatives from

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[22] The Appalachian Regional Commission (April 2016) "The Appalachian Region: A Data Overview from the 2010-2014 American Community Survey". Retrieved from: Chartbook http://www.arc.gov/assets/research_reports/DataOverviewfrom2010to2014ACS.pdf

the local Chambers of Commerce, workforce development agencies, social services, and small business assistance programs in broadband planning and outreach efforts.

Health Care

Despite progress on many fronts, health challenges continue to plague too many citizens in Appalachia. Documented negative disparities in overall health, incidence of chronic conditions, mental health problems, and substance abuse stress a care-delivery system that is inadequate to the task.[23] The result is 19 percent greater loss of years to preventable causes and mortality rates that are rising even as they decline across the nation (1,018 deaths per 100,000 in Appalachia versus an average of 800 deaths per 100,000 overall). Similarly, the proportion of Appalachians age 21 to 64 with a disability was 21.3 percent in 2000, compared with 19.2 percent for the nation as a whole. Telemedicine offers enormous opportunities to improve access to high-quality care throughout the region in a cost-effective manner. Specialized funding opportunities targeting expansion and maintenance of telehealth infrastructure make this area a strong target for leveraging support for a broadband plan overall. Representatives from the health care community should be engaged early on in the planning process.

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[23] U.S. Food and Drug Administration and the Cecil G. Sheps Center for Health Services Research at the University of North Carolina at Chapel Hill. (July 2012). Health care cost and access disparities in Appalachia. [PDF] Retrieved from: http://www.arc.gov/assets/research_reports/healthcarecostsandaccessdisparitiesinappalachia.pdf
Demographic statistics retrieved from ARC http://www.arc.gov/reports/custom_report.asp?REPORT_ID=61

Chapter 3: Stories from Appalachia

Overview

Across Appalachia, efforts have been underway to resolve broadband availability, affordability, and quality of service issues. The stories below, as well as vignettes spread throughout the document, serve to illustrate how communities access quality Internet connectivity.

Economic Development and Cultural Heritage: Appalachian Quilt Trail and Broadband Keeps Tourism in Rustic Appalachia Thriving

Appalachia is a region rich in cultural heritage, but its gems are usually found off the four-lane highways that route visitors to large tourism attractions. Barn quilts honor rural areas' agricultural and cultural heritage by recreating unique quilt squares on the sides of barns and other community landmarks. First appearing in Ohio, barn quilts are now found on more than 3,000 barns in 29 states. The patterns are colorful reproductions of unique patterns that have been passed down in families for generations and are often seen as family crests. With the assistance of broadband technology, driving tours of barn quilts are being used to encourage rural economic development and celebrate local heritage.

On an interactive website (https://www.tnvacation.com/vendors/appalachian_quilt_trail) and using social media, the Appalachian Development Council in Rutledge Tennessee promotes the Appalachian Quilt Trail that extends over 19 counties of eastern Tennessee. The Trail is made up of a series of tourable loops and trails that direct traffic to local points of interest—all marked by large, hand-painted quilt squares. An interactive, GIS-enabled map highlights barn locations, as well as other points of interest and tourist services. Visitors to the site have an enhanced online experience with new features to make their vacation planning much easier. Interactive pages contain detailed information about trail stops, places to stay and eat and more. Printable itinerary maps and a "Plan Your Trip" feature allow visitors to save and remove points on the itinerary, calculate the shortest route between two points, and get directions to designated points. Custom-made composite terrain and street maps list all major and local roads that are relevant to the quilt trails. An online marketplace features local handmade products, including barn-quilt memorabilia. This type of detail is only made possible by broadband technology. The ARC provided early funding for this project. It represents the marriage of technology and rich traditional crafts to promote sustainable development in rural Appalachia.

Rutherford and Polk, North Carolina
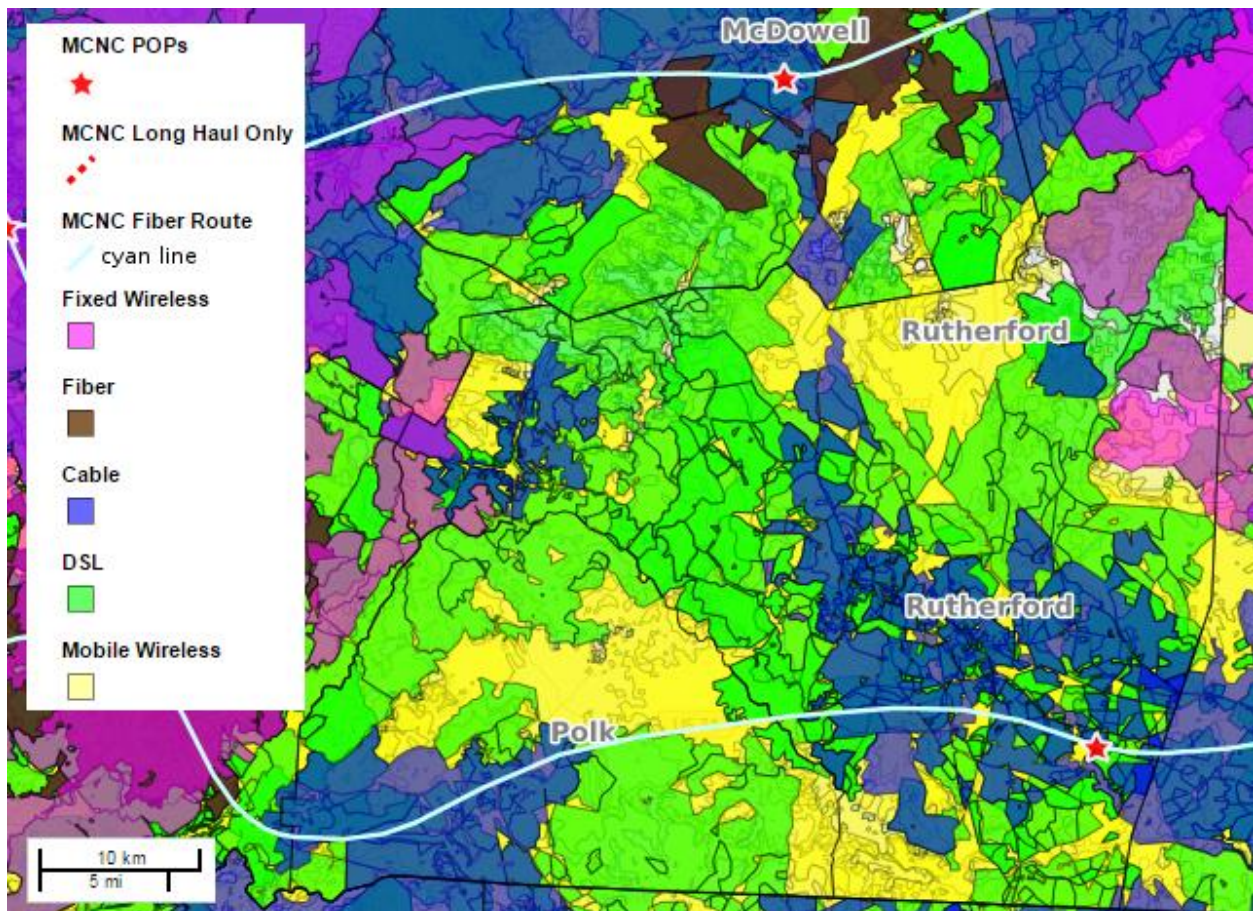
Map Source: Broadband Catalysts – Visualization of FCC Form 477 Data. Fixed June 30th 2015. Mobile December 14th 2014. Base map provided by OpenStreetMap

Rutherford County is located in southwestern North Carolina on the South Carolina border. It is economically diverse. Scenic Lake Lure and Chimney Rock are recreational areas that lie to the west and are strong tourism and retirement community magnets. Agriculture dominates in the northeast; the central and southeastern parts are more industrialized. Manufacturing employment is half of what it was in 2000.

In June 2015, Rutherford had the ninth highest unemployment rate among North Carolina's 100 counties. Rutherford had seen textile and furniture manufacturing decline and its tobacco production fade over the prior years.

Rutherford County is working to make a transition from a manufacturing-dependent economy to an information-enabled economy. Rutherford County is partnering in a collaborative way with adjacent Polk County through e-Polk (www.e-polk.org), a nonprofit Center for Regional Competitiveness, and its PANGEA network (http://www.pangaea.us/) to bring the

world of the Internet to Rutherford and Polk Counties. They believe this will make a major difference for their county's economic future.

Along with an operational grant from the Z Smith Reynolds Foundation, the e-NC Authority, formerly the Rural Internet Access Authority, aided the e-Polk nonprofit and Polk and Rutherford counties with funds to create PANGAEA. This network was charged with 'affordable, reliable connectivity and services for the region" to enhance economic development and create a broadband platform of innovation enabling underserved areas. Starting with 7 miles of fiber and now reaching more than 200 miles of fiber plus, PANGAEA has grown its network.

In 2007, Rutherford County matched an ARC (www.arc.gov) grant of $178,920 with $76,680 to augment an existing multiphase, fiber network project to enhance broadband Internet availability to schools and public safety centers. The Golden Leaf Foundation, a tobacco buy-out foundation, provided the bulk of the funds for the existing network while ARC funds piggybacked on the fiber network to establish the wireless redundancy that is required for secure public safety applications. A wireless network was developed, with the primary benefit supporting emergency 911 responders, police, and fire fighters. This network utilized the PANGAEA network services.

This is an example of a public, nonprofit partnership of a county government, a state authority, a federal agency, two foundations, and a nonprofit network (PANGAEA) working together to enable the development of an infrastructure broadband highway to serve the region. There are other infrastructure networks, such as a private cable company and private infrastructure network operators, who covered portions of the two counties. These networks have enabled Facebook to move a major center to Rutherford County, and a massive new Horse Equestrian Center has been created here. Progress for the two counties toward a more prosperous economic future is being made in Rutherford and Polk Counties as a result of collaborative efforts to build a strong infrastructure network.[24]

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[24] Pangaea Network was created by e-Polk. The network, known as PANGAEA (http://www.pangaea.us/), offers traditional Internet bandwidth (unlimited speeds) that serves education, health care, government, commercial, wholesale to residential Internet Service Providers, and a wide-area, fiber-optic network, (e.g., school, medical, legal networks). The Rural Internet Access Authority, a state authority at the time, now superseded by the NC Broadband, provided the funds for PANGAEA. RIAA received its initial funding from MCNC (http://www.ncren.org), a nonprofit information technology entity in the Research Triangle Park.

Allegany County, Maryland

Broadband for Education and Distance Learning: Public School Smart Board
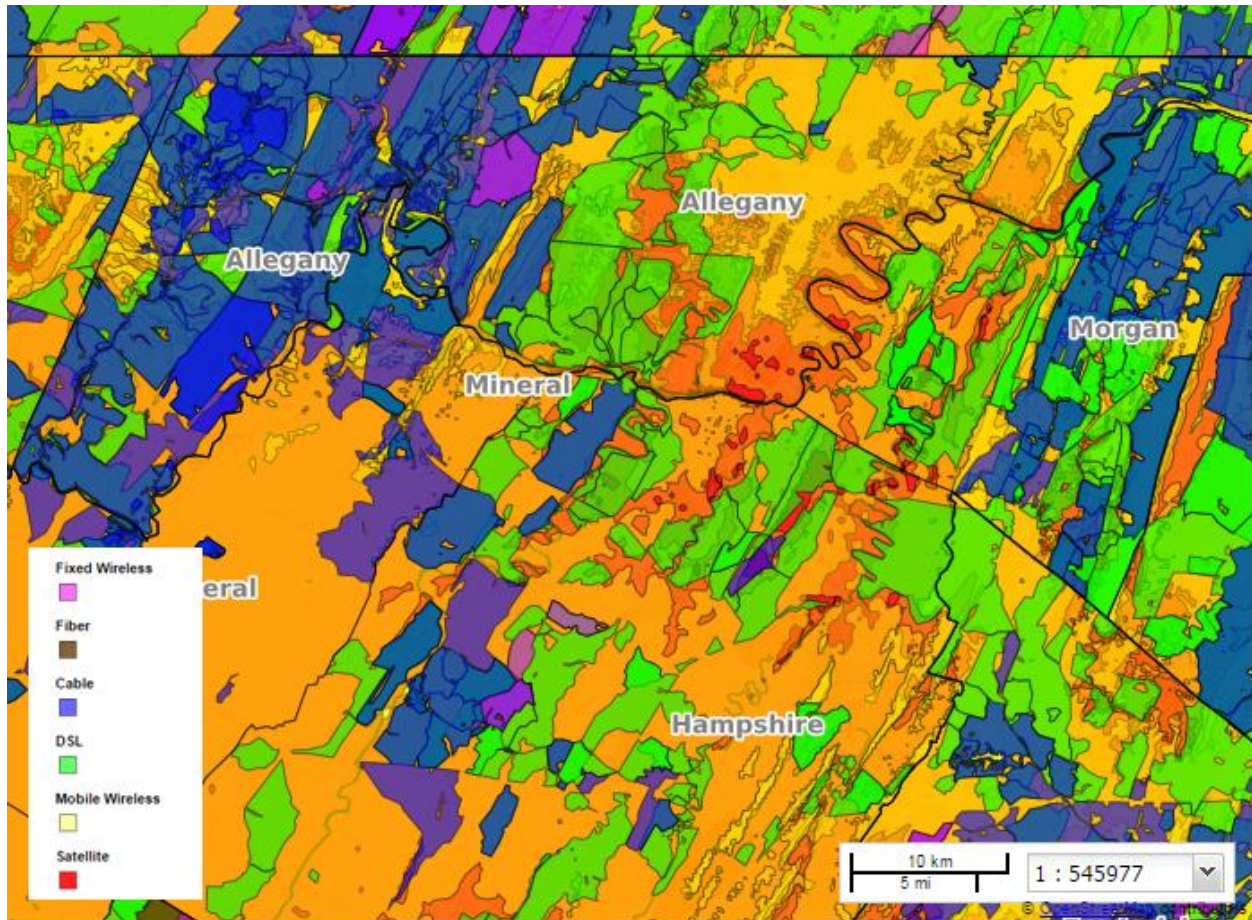
Allegany County's economy is in transition, with high unemployment and low median income.[25] The employment focus needed to shift to a workforce that would be capable of supporting the targeted small manufacturing, sustainable energy, information technology, and tourism economies. An investment in education had to be made to prepare workers for skilled jobs. Educational attainment at the high-school level was comparable to state and national averages; however, there was a lower rate of college graduates. A goal was set to increase by 20

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[25] Appalachian Regional Commission. (November 2015). Program evaluation of the Appalachian Regional Commission's telecommunications and technology projects: FY 2004–FY 2010. Retrieved from http://www.arc.gov/assets/research_reports/ProgramEvaluationofARCTelecommunicationsandTechnologyProjectsFY2004-2010.pdf chapter 7-26

percent the number of students who would receive a passing score on the Maryland State Assessment for Algebra/Data Analysis.

The Board of Education decided to purchase 200 Smart Boards for 20 classrooms to support instruction in science and technology, beginning with Algebra I. A grant from ARC provided 50 percent of the project funding, with the remainder from Allegany County. Lead teachers were selected and trained before placing Smart Boards in classrooms; they then trained other teachers.

> • *Teachers used connected Smart Boards to tailor educational materials to student needs.*
> • *Students were more engaged with the digital presentations and could obtain small-group or independent work on topics teachers gave them.*
> • *Smart Board enabled real-time monitoring of students to assess students more easily using multiple-choice tests on presented materials.*

This model used good research design and evaluation to document impact and a pilot project to engage trainers, teachers, and students. Leadership from an organized and knowledgeable Chief Information Officer (CIO) was important to the effort's success. The CIO was active in enabling access, deployment, and adoption for the entire project. The use of Smart Boards with trained teachers and use of a train-the-trainer model built the necessary internal champions and mentors who created this successful project.[26]

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[26] Appalachian Regional Commission. (November 2015). Program Evaluation of the Appalachian Regional Commission's telecommunications and technology projects: FY 2004–FY 2010. [PDF} Retrieved from http://www.arc.gov/assets/research_reports/ProgramEvaluationofARCTelecommunicationsandTechnologyProjectsFY2004-2010.pdf

Garrett County, Maryland

Public-Private Partnerships for Innovation: Wireless White Space
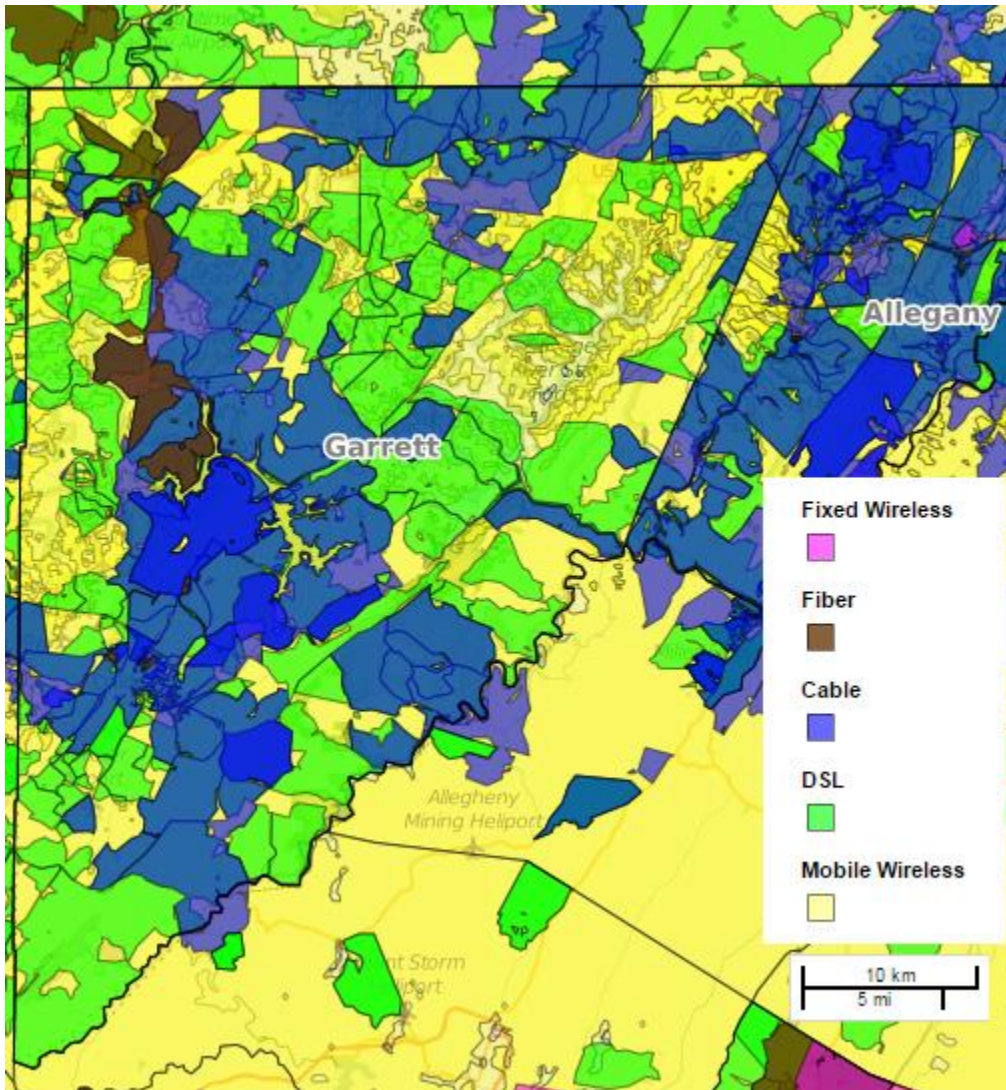
Map Source: Broadband Catalysts – Visualization of FCC Form 477 Data. Fixed June 30th 2015. Mobile December 14th 2014. Base map provided by OpenStreetMap

Garrett County government, working with a broadband planning consultant and a service provider and utilizing an innovative technology, is working to bring high-speed broadband to a mountainous and heavily forested region. Garrett County, Maryland and Declaration Networks Group (DNG) were joined by CTC Technology/Energy, which developed the county's Broadband Feasibility Study and Implementation Plan. CTC supported Garrett County in the development of a multi-year technology plan and then assisted in working to see development of a long-term public-private partnership contract with DNG. DNG is to leverage existing fiber

networks and unlicensed spectrum by the FCC (TV white-space frequencies) to support the use of high-quality broadband services. The planning process that began in 2012 led to a three-year grant from ARC in 2015 that will bring broadband Internet access to previously unserved communities in Garret County. The network is expected to provide a positive impact on the unserved and underserved regions of Garrett County and to be a very effective model to stimulate broadband investment.[27]

The innovative approach of using TV white-space spectrum offers promise for addressing challenges posed by mountainous terrains and areas of heavy foliage that thwart conventional network signals. By leveraging existing middle-mile fiber assets, along with community-owned assets and sites, a fixed wireless network is being created. The effort has taken time to come to fruition, but this hybrid network of fiber-connected utility poles, conventional wireless frequencies, and TV white-space frequencies will enable the community to become more competitive in a 21st century information economy.

Local Development Districts

To ensure that funds are used effectively and efficiently and to strengthen local participation, ARC works with the Appalachian states to support a network of 73 multi-county planning and development districts (LDDs) that cover all 420 counties in the ARC Region. Critically, LDDs work with communities and other stakeholders to identify and develop plans to address prioritized economic and community development needs and to build community unity and leadership. LDDs can provide technical assistance and planning expertise and facilitate access to organizations that might partner in development efforts. Stories from Kentucky and Pennsylvania are offered as examples of LDDs working closely with community stakeholders to implement broadband-based strategies for growth

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[27] CTC Technology and Energy. (2012). Broadband in Garrett County: a plan for expansion and adoption. [PDF] Retrieved from: https://www.garrettcounty.org/dotcom/files/GarrettCountyBroadbandReport.pdf

Kentucky

Broadband for Job Creation: Kentucky Regional High Growth Training Center
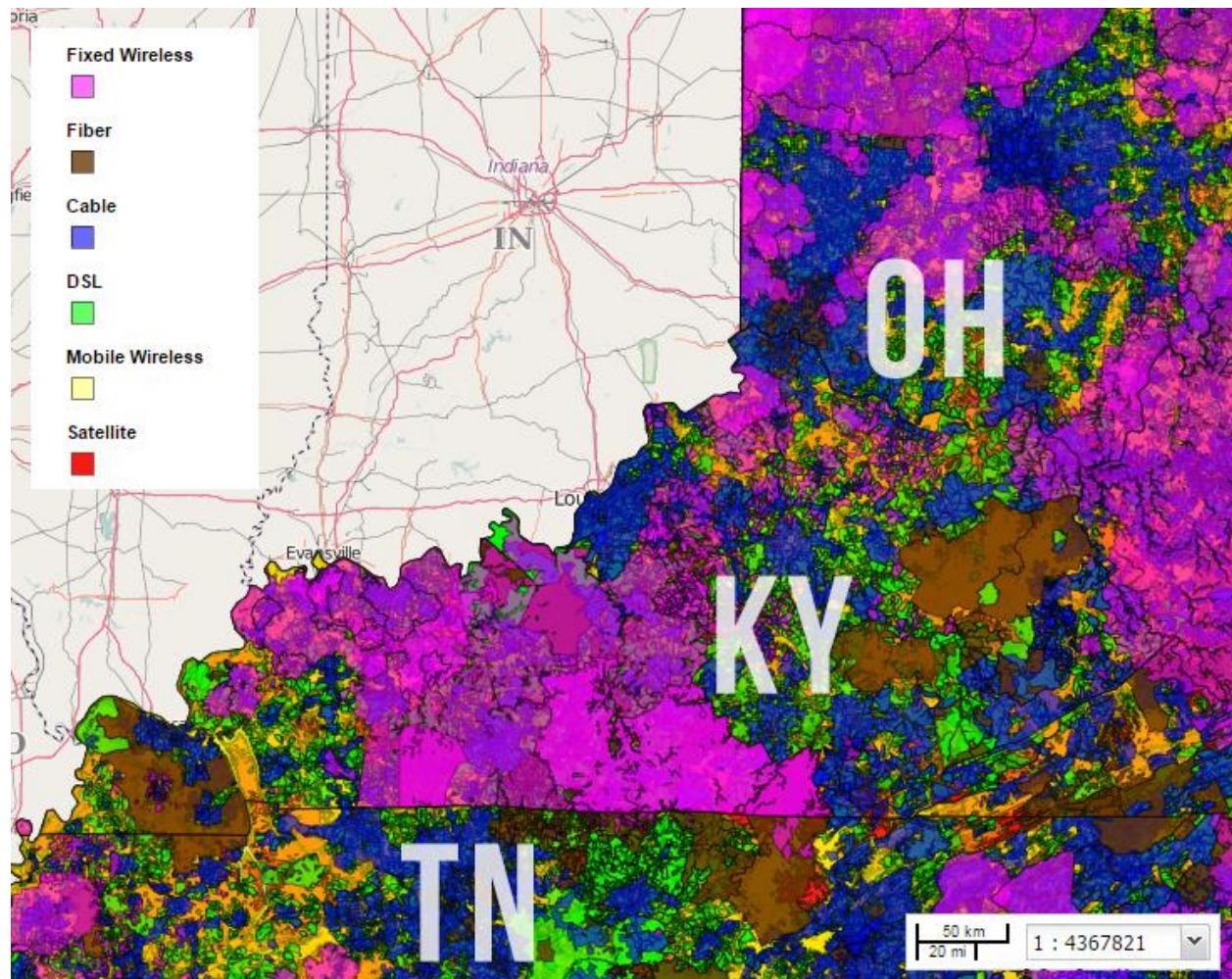
Map Source: Broadband Catalysts – Visualization of FCC Form 477 Data. Fixed June 30th 2015. Mobile December 14th 2014. Base map provided by OpenStreetMap

This is a best-practice story of collaboration across stakeholder groups to solve a workforce problem in a critical infrastructure sector.[28] It both utilizes broadband to deliver training resources and sets the stage for growing the skilled workers needed to support expansion of network technologies in the future. Pulaski County, Kentucky has jobs, but not enough of the sort needed to improve per-capita income and poverty levels that underperform state averages. At the same time, a shortage of skilled workers prevents electric utilities from filling openings

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[28] Appalachian Regional Commission. (November 2015). "Program Evaluation of the Appalachian Regional Commission's telecommunications and technology projects: FY 2004–FY 2010. [PDF] Retrieved from http://www.arc.gov/research/researchreportdetails.asp?REPORT_ID=120

paying above average wages for trained linemen to install, maintain, and repair electric power, telephone lines, and fiber-optic cable. An unusually diverse set of public and private organizations came together to creatively address this problem/opportunity, including: the community college, South Kentucky Rural Electric Cooperative, Somerset Pulaski County Development Foundation, Pulaski County Fiscal Court, ARC, U.S. Economic Development Administration, U.S. Department of Agriculture Rural Economic Development Loan and Grant program, and Lake Cumberland Area Development District (LCADD). LCADD is a 10-county, 14-municipality LDD that provided leadership and coordination for the effort

The planning group identified the deficiencies as an opportunity to address an important industry need and upgrade skills via apprentice-level training through creation of a utility lineman training center. Built from scratch on county land and administered through the community college, the Center has enrolled more than 800 individuals; 591 have completed certification, and 502 were employed as of December 2015 in well-paying, future-oriented jobs. Applicants must have a high school diploma/GED. Physically and mentally rigorous classes run for 32 weeks and include general work readiness programs and high standards to prepare graduates for employment. Industry involvement and oversight is strong and includes apprenticeships leading to full certification. The training program is expanding to include installation and operation of smart-grid electric meters and certification as energy auditors. This expands the capabilities of utility companies in Kentucky, positioning them to respond to requirements being created by the Internet of Things.

Pennsylvania - SEDA-COG

Broadband Growing Government Capacity:

Map Source: Broadband Catalysts – Visualization of FCC Form 477 Data. Fixed June 30th 2015. Mobile December 14th 2014. Base map provided by OpenStreetMap

This region composed of 11 counties represents 14% of the state's geography but has only 5 percent of the population. There are more than 294 municipalities located along the Susquehanna River. Population density is 40 percent of the state average. The region has more than 9,000 farms and is rich in natural resources (timber, minerals, and energy) Although Pennsylvania State University is in this area, the counties that make up the SEDA region vary widely in their demographic and economic profiles. The population of elderly citizens in the region is 11.8 percent higher than the state of Pennsylvania. Research has shown that lack of availability, adoption, and use of broadband present real impediments to the region's economy.

Broadband Business Model: Council of Government Adoption and Use Model

Broadband is listed in the 2015 CREDR Economic Development Five Year Report as a continuing major goal of the SEDA-COG. This region's Director of initiatives to recruit broadband deployment has for more than a decade acted as a lobbyist pro bono for extension of broadband to the SEDA-COG area. He has noted that adoption of broadband and learning to

effectively use it is critical to building the customer base for broadband companies—public, nonprofit, or private sector. Their model was to develop a technical assistant team to aid regional businesses and organizations in learning about broadband and its adoption and use. Students from seven universities in the region worked with SEDA-COG staff to improve Internet skills for businesses and citizens. A regional website was developed. SEDA-COG still provided assistance with websites this past year. Because more people began to use the web, more companies are, thus, willing to provide high-speed broadband to the SEDA-COG area.[29]

Tri-State Broadband

Regional Cross-Border Collaboration
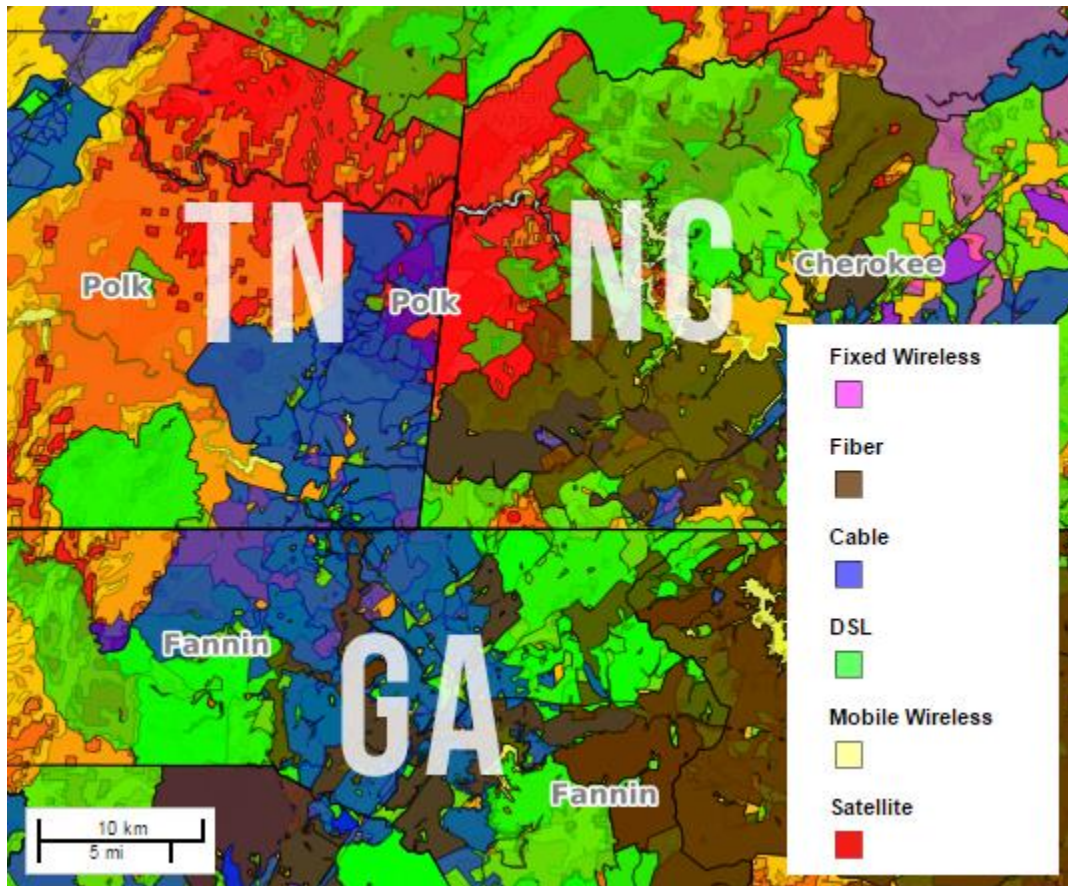
Map Source: Broadband Catalysts – Visualization of FCC Form 477 Data. Fixed June 30th 2015. Mobile December 14th 2014. Base map provided by OpenStreetMap

Southwestern Community College determined through research that a fiber-supported

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[29] Appalachian Regional Commission. (November 2015). Program evaluation of the Appalachian Regional Commission's telecommunications and technology trojects: FY 2004–FY 2010. [PDF] Retrieved from http://www.arc.gov/research/researchreportdetails.asp?REPORT_ID=120

broadband network was needed to provide a mission-critical, dependable network to support state and county government, data centers, and economic development. Partners in the enterprise development were Drake Enterprises and the Eastern Band of the Cherokee tribe. Balsam-West Fiber Network was created to birth this new broadband fiber-telecommunications transport carrier.

Broadband Business Model

Over 400 miles of a ringed fiber network was designed to be dependable 99.999 percent of the time. This would lead to 5.26 minutes of downtime per year. In 2003, Drake Enterprises and The Eastern Band of the Cherokee created a partnership to become the founding providers of services to their area of the tri-state Appalachian Region (North Carolina, Tennessee and Georgia). To date, Balsam West continues to add infrastructure, bringing fiber-optic technology to carriers, data centers, and communities. They have kept their vision on the future to ensure economic growth for their customers.

In 2011, Graham County, NC asked the e-NC Authority for help in attracting broadband Internet providers to their rural county. Building upon the previous public-private partnerships and non-profit efforts of Balsam West, MCNC, and the Education and Research Consortium of the Western Carolinas, Inc. (ERC), the county broadband planning effort was able to offer wireless provider, Dnet, with access to a county-owned tower. Roof space on the county health department facility, which has line of sight to the county-owned tower and has access to the fiber backbone, helped make broadband more available in rural areas and even facilitated a free, downtown Wi-Fi project in Robbinsville, NC.[30] [31]

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[30] Gartner. Telecommunications Carrier. (n.d.) A telecommunications carrier is a generic phrase that covers all entities that provide some form of telecommunications services (fixed and/or mobile, voice and/or data) as their primary business to all or a subset of consumers, enterprises, governments, and other telecom service providers. Retrieved from http://www.gartner.com/it-glossary/telecommunications-carrier/
[31] Appalachian Regional Commission. (November 2015). Program evaluation of the Appalachian Regional Commission's telecommunications and technology projects: FY 2004–FY 2010. [PDF] –Retrieved from http://www.arc.gov/research/researchreportdetails.asp?REPORT_ID=120

New York - BOCES

Leveraging Educational Resources Through Virtual Distance Learning: Multi-Government BOCES Partnership New York
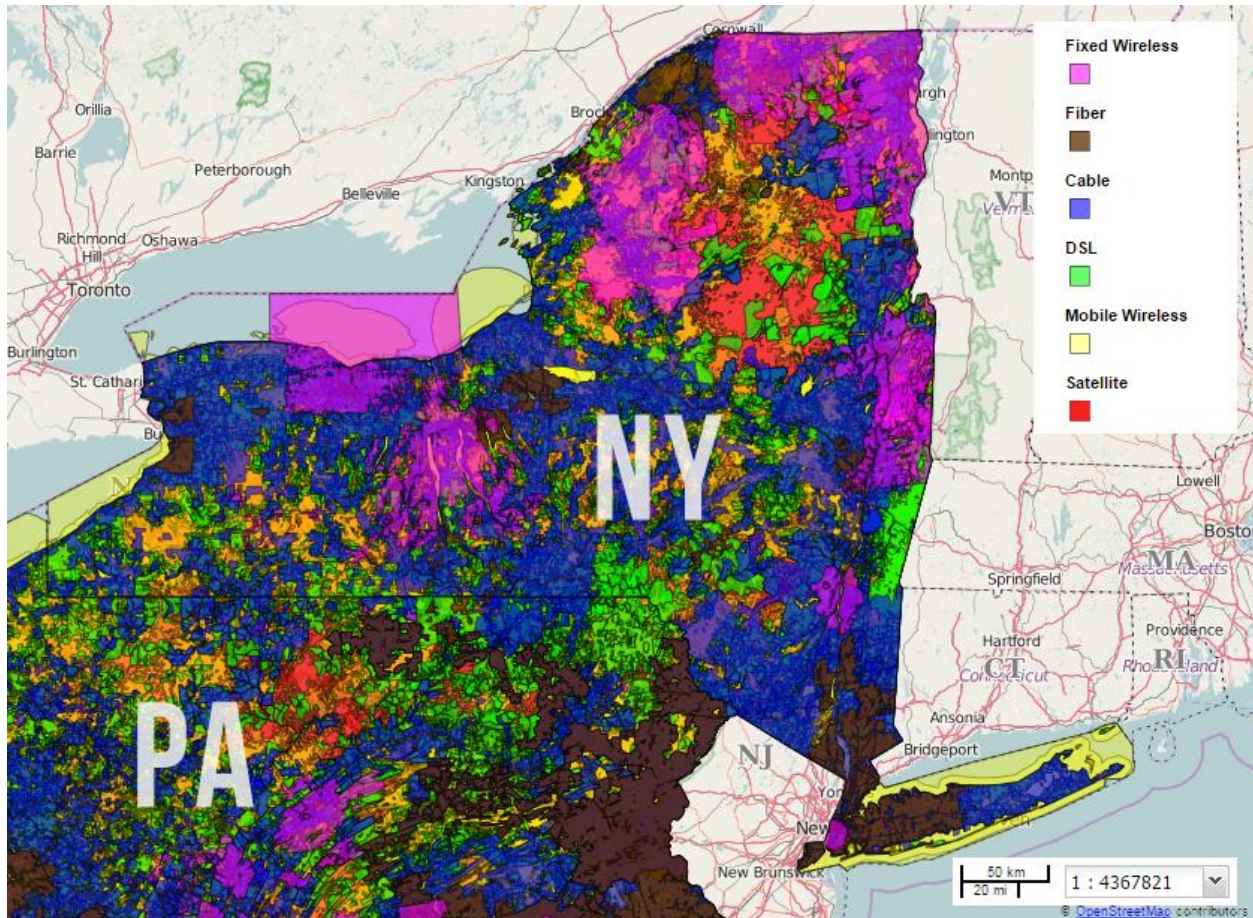
Map Source: Broadband Catalysts – Visualization of FCC Form 477 Data. Fixed June 30th 2015. Mobile December 14th 2014. Base map provided by OpenStreetMap

Schools in rural southern New York worked collaboratively with the State Board of Education and ARC to develop a centralized data center to enable broadband-supported training, applications and content delivery to teachers and students. The Chemung, Schuyler, and Tioga Board of Cooperative Educational Services (Greater Southern Tier-GST BOCES) in Southern Tier New York acts as a regional educational cooperative that operates in Steuben, Schuyler, Chemung, Tioga, and Allegany Counties. GST BOCES received an ARC grant for development and delivery of educational programs for both teachers and students focused on training and learning to utilize virtual learning. ARC and New York State government were critical partners in this initiative. This project demonstrates the value of a regional partnership for educational

broadband applications[32]

Through inter-governmental partnerships, GST BOCES was enabled to leverage resources to achieve the scale needed to deliver critical virtual services and science courses to students that they otherwise could not have received. A central data center was created to share more than 100 megabytes of data for use across the network. The cooperative enabled the BOCES network to serve as an extension of the local school districts, bringing educational resource to the area from the New York State Educational Department. This connectivity enhanced the global knowledge of teachers and the adoption of emerging Internet tools, such as social media, at the local system level and between school regions. The Education Opportunities Network (EON), now in its latest iteration, called Ed2Go, (www.ed2go.com/gstboces/about_us.html) was considered to be an added asset for the eleven counties of the BOCES area to be eligible for the proposed $230 million Southern Tier Agricultural Economic Development initiative of the New York Governor.

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[32] Appalachian Regional Commission. (November 2015). Program evaluation of the Appalachian Regional Commission's telecommunications and technology projects: FY 2004–FY 2010. [PDF] Retrieved from http://www.arc.gov/research/researchreportdetails.asp?REPORT_ID=120

Chapter 4: Broadband Planning Roadmap

The picture of strong communities varies across the Appalachian Region. Communities have many different layers—educational, social, cultural, economic, spiritual and technological—that interplay and, in the composite, determine communities' sustainability and competitiveness. Technology, specifically broadband Internet, is central to this mix. Ensuring that a community becomes a Digital Community is the focus of the resources provided in this toolkit. A number of excellent guides to community broadband planning exist that provide detailed descriptions and checklists to assist in efforts to ensure a better-connected future. Links to the best of these resources can be found in Chapter 9: Resources. The following information distills the consensus of the learning curves represented in other toolkits. Note that use of the term "roadmap" implies a linearity that may not be required; steps outlined below may take place concurrently or in an order that works best in your situation.

Getting Started: Organizing Your Effort

Creation of a Digital Futures Planning Committee

Your objective is to guide your town and county to establish their digital communities program to develop a framework that can:

   • *Expand high-speed Internet access to your area*

   • *Enable the adoption and utilization of value-adding applications in education, healthcare, public safety, government services, and other activities that serve the public*

   • *Build a competitive economic edge for your community*

   • *Train people to integrate the Internet into their daily lives to enable their full participation in the digital economy*

   •*Develop a strategy to ensure an ongoing focus on technology as a necessary tool to enable prosperity and competitiveness of the people, institutions, and businesses in your community.*

Research and experience point to the critical importance that local, grassroots

involvement and ownership has in the success of efforts to transform communities. This is particularly important to an issue affecting so many stakeholders on so many levels, such as broadband. A successful planning effort will require the following:

- *Creation of a Steering Committee that can act as a distributor of information as you organize your initiative*
- *Identification of an e-champion, the person who will be elected Chairman and will spearhead the initiative*
- *Cross-sector involvement of local officials representing all stakeholder groups*
- *Inclusive engagement of a broad spectrum of the public as individual foot soldiers from across the town, county, and/or region.*

The broadband steering committee should be recruited from education, healthcare, local government, economic development, public safety, libraries, business, telecommunications service providers, and interested citizens. The makeup of the committee can provide significant external credibility and a mechanism for public accountability. As the process moves forward, committee members will be expected to serve as conduits to their respective stakeholder groups to encourage the flow of information and in-kind services (such as institutional support needed to organize meetings, ensure effective communications, and provide logistical support) that will be needed to make the effort a success. From this group, a committed and organizationally competent person should be selected as the champion to lead the planning effort.

Watch a video from The NetWork Kansas Entrepreneurship (E-) Community Partnership.

Engaging Your Community

If change is difficult, transformation has to be harder. Broadband has the capacity to change how individuals, institutions, and businesses in your community work, learn, play, seek and receive services, and stay healthy and safe. As agents of change, your broadband planning committee needs to work from the outset to seek input and support from the public and key stakeholder groups to ensure that the plan that is developed meets the needs and desires of the broader community. This means involving other parties who would like to see broadband come to their community. Public engagement also means taking concerted and ongoing efforts to reach out to those in the community who may not yet appreciate the benefits that broadband can deliver. Public engagement provides critical two-way information exchanges that the planning

committee can use to:

- *Inform the public about the goal, process, and, as time passes, the progress of the planning effort*
- *Obtain input on the type of access, technology, and training that is needed*
- *Share research results*
- *Refine and customize plans to reflect the evolving priorities of the community*
- *Lay the groundwork for partnerships and collaborations needed to realize emerging broadband plan.*

Common need can create a strong community of local broadband enthusiasts who are willing to assist you with the effort necessary to gain credence with your local officials and business communities. Draw on these enthusiasts to populate subcommittees created to focus on research and feasibility, marketing, funding, and other critical aspects of network planning and deployment. Remember that each person who becomes aware and supportive of the effort becomes a conduit to their social and professional circles, creating ripples of interest that can be scaled into an opportunity that will be more compelling for providers and for partners recruited to fund the new broadband networks and adoption programs. NTIA has developed a Community outreach Checklist (see page 30 of NTIA Planning a Community Broadband Roadmap) that can provide guidance as you begin to formulate your plans for public engagement.

Assess your Community's Broadband Situation

Identify Demand

Better data supports better decisions, so your broadband planning committee will need to be well-positioned to gather information on unmet and projected demand for broadband services that is current, accurate, and comprehensive. This is an essential first step in the process of identifying the scale and nature of the challenge you face, helping you prioritize areas to serve and possibly identify potential partners and funders. Effective demand assessment utilizes some combination of surveys and/or interviews to collect information from households, businesses, and organizations/agencies on the location and type of current Internet user, the type and cost of their current broadband services (if any), the types and bandwidth requirements of applications currently in use or planned, and their level of satisfaction with available broadband services and speeds. Additional information related to interest, cost sensitivity, capacity, and digital

preparedness identifies opportunities to target demand-building efforts as part of broader strategies to move the community to a more competitive level of digital preparedness.

While there are many options to aggregate this demand information, it is good to work through local government, places of worship, libraries, and businesses, especially those with broad reach, such as utility companies. Schools can be excellent partners, as they have an interest in addressing the lack of access that creates what is referred to as the Homework Gap affecting children whose studies are challenged by the lack of adequate broadband access at home.

Mapping

There are numerous factors that can increase the cost of broadband deployment. Many of those are specific to the situation and locale and can be seen on maps and topographical maps. Rivers, streams, estuaries, bridges, mountains, and coves/canyons are all examples of things that can dramatically raise the cost of deploying broadband infrastructure. Even beyond the costs, getting environmental approval can add years to a project.

When you encounter bridges and other water crossings, look into any existing conduit or cabling that may have been previously deployed. Along stretches of rocky mountain road, identify the telephone pole provider, as they may be the only cost-effective path through rocky terrain. Some of this information is freely available through projects like openlayers.org, Google Maps and Google Earth, and other sources. Many of these sources can be unified into a single map and laid over the terrain. Free tools like Google Earth have this capability, and more advanced tools like Terrain Navigator Pro and ESRI ArcMap provide additional functionalities, such as line-of-sight-calculation between two points and view shed analysis, which shows the geographic area with line of sight to a specific point or tower location. Combining view shed analysis and satellite imagery, one can effectively gauge where "line-of-sight only" wireless technologies can be effectively deployed. Often in areas with significant foliage, a technology and frequency range effective at penetrating leaves must also be deployed. There are numerous resources that can assist your mapping effort:
- *There are other free tools that can assist in the planning process as well*
- *Cambium Networks Link Planner goes well beyond a simple line-of-sight checking tool but is worth the download for that feature alone*
- *Boundless OpenGeo Suite: While many of the open source components of this suite are available*

individually, this free suite provides a cohesive interface and a software developer's kit (SDK) for creating interactive maps. This suite was used in creating the National Broadband Map and the North Carolina Open Source Broadband Map. http://boundlessgeo.com/

- *The North Carolina Open Source Broadband Map provides an advanced* <u>mapping interface</u> *written in Ruby on Rails atop PostGIS and OpenLayers. This map automates the collection and geocoding of unserved citizen addresses. It also auto-locates clients searching for broadband and shows them the options available at their current location or any location they may search for. https://github.com/nccgiaservices/ncbroadbandopenmap*

- <u>QGIS:</u> *Free and open source, this GIS application provides an affordable alternative to those who don't have sufficient budget or access to use retail GIS software*

- *Broadband Catalysts: Simple Open Source Map - Built using the OpenGeo SDK,* <u>this simple broadband map</u> *provides robust functionality with all the SDK app code contained in a single text file that can be easily modified for other purposes. http://broadbandcatalysts.com*

- *FCC Mobile Testing App: FCC Unveils Mobile Broadband Speed Test App to Empower Consumers. https://www.fcc.gov/document/fcc-unveils-mobile-broadband-speed-test-app-empower-consumers*

Identifying Likely Topologies

Once you have gathered as much demand data as possible and have had that data mapped, you should be able to identify clusters of demand. Wireline technologies are generally preferred to wireless connections and have some stability and reliability advantages. Existing wireline providers who serve adjacent or nearby areas are likely candidates to fill the demand. Often, just having the demand data is enough to encourage a provider to expand into that area. Note that wireline expansion can take a great deal longer than wireless expansion, and the service might still take years to deploy. Anything the county can offer the wireline provider in the form of incentives, rights-of-way, pole attachments, easements, permits, or facilities can shorten the deployment time and make it even more attractive to providers.

State-level broadband maps, embedded in the National Broadband Map, can be used to determine what providers serve the surrounding areas and generate a list of possible partners. Each potential partner should be willing to give some idea as to what areas they might be able to serve and which they won't. While providers are generally loathe to make promises on future deployments, most will give you a rough estimate on how long it might take.

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At this point, you will most likely be left with areas that are unlikely to ever get served with wireline service. These are the areas most likely to be served using fixed wireless. Check the broadband map for fixed wireless providers in the surrounding areas and make a list of potential wireless partners.

Understanding the Technology

Technology-Specific Issues That Define Your Options

The most common reason why private sector fiber broadband carriers have not moved into rural areas or deployed fiber where copper is currently (retrofitted) is the low population density in rural areas and communities. Many challenges contribute to this factor, but the primary barrier is the difficulty to make a profit for wireline providers to gain the return on substantial investment required to provision broadband in a time frame of three years. Wireline providers have difficulty making a business case to serve many rural areas using the copper plant that may have been in place for more than 40 years or to upgrade rural areas with fiber. Other technology-specific challenges include:

- *Cable: If you live in an area where there are fewer than 15 households per mile or your home is more than 250 feet from the road, it is unlikely that cable service will make the significant investment to come to your home. Your community could provide some investment into the deployment costs. You can also gain subsidies by gaining access to existing assets, such as: poles, rights-of-way, bridges, and roadway easements.*

- *DSL (Digital Subscriber Line): DSL providers have an advantage of having copper lines going to most homes and businesses. Their challenges include the poor condition and age of the copper. The criteria to get DSL service is as follows: First, the copper that runs to your home must connect to a DSL-enabled central office or remote cabinet. (Remotes are facilities where telephone companies locate equipment distant from their central offices.) Second, the home or business, etc. must be at least within 18,200 feet from the remote or central office. Third, there must be an open port on the DSL Access Multiplexer (DSLAM). The DSLAM aggregates (multiplexes) multiple digital signals and allows them to travel across a single backhaul circuit. The backhaul usually is a fiber-optic cable that is the 'middle mile' or 'backbone' of the Internet. DSLAMs generally have 24 ports, cost around $25,000 to deploy,*

and can be more if you calculate the cost of provisioning and deploying the fiber backhaul. Full DSLAMs (occupied 24 ports) make money, and most empty DSLAMs lose money.

- **FTTH** *(Fiber to the Home)***:** *FTTH deployments are expensive to install. Trenching is required for most installs, raising deployment cost. To encourage growth of FTTH networks, consider offering subsidies and/or low-cost access to poles, rights-of-way, easement, etc.* <u>An example can be found in the Dig Once section of Chapter 9 in this document.</u>

- **Mobile broadband:** *Mobile broadband equipment is deployed from the same towers that provide voice service. Most rural areas have inadequate mobile broadband coverage. Even when signals are good, there may not be sufficient backhaul to provide the speeds available in urban areas. On mobile broadband plans, the cost of $75 would average to $10 dollars per gigabyte (GB) of data use, compared to an average of less than $0.50 per GB of data for wireline. To illustrate the impact of this price difference: your new high definition television has Wi-Fi and Netflix built in. Streaming a high-definition movie on Netflix transfers 4GB of data, which would cost approximately $40 in data transfer over a mobile hotspot versus the $1 to $2 if streamed over DSL, cable, or fiber.*

- **Satellite:** *Geosynchronous satellite service suffers from pricing similar to mobile broadband. Costs are in the area of $10 per gigabyte of transfer. Satellite is also 20 times more expensive per bit than wireline technologies.*

- **Fixed wireless -** *Fixed wireless uses towers, poles, and even private residences as transmitter sites. It is becoming more commonplace in rural areas. It requires a radio and antenna permanently affixed to the customer's home or structure. Fixed wireless providers use the unlicensed spectrum, which is free to use. This frequency is the same that cordless phones, Wi-Fi access points, and other consumer electronics use. Some fixed wireless providers use the licensed spectrum, for which they have paid many millions of dollars even for a relatively small coverage area. Fixed wireless providers face a number of challenges, including leaves and trees. Most unlicensed frequencies do not penetrate tree foliage well, so customers need a line of sight between transmitter and their home. Limited foliage penetration within a few miles of the transmitters is possible but at a higher cost and lower level of service. Fixed wireless providers prefer to have a clear line of sight between the transmitter and the customer; the distance between the two can be as great as 20 miles.*

- **TV White Space:** *A new type of fixed wireless that uses frequencies previously reserved for broadcast television. These frequencies are fairly good at penetrating foliage, but the current cost of transmitters is high. Once transmitters are being mass-produced for the TV White Space, costs to deploy these devices will be reduced.*

Inventory Assets

Inventorying assets that belong to your county or community can find you assets that you can leverage in obtaining broadband providers. This can reduce the amount of funding needed for the broadband project. It is important to include both "hard" and "soft" (human) assets in your tally. Inventory of Assets may include the following, but are not limited to items below:

- *IT and GIS professionals*
- *Existing vendor relationships*
- *Civic groups*
- *Community volunteers*
- *Educational institutions, which are a source of student labor and/or expertise*
- *Commercial-carrier construction companies with whom you can negotiate dark fiber or conduit during permitting or franchise negotiation*
- *Municipally owned utilities with assets, customer base, and back office operations that can be leveraged for partnerships.*
- *Ongoing or pending capital projects, such as water, road construction, main street revitalization, new sub-divisions, etc.*
- *Land can be used for tower construction/location of points of presence, etc.*
- *Towers owned by county or municipality may reduce or suspend lease payments.*
- *Silos, water tanks, buildings to place wireless equipment. Agreements/Contracts near expiration that can be re-negotiated may provide a platform for obtaining services.*

Existing Services and Networks

Assessing the adequacy of a community's network infrastructure and services is essential to an effective planning effort. Your inventory should include a listing of all ISPs in the area and, as much as possible, information on the location of various network- related infrastructure, such as central offices for providers, middle mile points of presence, the amount and location of fiber-optic cable, etc. Information gathered on ISPs in the targeted community, as well as those in adjacent areas who might be incented to expand their service reach, should include their retail service footprint, their service model (retail, wholesale or both), and their technology products, including wireline, cable, fixed wireless, mobile wireless, or satellite. Data on costs, data caps, and knowledge of where the closest middle-mile project is located or if there is fiber-optic cable

in or near one's community is important in the planning and assessment process. ISPs can be classified in a couple of ways:

First, they may be classified by their retail service footprint. There may be one or more ISPs within the community. In addition, there may be ISPs that serve adjacent areas and may be interested in serving additional areas; lastly, there may be regional ISPs that may not be adjacent, but who have services not too distant from the target community and may be convinced to expand to the target area.

Open Architecture Network

You could consider an open-architecture network, such as developed by Mid-Atlantic Broadband (MBC), a nonprofit corporation in Southwestern Virginia. An introduction to this network can be reviewed at *www.mbc-va.com/*

MBC supports a 100GB research network in Virginia for Mid-Atlantic Research. MARIA is a non-profit corporation. MBC's middle-mile fiber network provides affordable infrastructure and carrier-class broadband connectivity to drive economic growth.

The important thing in planning for broadband in communities is that you must determine the minimum broadband standard to meet your customer base. What offered services are critical? You need to realize you will have to constantly upgrade infrastructure. Can you manage the recovery of the investment and match that with affordable broadband? Can you actually erase or minimize the digital divide and be committed to seeing that the broadband offerings will evolve?

Another guide to review of broadband policy from a state perspective has been published by the Pell Center for International Relations and Public Policy: State-Level Broadband Policy – A compendium of resources and approaches.[33]

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[33] Seifer, A. Pell Center for International Relations and Public Policy. (September 2015). [PDF] Retrieved from: http://pellcenter.org/wp-content/uploads/2015/09/State-Level-Broadband-Policy-FINAL.pdf

Survivability

Survivability of network ownership must always be an issue in any broadband plan. Just as AT&T was broken up by the Judge Green decision in the 1980s, it has now been resurrected to again become AT&T some 30 years later.

There should be focused concern on when to exit ownership of a local nonprofit or community-managed network in order to better serve the community if that becomes an issue. In drafting legal documents, this should be a concern of your attorneys, regardless of the chosen type of network.

Open-Access Network

A Middle-Mile Open-Access Network connects local, last-mile networks to the backbone of the Internet. They transport large amounts of bandwidth between the endpoints of a network. They also can connect towers for wireless services, community anchor institutions, and other larger customers. Mid-Atlantic Broadband is such a network. Business leaders, in collaboration with telecom experts, developed a blueprint for an advanced open-access, fiber-optic network for Southern Virginia. Old Dominion Electric Cooperative, an electric generation and transmission cooperative in Virginia, realized the need for this critical economic development infrastructure and provided the leadership and funding necessary for initial business planning and strategic seed capital. The outcome was the creation of an independently operated wholesale telecommunications company.[34]

An excellent discussion of financing municipal networks can also be found at the Institute for Self-Reliance at https://ilsr.org/financing-municipal-networks-fact-sheet/

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[34] Mid-Atlantic Broadband Communities Corporation – http://www.mbc-va.com

Private-Sector Networks

Private-sector owned networks—such as AT&T, Century Link, Frontier, Verizon, and Google—are also very acceptable methods to consider for deployment of networks in your area or upgrading of the networks that currently are offered to your area. AT&T is rapidly working across a number of states, including North Carolina, and their larger cities to provide fiber services. See *Charlotte Observer* (http://www.charlotteobserver.com/news/business/article24403021.html).

These providers could be offered incentives to come into an area in a public-private partnership, or it is possible to have them collaborate with the community, town, or region.

Municipal Networks and Barriers to Entry

Chattanooga's gigabit network and Wilson, North Carolina's Greenlight gigabit network are examples of gigabit networks run by municipalities. These two municipal network owners are involved in the current suit before the 6th United Court of Appeals Circuit (Michigan) in a challenge to laws that block municipalities from delivering broadband. Tennessee and North Carolina appealed the FCC Order that noted these two states' laws were barriers to broadband infrastructure development. The two states' Attorneys General filed an appeal attacking the FCC decision that noted these two states' laws violated the FCC Order.

There are also other issues that can create barriers to entry for such municipal and county governments that will be affected by the outcome of this case. Prohibitions now exist in multiple states (AL, AR, CA, CO, FL, LA, MI, MN, MO, NC, NE, NV, PA, SC, TN, TX, UT, VA, and WI).

Noted in a Baller law firm presentation is the fact that from 2005-2010 most efforts at legal barriers that blocked local government or state government broadband deployment to private customers were defeated. In 2011-2015, laws in North Carolina and South Carolina were

enacted but defeated in Georgia, Indiana, Kansas, Missouri, and Utah. A 2016 negative bill was killed in Colorado but was still pending in Missouri in April 2016.[35]

The FCC in February 26, 2015 adopted an order granting section 706 petitions for preemption filed by the Electric Power Board of Chattanooga, Tennessee and Wilson, North Carolina (WC dockets no. 14-115 and 14-116 (http://goo.gl/uaeEAp) FCC Memorandum Opinion and Order _ Petition for Preemption (PDF)

Opportunities to Leverage Existing Assets to Reduce Costs

Communities often have available existing assets, hard as well as soft, which could be used to improve financial projections for a community-wide deployment. The more existing assets are made available to the private-sector provider, the more attractive it will be to extend service into underserved or unserved areas.

The anchor tenant model is the most common approach currently used by municipalities to encourage private investment. This model provides substantial guaranteed cash flow to the provider for municipal use of the network, increases the ability of the private provider to obtain the required capital to deploy a network in the community, and increases the projected operations.

Community governments may prefer not to become an anchor tenant but want instead to pursue an approach which does not require a direct financial investment. Some laws and policies may not permit the local county government to become an anchor tenant; however, they can become a customer in the future when the network services are established.

Staff Resources/Expertise

Providers considering network deployment understand the technology, the Internet, and how to operate a competitive business. Therefore, when they enter the market, their needs are focused on understanding its unique characteristics: the market, the opportunity, the community. Understanding the market is a costly but necessary first step for any provider entering a new market. The market research conducted as part of a study provides potential providers with a

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[35] Baller Herbst Law Group. (April 6, 2016). State restrictions on community broadband services or other public communications initiatives. *Presentation at Broadband Communities Summit*. [PDF]. Retrieved from http://www.baller.com/wp-content/uploads/BallerHerbstStateBarriers6-1-15.pdf

solid foundation for understanding their market.

In addition to providing the market research results, city/county staff can often assist the provider in applying for city, county, and state permits and have access to GIS maps and other information. Staff also possess knowledge of unique community characteristics that can assist a new market entrant.

To help encourage investment, it is important to examine assets from a business perspective. These assets include any available community resource that increases operating margins by:

- *Reducing operating costs, such as pole attachment fees, energy fees, customer acquisition, and maintenance*
- *Reducing the required investment to deploy the city-/county-wide networks*
- *Increasing the number of anticipated consumers without lowering per customer margins.*

This section provides a framework to explore ways to leverage assets. The examples used in the framework are just examples and by no means an exhaustive list.

Reduce Customer Acquisition Costs

Name recognition and product branding are essential elements when entering a new marketplace. Obtaining market recognition requires expensive advertising and marketing programs. Companies whose name is not recognizable often spend $250 to $500 to capture a new customer for a $20 -$30 per month gross revenue stream. The city/county, through press releases, public education forums, and existing communication channels, can substantially reduce the provider's cost of obtaining credibility and name recognition.

Another consideration is to use City/County brand name or endorsement for the new service offering. Determine which approach has the most value or impact on a consumer's decision to purchase the product.

However, if the provider's brand is used in conjunction with access to city/county communications channels it may reduce the cost of marketing the service by raising the credibility level of the provider.

Promotion of digital inclusion efforts can assist the provider in capturing market share through press releases and public statements that note the benefits of the network will assist the

provider with educating the reluctant consumer and capturing market share.

Other Potential Methods Include:

• Include information on network services in city/county mailings, newsletters, cable access channel, and other citizen communications

• Provide access to water billing and other records which provide potential customer contact information

• Facilitate involvement with the Chamber of Commerce, local real estate professionals, and other private organizations

• Promote availability of services with the Visitors and Convention Bureaus, and directly with entertainment and tourism venues.

Increasing the Number of Subscribers

Hand-in-hand with efforts to reduce customer acquisition costs and increasing the size of the market (number of households acquiring high-speed Internet) and the market share (percent of total high-speed market using network service).

Examples of Increasing Market Size Include:

• Encourage local business to offer network services at employee homes as part of a benefit package

• Consider offering network services to city/county employees as part of a benefit package

• Encourage businesses to offer free wireless access for customers

• Encourage schools to encourage students to obtain access

• Work closely with the Chamber of Commerce and other agencies to encourage use of the service by all members

• Leverage the city/county Community Services Department, which owns and manages public housing units located throughout the city/county.

Reducing the Required Investment

The city/county has developed and owns a significant amount of connectivity-infrastructure assets through master planning, project coordination, construction, and asset management. Infrastructure that may reduce investment includes fiber optics, conduit, and other physical assets, such as buildings and other fixtures.

The following sections describe the assets that may be available to the city/county for further communications deployments.

Rights-of-Way

The city/county should consider offering all their owned Rights-of-Way and provide assistance in obtaining Rights-of-Way and permits with the state/federal governments for burying of fiber/conduit, installing free standing towers/poles to mount the wireless equipment, bridge attachments, etc.

Conduit

Maximizing the use of available, unrestricted conduit is a key component of reducing initial provider investment. Permitting a provider access to existing conduit substantially reduces the overall project cost by reducing the need for costly, boring, and street cuts and decreasing labor and equipment hours. The difference in cost between new underground construction and pulling fiber through existing conduit is about $50,000 per mile (in cities). Communication conduit may be installed for an incremental cost during Right-of-Way capital improvement projects (CIP). Examples of CIPs that offer excellent opportunities include sidewalk, curb, and gutter repair, new area development, street repaving or reconstruction, sewer-and water-improvement projects, and trail-way construction.

Pole Attachment/Energy Cost

Pole attachment agreements provide space on a utility pole for the attachment of fiber optic cables, Wireless Access Points (WAPs), and other devices. These agreements are typically limited to fiber-optic cables owned and operated by the owner of the agreement. Many different companies own these poles in your area, these should be identified and mapped (GIS) as a leveraged resource.

One of the highest operating costs, excluding staffing, is pole attachment and minimum energy fees. These fees are charged on a monthly basis per attachment. These fees vary depending on availability, company policy, and what is required or allowed on the poles. If the plan calls for adding a WAP on the pole, then the monthly charge could triple due to having to provide power for the wireless device on that pole.

Potential methods to reduce the pole attachment/energy fees include adding the WAP to the agreement for powering the street lamps. The success of this approach depends upon the city/county agreements with the electric power supplier. The agreement may prohibit adding non-city-/non-county-owned devices to the lampposts' electric supply.

Another Approach Is to Leverage Solar-Power Solutions.

Use of solar power with battery backup eliminates the minimum energy charge assessed by the electric company.

To facilitate the solar-power approach, the city/county may consider offering assistance in obtaining Rights-of-Way and permitting for free-standing poles to mount the WAP, solar panel, and backup battery.

Antenna Mounting Facilities

The city/county and other public entities have several assets for mounting antennas to establish wireless networking links. Assets that are most often used for mounting antennas include:

- *Multi-story buildings*
- *Existing tower structures*
- *Water towers*
- *Lamp posts.*

City/County Buildings

The city/county and the school districts have hundreds of public facilities, including school buildings, libraries, recreation centers, and governmental offices.

Government buildings are prime locations for secure storage/operations of electronic

equipment because they provide easy access to power and heating, ventilation, and air conditioning (HVAC).

The ability to house equipment at these locations facilitates the maintenance and operations of a network and provides for physically secure network assets. It greatly reduces the provider's expenditures for installation of vaults or purchase of real estate to house equipment.

Conceptual Network Design

This section examines the engineering considerations and the implementation costs that must be considered with respect to the general feasibility of constructing a city-/county-wide network, whether a city-/county-owned or a commercial network capable of offering high-speed data services to residents and businesses.

It is best for the city/county to define their residents/businesses needs and the leveraged assets available to the network provider and allow all vendors to offer their design and technical proposals without restraints. Then determine which proposal best suits your requirements.

City/county governments must implement applications to utilize these facilities.

Example Applications Include:

- *Building inspections using handheld devices*
- *Connectivity for events, e.g. signage, credit card readers, coordination*
- *Parks and recreation kiosks for reservations*
- *Webcams for security*
- *Construction-site coordination*
- *Update GIS, work-order databases from the field*
- *Access to police databases and provide ability to file reports remotely*
- *Remote control of irrigation systems*
- *Wireless parking meters with time-of-day pricing, open-space sensing, credit card payment*
- *Real-time bus information*
- *Traffic-signal synchronization*
- *Safety: vehicle to vehicle and to off-road*
- *Congestion management*

Digital Communities Check-Up Plan.

How much will this cost—this Digital Communities Plan? What is our timeline?

Planning funds should be enough to cover the costs of public forums and the Steering Committee's meetings, travel, and promotional materials. Utilize your local librarians, if possible, for research. A foundation in your area could provide a grant; a local community club might add some funds to that; local government(s) could provide some small allocations; and it is possible for private-sector groups to fund the initiative.

Many digital communities are able to gain donations of meeting space from non-profits, churches, community centers, or local businesses.

How Long Should It Take To Create Such a Digital Communities Plan?

- *1 month for selection of the Digital Champion and Steering Committee*
- *4 months for the first public engagement forum*
- *3 to 6 months for research*
- *8-12 months for fundraising*
- *6 months for the Digital Communities Plan*
- *Implementation Timeline for the Digital Plan should vary on the projects size and scope that your community wishes to move forward. Annual check-ups and updates might take one month or longer.*

Time Saving Tips

Reducing the time between initiating a broadband planning process and actually "flipping the switch" is a matter of preparation and using the new tools, resources, and sample documents that are now available. Furthermore, there is much to be learned from the experience of others. Those communities listed on this site have volunteered their expertise and information so that communities getting started can more quickly ascend the learning curve and reach deployment status. Some key points to remember:[36]

- *Assemble a team of committed individuals who believe (and are willing to stand up for) the process*
- *Make sure your policy and procedure house is in order—comprehensive plans, community zoning regulations and process, policies, fees, etc. must be broadband "friendly"*

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[36] Wired.Virginia.gov. (2011-2016). –Time saving tips. Retrieved from http://www.wired.virginia.gov/toolkit/time-saving-tips/

- *Use the community tool-kit and mapping information available through this site to expedite the planning process*
- *Leverage (policy, physical, in-kind) resources at your disposal—Public-Private Education Facilities and Infrastructure Act of 2002 (the "PPEA"), Virginia Resources Authority (VRA), Wireless Authorities, etc.*

Public Safety

Questions to Consider About Public Safety and Broadband

- *Are the right tools in place for the public safety sector to leverage broadband? If yes, what tools are in place? If not, what hardware, software, and other equipment do you need? Can you provide examples of how it would improve today's public safety sector?*
- *Do current processes and procedures encourage the use of broadband? What could you do differently with broadband that would promote its use in the public safety sector?*
- *Is everyone properly trained to use broadband technology effectively? How can we better prepare the public safety workforce to utilize broadband to its maximum benefit?*
- *Does broadband access and availability meet minimum standards for critical public safety applications? If yes, how? If not, what are the locations that need broadband enhancements and the challenges in getting it there?*
- *Is broadband technology cost-prohibitive? If so, what are cost-saving measures that could be implemented to increase use?*[37]

Public Safety - Case Study

The city of Marietta, GA offers a case study of how wireless broadband networks can be integrated into a municipal information-technology system. Marietta is currently deploying the initial stages of a Tyco Electronics VIDA Broadband system. The VIDA Broadband network operates on the city's private 4.9 GHz spectrum, which is reserved by the FCC solely for the use of state and local governmental and public safety agencies. This spectrum, which is available for free to the Commonwealth and all the localities within the Commonwealth, allows governmental agencies to build out private broadband networks that ensure capacity and coverage where these governmental agencies need coverage. This is in contrast to commercial networks, which generally build out in areas of highest population density.

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[37] West Virginia. (n.d.) Regional broadband planning teams tool kit. [PDF] Retrieved from http://www.wvgs.wvnet.edu/bb/reports/WV_Broadband_Planning_Toolkit.pdf

The Marietta broadband network is being built to support a number of city agencies' applications. The initial users of the Marietta network are the city's Bureau of Lights and Water and the Marietta Police Department. The Bureau of Lights and Water is using the network to monitor its facilities (notably unauthorized access to and water levels at the city's primary water tower). The Marietta Police Department is interested in using the same network infrastructure to provide broadband connectivity for a mobile video-surveillance unit. The mobile video-surveillance unit would be moved to various areas in the city to monitor areas where community events, graffiti, or other criminal activities became issues. The VIDA Broadband network uses the WiMAX, or 802.16, protocols to provide the city with grade of service (allocated bandwidth on a per-application basis), encrypted security, and authentication (allowing only authorized users on the network).

Although the cost and coverage of the initial network deployment is relatively small, the city can grow the network as funding and needs become apparent. The deployment of the network is being led by the city's Information Technology (IT) Department, which has taken a broad view of support for the city's agencies on the network. Because IT is leading the wireless broadband initiative, the network is being made available for other agencies that can benefit from the infrastructure. Future uses include providing city fire stations with broadband network connectivity and including the broadband network as part of the Bureau of Lights and Water's automated meter-reading system.

The products used in the VIDA Broadband network are designed for public safety usage, which means that they are capable of operating in a wide variety of environmental conditions. Tyco Electronics, with over 75 years' experience in deploying radio networks for mission-critical applications, has been building networks to withstand hurricanes, floods, ice storms, and earthquakes. Historically, commercial networks have suffered from outages due to congestion or equipment failure in times of extreme catastrophe. In contrast, the VIDA broadband network, allocated exclusively for governmental use and engineered for system reliability, provides communications when communications are needed most.

Acknowledgment: Paul May, Tyco Electronics (maypaul@tycoelectronics.com) for providing input to this section.[38]

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[38] Wired.Virginia.gov. (n.d.) Public safety - case study. Retrieved from http://www.wired.virginia.gov/toolkit/applications-of-interest/public-safety-case-study/

Telehealth: Delivering on the Broadband Promise in Rural Alabama
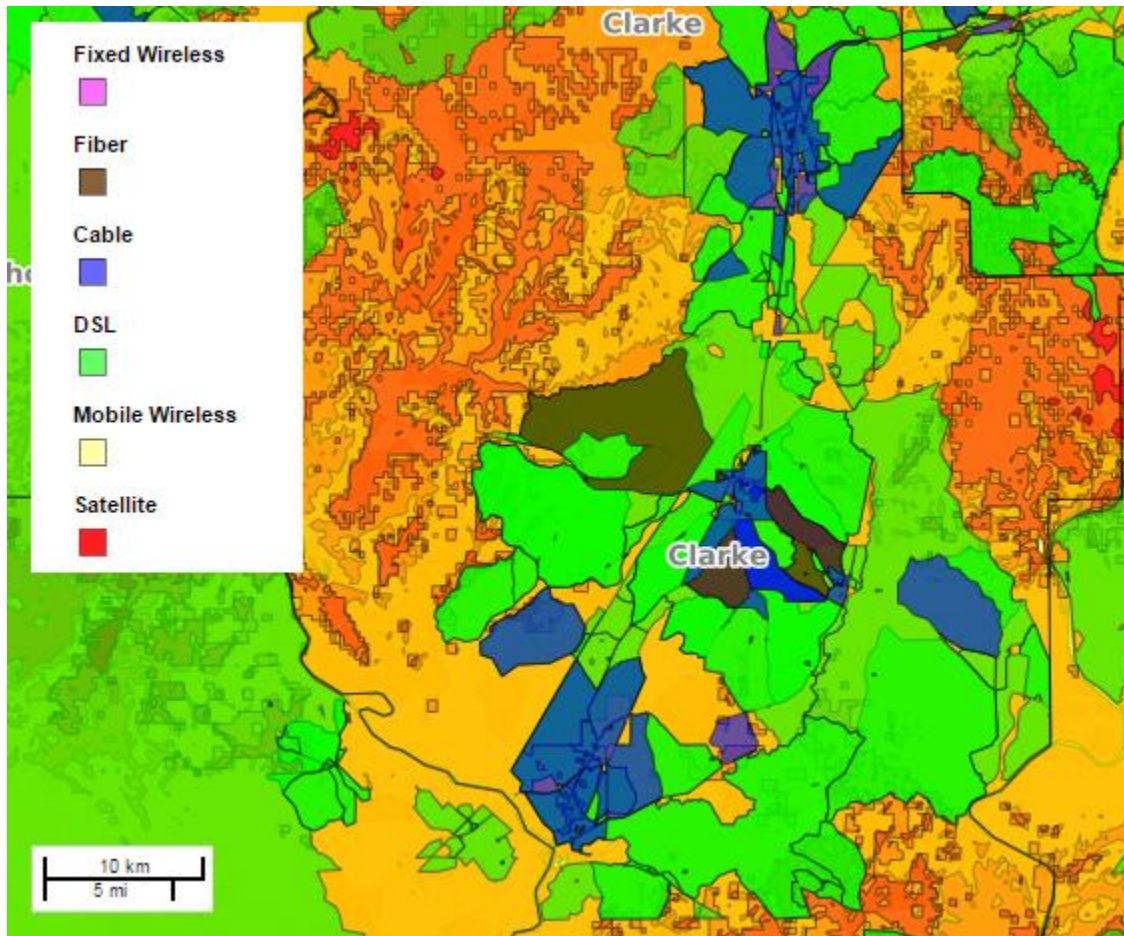
Map Source: Broadband Catalysts – Visualization of FCC Form 477 Data. Fixed June 30th 2015. Mobile December 14th 2014.
Base map provided by OpenStreetMap

Telehealth holds special promise in Appalachia as an answer to many of the challenges that characterize health care delivery. Telehealth services depend on broadband Internet for the enormous bandwidth and speeds required for remote delivery of videoconferencing, high-resolution diagnostic imaging, and real-time streaming of electronic health records. Compared with traditional practices, telemedicine delivers cost savings to patients, providers, and payers, as well as comparable quality, outcomes, and patient satisfaction. Beyond infrastructure challenges, disparate state rules and regulations further complicate its adoption and use for cross-border and specialty-practice use.

Rural Hale County in Alabama reflects many of the challenges typifying health care in Appalachia. Its small (15,406) and dwindling population declined almost 4 percent between 2000 and 2015. This is a very distressed community where 26.6 percent of the population lives in poverty, 39 percent qualify for Medicaid, and more than 23 percent of adults have not completed

high school. A quarter of the population is on disability and two-thirds of the 16.9 percent who are older than 65 live alone. Confounding this, Hale County has the state's largest shortfall of primary care providers and no public transportation. With the help of ARC, local health area provider Whatley Health Services (WHS) is looking to telehealth to bring better care to the citizens of Hale County.

In 2011, WHS leveraged a grant from ARC to obtain the medical and dental equipment, technology, electronic health licenses, and training needed to operationalize a new facility in Greensboro, Alabama. Electronic health records went live in 2012, and electronic dental records in 2015. The telehealth services are enabled by redundant infrastructure that leverages limited human-resource capacities, with a centralized, 3-person IT staff maintaining networks that connect the Hale County facility to the larger 12-site Whatley service centers in 8 surrounding counties. This continuity of shared, specialized-consult services, such as radiology, in critical-care situations or emergency conditions, like when devastating tornadoes sweep the region, is important. Cost savings are significant with improved operations and real-time record-sharing with remote colleagues. Record accuracy and security have improved, as has patient satisfaction.

The lack of personal or public transportation or the ability to pay for transportation prohibits trips to major medical service centers by many residents. The WHS initiative highlights the benefits telemedicine holds for rural communities. Relationships between WHS and larger, remote, medical research and training centers have been strengthened, paving the way for access to specialized research and education programs; for example,: local AIDS patients now receive education and support services remotely though a partnership with the Medical School at the University of Alabama at Birmingham. Thus, students and practitioners at urban partner organizations are exposed to the challenges and opportunities to be found in rural health settings.

Additional useful information on steps to a successful Telemedicine program can be found here: http://www.amdtelemedicine.com/downloads/10_steps.pdf

Chapter 5: Models of Broadband Deployment

Your broadband planning committee is hard at work, establishing relationships with key stakeholder groups and building trust through public-engagement efforts. The information gathered that documents gaps, assesses bandwidth needs, inventories existing service options and assets, and characterizes the utilization and digital readiness of the community will be crucial as you begin to explore options for deploying and operating the new network. The following discussion borrows significantly from the NTIA Guide to Public Private Partnerships in the review of common deployment models and offers best-practice examples.[39]

Public-Private Partnership

Partnerships in a broadband-deployment venture can be useful in accessing the technical skills and knowledge needed to determine if there is sufficient demand to develop a successful deployment and to manage and maintain the infrastructure once deployed. Partnerships enable communities to leverage limited public funds though cost sharing and enhance revenue by finding anchor tenants, such as schools, libraries, community centers, and nonprofit health clinics. In all cases, successful partnership can leverage public financing, community assets, and local leadership in collaboration with private-sector expertise and capital to expand broadband. Partnerships to design, deploy, and operate broadband networks are important.

Private-Sector Led

A commercial operator (private or non-profit) builds, owns, and operates the network. The role of the public-sector partner is to enhance the business case for the development. Contributions from Community Anchor Institutions and economic development authorities may include some combination of planning, monetary and regulatory support, demand aggregation, and securing customer commitments in advance.

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[39]National Telecommunications Information Administration. (January 2015). An introduction to public-private partnerships. [PDF] Retrieved from http://www2.ntia.doc.gov/files/ntia_ppp_010515.pdf

Private-Supported and Government-Led

The public partner can use an existing organization, such as a municipal electric system, or create a new partnership. The public entity owns the network, and private partners construct, operate, and maintain the network in exchange for financial and in-kind support.

Joint Ownership

Commercial operator(s) (private or non-profit) and the public enterprise co-invest in the network and share capacity. Finances are contributed by both, as well as in-kind and other support for the project. The public partner can provide significant valuable in-kind support with regulatory issues relating to use of pole attachments or through the use of public assets, such as water towers.

Beyond Infrastructure: Partnering to Grow a Connected Community

Partners can use surveys, interviews, inventories, and public-engagement exercise conducted during the planning stages of the broadband effort to develop targeted awareness and capacity-building programs. For example, partners should work together on public-relations campaigns to promote the benefits the new network brings to the community and co-develop computer and digital literacy training. Community stakeholders who have been active in the pre-deployment planning and public engagement can continue to play important roles in ensuring the success of outreach efforts once the network is complete.

Municipal, Electric and Telephone Cooperative Deployment

During the coming years, all of the companies that deliver telephony, the broadband Internet, electricity, as well as other utilities (water, for example), will find new technologies to aid them in delivery of services to their customers. It is not always possible to find operational information about private-sector utilities, but noted below is an example of comparison of electric-cooperative utilities operations with private-sector and municipal electric utilities. In the future, you may see cooperation between these different sector companies to provide cost-

effective services, or individual utilities may begin to offer two or more different utility services to your home; for example, electric-utility cooperatives may begin to offer broadband in partnerships with telephone cooperatives; public-private partnerships between a private telephone company and a telephone cooperative or municipal electric- and water-utility companies may begin to offer broadband Internet to homes. New technologies facilitating the development of these novel partnerships could include drones, nanotechnology, robotics, and the Internet of Things.

Utility Cooperatives - A Promising Deployment Model

Electric Cooperatives

National Rural Electric Cooperative Association (NRECA) is the national service organization that represents more than 900 private, not-for-profit, consumer-owned electric cooperatives (Co-ops) that serve 42 million people in 47 states. Compared with all electric utilities, Co-ops serve on the average 7.4 consumers per mile of line and have annual revenue of around $16,000 per land mile. Investor-owned utilities average 34 customers per mile and collect approximately $75,500 per mile, and publicly owned utilities, or municipals, average 48 consumers and collect $113,000 per mile. Distribution cooperatives are the foundation of the electric cooperative network. They are the direct point of contact with the member-owners in the delivery of electricity and other services. Generation & Transmission cooperatives (G&Ts) provide wholesale power to distribution co-ops through their own generation or by purchasing power on behalf of the distribution members. Thirty-two statewide associations publish newspapers or magazines for the co-op consumer-owners, reaching more than eight million readers each month. Co-ops have a different business model with extended break-even periods to recoup capital investments, making them especially strong potential partners for communities in their service areas.[40]

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[40] NRECA (2016) Facts, Retrieved from: *http://www.nreca.coop/about-electric-cooperatives/co-op-facts-figures*

Electric cooperatives are:

- *Private, independent, non-profit electric utility businesses*
- *Owned by the customers they serve*
- *Incorporated under the laws of the states in which they operate*
- *Established to provide at-cost electric service*
- *Governed by a board of directors elected from the membership which sets policies and procedures that are implemented by the cooperatives' management*

Telephone Cooperatives

There are 260 U.S. telephone cooperatives, also known as Telephone Membership Cooperatives (TMCs), that were established to provide quality telecommunications service at a reasonable cost. There are approximately 1.2 million rural Americans who are served in 31 states. In the past, these cooperative have been located in rural areas but today some are also serving customers that are located adjacent to their normal rural areas.

Historically, they have provided local telephone services, long-distance telephone operations, direct-broadcast satellite, wireless, TV, mobile radios, cellular and key systems, and Internet access. Today, these companies are focusing on provision of broadband Internet services to their customers. Generally, they operate at cost in order to provide excellent services, but they must also accumulate equity capital to support ongoing operations and future initiatives. Net earnings allocated to members are based on patronage called "capital credits." The underlying value is retained for a period of time. These capital-credit retirement programs allow the value of accumulated capital credits to be returned, most often as credit on their customer's telephone bill. Members elect a board of directors from among their members. Each member has one vote. Bylaws may state that directors must be selected from territorial districts and may restrict voting to members who live in the territorial district. Directors are not normally compensated for service. Building on a history of grant and loan support from the USDA's Rural Utility Service for delivery of services to rural communities, telephone co-ops are emerging as strong, innovative broadband partners for rural communities.[41]

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[41] University of Wisconsin Center for Cooperatives. (n.d.). Rural telephone cooperatives. Retrieved from http://reic.uwcc.wisc.edu/telephone/

An excellent example of this model is profiled below --Wilkes Telephone Cooperative bringing fiber to the homes in rural northwestern North Carolina.
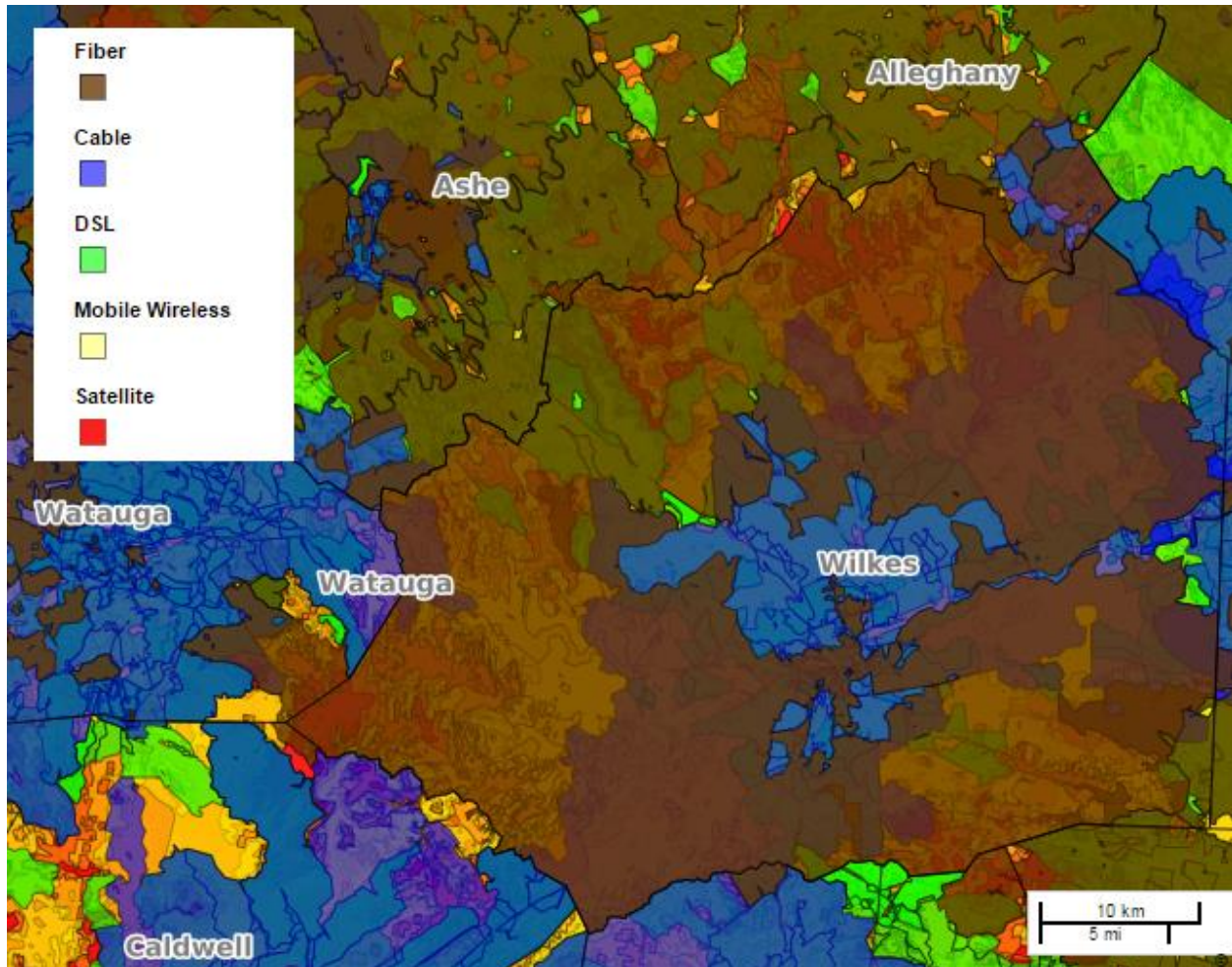
Map Source: Broadband Catalysts – Visualization of FCC Form 477 Data. Fixed June 30th 2015. Mobile December 14th 2014. Base map provided by OpenStreetMap

Wilkes Telephone Membership Corporation

Wilkes Telephone Membership Corporation is a TMC operating in Northwestern North Carolina and has been in business for over 60 Years. Wilkes TMC operates as Wilkes Communications (Wilkes) and is one of eight TMCs in the state. Wilkes' parent company is a cooperative that primarily serves members in Wilkes County and parts of Watauga and Alleghany counties. The cooperative service area consists of approximately 560 square miles serving the foothills, the Brushy Mountains, and the eastern side of the Blue Ridge Mountains along the Appalachian Trail.

Wilkes operates as a regulated incumbent local exchange carrier (ILEC) in its cooperative footprint and has also established a competitive local exchange carrier (CLEC) that began offering service in 2007 in Wilkes County, where Century Link provides wireline service. Wilkes has overbuilt its entire network with an all Active Ethernet, all IP, and all fiber-optic FTTH network. This overbuild was completed in 2015 and has passed over 14,700 structures in its ILEC cooperative footprint and 4,800 structures in its CLEC serving area. This $44M project was aided by being awarded a $15M ARRA RUS BIP grant. Wilkes plans to serve the remaining 18,000 structures in Wilkes County with fiber as well. The Wilkes network provides Voice over Internet Protocol (VoIP) services, Internet Protocol Television (IPTV), surveillance and health monitoring, IT-managed services, and broadband Internet with speeds ranging from 25Mbps up to 1Gbps available to every single subscriber.

Wilkes created RiverStreet Management Services in 2015 to pursue opportunities outside of the Wilkes County core footprint as RiverStreet Networks. Wilkes/RiverStreet currently serves customers in 15 counties in North Carolina. Wilkes/RiverStreet recently purchased three ILECs in North Carolina, located in and around the towns of Barnardsville, Saluda, and Fair Bluff. Wilkes has already begun to upgrade these networks from the current copper infrastructure to an all-fiber network exactly like the one Wilkes already maintains. This build will pass an additional 5,000 plus structures over the next three to five years. These properties will be branded and served as RiverStreet Networks. Wilkes/RiverStreet recently engaged in a public-private partnership (PPP) with Stokes County Government (Stokes) to expand its network footprint to over 5,000 structures in Stokes. Stokes issued a Request for Proposal (RFP), and Wilkes was awarded a grant to pass unserved customers in Stokes County not having access to broadband at speeds of at least 25/5 over a three-to-five-year build plan. Wilkes has already begun construction and plans to edge out off an initial backbone network where marketing studies show demand exists.

Wilkes/RiverStreet is actively engaged in pursuing other opportunities with county governments and municipalities to build a case to enter into the same type of partnerships throughout the state. Wilkes is part of several partnerships with other TMCs throughout the state. Wilkes is part owner of a regional fiber-optic network called Access-On. Access-On connects Wilkes, Yadkin, Surry, Skyline, and Randolph TMCs through northwest and central North Carolina. Wilkes, Surry, Skyline, and Yadkin TMCs also own Visions West, a jointly operated and shared head-end to provide signals for programming for IPTV service. Wilkes, Surry, and Skyline also jointly own Carolina West Wireless (CWW). CWW has its headquarters in Wilkes County and serves an expansive footprint covering most of western North Carolina. CWW is going through a complete 4G

LTE network upgrade and is a Verizon LRA partner, as well as a network partner for Sprint. Wilkes most recently jointly purchased Codero, which operates a nationwide data center. The eight TMCs comprise the membership of the North Carolina Telephone Cooperative Coalition (NCTCC) – Carolina Link. All of the TMCs in North Carolina are in different stages of growth and upgrades of their networks to an all-fiber FTTH platform. They have a long and rich history of investing in rural infrastructure and the communities they serve.

Eric Cramer

CEO Wilkes Communications

January 21, 2016

Municipal Deployment

Across America and in the Appalachian area, there are municipalities deploying high-speed broadband, in particularly gigabit networks. Chattanooga, Tennessee's electric utility is an example of a successful broadband initiative.[42] [43] A quick read of the EPB Chattanooga website will provide insight into their programs that are bringing the citizens, businesses, and institutions of Chattanooga into a competitive economic future.

Historically, there has been an intensive effort to prevent cities, counties, and even states from becoming involved in providing broadband to their constituents when the local telephone-exchange provider is not willing to move forward with these gigabit offerings. This is a dynamic situation in which the local demand for faster and better broadband may energize grassroots efforts to resolve their need for better service. These communities will need to work closely with their legislative bodies to make sure that there are no regulations that would prevent them from seeking a gigabit future. The Institute for Self-Reliance has been very much involved in providing a view of the changes among communities in America who have moved forward to provide their own broadband infrastructure; a review of their web site would be informative.[44]

A Self-Funding Model

An additional model—a self-funding one—was used by two different communities:

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[42] EPB Chattanooga. (n.d.)Your gig is here. Retrieved from: http://chattanoogagig.com/

[43] O'Toole, J. (May 20, 2014). Chattanooga's super-fast, publically-owned network. *CNN Money*. Retrieved from http://money.cnn.com/2014/05/20/technology/innovation/chattanooga-internet/

[44] Institute for Local Self-Reliance. (n.d.)Broadband. Retrieved from https://ilsr.org/initiatives/broadband/

Chattanooga, Tennessee and Wilson, North Carolina. Chattanooga Tennessee EPB and the city of Wilson, North Carolina self-funded their own gigabit networks. Both had their own billing systems, Chattanooga for electricity and Wilson also for electricity. As such, they had their own cost-accounting systems for electricity and water and could more easily view broadband as another item they would market to their current customers. Wilson worked hard overcoming its more than 5-year negotiation with a legacy wireline owner and a cable operator. Chattanooga had an easier time of it. Chattanooga utilized its new broadband offering as a model to create a smart and innovative city.

Chattanooga EPB began its life in 1935 providing electricity ultimately to more than 600 square miles. This was the result of a law passed by the legislature of Tennessee. On September 17, EPB fiber optics celebrated its fourth birthday with a third, free Internet speed increase for all residential customers. The price for a Gig (1,000 Mbps) was drastically reduced, with high-speed Internet choices simplified for residential customers: 100 Mbps for $57.99 per month and 1 Gig (1,000 Mbps) reduced to $69.99. In September, EPB reached a milestone with 50,000 residential customers now signed up for service. EPB provides electric power, digital cable TV, high-speed gigabit Internet, and phone. EPB services Chattanooga utilizing a community-wide fiber-optic network.

In July, 2014, EPB filed a petition with the FCC in an effort to respond to neighboring community requests for access to gigabit-enabled high-speed Internet service. Many communities surrounding Chattanooga either don't have access to high-speed broadband or any Internet services at all. The FCC is considering pre-empting state laws in 19 states which either prohibit or restrict municipal high-speed broadband deployment in underserved areas. Wilson NC Greenlight also filed along with EPB. See decision below.

Wilson NC Greenlight

Greenlight is North Carolina's only all-fiber-optic network.[45] Greenlight has bandwidth to support 1Gbps Internet, making it the highest-speed residential Internet available in North Carolina at the time of its initial deployment of l Gbps. Unlike other providers making promises for the future, Greenlight fiber technology makes this possible today! To meet customers'

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[45] About Greenlight - https://www.greenlightnc.com/about/

specific needs, Greenlight offers five levels of Internet bandwidth. Wilson worked for many years trying to develop a PPP but finally decided to move forward. It already had an electric distribution system and billing operations, so it already had many of the components needed to roll out a successful fiber deployment for broadband. It took them more than five years of working with various commercial providers but, as noted, was not successful in developing a partnership[46]. For $122.90 a month, Wilson offers cable TV, telephone service, and 40 mbps symmetrical Internet in its digital package. There are two more costly packages available.

Wilson and Chattanooga petitioned the FCC to allow them to begin to move outside their territory to offer services. Wilson was blocked by H129, a bill in the NC Legislature that passed in 2011 that prevented them from moving outside their territory of the city to offer broadband services. Chattanooga wanted to serve territories outside their normal area that were asking for broadband services. Chairman of the FCC Wheeler and commissioners decided in their favor.

WILSON RESPONDS WITH PRESS RELEASE February 26. 2015

CITY OF WILSON APPLAUDS FCC CHAIRMAN WHEELER AND THE COMMISSION FOR ITS LEADERSHIP IN DECIDING IN FAVOR OF LOCAL BROADBAND CHOICE

FOR IMMEDIATE RELEASE

NEWS MEDIA CONTACT

Will Aycock – 252-296- 3344

Email: waycock@wilsonnc.org

Wilson, N.C. -- The City of Wilson applauds FCC Chairman Wheeler and the Commission for their leadership today in approving the city's petition to preempt a North Carolina state law that restricts municipal Gigabit broadband deployment. Today's historic decision now enables Wilson and other North Carolina municipalities to provide the Gigabit broadband infrastructure and services that North Carolina and America need in order to remain competitive in our emerging knowledge-based, global economy. In Tennessee, the state filed in the Sixth Circuit US Appeals Court for review of the FCC's preemption decision. To this date, that decision has not been decided. However, the US Federal Court of Appeals in Washington this spring handed down a decision supporting the right of the FCC to make its earlier preemption decision. At publication time of this toolkit, there is a question whether this will be appealed to the US Supreme Court.

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[46] Greenlight Website - https://www.greenlightnc.com

Other Challenges After Deployment

The need for transparency in PPPs must always be seen as a challenge by all parties. Whenever public entities are involved in a partnership, citizens, local businesses, and local government officials want complete transparency. The need for someone who pays attention to maintaining the public presence of the partnership operations—and its capability of meeting its financial goals—is essential. The importance of the partnership is to be innovative and involve the local communities and businesses in these activities to assist all workers to build strong relationships among all stakeholders. Chattanooga EPB and Wilson both have been exceptionally good at transparency in all of their companies' activities.

Best Practice

Engage a Comprehensive Set of Partners

A broad set of commercial, government, and community partners provides advantages in executing ambitious projects and ensuring long-term sustainability. Close collaboration with other local and state government agencies can help streamline permitting and Rights-of-Way (ROW) access, especially for middle-mile networks that intersect many jurisdictions. A partnership with a consortium of schools and libraries can aggregate demand for a long-term, bulk-purchase contract. An alliance with commercial operators can invite investment support or capacity-purchase commitments and support for network maintenance and operations. For example, a middle-mile operator may require capacity to connect wireless towers or interconnect adjacent backbone networks. A local provider may want to serve specific pockets of residential or business customers. A research and education network may fund the connections to universities and other high-revenue anchor clients. A state government may operate its own network to connect government facilities.

Establish Early Measures to Facilitate Coordination

Having a large number of partners increases the complexity of coordinating the project, resolving conflicts, and governing the operations over the long term. During the planning stage, the community should document each partner's contribution and role in the project.

A Memorandum of Understanding (MoU) is a good initial instrument and may be binding or conditional. If non-binding, the community should establish a legal contract before

funds are transferred and project construction starts. During network deployment, the community should consider engaging an independent firm to manage the project and provide objective status reports. For every phase, a robust governance model will assist the partners in making critical decisions, resolving conflicts, and fostering inclusiveness, transparency, and overall accountability.

Future Proof with Extra Capacity

A network built with extra capacity offers many advantages. First, it "future-proofs" the network against data demand that very likely will continue to grow. Second, in the case of a fiber network, the marginal cost of installing extra fiber is minimal relative to the deployment cost. Third, the extra capacity can serve as a cost-effective way to acquire bandwidth from providers through fiber swaps or trades, for example, rather than having to pay cash or build new infrastructure. Finally, extra capacity becomes a critical asset that the investment partners can leverage to attract new partners or to develop new business models if the original model fails to achieve the targeted objectives.[47]

Understanding Capital and Operating Costs

This chapter is intended to provide communities and utilities with an idea of the range of different costs for a local fiber network. Because actual costs depend so greatly on the network being constructed, we have included ranges of costs for illustration.

This chapter focuses on a retail service model offered over fiber-to-the-premises (FTTP), which has been the most common among coop and municipal utilities. Under the retail model, the local government or utility becomes a competitive provider of voice, video, and data services. The model assumes the utility will define and update services on an ongoing basis, establish consumer level sales and marketing efforts, and establish consumer support services. The retail model requires a broad range of staff additions, training, marketing, and other activities to run and maintain.

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[47] National Telecommunications Information Administration. (January 2015). An introduction to public-private partnerships. [PDF} Retrieved from https://www.ntia.doc.gov/files/ntia/publications/ntia_ppp_010515.pdf

Capital Costs

Capital costs include fiber construction, installation to premises, electronics, and preparation of central office/hub facilities. At a general level, an FTTP build in an area of moderate density (i.e., 50 to 200 homes per mile), including electronics, might cost anywhere from $800 to $1,500 to pass each home or business and an additional $400 to $750 per location connected. As with any infrastructure construction, costs may vary widely depending on the specific area being built, and some costs will rise as the distance between premises increases. The cost range depends on many factors, but primarily on the: 1) breakdown between overhead and underground plant, 2) density of premises per mile of plant, 3) size of the project/available economies of scale, 4) length of the deployment, 5) prevailing labor costs, and 6) amount of pole make ready required.

We note that in areas of very low density (i.e., less than 10 passings per mile), the cost can exceed $10,000 per home/business passed. We have developed cost estimates for the various outside plant components based on available industry pricing for fiber and facility construction. A good practice is to perform detailed designs of representative areas of the system and generate estimates for each one, since there are numerous factors that can impact costs in a particular service area, including:

- *Home density*
- *Average home setbacks*
- *Percentage of overhead (aerial) versus underground construction*
- *Utility pole conditions and loading*
- *Congestion of underground right-of-way*
- *Soil conditions*
- *Guide to Fiber Planning for Communities and Utilities*
- *Restoration requirements for right-of-way disturbances, sometimes driven by permitting authorities, historical preservation organizations, and even homeowners' associations*
- *Overhead (aerial) construction*

Where space on utility poles exists, overhead (aerial) construction is the preferred method for most fiber-optic construction because it is typically far less expensive and time-consuming than underground construction. In an aerial electric-utility area the cooperative can install all-

dielectric self-supporting (ADSS) fiber cable in the utility space, thus avoiding pole replacement if the pole does not have sufficient clearance in the communications space. Estimated unit costs for the various outside plant construction materials and labor needed in developing the sample design are itemized in Table 1 and Table 2.

While materials costs are fairly consistent (depending upon volume), labor rates can vary greatly depending on the geographic region and the demand for personnel to perform outside plant construction. Labor costs will vary substantially according to demand for service. It is difficult to calculate labor charges without receiving firm bids from fiber-optic construction companies. Furthermore, a utility can potentially reduce costs by using in-house labor. Thus, it is necessary to examine labor costs within a likely range. Table 2 provides the most likely and worst-case labor estimates used in calculating our cost estimates.

Table 1: Aerial Construction Material Cost Assumptions

Item Unit Cost

- *60-count fiber Foot $0.65*
- *48-count fiber Foot $0.52*
- *24-count fiber Foot $0.44*
- *60-fiber splice case Each $338.75*
- *48-fiber splice case Each $271.00*
- *4-way tap 300 ft. Each $188.00*
- *6-way tap 325 ft. Each $231.50*
- *8-way tap 225 ft. Each $275.00*
- *12-way tap 200 ft. Each $365.00*
- *Fiber distribution cabinet (FDC) Each $13,000*
- *Hardware Foot $0.50*
- *Strand Foot $0.27*
- *288-count ADSS fiber Foot $3.75*
- *48-count ADSS fiber Foot $1.45*

Table 2: Aerial Construction Labor Cost Assumptions

Item Unit Low case/High case

• *Place strand Foot $1.25/$2.00*

• *Place ADSS fiber Foot $3.25/$4.50*

• *Lash cable Foot $1.80/$2.50*

• *Splicing Each $10.00/$45.00*

• *Place FDC Each $2,000/$5,000*

• *Place taps Each $15.00/$40.00*

Selecting a range of assumptions based on the discussion above, we find that aerial FTTP construction cost can range from $25,000 to $75,000 per route mile. These estimates do not include costs for make pole ready—the process by which utility poles are prepared for new cable attachments.

Utility company requirements, condition of existing plant, local permitting requirements and local code are all unique to an individual service area. In addition, some utility-pole owners allow the new provider to survey and perform any necessary changes on their own while others require that their own crews complete the make-ready work. During the make-ready survey, each pole is visited and attachments on the pole are identified and recorded. The height of the pole, anchor status, and location of pole attachments are captured in a "stick drawing." In addition, the proposed new cable attachment type and location is determined following utility pole owner, Rural Utility Services (RUS), and National Electrical Safety Code (NESC) requirements. Required changes in existing utility attachments are documented. Each utility examines the requested changes and submits an estimate for clerical, engineering, and inspection costs to the new operator. Typical make-ready work on the aerial plant includes raising or lowering lines, adding ground bonds, changing down guys, adding anchors, adding guards, and adding new attachment clamps. In some cases, the entire utility pole must be replaced for the new operator to attach to the pole.

Once the make-ready estimate is paid by the new operator, the utility or its contractor is permitted to complete the make ready. When construction is completed, the utility companies make a final inspection to ensure the plant was built according to plans. The utility companies then compare actual costs to estimated costs and reconcile the account. CTC estimates the average cost to complete make ready would range from $2,500 per mile in an area where poles

are not crowded to over $50,000 per mile where poles are crowded and many poles need to be replaced.

Underground Construction

Underground fiber-optic construction can vary greatly in cost depending on the type of construction, availability of space in the right-of-way, permitting requirements, and local ordinances in the areas of construction. In particular, traffic monitoring, lane closures, street and sidewalk repair (if any exist), and existing underground utility locations can affect the overall cost of construction. Many of the unknowns of underground construction cannot be determined until the final detailed design and walk-out are performed. Table 3 and Table 4 provide the material and labor costs used in our preliminary budgetary estimates. Due to the range of labor rates associated with construction, we include both low and high case labor rates.

Table 3: Underground Construction Material and Labor Rates Material Unit Cost

- *60-count fiber Foot $0.65*
- *48-count fiber Foot $0.52*
- *24-count fiber Foot $0.44*
- *60-fiber splice case Each $338.75*
- *48-fiber splice case Each $271.00*
- *4-way tap 300 ft. Each $188.00*
- *6-way tap 325 ft. Each $231.50*
- *8-way tap 225 ft. Each $275.00*
- *12-way tap 200 ft. Each $365.00*
- *Conduit Foot $2.00*
- *Splice vaults Each $550.00*
- *Tap vaults Each $200.00*
- *Fiber distribution cabinet Each $13,000*
- *Hardware Foot $0.50*

Table 4: Underground Construction Labor Rates

Labor Item Count Low Case/High Case

- *Place conduit Foot $1.80/$3.00*
- *Trench Foot $8.00/$20.00*
- *Bore Foot $10.00/$30.00*

• Pull fiber Foot $1.00/$2.50

• Splicing Each $10.00/$45.00

• Place FDC Each $3,000/$5,000

• Place tap vaults Each $150.00/$500.00

• Place splice vaults Each $650.00/$1,500

Selecting a range of assumptions based on the discussion above, we find that underground FTTP construction cost ranges from $60,000 to $250,000 per route mile, with the worst-case in a dense environment with extensive, costly restoration and hand digging required to locate existing utilities. Compared to many fiber construction projects targeting particular buildings or types of customers, complete FTTP construction is more costly on a per-route-mile basis.

Beyond Deployment: Other Challenges

Operating Costs

Operating costs for an FTTP network will vary dramatically based on the business model selected (retail, open access), services offered (broadband only, triple play), performance of services offered (best-effort data rates vs. committed interface rates), customer support levels (8am-5pm weekdays vs. 24/7), size of market (number of subscribers and geographic footprint of service area), and other factors. Some of the key cost areas are summarized below. Legal fees are not included in this list but will likely be an essential budget item.

Financing

Generally, a utility should assume two kinds of bonds. First, a 20-year bond will be needed to cover the cost of new fiber. Given current interest rates, we assume such bonds would be issued at an interest rate based on current market conditions and would be paid off in equal principal and interest payments over the 20-year depreciable life of the fiber. Second, we assume an additional bond would be needed to cover the remaining implementation costs, including headend equipment, operating equipment, customer-premises equipment and other miscellaneous costs. Most of this equipment investment depreciates over seven to 10 years, and the financial projections should include reinvestment and upgrade costs to keep the equipment useful over 20 years. This second bond is paid off over 10 years (reflecting the shorter life of the assets than that

of fiber) at an interest rate based on current market conditions. You will need to include bond issuance costs, a debt service reserve, and an interest reserve based on current market conditions. Any federal or other grant funds received for construction of the FTTP network would reduce the size of the bonds and the associated debt service.

Staffing

Sales and marketing staff are critical to the success of the business. Staffing requirements are highly dependent upon the local market; the more competitive the market, the greater role sales and marketing will play. The same rule applies for more new or innovative services, which require more consumer education to build demand. The ability to leverage other local resources will also impact the required sales and marketing staffing. A contract administrator might be required if the operation provides high-end data services, dark fiber, and other specialized services. Technical staff requirements will vary based on the services offered, which services are hosted, number of shifts, and other factors. For example, if the cooperative maintains its own cable television headend, the network will need at least one technician for its maintenance. The same is true for the broadband offering. Are the servers located on-site, or are they part of a wholesale service provided by another vendor? Requirements for field and support technicians can vary from one per 2,000 customers to one per 3,500 customers per shift. In addition, the operation may need a systems administrator and supporting staff. Customer service representatives and help desk support often range from one per 2,000 customers to one per 3,500 customers per shift. Outside fiber plant typically requires one technician per 80 to 100 miles of route miles of plant. This function can also be contracted out. Staffing costs also need to include ongoing training and other overhead costs. Considering all aspects of the operation, the cooperative will likely require skills in the following disciplines:

- *Sales/promotion*
- *Finance*
- *Internet and related technologies? Vendor negotiations*
- *Staff management? Networking (addressing, segmentation)*
- *Strategic planning? Marketing*

Marketing and Sales

It is important to be proactive in setting customer expectations, addressing security concerns, and educating customers on how to initiate services.

Internet Bandwidth

The size of the data pipe to the Internet and ultimate bandwidth cost per subscriber will vary according to the level of oversubscription and bandwidth sharing on the network. Oversubscription is defined as the ratio of the backbone transit Internet connection to the sum of the Internet connections provided to the utility members. For example, a residential-class broadband service may have an oversubscription ratio of 50 to 1 while some data-intensive businesses require a one-to-one ratio. Further, the cost of commodity bandwidth varies greatly across the country. In locations that have competitive backhaul markets, access can be less than $1 per month per Mbps while less competitive markets can see prices of more than $40 per month per Mbps, or even $100 per month per Mbps.

Billing

The cost of billing will vary based on the services and options offered. Billing for a data-only service can be relatively easy and cost less than $1 per month per subscriber. Billing for cable television and telephone services are more complex and require additional operating costs.

Maintenance

If fiber maintenance is done internally, the majority of this cost becomes a staffing expense. For underground plant, an additional expense will arise from locates. For aerial plant, pole attachment fees (if any) represent an ongoing operational cost. Ongoing maintenance and software licensing fees for hub and network electronics can exceed 15 percent of the accrued investment in the equipment. Ongoing maintenance on outside plant, exclusive of pole rental and locates, is approximately 2 percent of the initial capital cost per year although this will vary depending on the amount of construction in and around the rights-of-way; a utility will be able to better estimate the number after a few years of operations.

Telephone Service

Most utility networks offering telephone services today will find a partner to provide the interconnection to the public telephone network. This is typically negotiated on a case-by-case basis in the local market. The fees can often exceed 50 percent of the retail service price.

Video Content

Fees for video content depend upon two factors: number of subscribers and the channels offered. Each cable operator must negotiate the right to place a given channel in its lineup. Operators pay the content owners a monthly fee per subscriber rather than a flat fee. Content fees continue to rise at a faster rate than other expenses (often exceeding 10 percent per year). Small cable operators have limited buying power and typically do not have a content ownership stake (like some large cable operators), so they are often forced to sell cable services at a breakeven point or, worse, as a loss leader.

Bad Debt and Collections

In the retail market, some residential customers will move without paying their final bills and some businesses will go bankrupt or otherwise close their doors. In some service areas, the bad-debt percentage can remain relatively low (under 0.5 percent of revenues); in more challenging circumstances, losses can rise to as much as 3 percent or more of revenues.

Churn

Residential customers tend to switch services to respond to promotional offers. Some communities also have high resident turnover. Customer churn rates can range from a few percent per year to more than 1 percent per month. Churn costs include the cost of acquiring and hooking up a new customer. In a competitive market, most customer connection charges are waived, so churn can cost an operator more than $400 for each new customer acquired.

Equipment Replacement

Any equipment under the utility's control is relatively secure, so replacements are scheduled at predictable intervals and funded through depreciation accounts. If the service has customer premises equipment, that equipment is subject to theft and damage.

Facilities

The addition of new staff and inventory requires allocation of office and warehousing space. Like any commercial provider, the utility will need to invest in office space, warehousing space, network equipment space, and a retail storefront to help market the new services.

Training

Training of existing utility staff is important to fully realize the economies of adding a business unit. An acceptable benchmark is 4 percent of payroll per year.[48]

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[48]Wired Kentucky. (May 2015). Community fiber planning guidebook. [PDF] Retrieved from
http://kentuckywired.ky.gov/Resinfo/Documents/KentuckyWired Community Fiber Planning Guidebook 20150508.pdf
Costs here are assumed to be around the 2015 time frame.

Chapter 6: Funding and Partnerships

Funding and Technical Support for Broadband Planning and Implementation

Consider the entrepreneur: forward thinking and focused on bringing a new product or service to a market that may not be ready; needing to bootstrap investments and engage external partners to obtain essential technologies, expertise, and capital needed to realize their goals; compelled to take risks in the face of uncertain outcomes and resource constraints , especially development funds. If this description resonates, it is because community-driven efforts to bring competitive broadband to an underserved or unserved community are entrepreneurial. Fortunately, models for broadband funding pioneered by communities that have already traveled this route and funding resource guides have been created to facilitate your exploration of options to help underwrite implementation of your broadband plans.

Information and links to online resources offered in Chapter 9 are current as of this publication and have been gleaned from multiple sources. This information is meant as a guide to the array of programs, agencies, and models that exist and is not an endorsement of particular options. Further, programs and the nature and scale of assistance they offer are subject to change, so you are encouraged to use the links and contact information provided to access detailed information and updates directly from agencies' websites.

Good points of contact for identifying sources of technical assistance and insights on new funding options are the regional and state development/planning offices affiliated with select relevant federal agencies: the ARC[49]; U.S. Department of Agriculture/Rural Development[50]; and the US Department of Commerce Econimic Development Administration(EDA).[51] Some states maintain a broadband policy and planning office that may provide assistance.[52]

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[49] Contact information for ARC State Program Managers can be accessed at
http://www.arc.gov/about/StateProgramManagers.asp
[50] Contact information for USDA Rural Development Offices can be accessed at http://www.rd.usda.gov/about-rd/offices/state-offices
[51] Contact information for US EDA State Offices can be accessed at http://www.rd.usda.gov/contact-us/state-offices
[52] Strategic Network Group. (April 2014). The fifty states of broadband. Presentation at the 16th Rural Telecom Conference in Austin TX. Retrieved from: http://sngroup.com/states/

Start Local and Think Broadly

The planning process offers many opportunities to engage the interest, involvement, and (hopefully) investment of multiple organizations and businesses in efforts to improve broadband access and use. Their involvement is important: most broadband grants and/or loans require financial and/or in-kind match of resources as evidence of local support and commitment, so engaging local external partners early-on is vital. As an important first step to identifying and securing support you should inventory local, regional and state-level organizations that could be potential partners for the broadband effort. Look first to organizations represented on your steering committee and think broadly as you undertake this inventory. While few organizations have agendas that overlap completely with the broader broadband planning effort, there will be areas of coincident interests on which to draw. For example, a local hospital foundation that is interested in enhancing health-care delivery and outcomes through enhanced capacity to utilize telehealth services should be engaged as a planning partner and looked to for more tangible investment in the implementation efforts to follow.

Similarly, the best options for implementing comprehensive or phased plans may involve staged funding from more than one federal and/or state agencies. As an example, a comprehensive plan could include looking to the NTIA for planning and technical assistance, the USDA's Rural Utilities Service for funds to address overall shortcomings in the access infrastructure, the EDA for facility and infrastructure assistance related to a new workforce training facility, and the U.S. Department of Health and Human Services to support infrastructure, training, and equipment needed to improve the local telehealth network, and so on.

The message here bears repeating: when undertaking broadband planning and implementation projects, it pays to adopt a strategy of thinking broadly and strategically, engage local partners early on, require inclusion of broadband as a consideration in all public projects, and adopt a vision of nested projects that mutually leverage the resources needed to effect a comprehensive and sustainable approach to a more connected future.

Federal Assistance

Federal assistance to enhance broadband Internet access, adoption and use that targets anchor institutions, local, state and tribal governments comes in many forms:

- *Information*
- *Research*
- *Technical assistance*
- *Toolkits*
- *Grants*
- *Loans*

Some programs have as their primary purpose the improved access and use of broadband for community and economic development while others fund this goal in support of the primary programmatic goals. For example, a project to expand a farm-to-table food product program may be engaged to provide resources for broadband-related efforts to develop a supporting online market portal and training for agribusinesses recruited to the program. FCC funding for schools and library e-rate subsidies or telehealth networks can be leveraged in aggregation efforts to maximize communities' bargaining position with providers.

Sources of Information on Federal Support for Broadband

Facilitated access to information about opportunities and resources generally is available through the federal government's central funding portal at http://www.grants.gov/web/grants/search-grants.html and through the Catalog of Federal Domestic Assistance at https://www.cfda.gov/. Both portals support keyword searches and can be used to identify particulars related to status, eligibility requirements and agency/program contact information. NTIA provides a broadband funding resource that contains detailed information and web links to federal programs that provide resources and/or assistance related to enhancing the availability, adoption, and utilization of broadband Internet. This report can be found at http://www2.ntia.doc.gov/files/broadband_fed_funding_guide.pdf. Quick access to the programs detailed in the NTIA broadband funding guide is provided below in Table 5.

Table 5

Federal Programs Providing Support for Community Broadband Internet

Federal Agency	Program	Web Address	Broadband Funding Target					
			Infrastructure Deployment	Adoption and Digital Literacy	Public Computer	Planning	Research	Other
Appalachian Regional Commission	Telecommunications & Technology Program	http://www.arc.gov/funding/ARCGrantsandContracts.asp	X	X	X	X		
Federal Communications Commission								
	Connect America Fund	https://www.fcc.gov/document/fcc-releases-order-increase-connect-america-rural-broadband-speeds	X					
	E-Rate Program for Schools and Libraries	https://www.fcc.gov/document/fact-sheet-update-e-rate-broadband-schools-and-libraries	X					
	Rural Health Care Program	http://www.universalservice.org/rhc/healthcare-connect/default.aspx	X					

Federal Agency	Program	Web Address	Infrastructure Deployment	Adoption and Digital Literacy	Public Computer	Planning	Research	Other
U.S. Department of Agriculture - Rural Utilities Service	Rural Economic Development Loan and Grant Program	http://www.rd.usda.gov/programs-services/rural-economic-development-loan-grant-program						
	Telecommunications Infrastructure Loan and Loan Guarantee Program	http://www.rd.usda.gov/programs-services/telecommunications-infrastructure-loans-loan-guarantees	X					
	Farm Bill Broadband Loans and Loan Guarantee Program	http://www.rd.usda.gov/programs-services/farm-bill-broadband-loans-loan-guarantees	X					
	Substantially Underserved Trust Areas (STUA) Provision	http://www.rd.usda.gov/about-rd/initiatives/substantially-underserved-trust-area-suta	X					
	Community Connect Grant Program	http://www.rd.usda.gov/programs-services/community-connect-grants	X					
	Distance Learning and Telemedicine Grant Program	http://www.rd.usda.gov/programs-services/distance-learning-telemedicine-grants						X

Federal Agency	Program	Web Address	Infrastructure Deployment	Adoption and Digital Literacy	Public Computer	Planning	Research	Other
	Community Facilities Loan and Grant Program	http://www.rd.usda.gov/programs-services/community-facilities-direct-loan-grant-program	X		X			
	Electric Infrastructure Loan and Loan Guarantee Program	http://www.rd.usda.gov/programs-services/electric-infrastructure-loan-loan-guarantee-program	X					
	Rural Business Development Grants	http://www.rd.usda.gov/programs-services/rural-business-development-grants	X	X		X		
	Expansion of Rural 911 Service Access Loan and Loan Guarantee Program	http://www.rd.usda.gov/files/fact-sheet/RD-FactSheet-RUS-Rural911Access.pdf	X					
U.S. Department of Commerce – Economic Development Administration		https://www.eda.gov/funding-opportunities/						
	Public Works and Economic Adjustment Assistance	http://www.grants.gov/web/grants/view-opportunity.html?oppId=279842	X					

Federal Agency	Program	Web Address	Infrastructure Deployment	Adoption and Digital Literacy	Public Computer	Planning	Research	Other
	Economic Adjustment Assistance	https://www.eda.gov/pdf/about/Economic-Adjustment-Assistance-Program-1-Pager.pdf	X			X		
	Regional Innovation Strategies	https://www.eda.gov/oie/ris/						
	Partnership Planning	https://www.eda.gov/pdf/about/Planning-Program-1-Pager.pdf				X		
	Planning Program and Local Technical Assistance	http://www.grants.gov/web/grants/view-opportunity.html?oppId=280447				X		
U.S. Department of Commerce – National Telecommunications Information Administration (NTIA)	State and Local Implementation Grant Program	https://www.ntia.doc.gov/category/state-and-local-implementation-grant-program						
	BroadbandUSA – Connecting America's Communities	http://www2.ntia.doc.gov/						

Federal Agency	Program	Web Address	Infrastructure Deployment	Adoption and Digital Literacy	Public Computer	Planning	Research	Other
U.S. Department of Housing and Urban Development								
	Community Development Block Grants (including Section 108 Loan Guarantee Program)	http://portal.hud.gov/hudportal/HUD?src=/program_offices/comm_planning/communitydevelopment/programs	X	X	X	X		
	Public Housing Capital Fund	http://portal.hud.gov/hudportal/HUD?src=/program_offices/public_indian_housing/programs/ph/capfund			X			
	Public Housing Operating Fund	http://portal.hud.gov/hudportal/HUD?src=/program_offices/public_indian_housing/programs/ph/am		X	X			
	Multi-family Housing	http://portal.hud.gov/hudportal/HUD?src=/program_offices/housing/mfh		X	X			

Federal Agency	Program	Web Address	Infrastructure Deployment	Adoption and Digital Literacy	Public Computer	Planning	Research	Other
	Indian Housing Block Grants	http://portal.hud.gov/hudportal/HUD?src=/program_offices/public_indian_housing/ih/grants/ihbg	X					
	Title VI Loan Guarantee Program	http://portal.hud.gov/hudportal/HUD?src=/program_offices/public_indian_housing/ih/homeownership/titlevi	X					
	Native Hawaiian Housing Block Grants	http://portal.hud.gov/hudportal/HUD?src=/program_offices/public_indian_housing/ih/codetalk/onap/nhhbgprogram	X					
	Choice Neighborhoods Planning Grants	http://portal.hud.gov/hudportal/HUD?src=/program_offices/public_indian_housing/programs/ph/cn/planninggrants	X	X		X		

Federal Agency	Program	Web Address	Infrastructure Deployment	Adoption and Digital Literacy	Public Computer	Planning	Research	Other
U.S. Department of Labor, Employment and Training Administration		https://www.doleta.gov/grants/						
	Employment and Training Administration	https://www.doleta.gov/grants/find_grants.cfm		X	X			
Institute of Museums, and Library Services, Office of Library Services		https://www.imls.gov/grants						
	Native American Library Services Basic Grants	https://www.imls.gov/grants/available/native-american-library-services-basic-grants	X	X	X			
	Native American Library Service Enhancement Grants	https://www.imls.gov/grants/available/native-american-library-services-enhancement-grants	X	X	X	X		
	Native Hawaiian Library Services Grants	https://www.imls.gov/grants/available/native-hawaiian-library-services	X	X	X	X		

Federal Agency	Program	Web Address	Infrastructure Deployment	Adoption and Digital Literacy	Public Computer	Planning	Research	Other
	Laura Bush 21st Century Librarian Program	https://www.imls.gov/grants/available/laura-bush-21st-century-librarian-program		X		X	X	
	National Leadership Grants for Libraries	https://www.imls.gov/grants/available/national-leadership-grants-libraries		X		X	X	
	Sparks! Ignition Grants for Libraries	https://www.imls.gov/grants/availa ble/sparks-ignition-grants-libraries		X				
U.S. Department of Health and Human Services	Telehealth Network Grant Program	http://www.hrsa.gov/healthit/toolbox/RuralHealthIT toolbox/Financing/traditionalfunding.html	X					X
U.S. Department of Education	ConnectED/Office of Educational Technology	http://tech.ed.gov/wp-content/uploads/2014/11/Tech-Federal-Funds-Final-V2.pdf	X	X				

Non-Profit Partners

A number of non-profit organizations that are concerned with the digital divide provide equipment, software, training, and other resources to programs working to improve access to the Internet and digital literacy. Such organizations can be important partners in your efforts to address needs in all aspects of the local broadband ecosystem. Techsoup Global is an example of such organizations. Techsoup works with corporate donors, including Microsoft, Adobe, Cisco, and Symantec to provide non-governmental organizations, non-profits, libraries, and community-based organizations with the latest professional hardware, software, services, and educational content.[53]

Innovative Partnerships and Financing Models

Communities undertaking broadband planning efforts usually develop an appreciation for the mutual benefits that can be realized across various stakeholder groups when broadband availability, adoption, and use are increased. This shared appreciation provides a good template for pursuing creative solutions to the broadband challenges that confront the community. Best-practice models emerging from the BTOP and BIP broadband stimulus funding points to innovative partnerships and creative financing instruments as promising tools to fund infrastructure gaps and programmatic efforts needed to make Appalachian communities full participants in the digital economy. Illustrative examples and resource links follow.

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[53] See Tech Soup - http://www.techsoup.org

Public-Private Partnerships

Communities rarely have the financial or (in some cases) legal capacity to undertake broadband expansion projects on their own. One approach that has gained traction involves partnerships between public entities, usually local government and/or state agencies (health/education/public safety), and the private sector. Private partners are often existing Internet providers, providers recruited to the area or non-profit organizations formed to manage deployment and/or operations of the new infrastructure.Public-Private Partnerships (PPPs) are emerging as important approaches to addressing gaps in broadband availability and adoption. Two outstanding references with templates, checklists, and models include reports developed by:

- *NTIA – an overview of common broadband partnership models, the factors communities should consider in developing a successful partnership, and best practice gleaned through NTIA's oversight of $4.5 billion in BTOP broadband grants to public, private, and joint projects*
- *BroadbandUSA - Public Private Partnerships (PDF)*
- *Coalition for Local Choice (CLIC) (developed for the Benton Foundation) – a legal guide, models of partnership options, and checklists for legal and strategic consideration in forming a broadband PPP. The Emerging World of Public Private Partnerships,* www.benton.org
- *New Mexico Department of Information Technology Broadband Guidebook describes model for broadband PPP.* http://www.doit.state.nm.us/broadband/reports/NM_Broadband_Guidebook_v1_1_final.pdf

Excerpt from New Mexico Department of Information Technology Broadband Guidebook:

Chapter 5: Public-Private Partnerships
This section of the guidebook surveys a range of factors to be analyzed as a community considers entering into a public-private partnership to develop a broadband network. The variety of public-private partnership models reflects the diversity of interests, goals, and resources among the many communities seeking to build high-speed networks for their citizens.

Rural Infrastructure Opportunity Fund

When considering funding options, take a broader perspective and explore resources that might be accessed through creative approaches being taken by federal agencies and foundations to leverage resources for rural infrastructure and business- development needs. For example, the Rural Infrastructure Opportunity Fund was established in 2014 by the USDA and its private partner, CoBank,[54] to offer to a wide variety of new participants, including pension funds, endowments, foundations, and other institutional investors an opportunity to invest in and speed up development of rural infrastructure and market projects. Projects may be funded entirely through private sector dollars or may be leveraged with and extend critical government loan and grant programs. The USDA and other federal agencies help identify projects for funding, with broadband a key target for investment. Contact the USDA office in your state for more information on this program.

Self-Funding

A number of local government financing options are available to fund all or part of a comprehensive broadband expansion effort, including:

- *Bonds*
- *Grants*
- *Loans*
- *General tax revenue*
- *Capital contributions by anchor tenants*
- *Capital leases*
- *Tax Increment Financing (TIF) or other tax funds*
- *In-house/in-kind contributions*
- *Crowdsourcing*

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[54] For more information about the Rural Infrastructure Opportunities Fund, see http://www2.cobank.com/Products-Services/Public-Private-Partnerships/US-Rural-Infrastructure-Opportunity-Fund.aspx

For illustrative descriptions of communities that followed a self-funding approach utilizing promissory notes, donations, crowdfunding, or tax-credit financing, see the funding section of Virginia's *Wired* Toolkit.[55]

Closing Note on Funding

The NTIA's Broadband Funding Guide[56] offers excellent advice that closes the loop between planning and funding, noting that all organizations that provide broadband funds—federal, state, local, non-profit, or private—value the same things when evaluating funding requests; they all are seeking projects that are well-planned, broadly supported, and likely to succeed. Better broadband begins with a good plan.

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[55] Wired Virginia. Funding Models - http://www.wired.virginia.gov/toolkit/funding-models/

[56] NTIA (September 2015). BroadbandUSA: Guide to Federal Funding of Broadband Projects. [PDF] Retrieved from http://www2.ntia.doc.gov/files/broadband_fed_funding_guide.pdf

Chapter 7: Conclusion

Strategies for Setbacks and Roadblocks

Broadband planning is far from a prescription for obtaining complete and future-proofed coverage for your community. It can be, at times, difficult to convince community leaders and providers that your community should be their next investment. Broadband efforts can move at a snail's pace, two steps forward and one back, or not at all. The important thing is to persist and be open to new approaches, creative alternatives, and seeking help; many people who have taken the path you are on are willing to share their experiences.

If you are having trouble getting assistance from the local government, having your neighbors come to a meeting and publicly support you may help show that this is a widespread issue of concern to many. Another way to engage local leaders, who might not be swayed by the public need for access to broadband Internet, is to talk with local firefighters, EMT, and EMS stations, especially those in rural and remote communities. If those public safety agencies are suffering from a lack of connectivity, you will tend to find a very motivated and helpful audience who also tends to live in the area and understand the problem.

While many states have discontinued the state broadband initiatives, be sure to check to see if there is a state agency responsible for broadband planning efforts that may be able to help. At the local level, consider reaching out to local commissioners, planners, and managers. There may already be planning efforts underway with which you can coordinate. Also check Strategic Network Group's "The Fifty States of Broadband" (http://sngroup.com/states/). Persistence is key. The solutions to broadband availability issues are rarely solved in the short term, and it can be frustrating work as a result. Many successful projects take 3-5 years or longer to have significant impact.

If you have demonstrated demand but have not been able to attract providers to the table, look to see who provides service in adjacent markets. If you have mapped your demand and have at least some level of cooperation with the local government, you should have enough information to approach likely providers. While incumbent providers may not always provide service to all residents in an area, they can often provide parts of the solution to potential third-

party providers, such as fixed-wireless providers, who will need facilities that connect back to their main network or directly onto the Internet.

Should you find yourself still searching for support, review the 2016 Report on Broadband in States (link below), or consider attending a telecommunications conference, such as:

- *The National Association of Telecommunications Officers and Advisors (NATOA) -* natoa.org
- *Southeast Association of Telecommunications Officers & Advisors (SEATOA) -* seatoa.org
- *Rural Telecommunications Congress (RTC) -* ruraltelecon.org
- *2016 Report on Broadband in States* http://sngroup.com/states/
- *BBC Communities Summit,* 2017 Broadband Communities Summit

Focus on the Future

Rural broadband is a necessity for many people, and it is clear that providing this service in rural and sparsely populated areas is extremely costly and difficult to build and sustain on a for-profit or even non-profit basis. Communities are, however, not without ways to provide incentives to existing providers and attract new providers. There is no single, cookie-cutter solution to these challenges, and it takes a mixture of technologies and partners to get the job of providing comprehensive broadband coverage done, but with commitment and knowledge, a positive outcome can be achieved.

As time passes, the requirements on our digital infrastructure will increase along with the natural progression of technology, just as the amount of data transferred by a cell phone photo is many times larger than what it was in the early days of camera phones. Video will place greater demands on infrastructure and applications, such as GIS (geographical information systems) mergers with GPS, as well as virtual reality and biomedical applications transmissions, to name a few. New higher-resolution video standards will make video streaming a far more data-intensive practice than it is today. Personalized medicine and personalized learning will add to the daily use of these networks by individual citizens and institutions they interact with. Utilization of the networks for telemedicine, for justice, and for safety issues will be major stress agents on the network, far surpassing the significant strain it already puts on today's networks. And these are only the issues we can easily foresee; all of these, in addition to the more intensive use of networks by citizens and institutions focused on economic development, will enhance the necessity of future-proofing our networks in

order to remain economically competitive whether we live in urban or rural environments.

A Mantra for Progress

The message permeating this broadband primer and toolkit is simple: the future is digital, and the future is now. Competitive, sustainable communities have to develop and maintain the broadband networks required to support full participation in a global economy. That message is also complicated, especially for many Appalachian communities that are intrinsically challenged by geography and demographics that make achieving the needed connectivity through conventional market economics more challenging. Since convention is not likely to deliver solutions, you have to be prepared to take a path that is less certain, prone to resets and restarts, and undoubtedly difficult. There is no single, cookie-cutter solution to these challenges. It will take a mixture of technologies and partners to get the job of providing comprehensive broadband coverage done. There may be setbacks—financial, political, legal, and technical. Find people from across your community to join you in meeting this challenge, commit to common purpose, and pursue the goal for ubiquitous access and adoption for a stronger future, beginning today. Use the stories, tools, links to resources and advisors, and encouragement offered in this toolkit as guidance. And finally, internalize the following mantra to energize your efforts to deliver a better connected future:

<div align="center">

The Future is Digital!   The Future Is Now!

Plan— Partner— Persist — Progress

</div>

Chapter 8: Technology Primers

Internet Speeds

Internet speed is the most common metric that measures Internet connection quality. High speed Internet connections mean speed is measured in bits per second. Using a highway metaphor, to send 1.5 million bits per second (Mbps), then we need 1.5 million lanes. With every lane, the highway becomes wider or broader—thus, the term 'broadband."

Internet connection speed is measured in megabits per second (Mbps), though there are still dial-up and low-speed connections in use that are measured in kilobits per second (Kbps). There are 1024 kilobits in one megabit and 1024 megabits in a gigabit. Connection speeds are continuing to move towards gigabit networks. Families looking to stream multiple high-definition videos and/or multiple devices using high-bandwidth applications will benefit from the availability of higher Internet speeds.

Technology Types

Fiber-Optic Cable (Fiber)
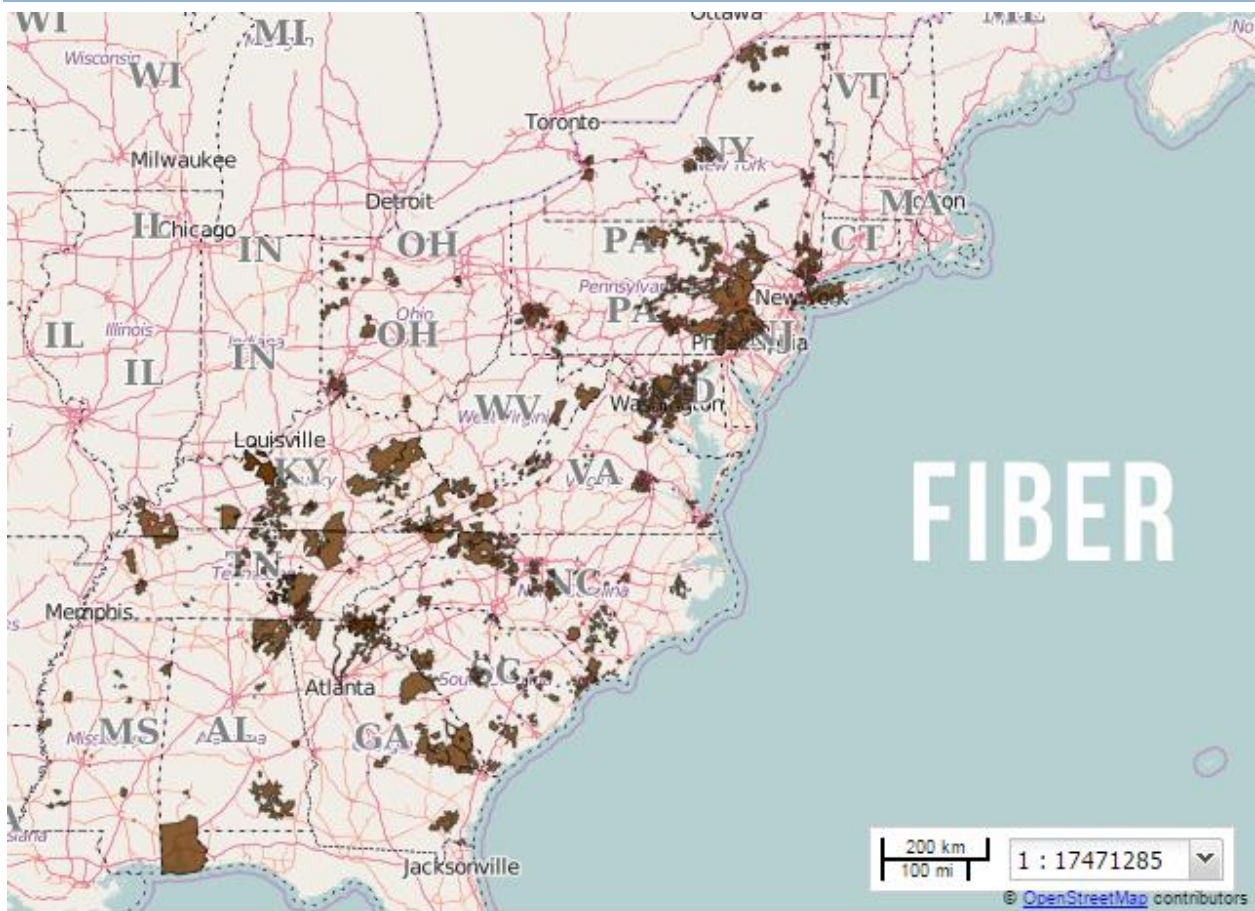
Fiber optic technology converts electrical signals to light and sends that light through very thin, transparent, glass fibers. Fiber transmits data at speeds far exceeding current DSL or cable modem speeds by tens or even hundreds of Mbps. Fiber can provide voice (VoIP) and video services, including video-on-demand. Most large network operators are offering fiber-based broadband in limited areas, expanding their fiber networks, and, in many cases, providing bundled voice, Internet access, and video services.

DSL

Map Source: Broadband Catalysts – Visualization of FCC Form 477 Data. Fixed June 30th 2015. Mobile December 14th 2014.
Base map provided by OpenStreetMap

DSL is a wireline transmission technology that transmits data faster over traditional copper telephone lines already installed to homes and businesses. DSL provides transmission speeds that range from several hundred Kbps to millions of bits per second. The availability and speed of your DSL service may depend on the distance from your home or business to the closest telephone company service facility.

Types of DSL transmission technologies:

ADSL (Asymmetrical Digital Subscriber Line) —ADSL provides faster speed in downstream direction than in upstream direction. It can also allow data transmission over the line used for voice service without disrupting telephone calls on that line. It is used primarily by residential customers.

SDSL (Symmetrical Digital Subscriber Line)—used by businesses for services like video conferencing. Downstream and upstream traffic speeds are equal.

VDSL (Very-high-data-rate DSL) provides very high-speed /robust connectivity for the provisioning of "triple-play" services that include voice, video, and Internet over a single connection.
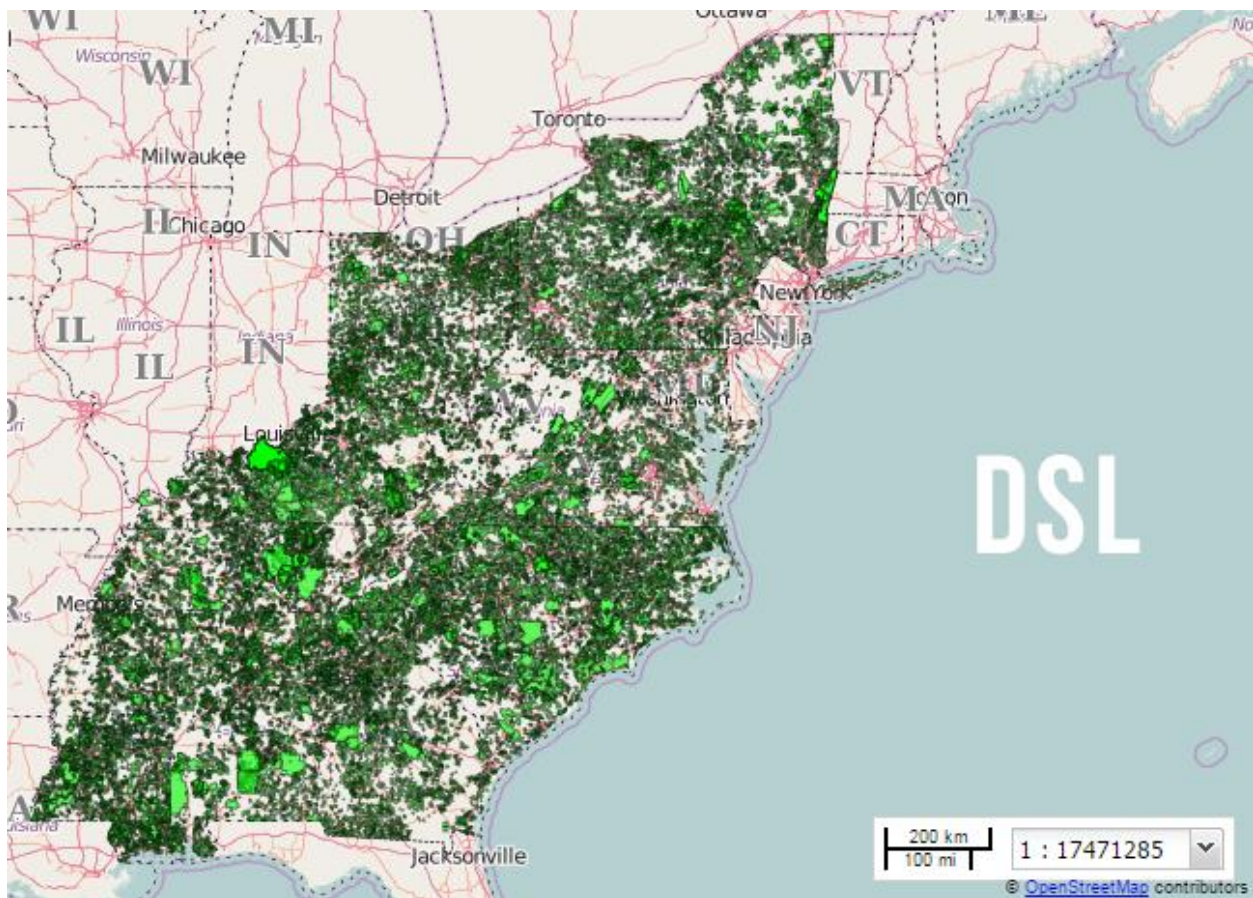
Cable Modem

Map Source: Broadband Catalysts – Visualization of FCC Form 477 Data. Fixed June 30th 2015. Mobile December 14th 2014.
Base map provided by OpenStreetMap
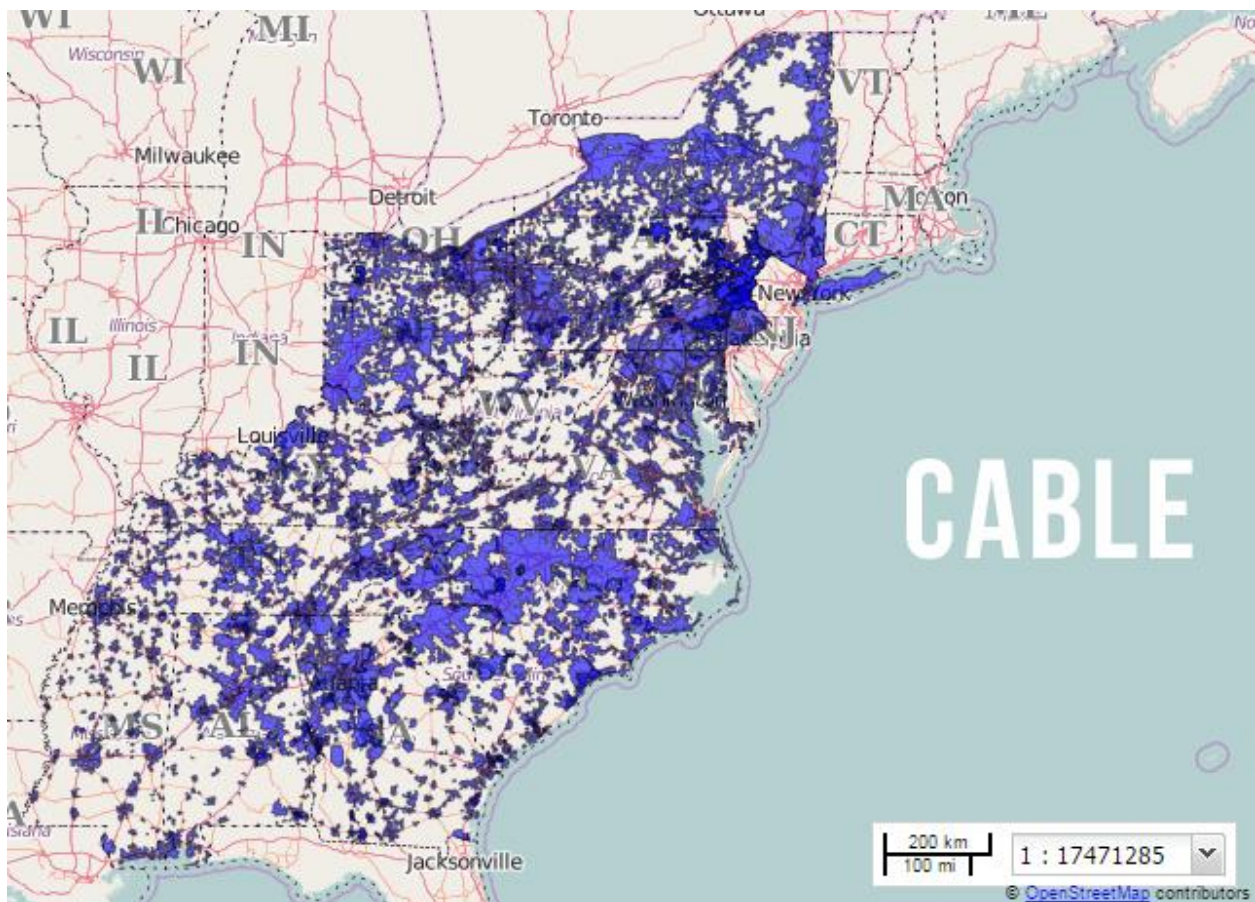
Cable modem service is used by cable operators to provide broadband using the coaxial cable that delivers picture and sound to your TV set. Most cable modems are external devices. They have two connections, one to the cable wall outlet and the other to a computer. Transmission speeds of 1.5 Mbps or more are provided. Speeds are usually faster than DSL. The new DOCSIS 30 protocol has enabled cable operators to feature service with download speeds of up to 260 Mbps and 120 Mbps of upload speeds.

Wireless

Fixed Wireless
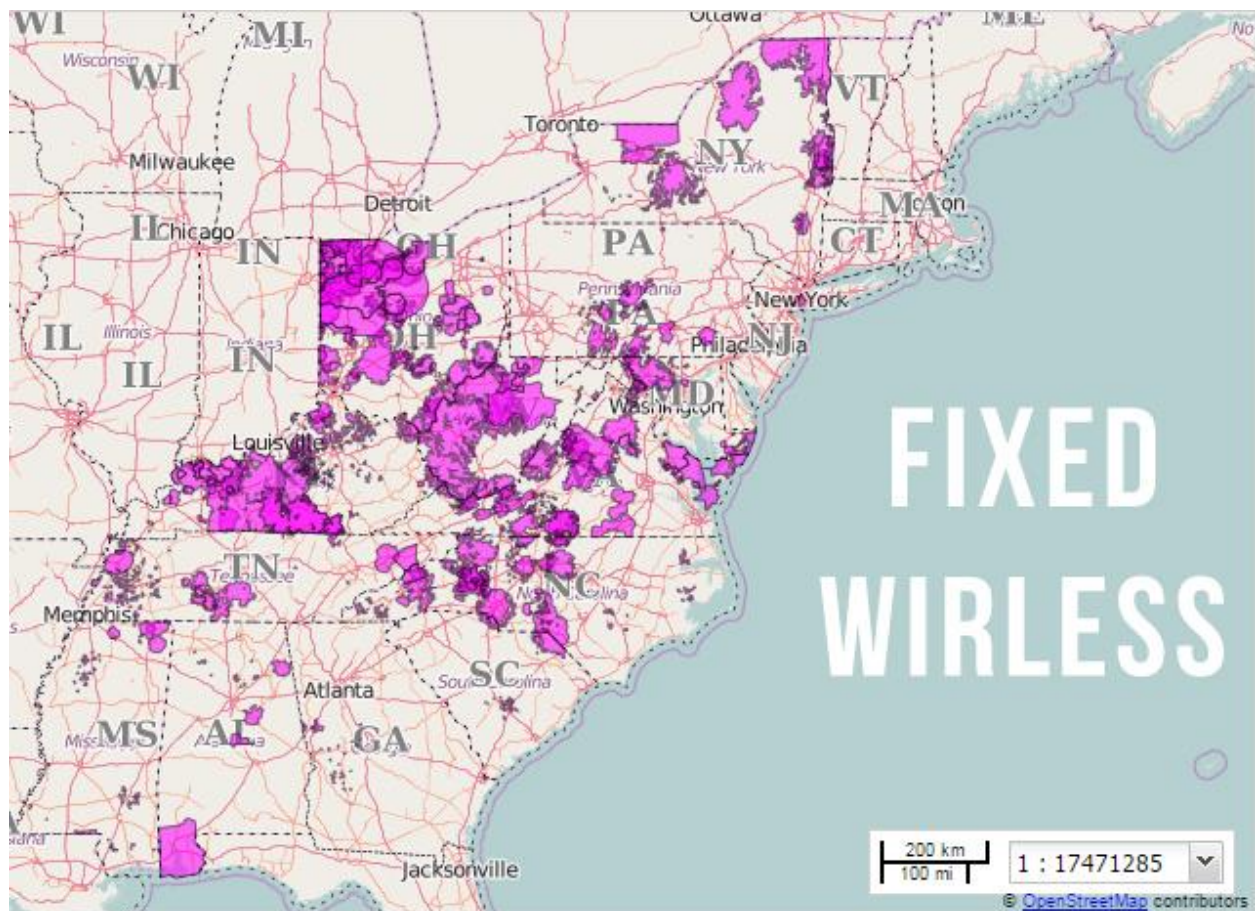
Map Source: Broadband Catalysts – Visualization of FCC Form 477 Data. Fixed June 30th 2015. Mobile December 14th 2014.
Base map provided by OpenStreetMap

Wireless broadband is either mobile or fixed. Wireless fidelity (Wi-Fi) is a fixed, short-range technology used often in conjunction with DSL or cable-modem service to connect devices in a home or business to the Internet. Wi-Fi uses a radio link between the customer's location and the service provider's facility. Often Wi-Fi is used in public spaces called "hotspots" found in parks or downtowns.

An external antenna is required. Newer services (such as WiMax) use a small antenna located inside a home near a window, and higher speeds are possible. Fixed wireless Internet requires line-of-sight (LoS) or near-line-of-site (NLoS). LoS requires an unobstructed view between the transmitter and the receiver. The transmitter is usually on a tower or tall structure, and the receiver is in a private residence or business. Trees, structures, and topography can all obstruct LoS and prevent service availability. LoS residences can connect to transmitters as far

away as 24 miles. NLoS availability enables connection to a tower that is 5 miles away. NLoS equipment enjoys greater range when an unobstructed view is present.

Mobile Wireless

Map Source: Broadband Catalysts – Visualization of FCC Form 477 Data. Fixed June 30th 2015. Mobile December 14th 2014. Base map provided by OpenStreetMap

Mobile wireless broadband services, such as 3G, 4G* and LTE (Long-Term Evolution), are also becoming available from mobile telephone service providers. These services generally require a special card with a built-in antenna that plugs into a user's laptop computer. Smartphones, mobile broadband personal hotspots, and MiFi devices can also be used to gain access to mobile broadband. Generally, 3G mobile broadband provides lower speeds, in the range of several hundred Kbps. Though most post-3G offerings do not meet the speed requirements of the official 4G specification, network providers may advertise their networks as 4G, as long as those networks provide a significant speed improvement over 3G offerings. LTE is an example of post-3G technology that is not yet capable of the 4G specification speeds but

can be advertised as 4G. The new wireless technologies can offer download speeds of 30 Mbps and serve sometimes as a viable replacement for residential broadband. If there are many users connecting through a single cell tower, capacity issues can result in degraded performance.
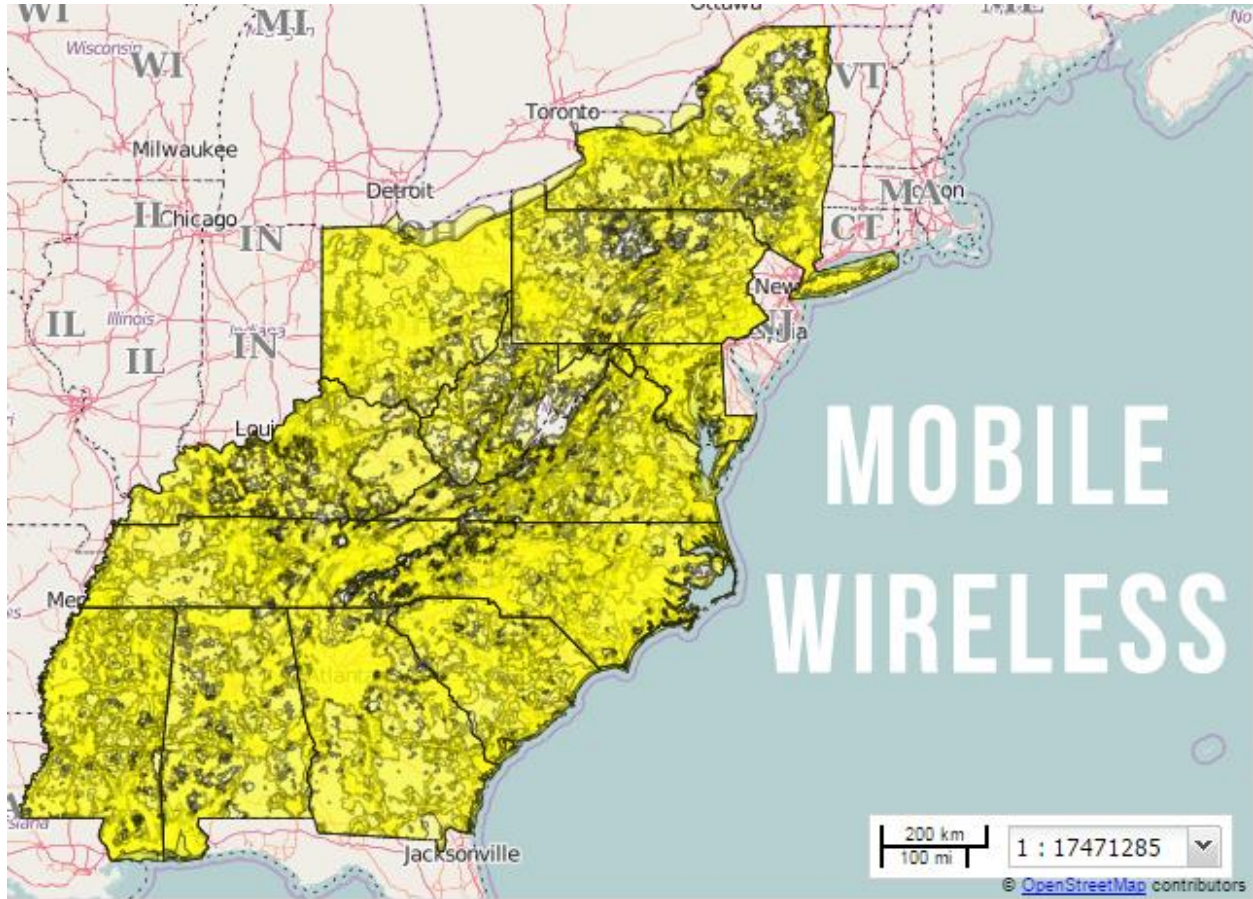
Satellite

Map Source: Broadband Catalysts – Visualization of FCC Form 477 Data. Fixed June 30th 2015. Mobile December 14th 2014. Base map provided by OpenStreetMap

Satellites can provide links for broadband service. It is another form of wireless broadband. A consumer can receive service at a speed of 1 Mbps and send (upload) at a speed of 200 kbps. Issues to consider are latency, data limits, and cost for a base station and a satellite Internet modem, rain fade, weather conditions, and a clear line of sight to the provider's satellite.

Just as satellites orbiting the earth provide necessary links for telephone and television service, they can also provide links for broadband services. Satellite broadband is another form of wireless broadband and is particularly useful for serving remote or sparsely populated areas.

Downstream and upstream speeds for satellite broadband depend on several factors,

including the provider and service package purchased, the consumer's line of sight to the orbiting satellite, and the weather. Satellite service can be disrupted in severe weather conditions or heavy cloud cover. Typically, a consumer can expect to receive (download) at a speed of about 1 Mbps and send (upload) at a speed of about 200 kbps. These speeds may be slower than DSL and cable modem, but the download speed is still much faster than the download speed of dial-up Internet access for most applications. While satellite-based broadband can provide fast download speeds, there are limitations that should be considered before investing in a new satellite Internet installation:

● *Latency – This is a measure of the time it takes for a request to reach its destination and then for a response to be received. Latency is measured in milliseconds (ms). Satellite-based Internet access generally suffers from high latency (greater than 200 ms on average). In contrast, dial-up is narrow band but low latency (less than 100ms on average). Fiber optic, cable, and DSL are all broadband and very low latency (less than 50ms on average). The result is that applications that require a single request for a large amount of data, such as watching a video, may perform reasonably well via satellite whereas applications that involve many requests that require rapid responses, such as video games, will perform poorly or not function at all.*

● *Rain fade – Internet via satellite suffers from a limitation similar to that of satellite television, which is rain fade, or reduced performance or availability during times of heavy precipitation or thick cloud cover. Outages under these types of weather conditions are unavoidable but are also temporary in nature.*

● *Data limits – There is only so much room for equipment onboard satellites, and adding capacity can be very costly; therefore, satellite Internet providers must conserve their available capacity in order to serve the most possible customers. Many satellite providers implement daily transfer limits. While the amount of data allowed for a single 24-hour period varies, a limit of 250MB per day is not unusual. These limits mean that while watching streaming video or other bandwidth-intensive activities may be technically possible via satellite, there are limits to how much of these types of media users will be able to consume in a single day. This limitation often precludes satellite Internet users from participating in distance learning and other Internet-based activities that non-satellite users often take for granted. When limits are reached, some providers cut off service for the remainder of the 24-hour period while others throttle the available bandwidth back to speeds similar to dial-up.*

● *Cost – Obtaining satellite broadband can be more costly and involved than obtaining DSL or cable modem. A user must have:*

    ● *A two or three foot dish or base station – the most costly item*

- *A satellite Internet modem*
- *A clear line of sight to the provider's satellite.*

BPL

Broadband over Power Line (BPL) delivers broadband over the existing low- and medium-voltage electric-power-distribution network. It is provided to homes through existing electrical connections and outlets. Speeds are comparable to DSL and cable modem speeds. The technical challenge of radio interference makes it currently available only in very limited areas. Many electric companies have deployed fiber alongside their power lines for managing the grid and, in a few cases, to provide last-mile broadband access to residences and community anchor institutions. BPL is not in widespread use in the United States due to technical challenges related to wireless interference.

Data Caps

Some Internet Service Providers limit the amount of data their plans include in monthly service. Common data caps on mobile broadband and satellite broadband ranges from l GB to 10GB per month. Wireline (DSL, cable, or fiber) plans have data caps ranging from 30 GB – 250GB. The sub-sections below can be used to estimate the amount of data transferred during common high-bandwidth activities.

Vonage

Voice Calling - As much as 110-350 MB/hour[57]

Skype

Voice Calling - As much as 108MB/hour up and down and 215MB/hour total

Video calling/Screen sharing - As much as 400 MB/hour up and down. 800 MB/hour total

Video calling (high quality) - As much as 1.2 GB/hour up and down and 2.4 GB/hour total

Video calling (HD) - As much as 4.4 GB/hour up and down and 8.8 GB/hour total[58]

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[57] Vonage.com - https://support.vonage.com/app/answers/detail/a_id/838/~/bandwidth-saver
[58] Skype.com - https://support.skype.com/en-us/faq/FA1417/How-much-bandwidth-does-Skype-need

Windows

Updating service packs - As much as 1GB

Netflix

Good quality streaming - As much as 0.3 GB/hour

Better quality streaming - As much as 0.7 GB/hour

Best quality streaming - As much as 2.3 GB/hour

Video Games

Initial download for online game - As much as 7.5 GB or more per computer

Online game play - As much as 0.5GB/hour[59]

Latency and Jitter

A separate metric is used to determine the actual time it takes to make a round trip between two computers (hosts) that are communicating. This involves assessing how quickly a computer talking to another computer can say hello and obtain a response from the other computer. This metric is called "latency", or, alternatively, "ping."

Wireline technologies, such as DSL, cable modem, and fiber-optics tend to have very low latency. Traditional satellite connections have been high-latency connections. This is due to the physical distance the data must travel: satellite data makes a 44,000-mile round trip from space.

Fixed wireless Internet connections (i.e., an Internet device that uses an antenna mounted on a physical structure that communicates with a terrestrial transceiver) provide connections with similar characteristics to wireline connections. High latency can result in poor performance of latency sensitive applications, such as Voice over IP (Skype, Vonage, etc.), interactive distance learning, Virtual Private Networks (VPNs), telecommuting software, multi-player games, and any other application that requires rapid "back and forth" communication.

Mobile broadband has a high potential for high fluctuation in latency. Environmental issues and potential data traffic issues can introduce latency of as much as 1000ms (a full second) with as much as 900ms fluctuation. This fluctuation in latency is called jitter. Latency and jitter are not constants; traffic and environmental conditions can cause these measurements

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[59] Netflix.com - http://support.netflix.com/netflix-manage-bandwidth-usage

to vary. Variations across technology types are displayed in Figure 4. If you would like to check your current latency and jitter, you can use an online tool like the one at http://pingtest.net

Figure 4: Latency/Bandwidth estimation by connection type

Connection Type	Bandwidth	Latency (Ping time)	Jitter
Wireline (DSL,Cable,Fiber)	High	Low	Low
Fixed Wireless	High	Low	Moderate
Mobile Broadband	Moderate	Moderate	High
Satellite	Moderate	Extremely High	Moderate
Dial-up	Low	Low	Moderate

Packet Loss

Consider your TCP/IP protocol—a set of rules computers used to communicate on the Internet. The Internet is not owned by a single company, and no one organization controls the entire path between a computer and the host it is trying to reach. Packets cross over a dozen or more providers' networks to reach the desired host computer. Internet data is sent in packets. To deal with the assumption that some of those packets will not reach their destination, TCP/IP has the ability to retransmit data. Retransmission accomplishes the goal of delivering data, but it does so at the cost of performance. Short-term packet loss is indicative of high-traffic conditions, and long- term packet loss can be indicative of a physical issue that needs to be repaired, such as a bad switch, cable, or bad router. Again, you can test for packet loss using a ping tool, such as that at http://pingtest.net.

Public Safety

Public Safety Communications

Public safety communications play an increasingly critical role in our society. Firemen need radios to communicate, and the new body-camera systems of police need mobile bandwidth to transfer and store video in the cloud. Public safety must be considered in all aspects of broadband planning. Broadband deployment in communities might need to have access to a county-owned tower but cannot afford the rates the county charges. The ability to provide remote firehouse and EMT stations with primary or backup Internet service, video surveillance, or other connectivity needs can make a difference in developing support for local broadband deployment.

Public safety infrastructure is one of the most robust and hardened in our communities, making it valuable but sometimes difficult to connect to. If a community, in its planning for broadband deployment, provides greater and more resilient communications to its public safety agencies makes smart use of their existing public safety infrastructure, and establishes agencies as community anchor customers, the potential to partner for broadband deployment becomes much greater.

FirstNet: A National First Responders Network www.firstnet.gov

FirstNet[60] has been obligated by Congress to take all actions necessary to ensure the building, deployment, and operation of the nationwide public safety broadband network. After 9/11, it became clear that the nation needed a single, ubiquitous, interoperable data network. First responders use mobile data terminals (MDTs), which rely on our mobile broadband infrastructure provided by the major cellular networks. Rather than create a new system, FirstNet seeks to expand the existing networks through planning, subsidy, and spectrum availability. The mobile broadband network, in an emergency, can shift all network resources away from consumers and to first responders. Public safety communication will be based on commercial standards for the first time, resulting in lower costs, consumer-driven economies of scale, and rapid evolution of advanced communication capabilities. FirstNet is intended currently to carry data traffic, such as building blueprints for firemen or running tags from a police officer's MDT.

Legal and Regulatory Issues

When your communities do not have the necessary broadband to enable citizens who live in sparsely populated areas to operate home-based businesses or to enable students to work on their homework from home, local governments can step in and determine how best to develop a competitive marketplace of communications networks. It is possible after reviewing the policy issues that have to be determined that a careful decision must be made to determine whether to move ahead with development of a communication network for the city, rural or urban area, or a regional network. The decision must be made between an open-architecture network, a private-sector run, public-private-sector-partnership network or municipal-owned network. Differences in organizational structure, governance, service options, revenues, liabilities, and risks need to be understood to make informed choices between these options. A useful checklist of questions that can inform policy makers who are evaluating options for government-owned broadband networks has been developed by and is presented in Figure 5 below.

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[60] For more information, access *www.firstnet.gov*

Policy Maker Checklist

The following checklist of questions is offered to state and local policymakers as a resource for evaluating proposals for government-owned broadband networks (GON). When considering a GON, understanding the contours and mechanics of local broadband markets is essential. Because these networks typically require long-term commitments of limited public resources and entail the assumption of substantial risk, decision-making processes should be as informed and comprehensive as possible.[61]

Figure 5 - Questions to Ask When Deciding Whether to Undertake a Government-Owned Broadband Network

Have local officials comprehensively examined the local broadband market? Such examination should encompass both the supply side and the demand side.	☐
On the supply side: • What is the nature of local broadband competition? How many total broadband options—wireline, wireless, satellite, etc. —do consumers have access to? • Are there barriers to further deployment by incumbent Internet Service Providers (ISPs)? New entrants? • Has the municipality analyzed how it could leverage its resources to facilitate additional network deployment by private ISPs? • Examples include reevaluating existing rights-of-way administration, tower-siting approvals, antiquated zoning laws, and franchising processes. • Has the municipality engaged ISPs in dialogues around meeting clear goals on the supply side? • Has the municipality clearly articulated its supply-side goals for broadband via RFPs/RFIs and/or other such means of public communication? • Are there opportunities to use public-private partnerships (PPPs) to address supply-side challenges? Pilot programs? Other experimental approaches?	☐
On the demand side: • Are there data available on the nature of local broadband demand and use? Are there data regarding adoption rates across the municipality? Are there cost-effective ways of gathering such data (e.g., via existing survey tools, anchor institutions, etc.)? • Has the municipality engaged experts in the private and non-profit sectors to identify barriers to more robust adoption and utilization? Has the municipality begun work to remove these barriers? • Has the municipality inventoried and examined existing resources on the demand side—e.g., training programs, anchor institutions, digital literacy initiatives? • Has the municipality attempted to work with and through local social infrastructures to address real demand-side needs?	☐

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[61] Advanced Communications Law and Policy Institute. (2013). ACLP policy maker toolkit. [PDF] Retrieved from http://www.nyls.edu/advanced-communications-law-and-policy-institute/wp-content/uploads/sites/169/2013/08/ACLP-Policy-Maker-Tool-Kit-June-2014final1.pdf

• Has the municipality attempted to forge PPPs with partners in the private and non-profit sectors? Have these partners attempted to leverage existing funding opportunities at the state and/or federal levels to support these efforts? • In unserved and underserved areas, have partners in the public, private, and non-profit sectors engaged in sufficient demand-aggregation activities to create favorable environments for new networks?	

The following checklist of questions identifies issues to examine on both the supply side and demand side.

Evaluating Related Municipal Factors	
Has the municipality evaluated basic infrastructure needs and weighted them against perceived and real broadband needs? These include developing plans to maintain roads, bridges, dams, electric-grid components, water-system elements, ports, and other basic public infrastructure for which state and local governments are responsible.	☐
Has the municipality identified the full range of economic, social, and infrastructural opportunity costs associated with building a GON? Are there opportunities to achieve core public goals for broadband and new technologies generally without endeavoring to build a municipal network or otherwise interfere with organic market forces?	☐
Does the municipality have a balanced budget? A surplus? A deficit? Is it financially solvent? Are there competing priorities for funding? Is the municipality assuming additional debt (e.g., under-funded pensions)?	☐

Questions to Ask When Reviewing a GONs Proposal

Numerous non-GONs options may be available to address broadband issues on both the supply and demand sides. As such, state and local policymakers should carefully consider the myriad costs, risks, and complexities associated with owning a GON. When evaluating whether to invest in or approve a proposal for a GON, an array of variables should guide decisions. The following questions are offered as a guide for policymakers to use during these intricate undertakings.

Have policy makers exhausted other options for bolstering broadband from both the supply side and demand side?	☐
What is driving consideration of a GON in a particular municipality? Are there actual problems or issues that policymakers are seeking to address with a municipal network?	☐
Are policymakers looking to generate income? Spur the local economy? Make the local broadband market more competitive? Are they responding to unsolicited proposals?	☐
Have policymakers and planners consulted and involved constituents in the process? Have policymakers created opportunities and a process for informative dialogue amongst citizens and stakeholders during review and planning stages?	☐
With regard to reviewing specific GONs proposals: • Does the network plan consider and address the range of possible negative outcomes—e.g., low consumer demand, reaction by private ISPs, legal challenges, state preemptions, etc.? • Are performance and outcome expectations—among policymakers, the public, etc.—for the network grounded in solid data and analysis? Are assumptions and predictions about costs, take rates, and competitive impacts supported?	☐

• Have policymakers and planners addressed the challenges associated with network construction and maintenance? Factors include population density, geographic considerations, and recurring network costs. • Does the network plan have one or more "end games" or exit strategies? • Does the plan adequately consider (and contain strategies regarding) the market strengths and possible responses of private- sector providers? • Does the plan create competitive or regulatory advantages for the proposed municipal provider compared to non-municipal providers?	
Cost Financing and Business Policy Review	
With regard to costs: • What is the estimated cost of the GON? Does this estimate encompass all aspects of maintenance, operation, and technology upgrades? • What is the expected cost of hiring experienced management and expert staff, necessary for operating a network in a competitive market? • What is the expected cost for marketing and consumer outreach? Have these and other related costs been factored into the cost projections? • Have policy makers contemplated the costs associated with unwinding the network in the event of failure? • Have policy makers considered the risk and additional costs of a negative credit action (e.g., a credit downgrade) against the locality or parent utility as a result of a GON's financial or operational difficulties?	☐
With regard to financing: • How will the network be financed? Will this entail the assumption of debt by the municipality or by a quasi-public entity (e.g., a public utility)? • How much debt will planning, construction, operation, maintenance, and technology upgrades require upfront? Over the long term? How long will it take to repay these debts in the best-case scenario? How long in the worst-case scenario? Have policymakers quantified these scenarios? • Who bears the financial risk of network failure? Bond default? Are taxpayers shielded from these obligations? • Does the business model use alternative funding mechanisms that would limit taxpayer exposure to the costs of failure? • To what extent does the financing plan revolve around government grants or other public assistance? Are these funds guaranteed? Provided in lump-sum upfront or an installment basis? Is this aid conditional (e.g., tied to certain performance metrics)? • Has the municipality explored the feasibility of indemnification of public outlays if a network fails? This might be appropriate in instances where GONs proposal are offered unsolicited to municipalities.	☐
With regard to proposed business models: • Is the proposed business plan reasonable when measured against actual consumer demand for broadband services and when measured in light of competitive conditions in local markets? • To what extent does the business model hinge on cross-subsidies (e.g., by a parent electric utility)? Are these cross-subsidies legal? Sustainable? Do they provide the municipal network with a competitive advantage over providers? • Does the proposed business plan include contingency planning to address under-adoption, pricing adjustments by competitors, and/or outright failure? • Does the business model allocate any potential profits to the local government (e.g., payments in lieu of taxes)?	☐

• Does the business model factor in debt servicing generally? In the event that subscriber forecasts are off? • To what extent does the business plan include supplemental borrowing or allocation of additional funds/resources by local government?	
Legal, Regulatory, and Public-Policy Considerations	
Are there related utility laws that might impact core aspects of the proposal (e.g., rights-of-way) to provide a commercial service in direct competition with private providers?	☐
Is the municipality empowered under state law to engage in activities of industrial planning?	☐
In the absence of formal state or local rules regarding GONs, has the municipality considered a public referendum or other means of public engagement?	☐

Security

When planning the type of broadband network you wish to deploy or lease, network security is a major consideration. This is a situation where outside advice may be useful. Find a good consultant to take you through thinking about security. Query large companies near you about consultants, their credentials, and their charge structure. Security officers at local banks, savings and loans, and even the post office could be good sources for recommendations for security advisors.

Network security advisors/consultants should be able to address questions about the security profiles of the various options for network infrastructures (fiber, wireless, etc.) and about whether your network will need a dedicated security officer, and about the qualifications for that position.

This is not an all-inclusive list, but here are some questions to ask and consider.[62]

- *What security threats COULD I anticipate in operations of a network?*
- *What assets do I have that need protecting?*
- *What systems are critical to everyday operations?*
- *What systems rely on the operations of the network?*
- *How will I know if a breach to the network has happened?*
- *Threat detection can be assessed with multiple technologies. Is there an automated program or process that can assist to determine if a breach has occurred?*
- *Remember that employees (employees operate remotely or if they are operating offsite while traveling) accessing the network when communicating back to a person onsite can create security threats.*

Dig Once Policies

Dig Once Policies are essential to cost-effective broadband deployment. Dig once can be defined as the requirements designed to reduce the number and scale of repeated excavations for the installation and maintenance of broadband facilities in the Right of Way. The coordination of

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[62] Information Systems Audit and Control Association - https://www.isaca.org/

highway construction projects with the installation of broadband infrastructure reduces costs, and also may be the only option to install cable below ground. Coordination can also reduce deployment time by reducing the need for the duplication of federal and state review on permits for work to be completed at the same location. These Dig Once policies can also be legislated by the state or by the municipality, according to the appropriate legal standards of the state. Arizona, Utah, and Minnesota have experience in working with Dig Once policies.

Dig Once is important for broadband deployment. The US Department of Transportation's Federal Highway Administration notes that "90% of the cost of deploying fiber-optic cable is when significant excavation of the roadway is necessary." Arizona provides an example of how one state dealt with Dig Once by utilizing the authority of its Department of Transportation to include the transportation information in its purview, thus allowing agencies to coordinate the installation of multi-use conduit in state highway rights-of-way. The statute clearly states that the policy is targeted at rural broadband deployments. The legislation also includes cost-sharing mechanisms; Internet companies are required to pay a "cost-based rate" to lease conduit installed alongside qualified roads.

> *Minnesota also has a broader policy and adopted a more measured approach that is focused on taking advantage of cooperation between federal, state, and local governments. The Minnesota Department of Transportation has created a process that allows broadband providers to install copper or fiber-optic cable when state rights-of-way are open for other purposes. According to Mackenzie, Minnesota has "a basic statute in place, and we are now looking to align state law with federal law to leverage both state and federal assets."--Council of State Government May June 2016*
> *http://www.csg.org/pubs/capitolideas/enews/cs41_1.aspx*

Terms to Know

GLOSSARY

(from www.muninetworks.org under Resources)

This is a glossary of terms commonly used in discussions about community broadband. Many of these terms, and any terms that we have not included, most likely have definitions available on Wikipedia as well.

Astroturf

Definition from Wikipedia: A form of advocacy often in support of a political or corporate agenda designed to give the appearance of a "grassroots" movement. The goal of such campaigns is to disguise the efforts of a political and/or commercial entity as an independent public reaction to some political entity—a politician, political group, product, service, or event.

Asymmetrical

Internet connections have two components: a downstream and upstream. When the two speeds are not comparable, the connection is termed asymmetric. Typically, phone and cable companies offer much slower upload speeds than download, in part because the Internet tended to be a download-centric system in the 90's and early 00's. However, users increasingly need faster upstream connections to take full advantage of modern applications.

Backhaul

A general term for the segment of a network between the core and the edge. An example is the connection from a community network hub in a small town to a carrier hotel where it connects to the Internet backbone.

Bandwidth

The rate at which the network can transmit information across it. Generally, higher bandwidth is desirable. The amount of bandwidth available to you can determine whether you download a photo in 2 seconds or 2 minutes.

Bit

The base unit of information in computing. For our purposes, also the base unit of measuring network speeds. 1 bit is a single piece of information. Network speeds tend to be measured by bits per second - using kilo (1,000), mega (1,000,000), and giga (1,000,000,000). A bit is a part of byte, they are not synonyms. Bit is generally abbreviated with a lower case "b".

BTOP

Broadband Technology Opportunities Program - established by the 2009 stimulus legislation, a program to disburse $4.7 billion to improve broadband access and literacy throughout the country.

Byte

The base unit for file storage comprised of 8 bits. A 1MB (megabyte) file is made of 8 million bits. Bytes generally refer to the size of storage whereas bits are used frequently when discussing how rapidly files may be moved. Byte is generally abbreviated with a capital B.

Cable modem system

Cable television companies have offered Internet access via their cable system for more than a decade. The network architecture uses a loop that connects each subscriber in a given neighborhood, meaning they all share one big connection to the Internet. Over time, needs have increased faster than capacity on these networks. Because the cable network shares the last mile connection among hundreds of subscribers, a few bandwidth hogs can slow everyone's experience.

Cloud

Some refer to the entire Internet as a cloud - the idea being that all the information is just out there and it does not matter where. More commonly now, cloud computing refers to services such as Amazon's S3, for which users pay a fee to store information on Amazon's servers without ever really knowing the physical location. As we gain access to faster Internet connections (particularly on the upstream), cloud services may offer cheaper means of accomplishing tasks and assuring more reliable backups.

Conduit

A reinforced tube through which cabling runs. Conduit is useful both to protect fiber-optic cables in the ground and because one can place the conduit underground when convenient and later "blow" or "pull" the fiber cabling through the conduit.

CPE

Customer Premises Equipment - typically describes the box on the side of a house that receives and sends the signal from the network, connecting the subscriber.

DOCSIS 3

This is a technical specification that allows modern cable networks to offer considerably faster speeds than those used by earlier DOCSIS specifications. Comcast rolled out DOCSIS 3 in Minneapolis/St. Paul in early 2008, offering an "up to" downstream/5 upstream connection for $150/month. Note the slow upstream connection and the high price. The greatest flaw with DOCSIS 3 remains the shared nature of the last mile, meaning a few bandwidth hogs can slow everyone's connection on that loop.

Downstream

Internet connections have two components – a downstream and upstream. Downstream refers to the rate at which the user's computer can receive data from the Internet.

DSL

Digital Subscriber Line - or Internet access offered over the phone lines. DSL allows users to use the Internet at speeds greater than dial-up while also using the phone line for telephone conversations. DSL uses frequencies not used by human voices. Unfortunately, these frequencies degrade quickly over distance, meaning customers must live within a mile of the central office to get the fastest speeds.

Duopoly

A situation in which two companies own all or nearly all of the market for a given type of product or service.

Fiber-optic

A system that uses glass (or plastic) to carry light used to transmit information. Typically, each side of the fiber is attached to a laser that sends the light signals. When the connection reaches capacity, the lasers may be upgraded to send much more information along the same strand of fiber. This technology has been used for decades and will remain the dominant method of transmitting information for the foreseeable future.

FiOS

Verizon is the only large carrier building a ftth network. This network is called FiOS. Though FiOS is similar technologically to community fiber networks, we believe communities should have a strong voice in how the network is run, and Verizon does not offer this.

Franchise

A cable company wishing to provide television services in a community historically signed a franchise agreement with the municipal government. The agreement would specify what the community would receive from the cable company in return for access to rights-of-way (such as telephone poles). However, this arrangement has changed in many states recently, where states have preempted local control. Cities now are not permitted to offer exclusive franchises.

FTTH

Fiber-to-the-home. As most telecommunications networks use fiber in some part, FTTH is used to specify those that use fiber to connect the subscriber. Some claim they have a fiber-optic network because they use fiber to the node even when they use phone lines or a cable network over the last mile. FTTH may be more expensive to install currently but offers significant savings in terms of maintenance when compared to copper alternatives.

FTTU

Fiber-to-the-User is used somewhat interchangeably with FTTH to describe full-fiber networks.

Gbps

Gigabits per second - or one billion bits per second. 8 Gbps means that 8 billion bits are transferred each second. Using an 8 Gbps connection, it would take 1 second to transfer a 1 GB (Gigabyte) file - a compressed 90 min movie, for instance. 1 Kbps (Kilobits)<1 Mbps (Megabits)<1 Gbps

Greenfield

A plot of land that will soon become a residential development. Building a broadband network is cheap in Greenfields because roads, sidewalks, lawns, and buildings are not yet impediments to running the necessary wires.

HFC

Hybrid Fiber-Coax - a network that combines some fiber-optic elements (typically from the head end to a node in the field) and coaxial cable (typically the loop that connects the node to subscribers).

I-Net

Short for Institutional Network. This is the network a municipal government requires to carry out its duties. I-Net frequently refers specifically to a network built for city uses (connecting schools, for instance) by the cable company as part of the franchise agreement with the city. Cities are increasingly seeing the value of owning their own network. Synonyms: Institutional Network

Kbps

Kilobits per second - a measure of speed. 8 Kbps means that 8 thousand bits are transferred each second. Using an 8 Kbps connection, it would take 1 second to transfer a 1 KB (Kilobyte) file - a text file, for instance. Don't get lost in the details. When it comes to Kbps, more is faster, but anyone on the modern internet better measure their connection in Mbps. 1 Kbps < 1 Mbps (Megabits) < 1Gbps (Gigabits)

Last mile

Describes the final leg of a connection between a service provider and the customer. In DSL and cable systems, this is the most frequent bottleneck and the most expensive to resolve. The service provider may run a faster fiber-optic network into the neighborhood but deliver the last mile (which could be considerably less than a mile ("last" is the operative term) with a phone lines that cannot sustain fast speeds. Synonym: first mile

Latency

The amount of time it takes for a bit to get from point A to point B. In the words of Dr. Stuart Cheshire: "If you want to transfer a large file over your modem, it might take several seconds or even minutes. The less data you send, the less time it takes, but there's a limit. No matter how small the amount of data, for any particular network device, there's always a minimum time that you can never beat. That's called the latency of the device."

Mbps

Megabits per second - a measure of speed. 8 Mbps means that 8 million bits are transferred each second. Using an 8 Mbps connection, it would take 1 second to transfer a 1 MB (Megabyte) file - a photo, for instance. Don't get lost in the details - when it comes to Mbps, more is faster. 1Kbps (Kilobits) < 1 Mbps < 1Gbps (Gigabits)

MDU

Multiple dwelling unit - most frequently apartment buildings. MDUs can offer a challenge when building a ftth network due to the need to negotiate with building owners and rewiring that may be necessary to bring fast speeds to each unit.

Middle Mile

Middle mile is a term most often referring to the network connection between the last mile and greater Internet. For instance, in a rural area, the middle mile would likely connect the town's network to a larger metropolitan area, where it interconnects with major carriers.

NATOA

National Association of Telecommunications Officers and Advisers. NATOA is comprised of local government officials and employees who work on cable and broadband issues—from public-access television to managing the community's rights-of-way.

NTIA

National Telecommunications and Information Administration - a division of the Department of Commerce in Washington, DC.

Open access

An arrangement in which the network is open to independent service providers to offer services. In many cases, the network owner only sells wholesale access to the service providers who offer all retail services (i.e.: triple play of internet, phone, TV). Open access provides much more competition from which potential subscribers can choose.

Overbuild

To create a network that goes into competition with an incumbent provider.

Passed

Residences or businesses that have access to the network. As a FTTH network is constructed, it will generally be built through a neighborhood before individual houses or businesses are connected via a drop cable (which is also a fiber-optic cable). When a house or businesses is "passed," it means they are eligible to sign up for services (which may require a technician to hook up the drop cable).

Peer-to-Peer (PtP)

This is a type of network that allows computers to connect directly to each other rather than organizing them via hierarchical connections. This term is most often used to describe a type of file-sharing that has greatly increased bandwidth usage and allows faster downloading of the same file from multiple computers. Peer to peer technologies, such as Bit Torrent, can greatly reduce the cost of distributing content to a large audience but also have been used to exchange copyrighted materials without permission. P2P connections generate a lot of traffic and are often throttled or denied access by broadband providers.

PEG

PEG is an acronym for Public Access, Educational, and Government video programs. These are common programming options made available to the community by the cable company in return for access to the community's rights-of-way.

Quadruple play

Triple-play (television, Internet, landline telephone) plus cell phone service. Only a few companies are starting to offer this, combining the now standard triple-play (television, phone, and Internet access) with a cell phone plan.

RUS

Rural Utilities Service - a branch of the U.S. Department of Agriculture. RUS offers loans to entities deploying broadband in rural areas.

SDK

Software Developer Kit – pre-made tools, sample code, tutorials, and other resources that make it easier for third-party developers to design applications that integrate with other software.

Symmetrical

Internet connections have two components – a downstream and upstream. When the two speeds are comparable, the connection is termed symmetric. Fiber-optic networks more readily offer symmetrical connections than DSL and cable, which are inherently asymmetrical. Ultimately, purely symmetrical connections are less important than connections which offer robust connections both ways. However, modern asymmetrical connections via DSL and cable networks offer upload speeds that are too slow to take advantage of modern applications.

T1

A data circuit that transmits at 1.544 Mbps. Synonyms: T-1, T.1

Take rate

The number of subscribers to a service - typically expressed in a percentage of those taking the service divided by the total number of people who could take the service. If a community fiber network passes 10,000 people and 6,000 people subscribe, it has a take rate of 60%. When planning the network, it will be built to be profitable at or above a certain take rate, as defined in the business plan. Generally, networks require a few years to achieve take rates due to the long time it takes to connect each customer.

Telco

Telephone Company -- A provider of telecommunications services such as voice (telephony) and data services. Also called common carriers or LECs (Local Exchange Carriers); ILECs are incumbent providers, often AT&T or Verizon.

Telepresence

This term refers to a variety of attempts to use modern technology to make it seem like a person in a remote location is in the room. The more bandwidth available, the more realistic the remote person will appear. Modern telepresence applications are impressive, using sophisticated algorithms with multiple video cameras and microphones to go far beyond video-telephone systems.

Triple-play

The three main services offered over these networks - television, phone services, and Internet access. Many people like to get all three from the same service provider on the same bill. Service providers frequently offer deals that will lower the cost on these packages. Typically, television breaks even or loses money whereas the service provider makes the most profits from phone and Internet access.

Upstream

Internet connections have two components: a downstream and upstream. Upstream refers to the rate at which the user's computer can send data to the Internet. DSL and cable networks frequently offer upload speeds at only 1/10 of the downstream speeds. This is one of the main reasons DSL and cable networks are insufficient for the modern Internet. Synonyms: upload

USF

Universal Service Fund is a federal program with four programs: high-cost (subsidizes the high cost of services in rural areas), low-income (includes Lifeline and Link Up discounts to those in poverty), rural health care (reduced rates to rural health care providers to ensure they have access to services similar to their urban counterparts), and schools and libraries (E-Rate subsidizes telecommunication services to schools and libraries).

Wi-Fi

This is a suite of protocols that allow wireless devices to exchange information using unlicensed frequencies. Equipment carrying the Wi-Fi brand is interoperable. Recently, a number of cities and some private companies attempted to blanket their cities with Wi-Fi, but the technology is not well-suited to such large scale efforts. Wi-Fi has proved tremendously successful in homes and businesses in small cities.

Chapter 9: Resources

Links to Online Resources

Planning Tools and Templates

NTIA – Community Broadband Roadmap

Planning a Community Broadband Roadmap: A Toolkit for Local and Tribal Governments. This Toolkit presents the planning steps necessary to create a Community Broadband Roadmap, offers tips and advice from BTOP grantees, and provides links to resources and tools.
Community Broadband Roadmap (PDF)

NTIA - Broadband Adoption Toolkit

This Broadband Adoption Toolkit draws on the experiences of the recipients of grants from the Broadband Technology Opportunities Program (BTOP).
Broadband Planning Toolkit (PDF)

State Broadband Planning Initiatives and Toolkits

Florida - Tampa Bay - Broadband Planning Community Organization Tools - Resources to help convene meetings, provide public outreach, and stay organized

Community participation is an essential part of developing a comprehensive broadband plan. These tools can help with convening stakeholder group meetings, facilitating public workshops, and providing outreach about broadband planning to the local community/region.
http://www.tbrpc.org/bbplan/index.html

- *Contact database*
- *Broadband planning fact sheet*
- *Press releases*
- *Non-competition statement brochure*
- *Meeting/workshop notices*
- *Meeting/workshop agendas*
- *Meeting/workshop summary*
- *Meeting presentations*
- *Meeting/workshop event evaluation tools*
- *Meeting/workshop materials*
- *Broadband testimonial form*
- *Broadband planning quick links document*

West Virginia State Broadband Mapping Program Regional Broadband Planning Teams Project

Broadband Planning Processes—These documents walk through the entire planning process from the kick-off meeting to the development and implementation of the strategic plan, including identification of milestones along the way.

Broadband Planning Toolkit (PDF)

Virginia - Broadband Toolkit

A 5-step guide to bring broadband to your area.
Broadband Toolkit (PDF)

Kentucky - Guide to Fiber Planning for Communities and Utilities

In straightforward language, this guidebook explores a range of technical, business, and partnership models.
Guide to Fiber Planning for Communities and Utilities (PDF)

University of New Hampshire Broadband Center of Excellence

Study finds broadband adoption is tied to economic growth.
Broadband Adoption Study (PDF)

New Mexico Broadband Program - Community Broadband Master Plan Guidebook

In straightforward language and with action-oriented summaries, this guidebook explores a range of proven technical, business, and partnership models, as well as some that are more cutting edge. Importantly, the guidebook also frankly assesses the benefits and risks of each model so that communities can determine the best approach for their unique circumstances.
Master Plan Guidebook (PDF)

North Carolina Broadband Plan – Connecting North Carolina

Recommendations focus on lowering deployment construction costs, expanding access for K-12 students at home, preparing a 21st century workforce, and increasing small-business adoption and use. It also looks at ways to enable new health care technologies and provide the necessary tools to public- safety responders to ensure North Carolinians' safety.
Connecting North Carolina (PDF)

Tennessee – Memphis Area Infrastructure: Telecom and Broadband

Includes information on fiber networks, conduit, and a summary of broadband business models and their differences.
Memphis Area Infrastructure: Telecom and Broadband Recommendations (PDF)

Mapping Tools and Resources

North Carolina Open Source Broadband Map

North Carolina's open source broadband map and demand-aggregation system was created atop a suite of open-source technologies and platforms. The source code developed in concert with the NC Department of Commerce Broadband Division and Topsail Technologies is freely available on GitHub.
NC Open Source Broadband Map (Ruby on Rails Source Code)

Broadband Catalysts Simple Open Source Broadband Map

Built on the OpenGeo Suite SDK, this simple open-source broadband map is easy to manipulate and deploy with edits required to only a single text file. Source code and data available on request at BroadbandCatalysts.com.

Cambium Networks LINKPlanner – Line of Sight and Radio Frequency Planning Tool

LINKPlanner allows you to model "what if" scenarios - based on geography, distance, antenna height, transmit power, and other factors to optimize system performance before purchase.
LINKPlanner (Windows, Mac Software)

Reports and Statistics

White House - Executive Office of the President - Community Based Broadband Report

The benefits of competition and choice for Community development and high-speed Internet access
Community Based Broadband Report (PDF)

White House - Broadband Opportunity Council - Report and Recommendations

Pursuant to the Presidential Memorandum on expanding broadband deployment and adoption by addressing regulatory barriers and encouraging investment and training.
Report and Recommendations (PDF)

NTIA - BroadbandUSA: An introduction to effective public-private partnerships for broadband investments

This publication provides an overview of common broadband partnerships, the factors communities should consider in developing a successful partnership model, and tips and best practices NTIA has observed through its oversight of $4.5 billion in broadband grants to public, private, and joint projects across the country.
BroadbandUSA - Public Private Partnerships (PDF)

FCC - 2016 Broadband Progress Report

A report on broadband availability and expansion in the United States
Broadband Progress Report (PDF)

FCC - Measuring Broadband Provider and Technology Performance

A report on consumer fixed broadband performance in the United States
Measuring Broadband in America 2015

Center for Social Inclusion - Broadband in Mississippi: Toward Policies for Access Equity

This report is a follow up to Broadband in the Mississippi Delta: A 21st Century racial justice issue, a 2010 joint release of the Center for Social Inclusion and the Mississippi State Conference NAACP.
Broadband in Mississippi (PDF)