Leaping the Digital Divide

Encouraging Policies and Partnerships to Improve Broadband Access Across North Carolina
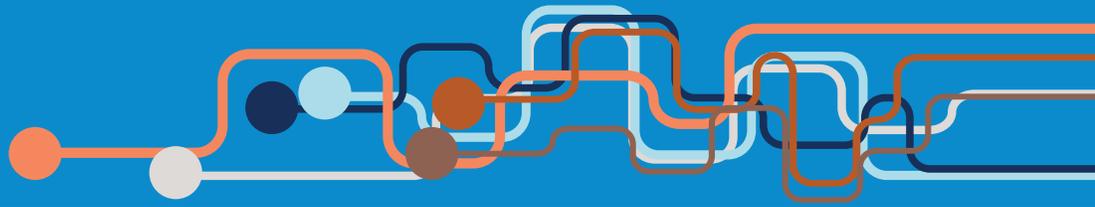
Erin Wynia, N.C. League of Municipalities

Joanne Hovis, CTC Technology & Energy

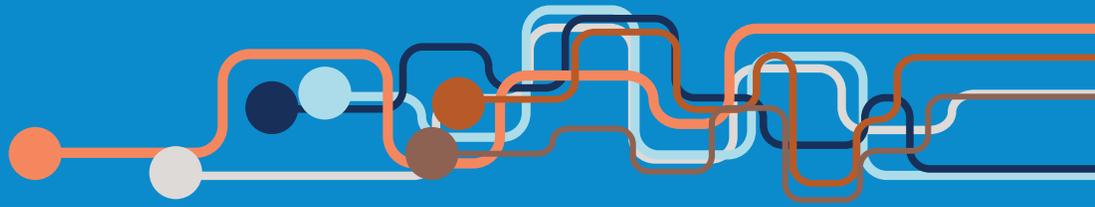*Foreword by Blair Levin, Brookings Institution*

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Foreword

BLAIR LEVIN
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In 1789, the General Assembly of North Carolina passed an act to establish a University, finding that, "Whereas in all well-regulated governments it is the indispensable duty of every Legislature to consult the happiness of a rising generation, and endeavor to fit them for an honorable discharge of the social duties of life, by paying the strictest attention to their education: And whereas an university supported by permanent funds, and well endowed, would have the most direct tendency to answer the above purpose."

Why did they do so? After all, universities up until that point had all been founded and operated by non-governmental forces. It is always difficult to discern historical motive, but it is not difficult to see that while UNC and similar state institutions that followed share many attributes with the privates, like Harvard, Yale and Princeton, they have also delivered public benefits for their states that the privates have not and are not designed to do.

Society continually debates what should be exclusively a matter of private investment and what should be a matter of public investment. We saw it in years past with electricity and other utilities, deployed by both private and public enterprises. We have seen it in all kinds of subtle ways on issues of who should pay for research and development, health care, community-based media, economic development projects, and in a thousand various ways throughout our tax code.

And we see it with broadband.

When the United States Congress, in 2009, told the Federal Communications Commission to write a National Broadband Plan, some objected, arguing that broadband had and should continue to evolve solely on the basis of private market forces. As a matter of history, that contention was flawed, as the development of all communications networks involved significant government action, including, among others, monopoly franchises, rights of way and pole access, universal service support, spectrum allocations, and intellectual property rights. The argument was

also wrong as a prediction. As the plan itself demonstrated, and as current debates over questions ranging from network neutrality to small cell deployment to the national security implications of 5G network deployment prove today, the public has both an interest and an economic stake in how these networks develop.

While broadband has been primarily funded by private sector resources, it produces a number of public benefits. Indeed, the public benefits are so substantial that communities who lack good broadband will soon find themselves without the staple resources to thrive in this century. Consider, for example, a recent study in which more than 90 percent of respondents identified quality broadband as "very important" in choosing a community in which to live — second only to "safe streets."

On this, popular opinion is right. The benefits flowing from broadband to the public include:

- Economic growth and better jobs. A 2014 study showed that 14 communities with widely available gigabit access enjoy per capita GDP that is 1.1 percent higher than similar communities with little to no availability of gigabit services, enjoying approximately $1.4 billion in additional GDP. Conversely, the 41 communities studied without gigabit broadband experienced forgone GDP of as much as $3.3 billion. Another study concluded that it is particularly important for the fast growing segment of home businesses, where fiber averages about $73,000 in revenues,

significantly higher than slower cable connected homes with $43,000.

- Increased property values. High speed broadband has been shown to add nearly $10,000 in value to a $300,000 single-family residence. It is the number one amenity sought by multi-dwelling unit homeowners and the number two amenity sought in single-family homes.

- Lower prices for broadband services. Where gigabit service is introduced, the cost of slower tiers drops significantly. When gigabit is available, tiers of 100 Mbps or faster drop in price by as much as $27, while pricing for the lower-priced 25 Mbps service decreases between $13 and $18 monthly. And when prices go down, so does the digital divide, as affordability goes up for every level of service.

These are far from the only benefits. Next generation networks also enable communities to enjoy all kinds of next generation education, health, and public safety-related services. Those services, and indeed all services in the economy, are going to become more and more dependent on data and, therefore, networks that move data quickly.

Bottom line: If a community wants to thrive in the economy and society of the decades to come, it needs a network capable of carrying that kind of traffic.

There is no silver bullet that works for every community. But there is a bullet that can kill every community — doing nothing.
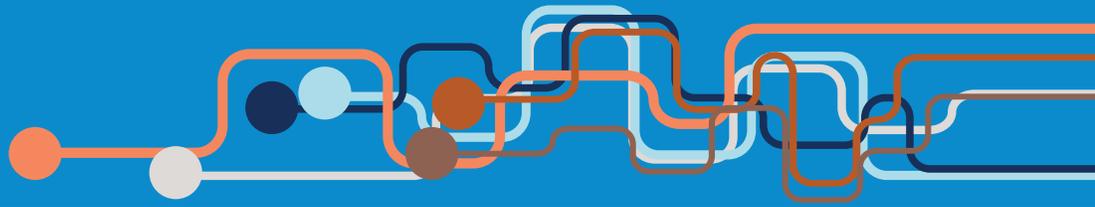
In this study, Leaping the Digital Divide, the authors lay out a thoughtful framework for how communities should understand the broadband opportunity and challenge ahead. The answers have to uniquely target the community's needs and priorities, while building on the community's assets; nonetheless, the underlying questions and analysis are similar for all communities, and all communities will benefit from studying this guide on how to build the partnerships they need for better broadband.

Further, state and federal officials should welcome this blueprint for how their local communities can improve the economics of broadband deployment and address such critical issues as the digital divide. Those state and federal offices would be wise to view local governments as key partners in accomplishing those goals, instead of, as some officials sadly and inaccurately do, roadblocks to accomplishing them. They should also provide local communities with the flexibility to craft solutions responsive to local conditions.

We all are the fortunate heirs of that decision, made over two centuries ago, to make a public commitment to higher education for untold generations of Tar Heels. That decision has produced immeasurable benefits to North Carolina, the United States and the world. And yet that decision did not foreclose the state from becoming the home of great private institutions, like Duke, Wake Forest, Davidson or others.

Just as that generation of North Carolina's leaders threaded the needle to drive both public and private benefits with higher education for generations to come, it is up to this generation to makes the necessary investments for generations to come. For this generation, that involves investments to ensure that bandwidth does not constrain economic growth or social progress.

The decision that led to the creation of UNC was a way for the state to take advantage of its most valuable resource – its people. Leaping the Digital Divide is a map that will point the way for communities in North Carolina to take advantage of the world's second most valuable resource – information.

Blair Levin serves as a non-resident Senior Fellow of the Metropolitan Policy Project of the Brookings Institution, and as a consultant to the investment community, to numerous communications enterprises, and to a number of local, state, and national governments on broadband policy. From 2009-2010, Mr. Levin oversaw the development of the FCC's National Broadband Plan. Prior to his work on the National Broadband Plan, Mr. Levin worked as an equity analyst, as Chief of Staff to FCC Chairman Reed Hundt and as a lawyer in North Carolina, where he represented new communications ventures, as well as local governments.

Executive Summary

Few people today question that broadband has become essential infrastructure, fundamental to commerce, education, health care and entertainment. Nonetheless, more than two decades into the digital revolution, many areas of North Carolina lack access to adequate broadband service, and even densely-populated areas can lack the kinds of internet speeds needed for business to thrive. To keep this gap from persisting and growing, state policy must change to help unleash new business models and partnerships, fostering the type of government-private sector cooperation and investment required to meet the unique needs of all areas of the state.

This report will examine the problem of access to high-speed internet and explore models of emerging public-private partnerships that can help solve the gaps in access. It makes a strong case that North Carolina must change its policy approaches to better encourage these partnerships, which are needed if major parts of the state are not going to be left behind economically.

That case is made by examining the following:

- High-speed broadband and the networks that support it are just as essential today as roads and electricity were in the first half of the 20th century. Still, stories abound in North Carolina of public school students flocking to downtown public wi-fi hubs in order to do homework, of farmers who sell their goods in a global market struggling to acquire the reliable internet connections needed to conduct business, of health care providers and their patients who cannot fully take advantage of modern telehealth due to the lack of adequate internet speeds.

- High-speed broadband attracts more capital investment into local economies. The connection between economic growth and broadband access and competition is obvious. Limitations on the availability of broadband and the lack of competition among broadband providers – whether that involves standard connections and speeds, or the high-speed connections required by some businesses – hinders both business and residential growth in many areas of the state.

- While all urban areas of the state contain sections that are considered underserved with respect to broadband access, the starkest gaps are found in rural areas. These gaps are unlikely to be filled by the private sector alone because population densities are not sufficient enough to attract business capital.
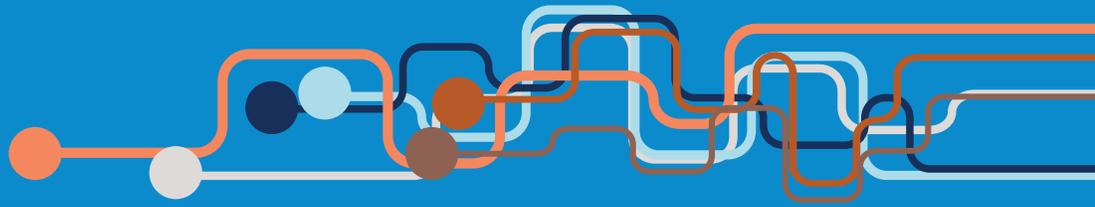
- A primary function of government is to build the infrastructure networks that people need in order to work, conduct business and simply to live their daily lives. That primary function is the same today as it was in the first half of the 20th century, when all levels of government worked together to build a road network that connected all North Carolinians, and when the federal government worked with rural cooperatives to bring electricity to all areas of the state.

- Public-private partnerships represent a promising means to limit risks for both the public and private partners, while generating huge benefits for the residents/customers served. A government or non-profit partner has the ability to allocate risk, finance infrastructure investment over a long period of time, and/or ease the creation of a broadband network; private partners can attract capital and offer expertise in the building and operation of a network.

- Current North Carolina law creates significant hurdles that can prevent public-private broadband partnerships from moving forward. As currently structured, the law generally limits the types of investments that a local government can make in broadband infrastructure and how money can be raised for this infrastructure.

ELIMINATING THE HURDLES

To unleash the full potential of public-private partnerships and close gaps in broadband access, these structural hurdles must be removed. Also, incentives for private providers, dedicated investment by all levels of government, and policies that streamline permitting and construction of broadband systems are needed.

The demand for better and faster internet is not going to slow, in North Carolina or anywhere around the globe. As that demand increases, the technology and investment needed to meet it will grow as well. Encouraging a blend of public and private investment is required if the needs of North Carolinians are to be met. These changes are fundamental to ensuring that rural North Carolina communities survive and thrive into the 21st century.

I. The Access Gap

It began with a vision. Last February, elected officials in the Johnston County town of Benson had invited residents and business owners to a town hall meeting that promised to provide some give-and-take on a topic of huge importance to everyone in attendance. They had gathered to talk about their vision for economic development and infrastructure—specifically, the creation of an economic development strategic plan for the town of nearly 4,000 residents.

It didn't take long for the business leaders in the room to focus on a very specific piece of infrastructure which they said they needed to ensure the town's economic future: broadband. Business owners discussed unreliable internet service, whether in their businesses or nearby homes, and lamented that the availability of high speeds through a fiber optic network throughout the town was still a dream.

In the months that followed, town leaders listened to the pleas from their local business owners. They knew the gaps in the availability of high-speed internet service in Benson left the Town's economic movers and shakers disconnected from people, places, conversations, markets, and commerce around the globe. According to Town Manager Matt Zapp, everyone understood where select areas inside the town, as well as areas adjacent to the town limits, had limited internet access and/or painfully slow speeds.[1] Benson's elected officials wanted more for their businesses and residents. So when the town's economic development strategic plan was released in July, a key topic, not surprisingly, was how limits on the availability of high-speed internet hurt the town and its future prospects.

"This limitation hinders growth in the residential market as prospective residents are increasingly reliant upon access in their daily lives and constricts economic development as access is necessary for commerce," the report read.[2]

The section concluded with the tangible steps town leaders wanted to take to realize their vision of a community that was plugged into the rest of the world, "Opportunities: Seek out public-private partnerships and other opportunities to expand high speed internet access options for residents."

With their vision laid out and a plan to implement it, Benson is now taking steps to give its citizenry better internet service options, first, by creating a public wi-fi hub in a five-block area of its downtown to encourage commerce and foot traffic. Eventually, town leaders hope to parlay that initial broadband infrastructure investment into something more for residents and businesses.
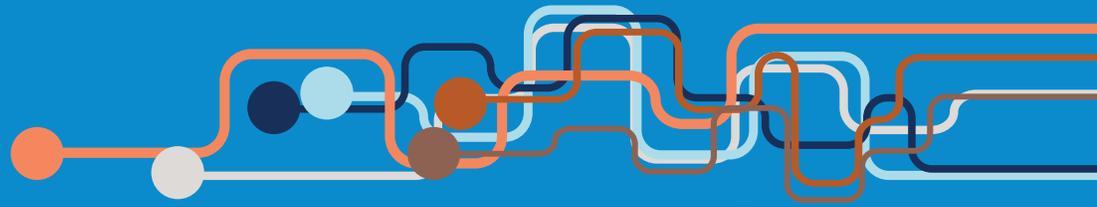
The town, though, is hardly alone when it comes to the need and the desire for better, faster internet services, or even internet period, in some cases. There are similar stories in communities across North Carolina, stories of public school and community college students flocking to public wi-fi hubs in the afternoons to do homework, of farmers having to wait out rain storms that interrupt service to get market reports or other crucial information now required to run their farms, of doctors unable to access needed patient histories online.

And as Benson and other communities look to public-private partnerships to find solutions, they do so in a policy landscape in North Carolina that makes those partnership difficult and dubious. This report will examine the problem of access to high-speed internet, explore models of emerging public-private partnerships that are helping to solve that access gap, and look at how North Carolina must change its policy approaches to better encourage these same types of public-private partnerships. Doing so will give local leaders the ability to realize their visions of a more prosperous future that can better serve citizens' expectations for basic 21st-Century infrastructure.

WHAT DO WE MEAN BY "BROADBAND" AND OTHER TERMS?

BROADBAND | How to describe the concept of "broadband" can be vexing for policy-makers. Do you define it by referencing the speed with which information can travel? The type of technology used to convey the information? The Federal Communications Commission (FCC) chose speed as its measure to describe broadband. While the definition has been revised upward over time, most recently, the FCC set the minimum speed for broadband at 25/3 Mbps, or megabits per second. Others may consider broadband service to be internet delivered via fiber, cable, or DSL technologies. For the purposes of this paper, we consider "broadband" to be internet service delivered at speeds at or above the FCC's definition, regardless of the technology used to provide the service.

DOWNLOAD/UPLOAD | Internet speeds are defined in terms of the amount of data, as measured in megabits, that can be downloaded and uploaded over a period of time. The first number in the two-part measurement refers to how much data can be downloaded from the internet per second, while the second number refers to the amount uploaded. For the FCC's definition of broadband, the standard is set at 25 megabits per second download, 3 megabits per second upload, or 25/3 Mbps. When fiber technology provides the service, speeds are the same for both upload and download times, so they are symmetrical. Fiber technology provides "gigabit" service of 1,000 Mbps or more.

MIDDLE MILE/LAST MILE | Middle mile infrastructure refers to broadband infrastructure that links an internet service provider's core network infrastructure to last mile infrastructure. Last mile infrastructure is broadband infrastructure that serves as the final leg, connecting the internet service provider's network to the end-use customer's on-premises telecommunications equipment.

DARK FIBER/LIT FIBER | Dark fiber is installed fiber optic strands that have not been connected to electronics, so the strands carry no data and are not connected to the internet. In contrast, lit fiber has been connected to electronics, thereby allowing data to move over the fiber strands.

WIRELESS VS. WI-FI | In the broadband context, wireless is a term that describes the movement of data over a radio spectrum. Notably, all wireless networks require wires at some point to convey the data from the wireless spectrum to a larger, wired broadband network. Wi-fi is a specific set of wireless protocols. Therefore, wi-fi is a subset of wireless technology.

BACKHAUL | Backhaul refers to the equipment, including electric wires and electronics, needed to link the core of a broadband network with points at the edges of the network.

CONDUIT | A conduit is a tube or pipe that allows telecommunications wires to pass through it, offering protection.

GIGABIT | A gigabit equals 1,000 megabits and is an internet speed offered by technologies such as fiber.
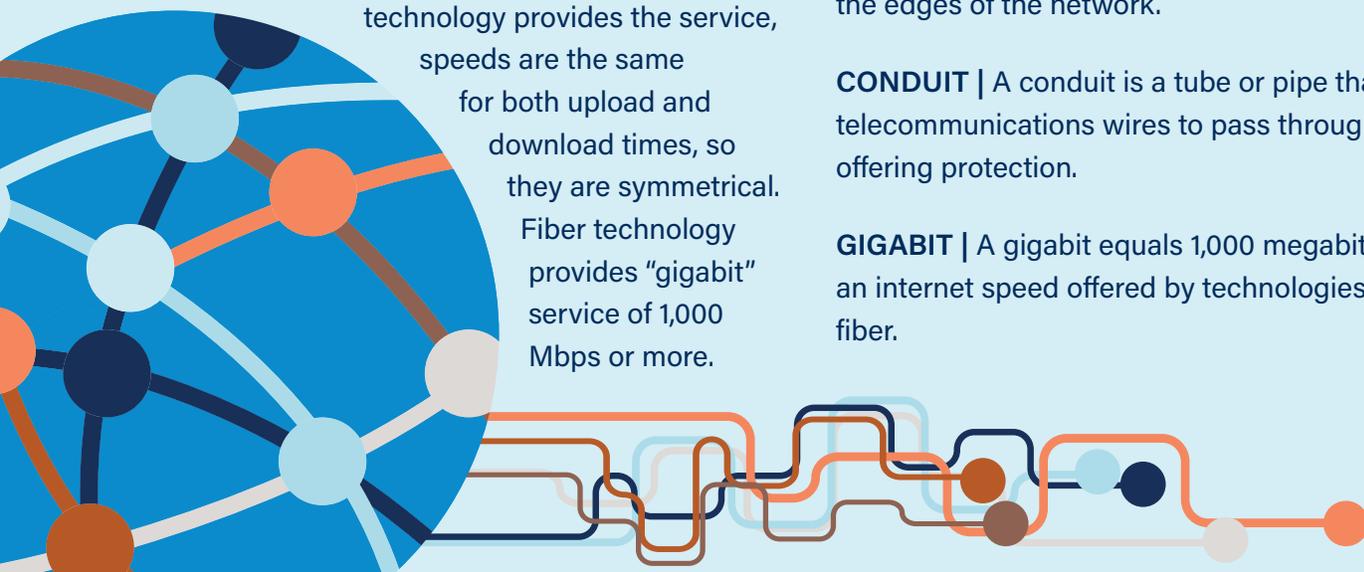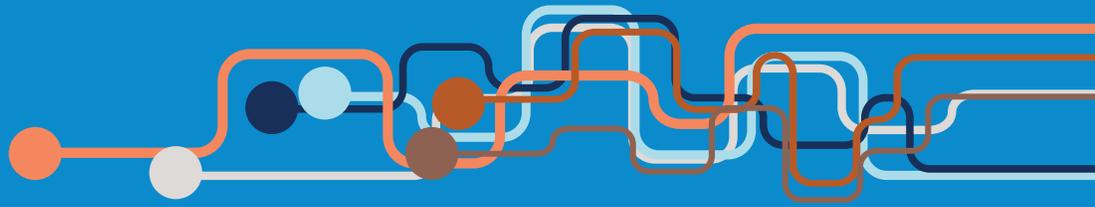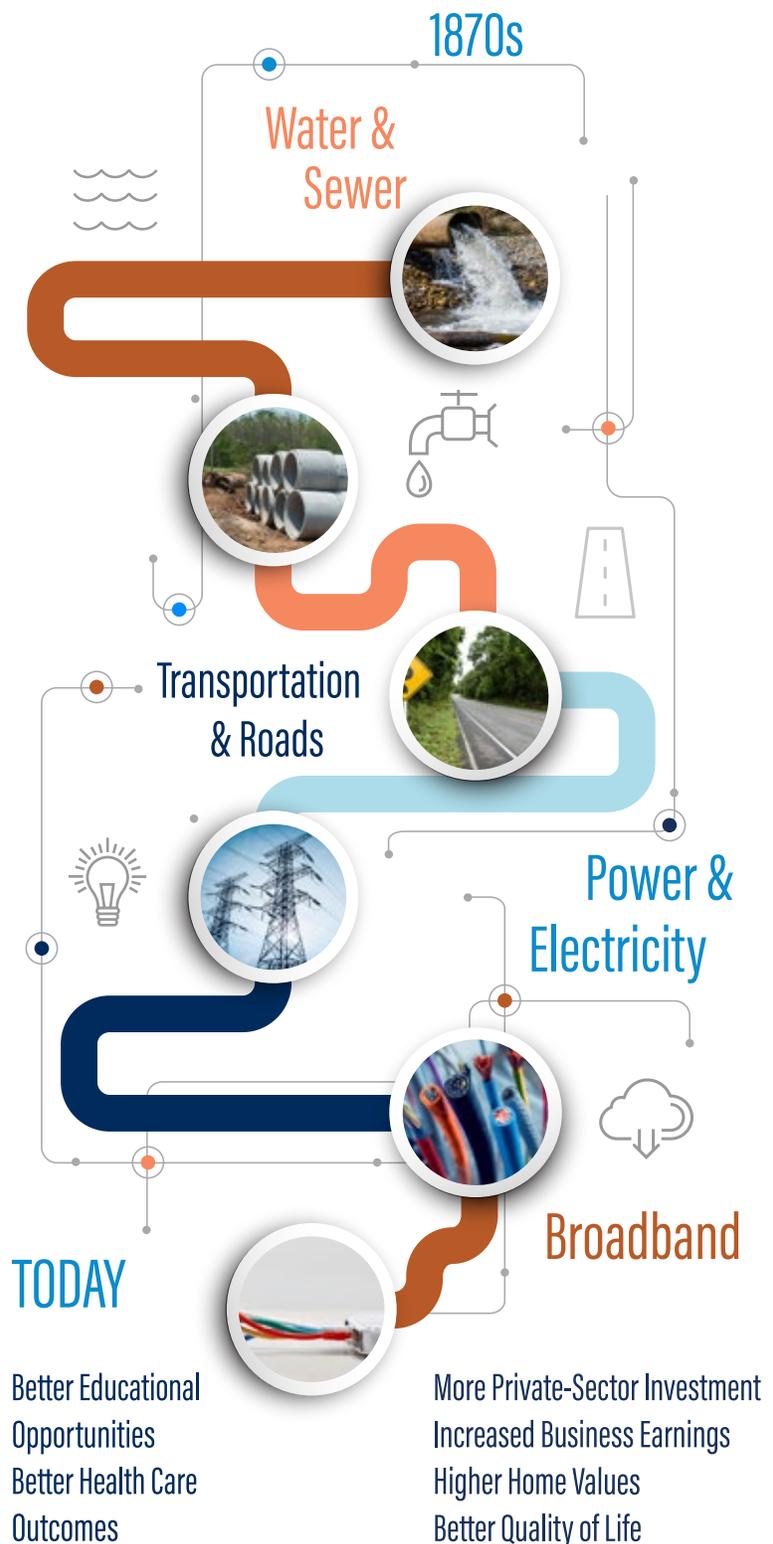
THE CASE FOR GOVERNMENT INVOLVEMENT IN BROADBAND

One of the primary functions of government is to build the infrastructure networks people need to sustain their lives and livelihoods. Today, high-speed broadband joins transportation, electric, water, and natural gas networks as a component of basic infrastructure services that Americans expect to be provided. High-speed internet service is the number-one amenity sought by multi-family residents, and the number-two amenity for single-family residents, according to a recent study.[3] Local governments, in particular, can and should play a role in creating the infrastructure networks to provide this service, which are often too costly for private sector entities to build solely on their own.

Traditionally, when considering infrastructure networks that widely benefit the public, governments step up to build assets with a long lifespan. Whether it's a street network, electric grid, natural gas system, or drinking water treatment, all of these long-term investments are made with a goal of giving communities an edge: increased economic activity, higher educational attainment, and better health outcomes.

Broadband networks have become as indispensable as any of these other century-old infrastructure systems. And yet, as indispensable as broadband has become, North Carolina public policy restricts local governments' ability to play a role in meeting today's critical infrastructure challenge. As a result, communities are being left behind and remain disconnected from the world, particularly in rural areas of the state.

1870s

Water & Sewer

Transportation & Roads

Power & Electricity

Broadband

TODAY

Better Educational Opportunities
Better Health Care Outcomes

More Private-Sector Investment
Increased Business Earnings
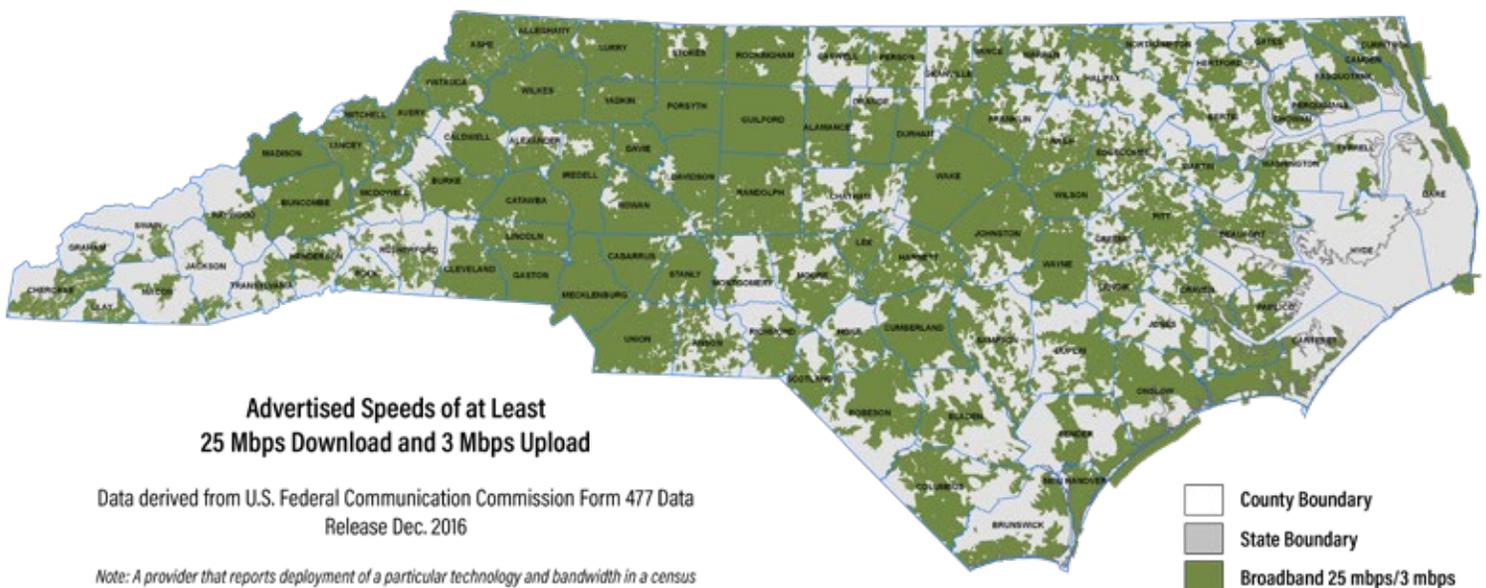Higher Home Values
Better Quality of Life

Look no further than the work of the North Carolina Broadband Infrastructure Office (NC BIO), which estimates that at least 637,671 North Carolinians—most of them rural residents—lack broadband service at the Federal Communications Commission's (FCC's) minimum speeds, a figure that likely underestimates the scope of the problem.[4]

State leaders in the first part of the 20th Century faced similar infrastructure challenges and ultimately concluded that the public could not rely on the private sector alone to meet that challenge. While private financiers such as James B. Duke invested in early electric power plants along the Catawba River to f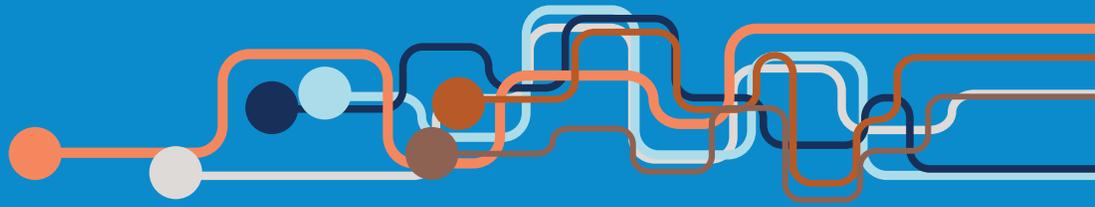uel the state's burgeoning textile industry, farmers in rural areas suffered due to the lack of electric service in those areas. The financial challenges of serving sparsely-populated areas proved too much for the private sector, so government- and farmer-based cooperatives stepped in to fill the void. With loans obtained through the federal Rural Electrification Act of 1935, the electric cooperatives helped to power large swaths of rural North Carolina. Eight decades later, those cooperatives still provide electric service to most parts of rural North Carolina.

Also in the first part of the 20th Century, during the 1920's, state leaders responded as the ability to transport people and goods using automobiles created new economic

BROADBAND SERVICE INVENTORY FOR NORTH CAROLINA

Advertised Speeds of at Least 25 Mbps Download and 3 Mbps Upload

Data derived from U.S. Federal Communication Commission Form 477 Data Release Dec. 2016

Note: A provider that reports deployment of a particular technology and bandwidth in a census block may not necessarily offer that service everywhere in the block.

County Boundary
State Boundary
Broadband 25 mbps/3 mbps

Source: North Carolina Broadband Infrastructure Office

opportunities. At the time, the state's patchwork of mostly dirt roads held people back from accessing those opportunities. Motivated in part to prevent farmers' harvested crops from rotting along washed out, unpaved roads, state leaders undertook the enormous task of statewide road paving and bridge building that was needed to see the state's economy thrive.

As was the case over a century ago, North Carolina now faces significant shortfalls with respect to which of its citizens benefit from critical infrastructure—in this case, broadband infrastructure. In particular, while all urban areas of the state contain communities that are considered underserved with respect to their broadband access, the starkest gaps are found in its rural areas.

The scope and scale of the rural shortfall is significant. North Carolina is still a place with large swaths of sparsely populated lands, and in the 2010 Census, the state measured the second-highest number of rural residents in the country (3.2 million), second only to Texas (3.8 million).[5] According to the NC BIO, 95 percent of North Carolinians who did not have access to broadband service in 2016 at the FCC's minimum speeds lived in rural areas.[6] This figure translates to 607,431 rural residents who have no option for high-speed internet. Ensuring that these residents gain access to high-speed internet services will require a local grassroots response not unlike the way rural North Carolinians banded together nearly 100 years ago to form electric cooperatives.

Meanwhile, although major internet service providers (ISPs) are bringing super-high gigabit speeds to some urban areas of the state, the demand for those speeds in both urban and rural areas is likely to continue to outpace availability. The number of businesses and residential users that demand access to high-performing broadband networks is only going to grow as technology evolves. The demand comes because real dollars are at stake. For example, a recent study showed that home-based businesses served by fiber technologies averaged $73,000 in annual earnings, in contrast to $43,500 for home-based businesses served by cable broadband technologies.[7] That same study found that if fiber served a $300,000 home, it added $10,000 in value.

REAL PEOPLE, REAL CONSEQUENCES

That the stakes are high – affecting business owners, health care providers and their patients, and school students – can been seen in communities across North Carolina. In Burlington, John Plageman spoke to the Burlington Times-News in early 2018 about the urgent need to access a fiber-optic broadband network so that his architectural firm can operate efficiently.[8] Plageman Architecture is located in the town's downtown. He pointed out that it can take up to six minutes to upload a typical client file "when it really should take about a second." Plageman added, "There's a certain point where it is not financially feasible to stay downtown because I cannot grow."

Health care providers in rural towns face their own unique access challenges. Kim Schwartz is CEO at Roanoke Chowan Community Health Center, which as a federally qualified community health center operates facilities in Ahoskie, Colerain, Murfreesboro and Creswell in the northeastern part of the state. The centers themselves are served by CenturyLink, and though internet service can slow at times, Schwartz says the bigger issue is a lack of quality residential connections – and in some cases, service at all – for patients and the health care providers who work there.[9]

Patients who have chronic conditions – congestive heart failure and diabetes are a couple of examples – and are most at risk typically have readings of their blood pressure and other health indicators monitored

Businesses of all types need fast, reliable internet connections to succeed and thrive. Gaps in high-speed broadband can be found not only in rural, unincorporated areas, but in municipalities all across the state.
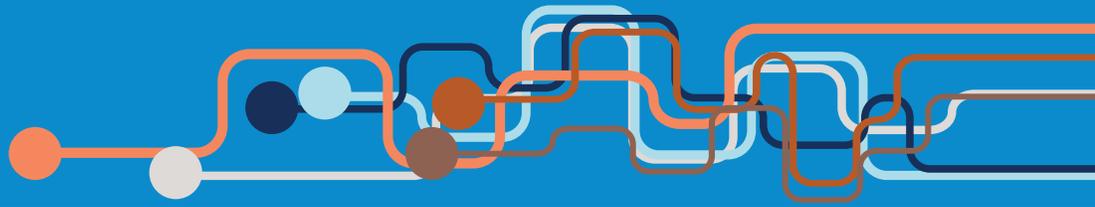
Technology and broadband connections in rural health centers, as seen here at Roanoke Chowan Community Health Center, are changing health care outcomes. But patients and health care providers require fast, reliable connections at home to take full advantage of telehealth advances.

remotely and automatically from their homes. The monitors are connected via Bluetooth and the readings fed to an internet module in the home. At the health care clinics, workers watch an internet-connected dashboard to track each patient. Of course, if those patients do not have an internet or wireless connection, none of that monitoring is possible. Schwartz says about 10 percent of patients fall into that category.

"It is better than it used to be, but these are poor communities. There are not a lot of resources, and we have one provider, and people do not live close together, so there is not a lot of incentive to expand service," she said. "People talk about mountains and how that is a barrier. Down here, we have lots water. That doesn't make things easy."

For the employees of Roanoke Chowan Community Health Center (RCCHC), the issues around internet access can be equally grave, and more urgent. Often when they receive a call and need to access patient information via the internet, it is an emergency. Schwartz noted that RCCHC's medical director, Colin Jones, lives a family farm and still has to rely on dial-up service. In Schwartz's world, there is a lot of discussion of "health care equity," that rural communities face barriers that make quality health care more difficult and more expensive to deliver. Internet access is part of that inequity. "It isn't an equal playing field. There needs to be health," she said.

Cece Hudson and her husband, Jart, run a large family farming operation in Sampson

County in Turkey/Warsaw area. They farm tobacco, peanuts, sweet potatoes and corn. They employ 15 people year-round and have seasonal peak employment of around 95 workers. They also rely on DSL for their internet access through their local telephone co-op. It is service that Hudson says is spotty at best. "It is not atypical to be trying to download a document and you are disconnected, or the speed is so slow that your access to the site you are using times out," she said. "It is only slightly better than dial-up."[10]

Nonetheless, the farm's operation has become dependent on the internet, the access to the information that it provides, and the access needed to meet the requirements of any substantial business. "Crops like peanuts and

WHY FCC DATA IS INACCURATE

The Federal Communications Commission (FCC) requires internet service providers to report twice a year on where they offer internet access service, and at what speeds. Because the data is reported at the census block level, and because the FCC allows a provider to count all tracts in that census block as served even if only one tract actually receives the service, the reported service levels often appear inflated compared with actual service offered on the ground. Other reasons for inaccurate data include:

- Many ISPs still report their advertised speeds rather than the actual speeds customers experience.

- The reported speeds do not account for slowdowns that happen during "rush hour," when numerous customers simultaneously use a network. This network congestion occurs with most non-fiber broadband technologies.
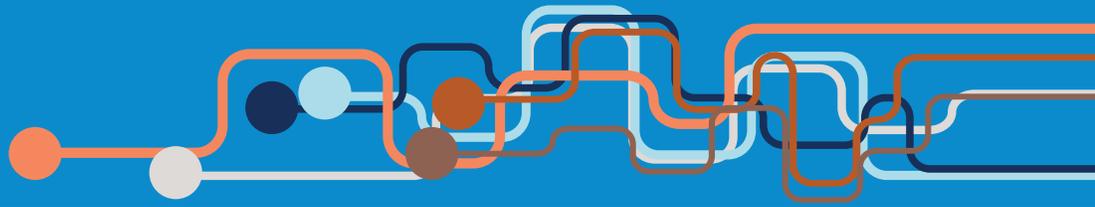
corn, they are commodities. You follow those markets daily. Fuel prices, LP gas, that we depend on," Hudson said. "We pull soil reports from the USDA. We file our payroll taxes on the internet. We are pretty dependent on the internet in running our farming operation."

In North Carolina public schools and community colleges, high-speed internet has become ubiquitous, to a large degree because of the efforts of the state-created nonprofit Microelectronics Center of North Carolina, or MCNC, and funds coming from the federal E-Rate program. The same cannot be said of many areas where those students live and need to access the internet for homework assignments and online classes.

When Charis Shattuck's fifth-grade students sit in her classroom at Mariam Boyd Elementary School in Warrenton, they often huddle over a Chromebook, utilizing apps that allow Shattuck to see their work in real time, a technological shift that permits teacher-student feedback in ways never imaginable in an age of pencil, paper and chalk blackboards. It's possible, in part, due to the school's high-speed internet connection. But when those students go home, at least 40 percent of them lack access to high-speed internet, an obvious learning disadvantage. Shattuck was among the Warren County school officials who spoke to WUNC radio in 2017 about how digital learning and the lack of internet access in rural homes threatens to widen learning gaps in poor, rural areas of the state.[11]

It is not a problem unique to K-12 school students. That same concern was raised by Jennifer Haygood, acting president of the North Carolina Community College system, during an educational forum held in Charlotte in October of that year. At that forum, Haygood agreed with another presenter, North Carolina House Speaker Tim Moore, regarding the significant state investments in ensuring community colleges provided online learning. But she indicated it was not enough. "We do have online, and the North Carolina Community College system has historically been on the forefront of distance learning. But we also have to make sure our rural areas have broadband access, because if we don't have broadband access, we can't take advantage of all the resources we have," Haygood said, receiving a loud round of applause.[12]

> **Internet access within North Carolina schools is ubiquitous. The same cannot be said for when school children go home.**

BROAD PUBLIC SUPPORT

The sentiments expressed by that cross-section of North Carolinians are widely shared. Local leaders will find broad support when meeting the need for high-speed internet service. Overwhelmingly, Americans want a locally-driven initiative for building broadband infrastructure. In a March 2017 Pew Research Center survey[13], a full 70 percent of respondents were in favor of local governments being able to build their own networks. This strong majority position cuts across ideological lines, with 74 percent of Democrats and 67 percent of Republicans voicing support for community-owned broadband. State leaders should feel confident that a policy that empowers citizens and their local governments to play a role in building basic broadband infrastructure will enjoy widespread public approval.

And once built, high-speed broadband networks pay dividends that are plain to all. Students can complete homework assignments at home. Veterans can talk over health decisions with doctors that are hours away. Farmers can monitor market prices from the field. Small retail stores can process credit card transactions in real time. Manufacturers can receive orders from overseas. Tourist destinations can stop losing guests to competitors that offer faster internet. Digitally intensive businesses – videographers, architectural firms and others – can upload the data files they need to remain competitive.

High-speed broadband infrastructure attracts more capital investments into local economies than would be made without access to this service. When built in rural areas, these networks give people more opportunity—and with that opportunity, a real choice to live, work, and raise their families in those communities. And so as public- and private-sector leaders across North Carolina think every day about how to shape the potential success of their communities, broadband networks rise to the top of the "must-have" list.

Empowering local leaders to play a role in building these networks means faster completion of the networks. Further, allowing local governments to partner with private-sector ISPs and other governmental and non-profit organizations takes advantage of local officials' strengths. As those chosen to lead their communities, local leaders are uniquely positioned to form and execute a vision for prosperity in their community. In the 21st Century, that vision includes access to high-speed broadband. And by building broadband networks through public-private partnerships, leaders may expand on local governments' traditional role of providing critical infrastructure.

Public Support for Local Government Building of Broadband Networks

67%
REPUBLICAN

74%
DEMOCRAT

70%
OVERALL
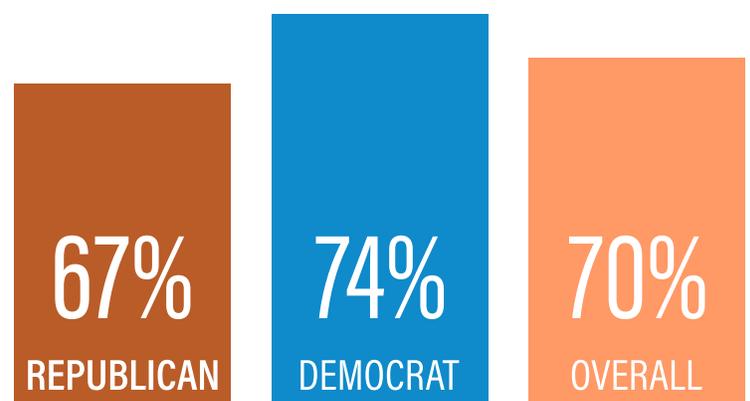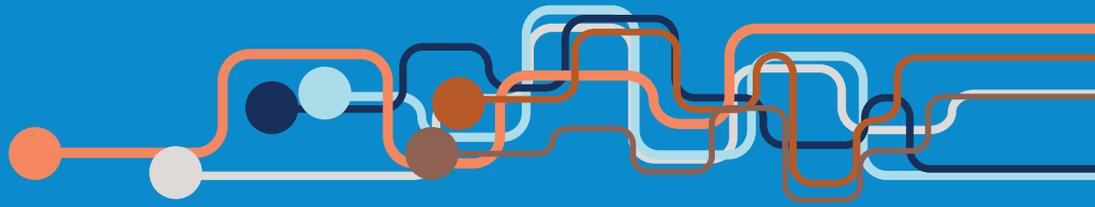
II. Making the Case for Fiber

Internet service providers (ISPs) deliver internet using several different types of technologies. But which technology is the best investment? To answer that question, we must examine the capacity and limitations of the last-mile technologies used today to bring internet service to a home, business, or institution.

Fiber. Fiber optic cables are the standard-bearing technology for internet delivery for generations to come. The reasons for fiber's endurance are numerous. It has enormous bandwidth capacity, which enables ISPs to offer customers symmetrical download and upload speeds and to accommodate future expected usage demands. Fiber is also not subject to interference, and it does not require amplifiers to carry a signal over long distances (6-25 miles is typical). Fiber does not corrode due to weather or other environmental conditions, saving maintenance costs. But perhaps one of the greatest benefits to an ISP is the longevity of the infrastructure: once a premises is connected to fiber, there is no need for significant infrastructure updates for decades. If more bandwidth is needed, the operator only needs to upgrade the network electronics, rather than having to replace cables. Those electronics are widely available at an affordable price, even to provide gigabit service. For these reasons, fiber is one of the few communications technologies that can legitimately be referred to future-proof,

providing customers with better and faster service even with anticipated exponential growth in service demands.

Cable. Unlike fiber, cable broadband technology is currently the primary means of providing broadband services to homes and businesses in most of the United States.[14] Technically called "hybrid fiber-coaxial" cable networks, these networks will remain the main pathway for broadband service to most homes and businesses for the foreseeable future due to their ubiquity and greater bandwidth than competing technologies such as wireless solutions or DSL copper telephone lines (though not fiber). However, as demand for data capacity has increased, cable networks have proven to be increasingly insufficient to support high-speed internet services. While the technology may be augmented in future years with fiber and other upgrades, cable still faces limitations in terms of physical bandwidth capacity[15], the fact that its old systems were optimally engineered for broadcasting, and the slowdowns that occur during "rush hour" when users are simultaneously utilizing the cable network's internet service.

Digital subscriber line (DSL). The copper telephone wires that were extended to virtually every premises in America over the past hundred years have been retrofitted to deliver broadband services since the early

days of the internet. Because of the ubiquity of those copper lines, this technology has been an important way for people to connect to the internet. However, DSL remains a very limited—and nearly obsolete—technology. Copper wires have a fraction of the bandwidth of even coaxial cable, and they suffer from greater signal loss and interference than cable. It is only a matter of time before the growing demand for bandwidth comes up against the physical limitations of copper. Even if an ISP can satisfy present customer demands, it is a significant challenge to upgrade a DSL network. Many telecommunications companies are minimizing their investment in copper lines, and some are abandoning copper altogether, making new investment in DSL likely obsolete within a decade.

Fixed wireless. Service providers have attempted to fill last-mile broadband coverage gaps—primarily in low-density rural areas where the cost of building wired networks is high—with a technology called "fixed wireless." These networks send a wireless signal from a base station to antennas on or near the customer's premises. However, most fixed wireless technologies work only if the antenna is in the line of sight to the base station, which can prove difficult in mountainous regions or areas with dense vegetation or multiple tall buildings. And because the signal is being sent through the air, climate conditions like rain and fog can impact the quality of service as well. Additionally, fixed wireless technology may not offer fast internet connection speeds due to the challenge of providing high bandwidth wirelessly over long distances, the

WHY DO WE NEED FIBER WHEN WE HAVE WIRELESS TECHNOLOGY?

While cutting-edge wireless technologies may in some cases surpass the bandwidth capabilities of some older-generation wireline products, fiber networks easily surpass even the best of all current and future wireless technologies. Even cable networks can, with existing technologies, deliver faster speeds than existing or emerging wireless products, as can well-maintained DSL networks with adequate investment in electronics. Therefore, for the amount of bandwidth currently demanded by most users—an amount that will only increase with time—wireline solutions represent the most reliable, consistent way to deliver high-speed internet.
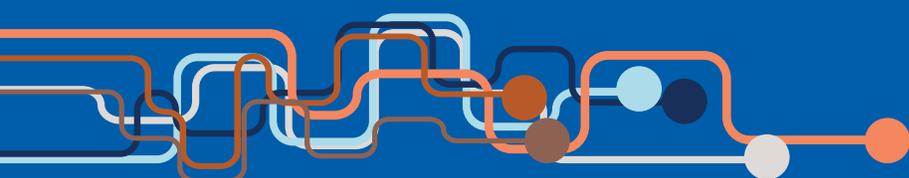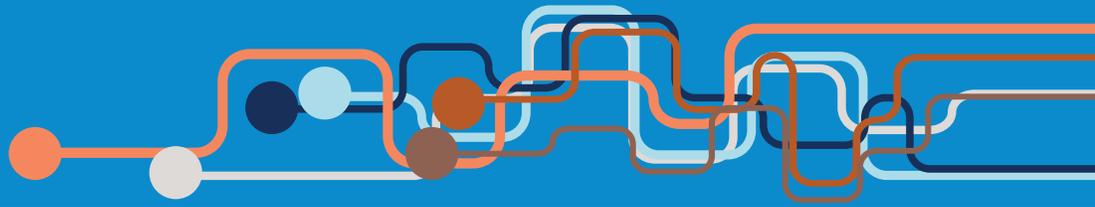
Fiber VS. Other	Unlimited Bandwidth	Unaffected by Weather	Unaffected by Sight Lines	No Rush-Hour Slowdowns
Fiber to the home	✓	✓	✓	✓
Cable	✗	✓	✓	✗
DSL	✗	✓	✓	✗
Fixed Wireless	✗	✗	✗	✗

speed limitations of the wireless spectrum being used, or the same "rush hour" effect that slows down cable-based internet speeds when multiple customers use the service simultaneously.

3G/4G LTE mobile broadband. Mobile carriers currently offer a mixture of third-generation (3G) and fourth-generation (4G/LTE) wireless technologies that in many cases provide faster connection speeds than a typical residential customer's internet service. But compared to wireline services such as fiber and cable, 3G and 4G/LTE wireless technologies have limitations, including lower overall speeds[16], severely limited upload speeds[17], and less reliability in service.

5G mobile broadband. Because no formal 5G standard exists yet, all next-generation wireless technologies branding themselves as "5G" do so mostly in marketing materials and other similar contexts. The technology itself is still under development by researchers, manufacturers, and committees that write technological standards. Generally, 5G works by networking short-range, high-capacity antennas spaced in some cases just a few hundred feet apart. The antennas receive an internet signal from fiber optic cables, meaning 5G works as a combination of fiber- and wireless-based technologies. Therefore, due to the short range of the antennas and the need for fiber, 5G will not be a rural broadband solution. Instead, due to the anticipated boosts to wireless service speeds in urban and suburban locations, it may provide a viable internet service alternative to homes and businesses in those areas.

III. Broadband Partnerships

As with any deal, a public-private partnership (P3) represents a way to allocate risk, benefit, and control. When it comes to broadband, while the benefits of having high-speed internet service are clear and discussed elsewhere in this paper, many community leaders wrestle with the high cost of building the infrastructure needed to deliver that service, and with the responsibility of serving the network's customers. The desire to serve all parts of a community is also at the front of community leaders' minds. Meanwhile, private ISPs enjoy a long history of serving customers, yet they often struggle to make the numbers add up to build networks in all areas of a community (if they can turn a profit by building in that community at all).

Because customers pay to use broadband infrastructure—thereby creating a revenue stream—public officials have a large incentive with which to attract private interest in a partnership. As a result, public and non-profit entities such as counties, cities, school systems, and electric utilities have increasingly embraced opportunities to develop high-speed broadband networks in their communities using emerging P3 models. These models present a promising alternative to the traditional public utility models, where the local government or non-profit is both the owner and operator of the system. Instead, P3s provide a solution for communities that lack the capital or expertise to deploy and operate fiber networks, or to act as ISPs on their own.

A successful broadband partnership must align each side's needs, and it will inevitably involve trade-offs. The arrangement will allocate all the risks, benefits, and control of a network. On one end of the risk spectrum, there is private investment with public facilitation—the lowest-risk model for the public partner and highest-risk model for the private partner. On the other end of the spectrum sits the traditional P3 model, whereby the public partner assumes all financial risk to pay for the infrastructure while the private partner builds and operates the network. The middle ground between these two models is one that shares the risks, rewards, and control, but the partners will only achieve success if they are able to accommodate each other's priorities and develop an agreement for a win-win outcome. With the exception of those in communities fortunate enough to attract investment from a private partner that will pay the capital costs of a broadband network, most P3s will require some amount of public investment, and they follow one of the last two model types.

THREE MAIN BROADBAND P3 MODELS

While the specifics of a P3 will vary from community to community based on
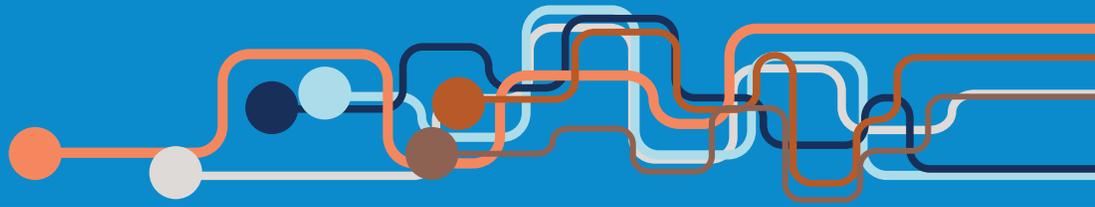
each project's unique business case, P3 arrangements tend to follow one of the following three models. All models may be adapted to include multiple public or private partners, depending on a community's specific needs and circumstances.

- **Public facilitation of private investment.** In this model, the public partner does not make an investment in broadband infrastructure itself; rather, the public partner implements modest measures to enable or encourage greater private sector investment and to attract private capital. In this scenario, there is no public control of where the broadband network is built; the private partner alone makes those decisions. Due to the lack of decision-making and control in this type of arrangement, the public partner assumes little to no risk. Instead, the private partner assumes all risk, although in return, the private partner also retains

complete control of all decisions regarding the network, reaping the benefits from its decision-making.

In some examples under this model, the public partner provides modest support in the form of a dedicated staff member to assist in the deployment process, or perhaps economic development credits. In other cases, the public partner offers up a smooth and efficient permitting process.

Partnerships using this model are likely to be limited in number due to several key realities. First, this model works only in areas where the private partner will realize a financial return on its investment. And secondly, the non-financial goals of the public partner, such as expanding broadband to all neighborhoods and areas in the community, are never realized if they are of less interest to the private partner.

RETAIL FIBER AVAILABILITY
Private Providers' Residential & Business Fiber in North Carolina
Based on FCC Form 477 Data from December 2016 (Released November 2017)

Private Providers' Residential & Business Fiber

Urban Areas
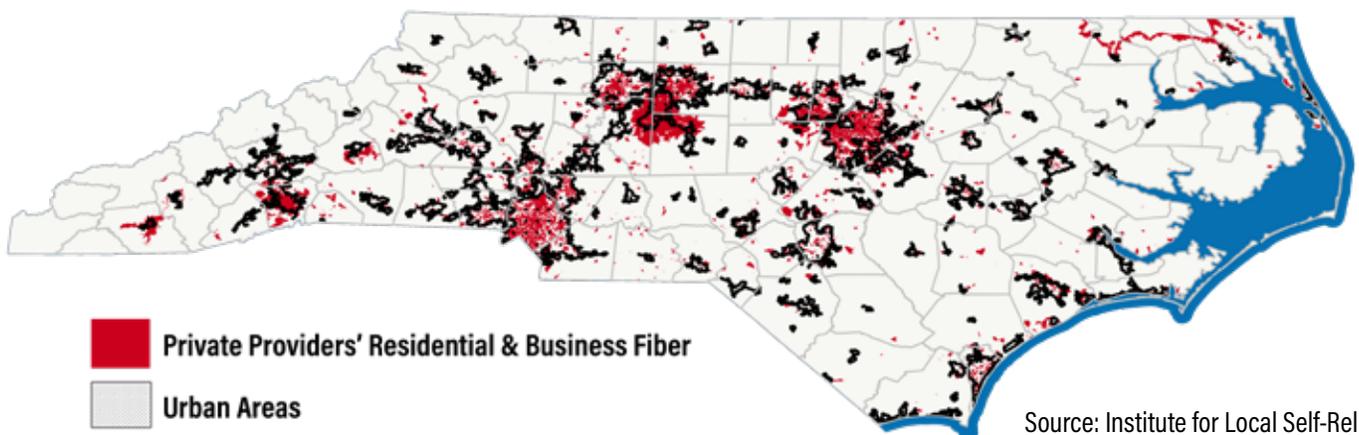
Source: Institute for Local Self-Reliance

- **Public funding and private execution (concessionaire model).** In this type of P3, the public sector makes a substantial investment in broadband infrastructure, while the private partner undertakes the actual work of executing the project: lining up financing, then designing and constructing, and finally operating the network. In return for its efforts, the private partner receives the public partner's guaranteed pay-back for the project costs. This approach is also known as the concessionaire model because the public partner grants a long-term concession to the private partner. For its money, the public partner does not have to face the challenges of building and operating the network, and it may take advantage of the

Case Study: HUNTSVILLE, ALABAMA

In February 2016, the city of Huntsville, Alabama—the state's northern technology hub—announced that its municipal electric utility would build a dark fiber network throughout its city limits, with Google Fiber leasing and lighting much of that network to provide gigabit service to residences and businesses. The city and Google Fiber structured the P3 deal so that Google Fiber would lease fiber from Huntsville at different prices based on the amount of fiber used. Those same lease terms are available to other private ISPs as well. Other cities that have leased their fiber assets to private companies have based the payments not only on the amount of fiber used, but also on how many customers the ISP served and how much revenue it generated. In those other deals, the cities experienced less predictability and certainty about the amount of lease payments they would receive, but they enjoyed greater potential than Huntsville will have to share in the ISPs' financial successes.

The Huntsville example plays to the classic strengths of public and private sectors relative to broadband services. Under this deal, the city remains in the business of building infrastructure, a business it knows well after a century of building roads, bridges, and utilities. In turn, Google Fiber (and other private ISPs that choose to lease the city's fiber in the future) will assume responsibility for all aspects of network operations, equipment provisioning, and internet service delivery. The city receives a predictable payment from leasing its fiber, and the private partner(s) receive all the profits from providing services by lighting up that city-owned infrastructure.
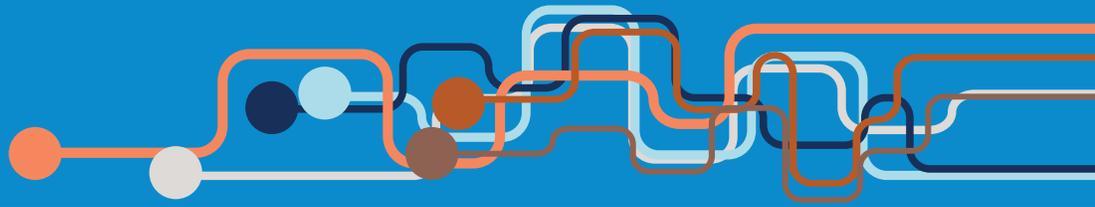
private partner's expertise in building and running a network.

These P3s are structured in much the same way that P3s for transportation projects have been done over many prior decades. And while this approach is very new in the context of broadband infrastructure, a number of companies have emerged with fully-articulated business propositions for localities. If properly structured to maximize benefit for the public partner in return for assuming substantial risk, this P3 model can offer a comprehensive solution to building broadband infrastructure that serves an entire community or is targeted to a particular priority area such as a business district or underserved neighborhood. This model is also the most likely type of P3 for projects in rural communities.

- **Shared investment and risk.** For this final P3 model, the public and private partners find creative ways to share the costs and risks of building, operating, and maintaining a broadband network. In negotiating these arrangements, each partner will allocate capital and operational risk, ideally targeted to their respective strengths and weaknesses. For example, the public partner could utilize its public works expertise and build a dark fiber broadband network itself throughout the entire community, designing and constructing the system of fiber, backhaul, and conduit that makes up the network. Meanwhile, the private

partner could draw on its operations and customer service experience and light the fiber by using that network as an ISP for a period of time. In this scenario, the public partner realizes the benefits it seeks (high-speed broadband service to all, use of the network for its own internal operations, etc.) at the same time the private partners achieve their goals (current and future profits).

Shared risk P3 models are in their early days for broadband infrastructure, leaving few examples to draw upon. However, this model is likely to emerge in urban areas where private partners will realize the most financial reward for their risks.

IV. North Carolina Law and Policy

Even if a North Carolina local government succeeds in making the business case for a broadband partnership and galvanizing public support for the system, state law is not clear cut in this area, with some arguing that it creates hurdles to broadband partnerships. Because of disputes and uncertainties about the meaning of the law, it would be beneficial for North Carolina cities to have greater clarity regarding the types of investments a city may make in broadband infrastructure[18]. The legal picture is murkier and more uncertain for counties in terms of their authority to make broadband investments, indicating that they are also in great need of clear-cut authority to enter into broadband partnerships.

EXISTING NORTH CAROLINA LAW

Clear legal authority exists for North Carolina cities to provide the following broadband services over municipally-owned broadband infrastructure[19]:

1. To share data or voice communications between governmental entities, for internal governmental purposes. Examples of this type of communications network include a city's public safety communications system or traffic signalization system.

2. To remotely read electric, water/sewer, or parking meter data, including smart meters that aid the government in accurately measuring energy and water consumption, and to provide smart grid services.

3. To provide free internet services to the public. This type of service includes free downtown wi-fi networks.

In part due to the newness of the partnership approach, existing North Carolina law does not provide express statutory authority for cities or counties to provide broadband infrastructure as part of a partnership in the various ways described in Part III. Providing express authority to cities and counties to participate in broadband partnerships would end any debate as to the scope of municipal and county authority and provide private partners with the black-and-white legal certainty that some may expect in order to enter a partnership.

NEW AUTHORITY NEEDED FOR PARTNERSHIPS

Given the lack of express statutory authority to build broadband infrastructure which some entity would utilize for profit, the public-private partnership arrangements described in Part III may not become widespread in North Carolina unless state law is revised to provide express authority for cities and counties to participate
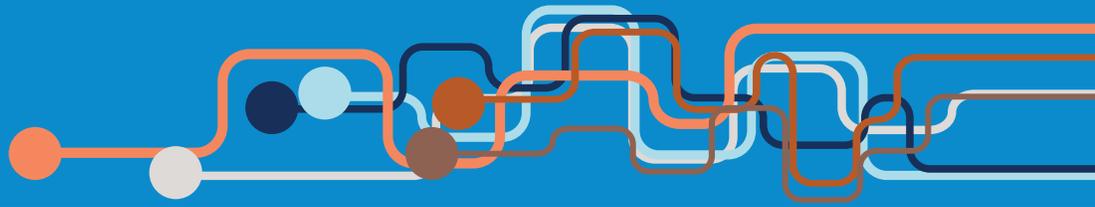
in these partnerships and to speak clearly as to the state's support for the partnership approach. For viable partnerships to move forward across the state, cities and counties need a strengthened law that fills in existing gaps and provides unambiguous authority:

1. To raise money for broadband infrastructure, including taxes and borrowed funds;

2. To spend money on broadband infrastructure;

3. To lease infrastructure to the private and non-profit entities that will operate and profit from using the broadband infrastructure to provide internet service.

Note that these authorities do not allow a local government to become an ISP or operator of a broadband system. Rather, these authorities focus the local government's role in the partnership to serving as the builder and owner of the infrastructure.

Legal limitations also hold back another key potential partner in expanding broadband systems into rural areas of North Carolina: electric cooperatives. Like the financial limitations state law places on cities that wish to provide their citizens internet service for a fee, North Carolina statutes place prohibitive conditions on electric cooperatives when they provide telecommunications services and products to their members.[20] Further, electric cooperatives face significant challenges in deploying broadband infrastructure on their poles and rights-of-way along thousands of existing easements that do not grant use of private property for telecommunications purposes. Statutory changes

TELEPHONE MEMBERSHIP CORPORATION SUCCESS STORIES

Unlike electric cooperatives, North Carolina telephone membership corporations (TMCs) do not face legal limitations on their ability to build broadband infrastructure and operate broadband services. Accordingly, each of North Carolina's eight TMCs—operating in large, rural swaths averaging eight customers per mile—offers broadband service that reaches all TMC customers. Two TMCs—Atlantic Telephone Membership Corporation (operating in Brunswick County) and Wilkes Communications (operating in Wilkes County)—offer packages with symmetrical gigabit speeds. In all cases, the TMCs took advantage of existing legal authorities, pole ownership, and right-of-way access to deploy fiber-based broadband service to their customers, ensuring they are not left behind in the digital economy.

to address these issues are necessary to unlock the potential of electric cooperatives as significant partners in building rural broadband infrastructure.

## PUBLIC-PRIVATE PARTNERSHIP LAW REFERS TO CONTRACTING

It is important to recognize that while P3s represent the most promising arrangement for building out rural North Carolina's broadband infrastructure grid, the state's existing P3 statute does not address the issues of authority detailed above. Rather, this statute simply describes the public-private partnership method of contracting. Other state laws authorize other forms of public contracting that may be used by local governments in this context as well, and with each form of contracting, the laws set parameters for the type of risks assumed by the parties to a deal. The current P3 statute was developed primarily for use in road and building projects, so its allocation of risks between the public and private partners well-fits the business cases for those types of infrastructure projects. However, because broadband infrastructure projects require a significantly different business case to be beneficial to all partners, it is likely that the partners in a broadband infrastructure deal would utilize other authorized forms of contracting besides P3 contracting.

SUPPLEMENTAL LOCAL POLICIES

Numerous other supplementary policies exist that can incentivize and speed up the construction of broadband infrastructure. The N.C. Broadband Infrastructure Office identified many strategies in its 2016 state broadband plan, "Connecting North Carolina."[21] Some policies that North Carolina local governments may implement now include:

- Streamlining local permitting processes that accelerate ISPs' access to public right-of-way. Best practices for local governments in this area include publishing the review process' steps and timelines for approvals, adhering to those approval timelines, and holding pre-application conferences between providers and local permit reviewers.

- Prequalifying third-party inspectors to supplement local governments' own oversight of broadband projects built by the private sector. This policy enables a local government to ramp up its construction inspections capabilities when faced with a significant crush of requests that come during short-term broadband construction projects.

- Publishing data sets regarding government-collected information and assets. The local government data sets of most interest to broadband providers include those inventorying existing public right-of-way and easements, addresses, streets, building footprints, streetlights, neighborhood boundaries, parcels, utility poles, manholes and handholds, zoning, existing underground utilities, and existing broadband assets such as fiber and conduit.
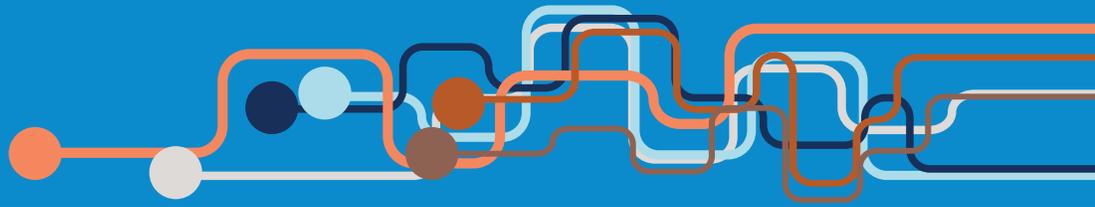
- Performing timely, accurate locates of local government-owned infrastructure like water/sewer pipes. Because broadband providers utilize the same right-of-way as other utilities, they must rely on those utilities to mark the location of their underground infrastructure before stringing fiber on poles or digging to lay conduit. The faster that public and private utilities perform these "locate" requests, the faster a provider can build its system.

- Offering space in local government-owned buildings for providers' equipment and office needs. Local government buildings may offer providers temperature-controlled, secured indoor space near business and residential customers to house necessary system electronics and office space.

- Recruiting major institutional or business customers. Because broadband providers must realize a certain number of customers to their service to justify the expense of building a system, they can benefit from local officials' efforts to recruit large institutional or business customers as the "anchor" customers for their broadband services.

Other policy changes that would incentivize and speed up construction of broadband systems across the state would require action by the N.C. General Assembly. If authorized under state law, these local government actions would lower costs for broadband providers:

- Building broadband infrastructure and leasing it to private providers. Such infrastructure includes conduit, fiber, and backhaul electronics.

- Requiring installation of fiber with all new commercial and residential construction projects. Updates to the State Building Code would be necessary to implement this policy.

- Instituting "dig once" policies. A dig once policy requires utility providers, when they undertake a project in the right-of-way, to coordinate with the local government on the installation of extra fiber or conduit. Such policies require a high level of oversight by the local government, including advanced planning and development of technical specifications.

- Implementing "one-touch make-ready" policies. Make-ready is a telecommunications industry term that refers to the work performed on a utility pole when providers with existing wires move those assets to make room for another entity's wires. Typically, each provider on a pole takes responsibility for moving their own wires, which results in a slow, duplicative process before the new pole user can install their wires. One-touch make-ready policies mandate that one technician should move all wires on the pole at once.

THE BUSINESS CASE FOR BROADBAND

As with any major infrastructure investment, such as a transportation system or electric power supply, the amount of capital required to extend broadband networks across the entire state is breathtaking. Just two years ago, the FCC estimated it would take $40-$80 billion to build out broadband infrastructure nationwide to homes and businesses that lacked service at the FCC's 25/3 Mbps levels. With numbers like these, it cannot be left entirely up to private providers, or entirely up to the government, to build out a broadband network. It will take a blend of public and private investment. Successful public-private partnerships will build upon the strengths of each sector. But at their root, these agreements will memorialize the commitments each sector is willing to make to support their business case.

For the government partner, the business case will likely include financial gains such as the proceeds of lease payments. But the government's business case will also include clear community benefits such as increased economic, educational, and health care opportunities for citizens.

For the private partner, the business case hinges on how much earnings they can expect to realize from operating a broadband service. Revenues will depend on how many customers sign up for the service. Business and institutional customers utilize more bandwidth, but they offer higher revenue potential for a private ISP. Communities without large business or institutional customers will likely need heavier government investments and incentives to make the business case work for their private partner.
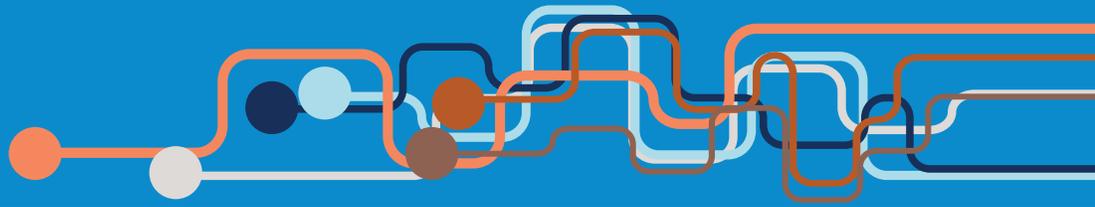
STATE POLICY CHANGES

At the state level, North Carolina can incentivize the construction of broadband infrastructure networks by instituting policies that mandate installation of underground conduit to house fiber in the future. Under such a policy, every time a state agency—such as the N.C. Department of Transportation or N.C. Railroad—dug in the right-of-way, it would install conduit at the same time. This conduit could then be leased in the future to an ISP, who could easily install fiber in the conduit, thereby saving time and money with the reduced barriers to accessing the public right-of-way.[22] The cost of conduit to the government agency in most cases is negligible compared to the cost of the associated transportation construction project. To take these policies a step further, state agencies could also install dark fiber along their managed right-of-way and lease it to ISPs.

And as with all other forms of basic infrastructure, broadband infrastructure will only become ubiquitous in North Carolina with financial support from all levels of government, including federal, state, and local. Several federal agencies award grants and funding to local governments to assist in building broadband infrastructure. However, no comparable state-level fund exists in North Carolina. Other states with robust state-level broadband funds, such as Minnesota[23], appropriate state dollars to public and private entities through a competitive grant program administered by the state broadband agency. A similar grant fund, established

Local Governments Need Explicit Authority to:

Raise money for broadband infrastructure, including taxes and borrowed funds.

Spend money on broadband infrastructure.

Lease infrastructure to the private and non-profit entities that will operate and profit from using the infrastructure.

within the N.C. Broadband Infrastructure Office, would fill a critical gap in North Carolina's broadband policy.

Finally, North Carolina state policy-makers can stimulate a build-out of broadband infrastructure with policies designed to incentivize customers to subscribe to the service. All ISPs—whether public, private, or non-profit—must make a business case for recouping the costs of investing in the infrastructure. Therefore, they require a minimum "adoption rate," or number of subscribers, to meet the financial targets in the business case. State programs to educate North Carolinians about the benefits of high-speed internet service, subsidies for low-income subscribers, and other digital literacy efforts will all contribute to making the dollars and cents add up for ISPs.

V. Conclusion

High-speed broadband is now fundamental to commerce, education and health care in North Carolina. It is essential 21st Century infrastructure, and as with roads and bridges, communities that are not adequately connected to the larger network cannot and will not succeed economically.

Although gaps in access to minimal internet connections may be closing in rural communities, those connections are nearly obsolete for many uses as soon as established. Meanwhile, the types of high upload speeds required of digitally-intensive businesses – whether home-based entrepreneurs or high-tech firms connecting to similar businesses around the world – remain lacking in a wide swath of the state.

Two decades into the digital revolution, it has become clear that private-sector solutions alone are not going to close this gap, and that large private-sector providers and their investments will continue to primarily focus on densely-populated areas. At the same time, local governments – as experienced providers and builders of infrastructure – are uniquely positioned to help close the digital divide. They cannot accomplish that task though without help at the state policy level.

State policies that encourage and provide more explicit authority for local governments and others to enter into broadband-related public-private partnerships are required if North Carolina is to meet the digital needs of all its citizens. Incentives for private providers, dedicated investment by all levels of government, and policies that streamline permitting and construction of broadband delivery systems also need to be a part of the solution.

The demand for better and faster internet is not going to slow, in North Carolina or anywhere around the globe. As that demand increases, the technology and investment needed to meet it will only grow as well. Encouraging a blend of public and private investment is required if that demand is to be met. And meeting that demand is fundamental to ensuring that all North Carolina communities survive and thrive into the 21st century.
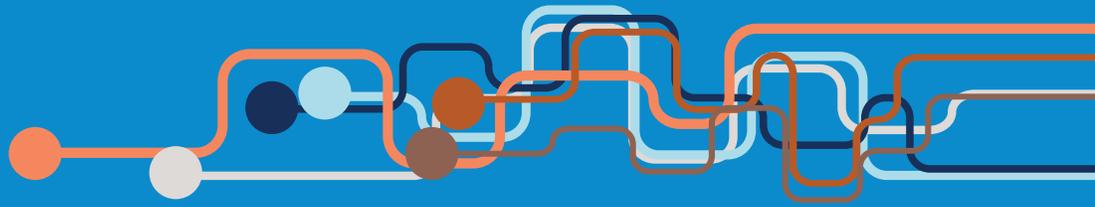
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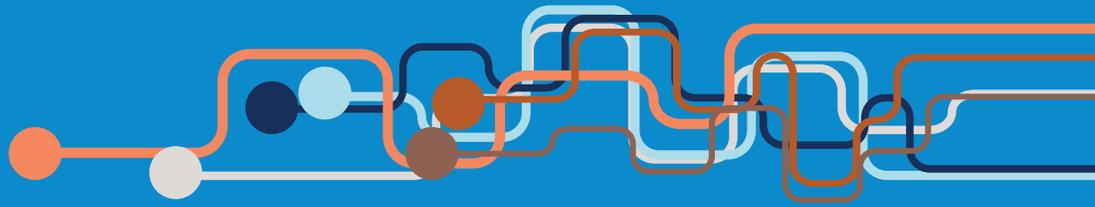
About the League

The North Carolina League of Municipalities is a service and advocacy organization representing nearly every city and town in North Carolina, helping them to more effectively and efficiently serve their residents.

For more than 100 years, our organization – as directed by our members – has worked to promote good government and vibrant cities and towns. We do that by offering non-partisan advocacy, insurance and a range of other services.

For more information about the League, visit www.nclm.org. To contact the League about information found within this publication, please call (919) 715-4000.

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10. From interview by NCLM, Dec. 7, 2017.

11. WUNC Radio, *Digital Learning Threatens to Leave Some Student Behind*, May 16, 2017.

12. Higher Education Works, www.highereducationworks.org, Aim High, Achieve More forum, Oct. 4, 2017.

13. http://www.pewresearch.org/fact-tank/2017/04/10/americans-have-mixed-views-on-policies-encouraging-broadband-adoption/.

14. Fiber only passes by eleven percent of U.S. households, according to the 2016 North American survey conducted by RVA LLC for the Fiber to the Home Council Americas.

15. The typical HFC technology now in use, called DOCSIS 3.0, offers 200/108 Mbps connection speeds, compared to fiber's speeds of 1/1 Gbps and above.

16. At their peaks, today's newest wireless technologies provide only one-tenth the speed available from fiber or hybrid fiber-coaxial systems.

17. Limits on upload speeds mean users generally do not share large files using wireless services. The same limitation on upload speeds also makes it less feasible to use wireless service for video conferencing or any other two-way real-time applications that require high bandwidth.
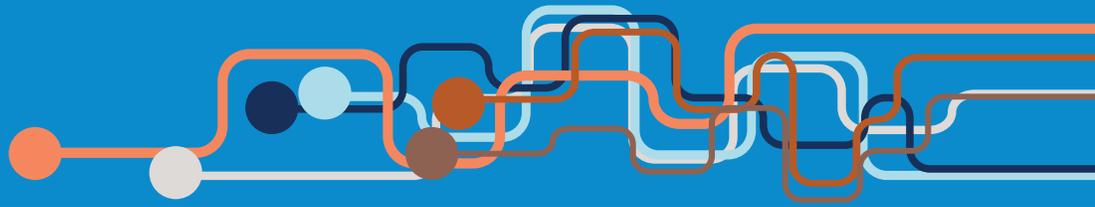
18. With the passage of S.L. 2011-84, the N.C. General Assembly enacted Article 16A of Chapter 160A, entitled "Provision of Communications Service by Cities." The law contains numerous conditions placed on cities seeking to provide internet service to the public for a fee. Taken together, these conditions pose such substantial financial and political hurdles that since passage of the law, no city has pursued such a project.

19. N.C. Gen. Stat. § 160A-340(3).

20. N.C. Gen. Stat. § 117-18.1.

21. N.C. Broadband Infrastructure Office, 2016 State Broadband Plan, Connecting North Carolina, https://www.ncbroadband.gov/wp-content/uploads/2016/06/akljsnenx.pdf.

22. CTC Technology & Energy estimates that providers save up to 90% on the costs of running underground fiber if the government leases them available conduit. *Gigabit Communities: Technical Strategies for Facilitating Public or Private Broadband Construction in Your Community* (2013), available at www.ctcnet.us/gigabit.

23. The Minnesota Office of Broadband Development administers the Border-to-Border Broadband Grant Program, which provides up to half the costs of a broadband infrastructure project in an unserved or underserved area of the state. Minnesota law sets the standards for "unserved" and "underserved" areas. Grant recipients may include either for-profit businesses, non-profits, or local governments or Indian tribes. In 2017, the Minnesota legislature appropriated $20 million to this fund.

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