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FIBER-OPTIC
FEASIBILITY STUDY

CHATHAM COUNTY, GA

Acknowledgements

Magellan Advisors wishes to thank Chatham County for the opportunity to assist with this important work. We would like to thank Chatham County staff for the time and thoughtful input they invested in providing insight into the development of this feasibility study.

Magellan Advisors would also like to thank the staff of the Coastal Georgia Indicators Coalition for their instrumental role in coordinating and bringing together representative voices of the business community, community anchor institutions, and homeowner groups from across Chatham County.

We would like to thank the people and organizations of Chatham County who took the time to share their experiences and opinions through the survey process and group discussions. The insights derived through interviews, surveys, and documentation were central to the development of Chatham County's study. The valuable input for this study would not have been possible without the willingness of local businesses and residents to share discussions around all of their internet connectivity challenges and ambitions.

Magellan Advisors does not always recommend that client communities build fiber networks, but we do often recommend that cities and counties work together to pursue partnerships. In working with Chatham County, we have the highest confidence that the County will be a strong and cooperative partner with each of the municipalities of Chatham County along with the City of Savannah and private service provider partners.

While Chatham County and the City of Savannah initiated separately researched and modeled feasibility studies, the collaborative spirit exhibited by both City and County during the process made it clear that together each would be stronger through a fiber partnership. Through the separate research and modeling for each entity, it became clear that the strategies set forth in each study should be complementary in nature.

The cooperative spirit that County staff has demonstrated with each of its municipalities and stakeholders suggests that a bright fiber-optic future is well within reach of the residents, businesses, and community organizations across all of Chatham County.

Table of Contents

LIST OF FIGURES

1. INTRODUCTION

Chatham County has a long and auspicious history. The citizens of Chatham County understand the value of planning because it is evident in Savannah's squares, parks, and boulevards. This report, and a parallel study conducted for the City of Savannah, is a modest but important contribution to the community's tradition of forethought. Careful, inclusive planning is essential to long-term community vitality, and Magellan Advisors is honored to help Chatham County chart a course into the digital future.

In the past, commercial and industrial sites, housing, public spaces, power, transportation, and water were critical for community viability. Today, competitiveness, prosperity, and quality of life are determined by bits and bytes, code and data, networks, "smart" systems, and software applications. Indeed, digital technology has become the key to effectively managing and using traditional resources. It is creating new possibilities for business, commerce, education, healthcare, governance, public safety, and recreation. All of this depends on bandwidth and connectivity - ability to move information quickly and flexibly from and to most anywhere.

The vast array of devices that permeates Chatham County is only going to increase. Those devices enable people to greatly improve and transform how they live, work, and play by connecting them to each other and giving them access to valuable information. Increasingly, digital technology is transforming the way cities operate. Technology is at the heart of citizens' evolving expectations of their local governments. The general innovation is that digital technologies allow governments to operate better, cheaper, and faster. Citizens can use digital technology to interact with each other in unprecedented, highly informed, easier, and more dynamic ways. They are expecting similar ease of use and flexible interaction with their local governments.

Local governments are responding with new investments in technology and with new partnerships. The challenge is to balance technology investments with other fiscal needs in an era of tight budgets. But there are opportunities, as well, to overcome the challenge and do even more:

- Control and reduce cost by replacing facilities, labor, materials, etc. with technology
- Enable citizens to serve themselves and their neighbors, and otherwise engage them to make government services more efficient and effective
- Generate local economic, environmental, quality of life and place, etc., metrics to guide development, help citizens, and inform policy making
- Improve service quality and response time, and provide citizens with clear, meaningful performance metrics
- Provide new high-value services to attract new investment, foster community, economic, and workforce development, and generate new revenue streams

The critical, foundational resource for these applications or users are network facilities. Networks facilities include antennas, conduits and ducts, poles, towers and other "vertical

assets," as well as fiber-optic cables. Fiber-optic cables are the key resource because they are real assets with long-term value that can carry huge amounts of information. Fiber-optic network capacity and connections can be segmented in many ways, reconfigured with relative ease, and are highly secure. Most digital technologies rely on fiber-optics and new technologies will likely increase the value of fiber-optics rather than replace them.

Of course, fiber-optic cables must be deployed and installed. Thus, conduits, ducts, and utility poles or towers, to which aerial cables are attached are valuable real assets. Antennas, which are necessary for a variety of wireless communication media must be interconnected via high-capacity fiber-optic cables. Finally, every location that is to be connected via fiber must have a cable entrance, a terminating point, and means of connecting devices to the fiber. Fiber-optic terminating equipment is typically installed in a rack in a closet in a building or enclosure. All of these items are valuable real assets that comprise a community's information infrastructure.

Network facilities have practical, operational, and market value based on where the facilities are located and how they are used. This report is about optimizing that value. It considers the benefits of fiber-optics and how to maximize them, and it details the costs of fiber-optics and how to minimize them. Building, running, and even using fiber-optic infrastructure is not a short-term, seat-of-the pants endeavor. These activities demand a clear vision for current and future citizens' expectations and requirements, require substantial input from local business and civic leaders, and benefit from principled thinking about the role of local government. Chatham County will be most successful with information infrastructure if it is guided by some simple, measurable principles:

- ### *Be Good Stewards of Public Assets and Taxpayer Dollars*

  How can local government give citizens the most affordable Internet access and other digital network services to have a direct value to citizens, and be used to improve local government performance? The County and its incorporated areas should give citizens great return on their taxes by avoiding, eliminating, or reducing recurring public costs, investing in public assets, and catalyzing private investment.

- ### *Enable Quality of Life with Applications, Content and Data*

  How can local government help citizens be more comfortable, prosperous, and well? Technology is a powerful enabler of business, education, healthcare, safety, and security. The County should focus on applications that deliver content or generate information to enable citizens' economic, environmental, personal, and social "smarts." This should be done as much as possible in partnership with private companies—ideally local ones—to minimize costs while maximizing economic impacts. The fundamental metrics are business and household incomes, innovation, productivity, security, and wellness.

- ### *Enhance Quality of Place with Advanced Infrastructure*

  As with any infrastructure, the best technology is transparent but usable and useful. The County should invest in technological "things you never notice until they break" (i.e., infrastructure) and in making sure those things never break. The County should engage the full the range of public, private, non-profit, and for-profit entities to direct and fully capitalize on those investments. This can be measured by domestic and foreign direct investment, population growth via in-migration, real estate development and prices, and tourism spending.

- ### *Foster a Robust Marketplace and Competitive Offerings*

  How can local government spur private investment that brings more, better, and lower cost products and services to citizens? Capital and operating expenses can be barriers that keep new or growing businesses from entering the local market. The County should structure its investments in a way that minimizes those barriers and acts as a catalyst for private investment. This can be measured via venture capital funding, product and service exports, costs of living, and commercial and retail sales. Workforce development is also a critical element of economic competitiveness, and local public investment in technology should spur individuals and organizations to invest in new and improved skills, which is measured by educational attainment, employment, training, wages, and workforce skills.

In summary, digital infrastructure can be used to deliver essential community services, enable a modern, connected economy, and support a higher quality of life. The purpose of this study is to help Chatham County understand how the it can accomplish these things and help its citizens get better connectivity and more bandwidth, while meeting its internal technology needs.

Magellan Advisors' goal is to provide a clear picture of current, unmet needs for bandwidth and connectivity, and of how fiber-optic infrastructure can enable the County's economy to improve and grow into the future. Along with those insights we provide actionable short-term options and plans for achieving specific results and position Chatham County broad-based, long-term opportunities. Chatham County should invest in fiber-optic infrastructure and related facilities to better serve its citizens, enhance quality of life and quality of place, and spur sustainable economic growth. This study details how to do this in a manner that is economically feasible, fiscally responsible, and practical.

1.1   Chatham County, Georgia

Chatham County is the northernmost of Georgia's six coastal counties. Named for William Pitt the Elder, Earl of Chatham, it was formed out of Christ Church Parish and St. Phillip Parish in 1777, one year after the founding of the United States of America. It is the fifth oldest county in Georgia and is the home of Savannah, which serves as the county seat. Other incorporated towns include Bloomingdale, Garden City, Pooler, Port Wentworth, Thunderbolt, Tybee Island, and Vernonburg.

Figure 1: Chatham County map
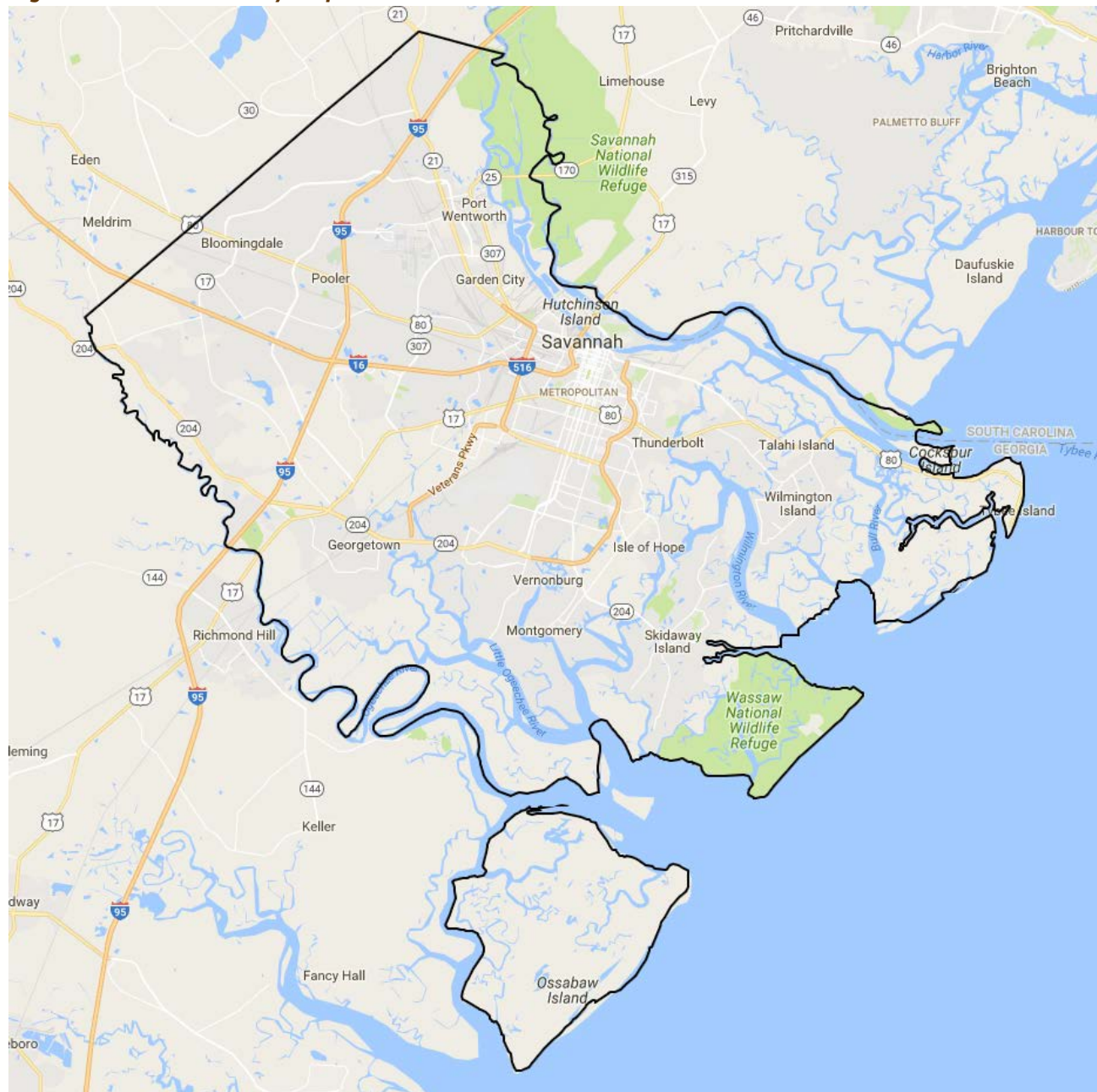
1.1.1   Chatham County Demographics

In 2015,[1] Chatham County had a population of 286,956 with 104,912 households[2]. As shown in Figure 2, Chatham County has relatively more of a young adult population than the rest of the country, specifically the age ranges 20 to 34 years, though there are also age spikes at young and old edges of the scale. Chatham County median age in 2015 was 34.3, compared to 37.6 for the U.S. and 35.9 for Georgia.

Figure 2: Chatham County percentage of population in various age ranges
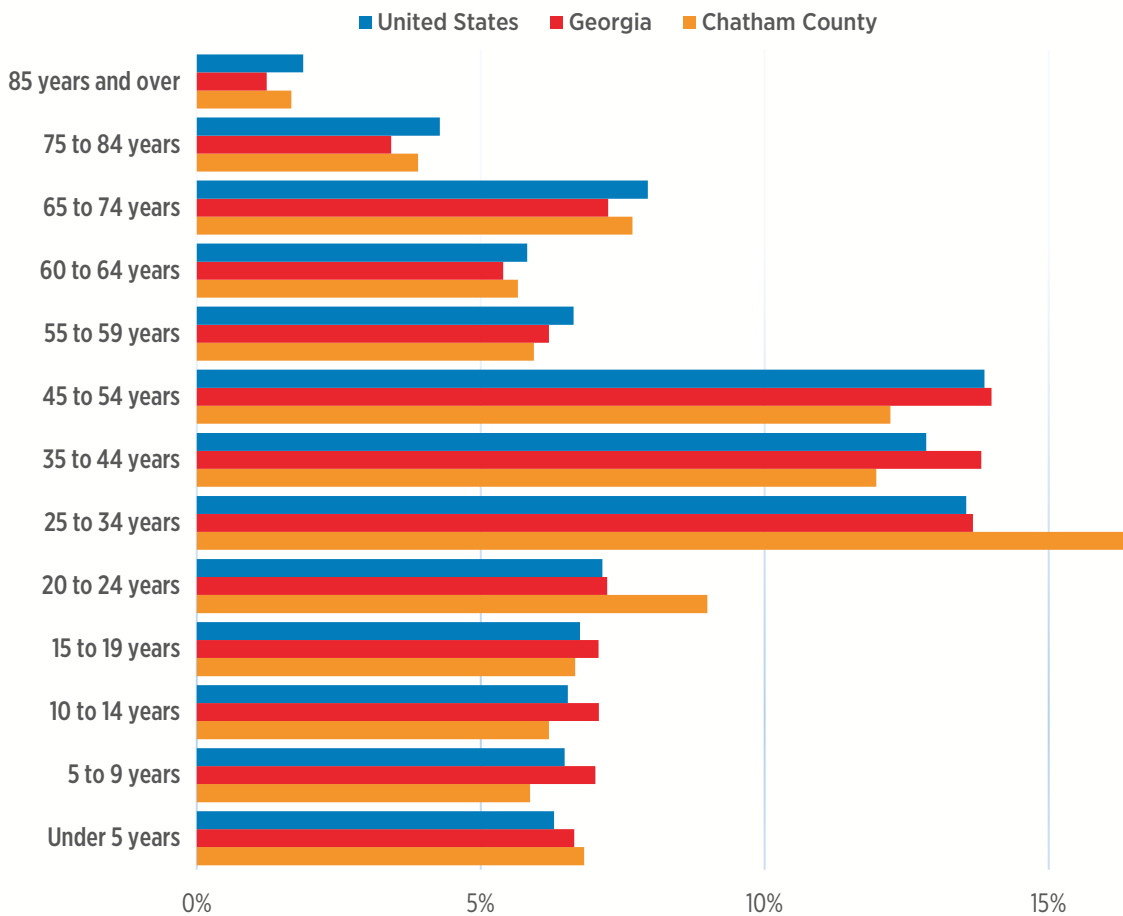
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Chatham County is relatively well-educated, as illustrated in Figure 3, though wavering in percentages of individuals attempting some college and finishing high school. Median incomes are consistently lower for all educational levels in Chatham County, closely proportionate with state and national incomes and differences increase with educational achievement, as shown in Figure 4.

Figure 3: Chatham County educational attainment
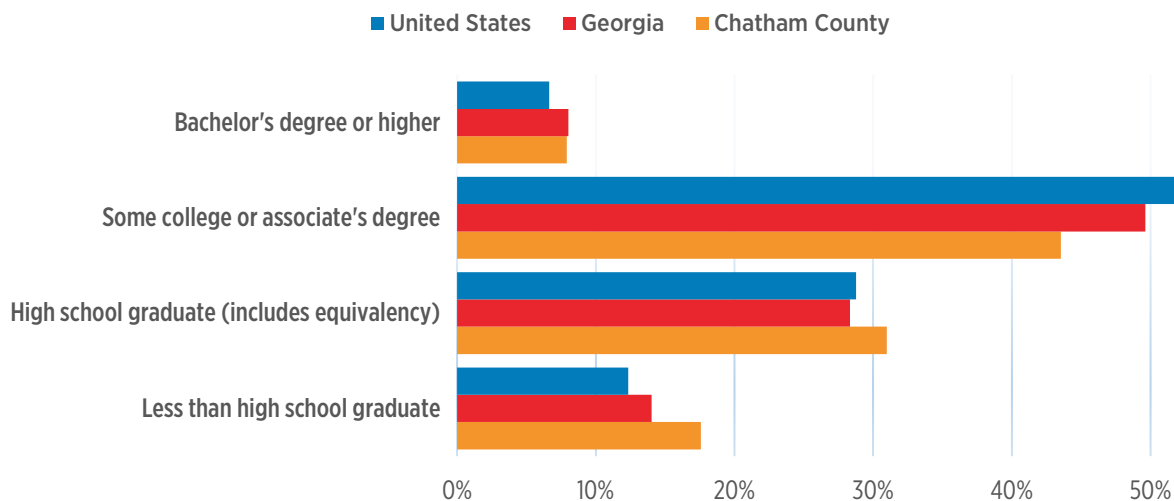
Figure 4: Chatham County median income
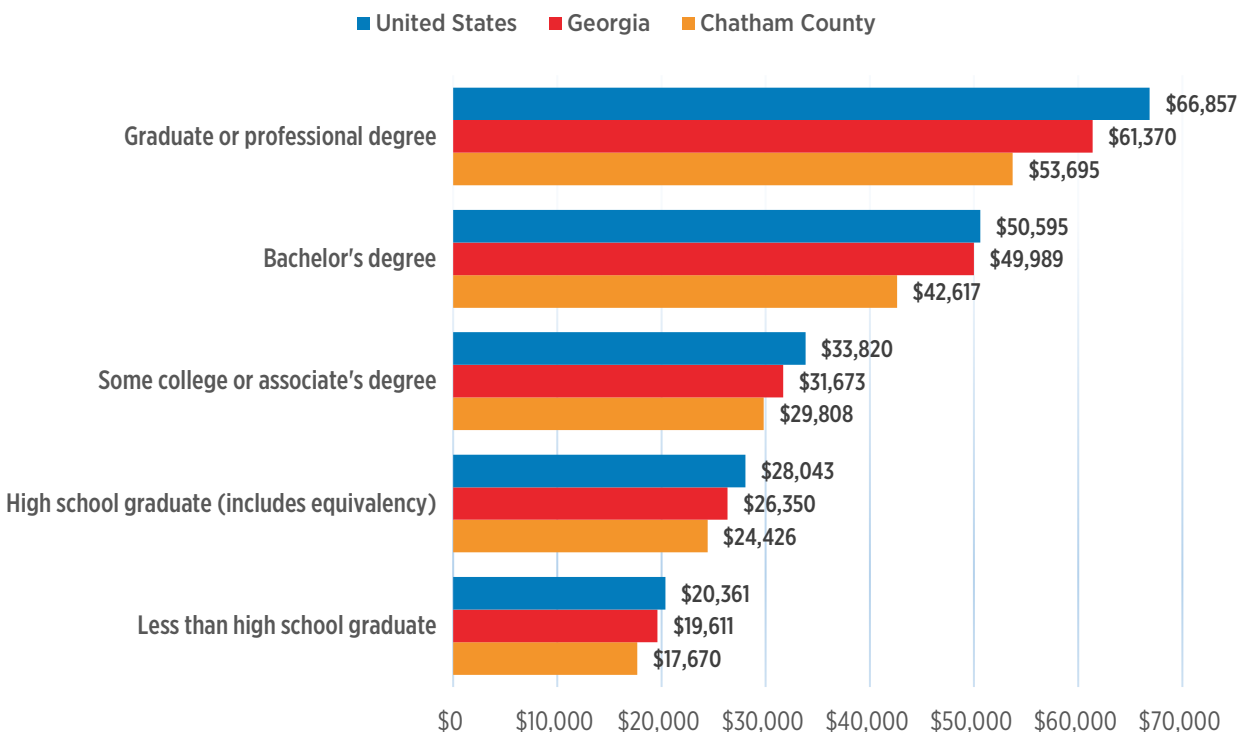
The differences in income are even more apparent when considering families. Chatham County has a higher portion of families at low and very low income levels than the state and nation. It also generally has a smaller percentage of families at mid- to high-income levels, as shown in Figure 5, though there is a spike in households earning between $50,000 and $74,999.

Figure 5: Chatham County households at various income levels
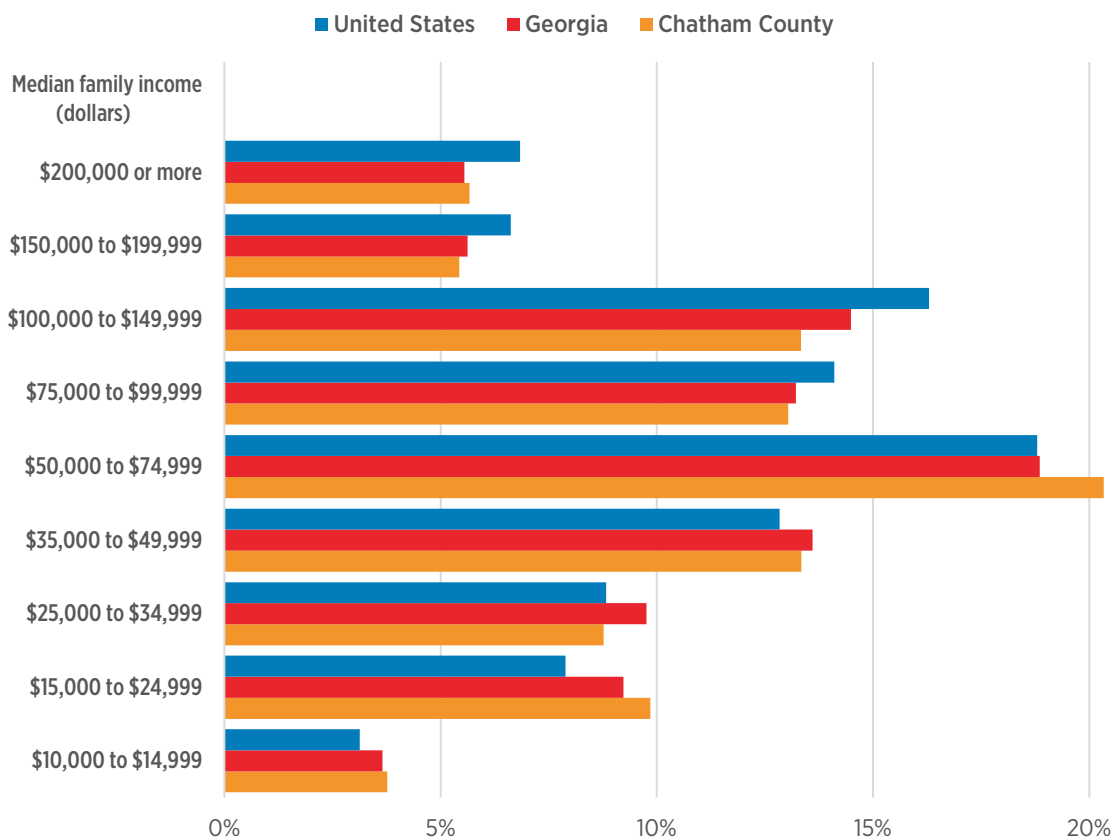
1.1.2 The Chatham County Economy

Relatively more of Chatham County's workforce is in service occupations than the state or nation, as illustrated in Figure 6. While the largest percentage of occupations in Chatham County are management, business, science, and arts, the County has relatively more service sector workers than other parts of the country. The County is roughly equivalent in terms of construction, maintenance, office, and sales occupations.

Figure 6: Chatham County workforce percentages in various occupations
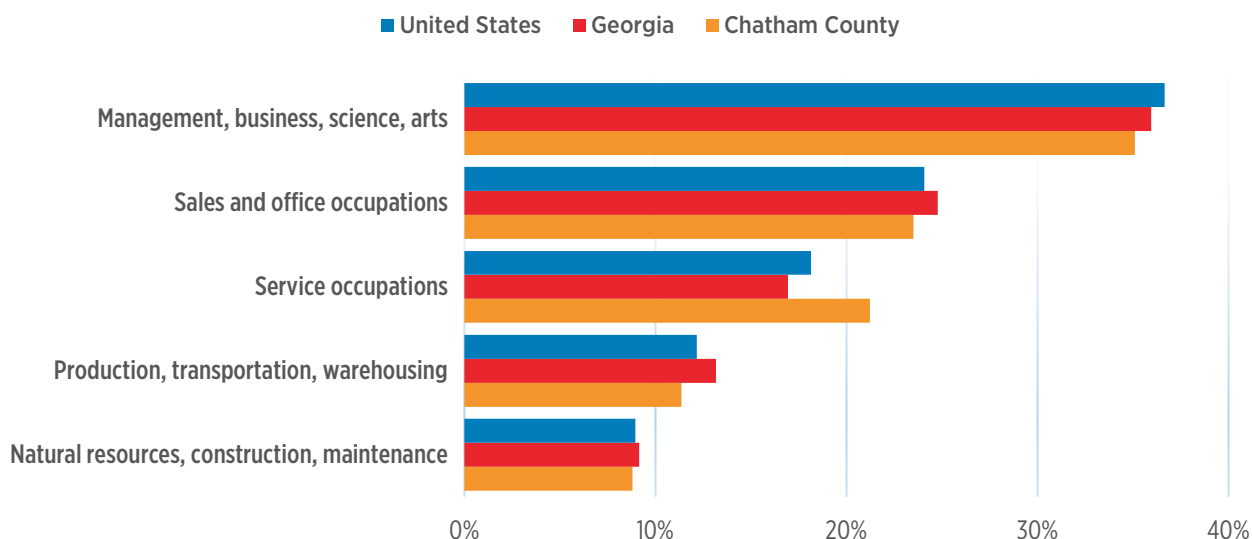
Chatham County's mean and median annual family incomes are about 10% lower than those of the United States, as shown in Figure 7, and just $1,000 less than the State of Georgia. Chatham County's per capita income is also lower than the state and nation. The difference between mean and median suggests that the distribution of incomes is skewed, with families and individuals concentrated in lower income brackets.

Figure 7: Chatham County annual incomes

Annual Incomes	U.S.	Georgia	Chatham
Median family income	$66,011	$59,410	$58,394
Mean family income	$88,153	$79,648	$76,713
Per capita income	$28,930	$25,737	$25,690

Chatham County has a diverse economy, anchored by manufacturing, tourism and hospitality, and transportation and distribution. Figure 8 shows where the workforce is employed. Chatham County, like other parts of the country, has the largest proportion of workers in education, health, and social assistance industries. But this figure also shows the County's concentration of service sector employees.

Figure 8: Percentage of Chatham County workforce in industry sectors
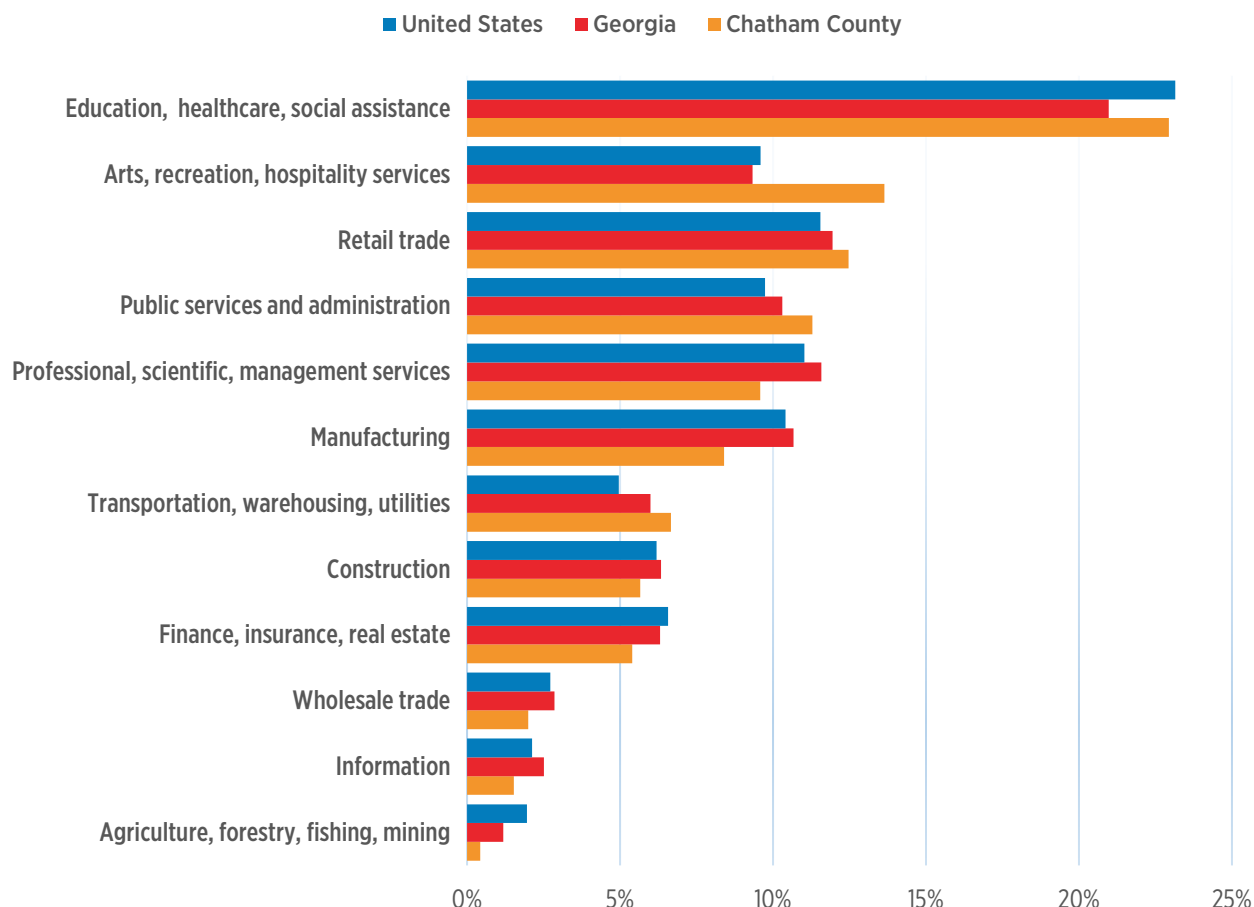
Chatham County also has relatively more educational services, healthcare and social services, and public administration than other parts of the country. Retail trade has the largest percentage of the total number of establishments and individual business locations, followed by other services. Healthcare has the largest percentage of employees, followed by retail and accommodations and food services.

Chatham County has a strong entrepreneurial ecosystem with numerous start-up companies that focus on creative markets that promote their services outside of the county. Chatham County also boasts major infrastructure. The Georgia Ports Authority's Port of Savannah, which has both breakbulk and container terminals, the Savannah International Airport, and extensive rail lines and interstates that connect the county with the country and the world.

Figure 9 compares the percentages of total employees and establishments per sectors with the location quotient (LQ) per sector.[3] This dataset shows that Chatham County is especially strong in manufacturing (1.84 LQ) and accommodations and food services (1.68 LQ). Major industries include Derst Baking, Great Dane Trailers, Gulfstream Aerospace, International Paper, JCB heavy equipment, and Morris Multimedia publishing.

Figure 9: Location quotient sector comparison

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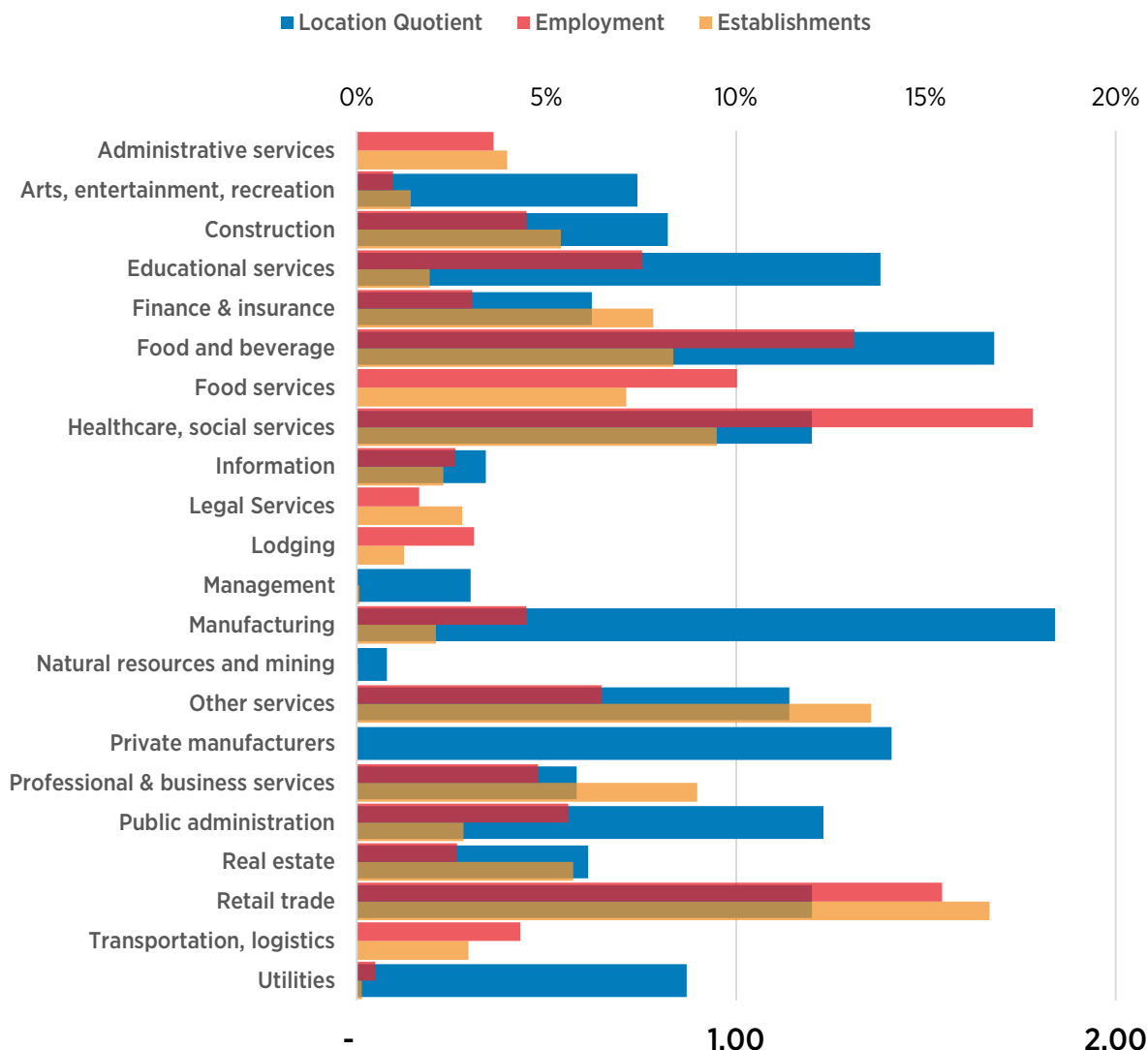
[3] Source: ESRI and Infogroup, 2016, via U.S. Bureau of Economic Analysis. Location quotient (LQ) is a measure of concentration of firms relative to the rest of the US. An LQ over 1.0 represents a higher than typical concentration; LQs under 1.0 mean the area has less of that sector than the US.

Figure 10: Economic indicators for Chatham County

Sector	Establishments		Product ($1,000)		Payroll ($1,000)		Employees	
	2012	Annual Rate	2012	Annual Rate	2012	Annual Rate	2012	Annual Rate
Accommodation and food services	897	3.7%	1,024,669	8.1%	277,269	8.7%	18,046	3.1%
Administrative support services	391	1.3%	484,563	-1.0%	245,182	-2.2%	9,633	-3.2%
Arts, entertainment and recreation	103	0.3%	125,963	4.5%	41,127	3.3%	1,839	-1.9%
Educational services	44	4.2%	99,233	NA	20,020	NA	421	NA
Finance and insurance	450	NA	NA	NA	175,542	NA	2,953	NA
Healthcare and social assistance	721	2.3%	2,327,431	5.9%	860,849	4.7%	18,354	1.4%
Information	113	1.0%	NA	NA	72,514	-2.8%	1,621	-2.8%
Manufacturing	NA	NA	NA	NA	NA	NA	NA	NA
Other services	414	-0.9%	NA	NA	NA	NA	NA	NA
Professional and technical services	708	2.4%	640,190	6.3%	253,435	6.5%	5,871	5.9%
Real estate and rental and leasing	388	2.1%	383,340	6.1%	60,368	5.2%	1,837	0.9%
Retail trade	1,204	0.2%	4,256,416	4.7%	375,335	2.5%	15,767	0.1%
Transportation and warehousing	370	NA	1,302,894	NA	342,998	NA	9,448	NA
Utilities	21	NA	NA	NA	NA	NA	NA	NA
Wholesale trade	317	-1.1%	5,812,883	10.8%	197,580	2.1%	3,925	-0.2%
	Total	Average	Total	Average	Total	Average	Total	Average
Chatham Totals	6,141	1.4%	16,457,582	5.7%	2,922,219	3.1%	89,715	0.4%

Chatham County's economy grew across the board between 2002 and 2012—including during the period of the "Great Recession," as detailed in Figure 10. The average change across all economic metrics was 2.6%. The largest growth was in Wholesale Trades' product, which changed 10.8% between 2002 and 2012, followed by an 8.7% increase in payroll for Accommodations and Food Services, which also grew its gross product by 8.1%. The only sectors with clear declines were Administrative and Support Services, with decreases in employees, payroll, and product, and Information, which saw decreases in employees and payroll. Interestingly, the largest reduction in establishments between 2002 and 2012 was in Wholesale Trades (-1.1%), the sector with the largest growth in product.

In 2012, the sectors included in the Census Bureau's data[4] had over 6,000 establishments and nearly 90,000 employees. They generated about $16.5 billion in gross product, and nearly $3 billion in payroll. Retail Trade and Healthcare & Social Services dominated Chatham County's economy, representing 19% across all metrics.[5] Retail accounted 26% of the county's gross product and 20% of its establishments. Healthcare & Social Services generated 29% of the county's total wages.

Accommodations & Food Services had more jobs (18,354, or 20.1%) in the county than any other sector. Services and Wholesale Trade each represented approximately 13% of the county's economy across all metrics. Wholesale was a particularly strong contributor to gross product, responsible for 35% of that metric. Chatham County's smallest sectors, based on the average of all four economic metrics, were Education (0.5%), Arts, Entertainment, and Recreation (1.5%), Information (2%), and Real Estate and Rental/Leasing (3.2%).

Although 2012 Census Bureau data for Manufacturing was not available, that sector generated 36% of the Chatham County's gross product, 24% of wages, and 14% of employment in 2002, despite only accounting for 4% of establishments. It accounted for 19% on average of all economic metrics. So, it has been an economically prominent sector in Chatham County. Other sources[6] indicate that Manufacturing had 327 establishments and 9,935 employees in 2016, suggesting that the number of establishments in Manufacturing grew while the number of employees declined. This same source indicates that the Construction sector had 968 establishments and 9,705 employees in 2016, making it a significant part of the Chatham County economy, as well.

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[4] Source: US Census Bureau, American Fact Finder, https://factfinder.census.gov; Economy-wide Key Statistics. Annual rate is the percentage difference between 2002 and 2012 divided by 10. "NA" indicates data is not available for that sector/year. Specifically: there is no data for Manufacturing in 2012, and agricultural, construction, and mining sectors are not included in the Economy-Wide Key Statistics.

[5] For the sectors included in the Census Bureau's data. The actual percentages are less because some sectors are not included. See footnote 3.

[6] Infogroup, prepared by ESRI for the City of Savannah in 2017. This data is only for 2016 and does not include prior year or metrics for product and payroll. It is not comparable to the Census Bureau data, so was not used in this analysis.

1.2 Overview of Broadband Networking Technology

Broadband refers to high-speed internet services, which provide online content—websites, television shows, videoconferencing, cloud services, or voice conversations—to be accessed and shared via computers, smartphones, and other devices. The Federal Communications Commission defines broadband to be at least 25 Mbps downstream to the device, and 3 Mbps upstream,[7] though demands are increasing. There are multiple broadband delivery systems, though mainly cable, DSL, fiber, and wireless that connect devices to the internet.

Fiber is considered the gold standard for supporting broadband, essential for fast, reliable connections. Fiber-optic cables — or just "fiber"— is a strand of glass the diameter of a human hair that carries waves of light. Using photons across glass, as opposed to traditional electrons across copper wire, fiber has the capacity to carry nearly unlimited amounts of data across long distances, literally at the speed of light. The term, "broadband" refers to the high-speed service, which enables devices to access online services.

Broadband is generally divided into business and consumer services, and those services have multiple tiers of performance and cost. Broadband is just one of many services, which include other types of telecommunications services. The variety of services and technologies are increasing—exemplified by the explosion in smartphone apps[8]—but the networks themselves are converging, so that anything can potentially connect with anything else.

Broadband is deployed throughout communities as wires that carry digital signals to and from users. The content comes into the local community from around the world via global, national and regional networks. The local infrastructure is built, connected and operated by internet and telecommunications companies that own the physical wires to each household. This started with telephone companies, which deployed twisted-pair copper telephone lines. The second wire came from television companies in the form of coaxial cable. Later satellite and wireless phone companies provided video and voice, with more flexibility to mobile and remote devices using radio waves. Beginning in the mid-1990s all of these companies repurposed their infrastructures to connect to the internet and carry digital content.

Infrastructure that is aging and built on the older technologies described above result in slower, less reliable access to content. Due to capacity limits of this infrastructure, companies can't reliably provide high speeds, and often limit the amount of data consumers can use. Fiber provides the robust infrastructure that connect telephone and cable infrastructure between communities and around the world. It was originally used by telecommunications for their core infrastructure, to connect their major switching centers, and was only available to their biggest corporate and institutional customers. Today, fiber-optic is in homes and businesses throughout the world providing telephone and television as well as internet access services. The next section describes internet access technologies in more detail.

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[7] See www.fcc.gov/reports-research/reports/broadband-progress-reports/2016-broadband-progress-report. "Mbps" is an abbreviation for megabits per second, or 1,000,000 bits per second, which is a measure of information transmission rates.
[8] "App" is a shortened form of "application" and refers to software packages that give devices certain functions.

Figure 11: How fiber-optic networks connect our communities
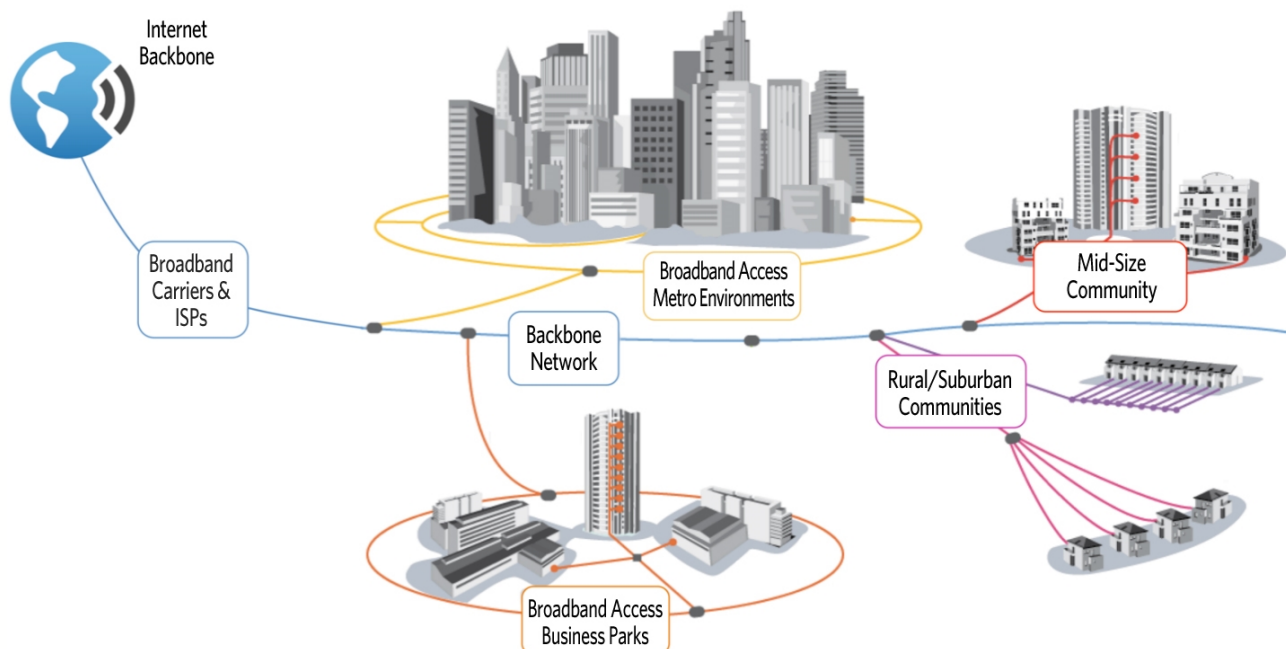
1.2.1   Dial-Up Access

Though not defined as a broadband technology due to speed and bandwidth[9] limitations, dial-up access still exists. Dial-up internet access uses the public switched telephone network (PSTN) to establish an analog connection from a computer to an internet service provider (ISP). The computer connects via a modem by dialing a telephone number on a conventional telephone line and translating digital data into an analog signal.

1.2.2   Digital Subscriber Line (DSL)

DSL is a wireline technology uses high frequencies, which are not used by analog voice calls, to transmit digital data over traditional copper telephone lines faster than modems. DSL-based broadband provides transmission speeds ranging from several thousand bits per second (Kbps) to millions of bits per second (Mbps), generally ranging from 1.5 Kbps to 10 Mbps. DSL operates over the phone line—in parallel with voice traffic so calls are not affected—which plugs directly into a computer or router at the customer's site. The other end of the phone line connects to a DSL line card in the telephone company's central office or remote cabinet. Each user's data is multiplexed with their neighbors' over high-capacity fiber, transported to internet interconnection points, then routed over internet backbones to their online destinations. There are different types of DSL:

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[9] *"Bandwidth" is technically the range of electromagnetic frequencies that a piece of broadband infrastructure accommodates. In general use, "bandwidth" relates to how much information capacity is available for connections on a portion of a network.*

- Asymmetrical Digital Subscriber Line (ADSL/ADSL2/ADSL2+) provides faster speed in the downstream direction than the upstream direction. This is fine for most customers who receive a lot of data but do not send much.
- Symmetrical Digital Subscriber Line (SDSL) – SDSL has the same up- and downstream speeds. Used typically by businesses that generate online content or for services such as video conferencing, which need significant bandwidth both to and from the internet.
- Very-high-bit-rate Digital Subscriber Line (VDSL) – is a new generation of technology that provides up to 52/16 Mbps. It is more sensitive to line quality and requires a more expensive line card.

The availability and speed of DSL service depends on the distance from the customer to the closest telephone facility known as a central office. Telephone lines were optimized for voice communications and conditioned to eliminate high frequency noise. Consequently, some telephone lines cannot handle DSL, and others must be modified to support the service. Multiple DSL lines can be bonded to provide higher speeds, but the cost multiplies, too.

1.2.3 Digital Carrier Systems

Most commonly known as T-1s, this is the digital telephone standard in the US and has been the mainstay of corporate telecom for years. This service uses a four-wire interface to deliver 1.5 Mbps, which can be subdivided into 24 channels when bonded together. While not falling within today's federal definition of broadband, this is the way many companies get internet access and connect their various facilities. T-1s are almost universally available from local service providers, although they may charge for mileage and other things that make the service rather expensive. The digital services hierarchy extends to multi-megabit services, and fits with the even higher bandwidth optical carrier services.

1.2.4 Cable Modem

Cable operators provide broadband to subscribers using the same coaxial cable that has historically delivered content to televisions through a cable modem across the same "tree and branch" network used to distribute channelized broadcast television. Technically termed DOCSIS (Data Over Cable Service Interface Specification), cable broadband literally allocates channels for carrying data to and from customers instead television. Most cable modems are external devices that have two connections: one to the cable wall outlet via coaxial cable that goes out to the internet, the other to a computer or router via Ethernet cable.

On the cable network, where the coaxial physically ends, a DOCSIS interface strips out the data and routes them all to their destinations via fiber optic cable. DOCSIS uses a "multiple access" approach to network in which every user's data is intermingled with others on the wire from the house to the router. Transmission speeds vary depending on the type of cable modem, cable network, and traffic load.

In response to growing consumer demand for bandwidth, DSL and cable network operators upgrade outdated or underperforming equipment following their revenue models and capital budget limitations to attempt to make the infrastructure faster and more reliable. However, several fundamental issues exist that pose long-term challenges to meeting the growing bandwidth demand through copper infrastructure:

- Broadband signals degrade significantly over copper as distances increase.
- Broadband signals over copper are susceptible to electrical interference and signal degradation, particularly as they age.
- The amount of bandwidth available on portions of broadband networks is often shared among multiple users, which can result in an uneven distribution of speed to users, and slower speeds to all as facilities become congested.

1.2.5   Fiber-Optics

Fiber-optic network technology converts electrical signals carrying data into light and sends the light through transparent glass fibers about the diameter of a human hair. Fiber transmits data at speeds far exceeding copper, typically by hundreds of megabits per second. With fiber-optic broadband networks, speeds in the billions of bits per second range are possible. The fiber-optic network today operates at nearly 300 Terabits per second, which is so fast that a single fiber could carry all of the traffic on the internet.

More commonly, fiber-optic networks provide between 100 Mbps and 10 Gbps to users. Fiber-optic networks can be designed to be highly reliable as well as really fast. Fiber-optics are used extensively by major corporations and institutions and are at the core of every telecom company's network. There are numerous standards for fiber optic networks. The two most common for broadband applications are Active Ethernet (AE) and Gigabit Passive Optical Network (GPON).

The actual speed the customer experiences will vary depending on a variety of factors, such as how the network is structured, the hardware attached to the fiber-optics, and how the service provider configures the service. The same fiber that provides broadband internet can also simultaneously deliver voice (VoIP) and video services, including video on demand. Fiber operates synchronously, meaning the service is just as fast to download as to upload, which is increasingly important for households and businesses.

Dark fiber is a fiber-optic strand with no hardware attached to generate laser light signals across the fibers. From the business perspective, dark fibers are facilities—real estate—that are leased to customers. As with any real estate, the value of dark fiber depends on location, location, location: its end points and route. Dark fiber customers are large enterprises, including internet service providers, that need to interconnect local area networks or "last mile" access network infrastructure. The fiber has to be lit in order to actually carry data between network nodes and provide bandwidth, connectivity, and other network services.

Someone has to put equipment on each end. That equipment has to be powered and connected to other network infrastructure, and must be housed in a building or cabinet. And, of course, all of this infrastructure must be secured and maintained. Dark fiber lessors and lessees need to be thorough, clear, and in agreement about who is responsible for each portion of the infrastructure.

Fiber to the Node (FTTN) brings high-capacity fiber-optic cables to communities and then connects to existing DSL and coaxial equipment. This is not an "all fiber" approach. Rather than bringing fiber-optic cables to every home or business, the fiber is connected to the existing copper network to increase its capacity. The copper-based "last mile" network that connects homes and businesses to the local nodes is still a bottleneck and results in subscribers not accessing the true speeds of fiber-optic connections. Fiber to the Premise (FTTP) provides internet access by running fiber-optic cable directly from an internet Service Provider (ISP) to a customer's home or business. This approach is "all fiber" all the way to the customer. Fiber facilitates much faster speeds than copper wire, generally needs to be serviced less, and is "future proof" because technology can increase the bandwidth of fiber-optic cables. AE and GPON are both FTTP technologies.

Figure 12 illustrates the relative difference between common internet connection methods, comparing access technologies from basic dial-up service through DSL, cable, and fiber. Whereas traditional broadband technologies have an upper limit of 300 Mbps, next-generation broadband that utilizes fiber-optic connections surpasses these limitations and can provide data throughputs of 1 Gbps and greater.

Figure 12: Physical bandwidth capacity comparisons

Dial-Up – 56Kbps
- *Legacy Technology*
- *Shared Technology*

ADSL – 10Mbps
- *First Generation of DSL*
- *Shared Technology*

ADSL2 – 24Mbps
- *Second Generation DSL*
- *Shared Technology*

Cable – 150Mbps
- *Data Over Cable (DOCSIS 3.0)*
- *Shared Technology*

Next Generation Fiber – 1Gbps
- *Passive Optical, Active Ethernet*
- *Shared and Dedicated Technology*
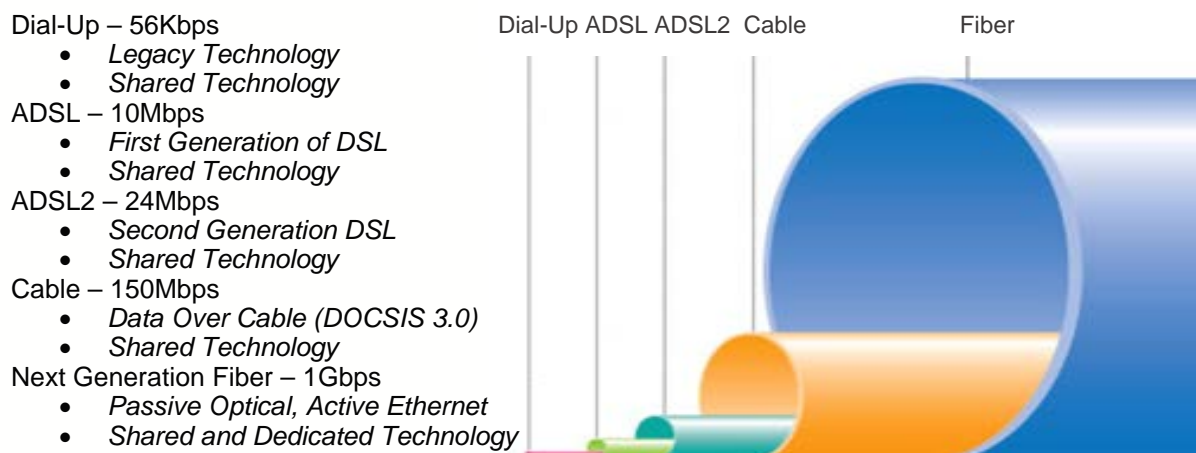
1.2.6 Wireless

Wireless broadband can operate as mobile, hotspot, or fixed. Wireless can also be used as "backhaul" to connect remote locations or sparsely populated areas, where DSL or cable modem service would not be economically feasible, via long-range directional antenna. Fixed wireless services allow consumers to access the internet from a fixed point while stationary, and often require an external antenna with direct line-of-sight between the wireless transmitter and receiver. Speeds are generally comparable to DSL and cable modem. These services have been offered using both licensed spectrum and unlicensed devices.

Hotspot wireless uses the Wi-Fi standard to provide connectivity for digital devices in a particular area via physical access points and a router, which interconnects wireless devices to the internet. Hotspots typically operate at 54 Mbps, but the actual bandwidth depends on the quality of the wireless signal and speed of backhaul to the internet. Wi-Fi is a multiple access technology, so bandwidth is shared with other users. While users can move around in the hotspot, they can't drive away: Wi-Fi does not provide a mobile connection. Wi-Fi is fast and robust, if limited in distance and susceptible to interference because it operates in open, unlicensed spectrum. Wi-Fi hotspots are common at hotels, restaurants, and public buildings for public access. It is used in many homes and businesses for private access. Many WISPs use Wi-Fi, and it is increasingly available from traditional telecoms (AT&T and Comcast have a large number of branded hotspots). Wi-Fi complements cellular data via mobile wireless (users often use it to avoid cellular data caps and slow speeds), and is used in conjunction with wired broadband services—most hotspots connect to the internet via broadband.

Wireless cellular data services, which borders on broadband speeds, are widely available from mobile phone companies. Typically referred to as either 3G or 4G (G for "generation"), mobile connections operate within cells that hand off signals from antenna to antenna as the device moves. 4G can move data at 12/5 Mbps, but speeds in the Kbps range are more common. Cellular data connections are most commonly used with smartphones, or with computers via cellular network interface card. Many smartphones can act as Wi-Fi hotspots or tether to computers via Bluetooth.

1.2.7 Satellite

Satellite internet uses licensed radio spectrum to send data from and to anywhere on Earth. The signals go on a 46,000-mile roundtrip from earth-bound devices through the atmosphere via the satellite and back to earth to another computing device. These radio signals have limited capacity and thus the connections tend to be slow. Because of the distance the signal must travel, satellite transmissions are susceptible to weather. Satellite should be considered a last resort for all but the most rural and remote areas. Areas with a high adoption of satellite generally indicates a need for better service. Today, the federal government finds that no satellite broadband service meets the 25/3 Mbps threshold of broadband.

2. CHATHAM COUNTY BROADBAND NEEDS ASSESSMENT

The broadband needs assessment will focus on the supply and demand sides of broadband by examining service providers that serve customers in Chatham County. The assessment will also examine how Chatham County households and businesses use the internet today and the near future. This chapter will explore topics of broadband availability, adoption, and utilization from the perspective of residents and businesses.

The assessment will determine local indicators of broadband importance and identify barriers that discourage or prevent local broadband service adoption and identifies opportunities for future increased broadband adoption and socioeconomic benefit. Through the benefit of in-person meetings and online and printed surveys of Chatham County households and businesses, the broadband needs assessment explores how the internet currently benefits local households and facilitates the operations of local businesses and organizations.

2.1   Service Providers in Chatham County

Chatham County has several telecommunications companies that provide a range of services. Generally, these services can be divided into residential, business and commercial, and enterprise services. While retail providers around the country are transitioning to fiber infrastructure, the pace of this transition is slow and uneven. Telecommunications corporations simply aren't vested in Chatham County enough to prioritize the investment in network upgrades. Simply put, the corporations often focus on areas of the country with high population densities so that the return on investment can be maximized.

This market analysis of the supply side of broadband includes information about the providers that serve the homes and businesses of Chatham County. It focuses on residential and business broadband—high-speed internet access services— and considers telephone and television services that are often bundled with broadband.

The internet service providers that offer retail broadband service to the commercial and residential markets of Chatham County include:

- **AT&T** (http://www.att.com) is the incumbent local exchange carrier and global communications provider, headquartered in Dallas. In Chatham County, AT&T has invested in its wireless and wireline networks, but AT&T considers network capacity and location as competitive information so it doesn't issue maps. AT&T contends that fiber is available most anywhere, yet FCC data and Magellan research found no AT&T fiber customers. AT&T has plenty of T-1 and DSL customers, which are completely different services. AT&T recently announced a new "business fiber" service coming out that is rumored to be priced from $50 to $300 depending on the speed.

  In Chatham County, AT&T competes against Comcast, which has more of the county market than AT&T because of speedier cable offerings. AT&T says it is continuing to work on residential fiber service; it has a plan to address "low-hanging fruit."

- **Comcast** (http://www.xfinity.com) is the incumbent cable provider serving Chatham County. Comcast maintains offerings of voice, internet, and video that are delivered to subscribers via coax cable through the Xfinity brand. Maps depicting Comcast's broadband infrastructure were requested but not provided for proprietary reasons.

- **EarthLink** (www.earthlink.com) is a nationwide network operator with more than 29,000 fiber route miles, and provides retail residential DSL and business telecommunications services to Chatham County. However, Earthlink was recently acquired by Windstream and the future of the brand is uncertain. Maps of EarthLink's (now Windstream's) network and service offerings can be viewed at: http://www.earthlink.com/why-earthlink.

- **Hargray Communications** (http://www.hargray.com) is dedicated to meeting the communication needs of residential, business, large enterprise and resort customers. A rather large firm with more than 400 employees, including 100+ service technicians, which all live, work and contribute in the Low Country region of Georgia and South Carolina.

- **Level 3 Communications** (http://www.level3.com) is a global communications provider headquartered in Broomfield, CO that provides communications services to enterprise, government and carrier customers in over 60 countries. Savannah is considered an "On-Net Metro Network Market" for Level 3. Telecom firm Century Link recently announced its intention to purchase Level 3. Level 3's Enterprise Solutions provides voice and video, data and security, and managed network services. A map of Level 3's network is at: http://www.level3.com/~/media/files/maps/en-network-services-level-3-network-map.pdf

- **Seimitsu** (http://www.seimitsu.com) specializes in custom business communications solutions and delivers network connectivity via fiber and wireless throughout Savannah and Chatham County. A local and growing IT services provider in business since 1984, Seimitsu offers IT services, data services, infrastructure, voice, and surveillance services.

- **Southern Telecom** (http://www.southern-telecom.com) is the telecommunications subsidiary of Southern Company, the parent company of Georgia Power. Founded in 1997 and headquartered in Atlanta, Southern Telecom offers wholesale long-haul dark fiber-optic solutions to the business community along with colocation and data services with over 1,500 route miles of fiber-optic cable through the Southeast.

- **Verizon** (http://www.verizon.com) is an incumbent telephone company in much of the United States, and a major provider of cellular telephone services and managed telecommunications services for enterprises.

- **Windstream** (http://www.windstream.com) is an incumbent telephone company (formerly Alltel) that offers competitive services. As with other telephone companies, Windstream provides a wide range of telecommunications services, including fiber-

optic broadband in selected areas, as well as DSL broadband and traditional telephone service. Windstream considers Savannah to be a "major market."

- **XO** (http://www.xo.com) is a competitive provider that owns and operates large, high-capacity IP and Ethernet networks for domestic and international communications. XO was recently purchased by Verizon, so many of the data networking, cloud connectivity, and managed services solutions will likely be rolled into Verizon's service offerings. A map of XO's network (now Verizon's) is online at https://www.xo.com/about-xo/our-network/complete-network.

- **Zayo** (http://www.zayo.com) owns and operates an 112,600-mile network in North America and Europe with connectivity to thousands of data centers, enterprise locations, carrier exchange points, wireless towers, media centers, entertainment venues, financial exchanges and cloud providers. It offers dark fiber services, which is dedicated high-capacity, low-latency bandwidth. In addition, Zayo's offerings encompass a range of managed bandwidth, lit fiber solutions, including wavelength, Ethernet, IP and video transport, across an expansive network footprint. A map of Zayo's network is at http://www.zayo.com/solutions/global-network.

2.1.1 Federal Data Analysis of Chatham County Broadband Availability

While the nation continues to make progress in broadband deployment, much of America still lacks access to advanced, high-bandwidth services, according to the Federal Communications Commission's (FCC) 2016 Broadband Progress Report.[10] Section 706 of the Telecommunications Act of 1996 requires the FCC to report annually on whether advanced telecommunications capability "is being deployed to all Americans in a reasonable and timely fashion," and to take "immediate action" if it is not.

The red shaded areas of Figure 13 indicate the areas in and around Chatham County not that have no broadband service available; much of the unserved area is uninhabited coastal marsh land.

Figure 13. Areas not served by a wireline broadband provider
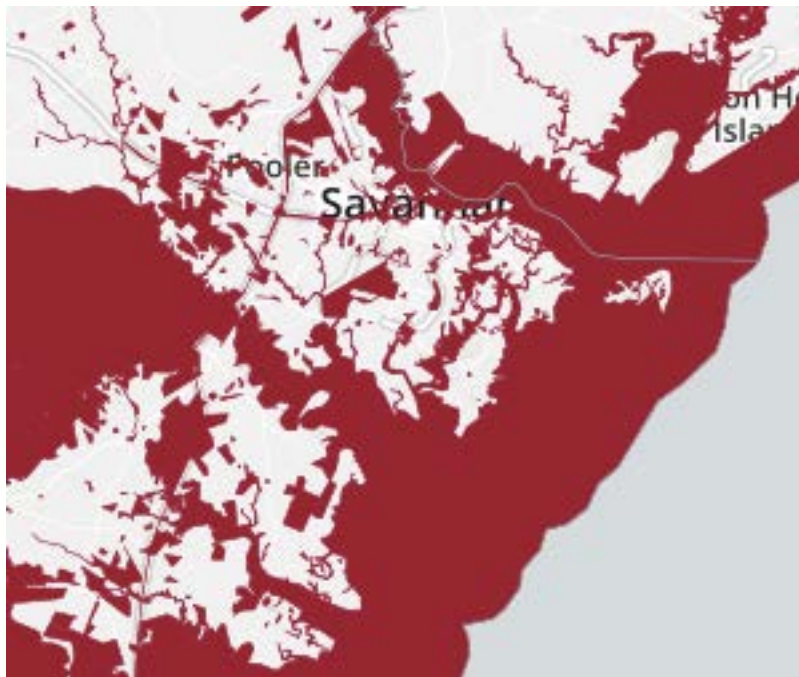
Congress has defined advanced telecommunications capability as the "high-quality" capability that allow users to "originate and receive high-quality voice, data, graphics, and video" services. The FCC has most recently set the broadband speed benchmark of 25 Mbps download and 3 Mbps upload (25 Mbps/3 Mbps) for fixed, wireline services.

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[10] *2016 FCC Broadband Progress Report: https://apps.fcc.gov/edocs_public/attachmatch/FCC-16-6A1.pdf*

The blue shaded areas of Figure 14 represent areas of Chatham County where advertised broadband speeds fall below the FCC standard definition of broadband (25/3 Mbps). Figure 15's shaded areas are where advertised speeds are 25/3 Mbps or greater. Note the substantial overlap in the shaded areas between figures.

Some of this area is where there are advertised services with 25 Mbps downstream speeds. The overlap also demonstrates the limitations of the FCC's data. The FCC is the only source of this data, but the data are somewhat dubious. Therefore, these data should be interpreted generally as a broad indicator of availability rather than as a highly accurate or detailed measurements. Figure 16 shows that some areas in and around Chatham County have advertised service that is 1 Gbps or faster.

Figure 14: Areas where wireline broadband service is below 25/3 Mbps threshold
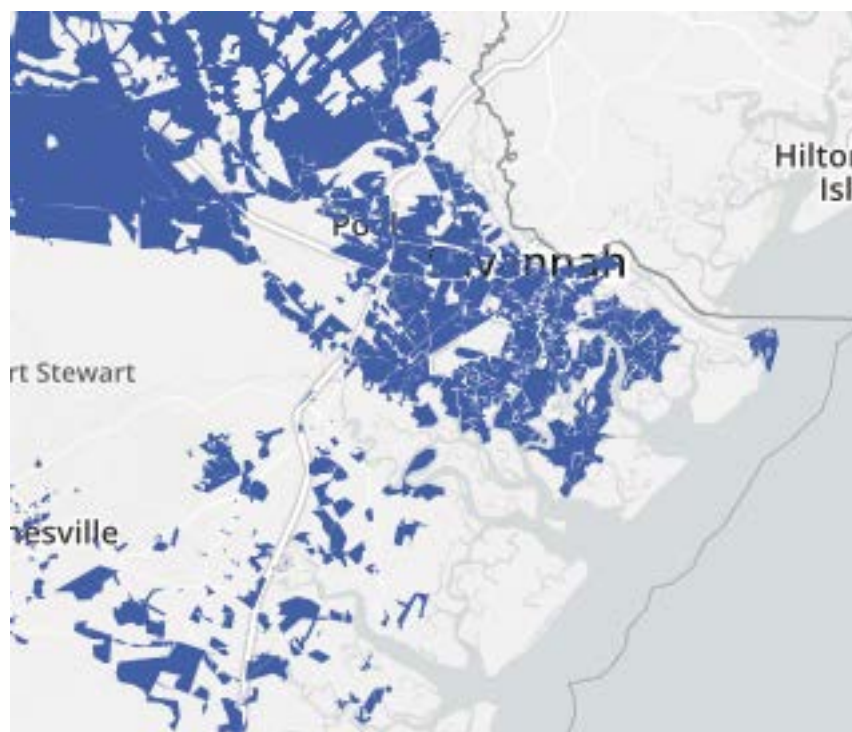
Figure 15: Areas with advertised speeds of 25 Mbps or faster
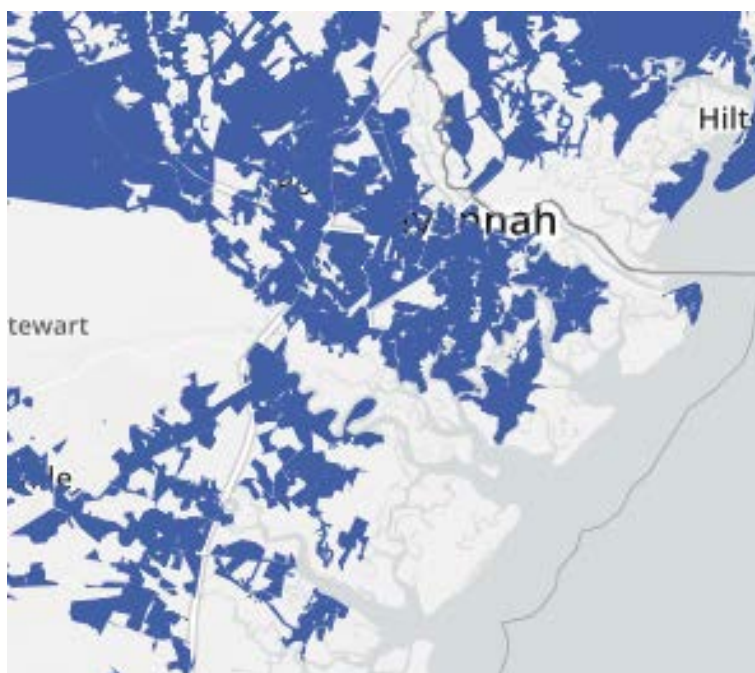
Figure 16. Areas with advertised 1 Gbps or faster broadband service
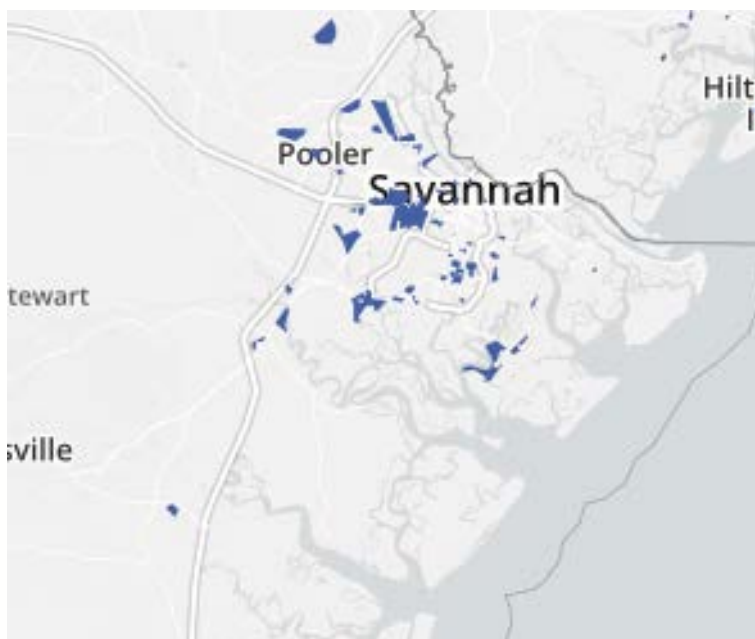
Figure 17 through Figure 19 show availability of the various broadband services in Chatham County. DSL is nominally the most widely available service. Whether a specific location can actually get DSL depends on a number of factors, particularly the length and quality of "local loop" wires to that location. Even locations that have the service may not get the full advertised bandwidth.

Figure 17: Areas served by DSL
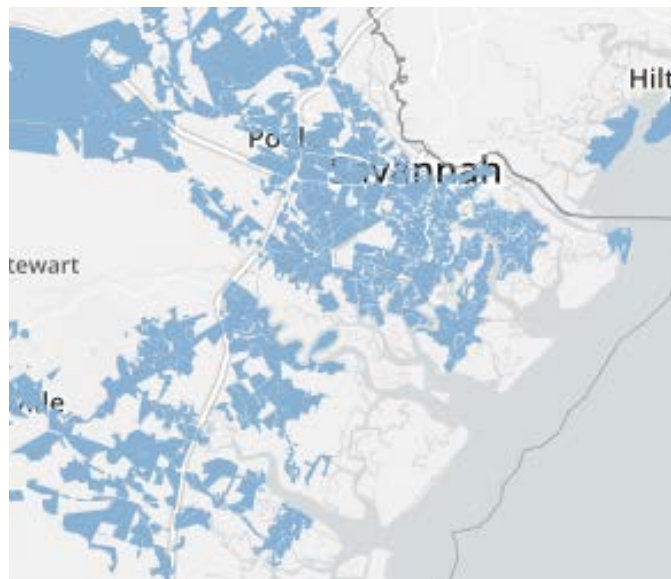
Figure 18: Areas served by cable
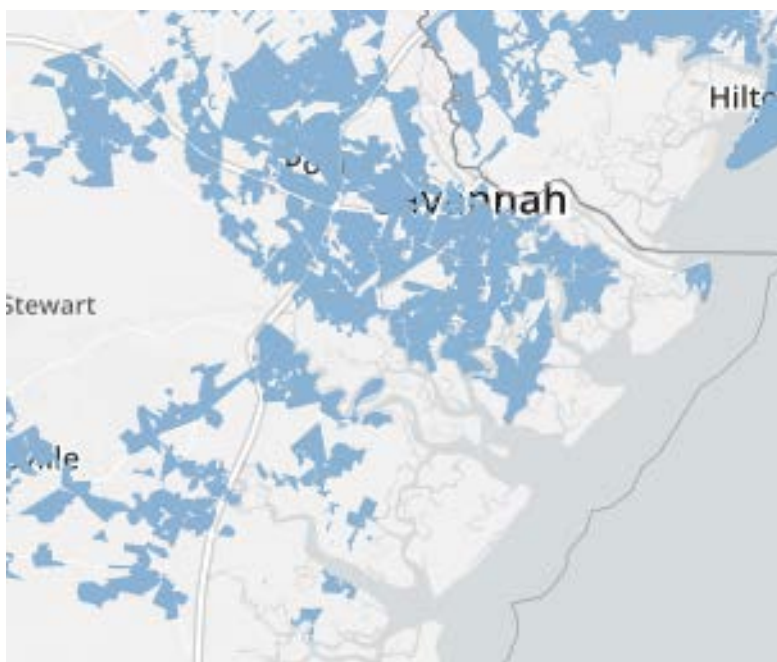
Figure 19: Areas of Chatham County served by fiber
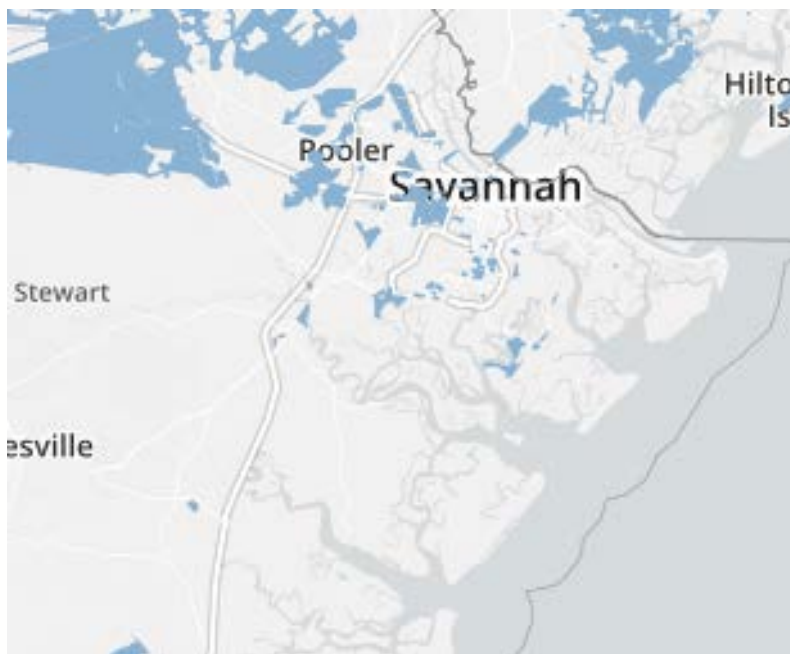
An alternate source of data, sourced directly from consumers and the marketplace, BroadbandNow, indicates that areas in Savannah that the FCC believes has fiber-based broadband, have no providers offering the service. The FCC shows no fixed wireless broadband in the area. The FCC data show that cellular data ("cellphone internet") is universally available in the area. This service is simply too slow and unreliable to be considered true broadband. It is appropriate for back-up or secondary connections, or as a last resort. For that reason, we do not consider that technology in this analysis.

The number of providers is an important broadband metric because competition drives prices down while driving service quality up. Figure 20 through Figure 23 show the number of providers in areas in and around Chatham County. Most areas are served by either one or two providers.

Figure 20. One provider
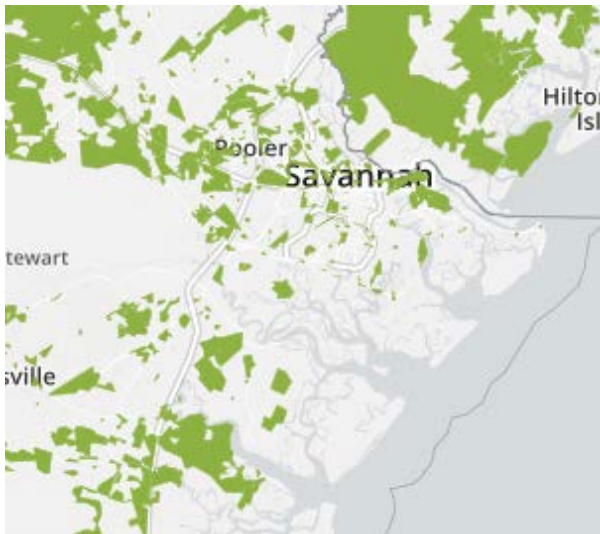
Figure 21. Two providers
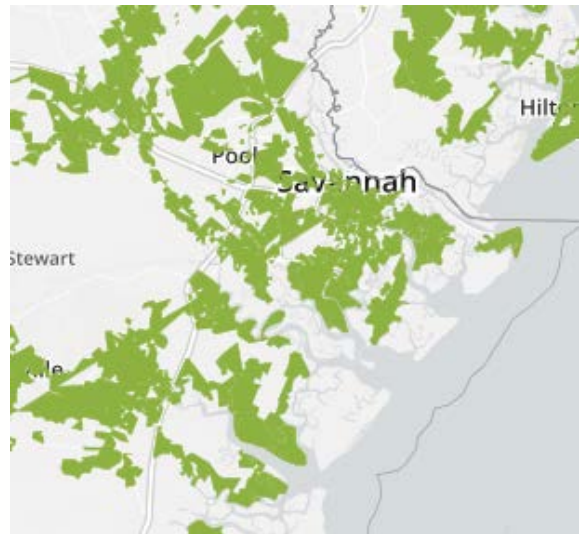
Figure 22. Three providers
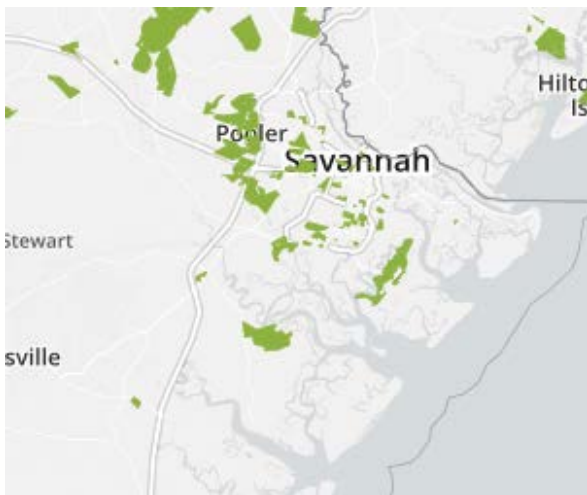
Figure 23. Four or more providers
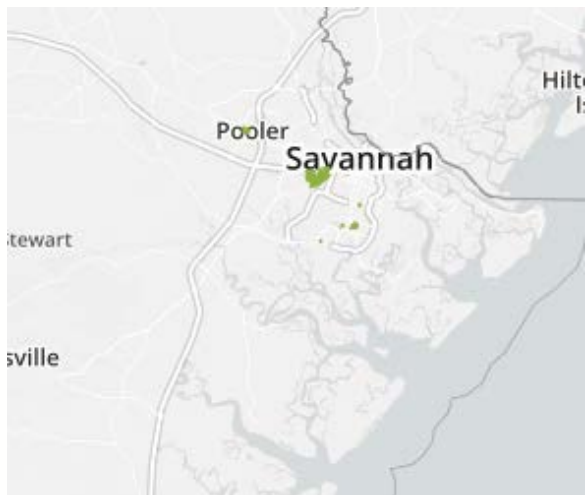
Overall, Chatham County is inconsistently served by a limited number of broadband providers. The choice is generally between relatively low-speed DSL and somewhat faster cable. DSL, as mentioned above, is inconsistent in terms of speed, and can have major reliability issues. Cable broadband speeds are increasing with new generations of the underlying standard (DOCSIS), but it is a shared medium. This means that all users on a network segment share its bandwidth. Therefore, if the segment serves multiple locations, and multiple users at each location are using bandwidth-intensive applications (gaming or streaming videos, for example), all users will experience degraded performance.

2.1.2 Uncertainties in the Local Broadband Market

According to survey results, 95.4% of households and 78.2% of businesses in Chatham County that subscribe to internet services do so from providers that use a copper-based infrastructure. As we heard from business and residents alike, the quality of their cable and DSL service varies predictably by time of day, and delivery of internet content is limited in areas where copper infrastructure is shared by multiple subscribers.

In discussions with the local incumbent service providers, there are no plans to build out fiber infrastructure other than continuing the dedicated service offerings to individual customers, upon request. In many cases, businesses and homes have little choice other than to purchase services from local service providers that offer legacy network offerings of DSL and cable.

Should a Chatham County resident or business owner want a fiber-optic connection today, the customer typically must negotiate a contract for dedicated services, which often requires a costly custom-built connection from the provider's network to the premises. The cost of infrastructure is borne by the customer that requests the connection.

These types of dedicated arrangements are far more expensive than traditional services and typically only benefit larger enterprise customers and community anchors that can afford these negotiated services. These fees typically start in the tens of thousands of dollars, based on distance between the customer and the service provider, and often requires a long-term contract agreement for services.

Compounding this problem with its insufficient infrastructure, the current incumbent providers are in a period of instability and uncertainty, as Verizon and AT&T are each in the middle of corporate mergers and potential divestiture of existing local infrastructure.

- AT&T has retired its U-Verse service to focus on newly acquired DirecTV, which could also impact the many DSL subscribers in Chatham County. There is a trend from AT&T toward increased attention on mobile wireless and satellite and less on fiber networks.

- Century Link has announced plans to acquire Level 3. Level 3's long haul and middle mile networks will complement Century Links distribution network. It remains to be seen if Century Link expands Level 3's scope of services to Chatham County.

- Charter has merged with Time Warner Cable and Bright House Networks. Once the merger transition is complete, Charter will service more than 23 million customers, rivaling Comcast as the number two cable operator in the U.S.

- Google Fiber has recently "paused" deployment plans, which were limited to a few major markets. The company is reconsidering its approach of targeting investment to areas with high pre-subscription

- Verizon Wireless serves much of Georgia, but it is in the process of divesting its wireline business in the states of California, Florida and Texas, and the future is uncertain for its FiOS product in many markets.

Until these corporate transitions play out and decisions about how these new entities intend to serve their markets, there is a degree of uncertainty in the retail broadband market of Chatham County. Of course, as soon as this round of corporate moves wraps up, another set will be in the works. Communities that don't want their fates determined by corporate decisions made by distant executives and disconnected shareholders will likely have to invest in themselves to assure they have the next generation of broadband infrastructure.

2.2 Chatham County Broadband Market Analysis

2.2.1 Residential Broadband Market Analysis

To provide an analysis of the residential broadband market, Magellan randomly selected six residential addresses from Chatham County. Magellan's team contacted each residential retail provider identified as operating wireline services in the Chatham County market to determine service availability, service levels, pricing and other details from known providers.

Residential services were identified from Comcast, but none of the addresses had service connections readily available from other competitive providers, such as AT&T, CenturyLink, or local providers Seimitsu or Hargray. Reflective of other findings in the broader study, none of the six addresses were served by more than one provider.

Comcast offers services "up to" 300/25 Mbps for $99.95 for most residential addresses. Given the consistency of service levels and pricing, Comcast likely advertises maximum speeds throughout Chatham County. These services are quoted as "up to" certain levels, while specific service levels would not be known until the time the order is placed, though speed test data provided through this study's online survey prove those speeds elusive. When none of the randomly selected residential addresses in Figure 24 were served by AT&T, through the survey data, we found that AT&T provides limited availability to some residential addresses in the county, such as basic DSL for $30.

Figure 24: Residential broadband service offerings in Chatham County

Location	Provider	Type	Download (Mbps)	Upload (Mbps)	Monthly Cost
12 Sandy Shoals Pass, Port Wentworth	No Service	N/A	N/A	N/A	N/A
505 Heritage Ct, Pooler	Comcast	Cable	150	25	$69.95
1602 2nd Ave, Tybee Island	Comcast	Cable	300	25	$99.95
5 Jones Ave, Tybee Island	Comcast	Cable	300	25	$99.95
8 Walnut St, Bloomingdale	Comcast	Cable	300	25	$99.95
2305 Shaw Ave, Garden City	Comcast	Cable	150	25	$69.95

2.2.2 Commercial Broadband Market Analysis

To provide an analysis of the broadband market for businesses, Magellan randomly selected eight commercial sites by address from across Chatham County. Magellan's team contacted each retail provider identified as operating services in the Chatham County commercial market to determine service availability, service levels, pricing, and other details.

Business services were identified from AT&T and Comcast Business, but none of the random addresses had business class service connections readily available from other competitive providers, such as EarthLink, CenturyLink Business, or local providers Seimitsu or Hargray. In fact, details were sparse with AT&T and Comcast services at each address.

Comcast offers services up to 150/20 Mbps for $264 at each business address. Given the consistency of service levels and pricing, this is likely advertised this way by Comcast throughout Chatham County. Note these services are quoted as "up to" certain levels, while specific service levels would not be known until the time the order is placed. Similarly, AT&T provides limited availability of service offerings to the selected businesses addresses. Where available, DSL was typically packaged among the standard U-Verse package, with occasional internet-only services offered. Only one business location had speed and price quoted.

Figure 25: Business broadband service offerings in Chatham County

Location	Provider	Type	Download (Mbps)	Upload (Mbps)	Monthly Cost
2812 River Drive, Thunderbolt	Comcast	Cable	150	20	$264
	AT&T	DSL	6	0.512	$50
1004 Memorial Lane, Savannah	Comcast	Cable	150	20	$264
	AT&T	N/A	N/A	N/A	N/A
1403 Bulter Avenue, Tybee Island	Comcast	Cable	150	20	$264
	AT&T	DSL	18	1.5	$60
102 US 80, Bloomingdale	Comcast	Cable	150	20	$264
	AT&T	DSL	5	1	$60
528 US 80 W, Garden City	Comcast	Cable	150	20	$264
	AT&T	N/A	N/A	N/A	N/A
459 Pooler Parkway, Pooler	Comcast	Cable	150	20	$264
	AT&T	DSL	6	0.512	$50
108 Appleby Road, Wentworth	Comcast	Cable	150	20	$264
	AT&T	DSL	6	0.512	$50
214 Vernonburg Road, Savannah	Comcast	Cable	150	20	$264
	AT&T	N/A	N/A	N/A	N/A

The limited business offerings from service providers is somewhat surprising given the significance of a county like Chatham County. Yet this market analysis is consistent with other service provider findings across this study in that only five of the eight addresses were served by more than one provider, and service level offerings are limited, regardless of provider. However, one can assume that should a business anywhere in Chatham County request better connectivity, any of these business providers would entertain the possibility of a custom build connection direct to their building.

These findings suggest that commercial broadband services are woefully lacking in Chatham County, especially outside a few "broadband islands." While as many as four national internet service providers nominally serve Chatham County, there is not necessarily healthy internet provider competition throughout the county. Providers simply don't serve many locations. Similar service providers don't compete in the same communities and neighborhoods for the same households and businesses—cable companies often won't compete with each other, and telephone companies will not compete with other telephone companies. This effect is most pronounced for commercial services. Fiber-optic is a great option where it is available, but the majority of locations have limited options.

The service quality varies across Chatham County due to the limitations and state of the current infrastructure. Most broadband customers in Chatham County access the internet via copper wire, predominantly via coaxial cable and also via telephone twisted pair wire for DSL. Both types of network infrastructure have limited bandwidth due to the physical character of copper wiring. While cable has more bandwidth than DSL, it is shared bandwidth and networks are often over-subscribed, which degrades performance. Signal quality can be considerably degraded by aging infrastructure and by providers taking on more subscribers than the infrastructure was designed to handle. Consequently, services may not deliver the speeds providers promise. The legacy copper networks are also more susceptible to outages.

Enterprise Network Services

In addition to retail service providers that serve households and businesses, regional and national telecommunications carriers also maintain data transport routes and provide local network services in Chatham County. Generally invisible to the retail public, these "long haul" networks are composed of fiber-optic cables that typically follow the routes of railroads, power lines and highways throughout the country, with access points in communities throughout the Southeast, such as data centers in Jacksonville, Atlanta, Charlotte and in other regional cities throughout the U.S. The long-haul networks interconnect with national and international backbone networks that collectively make up "the internet."

2.3   Chatham County Broadband Needs Assessment

Through this needs assessment, Chatham County leadership will gain a better understanding of how their households access and use the internet. To help research the broadband related issues faced by county households, town hall sessions and meetings with key broadband consumers were facilitated in communities around the county. Also, an online and print survey was conducted that included questions about current broadband access and how the internet is used today and how it will be used in the near future.

The survey results provide County leadership with a broad understanding of the broadband needs of the county, plus it gathered local opinions on the role that the County could have with the delivery of internet services. Aggregate results of the survey and the stakeholder engagement process will be distributed throughout the study.

Community Engagement

As part of the needs assessment research process, Magellan and Chatham County staff visited with community and business leaders throughout the county during the fall of 2016. The goal of each meeting was to understand the connectivity challenges from the people who live and work in the county, and better understand how the internet impacts the things they do. These community meetings provided the opportunity for candid and open discussions with key employers, government and community organizations, business and community leaders, educators and first responders, as well as service providers and others.

The meetings allowed each to share how they use the internet today and how they envision using the internet and broader applications and technology tools in the future. As detailed in this study, residents and businesses in Chatham County have distinct needs for internet connectivity and better broadband services.

Business and Residential Survey

Knowing that it is impossible to speak with every resident and business owner in the county, an online and printed survey of Chatham County households and businesses was conducted. The survey was promoted in large part with the help of City of Savannah and Chatham County project staff, on City and County websites, in public meeting announcements and by word of mouth. In sum, 1,092 Chatham County households and 45 businesses responded to the survey.

The high household response rate lends to a high statistical relevancy of data. With 52,800 households in Chatham County, the number of survey responses yield a 95% confidence level with a ±3% margin of error, which exceeds industry research standards of 95% confidence level and a ±5% margin of error. While the response rate of businesses was somewhat lower, with 12,676 businesses in the county, the responses yield a statistically relevant 95% confidence level with a ±8% margin of error.

The survey responses were entered into the survey platform and evaluated using Magellan's established data analysis techniques. Statistically significant differences between response categories are highlighted and discussed, where relevant, in the needs assessment narrative.

The survey captured information about residential and business internet services, satisfaction with those services, and desire for improved services. Chatham County residents appear to be using the internet more every day and survey responses show that the internet has dramatically risen in importance to the point that people can't live without it.

Figure 26: Chatham County internet subscribership
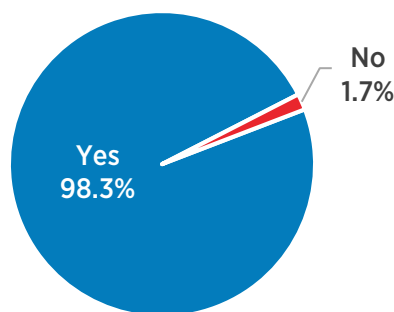
Of the 1,092 Chatham County households that completed the survey, 98.3% reported subscribing to internet services. Where access is available for county households, the adoption of the internet and use of internet-enabled devices is strong. As we'll see in the coming sections, the internet has clearly become ingrained in the lives of Chatham County residents and suggests strong demand for residential broadband services into the future.

2.3.1   Barriers to Chatham County Household Internet Subscribership

First, before moving into the characteristics of Chatham County households that subscribe to broadband, it is important to understand the reasons why households do not subscribe to internet services. From all surveys collected, only 1.7%, or 19 households, reported they do subscribe to internet services. Remarkably, across all surveyed households, there were no households that reported they chose not to subscribe because they do not need the internet.

Among the surveyed households that do not subscribe to internet services, we asked them the single-most important reason why they do not have service at home. The goal of asking the question is to understand whether non-subscribership is the choice of the household, or if their decision reflects local broadband market conditions, such as a lack of service availability near the home, or if the high cost of service discourages service adoption.

Survey results in Figure 27 show that of the non-subscribing Chatham County households, an overwhelming 76.5% say they choose not to subscribe to service because residential internet access is too expensive. Service levels and costs are analyzed in later sections, and for some county residents, internet access is so costly that they choose to go without at their home and seek out other means of access. Nearly 1 out of 5 Chatham County households (17.6%) that do not subscribe to broadband say that broadband isn't available at their home.

The remaining response was from a quality of service perspective, with 5.9% of non-subscribing households saying that available services are too slow or unreliable, perhaps dropping service from poor previous experience. Most encouraging in these findings is that every responding household recognizes a need for the internet.

Figure 27: Most important reason for not subscribing to household internet services
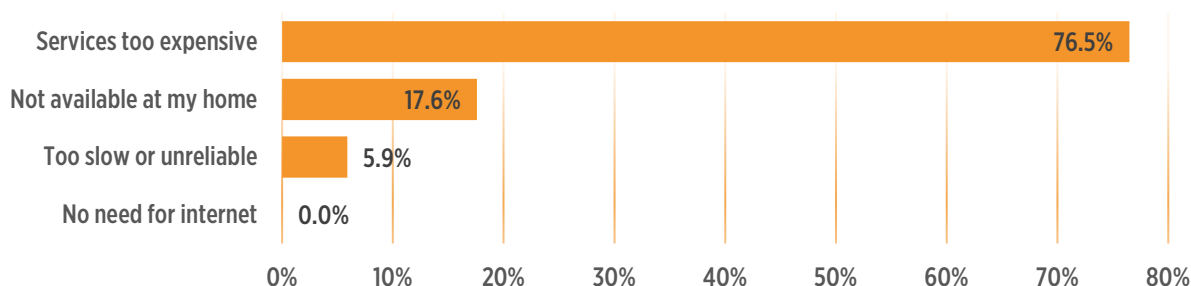
While these percentages are very telling of local broadband market conditions, the Chatham County findings conflict with national household averages. In fact, both Chatham County and Savannah households do not align with the most recent U.S. Department of Commerce research[11] that identifies non-subscribing U.S. households with "no internet availability" at 48%, with "too expensive" the reason of 28% of U.S. households.

These findings shine a light on issues beyond access to the internet and reveal a digital divide in Chatham County that is based more on cost of services. This could be an indication of incumbent service providers charging too much for service, but could also reveal the economic conditions of some households in the county. Indeed, the notion of being "too expensive" is a relative term, as what could be out of financial reach for some households and income levels could be considered discretionary spending for other households.

Still, survey responses show that Chatham County households recognize a need for the internet, and in 83% of cases the internet is available at their home, yet the majority of households do not subscribe because they say internet service is not affordable.

Considering this further, when Chatham County households are able to provide more than one reason as to why they don't subscribe to internet services, mobile access and the need to access the internet outside the home emerge as significant alternatives.

100% of responding Savannah households expressed a need for the internet

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As seen in Figure 28, while an overwhelming number of households report that services are too expensive (76.5%), roughly a third (35.3%) rely on their mobile devices, while the same percentage (35.3%) rely on access the internet outside the home. Outside the home could mean at work or school, the library, or even public Wi-Fi locations around town. Lastly, and not insignificantly, 17.6% of county households report that the internet is not available at their home. Again, it is worth repeating that no responding Chatham County household said they do not need the internet.

Figure 28: Reasons for non-subscribership from Chatham County households
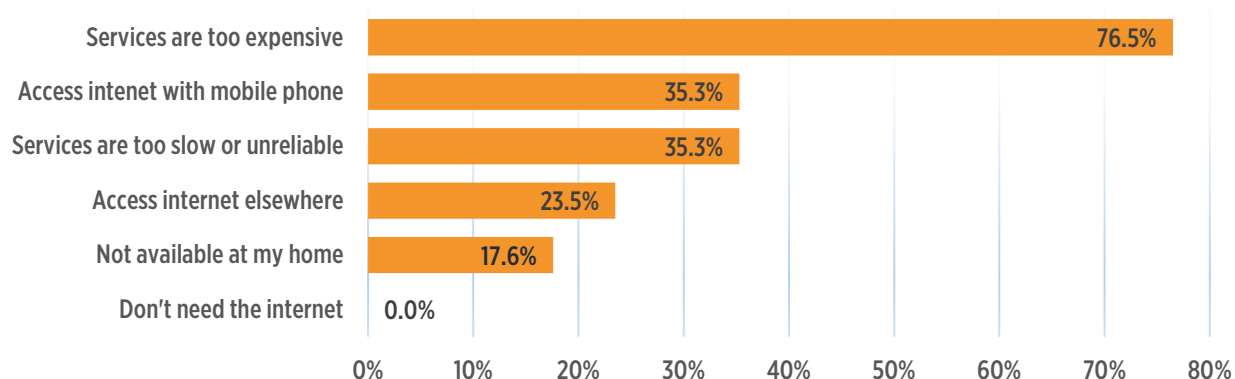
Some important observations can be made in comparing these two sets of data. First, while cost of service appears to be the reality of market conditions in Chatham County, two additional reasons hint at possible workaround solutions for non-subscribing households that need internet access. "Access internet with mobile phone" and "access internet elsewhere" both made significant gains between the two questions.

Reflecting a national trend, internet-enabled mobile devices are emerging as a necessary substitute for home internet access. While no Chatham County household lists mobile access as the sole reason why their household doesn't subscribe to wireline access, a remarkable 35.3% of non-subscribing households report their mobile phone as a reason their household does not subscribe to internet services. These homes don't choose mobile over wired connections; they use their mobile phones because wired residential service is too expensive. Where cost is an issue, if given the choice between wired home internet access or inferior and costly mobile internet access, most will choose mobile wireless because of the voice and mobility aspects.

Likewise, no non-subscribing Chatham County households say they don't subscribe to services because they access internet elsewhere. Yet when given the opportunity for multiple responses, that response increases to 23.5% of households that access the internet outside the home, possibly at work, school, or a public place such as a library or a restaurant. It is possible these households choose to go elsewhere instead of subscribing to household service, but it is more likely that those households must to go elsewhere for alternative internet connectivity because they have no affordable choice for their household.

To get an idea of how many non-subscribing Chatham County households would subscribe to services if given the opportunity, we asked households a series of questions to gauge how much the internet is a part of their household functions. We wanted to understand if non-subscribing households made the active choice to not subscribe to services, or if households wanted to subscribe to internet services but couldn't realistically purchase services.

As seen in Figure 29, over half (58.8%) of non-subscribing households have a need for internet access for training and education purposes. These households could represent grade school children without access for homework and assignments, or it could represent college students or even working poor who can't afford broadband at home. These groups likely have access to the internet at their schools or seek out public Wi-Fi where alternative methods of training or study can occur, but important aspects of convenience, having ready-access, and opportunities around "anytime learning" are lost.

Figure 29: Survey responses from Chatham County households without internet access
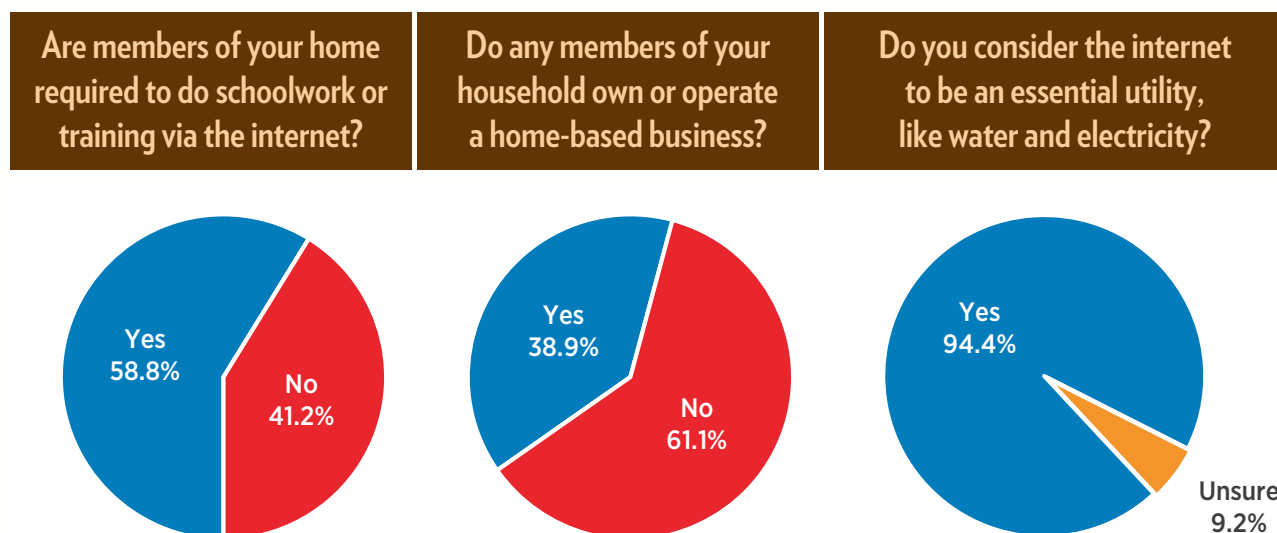
A surprising number of non-subscribing households operate a home-based business. At 38.9%, representing seven county households, the ability to compete as a small business today without the benefits of the internet is difficult. Any home business would certainly see an increase in efficiency and access to new markets and suppliers if exposed to internet connectivity. This connectivity would certainly increase sources of revenue and bring opportunities to cut costs, all working toward growing the business.

Certainly, some small businesses can operate without benefit of the internet, but with improved connectivity to information and resources, the competitiveness of county residents and their business would greatly be improved. Even the smallest home business in an unincorporated area of Chatham County can compete on a level playing field in terms of improved business information and communications, allowing Chatham County to develop a growing household workforce.

Because of the economic development aspects of fiber networks, the perception of internet service having the importance of traditional public utilities is increasing each year. More people are recognizing broadband as the "fourth utility" and are acclimated to – if not expecting – municipalities and utilities to provide broadband connectivity. An overwhelming majority (94.4%) of non-subscribing Chatham County households view broadband as an essential utility. Note that there were zero "No" responses; only "Yes" and "Unsure."

Taken together, the survey of non-subscribing households clearly indicates that Chatham County residents recognize the importance of the internet to their household and would likely adopt services if available at an affordable price.

2.3.2   Chatham County's Internet-Subscribing Households

As we begin to examine the 98.3% of responding Chatham County households that subscribe to internet services, we'll first look at the connection method chosen by households before moving into details around cost and satisfaction with service quality and customer support. The balance of this section will generally assess the ability of today's internet service providers to meet the growing demands of Chatham County households.

As illustrated in Figure 30, cable is the overwhelmingly dominant provider of internet connectivity for 80.6% of Chatham County households. The next closest connection method is DSL at 14.7%, while all other connectivity options pale in comparison.

Where cable is available, it is the generally the better alternative among legacy copper connection methods, and as we'll see in later sections, is considered superior to wireless and satellite forms of connectivity in terms of speed and service reliability. While only 2.7% of households connect via fixed wireless, about 1.1% of households remain on dial-up and satellite. With limited deployment into the county, fiber is only subscribed to by 0.2% of households, which represents two households in Pooler. In Chatham County, household internet connectivity is almost entirely via legacy copper and little of anything else.

Figure 30: Chatham County households internet connection method
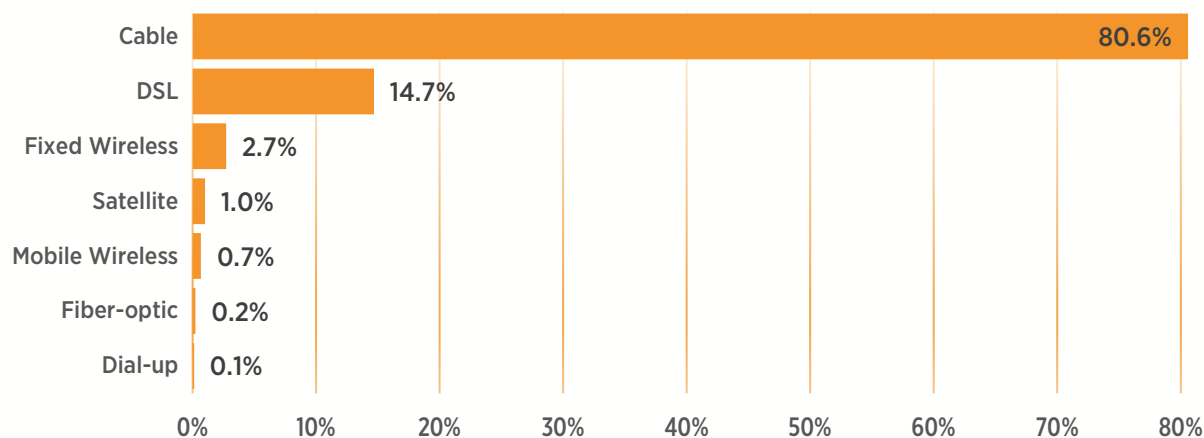
Chatham County households were asked if their current internet service provider is fulfilling the needs of their household. Across all connections, most households responded that their internet service is not meeting the needs of their household – and by a significant margin. As seen in Figure 31, an overwhelming number of Chatham County households – over 60% - say their current internet service does not meet the needs of their household.

Figure 31: Responses to, "Are internet services meeting your household needs?"
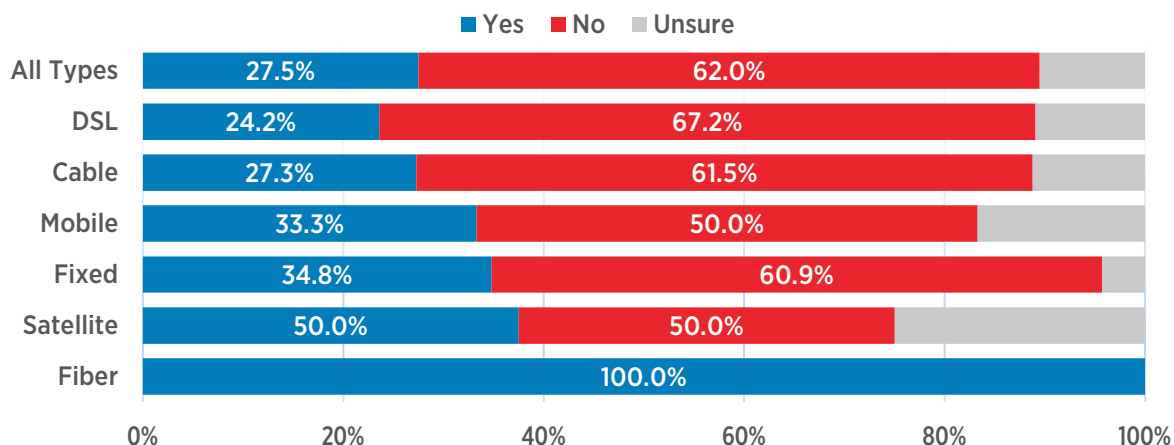
Weighted down by underperforming DSL and cable, only 27.5% of Chatham County households reported that their current internet services were meeting the needs of their household. Performing best was fiber, while all forms of wireless and satellite connectivity meet the needs of Chatham County homes better than DSL and cable.

The 62% of Chatham County households that reported their internet services did not meet their needs were asked the specific ways that their household internet service is insufficient. Again, as we saw with the non-subscribing Chatham County households, the cost of service is a serious issue. From that group, 80.5% claimed the "price is too high for received services," while 59.1% said their service is "not fast enough," with 54.4% saying their internet service is "unreliable."

When broken out and visualized by connection types, in Figure 32 we once again see poor overall ratings for satellite and mobile wireless, with slow speeds of DSL and satellite and the high cost of cable and mobile wireless standing out. Of note, all fiber households responded that their household's needs were met, so fiber connections don't appear in Figure 32.

26% of Chatham County households report their cable or DSL service meets their internet needs

Figure 32: How Chatham County household internet access is insufficient, by connection type
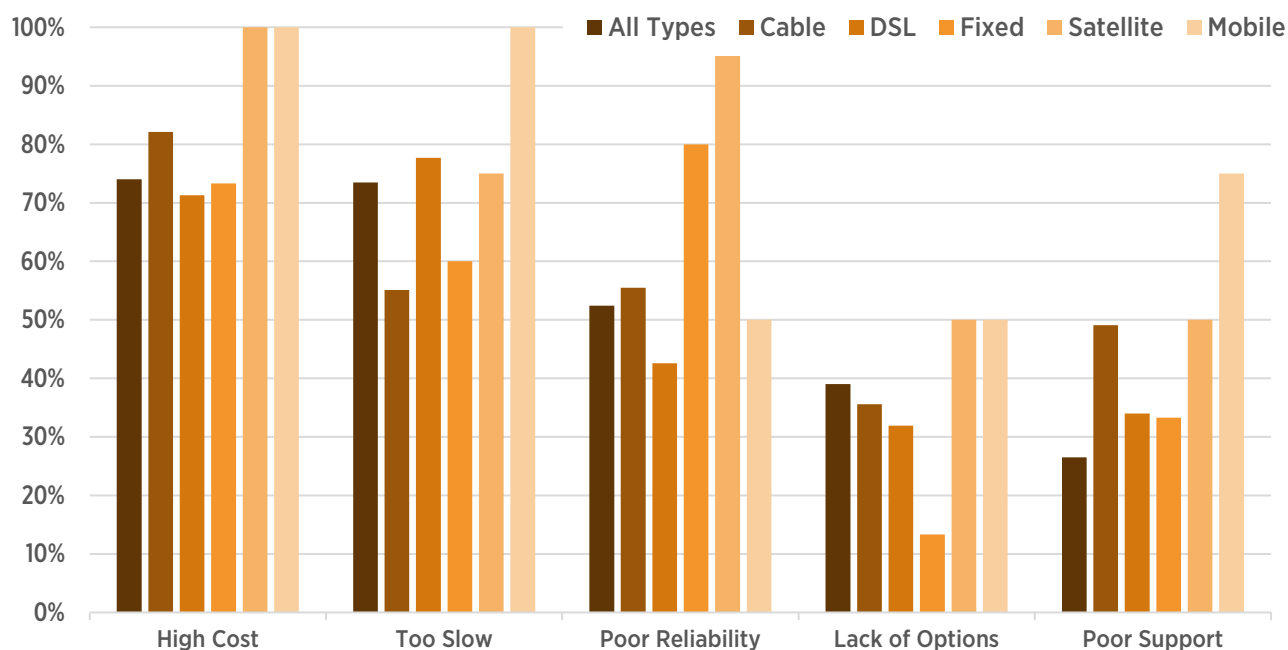
Regarding price, survey responses indicate that most Chatham County households (37.5%) pay between $50 and $74 each month for their home internet services, with 22.3% paying $79 to $99 each month. The percentages across Chatham County shown in Figure 33 are for any type of standalone or "unbundled" internet service. On the costlier side of the spectrum, 16.5% of households pay over $100 each month, while conversely, 23.6% of households pay less than $50 each month for internet service.

Figure 33: Chatham County household monthly cost by internet connection type
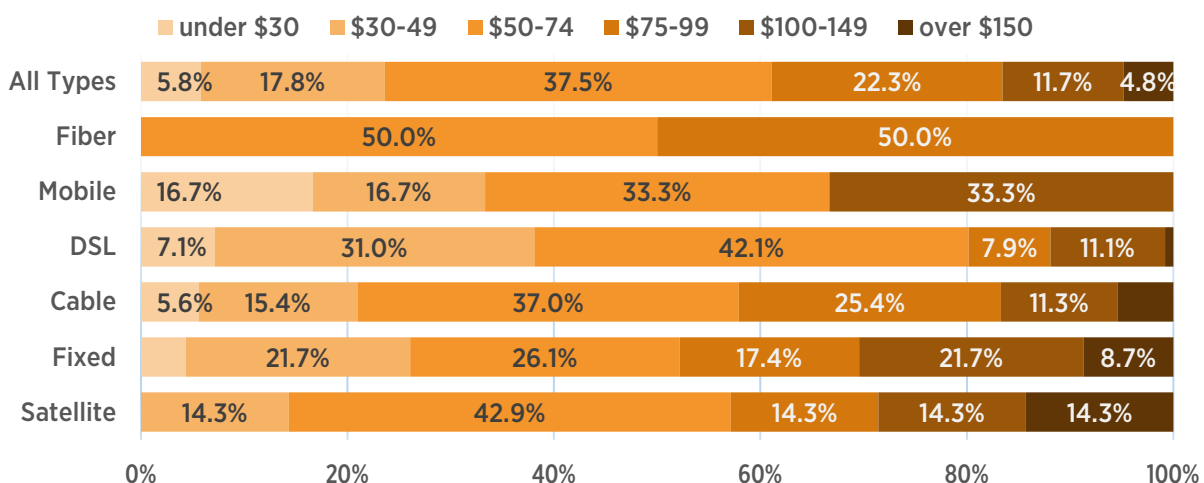
Digging deeper into the numbers we compare the residential cost across six leading connection types in Chatham County. Cable is by far the most common internet connection in the area (see Figure 30), with most subscribers (37%) paying between $50-$74 a month, with 25.4% paying in the $75-$99 range. Almost half of DSL subscribers (42.1%) fall in $50-$74 range, with another third of households (31%) that report paying in the $30-$49 range.

Also, largely because of the dominant proportion of cable subscribers, of the 16.5% of all Chatham County households that pay over $100 each month for internet service, 81.4% of that group is from cable households.

Lastly, with only two fiber, seven satellite, and six mobile wireless households responding to the survey, solid assumptions cannot be made throughout the report about those three connection types. Specifically, where cost is concerned, there is little consistency within each group, as cost seems to be distributed across all pricing categories.

In terms of customer satisfaction, Figure 34 shows that Chatham County households appear to be generally unsatisfied with their internet provider in terms of customer support, price and availability of value added services. There are far fewer responses on the completely satisfied side of the range among all categories, with three categories showing high levels of dissatisfaction that reflect need for improvement.

Figure 34: Satisfaction levels with current services among Chatham County households

| | Not Satisfied - Completely Satisfied | | | | | | Trend |
	1	2	3	4	5	6	
Price	28.0%	27.7%	21.1%	15.1%	5.9%	2.2%	
Speed	12.2%	17.6%	18.9%	22.6%	23.2%	5.5%	
Reliability	12.0%	16.3%	17.1%	19.8%	30.5%	4.2%	
Support	27.8%	23.0%	15.0%	17.9%	13.8%	2.5%	
Services	23.8%	20.0%	20.1%	21.1%	12.5%	2.5%	

A healthy trend line resembles a bell-shaped curve, and ideally with a trend line higher on the right side than left side, which would indicate increasingly higher levels of relative satisfaction. Of the five categories, only two have a positive trend line that would suggest a community with healthy competition. Even while reliability scores appear to be best, the customer support ratings reflect poor provider response when services have trouble. These negative trends give cause for concern, particularly with price and customer support.

Residents clearly think they are paying more than they should for the services they receive, and would like more value-added services to be available from their provider, things like burst speeds as needed, website hosting, cloud services, or even off-site backups as part of the monthly cost. While the desire for faster and cheaper is perhaps a reflection of human nature, few households are completely satisfied with any aspect of their internet service experience.

The lack of household broadband competition in Chatham County has created an environment of very poor customer service, where internet providers think they don't need to roll out additional new services or fight to win over customers simply because county residents have no choice in service providers. If a Chatham County household wants broadband, the choice essentially remains cable from Comcast or DSL from AT&T. Both options come at a premium cost with limited pricing tiers and service levels. Clearly, affordable connectivity is a legitimate dividing issue for Chatham County households.

2.3.3   Demand Indicators

To better understand how Chatham County households use the internet today and to identify indicators of growth, we asked how many devices are used in the home that connect to the internet. Of Chatham County households that subscribe to internet services, 94.5% connect three or more devices. Comparing Chatham County with national averages,[12] it turns out that 90% of U.S. households have three or more internet-connected devices.

Further, while just under half (47%) of U.S. households have five or more devices connected, 82.9% of Chatham County households report connecting five or more devices. As seen in Figure 35, it is equally notable that 24.3% of Chatham County households report connecting 10 or more devices, almost three times the U.S. average of 8.7%.

Figure 35: Internet-enabled devices in U.S. vs. Chatham County households
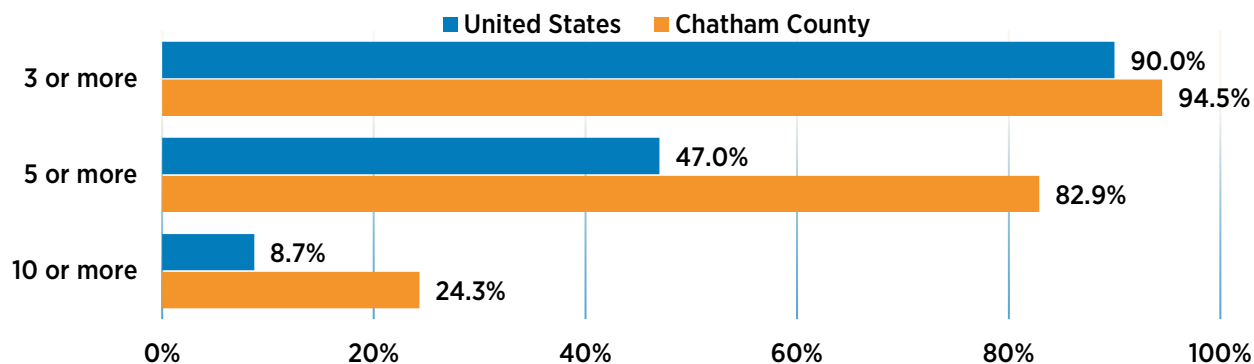
In looking at the number of internet-connected devices per household, Chatham County residents have a healthy appetite for technology and devices that connect to the internet. In fact, Chatham County survey respondents claim an average of 8.4 internet-connected devices per household. The Chatham County average is well above the national average, as the number of connected devices per U.S. household is 5.2.[13]

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[12] *http://www.ericsson.com/res/docs/2014/emr-november2014-regional-appendices-rnam.pdf*
[13] *http://www.connected-intelligence.com/about-us/press-releases/49-million-us-internet-homes-now-own-connected-tv-or-attached-content-device*

94.5% of Chatham County homes connect 3 or more devices to the internet. 82.9% connect 5 or more devices, well above the national average of 47%.

The number of connected devices per Chatham County home is 8.4, well above the national average of 5.2 devices per household.

Demand is clearly strong in Chatham County, with these numbers set to climb as more devices and services come to market. While the survey did not ask for specific devices inside the home that connect to the internet, the most current U.S. research[14] finds that devices related to security and safety lead the way, with devices that help manage utilities and energy consumption next, followed by smart appliances, health and wellness monitoring, and entertainment and gaming systems.

These demands extend to many devices inside the home that are connected to the internet and often are automated and require little or no human interaction. As an example, for the first time ever, 53% of U.S. households have smart TVs that connect to the internet.[15] Many multimedia entertainment systems, thermostats, irrigation systems, food storage and preparation areas, and security and monitoring systems are now connected to the internet, consuming even more home broadband bandwidth. In the coming years, the explosion of internet-connected devices in and around the "smart home" will lead to increased use of always-on residential broadband connections.

Gartner Research says there were 174 million smart homes in 2015, and that number almost doubled in 2016 to 339 million. Consumer applications fueling the growth of smart homes are smart TVs, smart lighting and various automation tools, such as smart thermostats, home security systems and kitchen appliances. Overall, the total number of connected devices is expected to hit 1.6 billion, up from 1.2 billion in 2016.[16]

[14] *Delivering on the Promise of Connected Homes: www.mckinsey.com/spContent/connected_homes*
[15] *http://www.broadcastingcable.com/sites/default/files/public/pdf/MagidTubeMogulPressReleaseFINAL.pdf*
[16] *http://www.gartner.com/newsroom/id/3175418*

Enabling smart homes is the ability to wirelessly connect all the various devices around the house quickly and conveniently. Today, this wireless connection is most commonly made through Wi-Fi technology, which is often done through the use of a router with wireless functionality. In Chatham County, 98.8% of surveyed households that have a broadband connection also have a Wi-Fi router installed in the home.

With the ease of Wi-Fi connectivity, homes are consuming more real time video and streaming applications, which require significant bandwidth, reliability, and performance from their broadband connections. A typical home might have one television set connected to broadband over a wired connection, while other devices on which video is viewed — such as tablets and Smart TVs — are connected over Wi-Fi.

Today, average monthly broadband usage in U.S. homes is 190 gigabytes per month, according to a report from iGR Research.[17] More than 95% of this traffic is video, as TV watching has moved from a group activity where the whole family might watch the same show, to now being a personal activity. So not only are homes watching video over the internet, if four people live in a household, that often means four different devices with four times the data going in.

Figure 36: Chatham County households rank the importance of the internet
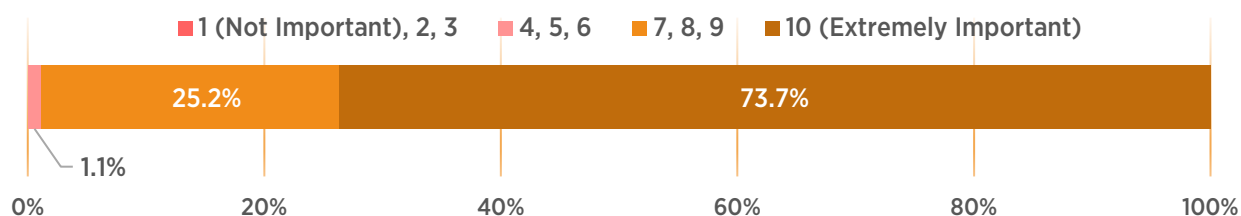
As national studies show, the internet has certainly become an important part of our lives, and this is no different in Chatham County. Amid challenging service offerings through the county, an overwhelming number of households recognize the importance of the internet. As visualized in Figure 36, on a scale from 1 to 10, 73.7% of Chatham County households ranked the importance of internet with a 10 as "extremely important," the highest ranking. In fact, no survey responses ranked the importance as below a 4. An incredible 98.9% of Chatham County households ranked the importance of the internet between 7 and 10.

2.3.4   Chatham County Residential Word Cloud

Word cloud visualizations can be a powerful tool when analyzing large amounts of qualitative data. In addition to normal research techniques, using a word cloud may help identify potential issues that would otherwise go unnoticed. Word clouds work in a simple way: the more times a specific word is used, the bigger and bolder it appears in the graphic. Color has no meaning here except to help differentiate words.

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[17] *http://igr-inc.com/advisory-subscription-services/wireless-mobile-landscape*

For Chatham County, word clouds can help us generalize how residents feel about their residential internet access today and allows us to gain a better understanding of the various aspects of broadband that residents value. It also provides assumptions of how residents think they would benefit if broadband services were much better than what is available today. This all helps paint a fuller picture of the state of broadband in Chatham County when used in conjunction with the more quantitative data the surveying process provides.

The open-ended survey question simply asked, "What would you do if your household had the best internet service imaginable?" The word cloud in Figure 37 visualizes the responses to that question. Over 8,000 words were generated with 480 responses to the question. For comparing the appearance of words in the word cloud, the word "streaming" had the most appearances at 126, "work" was next at 119, and "video" was not far behind at 101.

Several observations can be made from the usage of certain words and groups of words that fit along a theme. As seen in the image:

- Several words appear many times, such as "streaming," "work," "video," "home," and "connection," all appearing in the survey response over 100 times each.

- Some of the more passive characteristics hint at the entertainment and perhaps less productive side of the internet, words such as "watch," "download," "playing," "movies," "games," "music," and "netflix" as uses for their residential connections.

- Some clusters of words hint at the social aspects of connectivity, with words like "family," "social," "friends," "children," and "local" emphasizing the important local communications benefits of broadband and that not all internet usage is worldwide.

- Some productivity-focused words also appear numerous times, with action words like "work," "research," "business," "faster," "efficiently," and "smart" hinting that households want to do more industrious activities with broadband.

- Some words are more aspirational in nature, such as "possibilities," "college," "school," "improve," "degree," and "education" as people are hopeful that fiber will be a tool to help them realize some of the beneficial self-improvement uses of broadband.

- Some words hint at the quality of current broadband experiences, indicated by the appearance of "reliable," "faster," "waiting," "frustration," "interruptions," "affordable," and "better" as people think of the broadband they have now versus the broadband services that could be available through a fiber infrastructure.

*Figure 37: Chatham County residential word cloud*

The Changing Face of Work

As the household section ends and the transition is made to the business section, this is a good opportunity to look at the workforce space between homes and business and examine home-based businesses and teleworking in Chatham County. An impressive 26.2% of Chatham County households that responded to the survey report operating a home-based business. A home-based business not only suggests the self-employed who work full-time from home; it also reflects people who work at a full-time job and have another business at home, whether for hobby or significant recurring income.

For comparison with national numbers, the most recent findings from the U.S. Small Business Association says there were 14.56 million home-based businesses in 2013, representing 12.4% of U.S. households.[18] So at 26.2%, households in Chatham County are just over twice the national average for home-based businesses.

Equally impressive, over half (57.4%) of Chatham County households reported having someone who telecommutes, or occasionally works from home for an outside employer via the internet. To compare national numbers, a 2015 survey from Gallup Analytics[19] found that 37% of U.S. workers have telecommuted within the previous year.

Figure 38: Survey responses from Chatham County internet households
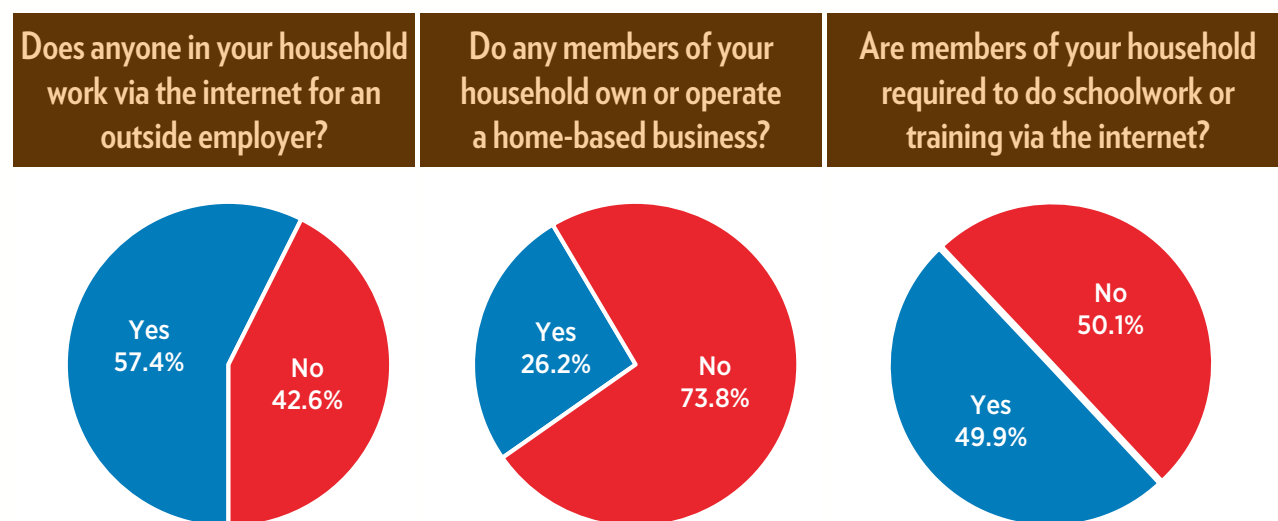
In all household groups that work from home and depend on residential internet services for incomes, Chatham County is well above national averages. Teleworkers in the U.S. work an average of 6.4 days from home each month, with 9% working over 10 days each month from home. With these numbers expected to increase, one could speculate that if residential broadband was better and more affordable, county properties would be more attractive and could lead Chatham County to realize an increase in residential entrepreneurial development.

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[18] https://www.sba.gov/sites/default/files/FAQ_Sept_2012.pdf
[19] http://www.gallup.com/poll/184649/telecommuting-work-climbs.aspx

2.4   Chatham County Business Needs Assessment

Chatham County is steeped in history and successfully promotes itself as an authentic destination that appeals to a broad demographic. Savannah's development as a port city at an ideal location along the nation's eastern seaboard continues to provide opportunities in manufacturing, logistics and international trade. Businesses in Chatham County compete in a region entrenched in tourism, retail services, manufacturing and shipping industries.

Just as Chatham County relies on highways and public infrastructure to transport its visitors, or its shipping containers and ports to carry away its manufactured goods, broadband that is affordable and reliable is a key economic development tool to facilitate and data-driven businesses. The needs assessment processes found that the bandwidth demanded today by many Chatham County businesses outpaces the services that internet service providers are able to deliver.

To gather a better understanding of broadband service issues faced by county businesses, an online and paper survey was conducted that included questions related to broadband access and its use. Details of the survey results follow, but in summary, the data shows that where broadband access is available, the adoption of the internet and use of internet-enabled applications and devices is very strong. In fact, of the 45 businesses in Chatham County that completed the survey, an impressive 97.8% subscribe to internet services at their business.

Figure 39: Responses to the question, "Does your business have internet service?"
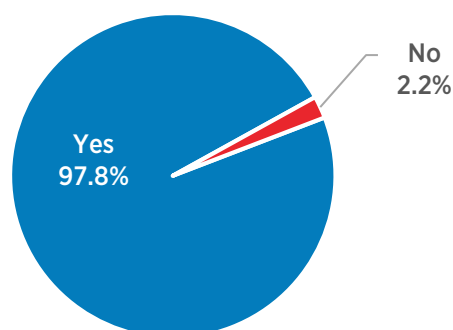
Just over half (53.3%) of Chatham County respondents were from businesses with 10 or fewer employees, while 26.6% of responses were from businesses with over 100 employees. Regardless of size, these businesses reported the need for improved broadband infrastructure, as many are hampered by the high cost and poor quality of legacy cable connections offered by service providers that serve Chatham County.

As seen in Figure 40, the majority of businesses in Chatham County subscribe to services via cable (43.4%), with DSL and fiber each at 11.3%. Surprising is the appearance of mobile wireless connections, accounting for the same percentage as fiber and DSL combined. Making up the remaining is fixed wireless with a small percentage of legacy T-1 connections. These connection types indicate the lack of broadband competition in Chatham County, as many businesses around the country have transitioned away from T-1 in the last decade.

Figure 40: How Chatham County businesses connect to the internet

Connection	Percentage
Cable	43.4%
Mobile	22.6%
Fiber	11.3%
DSL	11.3%
Fixed	7.5%
T-1	3.8%
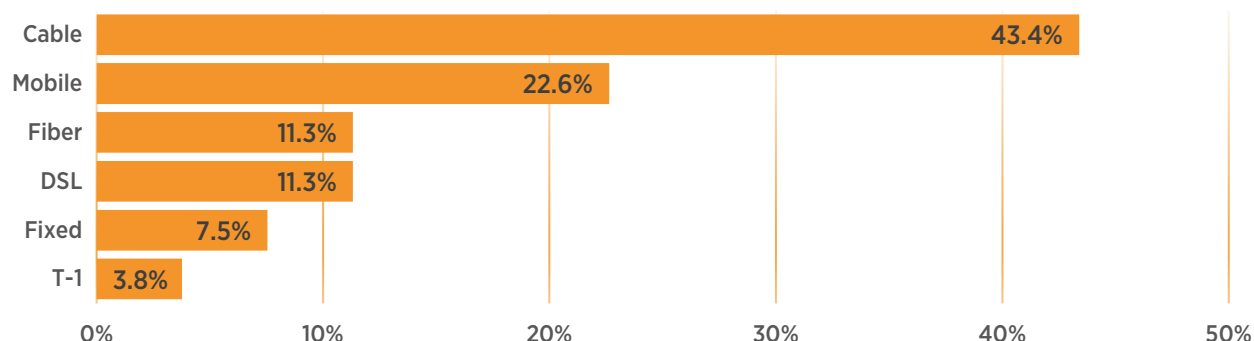
What is interesting is the comparison of broadband services subscribed to by small businesses and large businesses in Chatham County. In Figure 41, survey responses from businesses that employ less than 20 people are represented by the chart on the left, while the chart on the right represents business with over 50 employees. Note that only 3% of surveyed small businesses subscribe to fiber, while fiber is the choice of 35.7% of larger employers.

Figure 41: Chatham County business internet connections, based on employment size

Under 20 Employees:
- Fiber 3.0%
- Fixed 6.1%
- DSL 15.2%
- Mobile 24.2%
- Cable 51.5%

Over 50 Employees:
- Cable 35.7%
- Fiber 35.7%
- T-1 14.3%
- Fixed 14.3%
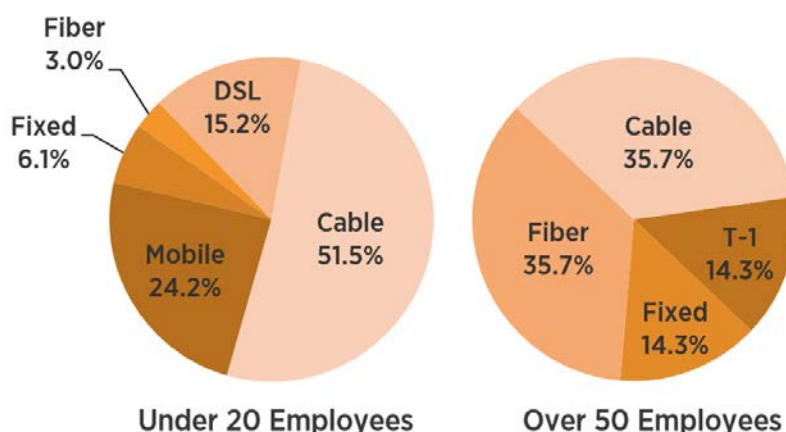
Certainly, bandwidth requirements for larger employers are driven by the fact that larger businesses have more employees, computers and equipment, and thus have a stronger dependency on the advanced capacity and communications connectivity that fiber offers. Where there is a lack of having fiber as a viable choice, copper-based cable remains the option for most small businesses in Chatham County. Not lost in all this is the cost of fiber, which can more easily be tolerated by larger organizations.

However, an important point here is the lack of widely available fiber connectivity from service providers in much of the county. Figure 41 suggests that fiber-based connections simply aren't universally available or affordable for smaller businesses in Chatham County. Such a lack of service options severely limits smaller start-up companies and data-centric

organizations from having access to bandwidth at a cost that would allow them to be innovative and be able to grow.

Another point illustrated in Figure 41 speaks to the overall quality and reliability of wired broadband versus wireless broadband. Significantly fewer business in Chatham County with over 50 employees rely on wireless forms of connectivity, 14.3% for large businesses versus 30.3% for small businesses. Availability and price are certainly at play, but data suggests that larger businesses in Chatham County choose wired network technologies over wireless for better reliability in addition to bandwidth capacities.

Data from this survey shows that to support large employers, fiber is the best solution. For small businesses that were surveyed, many are settling with the connectivity available to them, which could be stifling their business efficiency, growth, and opportunities for innovation and collaboration. With fiber, Chatham County can incubate home-grown businesses, grow small businesses into large employers, and be a magnet for relocating both expanding employers and emerging entrepreneurs.

35.7%
Chatham County businesses over 50 employees have fiber connections.

3.0%
Chatham County businesses under 20 employees have fiber connections.

Therefore, it is critical that community leaders promote the availability and affordability of fiber-based broadband in business and industry recruitment efforts just as access to transportation corridors and the availability of water and electric utilities. The lack of fiber infrastructure is a major obstacle to attracting businesses, as competing for site selection deals for larger enterprise require fiber capable of high-speed broadband services.

In thinking of internet services that can support local business, Figure 42 shows that only a third (33.3%) of all responding businesses say current internet services are fulfilling their business needs. Because of the array of connection types subscribed to by Chatham County businesses, it is useful to understand how the different types of connections have a role in meeting the needs of county businesses.

As seen elsewhere in Chatham County, particularly with the household needs assessment, Figure 42 shows that mobile wireless and legacy copper-based DSL connectivity rates among the lowest in the ability to meet the needs of business customers. Fiber and T-1 connections rate above average, while a cable represents the average connection for meeting the needs of business customers.
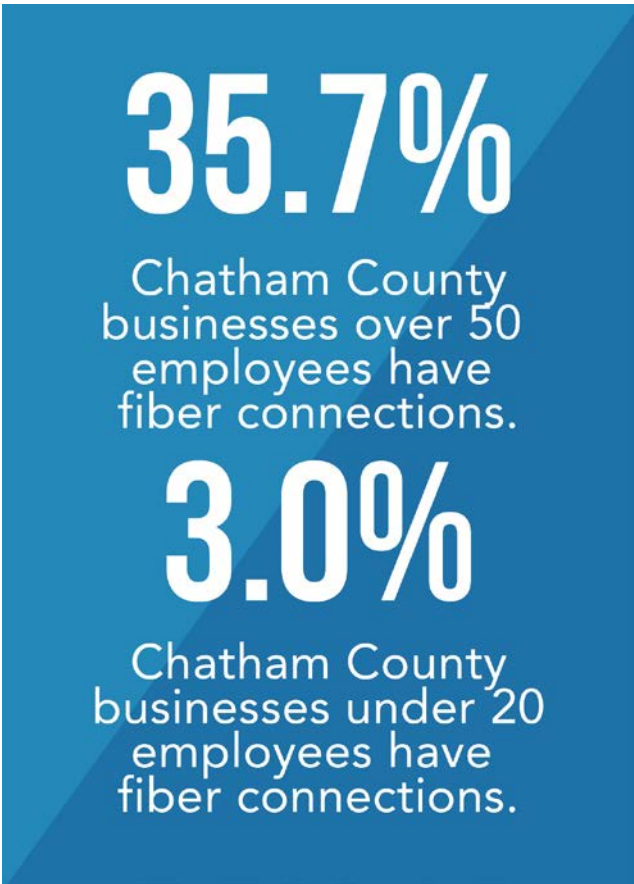
Figure 42: Internet services meeting business needs, by type

Legend: ■ Yes ■ No ■ Unsure

Type	Yes	No	Unsure
All Chatham	33.3%	59.3%	
Mobile	16.7%	66.7%	
DSL	25.0%	50.0%	
Fixed	33.3%	66.7%	
Cable	35.3%	58.8%	
T-1	50.0%	50.0%	
Fiber	50.0%	33.3%	
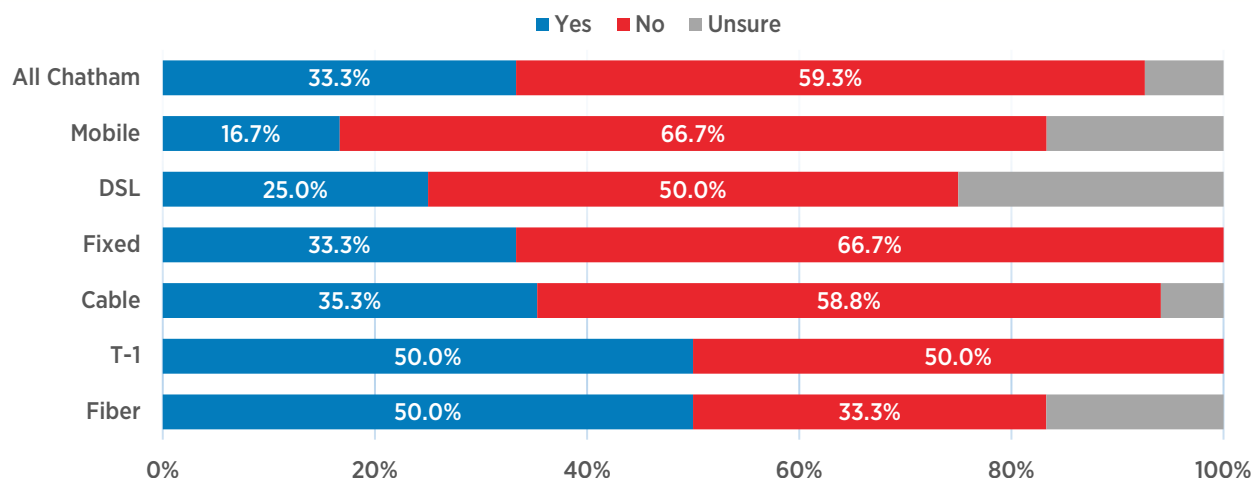
For the 59.3% of Chatham County businesses that said their current provider was not meeting the needs of their businesses, when asked how their internet service provider is not fulfilling their business needs, 76.5% responded that "speeds are not fast enough." Interestingly, the second highest response was "access to customer support" at 64.7%, which is unique to Chatham County as compared across other Magellan clients. Rounding out the list is 58.8% responded that their service was "unreliable or undependable," while "price too high for received services" came in with 47.1% of responses.

Customer support issues typically don't garner high responses, but in Chatham County, almost two-thirds of businesses claim customer service and technical support is insufficient in meeting the needs of the business. This can be indicative of lack of competition in Chatham County, as service providers know their networks are aging and prone to technical issues, while provider representatives know there is not much that can be done to improve service quality in Chatham County without wide-scale infrastructure upgrades. With lack of competition, there is little incentive for current providers to invest in infrastructure upgrades. In many cases, in Chatham County the choice is often the cable or DSL provider, or nothing.

When asked why their business hasn't upgraded internet services to greater speeds and service levels, 58.8% said that "better services are not available in my area," with the same percentage of responses for "no other providers are in my area." Of note, only 29.4% of business responses said the cost was too high.

While on the topic of internet reliability, 40.7% of Chatham County businesses reported no disruption or minimal disruption of less than an hour each month. On the other hand, 18.5% of businesses reported severe or total disruption of their business internet service each month, with their internet service completely out over a day each month. Only 22.2% of Chatham County businesses reported no broadband disruptions at all.

Businesses were asked their levels of satisfaction with their current internet provider. Despite 29.6% of businesses claiming disruption of service for eight hours or more each month,

findings in Figure 43 appear to be somewhat brighter. As in the household section, what one looks for in a healthy trend line is a bell-shaped curve, ideally a curve with a higher right side than left side, which would indicate relatively higher levels of satisfaction. Surprisingly, responses reflect a decent level of satisfaction with price, and it is represented by the healthiest trend line of the four criteria.

Figure 43: Satisfaction with current internet services among Chatham County businesses

| | Not Satisfied - Completely Satisfied | | | | | | Trend |
	1	2	3	4	5	6	
Price	8.0%	12.0%	28.0%	36.0%	12.0%	4.0%	
Speed	12.0%	28.0%	8.0%	36.0%	12.0%	4.0%	
Reliability	16.0%	20.0%	16.0%	16.0%	28.0%	4.0%	
Support	28.0%	16.0%	12.0%	24.0%	16.0%	4.0%	

While all categories show more responses on the "not satisfied" side of the scale than one would like to see, price and speed do show the healthiest trend among the four categories, with reliability showing an interesting trend that spikes on the satisfied side but drops off to only a few "completely satisfied" responses. The concern here is the high number of businesses not satisfied with their customer support. As mentioned earlier, this could be an indication of customer service staff being unable to offer permanent solutions to aging copper networks in Chatham County, perhaps promising quality improvements that never happen. When service problems are not resolved after repeated calls, it has the effect of unresponsive customer support that leads to high rates of dissatisfaction seen here.

Looking at the cost of internet services for businesses in Chatham County, in Figure 44 below we see that the highest group of businesses (27.7%) pay over $300, with the second largest group paying between $50-99 per month, 25.5% of Chatham County businesses. As shown, these businesses typically subscribe to relatively inexpensive fixed wireless and DSL service, while others subscribe to relatively expensive fiber. No Chatham County business that responded to the survey pays below $49 each month for internet service.

Digging deeper into the numbers we see monthly cost to businesses across the various service offerings in Chatham County. Cable is the most common internet connection for businesses in the county (see Figure 39), with most subscribers (31.8%) paying between $100 and $149 a month. Most DSL subscribers (60%) fall in the $50-$99 range, while most wireless subscribers are distributed across all cost ranges. All business that have fiber connections in Chatham County pay over $300 each month for service. All told, 25.5% of Chatham County businesses pay under $100 per month, while 38.3% pay over $200 per month.

Fiber is the most expensive form of internet service, with all surveyed Chatham County businesses paying over $300 per month for service. Obviously, more devices and more applications, such as multiple phones and video streams, can be supported by fiber so the

cost per device is lower. Again, indicative of poor competition, several businesses remain on T-1, which share high-cost on par with fiber and the more expensive connection methods.

Figure 44: Chatham County business monthly internet cost, by connection type
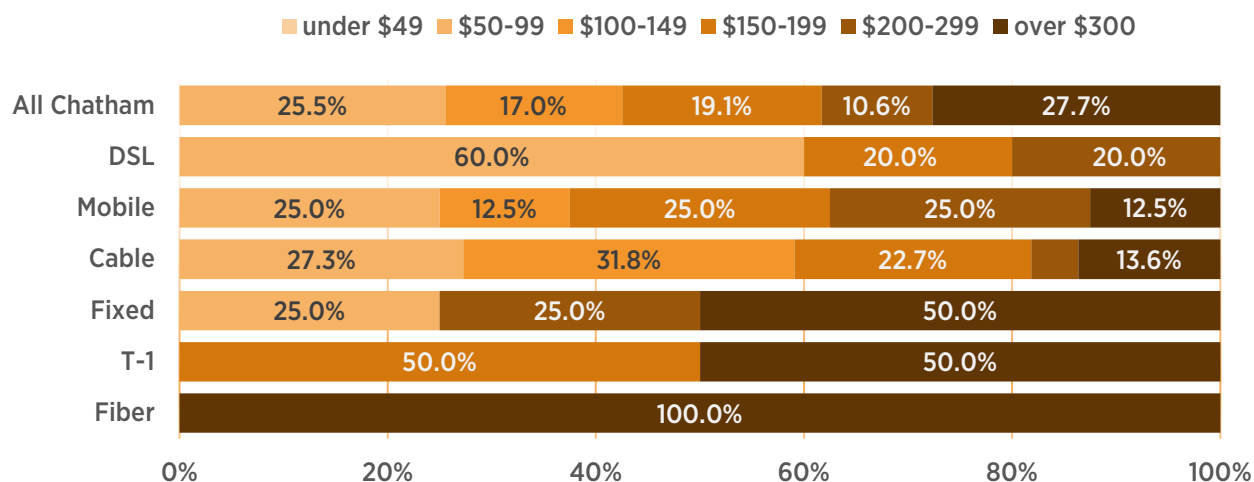
Striving to learn more about the needs of Chatham County businesses, we listened to several businesses and understand that bandwidth consumption is outpacing the service levels that service providers can deliver. As heard in meetings with county businesses, when broadband services cannot meet their needs, they lose productivity. This impacts their bottom line and makes them less competitive with businesses that have more robust broadband services.

In many cases, Chatham County businesses subscribe to services from the only provider that can serve their location. In much of the county, that provider is typically either cable from Comcast, or DSL from AT&T, with occasional offerings by a local provider like Hargray or Seimitsu and fixed wireless providers. However, rarely do businesses have a choice in broadband service providers – typically it is *either* Comcast that serves areas with cable access, *or* AT&T that provides areas with DSL.

As shown in Figure 45, even when a provider contracts to deliver "up to" a certain level of service to business customers, actual measured speeds from Chatham County business internet connections show service providers woefully under-deliver. So bad, in fact, that some businesses could be justified in claiming they are being charged rates for higher service levels that they might never achieve.

Figure 45: Chatham County subscribed speeds versus measured speeds

Chatham County Businesses	Subscribed Speeds	Measured Speeds	Percent Difference
Download Speed (Average Mbps)	66.6	41.96	-37.0%
Upload Speed (Average Mbps)	28.29	14.72	-48.0%

This lack of service provider competition limits the improvement of services throughout the county because there is no incentive for a service provider to improve their service. Due to the physical limitations of copper-based networks, better services simply are not possible without infrastructure upgrades.

From the corporate service provider perspective, it continues to profit by overselling costly services across an infrastructure that was installed and paid for decades ago. Even though there is certainly a demand and a concentration of customers in Chatham County, where there is no competition there is no incentive to improve that infrastructure.

"COMPETITION IS NOT ONLY THE BASIS OF PROTECTION TO THE CONSUMER, BUT THE INCENTIVE TO PROGRESS."

President Herbert Hoover
1930 State of the Union Address

In fact, instead of upgrading their networks on their own, service providers often wait until a business customer is willing to pay for a dedicated fiber build to their property. This cost is often prohibitive to all but the largest businesses and employers, but in building to those conceding customers, the provider can then sell the upgraded service to additional customers along that new route.

This ugly tactic is used frequently by service providers around the country, and exemplifies how easy it is for outside corporate telecom interests to have an influence over the competitiveness and success of local businesses, and more broadly on the Chatham County economy. Therefore, it is critical that Chatham County can promote the availability and affordability of broadband services as it executes economic and workforce development strategies.

As discussed in the household section, the same holds true for businesses in that broadband has evolved to carry more and more data because of the advancements in networked applications and the rapid growth in the number of online devices. Every application requires a certain amount of bandwidth on a broadband connection to function properly.

As time has progressed, we have witnessed significantly more devices, each with hundreds of possible applications, and significantly more bandwidth being used by those applications. Figure 46 illustrates the bandwidth requirements of common applications and the impact of multiple applications running across a broadband connection.

Figure 46: Growth in application bandwidth demand
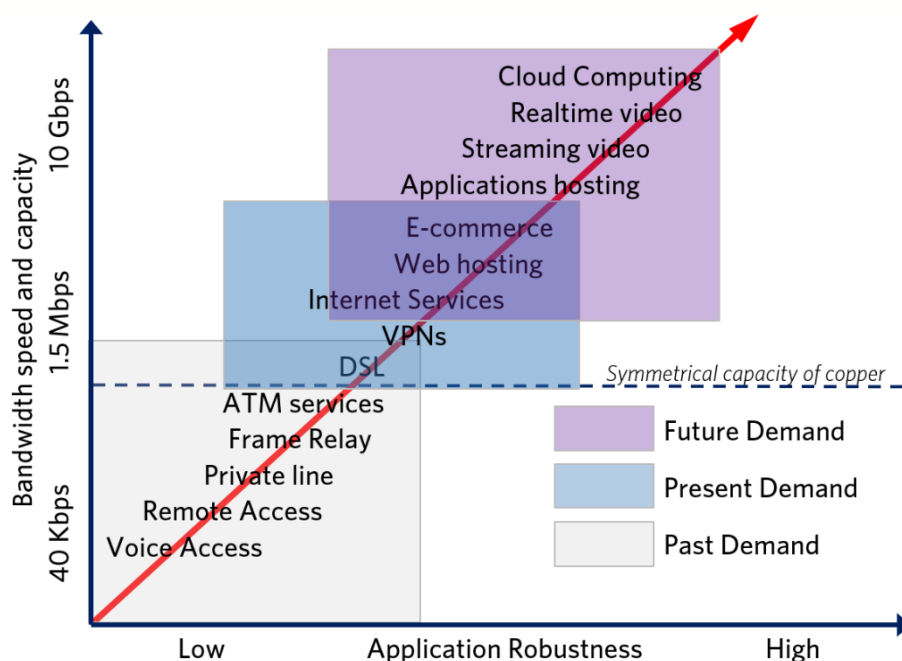
In addition to current business needs, an innumerable offering of cloud services and online-only applications further drive the need for more broadband as real-time and cloud-based applications require additional bandwidth, both in download speed and upload speed. These applications often synchronize in real time, meaning that they are always consuming bandwidth at a constant rate rather than only when the user is actively engaging the application. As more of these applications are deployed and gain popularity, broadband connections will need to accommodate the increased bandwidth load.

Having access to broadband and subscribing to service is one thing, but to realize benefits from broadband, meaningful utilization must occur. In fact, as seen in Figure 47, Chatham County businesses clearly recognize the importance of the internet for their business. On a scale of 1 to 10, 82.9% of all surveyed businesses ranked the internet as a 10, for "extremely important" to the growth of their business. What's more, no business ranked the importance of the internet below 8.

Figure 47: Chatham County businesses rank importance of internet to business growth
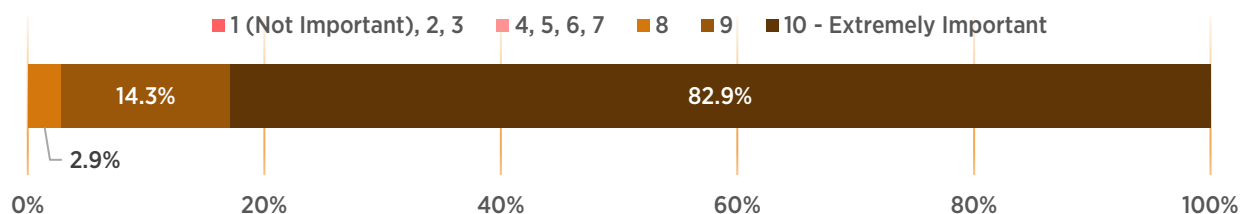
2.5   Chatham County Community Anchor Institutions

As we look to the future, local governments and public sector organizations like schools, hospitals, libraries, first responders, civic organizations – all considered "community anchor institutions" must operate efficiently and strive to work smarter through technology. Each organization and its staff should be able to access information and have a process to do their jobs as proficiently as possible. Technology today can facilitate the share of data-intensive information that can help all local organizations and departments share workflow documents, detailed maps and blueprints, high resolution photographs and other documents and forms of unified communications.

Fiber-optic infrastructure can be used for an assortment of public benefits, including enhanced utilities and improved collaboration and infrastructure sharing programs, as well as improved public safety and first response. When local government and public service organizations use broadband, the fiber then provides a platform for long-term adoption and potential for smart community innovation. All material in this section comes directly from community stakeholders during focus group discussions and personal interviews.

2.5.1   Business and Industry

Tourism and hospitality services are big business in coastal Chatham County. Thanks to that, much of Chatham County has a high concentration of accommodation, food services, and retail service businesses (Figure 8). These hospitality businesses primarily have two general connectivity needs, one for the guest experience and the other for managing the business. Internet access for small, non-tech businesses seems to be adequate but most have needs for backup connections. Frequent outages are currently handled by "staff mobile phones and a credit card reader." Many of these companies seem to have basic internet requirements for accessing online management applications, conducting basic purchase transactions, and providing customers' internet access. Outside of a retail business, the millennial traveler wants technology; they want Wi-Fi connectivity while just walking down the street.

Economically, Chatham County is located in the center of a region between Jacksonville, Atlanta, and Charlotte. However, many companies say they have a really hard time getting strong IT talent to come from outside of the area. Chatham County is also strong in manufacturing. The larger companies have no complaints about day-to-day internet quality because they often have dedicated connections with guaranteed levels of service quality. Short of catastrophic weather impacts, enterprise connectivity is relatively stable.

Yet, largely due to coastal weather events, each large employer we spoke with shared stories of what their company location does when the internet goes out completely for long periods of time. Some have operating procedures in place, while those that don't describe those times as "when everything goes crazy." Even small businesses and community anchors with cable complained about reliability, saying they can lose connectivity about once a week.

As related to dependability of the internet, the hesitation to do more with technology is not about the broadband, it's about the experience in general. There won't be a lot of

commitment to technology growth if it is seen as more of a problem than a solution. There are a lot of branch offices in the Chatham County area that are parts of bigger companies. These locations may be relatively small, but they implement technology on the back of a parent company or headquarters initiatives aiming to operate as if all were in the building. When connectivity goes down, as one large county employer put it, "when the internet goes down, our productivity and operations often cease, and if we're not making things, we're losing a lot of money."

When smaller companies have a problem with technology, they must call one company then another. There is no single point of contact. Eventually their vendor has to contact the broadband provider because that's usually where the problem is, but the vendors can't call the provider directly. Some local manufacturers worry about their ability to land contracts with major clients due to cyber-security issues. Others report issues when transferring large files to local companies, which could prove a barrier to sourcing more locally.

Similarly, large companies can send paper files. Enterprise requirements of suppliers to use specific systems is a larger challenge, yet this not true for creative industries, such as film and graphic design, which work with and need to transmit large files. Abundant bandwidth is important in these sectors. Likewise, the burgeoning game development community says they need gigabit speed and need it to be symmetrical. An informal survey of people in game development by Savannah Development and Renewal Authority suggested that broadband is a game changer. Some local technology leaders see a lot of potential benefit from that approach.

And to the credit of local leadership, a lot of excitement has been generated and progress has been made around tech-based economic development throughout Chatham County, and future efforts have a lot of good work to build on. The project that put fiber under Martin Luther King Blvd in Savannah was a digital divide program, which is an important and resonating issue in the county. County leaders believe anything they can do to address the digital divide is good. For households that have access, leaders recognize that the need for bandwidth is just going to increase, and that broadband is going to be important to attract and retain people to the county.

Those who are trying to market Chatham County and promote it to the world say there is some misinformation from the provider community about what they have available in the county. Population in some parts of the community are dense enough to support increased investment, especially for wireless, but other areas do not have enough demand. Some county leaders were unwilling to advocate for municipal broadband, but they could see that it would be very easy to explain and market that to the world once available.

Chamber of Commerce

The Savannah Area Chamber of Commerce has a stable membership of 2,200 organizations, 80% of which are small business. The Chamber hasn't heard anything about needs for bandwidth or connectivity. Broadband not a significant or big topic with Chamber members, although there is some frustration from large users about fast enough pipes and with limited

availability of cable. The chamber itself is located next to a hotel with cable broadband but couldn't get the service.

A lot of people in emerging tech companies want fast connectivity in Savannah's squares, but they're most concerned with what they can get in their offices. Over 85% of member have web presence. The web is diminishing in importance due to social media. No more than 30% are doing social media and digital marketing. These topic gets a certain amount of "glaze over" barriers to rank and file businesses. The chamber recently added a cloud application and thought, "Maybe we need to bump up the speed," but they have the fastest reasonable option. There are some opportunities with tech-centric business, but most businesses are using core applications adapting to devices other than computers. Most chamber members are using computer technology—whether just PCs, internal servers, or cloud services—for accounting, customer and supplier management, and marketing support.

Chamber representatives think there's a lot of confusion about what the community has. The Chamber's governmental affairs we confused about what's going on and who's leading the charge. For example, Georgia Power spent lots of money, etc., rewiring downtown but didn't have any cooperation or coordination to get build broadband infrastructure. The chamber's position is that the city shouldn't require the companies to do the coordination, that local government should be a facilitator of infrastructure development.

The Chamber sees that technology needs are met in most industries. The software solutions for distribution, logistics, and warehousing have become rather complex. This is a big deal but the companies pretty have taken care of the connectivity challenges. Hospitality's customers have forced them to provide Wi-Fi, and their customers are around long enough to need speed. Hotels and restaurants use broadband for self-management, customers, suppliers, and employees. They are first to adopt social marketing techniques to reach customer. There are challenges with medical industries and doctors' office, largely due to HIPPA requirements and complex platforms that don't all talk with each other. Healthcare needs data management and people to run it all. The Savannah area may be lagging in startups and tech: it's common for the SCAD students to come here but go somewhere else for employment. The local economy just is not that big, and doesn't have a critical mass of startups. Entrepreneurs like to startup where there's other startups and venture capital. Those things aren't huge here. There are things that could be done to foster a better startup environment but that might be better invested elsewhere. There is not enough current activity to justify targeted investment, to ensure reasonable return on investment.

The Chamber hears about the need for better public safety everywhere. It's gotten louder over the last several years. There are a lot of ways to address this issue, from home surveillance to cameras on lamp posts with wireless connections. The more cameras probably the better, but again the biggest issue is how to pay for it. Social equity isn't the Chambers sweet spot and not where our expertise is. The city and county have gone through great lengths to establish community centers with connectivity and other resources. The Chamber has many rhetorical questions about this: When is it a public responsibility to

provide technology and when is it not? Would it be ideal for everyone to have broadband, certainly, but whose role is it to provide and pay for broadband?

The Chamber would be interested in "best practice" models, particularly those that show where the return on investment is, and could bring together members to discuss. There are four or five service providers that businesses can choose from, so it's not like they go without. There's got to be some return for private sector. The challenge is to figure out how government can incent investment and make the investment less so providers reach profitability sooner. The general conclusion for the Chamber is that broadband can be a barrier and constraint it is not a driver; it's an enabler.

Creative Coast

The Creative Coast is a non-profit organization that works to build and support the network of creative and innovative local businesses. Magellan met with four representatives of the organization. Participants felt the focus should be on network connectivity; making sure as many locations as possible have access to high-capacity fiber-optic network infrastructure. "Businesses still can't get reliable internet here," one participant insisted, "It's terrible and expensive." When the Creative Coast representatives get together with other people, "that's all they talk about." Of course, these comments were likely hyperbole but it was obviously a major issue for the group. They felt there were limited options for internet access in Savannah.

Creative Coast representatives were concerned that a tech-centric environment can't evolve because the lack of connectivity options. For example, they noted that the Savannah Economic Development Authority (SEDA) has been talking about a tech district but hasn't been able to get serious about it because, according the discussants, no one has willing to commit. When the Creative Coast speaks about what it's trying to do people feel it makes sense. The general need for knowledge-based economy is well-understood and favored, "but that's where it stops: we don't upgrade our infrastructure" as necessary for technology industries. Savannah has a strong accommodation, food service, and tourism sector. The participants felt that Savannah is very focused on these current strengths and not looking at other opportunities. Now it looks like people are willing to step up, participants noted, but there is a need for champions and telling the story better in order to get real investment.

The Creative Coast would like Savannah to have infrastructure to directly connect between local businesses. Its stakeholders are interested in the idea of an open backbone that can be used by entrepreneurs. This could be developed in partnership with local technology companies. For example, one company has 12 pairs of fiber coming in from Seimitsu, a local network company, each of which is capable of a gigabit-per-second. The company just puts equipment on the end and decides how much it wants to pay. Comcast won't do that, Creative Coast stakeholders noted. They wondered why multiple small towns in Georgia have fiber-optic services throughout them, but Savannah doesn't. They felt Savannah should have duct laws that mandate utilities put additional ducts in the ground when doing construction, like other cities.

If a startup here can get a lead investor from somewhere else, then it can get local capital investment. And, if it can raise seed money in Savannah, it can then go to Atlanta for venture capital. It's a little like that with connectivity: the "brains" of the businesses are somewhere else. Local connectivity accesses and complements those asset, but businesses don't rely on it. Savannah has got to get beyond thinking that basic broadband can provide the necessary connectivity. The area needs more connectivity but also greater reliability—there are issues with hurricanes, etc.—for functions like replication between data centers. There are types of business, like video and games, that the area wants to attract but can't get without more connectivity. They also foresee rapid growth in need for mobile bandwidth due to new applications. For example, augmented reality will "wreck" cellphone networks. It could be a "you pay for what you use" arrangement for high-bandwidth applications.

One participant in the Creative Coast discussion was the owner of company that has gone virtual because it couldn't attract top-level talent. This locally-based e-commerce company, which employs about 30 people, pays $30k/month for hosting in Atlanta to serve 400 merchants. Most startups just plan to use AWS or Microsoft Cloud, which can be even more expensive. Greater connectivity could help reduce these costs. Improved connectivity could also help with the talent challenge.

The company hires less experienced workers because price is right and we can train them the way we want. To get the deeper expertise a person must have worked several companies and created a lot of products. The experienced programmers are the hardest to recruit, although that's easier now that the virtual. People say, "I can't hire developers here," but "developers" is just shorthand for technical talent. That kind of professionals are hard to recruit to Chatham County. The problem was not quality of place, including broadband, it was lack of career options in Chatham County.

There is a need software and hardware talent but not a lot of opportunities for them in Savannah. If experienced professionals could work remotely here for major companies, it would help us get the snowball rolling. If the Creative Coast could fill its co-work space with people working with known companies, it would show that a person can live in Chatham County and have multiple career options. "If you had just a couple of large technology employers," the entrepreneur executive noted, "that would help me hire people for my business." Having great fiber-optic connectivity also has marketing benefits. "Just to being able to say we have it," would help with recruiting technology companies. If Chatham County had the infrastructure there would be more creative and innovative activities.

Georgia Ports Authority

The Georgia Ports Authority connects with its customers and partners solely via the internet, and has no point-to-point connections to customers. The Authority does have point-to-point connections between its Garden City and downtown (Ocean Port) facilities. It has enough data transfer speed, and can shop around to get two or three quotes if it needs more. The Authority is opening facilities in other parts of the state, and is beginning to shop for point-to-point connections to those locations. The Authority recently sold 500 acres in its Savannah River International Trade Park for commercial development to accommodate

growing customer demand for warehousing, distribution and intermodal facilities near the Port of Savannah.

The GPA is a critical asset for the Chatham County industrial and workforce base, providing positive impacts to the economy of the Southeastern U.S. and beyond. The GPA seems to have good connectivity, but officials were unsure about the connectivity needs around affordable and reliable access for the various companies at and around the Port. Support for video surveillance and improved wireless communications were top of mind for GPA officials, so plan moving forward should include improvements around the port. Similarly, the airport voiced the need for increasing their surveillance capacity.

For example, all the cargo has unique identifiers, which the ports' terminal operating system uses to keep up with locations and movements. The GPA uses EDI (electronic data interchange) to update customers. The ports also do many file transfers for work orders, billing, etc. The ports have infrastructure in container field for sending and receiving work instructions, including hundreds of wireless devices that connect via a mesh network.

Redundancy, reliability, and uptime are very important to the Authority. It would like for providers to have their facilities underground. The Authority had trouble with the wireless mesh network at first but the vendor stepped up and got it to work. It had so many subscriber devices in a limited area that it choked. The ports also have a narrow band network for internal, on-premises radio communications. The Authority is close to establishing a hot site data center in Dublin, GA, for disaster recovery via Level 3. It also uses Windstream and AT&T. The Authority has used Comcast in the past, and has talked with Hargray, but has nothing with Seimitsu.

2.5.2   Education

The Savannah-Chatham County Public School System (SCCPSS) has approximately 38,000 students over 30,000 devices. It serves students across Chatham County, as well as in the City of Savannah. Fifty-one schools, including Montessori schools in the county, are part of school system. There are eight municipalities in Chatham County, with lots of unincorporated areas. Some schools sit in multiple jurisdictions. For example, Godley Station is in the city but New Hampstead and Thunderbolt City are not.

The school system wants students to have internet services for non-school hours, especially for low income children and families. Low income neighborhoods have limited resources, residents have limited choices at affordable cost, and there's a line for computers at the public library, so SCCPSS is looking at other options. One is to use the city's network infrastructure to provide access at community centers and similar locations, which might require putting in school system WAPs. The system is also considering providing Wi-Fi outside the schools for the students' access at night. The schools allow the city devices such as on police surveillance cameras the systems' network. A key issue for the schools is providing secure access to students, and assuring that school system bandwidth and other resources are only used for educational purposes. Public safety is also an important concern.

All the schools we spoke with are moving to a variant on the one laptop or one tablet per child model, with many able to take devices home. When outside the school, many students and educators use online collaborative tools, such as Google Classroom to access lesson plans, collaborate with fellow students and post completed assignments.

The common concern among all school leaders we spoke with in Savannah is the topic of connectivity in the home. With the age of digital textbooks and online testing upon us, school administrators worry about how to reach rural and remote households where connectivity is limited, just as they're concerned with how to adapt the changing curriculum for homes that can't afford broadband access.

The FCC E-Rate Program

For the most part, the internet connectivity needs of county schools appear to be doing well. The school systems we spoke with have gigabit fiber connections to central offices and many have fiber between school sites, while a few have connections to their outlying schools in the 100-500 Mbps range. The system has 1 or 10 Gbps connections from every school to system headquarters. The state pays for 5 Gbps internet connection and the system has a separate 1 Gbps connection.

E-Rate is the commonly used name for the Universal Service Program for Schools and Libraries, which is administered by the Federal Communications Commission (FCC). The program provides federally-subsidized discounts to help schools and libraries obtain affordable telecommunications and internet access. It is the federal government's largest educational technology program.

The E-Rate program is one of four federal programs funded through the Universal Service Fund fees that are charged to telecommunications companies that provide interstate services, which is passed on to consumers on their telecommunications bills. Since all households that subscribe to services pay into the Universal Service Fund, it is important that communities maximize their participation in the E-Rate program to help recoup the investment made by their residents that pay into the fund.

PeachNet is E-Rate provider. E-rate pays 76% of internet access costs. The system's goal has been 3-1 ratio of modern technology, and it is starting 1-1 initiatives even though they are not fully funded. The STEM school has 1:1 on take home iPads, and by 2020 the district will provide 1:1 take-home laptops. This involves asking teachers to change how they teach, how do students do group work, etc. It also requires the system to look at how to provide 24/7 connectivity to students.

Students have access to Internet Essentials program via Comcast,[20] if they are eligible for free & reduced lunch and have good credit standing the company. AT&T told the schools it has a plan but had not shared information about that program as this report was being

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[20] For more information see https://www.internetessentials.com

developed.[21] The system recently did a survey of Savannah High School students for Sprint program to provide access.[22] It found that 293 had high-speed at home, 100 didn't, and 80% had cell phone with internet access. To participate in the Sprint program, a student must be in grades 9 through 12 and low-income.

In addition to the bandwidth, there's the device: if they can't afford the bandwidth they can't afford the device. The device depends on what students want to do. The schools have a few take-home programs because the community provides SPLOST funding for technology, which the system uses along with e-Rate and other funds. The system had heavy investment in portable technology and wireless access. But SCCPSS has limited resources to support individuals who have no computer, no internet, and no personal support. The schools just don't get the opportunity to provide advice about these programs to students. The schools do digital literacy event every year to publicize these options, and has given information on these programs to media specialists. Savannah Graduates, a non-profit working to increase secondary graduation rates, also concerned with students' technology access, as well providing coaching, counselors, and mentoring and working with families of students. The organization has counsellors in 3 high schools who are using the schools' tech, and its goal is to be in all the area high schools.

2.5.3 Colleges

SCAD has been on a strong growth curve, outpacing economy and other private universities. It is anticipating 10,000 students in Savannah. Everything SCAD does is surrounded in technology. It recently transitioned to a very responsive e-learning environment, including all classes. The college is pushing connections in the way it is teaching. Content is getting richer and richer. It has scaled-back video-conferencing in favor of web conferencing on smartphones. Admissions advisers, for example, are using 15-20 Gbps for conferencing and emailing large files. Every day the college has 15,000 to 20,000 devices on its network.

The college has about 70 buildings and is very spread out—only 20 or so buildings are in the college's core area. Its buildings are connected via with aerial fiber between them and a pipeline back into Atlanta, where its second campus is located. It moved a lot of disaster recovery facilities and other IT infrastructure to Atlanta. SCAD contracted to have its fiber installed. The college lost two fibers during hurricane Matthew in 2016, only one of which was broken. It has worked with county, schools, and city on attempts to provide connectivity in Savannah's squares. SCAD has multiple 10 Gbps internet connections.

SCAD has off-loaded some of student traffic by moving them off the college's core network. Students rely on their data connections, and expect premium service no matter where they are. In 3 to 5 years SCAD will easily be at 40 Gbps for students, not business. Whatever you give them they'll max them out, with team gaming online platforms for example. SCAD provisioned its guest network as totally separate network, also, to avoid overuse by students.

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[21] *This is likely AT&T's "Access" program. For more information see https://www.att.com/shop/internet/access*
[22] *For more information see http://goodworks.sprint.com/1millionproject*

It is hard to get direct ROI on connectivity because it is an amenity. Yet, the SCAD CIO has Century Link DSL at home that is 3 Mbps, and can't get them to run fiber down the street.

Armstrong State University has 7,000 students, undergraduate and masters' programs. 70% of its students are local, but a lot are from Atlanta and many use the eClassroom.[23] There are 1800 students on campus, with about 5 devices per student. There is a move in GA to privatize student housing data and video services via Apogee,[24] which is included in fees. The university uses PeachNet as its primary ISP, especially for business systems. It has a Level 3 (which is being acquired by Century Link) 300 Mbps secondary connection and, has Hargray for backup/tertiary connectivity. Armstrong State University has a big dark fiber ring on campus, so can connect to any of on-network resource from anywhere on campus. The campus has Wi-Fi everywhere. The university is looking at possibility of a 10 Gbps connection. It anticipates more student bandwidth needs in 3 to 5 years—the students are going to find more and more ways to use more and more bandwidth—and foresees a need for 40 Gbps.

The university mostly needs redundancy, especially with everything moving to the cloud. The university does not have redundancy because it is located on south side of city, close to I-95 and several rivers, so physical routes are a challenge. Armstrong may have a hybrid data center in the near future, with some in the cloud and some onsite, and a dedicated circuit from Hargray to its Liberty Center site in Hinesville. In January of 2017, the University System of Georgia Board of Regents voted to consolidate Armstrong State University and Georgia Southern University, which is in Statesboro, Georgia. The consolidation will undoubtedly impact the university's network infrastructure and likely increase the importance of redundant connections to the Savannah campus.

Savannah Technical College has approximately 3,500 students at four campuses: the main one on White Bluff in Savannah; another near Pooler (in city of Savannah), one in Hinesville, and one in Rincon in Effingham County. Internet service is a small part of the college's WAN, which operates over a Metro-Ethernet MPLS network provided by Windstream, under contract until 2020. It is not getting any e-Rate funding. Savannah Tech has had VoIP for eight years, and anticipates that it will soon need to upgrade telephone equipment for video to the desktop. College personnel regularly do meetings online. As they plan for technology, the college's IT personnel must look at enrollment. They are going to have to get some type of "real" video conferencing from the classroom to other campuses because funding, personnel, and systems will to go where the enrollment is. Redundancy is also an issue. If the college loses connectivity it loses access to cloud applications, particularly Office 365. The college is moving toward a "blendplex" classroom, which means student access to broadband would be huge because it will require 24/7 use access. The college would like to separate its student traffic from business systems. On Saturday, when students are not on campus, the network's performance is excellent.

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[23] Provided by D2L (Desire to Learn), https://www.d2l.com
[24] https://www.apogee.us

Savannah State University, which is located on the east side of Savannah, has about 5,000 students and about 800 faculty and staff. The university has a 1 Gpbs internet access and backbone connection via PeachNet. The campus totally wireless, which was recently upgraded, and VoIP for telephone services. The university has a laptop loaner program that provides virtual desktop access to web and special applications (MS Office, SPSS, etc.). Approximately 60% of its IT services are in the cloud. The network was tested by hurricane Matthew. When the power came up after 2.5 days it was reasonably easy to bring it all back up. Savannah State has separate faculty and student (residential) networks. It does not pay for academic internet services, but pay about $4,000 year for student access. There are some 700 surveillance cameras around campus. Its operating funds come from state. The university received a title 3 IT grant to revitalize its Banner enrollment system, some one-time funding from USGs for things outside budget, and a $250,000 grant for software from Marshall Foundation. The university is providing online courses via the University System of Georgia's Desire2Learn learning management system (LMS). It is increasing online offerings, especially after losing 6 days to the hurricane, adding materials for classwork in the LMS.

2.5.4 Healthcare and Social Services

Broadband is expected to transform healthcare, simultaneously enabling better outcomes and lowering costs, both on the internal operations of the healthcare practice, and on the patient care side through telehealth. The National Broadband Plan says that Electronic Health Records and Remote Monitoring technology could alone save over $700B over 15-25 years.[25] Beyond the cost aspects, using telehealth is a viable way to revolutionize patient care.

The American Medical Association (AMA) believes that the appropriate use of telehealth applications to deliver care to patients could greatly improve access and quality of care while maintaining patient safety. In 2014, the AMA created guiding principles[26] for ensuring the appropriate coverage of telehealth services that state:

- Telehealth provided over robust broadband networks can facilitate immediate diagnoses and care to prevent lasting damage to stroke victims, prevent premature births, and deliver psychiatric treatment for patients in underserved rural areas.
- Telehealth is viewed as a cost-effective alternative to the more traditional face-to-face consultations or examinations between provider and patient.
- Similar to regular small businesses, rural clinics and small physician offices have the same price sensitivity to broadband, which is often priced beyond their means or altogether insufficient to support their health IT needs.

For patients, remote access to healthcare providers offers major advantages over traditional methods of delivery. Obviously, broadband connectivity to the patient's home is the enabler of all telehealth benefits. At the top of this list is making certain types of care more

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[25] http://www.broadband.gov/issues/healthcare.html
[26] https://download.ama-assn.org/resources/doc/hod/x-pub/a14-cms-report-7.pdf

accessible for those who struggle to get to distant medical facilities, which are precisely the demographic that commercial service providers neglect – the elderly and the poor.

While not a substitute for in-person visits, telehealth can provide face-to-face care and improve a patient's understanding of his or her own health. Broadband is crucial for healthcare providers as they begin to leverage electronic medical records and other important capabilities of telehealth and the electronic exchange of health care information.

The Healthcare Information and Management Systems Society (HIMSS) recently published a study[27] of the telemedicine industry and the use of the technology by healthcare organizations. The research found that 57.7% of healthcare organizations in the U.S. have adopted some form of Telehealth, and that most of those organizations use more than one type of technology.

Bandwidth needs of healthcare providers in Chatham County are guaranteed to continue growing, and connected devices are incorporated all the time. The FCC's Connect2Health program considers ways to accelerate the adoption of healthcare technologies by leveraging broadband. The FCC envisions that future healthcare systems will use broadband-based tools to allow clinicians, pharmacies, and health and social service providers to collaboratively optimize health outcomes – all in an interconnected healthcare ecosystem.

The Georgia Coastal Health District covers eight county health departments, with administrative offices in Brunswick and Savannah. The district has two general clinics in Savannah, one of which is closed for renovation, and operates the largest HIV care center outside Atlanta, which is currently involved in 12 clinical trials. It had been on a Georgia Technology Authority circuit[28] that just wasn't enough. It switched over to an ISP (Comcast), which has been better. The district lost that connection during hurricane Matthew, which made it difficult for staff to respond to the emergency. The district has Wi-Fi internally, uses laptops in the field for inspections, and everyone connects via VPN. The district uses online interpretation software, distance learning/training, and intra-office conferencing, and all its phones are all interconnected. The district is launching an online nutrition education with laptops and kiosks, and it is putting COWs (computers on wheels) in clinics. Telehealth programs in the district's clinics identify children who may have syndromes that need additional treatment. They are typically done in conjunction with doctor or mid-level, and it is unclear what kind of connections they're using. The district is getting closer to having an internal EHR. The current patient information system is proprietary, which has made it difficult to move toward a state-wide standard. The district has one IT person and regional director in Brunswick, an IT person in Savannah, and is relocating its servers.

Chatham County Safety Net Planning Council (Safety Net) is a county-wide planning body working to strengthen the health care infrastructure for primary care and improve access to health care. Their offices are in the Coastal Health District public health offices, which

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[27] http://www.bna.com/telemedicine-market-nearly-n57982063688
[28] Provided by AT&T under master services agreement with the State of Georgia.

includes internet access. Safety Net spent a lot of money to build its own health information exchange (HIE). Nobody was using that version Health Link, and it didn't seem to the right strategic direction, so Safety Net joined with GRACIE.[29] GRACIE operates out of Sandersville, Cerner manages platform, is housed at a remote data center, and provides hot-site and remote access for emergencies. One of the strategic reasons was because Savannah is in hurricane zone. The partnership allowed Health Link to save 2/3 of cost. It was supposed to be online by 2015 but took longer than expected due to vendor interface and coordination with partners. Health Link now has Chatham Care, Ryan White HIV clinic, Gateway Behavioral Health, and Memorial Hospitals on it, and is providing portal access at the county jail. St. Joe pulled out but could come back in, and other providers are joining GRACIE independently. Utilization is up because Memorial has incorporated Health Link into their admission process, which encourages others to download and close records.

Safety Net has an internal technical expert reached out to find best practices for integrating the HIE process into treatment protocols. There are some connectivity concerns at the jail and for small practices, particularly during upgrades. Better connectivity would help healthcare provider organizations, especially smaller practices, connect with GRACIE, and it would help patients access portals provided by doctors via their EHR vendor. Safety Net goes out into community to enroll people in Medicaid and health insurance programs, which would really benefit from universal high speed access. Today, Safety Net meets with clients everywhere using cellular data hot spots which are slow.

The Savannah Business Group (SBG) is an association of employers with self-funded healthcare that represents about 15% of the commercial sector. Its representative sees a lot of connectivity needs. He noted that Savannah doesn't have any integrated health systems. There are two medical centers but most of the practices are independent. A lot of people start in more rural hospitals and come to Savannah. Patient records should ideally be transmitted while the patient is in-transit. It's not just a matter of having the bandwidth. If the devices are outdated, it doesn't matter. There may be a fiber-optic line outside a medical office, but if it's copper into the office providers can't tap the bandwidth of the fiber. SBG members have had problems with the registries because people enter duplicate or incorrect data, so there has been talk about community-wide master patient index. The HIE could reduce a lot of costs.

SBG is concerned that software for portals has been sloppy, especially the security steps. There is still a lot of fear among people about their information. HIPPA has been amended to make 3rd parties more accountable for data. Employers and hospitals are going to want to do big data stuff but the data is scattered all around. The drug seeker is an example of people who don't want the data integrated. HealthLink has done a lot to get physicians online, and it is proud of EHR penetration. SBG sees issues with lack of a patient portal, very low use of personal health records, and need to add in imaging and labs.

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[29] For more information see http://grachie.org

Online education and telehealth are important, according to SBG, because a lot of people who commute into Savannah during the day don't have access to healthcare near home. Some of the highest hospital readmission rates are related to rural locations and conditions such as congestive heart disease, which can now be monitored remotely. The state medical board recently changed the rules for physicians on telehealth. It should be video and physician is required to have a relationship with the patient. Medicare, Medicaid, and state are all accepting telemedicine as primary care. Hospitals have put kiosks at some major employer locations, and employees get a discount for logging in and getting a health assessment.

Healthy Savannah focuses on wellness but also looks at population health. Education is one of the big equalizers of health, so Healthy Savannah is concerned about connectivity and access to healthcare. The areas with the highest incidence of diabetes, heart failure, etc., don't have the connectivity. Connectivity and health are functions of income. Savannah leaders need to think about the social determinants of poverty and how to address those. How do we create a safer environment for children to grow up in? Unless the community addresses the safety issues, Healthy Savannah maintained, citizens are not going to get healthier. Violence and trauma are big issues, along with behavioral health and mental health. Youth crime has been rampant. Suicide attempts have greatly increased along with social media (dues to sense of inadequacy as well as cyber-bullying). Think about a single mother raising two or three kids, they don't have good ways to deal with these issues. Healthy Savannah has been working on matrix/clearinghouse of youth services and multi-agency center like family justice center model, and it has a grant from the Annie E. Casey Foundation to look at different approaches.

St. Joe's two hospitals are interconnected via Hargray Metro-Ethernet, and it has Metro-Ethernet in Garden City from Comcast. It also has wireless between the two hospitals but that is not adequate even for backup connections. Most of St. Joe's offices are connected via Comcast Business broadband. St. Joe doesn't do much telehealth but it has a stroke network that connects to smaller hospitals for observation and treatment. Its home health network is expanding to make sure people take medicine and eat, and to reduce re-admission. St. Joe is enlisting physicians to be part of organizations, so expects to see more offices. St. Joe would love to have fiber to every location. It would help tremendously, to distribute telephone calls as well as data. St. Joe provides open Wi-Fi for guest network. The organization limits Wi-Fi use, but the Wi-Fi is saturated and slow. All patients get quality surveys and St. Joe's reimbursement is based on those responses, so the organization wants patients to good experience on everything, including Wi-Fi.

2.5.5 Government and Public Services

Fiber-optic networks provide a public infrastructure that can be used for an assortment of public benefits, including enhanced municipal management and service offerings, as well as new e-government applications that encourage interdepartmental collaboration and efficiencies through infrastructure sharing. In addition, the fiber network provides a platform

for long-term adoption and smart community innovation, ranging from applications for energy management to enabling a community-scale platform for the Internet of Things.

As we look to the future, county governments and public sector service providers must operate more as a business. Each need access to information and communications to do their jobs and serve the needs of the public as efficiently and effectively as possible. These organizations need broadband networks that let them share streaming real-time video, detailed maps and blueprints, high resolution photographs, and other files. Mobile technology capable of sending and receiving bandwidth-intensive information can help all local departments, specifically coordinating the central roles of police, fire, and emergency medical services during emergency response.

During the stakeholder engagement process, we spoke with several local and county government leaders, both elected and appointed, as well as departmental administrators and staff, and people who both work in an office setting and those who work in the field, either as public responders or as staff at various public facilities.

The Live Oak Public Libraries cover a lot of area, from rural inland communities all the way to the ocean. The libraries are partners with education, are into businesses, and do outreach and community development. The libraries like to say they serve everyone, but that's difficult with the current connectivity. The big issues are access and speed. Librarians must work around the speed slowing down in the morning. People have better access when they're walking in the Jackson Park in the morning that they do at the library. Then about 3:00 or 4:00 in the afternoon everything slows down again. Patrons expect it to be immediate and up to speed. There's a lot of variation branch to branch.

The libraries are reducing the number of PCs because a lot of patrons are bringing their own devices. This is going to open lots of space, but what does that mean for library services? The libraries are checking out e-books and Jetpack cellular-to-Wi-Fi routers, and have provided training to older population. The libraries would also like to have seamless Wi-Fi systems, and are concerned about the connectivity in low-lying coastal areas.

Purpose of existing city fiber is for emergency management services and other city needs, and then free for residents. The city has been under tremendous pressure to deploy public safety cameras around the community. There is more and more demand for devices in the field to access large data bases. The city is installing conduit and other facilities along Broughton, Bay, and possibly River streets, working with Verizon, Seimitsu, and Georgia Department of Transportation. The city's data center is moving out of the Civic Center to an existing category-5 hurricane rated facility in Garden City. Fiber could be routed from DOT fiber in I-16/516 corridor or along Chatham Pkwy to Louisville Rd., then north along Dean Forest Rd, behind the airport, to Robert B. Miller Rd.

2.5.6 Economic and Community Development

Overall, Chatham County faces similar community and economic development challenges as other counties: maintain attractive and viable neighborhoods, retain existing companies, attract new companies, and create more jobs. Coastal Georgia's low taxes, natural beauty and particularly its central eastern U.S. location boosts the state's image not only for blossoming businesses, but also for empty nesters and recent retirees looking for a change of scenery.

Community institutions such as chambers of commerce, community centers, churches, environmental-focused and social services organizations all help support the people in the community and connect them to services. These organizations are typically stationed on the front lines in the community to assess and respond as necessary to fill gaps in services, to address immediate and urgent needs, and to investigate opportunities to solve persistent community problems.

Broadband clearly plays a vital role in helping social organizations fulfill their missions. Whether as simple as a community church streaming their weekly service or the local chamber of commerce sharing news of their latest event through their website and email, communicating local information is central to the mission of community organizations. Broadband equips these organizations with the tools necessary to ensure they operate efficiently, helping to organize and enable often-volunteer staff of budget-conscious organizations to be successful in the delivery of their important roles in the community.

While providers say, "we already have that capability" economic development professionals are not sure the area is competitive on cost. "We have to have access and not just one provider," noted one, "we need to have diversity." Dark fiber is becoming an issue. A couple of manufacturing prospects have recently asked about dark fiber. Many of the companies that local economic developers are recruiting come from major markets, and they want to know about such assets. "We have to have that kind of stuff or we're not even in the game," economic developers worry. They feel all the local stakeholders need to understand what dark fiber is and why it's important, but they have no idea of the current capabilities, and most don't know what it even means. Providers may say they already offer it but if citizens don't know about it there's a critical disconnect.

Large benefits could result for citizens from improving government/provider partnerships. An ideal plan for the city would consider several approaches, a range of technologies, and connectivity in "third spaces" such as community centers, libraries and parks. Competition is good when it drives choices and quality up while driving prices down. Cooperative, limited access, and open access approaches could do this, too.

While some leaders wonder if fiber is feasibility for everyone in Chatham County, the general sentiment seems to be, "Don't just do this for the tourists, do this where people live!" The move from digital consumer to digital producer is creating new opportunities. It is important to prepare for this as the infrastructure is upgraded by nurturing that area's burgeoning creative center. It was suggested that the network could be built from the residential areas

then into the city, and that sidewalks can be installed as fiber goes through. This could provide critical support for other initiative such as entrepreneurship programs to get people off social welfare programs. The underlying fact is that many Chatham County-area stakeholders see a need for abundant, ubiquitous broadband and are looking for practical ways to move toward that vision.

An accounting company on Island Expressway has Windstream fiber for primary and Comcast for secondary. They have been reasonably good service. AT&T has installed fiber in the building and is providing service to some tenants. The accounting company would love to have a 1 Gbps connection but hates to think how much it would cost. The company moved its production servers out of Savannah to a hosted location. It now needs to connect locations in Miami and Norcross with the data center for remote desktop and system management. The company is moving its telephone services to Skype. It had video conferencing but it was just people watching people. Quality of service is important with Skype, and video just comes with it. The company anticipates using the desktop sharing more than video calling. More and more access needed in homes because the company tries to be as flexible as possible for employees. Some employees have had issues with Comcast being slow to get service back up, specifically on Wilmington Island, and have no choices. The company's teams of auditors go out to different clients that don't have the greatest connectivity. Connectivity to the company's servers from outside the office is important.

A consulting and professional company on Chatham Parkway is one of three offices, including Atlanta and Charleston. Comcast unwilling to provide service without major cost, yet it provides service nearby. The company is going to be more distributed. Its primary headquarters are in Savannah but has people working out of homes and small offices across the nation. The company needs connections to homes and redundant connections. It would love to be able to offer all employees the option to work remotely. Everyone would need to have the same experience no matter where they are, mostly for access to cloud, and maybe telepresence for collaboration in Atlanta. The company sees a trend to push everything onto the network via cloud services. Once it's on the network the next step is out the perimeter. It's all about the content, experience, and collaboration. For example, building drawings are going away, and that information is moving to 3D models.

Savannah/Hilton Head International Airport

The airport is a key geographic point in any community-based fiber-optic infrastructure in the City of Savannah and Chatham County. The city's fiber network will follow a route adjacent to the airport, and private providers are eager to reach businesses in the area.

The airport is somewhat of an island. The airport recently got connectivity from Hargray because the company installed facilities to do business with Gulf Stream. The airport has Sprint as a secondary provider, but both connections come through the same cable. The airport has two 100 Mbps connections that can be upgraded to 2 Gbps without upgrading equipment, although the service fee would increase.

The airport has critical needs for improved surveillance, and there is potential demand around the airport, with additional applications possible. Public safety, police, fire, all fit into this picture. The airport's public Wi-Fi, which is important to customers, is currently getting 24 Mbps. There is a possibility to do more with the Wi-Fi. The airport will run more fiber internally for surveillance. The Federal government requires cameras around the airport's perimeter, so a fiber ring to connect them might be desirable. Traffic is an issue, too, especially at 5pm when Gulf Stream lets out.

2.5.7   The Internet of Things and Smart Communities

In planning for the fiber future of Chatham County, the network is becoming a foundation of countless applications being developed to increase efficiency, lower cost, reduce environmental impact, and enhance quality of life through connected devices. As better connectivity evolves through Chatham County it will give rise to the notion of "Smart Homes" and "Smart Communities."

All Smart Community applications fall into the broader concept of the "Internet of Things," which is the notion of smart and connected devices all working to make our lives more efficient and convenient. Smart Communities are more efficient at responding to local and national challenges, and can position themselves to be more resourceful and successful than other communities that do not leverage these smarter technologies.

As Chatham County expands its online services, applications migrated to a local network enjoy greater availability and increased bandwidths over what has traditionally been available, which creates a more effective and efficient municipal organization. High-speed, reliable broadband enables organizations to:

- Ensure better emergency preparedness
- Provide more information to residents, businesses and customers
- Provide enhancements to public safety
- Better serve the local community

- Respond quickly to the needs of the community
- Enable better interaction with citizens and businesses
- Improve operational efficiencies
- Reduce direct and indirect costs

To illustrate the excitement around smart home and smart community innovation, in 2015, there were 174 million Smart Homes, and that number doubled to 339 million in 2016. Consumer applications fueling the growth of smart homes are the lowering costs of smart TVs, smart bulbs and automation tools such as smart thermostats, home security systems and appliances that are working their way out of the home and into workplaces and public spaces. Overall, the total number of connected "things" inside and outside the home is expected to hit 1.6 billion this year, up from 1.2 billion in 2015.[30]

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[30] *http://www.gartner.com/newsroom/id/3175418*

The Internet of Things

The relatively new concept of the "Internet of Things" refers to the networking of physical objects using embedded sensors and other connected devices that collect or transmit information about a given object or device. Examples in the consumer market include smart watches, fitness bands, and home-security systems. Examples in the business market include sensor-embedded production equipment and shipping and storage containers, like radio-frequency identification tags for inventory tracking and fleet monitoring.

In public-sector environments, the Internet of Things (IoT) has exploded with perhaps more devices and applications than other sectors to drive efficiencies and citizen services. Sensors enable the optimization of vehicle parking availability and traffic flow, environmental sensors help better manage rainwater runoff or detect subtle changes to air quality, utilities can manage peak energy load balancing and usage through smart infrastructure applications and can detect leakages or contaminations to water supplies.

A multitude of citizen engagement applications drive the promise of the Smart City and Smart Communities movement through the marriage of consumer and industrial Internet of Things technologies. All such devices scattered by the hundreds, if not thousands, throughout a community are networked seamlessly through computer systems and generate an enormous amount of data. While IoT can ease commute pains for individuals, for example, the macro cost savings will be tremendous for a municipal government.

To be clear, most IoT applications often aren't eye-popping, world-changing ideas or innovations. In fact, most of them are pretty simple and pretty boring for those people not involved with the day-to-day needs of small business. Whether that's accurately knowing how much water is available in a well, or measuring temperature fluctuations in a greenhouse, the type of data that a network of sensors can generate helps small businesses make better decisions. That, in turn, translates into sustainable, real-world savings.

Individually, these savings might only be measured in the hundreds of dollars, such as to help fishermen avoid paying someone to monitor their catch or to help nurseries generate an extra crop over the course of a season. Collectively, however, given that 89% of all US businesses have fewer than 20 employees, even the several hundred-dollar savings can make a meaningful difference. In an era when many are concerned with technology replacing jobs, many of these simple IoT applications could help small businesses increase working capital through better efficiency. It's a classic case of working smarter and not harder.

Scaling county-level economic impacts to the state level and then to a national level could be staggering. Gartner Research believes IoT will support total spending of $235 billion in the U.S. in 2016, an increase of 22% from 2015.[31] Looking at the global scale, according to a McKinsey Global Institute report, the opportunities created by IoT may have collective benefits of as much as $11 trillion per year by 2025 across multiple sectors.[32]

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[31] www.gartner.com/newsroom/id/3165317
[32] www.mckinsey.com/insights/preparing_it_systems_and_organizations_for_the_internet_of_things

Clearly, the Internet of Things is gaining steam. Communities must equip their IT architecture to capitalize on this connectivity to create new sources of value for residents and enjoy sustainable financial and operational benefits. Community-owned fiber can provide a public infrastructure that can be used for public benefits, including enhanced municipal utilities, new e-government applications, technology collaboration and infrastructure sharing programs. In addition, a community-owned network provides a platform for long-term innovation of IoT Smart Community technologies and applications.

What makes the opportunities around the Internet of Things so significant is that it encompasses so many different aspects of improving lives overall, including resource management for water and power; road management for safety and congestion relief; higher quality public healthcare; and better communications between cities and their citizens to enable greater efficiencies. Examples today include traffic control networks, energy systems, street lighting, and more, with more innovation coming. By actively monitoring these systems in real time, the region can adjust delivery of services to meet the needs of the community while reducing costs.

Enabling Smart Communities

As communities invest in fiber infrastructure, they are provided the baseline infrastructure required to support a multitude of technology-based initiatives that require connectivity. These initiatives can include broadband services, collaboration opportunities, public safety applications and energy and utility management functions and features.

Broadband Services

- Common internet backbone for all anchors
- City and County
- Schools and libraries
- Hospitals and clinics
- Public Safety
- Community Support
- Interconnection with service providers
- Wi-Fi in public centers
- Internet of Things

IT Collaboration

- E-Government applications
- Bulk internet purchasing
- Application sharing
- Disaster recovery
- EOC communications

Public Safety Applications

- Video monitoring
- First responder support
- Collaboration with state and federal agencies
- FirstNet preparedness
- Internet of Things

Future Energy and Utility Management

- Smart Grid and Demand Response
- Automated Meter Reading
- Advanced Metering Infrastructure
- SCADA communications and control
- Internet of Things

3. CHATHAM COUNTY FIBER OPPORTUNITIES ASSESSMENT

Many years could pass before the decision to invest in Chatham County is made by corporate telecommunications executives in headquarter cities of Dallas and Philadelphia. To build fiber through any community with the population density, like most of Chatham County, is a difficult financial decision for outside internet providers.

As any business decision, the investment requires a financial return within a relatively quick time frame. It isn't that these telecom and internet corporations don't care about Chatham County, the decision to invest is simply a financial decision. For companies with a national presence, they are more interested in considering investments in populated and growing markets, and Chatham County may not fit that criteria as much as say, the growing suburbs of Austin or Atlanta.

The opportunity for Chatham County lies in the fact that the mission of the County is different than any competitive internet service provider that would serve the area. County and local governments are built to shoulder infrastructure debt and can handle longer debt horizons. Likewise, the financial return on investment expectation is lower for a county or local government than demanded of a corporate provider.

The chapter begins with a cursory look at the regulatory environment that defines the county's involvement with fiber and the delivery of broadband services. With the allowable roles of Georgia county governments better defined as related to the delivery of broadband services, the chapter looks at some of the many benefits that would resonate in the county with greater availability and utilization of broadband. The chapter closes with a summation of the county needs assessment that shapes the direction of the conceptual network design and the balance of the report.

3.1   Broadband Policy Issues in Chatham County

Chatham County has multiple options for promoting and providing, as well as using fiber-optic broadband services. The Georgia Telecommunications and Competition Development Act of 1995[33] opened the market to a broad swatch of the public sector with its definition of a "telecommunications company" as:

> **"…any person, firm, partnership, corporation, association, or municipal, city, or local governmental entity offering telecommunications services to the public for hire."**

In Georgia, a public authority is an instrument of the government chartered by government action for a particular purpose. A local government authority in Georgia must be registered with the Georgia Department of Community Affairs. Authorities are given special powers and exemptions—ability to issue bonds and exemption from state and local taxes, for example—

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[33] *http://www.legis.ga.gov/legislation/archives/19951996/leg/fulltext/sb137.htm*

for purposes including public infrastructure, institutional facilities, industrial recruitment, property redevelopment, and area revitalization.

An authority's purpose, powers, jurisdiction, and independence (its relationship to local government) are set in its charter. Certain types of authority can be created by general enabling act. Local law can be used to establish an authority with purpose outside those types (a network or technology authority, for example). There is at least one public authority in Georgia that was created for the purpose of increasing the availability of broadband and other technology, the South Georgia Regional Technology Authority, a 7-county, independent multi-jurisdiction authority headquartered in Arlington, Georgia.

The U.S. Congress reformed national telecommunications regulations the next year, but did nothing to impact the role of local governments. Other states have since moved to restrict local governments' role in telecom, but not Georgia. Generally, the State of Georgia has reduced telecommunications regulations. While the state Public Service Commission regulates local telephone service and telecommunications companies—such companies are required to register with the PSC—it does not regulate broadband.

Today, over 20 cities and local utilities are certified to provide telecommunications services in Georgia. A recent report by a Georgia legislature study committee called for "continuing to permit locally-owned and operated government broadband services," as well as programs to promote and support broadband development.

The only issue to be avoided is cross-subsidization. The County should maintain fully separate financing and operations for any broadband endeavor, and fully impute all costs and expenses to any County broadband entity to avoid legal liabilities. This effectively means that if the County were to provide broadband services, it would need to establish a separate County-owned and operated entity to do so.

There are numerous other roles that Chatham County might play in broadband. Generally, the county can leverage its purchasing power to extract provider concessions, or pursue policies that reduce providers' capital and operating expenses. While these roles are not mutually exclusive, the former puts the county squarely in the role of a consumer whereas the latter focuses on the county's role as an asset owner. To simplify, the County can either buy telecom services or it can build telecom infrastructure, and the County's role potential role will change based on how much it builds verses how much it buys.

3.2   Uncertainties in the Local Broadband Market

Through analysis of the available broadband infrastructure in Chatham County and through discussions with the area's internet service providers, much of the city lacks the fiber distribution technology needed to deliver fiber to the premises (FTTP) services. Through the media releases and in discussions with local incumbent service providers, upgrades to current platforms are under consideration in select areas of the city. However, amid reports within the last year that AT&T and Comcast would upgrade services, there appears to be no signs of building out more fiber infrastructure other than dedicated service offerings.

Should a Chatham County resident or business owner want a fiber-optic connection today, in many cases the customer must negotiate a contract for dedicated services. This typically requires a costly custom-built connection from the provider's network to the customer premise. The cost of infrastructure is borne by the customer that requests the connection, along with a multi-year service contract.

Compounding this problem with its insufficient infrastructure, the incumbent providers are in a period of instability and uncertainty, as Verizon, Charter and AT&T are each in the middle of corporate mergers and potential divestiture of existing local infrastructure. The service area should assume a "shake out" period after the mergers and should not expect new investments or fiber deployments to be made for some time.

- AT&T has retired its U-Verse service to focus on newly acquired DirecTV, which could impact the many DSL subscribers in Chatham County. There is a trend from AT&T toward increased attention on mobile wireless and satellite and less on fiber networks.

- CenturyLink has announced plans to acquire Level 3. CenturyLink, unlike other traditional telecoms, has focused on rural areas, but Level 3's long haul and middle mile networks will complement CenturyLink's distribution network. It remains to be seen how or even if CenturyLink expands Level 3's presence and scope of services to southeastern Georgia communities.

- Charter has merged with Time Warner Cable and Bright House Networks. Once the merger transition is complete, Charter will service more than 23 million customers, rivaling Comcast as the number two cable operator in the U.S.

- Earthlink and Windstream are merging, which will impact mostly business customers.

- Google Fiber has recently replaced its CEO, retrenched, and "paused" deployment plans, which were limited to just a few major markets. The company is reconsidering its approach to targeting investment to areas with high pre-subscription, and looking at wireless technology for the "last 100 feet" to the subscriber premises.

- Verizon Wireless serves much of Georgia, yet is in the process of divesting its wireline business in the states of California, Florida and Texas, and the future is uncertain for its FiOS product in many markets.

- All incumbents have been lobbying the FCC and politicians to drop the requirement to offer certain services as part of being the incumbent. With the results of the recent presidential and congressional elections many experts believe that the incumbents will eventually be granted these request, leading to stranded customers.

Until these corporate transitions play out and decisions are made as to how these new entities intend to serve their markets, there is some uncertainty in the retail broadband markets of Chatham County and the Southeastern US. Of course, as soon as this round of

corporate moves wraps up, another set will be in the works. Communities and regions that don't want to have their social and economic fates determined by corporate decisions made by distant executives will likely need to invest in themselves to assure they have the next generation of infrastructure and broadband services.

3.3 Chatham County Fiber Infrastructure Benefits

While corporate internet service providers focus on financial returns, the returns for Chatham County go beyond direct financial payback. The "off balance sheet" benefits of improved connectivity are far reaching, and such returns for the county could be difficult to quantify, if measurable at all, with social and economic impacts felt by everyone.

3.3.1 Enhanced Community and Economic Development

Increasing the availability of fiber-based services will allow Chatham County to enhance its economic development message regarding broadband capabilities. Through the deployment of fiber, communities and business parks in the county can promote themselves as being a "Gigabit Community." Any business evaluating a move to Chatham County would recognize that fiber services are readily available and prevalent at very competitive rates. This fiber community network concept, partnered with data center facilities, would provide the message that a business can locate anywhere in Chatham County and have next-generation broadband availability as good as anywhere in the world.

3.3.2 Increased Broadband Adoption and Utilization

Broadband adoption is influenced by two key factors: relevancy and affordability. Chatham County can improve both affordability and relevancy by making measured investments in infrastructure. Affordability and adoption of broadband services are positively correlated – as affordability increases, so does adoption. The County can influence adoption by working with broadband service providers to provide "lifeline" internet services at low costs for low-income residents and targeted populations in exchange for discounted use of its broadband assets. These incentive programs can help service providers deploy more quickly and at lower costs in exchange for their participation in such lifeline programs.

3.3.3 Improved Public Efficiency and Effectiveness

Leveraging new fiber assets to connect public institutions throughout the county creates opportunities to establish collaborations across multiple organizations. Establishing access to the County's dark fiber network would create an inter-governmental backbone connecting schools, libraries, healthcare, public safety agencies and community organizations. Benefits include cost reductions through joint volume purchasing agreements, file and application sharing, reduction in duplication of effort, better efficiency in multi-departmental approval or permitting processes, and improvements to emergency response and communications.

3.3.4   Reduced Taxpayer Spend

Improving public efficiency and effectiveness would reduce the costs of government to the local taxpayer. Any Chatham County broadband initiative can become a tool that facilitates cost reductions, not only for the County itself but for other government and public agencies across the county and region, including schools, libraries and community organizations. The network can "future proof" the connectivity needs of these agencies and protect them from cost increases as they grow and require additional bandwidth. Plus, the money that residents and business save can be spent elsewhere in the county, on top of the monthly revenue for operating the network that will stay local, further churning local tax dollars, as opposed to being sent to the headquarters of AT&T in Dallas or to Comcast in Philadelphia.

3.3.5   Reduced Lead Times

Prospective new businesses are negatively impacted by lead-times that delay activation of new services. The time to activate new customer broadband services is determined by the availability of existing infrastructure in the area around the new customer. With the Chatham County having more fiber infrastructure throughout the county and closer to any potential new customer, this can be used to supplement broadband service provider infrastructure to reduce these lead times. Over time, the County would connect more and more of the county with fiber, eventually having connections to every business and industrial site.

3.3.6   Improved Reliability and Performance

Chatham County fiber assets can be used to support the reliability and performance of other broadband services across the county and the greater region. County assets can provide route diversity to the networks of existing broadband service providers and increase capacity in those existing routes. A County-owner fiber network would increase such capacity in areas that are approaching their limit by equipping wireless towers with fiber connectivity, with would increase the bandwidth and service levels available to mobile customers. Every person and organization in the county can also use these fiber assets to upgrade speed and connectivity between their facilities and add diversity for their primary connectivity.

3.4   Developing Recommendations for Chatham County

Building off the county research from the needs assessment and discussions with county leaders, the following themes have emerged as opportunities and motivation for Chatham County to move forward in consideration of potential investment in fiber infrastructure. Many of these items will shape the network design, as being important community "anchors" and assets to incorporate into the conceptual design the fiber network and into the business models. Other items are more organizational in purpose, providing insight into the leadership roles that the County could consider as it this fiber initiative forward.

3.4.1 Consider the Off-Balance Sheet Benefits

Chatham County should position this not as merely a "broadband initiative," but as a community-based platform for smart growth. The fiber infrastructure platform should be as much about attracting, developing, and retaining skilled workforce to enable business growth as it is about deploying ultra-fast networks for its households. Legitimate needs were expressed from the local stakeholders engaged in the meetings.

There is adequate workforce demand in the region, and there is abundant property suitable for high-density residential, therefore the area is ripe to experience rapid residential growth. The region must work to maintain a balanced tax base empowered by a technological infrastructure to cultivate a well-prepared digital workforce. Economic impacts of broadband are very real and measurable. While these impacts are off the balance sheet for the provider, they show up on the balance sheets of their customers and the communities they serve.

The Savannah-Chatham County Public School System (SCCPSS) expressed the need for internet services for non-school hours, especially for low-income families. The SCCPSS knows that neighborhoods have limited resources and residents have limited choices at an affordable cost, yet the school system believes they have valuable resources to support individuals but have trouble reaching them. Likewise, the Savannah Economic Development Authority (SEDA) understands they need to attract high-tech businesses, but also realize they can't realize those goals without fiber.

3.4.2 Explore State and Local Strategic Partnerships

During the needs assessment process, different perspectives were shared on partnering with local and outside entities. Exploring such strategic partnerships may end with the realization of what is both possible and impossible to pull together, just as it can identify partners that are flexible and open to creating collaborative solutions. More involved conversations with the larger businesses of Chatham County could help define a partnership framework.

Also indicated through the needs assessment process, county businesses show demand for additional bandwidth and connectivity and need for more technology skills. As often the case, there is a divide between the strategy and the technology in some organizations. Consequently, the demand comes in response to market and organizational change, and not necessarily from technology as a catalyst or enabler of change within the organization.

Typically, the strongest demand for connectivity comes from:

- Organizations with multiple locations in the county, including external partners and suppliers.
- The locations of where strategic leadership – the executives who are involved in business strategy - are physically and virtually located.
- Dynamic sectors, such as those organizations and industries that are changing rapidly or leadership that foresees inevitable change.
- Big picture thinkers with the inclusive vision for where their organization, sector, or community is going.

3.4.3 Collaborate and Build on Existing Efforts

The Coastal Region Metropolitan Planning Organization (CORE MPO), the transportation planning agency for the Savannah urbanized area, conducted a comprehensive regional traffic management study that was published in 2016.[34] The three primary goals of the study were to reduce congestion, enhance travel safety, and improve regional transportation system operations. The system is desired to support of special regional events and holidays as well as day-to-day operations, but especially to support evacuations and emergency route planning during severe weather events.

The plan calls for, among other items, the development of the Chatham County Intelligent Transportation System (ITS) and a Traffic Management Center (TMC) to be supported by a redundant regional fiber optic ring, as shown in Figure 48.

Figure 48: Advanced Traffic Management System fiber diagram
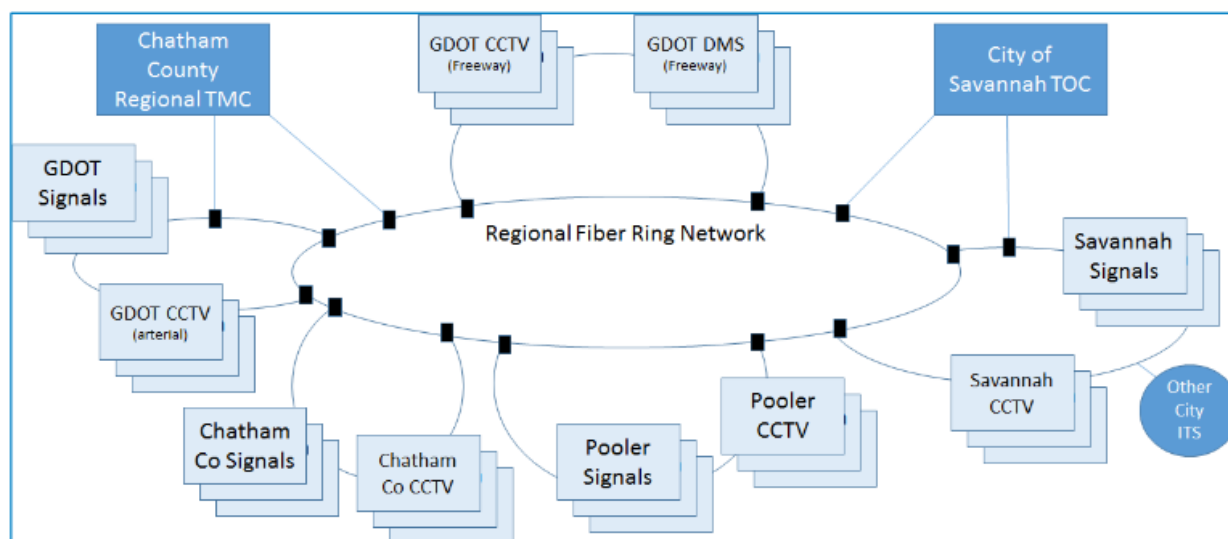
The ATMS study stopped short of providing indication of costs to deploy the fiber ring or identifying high-level routes for the fiber. Therefore, as the City and County consider this fiber-optic feasibility plan, it would be financially and operationally advantageous to also integrate the ATMS plan. The ATMS would become a key opportunity for cooperation to further meet the needs of the region through fiber-optics and networking technology.

Moving ahead with any collaborative effort, it would be beneficial to consider working through and establishing guiding principles for digital infrastructure investment in Chatham County. Here are a few key guiding principles that were envisioned through the various discussions with local stakeholders and officials:

- Enable governmental functions by reducing barriers to utilization and reducing costs for digital services and technologies.

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[34] *Coastal Region MPO website: http://www.thempc.org/Dept/Atms*

- Enable competitive offerings and innovation in telecommunications services by reducing barriers to market entry.
- Enable social good by providing access to relevant and meaningful information (education, health, workforce development, etc.) that cannot easily be used for social ills (crime, pornography, etc.).
- Support the attraction and development of technically skilled people and innovative consumer technology industries that support Chatham County's core economic drivers of tourism, distribution and logistics, and manufacturing.

3.4.4 Promote Broadband-Friendly Public Policies

Public policies are commonly used to increase the supply of broadband infrastructure that is available to serve a municipality or utility. It is important to encourage local governments, planning organizations and the developer community to adopt building and construction guidelines and techniques that help add to fiber infrastructure.

Most of the cost of deploying fiber is opening and closing the ground to bury conduit and fiber cables. Broadband-friendly policies encourage things like "Dig Once" practices that require the placement of conduit and fiber in the ground while it is open for any other purpose, placed alongside electric lines and water and sewer pipes as they are deployed.

A recent example of a step in the right direction, Savannah recently entered into an agreement with regional provider, Hargray, to cross a street in downtown. A Memorandum of Understanding was developed that deals with the sharing of underground conduit to allow Hargray to cross an intersection with fiber via conduit that was placed underground.

This cooperation was beneficial for both the public good and the service provider in that it saved time and money from opening the ground and restoring the paved surface, plus it kept a city street open that would have otherwise been closed for days. Such an arrangement could become a model that the City and County can use in future instances to help grow fiber throughout the city and county.

The City of Knoxville, TN for example, wants to have no role in the broadband whatsoever; therefore, it uses broadband-friendly public policies to make a more welcoming environment for the broadband market to compete in the city. Savannah and Chatham County can collaborate to develop open public policies that mirror each other in such a way that will encourage their departments to foster broadband growth through the city and county.

Policies can extend so far as to specify to land developers that conduit and fiber plans must be submitted along with permitting processes. Policies can also streamline the fiber permitting and deployment process and define the engineering standards so that providers know what to expect before entering the community. Through some of these broadband-friendly policies, within a short number of years, Chatham County could amass a significant amount of conduit and fiber-optic cable segments at a fraction of the cost.

3.4.5   Play a Role as a Redundant Provider

Many local organizations voiced concerns that because of lack of competition there was no viable backup connectivity when their primary provider fails. Because of the severe weather that Chatham County and the Georgia coast sees, the likelihood of network routes being impacted and going down are amplified. Discussions with large employers, enterprise manufacturers, and global importers and exporters revealed the strain on resources that happens in the wake of severe weather events. Enterprises described the additional provisions that must be factored in as a reality of doing business in Chatham County.

Corporate entities, fed up with dealing with the weather challenges and the hardships of recovery efforts, yet tied to the area because of port access or other entities, discussed plans to move data operations and staff to inland corporate locations and willing to pay steep costs to have their data center operations in regional cities like Atlanta or Charlotte. Fact of the matter is, all large enterprises understand the importance of diverse routes to connect their local facilities with corporate facilities outside the region, both to maintain operations and to provide off-site disaster recovery.

A Chatham County strategy that will insure continuity of its industrial base and to provide anchor tenants for any fiber initiative is to meet the network route diversity needs of its businesses community. Starting first as a redundancy provider, over time confidence of businesses can be built, and as redundancy customers fulfill contract obligations with their primary service provider, it could be possible for Chatham County to make gains as the primary service provider and slowly gain market share.

3.4.6   Provide Regional Data Transport and Fiber Leasing

For key industries and large employers with significant data needs, and component manufacturers with suppliers and vendors located around Chatham County and the southeast, leasing fiber to industrial tenants can be good for the business model for the business climate of Chatham County and coastal Georgia.

Dark fiber connections would either be leased directly by businesses needing to connect multiple local offices, or to connect a local office to a local data center where the business can purchase internet services and other content. In some cases, the government entity partners with broadband providers who market and sell their services to customers. The fiber network would become the "last mile" between a provider's local point of presence and the end customers.

Dark fiber is generally utilized by businesses and community anchors. In the most common case, dark fiber strands are leased using mileage-based pricing. Dark fiber is leased monthly for the number of strand miles utilized. A strand mile is a single strand of fiber optic cable over a linear mile in the network. The lease rate calculation for the existing fiber under lease is generally a formula that accounts for the total cost of the network plus ongoing maintenance divided by the number of strand miles available for leasing.

3.5 Conceptual Network Design

The network architecture described in the previous section leads to the conceptual design for Chatham County's fiber routes. Components of the design include:

- Aerial and underground placement requirements
- Fiber-optic routes in established ROW and easement with distance and slack
- Location of vaults, handholes, and pedestals, along with their sizes and quantities
- Placement of fiber distribution hubs, sizes and quantities
- Splitter configuration and density within fiber distribution hubs
- Fiber-optic splice points, splice cases and splicing
- Fiber-optic termination locations, sizes and quantities
- Equipment locations and requirements

Outside Plant Underground Specifications

Much of the network conceptual design is underground, with the financial modeling assuming a 70%-30% underground-aerial build. However, the design engineering study will identify the final aerial and underground requirements and specifications. This study assumes that the network will utilize loose-tube fiber cables across the backbone with 288 strands of available capacity. Most community organizations will only require 4-8 strands of fiber, which leaves ample free capacity for future expansion to add additional organizations to the network. The additional capacity will be ideal for broadband applications and enable more fiber connectivity to wireless assets and towers.

Figure 49: Underground fiber specifications

Basic Fiber Specifications	Basic Conduit Specifications
- Backbone cable size – 288 count fiber - Lateral cable size – 12/24 count fiber - Single mode, loose-tube cable - Jacketed central member - Outer polyethylene jacket - Sequential markings in meters - All dielectric - Gel-free/dry buffer tubes 12 fibers per buffer tube - Color coded buffer tubes based on ANSI/TIA/EIA 598-B Standard Color	36" minimum acceptable depth 2" HDPE smooth wall reel-mounted pipe depending on application - Warning tape installed at 12" or 18" - Maximum fill ratio of 50% - Maxcell or smaller innerduct - Vault placement at intersections, every 500ft in commercial corridors - Vaults sized appropriately to house underground lid-mounted pedestals and splice enclosures

Outside Plant Aerial Specifications

Aerial specifications are highly dependent on network segments and pole ownership, but the majority of the county network is conceptualized as being an underground deployment. All

long network segment will be underground, but fiber will come above ground as required for water crossings or where conditions are not suitable or practical for underground cabling. Overhead placement standards and specifications should be coordinated through the public policy process with input from relevant community partners.

Figure 50 illustrates the conceptual design for the network, including the primary fiber routes and laterals. The network map depicts a "blueprint" for the comprehensive network that fulfills the County's objectives for long-term connectivity. This conceptual design may be used to determine the priorities for building the network over time, and to help identify opportunities to fund specific routes within the network. The specific routing, splicing and termination plan for the network will vary from site to site and from phase to phase. Therefore, this plan lays out the framework for the network but allows for flexible implementation of the actual routes based on the specific needs of the organizations using it.

Figure 50: Chatham County conceptual fiber network
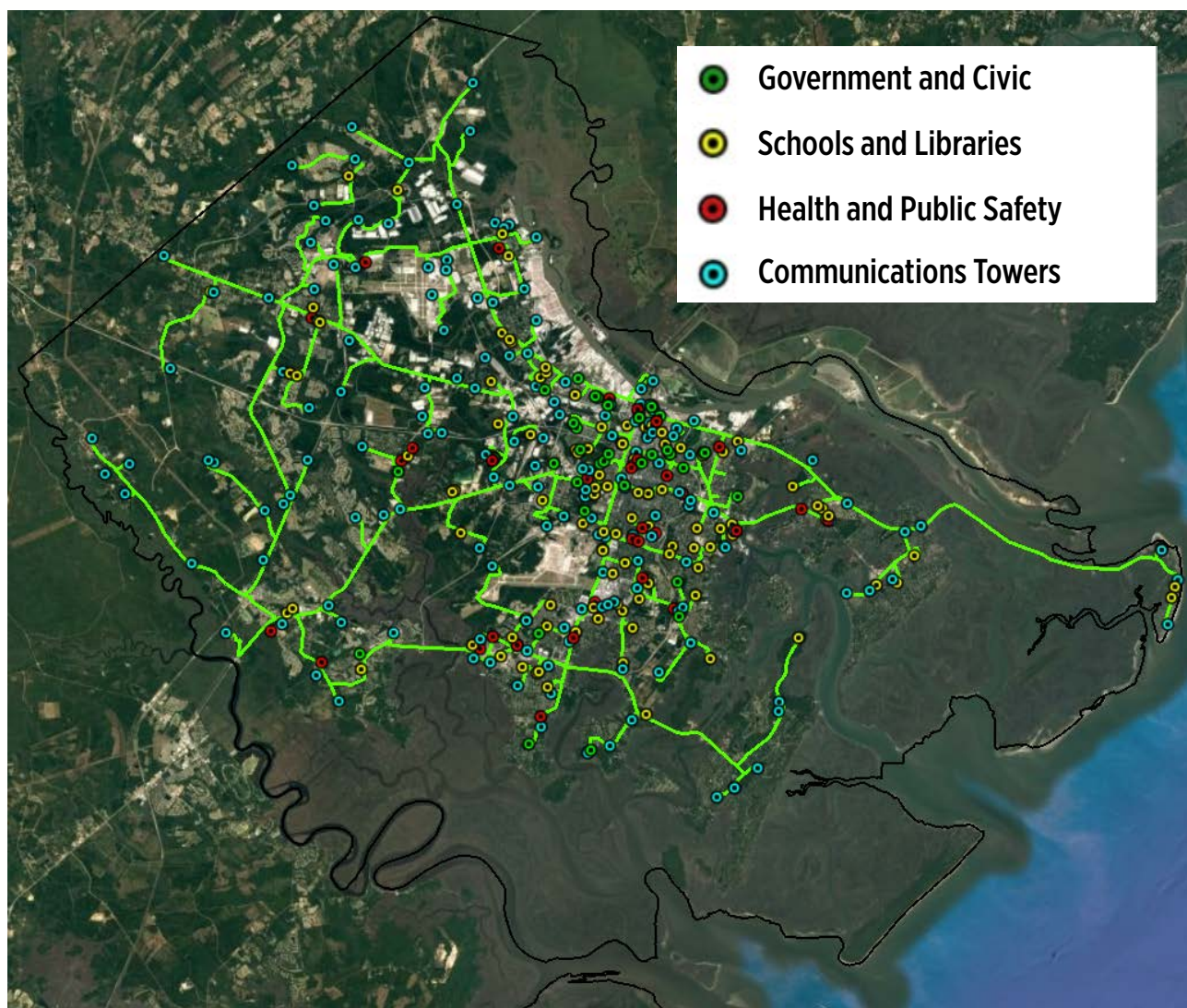
Figure 51 illustrates the conceptual fiber network route and lateral with endpoint connections for a proposed Phase One. Such endpoints will be Chatham County community anchor institutions, such as the police precincts, fire stations, hospitals and public health facilities. A proposed Phase Two, as seen in Figure 52, includes fiber routes to all schools and libraries, along with routes to communications infrastructure and wireless towers around the county. The entire conceptual network is comprised of 265 miles of backbone and lateral fiber that connects about 100 organizations and sites within the county, comprised of:

- 29 County and City facilities
- 8 Parks
- 9 Fire stations
- 1 Primary 911 center
- 9 Police facilities

- 10 Sheriff's office facilities
- 33 Public and private schools
- 5 Healthcare organizations
- 14 Library facilities
- 174 Commercial and County towers

Figure 51: Phase One, community anchors, government and public safety sites
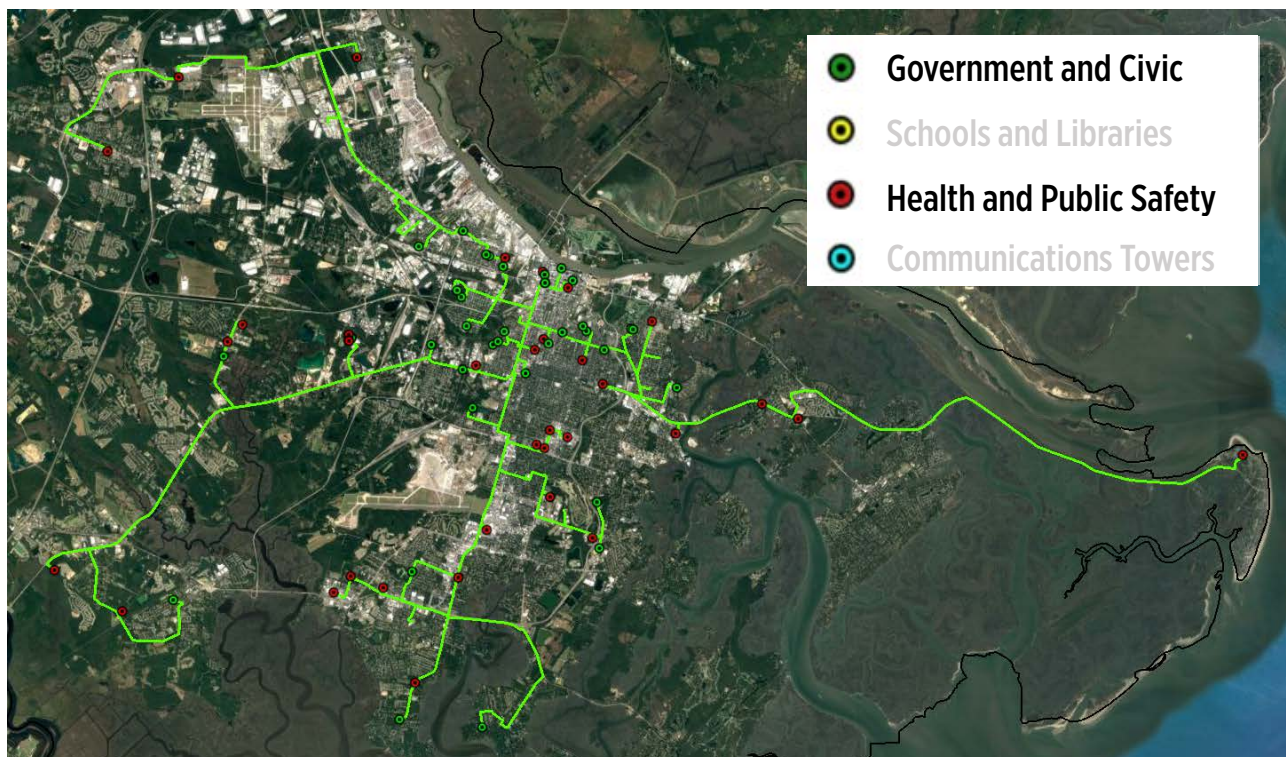
The network backbone connects to each organization, supplying direct fiber connectivity between their facilities. Once both phases are complete, the network will have provisions for high redundancy, ensuring that these organizations are able to maintain reliable connectivity to support their critical applications. It also provides numerous access points that support the attachment of future devices, facilities, and applications that organizations may utilize. As new smart city technologies are developed in transportation, utilities management, energy management, safety, surveillance, and community development, the County's fiber network will be an asset to support these connected applications and drive innovation.

Figure 52: Phase Two, community anchors, schools, libraries and wireless towers
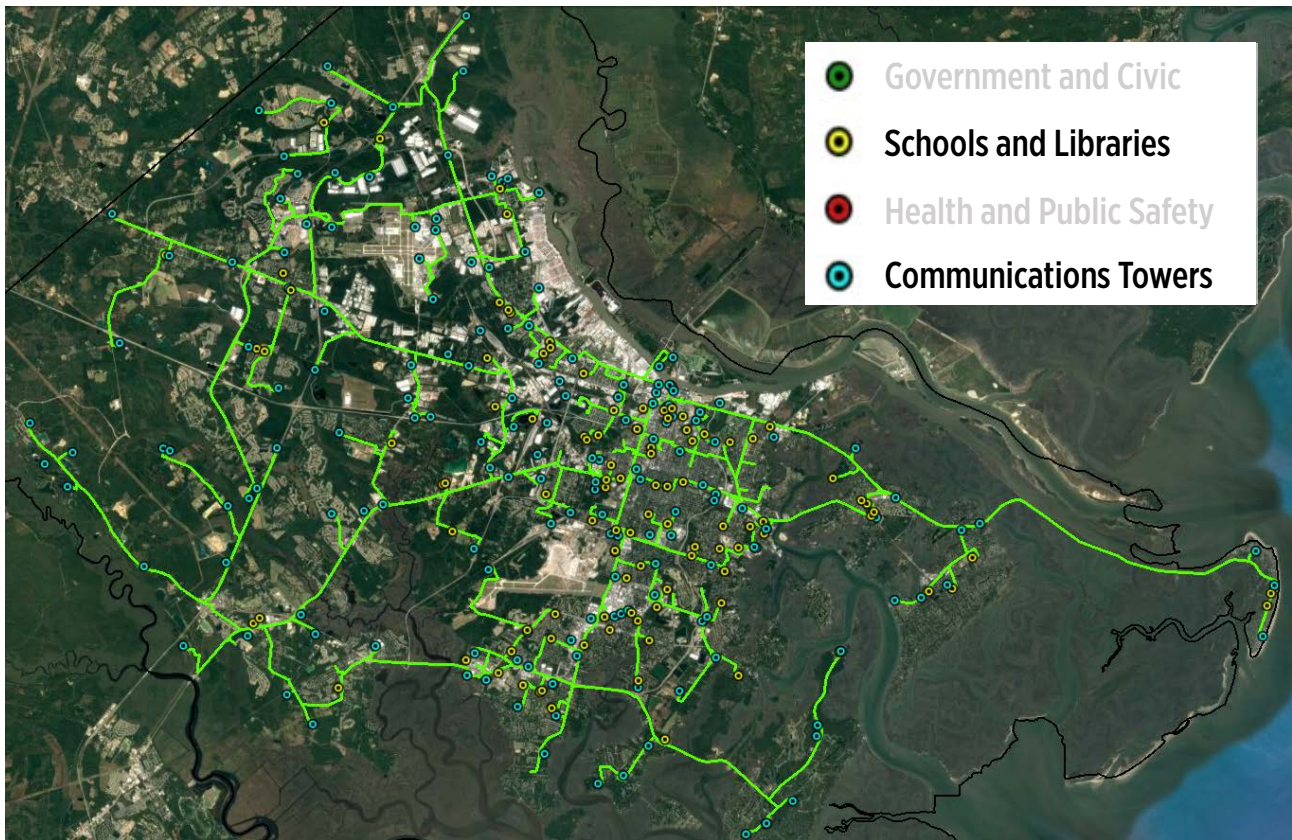
Coordination will be required in the design stage when new routes are being planned to maximize the number of partner sites that can be connected during construction. Each of these planned developments would have implications for Chatham County and would have bearing on a countywide network design.

With local and county government and community functions supported by the network, it may become a platform to expand access to leading edge broadband services for the county's businesses and residents. The network has been designed to pass major business and residential districts with capacity to support future deployments of fiber-to-the-premises services.

Although the County does not currently intend to provide retail broadband services, the County should seek input from broadband providers for parties interested in using the network to deliver services to businesses and residents. To that end, the County should consider releasing an RFI to solicit interest from broadband and wireless providers that may want to partner with the County on development of the network.

4. FIBER BUSINESS MODELS

Chatham County is now at the stage of the study to consider feasible broadband deployment and operations strategies. As such, the City seeks to gain an understanding of its business options by building knowledge of prevailing broadband concepts and business models. These models include a spectrum of broadband programs that others have implemented over the past 20 years.

While Magellan has learned over this period that certain truths hold across various models, no "cookie cutter" model exists to replicate the successes that other municipal providers have enjoyed. Each community is unique and therefore each broadband program must be tailored specifically to community needs, organizational capabilities, and market and regulatory conditions.

Figure 53: Chatham County's potential role in the delivery of broadband

Policy Only	Infrastructure Only	Public Services Provider	Open Access Provider	Business Provider	Full Retail Provider
		THESE INVOLVE SOME FORM OF PARTNERSHIP WITH A PUBLIC OR PRIVATE ENTITY			

In considering models for Chatham County, Magellan analyzed a handful of proven business models that could work with the City. Figure 54 illustrates the prevailing roles that municipal governments typically play in fiber infrastructure deployments elsewhere in the U.S. The analysis in this chapter and through the remainder of this report will discuss the opportunities for Chatham County to participate in a fiber network deployment and operation.

As Chatham County considers financing for the network, it is important to understand that the County does not likely qualify for many federal funds to help with this build. In fact, federal funding for broadband has been limited in recent years to primarily rural and remote areas of the country, so direct federal funding in the form of grants or "free money" is not likely. Additionally, low interest loans offered by the USDA would not be an option for the City because the it is not considered a rural area. Chatham County also does not qualify for FCC funds because it is not underserved by the federal definition, as wireline and wireless providers offer services that exceed the minimum thresholds.

There could be HUD funds available, but none that would offer standalone funding. These funds typically require broad collaborative efforts that focus on the beneficial applications and services provided by the technology, with limited funding for the actual infrastructure. These typically involve Housing agencies or are directly at projects with a broad workforce or economic development focus, such as rebuilding after catastrophic events with a focus on economic resiliency or diversification.

4.1 Considering Business Model Opportunities

Chatham County can play a vital role in the delivery of broadband services to its homes and businesses. Figure 55 provides a comparative look at proven fiber business models that can work for Chatham County.

Figure 54: Potential Chatham County fiber business models

	Policy Only	Infrastructure Only	Public Services Provider	Open Access Provider	Business Provider	Full Retail Provider
			These involve partnership with public or private entities			
Services Provided	None	Dark Fiber Only	Dark Fiber, Data Transport, Internet, Phone	Dark Fiber, Data Transport	Internet, Phone Value-Added Services	Internet, TV, Phone, Value-Added Services
Customers	None	Broadband Providers	Public Entities Only	Broadband Providers	Businesses and Anchors	Households, Businesses, and Anchors
Funding Required	Low	Moderate	Moderate	Moderate	High	High
Compete with Private Sector	None	No	No	No	Yes	Yes
Operational Requirements	Low	Low	Low	Moderate	High	Very High
Regulatory Requirements	Low	Low	Low	Moderate	High	Very High
Revenue Generation	Low	Low	Low	Moderate	High	Very High
Operational Costs	Low	Low	Low	Moderate	High	Very High
Financial Risk	Low	Low	Low	Moderate	High	Very High
Execution Risk	Low	Low	Low to Moderate	Moderate	High	Very High

The Public Policy Only option is not really a business model, but it is an effective way for municipalities to participate with the spread of broadband infrastructure with almost no risk. In this model, no networks are deployed or services marketed. Policies are simply a vehicle to acknowledge how City participation and support will make it cheaper and more accommodating for competitive broadband providers to better serve their communities. The Policy Only option costs littl, but can take years to effect change.

On the other end of the spectrum, Full Retail Provider models allow the City to do as the name suggests. The City can fully compete in the retail broadband market, offering a wide array of services and growth opportunities. The risk is higher, but so are the potential rewards, plus this model affords the provider full control of the network.

Public Services Provider, Open Access Provider, and Business Provider models all require the City to enter some form of public or private partnership to fulfill a determined role in the operation of the network.

A Model Built Around Need

Building off the network deployment as described in the previous chapter, the business models attempt to tap into current and near-term opportunities for Chatham County without undermining the prospects of future opportunities. One can envision that over time a robust network interconnecting regional and local entities would lead to substantial revenue share opportunities.

It is difficult to estimate or even identify these possible opportunities, but the financial modeling with provide estimates about possible revenues based on other similar networks. Such challenges and opportunities will be explored in this chapter. Although the strategy must be unique to Chatham County, certain truths are consistent across these initiatives:

1	Fiber-optic networks should be considered long-term infrastructure like road, water and sewer systems as opposed to a one-time project.
2	Support from local stakeholders must be gained through an understanding of their needs and providing services to meet those needs.
3	Focus should be on the benefits of broadband rather than the technology to ensure locals gains a clear understanding of the reasons for the initiative.
4	Broadband infrastructure initiatives require a careful balance of community benefit and financial sustainability to remain successful over the long-term.
5	Focus on organizational strengths when evaluating solutions that build on current competencies; where the City does not have competencies, consider partnerships to fulfill the solution.

4.2 Chatham County Fiber Revenue Opportunities

The scale of financial investment required for fiber-optic infrastructure is comparable to other public infrastructure projects, such as roads, water and sewer. The longevity of fiber as an investable infrastructure asset is also comparable, with a life cycle that extends well over 30 years. Fiber is "future proof"—its value as an asset will only increase along with its economic importance. Without question, fiber can serve many uses for a lot of people for a very long time. Investing in fiber today positions the County to offer an array of broadband services in the future that can generate revenue for the County.

Chatham County has a wide range of options for investing in, owning and utilizing fiber-optic infrastructure. Fundamentally, the options are to build or buy to meet the needs of county broadband stakeholders, but there are many layers of services and systems that the County could build or buy, considering the costs, risks and potential revenue derived from each.

4.2.1 Dark Fiber-Optic Infrastructure Availability

As detailed in the needs assessment section, many of Chatham County's businesses need better internet connectivity. Providing leased "dark fiber" transport facilities to its businesses, where Chatham County would own the infrastructure but lease strands of fiber. This would be beneficial to organizations with multiple locations to interconnect across a county-wide network. Local governments, schools, hospitals, financial institutions, information companies, manufacturers, and other organizations have a need for such capabilities. Being able to tap into any resources that can be leveraged for fiber network infrastructure can save both time and money and could provide opportunities for growth that might not otherwise be realized.

4.2.2 Infrastructure for Competitive Retail Providers

In addition to supporting existing business, development opportunities in the county often lack the connectivity to be competitive in attracting bandwidth dependent companies. Fiber infrastructure is not often installed by service providers in advance of revenue opportunities, which puts Chatham County at risk when executing economic development efforts.

In such cases, businesses would need to spend significant amounts of money to build out the provider's network infrastructure, which takes months, then must subscribe to costly service under long-term contract arrangements. Connectivity options are a key consideration in business expansion and relocation. By deploying fiber and having it quickly available, Chatham County gives itself an economic development advantage.

4.2.3 Duct Owner

The County builds and maintains parks, roads, water and sewer lines, and other physical infrastructure in the public rights-of-way. Duct is in many ways simply another form of such physical infrastructure. Instead of carrying people, vehicles, of water, ducts carry fiber-optic cables. Building and owning a duct system minimizes future construction disruptions. Duct can be installed along with any other underground facilities, and one in place, fiber-optic

Fiber Business Models

cable can be installed cheaply, quickly, and with little or no demolition. Once installed, the County can either lease duct for a fee, or give away access to directly promote development. For example, by installing duct in areas targeted for redevelopment, the County can facilitate advanced broadband in those areas.

4.2.4   Vertical Asset Ownership

Vertical assets, including buildings, poles and towers, are critical for all forms of wireless communications. Antenna are essential for wireless, and all that voice traffic and data must go somewhere. By placing vertical assets adjacent to ducts and fiber, or vice-versa, the County can encourage development of next generation wireless services. Whether it's Wi-Fi in the parks, mobile wireless in historic areas for tourism and public safety, or internet access for public housing, vertical assets are key. In some cases, vertical assets simply make wireless possible. In other cases, the County could either trade out access to vertical assets for service discounts or charge providers a fee to attach to the vertical assets.

4.2.5   Fiber-Optic Owner

The County can own fiber-optic cables, and it can use those for internal purposes, as means of directing investment and service provisioning, or can lease strands of fiber-optic to others. Major businesses and anchor institutions often need to interconnect various sites. Some telecommunications providers are happy to lease existing dark fibers to avoid upfront capital costs and reduce operating expenses.

By owning its own fiber, the County can eliminate, or at least reduce, recurring service fees and can look to serve its own needs and leverage its investment in fiber-optic cable to provide a connectivity for its own use and for the greater good of the community. Through this leveraging of fiber assets to critical community facilities, the County can lease dark fibers to service providers willing to offer FTTP service to residents and business.

4.2.6   Public Organization Services Provider

The County could become a service provider to other public organizations only. This does not entail the County providing any retail services to homes or businesses, but only services to other government organizations in the county. Magellan does not recommend that the County pursue retail services such as cities like Chattanooga, Bristol or Cedar Falls has done. Many jurisdictions across Georgia have built networks to connect public organizations for governmental purposes and needs. There are many types of services providers.

- Specialized service providers offer access to a service or set of services, for specific purposes. For example, the County could operate a public safety surveillance network, a network of informational kiosks, or a health information exchange network.
- Wholesale services provide a network that other providers use to serve customers.
- Managed/enterprise network services simply transport data among a specific set of sites, which could include an internet service provider's point-of-presence.

4.3 Network Cost Estimates

The network is segmented into two phases, as shown in Figure 56 and Figure 57.

Figure 55: Phase One of network deployment, community anchors

The network build has a total estimated capital cost between $19.9M and $26.5M. Capital costs were calculated by taking mileage for primary backbone and lateral routes, using an average cost per mile between $75,000 and $100,000. This per-mile cost range is likely higher than actual costs that the County would incur to build the network; however, given the many ways that this network may be developed, Magellan believes that using a conservatively high construction cost would account for any unforeseen modifications to the network that may adjust additional cost into the build. The County should continually refine these numbers as it pursues development of the network and should be able to bring these overall costs down 10% - 20%.

Estimated Operations and Maintenance (O&M) costs assume that the County would manage only the dark fiber operations, maintenance and record-keeping costs. Dark fiber O&M costs include ongoing maintenance, repairs, relocations and costs borne from the operation of the network. These costs could be offloaded from the County to a private partner if the County found that option more desirable than managing O&M directly. However, we estimate the dark fiber O&M in this plan so the County understands the potential costs incurred.

Figure 56: Phase Two of network deployment, schools and towers
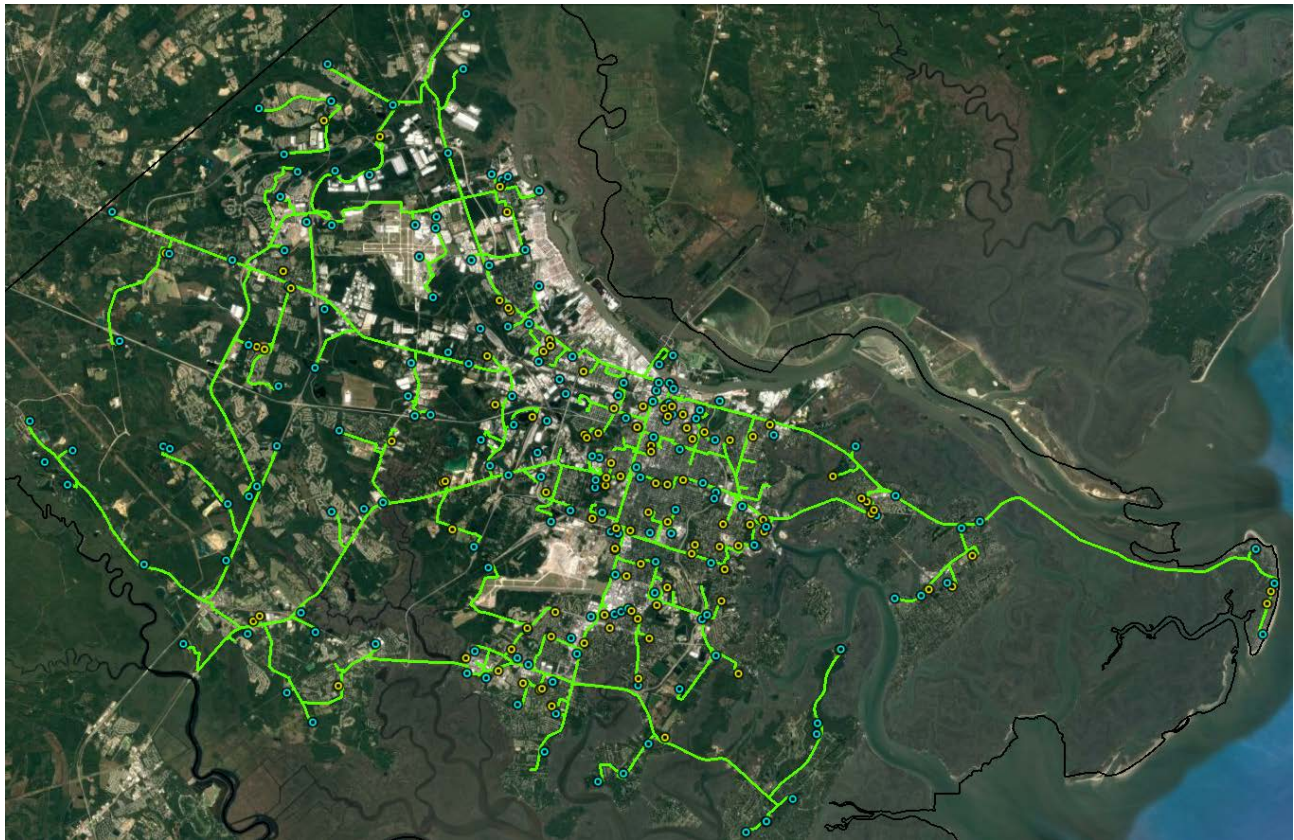
Figure 58 illustrates the total cost of ownership (TCO) of the network over 20 years. Based on preliminary costs and reducing these total costs by the savings the County would incur in its existing connectivity spend ($112,000 per year), the Phase 1 TCO ranges from $11.9M - $18.3M, including the $6.4M in cost savings. Phase 2 ranges from $9.6M – $13.3M with no cost savings for the County today, as this phase provides capacity to the schools and towers only.

Figure 57: Costs estimates, cost reductions and potential revenue

Sites	Phase 1	Phase 2
Mileage	177.48 Miles	88.24 Miles
Sites Connected	29 County and City; 8 Parks; 9 Fire Stations; E-911; 10 Sheriff Offices; 5 Healthcare Facilities; 14 Libraries	33 Public and Private Schools and 174 Wireless Towers
Capital Cost	$13.3M - $17.7M	$6.6M – 8.8M
Annual O&M Costs	$250K - $350K	$150K – $225K
Total O&M Costs Over 20 Years	$5M - $7M	$3M – 4.5M
Total Costs Over 20 Years	$18.3M - $24.7M	$9.6M - $13.3M
Reductions in County Costs*	$6.4M	$0
Total Cost of Ownership	$11.9M - $18.3M	$9.6 - $13.3M

*$112,000 in annual recurring County connectivity costs plus a 10% per year increase over 20 years.

4.4 Viable Business Models

4.4.1 Option 1: Deploy Through a Public-Public Partnership

Through a Public-Public partnership, the County could consolidate the demand among public organizations in Chatham County and solicit commitments to use the new fiber network at a predefined rate. The County and its departments and organizations spend on telecom services includes $112,157 for the County's remote sites today. These organizations could consolidate their purchasing power and commit to using the network over a longer period of time. If the total spend over that period, including future cost increases were less than the capital and operating costs of building the network, it would make sense for these organizations to capitalize their existing telecom spend and build the network. In addition, the "off balance sheet" benefits of the fiber network should be added to the total value to provide a fair comparison.

If the network enabled new capabilities for the public organizations that they wouldn't otherwise have by paying providers for their services, this could create additional value in the operational efficiencies enabled by the network. An example of one such efficiency is collaboration on technology programs that all organizations could run if a single countywide network were deployed. The County and City and their organizations could share resources, internet access, telephone services, cloud services and specialized applications across the network that could not be shared with traditional connectivity services.

Among these organizations, technology needs that could be consolidated through a collaborative public-public partnership would allow all organizations to participate in the network and reduce their ongoing costs. The Phase 1 network costs between $13.3 and $17.7 million. About $6.4 million in cost savings would be generated by connecting the County's remote sites to the network.

Figure 58: High Level Business Case for Public-Public Partnership - Phase 1

Over 20 Years	Phase 1
Capital Cost	$13.3M - $17.7M
Average	$15.5M
Operating Costs	$6,000,000
Cost Savings for County Remote Sites	$6,400,000
Total Capital and Operating Cost Remaining	$15,100,000
Annual Cost Reductions or Revenues Needed	$755,000

What other programs could reduce cost for the County and other organizations? For example, if all organizations consolidated their internet service procurements into a single bulk purchase, each organization could save considerably from what they are paying today and likely receive improved service. Similarly, these organizations could consolidate their

backup and disaster recovery infrastructure and services to reduce the capital costs of equipment, storage and connectivity by using a single shared infrastructure.

Each cost reduction mechanism that is enabled by the network leads to improvements in the business case to build it. The County would need to develop a schedule of cost reductions and value improvements that yield about $755,000 per year over a 20-year period. Figure 59 illustrates these results. Developing a schedule of all current costs and projecting their annual increases should allow the County to assess its total spend over the next 20 years (with appropriate margins of error applied). If the organizations come together and can substantiate that their overall spend will be lower to build the network than to "rent" services from providers, the County should consider its business case to build directly through a public-public partnership with other organizations.

In addition, the County could begin leasing excess dark fiber in the network to telecommunications carriers that want access into new portions of the county. Of the 288 fiber strands on the network, the County would likely maintain half of this capacity for fiber leasing. Common fiber leasing rates for government organizations range between $100 - $500 per mile per strand, depending on the urbanization of the market. Dense urban market draw higher rates whereas less urban markets draw lower rates. Chatham County would likely support rates estimated at $150 per mile per strand. Dark fiber leasing could supplement the business case by bringing in new revenues for the County. Although dark fiber opportunities are unclear today, the County could work with private providers to solicit demand for these services.

Phase 2 would be a more challenging business case because the network provides services to schools and towers only. Today, schools have fiber connectivity through the State network and are paying reasonable prices for access. The schools' needs will clearly grow over time and the County should continue discussions with the schools to determine if a countywide network could support their future needs. However, including schools in this particular business case may be a challenge since they already have connectivity and at low rates.

In addition, buildout to the towers would not create a cost reduction opportunity; however, it would create a revenue opportunity for the County that could be used to generate a payback for the County. Alternatively, the County could consider engaging private providers to solicit interest in Phase 2 and potentially Phase 1.

Example: The Missoula County Public Schools (MCPS) save $150,000 per year by investing in its own fiber infrastructure. Over a 20-year period school officials expect to save approximately $3 million. MCPS will be the first in the state to self-provision its wide area network (WAN), the connections between district facilities. Right now, the school pays approximately $287,000 per year to lease its WAN connections and for internet access; about $200,000 of that figure is dedicated to leasing the WAN. The $3.2 million fiber project will also enable the schools to provide excess fiber to other organizations in the area and reduce their costs further while providing new fiber connectivity.

4.4.2 Option 2: Deploy Through a Public-Private Partnership

While Option 1 requires the County to fund the build of the network, alternatively, the County could form a public-private partnership with an interested broadband provider that would co-fund and manage the network with the County. The public-private partnership option could create three benefits for the County:

1. Reduce the total amount of capital and operational funding required by the County;
2. Alleviate the County's requirement to operate the network; and
3. Through the provider, create a revenue source that helps sustain the overall network.

For Phase 1:

- The County funds the $6.4 million that it will save over 20 years by building the network to remote County sites;
- The private partner funds the remaining $9.1 million;
- The County and other organizations receive 48 strands for their internal purposes;
- The County and other organizations commit to using the provider's internet services over the new fiber network to create an anchor of revenues for the provider;
- The provider operates and maintains the network for the County
- The provider is free to use the remaining 240 strands of fiber to deploy broadband services and generate revenues how it sees fit.
- The provider grants a small revenue share back to the County to cover any small operational expenses, repairs, maintenance, inflation and other marginal costs.

Figure 59: High Level Business Case for Public-Private Partnership - Phase 1

Over 20 Years	Phase 1
County Capital Contribution	$6,400,000
Provider Capital Contribution	$9,100,000
Total Capital	$15,500,000
County Cost Reducations	$6,400,000
County Simple Payback	20 years
County Operating Costs	$1,000,000
Provider Revenue Share to County	$1,000,000
Net Cost to County	$0.00

For Phase 2:

- The provider bears the entire capital cost, unless the schools become an opportunity for deployment of new fiber;
- The provider interconnects the new Phase 2 network with the Phase 1 network, enabling the County to have access to its towers;
- The provider grants 48 strands in the new network to the County for its internal purposes through a 20-year IRU[35] agreement;
- The provider owns, operates and maintains its network and the County's portion under capital lease;
- The provider is free to use the remaining 240 strands of fiber to deploy broadband services and generate revenues how it sees fit.

In the public-private partnership, the benefits to the County would be:

- Zero net cost to the County over 20 years
- Fiber connectivity to all public organizations for a substantially lower cost than in a public-public model;
- Protection against future cost increases
- Access to County-owned tower infrastructure at no cost
- An ongoing revenue stream to cover inflationary and small operating costs.

The public-private model would shift the operations and maintenance of the network to the private partner and allow the partner to use excess capacity in the system to generate revenues. The benefit of using a public-private model is that the provider is better suited to manage the network and sell its excess capacity than the County in the public-public model.

The County would still likely need to contribute some capital to the project and the exact amount is unclear until the County solicits information from providers; however, the anticipated funding would be significantly lower than in the public-public model.

Example: In Seminole County, FL the County owns a 450-mile fiber-optic network that connects nine cities, all schools, community colleges, sheriff's offices and police stations. The County hosts common E911, telephone services and Internet services which all organizations can utilize if needed. This reduces the duplication of technology, staff and expense across all organizations.

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[35] *An Indefeasible Right of Use (IRU) is a permanent contractual agreement, that cannot be undone, between the owners of a communications system and a customer of that system. The word "indefeasible" means "not capable of being annulled, or voided, or undone." The customer purchases the right to use a certain amount of capacity of the system, for a specified number of years. IRU contracts are almost always long term, commonly lasting 20 to 30 years.*

5. RECOMMENDATIONS AND NEXT STEPS

Providing fiber connectivity to community anchor organizations would become a new source of revenue for the County. This could be accomplished directly by the County or by enlisting one or more private operators to partner with the County to both fund the construction of the network and share in its overall revenues. Additionally, the private partner could assume many of the of sales, marketing and operational responsibilities for the network, alleviating the County of these duties and possibly executing them more efficiently and likely at a lower overall cost than the County could do so on its own.

Therefore, rather than investing in and building the network on its own, Magellan recommends that the County solicit private operators to determine what interest they have in either co-investing with the County or funding the substantial buildout. Soliciting providers will help the County navigate potential opportunities to build the network without encumbering significant capital and operating costs. The level of investment that private operators are willing to make is directly correlated to the level of revenues they will generate from the project. Therefore, if the provider(s) are willing to fund a significant portion of the network, they will be entitled to a significant portion of the revenues generated from the investment.

The County should determine what level of investment it is comfortable making, based on the overall benefit received. The balance of this report highlights the recommended options that the County could consider in developing partnership strategies.

5.1   Recognize Fiber as Long-Term Infrastructure

Before formalizing a collaboration outside of the County government, it is important that County leaders recognize the importance of fiber and develop internal objectives for what Chatham County would like to realize through fiber-optic connectivity. Forward-thinking county governments understand that infrastructure is not intended to be a means of directly making money for their communities. They recognize that all infrastructure is an *investment* – whether roads, electric wires, water pipes and others – that acts as a facilitator, allowing the delivered service to generate much higher social and economic benefits.

In the same way, the investment in fiber infrastructure is not simply for better internet service – it's more than just internet access – it is a platform for local collaboration, innovation and smart growth. As with other forms of infrastructure, such as a new multi-million dollar highway expansion, the return on investment with fiber infrastructure is not simply money – there are many far more important social and economic benefits attached.

Chatham County should position the need for fiber infrastructure not as merely a "broadband initiative," but rather as a community-based platform for economic growth. The fiber infrastructure should be as much about attracting, developing and retaining skilled workforce to enable business growth as it is about deploying faster broadband service for county households.

5.2   Aggregate Demand

The County could consolidate the demand among public organizations in Chatham County and solicit commitments to use the new fiber network at a fixed fee. The connectivity needs of these organizations together would present a new and significant revenue opportunity to a provider and may incentivize them to invest in the network. If the County could market the network as a way to stabilize and reduce costs for all public organizations over a 5, 10, 15, or 20-year term, other organizations would likely consider supporting the project. This would also allow a private partner to secure a long-term and high-quality revenue stream from organizations that have a good track record of "paying their bills." Doing so would reduce the risk on the provider's capital and give the provider a guaranteed rate of return from the community anchors using the network.

This approach could also incentivize the deployment of new residential and business broadband services if a provider could utilize the network as a connection point to serve neighborhoods and business districts in Chatham County. For example, the County could negotiate certain covenants with a provider to require deployment of fiber-based internet services into key business districts to support the County's economic development needs. The network would be designed to allow for these future deployments of fiber to homes and businesses.

5.3   Form a County and Municipal Collaboration

A recommendation for moving forward is for Chatham County and the municipalities in the county anchor a consortium with special focus on economic development, education and public safety. There is tremendous value in creating a consortium of the County and other entities, such as higher education, hospitals, and even the industrial community.

First and foremost, the best thing is that the Cities and the County want to work together. During this study in all the meetings and conversations with leadership of each City we spoke with, there is a recognition of what it possible if the Cities and County work together.

"WE'RE NOT GOING TO DO THIS ALONE."

There is a strong willingness to work together, and City and County departments and staff have a track record of successful collaborations. In fact, there are several areas where the City of Savannah and County complement and align in their technology goals, and many areas where Chatham County fully cooperates today with all the cities in the county. Magellan can not imagine a fiber initiative going forward in Chatham County without all the communities of Chatham County working together.

A significant area of current cooperation related to technology is the development of the Chatham County Intelligent Transportation System (ITS) and a Traffic Management Center (TMC) to be supported by a redundant regional fiber optic ring, as shown in Figure 48. As the County considers this fiber-optic feasibility plan, it would be financially and operationally advantageous to also integrate the ATMS plan and collaborative with that is already underway. The ATMS plan should be considered a building block and key opportunity for City-County cooperation to further meet the needs of the region through fiber.

Such a consortium could be structured as a separate nonprofit entity that serves to strengthen collaboration and aggregate demand. The consortium would market services and manage the business, and could allocate a percentage of fibers owned by the public side of the partnership for "community benefit" purposes. Such purposes could be for healthcare, low-income households, educational and workforce programs, entrepreneurial support, and other items deemed important by public partners.

The County should assess what governance structure it would like to use to own and operate the fiber network. The governance structure of the collaboration, consortium or formal partnership should accommodate the County's existing fiber resources and new network that will be build, which may occur solely by the County, or jointly with the City of Savannah or other Chatham County cities, or in partnership with other providers.

The value of a consortium is that it brings together more demand, as recommended in the item above. A consortium also establishes independent management and could help subsidize service to high-cost/low-density areas, all with very little downside. The County can encourage greater broadband availability and lower costs via a formal partnership or consortium with other entities. The general idea is for the consortium to invest in network infrastructure. Members get access to and control over the infrastructure based on their investment. "The more you contribute, the more you get to use," and "use" can mean giving away access in order to accomplish other goals.

The public partner would benefit from a consortium model because it would offer a layer of separation from direct network ownership and would eliminate any public perception that the public partner is in the retail broadband business. The private partner or partners would be the operator of the network, offering managed services instead of being the outright operating management partner.

Other important members of such a consortium would be the Savannah Economic Development Authority (SEDA) because they understand the need to attract high-tech businesses, but realize they can't accomplish those goals without bandwidth and dark fiber. Likewise, the Savannah-Chatham County Public School System (SCCPSS) expressed the need for internet services for non-school hours, and it knows that residents have limited choices at an affordable cost. The school system believes they have valuable resources to support individuals but have trouble reaching them.

5.4   Formalize a Broadband Infrastructure Program

The County should consider the development of a Broadband Infrastructure Program (BIP), focused on meeting the needs and demands of County operations, bringing value to the greater community, and monetizing any broadband assets that are available as the network is constructed. A BIP would be new to the County and would require a formal structure to be successful. There are several tasks required to formalize a BIP, including:

- Document and maintain an inventory of available assets
- Implement a fiber management system
- Standardize agreements for fiber and conduit leasing
- Develop pricing policies for fiber and conduit leasing
- Publish rates and terms
- Create an enterprise fund to maintain proper budgets, cost accounting, and to track revenues of the program
- Create a capital fund to cover costs of building infrastructure

The BIP is basically a set of tactics to encourage broadband infrastructure growth and facility network development. A BIP would provide a plan and a process to inventory network assets throughout Chatham County, such as many of the items detailed in section 4.2. The BIP would define a process to provide current and continuously updated information about what assets are located where, who can access them, and who owns it today. A BIP would identify such assets and their details in an accessible GIS format

Capital investments in network infrastructure can greatly reduce the County's recurring costs, and can be leveraged to spur additional investment and service offerings by providers. Generally, the County can invest in underground duct, vertical assets, such as poles and towers, and fiber-optic cables, then lease these assets to providers. As part of the lease agreement, the County can get access to other assets, discounted services, or investment and service commitments from providers.

For example, if the County had extensive conduit and duct infrastructure, it could require a service provider to install fiber throughout the duct system and give the County, or the consortium, access to long-term use of fibers as part of the lease agreement. The County could take a similar approach with vertical assets.

Through a BIP, the County can develop such assets incrementally over time by having a policy to install ducts, poles and towers as part of other capital improvements. The general approach is to leverage County investments to spur private investments. Whether part of a consortium or not, a BIP can be pursued independently by each city in the county, though there should be many areas of overlap and should be developed in consultation with each other for comprehensiveness. The core idea is to target investments in network infrastructure to generate revenue and spur development.

There is little financial risk in a BIP because they require limited upfront funding if managed correctly. In some cases, counties are performing many of the individual items already, so it ends up being a matter of bringing all the separate items under a manageable structure. This activity is helpful in and of itself because many county and local governments struggle with incorporating broadband into their existing policies because they are unfamiliar with how to manage a new "utility" type of asset.

Regular communications between public works, traffic engineering, planning, and information technology are critical to broadband infrastructure programs. It may even be necessary to formally include these departments in a working group. The collaboration of multiple departments and the ability of these departments to work together toward a common broadband and technology goal is key to success.

In support of this, County leadership should facilitate and promote broadband-friendly public policies that influence how the BIP develops throughout the county. Some of the more common policies are explained in the next section. Implementing and enforcing these policies will also show the community and prospective newcomers that the County is serious about promoting broadband growth and accessibility.

5.5   Implement Broadband Friendly Public Policies

Implementation of a BIP as detailed in the previous section requires that stakeholders and local governments evaluate current land use, permitting, construction, and right-of-way policies. Existing informal policies and procedures also need to be examined to determine how broadband-friendly policies can encourage development of broadband infrastructure. Formalizing these policies will lead to deployment of broadband infrastructure in conjunction with other public and private infrastructure projects occurring within jurisdictions.

Broadband-friendly public policies are tools that local governments can formalize to encourage broadband infrastructure growth. Below is a list of ways that Chatham County and its communities can encourage broadband development through the adoption of broadband-friendly policies:

- Evaluate fees levied on broadband providers for constructing broadband infrastructure to ensure they do not discourage broadband investment.
- Streamline the broadband permitting processes within public rights-of-way to ensure broadband providers do not face unnecessary obstacles to building infrastructure.
- Work with public works, engineering, planning, and information technology staff to identify projects that could include broadband infrastructure at reduced costs.
- Identify opportunities to install broadband infrastructure in conjunction with public and private construction projects.
- Maintain broadband infrastructure specifications in an authority-owned GIS-based fiber management system, requiring updates as built, and implement processes for maintaining accurate documentation.

- Adopt policies that incorporate broadband as a public utility and create a policy framework to promote its deployment in public and private projects as appropriate.
- Draft policies to specific needs and adopt them into local policy, codes, and standards (including dig-once, joint trenching, engineering standards, etc.).
- Incorporate broadband concepts into the Capital Improvement Plan (CIP), as appropriate, and make a commitment to fund broadband infrastructure.

In addition to the policies themselves, the County should ensure that staff understands the purpose of the policies and how to integrate them into County workflows and business processes. The County will need to be responsible for deciding whether to install conduit with respective projects. For projects that will be designed with conduit, a funding source will also be required for the additional design work and installation of these facilities. Although this comes at a cost to the County, the County should expect these costs to be significantly lower than installing fiber in new construction. Many governments have realized 60%-80% savings when compared with new construction.

5.5.1 Joint Trenching and Dig Once

A primary element of a broadband improvement program is installation of conduit. Installation of fiber-optic conduit during all projects involving roads, sidewalks, trails, or lighting projects where the ground is to be opened for any other purposes would be less costly than installing conduit through standalone broadband projects. Since most costs to build broadband infrastructure are incurred through underground construction and restoration processes, this strategy can alleviate significant costs by opening the ground once and inviting all utilities and communications companies to deploy infrastructure while the ground is open.

Joint trenching and dig once policies can facilitate more opportunities to install conduit, fiber, and other infrastructure due to lower costs. Standardization of these agreements across all potential owners of underground infrastructure can be established to ensure all parties are aware of the joint trenching opportunities as they become available. Installations should be coordinated between all relevant parties as a basic element within the projects.

The County should explore requiring conduit in private developments and buildings. Basic conduit infrastructure can be added in to development projects, again, for a minimal incremental cost, and will allow those buildings and properties to be considered "fiber-ready." Additionally, the County could work with companies deploying broadband infrastructure to put in additional conduit, inner duct or fiber with those projects. Many jurisdictions acquire ownership to fiber strands within providers' fiber cables in lieu of permit fees. While there can be restrictions placed on the use of this fiber, it does allow public fiber to be constructed very economically.

5.5.2 Engineering Standards

Engineering standards most support and simplify management and operations. They ensure that infrastructure deployed at different times, in different locations, by different entities is consistent and functional. Generally, the County would adopt standards based on input from appropriate and knowledgeable stakeholders, and then operations staff assure the standards are met.

Standards include contracts and operating procedures, as well as details around specific network facilities, and even specify the order of the spatial placement of underground cables. The number of standards increase with service offerings, and there is no shortage of issues and resources that should be standardized. Chatham County can determine projects that could best utilize this strategy. This policy should also be coordinated with private utilities operating in the region, broadband service providers, and other underground utility organizations.

5.5.3 GIS and Infrastructure Record Keeping

As part of the implementation of broadband-friendly public policy measures, all municipalities should require that Geographic Information System (GIS) documentation of all broadband infrastructure installations, upgrades, and other items be maintained and updated. Organizations that keep networking-related records utilize GIS to track conduit and fiber segments.

The County should be mindful of their GIS capabilities and consider a GIS fiber management "plug in" or even a separate platform that will provide this functionality. This will allow the County and other government agencies that may collaborate to maintain a clear understanding of locations of the broadband infrastructure such as conduit, vaults, pull boxes, transitions, fiber-optic cable, and other outside plant resources.

5.6 Coordinate Fiber Deployment with Capital Projects

As the broadband-friendly policies detailed above are developed, they should also be coordinated with private utilities operating in the region, broadband service providers and underground utility organizations. This coordination will minimize the need to overbuild and will ensure that all service providers have an opportunity to place their infrastructure in capital projects as well.

The County should evaluate its 5 to 10-year Capital Improvements Plan to determine if there are any capital projects that may create the opportunity to install underground conduit and/or fiber. Road, lighting, construction and other projects may create opportunities to install basic underground conduit when other utilities are being relocated or underground construction is taking place. The County could also coordinate with water utility management and other utility companies in the area to identify opportunities to create joint builds for conduit and fiber.

Many governments have missed opportunities to build fiber at a low cost in conjunction with capital projects because no funding mechanism was available to support the addition of conduit and/or fiber to a project. The County could identify small initial fiber builds that would meet a current need for connectivity yet require minimal County investment. The County should set up a rolling fund for fiber deployment that allows it to take advantage of these projects when they arise.

5.7 Pursue External Sources of Financing

As the Chatham County considers financing for a fiber network, it is important to understand the funding mechanisms that may be available to help with the costs through meaningful local, regional, and state cooperation and collaboration.

Federal Funding

Federal sources of funding for broadband infrastructure has been dwindling, especially after stimulus programs ended along with the Broadband Technology Opportunities Program (BTOP) and the State Broadband Initiative (SBI). In fact, most federal funding has been focused in recent years to rural and remote areas of the country, so while not impossible, the hope of federal funding in the form of direct grants or "free money" is not likely.

Chatham County likely does not qualify for many current sources of federal funds to help with this fiber infrastructure build. In fact, Chatham County does not qualify for Federal Communications Commission infrastructure funds because it does not fit the federal definition of being unserved, as several wireless and mobile wireless providers provide connectivity in excess of 10 Mbps download and 1 Mbps upload. The FCC is currently attempting to improve its telemedicine and mobile health programs under the Connect2Health initiative. Additionally, low interest loans offered by the USDA would not be an option because Chatham County it is not considered a rural or remote area.

There could be HUD funds available, but none that would offer standalone infrastructure funding. These programs typically require collaborative efforts that focus on the beneficial applications and services provided by the technology, often with limited funding for the actual infrastructure. These often involve housing agencies or are aimed directly at projects with a broad workforce or economic and community development focus, such as bridging digital divide, or rebuilding after catastrophic events or abrupt industrial changes with a focus on economic resiliency or economic diversification.

These, as more federal programs are doing, stress the collaborative aspects of the proposal consideration. The BroadbandUSA programs through the Department of Commerce may also be a possible source of collaborative funding, should the various ConnectEd and ConnectAll initiatives continue, depending on the direction the new administration decides to take with broadband programs. Similarly, the Economic Development Administration has an Office of Innovation and Entreprenuership that frequently announces competitive funding for regional collaborations that strive to result in job growth and increased workforce competitiveness.

FirstNET may provide an opportunity to coordinate funding to plan and build fiber and wireless infrastructure within Chatham County. The County should continue to follow and coordinate with Georgia Firstnet officials to more fully understand how local governments will interface with the larger FirstNET program. Since AT&T has been awarded the FirstNet contract the County should also seek out information on how 5G may roll out in the county, how that roll-out may affect or improve connectivity of broadband assets, and if fiber tower back-haul is a revenue opportunity for the County. The County should continue to collaborate with the Department of Commerce/NTIA, program managers and Georgia resources to determine future opportunities to integrate within the FirstNET architecture.

Whether the specific federal programs listed above continue or they evolve into new programs remains to be seen, but the overall trend of stressing broad local collaboration will certainly continue. Therefore, the overall point here is that if a community has broader socioeconomic goals that it can reach through technology and network connectivity, and it has shown a track record of working together successfully to partner for the betterment of the community, federal funding programs are more willing to cast a wider net in proposal evaluations.

Private Investment

Private capital investment is a possibility for funding network construction, and this is how many privately-owned networks are financed. Of course, the critical elements are ownership and revenue. Investors get a portion of one or both in return for their investments. Publicly-owned networks can be financed by revenue bonds if they provide services for a fee, or portions of the network could be privately owned.

For example, the County could own the fiber sheath, allowing decisions about routes and termination points to be based on community interests, and offer strands of fiber to private investors who will value those assets based on their revenue-generating possibilities. Investors will be most interested if the network is routed through areas with high-densities of tech-intensive companies or wealthy households, or if the routes reach remote but high-value locations. Cities, communities and neighborhoods in the county could work together to aggregate demand and come as one to a backbone route.

Special Purpose Local Option Sales Tax

A special-purpose local-option sales tax (SPLOST) is a potential financing mechanism, which could make the local government an actual investor and not merely a customer. The SPLOST is a financing method for funding capital outlay projects in the State of Georgia through an option 1% sales tax levied by the county for building parks, schools, road, and other public facilities and infrastructure. Cities are normally not allowed to levy sales taxes, they instead share proportionately with their county, according to how much was collected within respective city limits and unincorporated areas; however, cities can have a separate tax if the county does not participate. A SPLOST is passed by the county commission, usually with the agreement of its city councils, and voted up or down by residents in a referendum, usually during the next scheduled election.

5.8   Next Steps

Reiterating the recommendations set forth in this section, the next steps move Chatham County toward developing and realizing county-wide fiber-optic infrastructure goals. Many of these recommendations center around forming local collaborations to aggregate demand and formalize broadband-friendly policies across the county. Many of these next steps are low-cost, organizational and policy-oriented steps that will lead to a broader fiber-optic partnership and county-wide fiber-optic deployment.

1	**Recognize fiber-optic networks as a long-term infrastructure like road and water systems as opposed to a one-time project.**
2	**Formalize a county-wide Broadband Infrastructure Program and develop a Fiber Master Plan**
3	**Incorporate Broadband Friendly Public Polices and streamline fiber permitting processes to encourage broadband growth.**
4	**Formalize a county-wide fiber consortium or collaboration through development of a Memorandum of Understanding (MOU).**
5	**Develop and solicit a Request for Interest from service providers to participate in network opportunities or become potential partner.**
6	**Pursue sources of significant funding, such as the SPLOST VII, for solidifying the County's share of a fiber partnership.**

Appendix A: Glossary of Terms

Term	Definition
3G – Third Generation	The third generation of mobile broadband technology, used by smart phones, tablets, and other mobile devices to access the web.
4G – Fourth Generation	The fourth generation of mobile broadband technology, used by smart phones, tablets, and other mobile devices to access the web.
ADSL – Asymmetric Digital Subscriber Line	DSL service with a larger portion of the capacity devoted to downstream communications, less to upstream. Typically thought of as a residential service.
AMI – Advanced Metering Infrastructure	Electrical meters that measure more than simple consumption and an associated communication network to report the measurements.
Bandwidth	The amount of data transmitted in a given amount of time; usually measured in bits per second, kilobits per second (kbps), and Megabits per second (Mbps).
Bit	A single unit of data, either a one or a zero. In the world of broadband, bits are used to refer to the amount of transmitted data. A kilobit (Kb) is approximately 1,000 bits. A Megabit (Mb) is approximately 1,000,000 bits. There are 8 bits in a byte (which is the unit used to measure storage space), therefore a 1 Mbps connection takes about 8 seconds to transfer 1 megabyte of data (about the size of a typical digital camera photo).
BPON – Broadband Passive Optical Network	BPON is a point-to-multipoint fiber-lean architecture network system which uses passive splitters to deliver signals to multiple users. Instead of running a separate strand of fiber from the CO to every customer, BPON uses a single strand of fiber to serve up to 32 subscribers.
Broadband	A descriptive term for evolving digital technologies that provide consumers with integrated access to voice, high-speed data service, video-demand services, and interactive delivery services (e.g. DSL, Cable internet).
CAI – Community Anchor Institutions	The NTIA defines CAIs as "Schools, libraries, medical and healthcare providers, public safety entities, community colleges and other institutions of higher education, and other community support organizations and entities." Universities, colleges, community colleges, social service providers, public safety, government, and municipal offices are all CAIs.
CLEC – Competitive Local Exchange Carrier	Wireline service provider authorized under state and Federal law to compete with ILECs to provide local telephone service. CLECs provide services by: 1) building or rebuilding telecommunications facilities of their own, 2) leasing capacity from another local telephone company (typically an ILEC) and reselling it, and 3) leasing discrete parts of the ILEC network referred to as UNEs.
CO – Central Office	A circuit switch where the phone lines in a geographical area come together, usually housed in a small building.
Coaxial Cable	A type of cable that can carry large amounts of bandwidth over long distances. Cable TV and cable modem service both utilize this technology.
CPE – Customer Premise Equipment	Any terminal and associated equipment located at a subscriber's premises and connected with a carrier's telecommunication channel

Demarcation Point ("demarc")	The point at which the public switched telephone network ends and connects with the customer's on-premises wiring.
Dial-Up	A technology that provides customers with access to the internet over an existing telephone line.
DLEC – Data Local Exchange Carrier	DLECs deliver high-speed access to the internet, not voice. Examples of DLECs include Covad, Northpoint and Rhythms.
Downstream	Data flowing from the internet to a computer (browsing the net, getting E-mail, downloading a file).
DSL – Digital Subscriber Line	The use of a copper telephone line to deliver "always on" broadband internet service.
E-Rate	A Federal program that provides subsidy for voice and data circuits as well as internal network connections to qualified schools and libraries. The subsidy is based on a percentage designated by the FCC.
EON – Ethernet Optical Network	The use of Ethernet LAN packets running over a fiber network.
EvDO – Evolution Data Only	EvDO is a wireless technology that provides data connections that are 10 times as fast as a traditional modem. This has been overtaken by 4G LTE.
FCC – Federal Communications Commission	A Federal regulatory agency that is responsible for regulating interstate and international communications by radio, television, wire, satellite and cable in all 50 states, the District of Rock Falls, and U.S. territories.
FTTP – Fiber to the Premise	A fiber-optic system that connects directly from the carrier network to the user premises.
GIS – Geographic Information Systems	A system designed to capture, store, manipulate, analyze, manage, and present all types of geographical data.
GPON- Gigabit-Capable Passive Optical Network	Similar to BPON, GPON allows for greater bandwidth through the use of a faster approach (up to 2.5 Gbps in current products) than BPON.
GPS – Global Positioning System	A space-based satellite navigation system that provides location and time information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites.
ICT – Information and Communications Technology	Often used as an extended synonym for information technology (IT), but it is more specific term that stresses the role of unified communications and the integration of telecommunications, computers as well as necessary enterprise software, middleware, storage, and audio-visual systems, which enable users to access, store, transmit, and manipulate information.
ILEC – Incumbent Local Exchange Carrier	The traditional wireline telephone service providers within defined geographic areas. Prior to 1996, ILECs operated as monopolies having exclusive right and responsibility for providing local and local toll telephone service within LATAs.
ISDN – Integrated Services Digital Network	An alternative method to simultaneously carry voice, data, and other traffic, using the switched telephone network.
ISP – internet Service Provider	A company providing internet access to consumers and businesses, acting as a bridge between customer (end-user) and infrastructure owners for dial-up, cable modem and DSL services.

Recommendations and Next Steps

ITS – Intelligent Traffic System	Advanced applications that, without embodying intelligence as such, aim to provide innovative services relating to different modes of transport and traffic management and enable various users to be better informed and make safer, more coordinated, and 'smarter' use of transport networks.
Kbps – Kilobits per second	1,000 bits per second. A measure of how fast data can be transmitted.
LAN – Local Area Network	A geographically localized network consisting of both hardware and software. The network can link workstations within a building or multiple computers with a single wireless internet connection.
LATA – Local Access and Transport Areas	A geographic area within a divested Regional Bell Operating Company is permitted to offer exchange telecommunications and exchange access service. Calls between LATAs are often thought of as long distance service. Calls within a LATA typically include local and local toll services.
Local Loop	A generic term for the connection between the customer's premises (home, office, etc.) and the provider's serving central office. Historically, this has been a copper wire connection; but in many areas it has transitioned to fiber optic. Also, wireless options are increasingly available for local loop capacity.
MAN – Metropolitan Area Network	A high-speed intra-city network that links multiple locations with a campus, city or LATA. A MAN typically extends as far as 30 miles.
Mbps – Megabits per second	1,000,000 bits per second. A measure of how fast data can be transmitted.
MPLS – Multiprotocol Label Switching	A mechanism in high-performance telecommunications networks that directs data from one network node to the next based on short path labels rather than long network addresses, avoiding complex lookups in a routing table.
Overbuilding	The practice of building excess capacity. In this context, it involves investment in additional infrastructure projects to provide competition.
OVS – Open Video Systems	OVS is a new option for those looking to offer cable television service outside the current framework of traditional regulation. It would allow more flexibility in providing service by reducing the build out requirements of new carriers.
PON – Passive Optical Network	A PON consists of an optical line terminator located at the Central Office and a set of associated optical network terminals located at the customer premise. Between them lies the optical distribution network comprised of fibers and passive splitters or couplers. In a PON network, a single piece of fiber can be run from the serving exchange out to a subdivision or office park, and then individual fiber strands to each building or serving equipment can be split from the main fiber using passive splitters or couplers. This allows for an expensive piece of fiber cable from the exchange to the customer to be shared by many customers, thereby dramatically lowering the overall costs of deployment for fiber to the business (FTTB) or fiber to the home (FTTH) applications.
PPP – Public-Private Partnership	A Public–Private Partnership (PPP) is a venture funded and operated through a collaborative partnership between a government and one or more private sector organizations. In addition to being referred to as a PPP, they are sometimes called a P3, or P[3].
QOS – Quality of Service	Refers to a broad collection of networking technologies and techniques to provide guarantees on a network to deliver predictable results reflected in

Recommendations and Next Steps

	Service Level Agreements. Elements of QoS often include availability (uptime), bandwidth (throughput), latency (delay), and error rate. QoS involves prioritization of network traffic.
RF – Radio Frequency	A rate of oscillation in the range of about 3 kHz to 300 GHz, which corresponds to the frequency of radio waves, and the alternating currents which carry radio signals.
Right-of-Way	A legal right of passage over land owned by another. Carriers and service providers must obtain right-of-way to dig trenches or plant poles for cable systems, and to place wireless antennae.
RUS – Rural Utility Service	A division of the United States Department of Agriculture, it promotes universal service in unserved and underserved areas of the country with grants, loans, and financing. Formerly known as "REA" or the Rural Electrification Administration.
SCADA – Supervisory Control and Data Acquisition	A type of industrial control system (ICS). Industrial control systems are computer controlled systems that monitor and control industrial processes that exist in the physical world.
SNMP – Simple Network Management Protocol	An internet-standard protocol for managing devices on IP networks.
SONET – Synchronous Optical Network	A family of fiber-optic transmission rates.
Steaming	Streamed data is any information/data that is delivered from a server to a host where the data represents information that must be delivered in real time. This could be video, audio, graphics, slide shows, web tours, combinations of these, or any other real time application.
Subscribership	Subscribership is how many customers have subscribed for a particular telecommunications service.
Switched Network	A domestic telecommunications network usually accessed by telephone, key telephone systems, private branch exchange trunks, and data arrangements.
T-1 – Trunk Level 1	A digital transmission link with a total signaling speed of 1.544 Mbps. It is a standard for digital transmission in North America.
T-3 – Trunk Level 3	28 T1 lines or 44.736 Mbps.
UNE – Unbundled Network Element	Leased portions of a carrier's (typically an ILEC's) network used by another carrier to provide service to customers. Over time, the obligation to provide UNEs has been greatly narrowed, such that the most common UNE now is the UNE-Loop.
Universal Service	The idea of providing every home in the United States with basic telephone service.
Upstream	Data flowing from your computer to the internet (sending E-mail, uploading a file).
UPS – Uninterruptable Power Supply	An electrical apparatus that provides emergency power to a load when the input power source, typically main power, fails.
USAC – Universal Service Administrative Company	An independent American nonprofit corporation designated as the administrator of the Federal Universal Service Fund (USF) by the Federal Communications Commission that manages the E-Rate program.

Recommendations and Next Steps

VLAN – Virtual Local Area Network	In computer networking, a single network may be partitioned to create multiple distinct broadcast domains, which are mutually isolated so that packets can only pass between them via one or more routers; such a domain is referred to as a Virtual Local Area Network.
VoIP – Voice over internet Protocol	An application that employs a data network (using a broadband connection) to transmit voice conversations using internet Protocol.
VPN – Virtual Private Network	A virtual private network (VPN) extends a private network across a public network, such as the internet. It enables a computer to send and receive data across shared or public networks as if it were directly connected to the private network, while benefitting from the functionality, security and management policies of the private network. This is done by establishing a virtual point-to-point connection through the use of dedicated connections, encryption, or a combination of the two.
WAN – Wide Area Network	A network that covers a broad area (i.e., any telecommunications network that links across metropolitan, regional, or national boundaries) using private or public network transports.
Wi-Fi	Wi-Fi is a popular technology that allows an electronic device to exchange data or connect to the internet wirelessly using radio waves. The Wi-Fi Alliance defines Wi-Fi as any "wireless local area network (WLAN) products that are based on the Institute of Electrical and Electronics Engineers' (IEEE) 802.11 standards."
Wi-Max	Wi-Max is a wireless technology that provides high-throughput broadband connections over long distances. Wi-Max can be used for a number of applications, including "last mile" broadband connections, hotspot and cellular backhaul, and high speed enterprise connectivity for businesses.
Wireless	Telephone service transmitted via cellular, PCS, satellite, or other technologies that do not require the telephone to be connected to a land-based line.
Wireless internet	1) internet applications and access using mobile devices such as cell phones and handheld devices. 2) Broadband internet service provided via wireless connection, such as satellite or tower transmitters.
Wireline	Service based on infrastructure on or near the ground, such as copper telephone wires or coaxial cable underground or on telephone poles.

Appendix B: Broadband Friendly Public Policies

Document provided under seperate cover

Appendix C: Fiber Business Model Case Studies

Document provided under separate cover