

Broadband Recommendations

Culpeper County
Town of Culpeper

DRAFT
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Executive Summary

Culpeper County and the Town of Culpeper are at a critical point to ensure that its business community, government agencies, and citizenry are able to keep up with the latest technological enhancements for work and home life. All of the data points in this study come to the singular conclusion that action must be taken now to ensure that broadband in the county is accessible, fast, reliable and affordable. This study clearly indicates the business community and residents will support an initiative to make the necessary infrastructure improvements.

In the spring of 2016, Culpeper County and the Town of Culpeper were awarded a DHCD (Virginia Department of Housing and Community Development grant to assess current and future broadband needs, evaluate current broadband service offerings, costs, and availability in the town and the county, identify public/private partnership opportunities with service providers, assess market demand, and recommend a comprehensive of strategies to improve broadband connectivity.

As part of the work, a survey of how both residents and businesses were using broadband and their needs was taken. More than 574 responses to the two surveys were received. The data shows that there is widespread dissatisfaction with current services.

- 90% of businesses and 83% of residents want better Internet service.
- More than 63% of households are using the Internet for K12 school work, college school, and/or job training at least once a week. 11% of residents work full time from home, and over all, 72% of residents are trying to work part or full time from home. Internet access is no longer an entertainment luxury, but a necessity for education and work.
- 29% of residents spend more than \$150/month for Internet access, and 68% are spending more than \$100/month. Internet, TV, and landline phone service is a significant part of household budgets.
- 93% of businesses are not at all satisfied or only somewhat satisfied with their current Internet service. 88% said Internet was very important to the success of their business over the next five years.

Broadband has, over the past twenty years, become critical infrastructure for communities. Routine activities of both residents and businesses now often require Internet access. K12 schools continue to expand the use of Internet-enabled learning resources, and children in households with inadequate Internet service are at a severe disadvantage. Libraries in the county are reporting record numbers of people using Internet, and anecdotally, many mothers

report that it is common that they have to take their children to McDonald's or other free WiFi locations so that children can complete their homework.

In Culpeper County and the Town of Culpeper, the large number of people trying to use the Internet for educational activities and job-related work indicates that the Internet access in the area has become critical to community and economic development. The availability of affordable and adequate broadband is has already begun to influence both business location decisions and home-buying decisions. A local real estate agent, during one of the planning meetings, related that it is becoming increasingly difficult to sell houses that do not have adequate broadband—the Internet is determining where people choose to live.

RECOMMENDATIONS AND STRATEGIES

Strategies that can improve broadband availability and affordability include:

Form an Authority — The County and Town would benefit from collaborating on broadband initiatives, and collaboration with adjacent counties could also be very beneficial.

Public/Private Partnerships — All telecom, at varying levels, involve both public and private collaboration.

Implement Comprehensive Plan Recommendations to Improve Wireless — Section 7 of the 2015 Culpeper County Comprehensive plan outlines an excellent set of recommendations to improve access and affordability of broadband.

Conduit/Dark Fiber Strategy — A strategy of steady year by year development of telecom conduit placement in the Town of Culpeper and in areas of growth focus in the County could lead to increased availability of fiber services from private providers who would lease conduit. If the County also placed dark fiber in the conduit, additional revenue could be gained from the investments.

Meet-me Box and Fiber Drop Strategy — Meet-me boxes and inexpensive fiber drops to nearby homes or business/retail locations could attract improved wireless services from service providers and/or promote increased competition.

Cellular Tower Access — Some cell tower owners are beginning to recognize that there are advantages to allowing fixed wireless broadband providers to co-locate on their towers with their cellular customers. The County may be able to play a role in accelerating this process.

Demand Aggregation — A simple ongoing Web-based survey managed by the County that collects customer demand information (including location) could be distributed periodically to service providers.

Referendum — It may be useful to have a public vote on allocating funds for broadband improvements in the county.

Nano-cell Cellular Strategy — In some parts of the county where broadband service to the home is adequate but cellular service is poor, wider use of nano-cell equipment can provide improved cellular phone service in homes and rural businesses.

Service District Funding Strategy — Coupled with the demand aggregation strategy, some areas of the county could be designated as “broadband service districts” to provide a funding mechanism for broadband infrastructure improvements.

Why Broadband?

Broadband networks are the first enabling technology since electricity to fundamentally impact society to such a great extent that it is now viewed in economic development circles as critical infrastructure. Access to broadband provides communities with the foundation necessary for economic growth and a sustainable quality of life.” [from the Culpeper County Comprehensive Plan]

When local governments undertake a study of broadband infrastructure, a key question should be:

“What is the benefit if the community invests in broadband infrastructure?”

And the inverse question should also be asked:

“What happens if we don’t make strategic broadband investments?”

This report assesses and analyzes current conditions and future potential of broadband in the Town of Culpeper and Culpeper County. Broadband has become essential infrastructure for both business activities and personal activities. The very strong response to the business and residential surveys (more than 500 completed surveys) indicates that affordable, high performance broadband is seen as an important issue.

World class broadband infrastructure will be necessary to maintain the town and county’s attractiveness as a great place to live and to work. This can only be accomplished if the residents and businesses have the right telecommunications infrastructure that will support the needs of existing businesses and also attract new businesses.

Broadband is not a silver bullet for the Culpeper region. Broadband investments need to be tied to a wider set of community and economic development strategies that help make the area an engaging and interesting place to locate and run a business and a vibrant and interesting place to live. Communities that have made broadband investments without taking the time to identify a broader set of goals and expected outcomes have usually been disappointed when broadband investments have not had much of an impact. However, it is clear that broadband investments are critical for economic viability.

Community investments in infrastructure will accelerate the availability of broadband options within the community, especially in the business and retail sector. It is important to note that this report does NOT recommend that the Town or the County sell services like Internet, telephone, and TV to residents and businesses.

If the Town or the County chooses to make investments, the improvements should be at the basic infrastructure level (e.g. wireless towers, conduit, dark fiber) that can be leased to the private sector. Lease payments, over time, would be used to pay back the initial capital expense and to fund additional improvements as they are needed.

Private sector firms, including existing telecom providers, would use the new infrastructure to compete with each other. Service providers using the network would pay a small portion of revenue to the network for the use of the infrastructure.

Demographic and work changes must be considered as part of the decision-making process. The survey results show that well over 50% of respondents are trying to work from home part or full time. Broadband availability and affordability are affecting a wide variety of lifestyle and economic decisions: Consider the following data from a Fiber To The Home Council report (March, 2013):

- ▶ Among young people under 35, 54% of males are “very interested” in advanced broadband services, and 44% of females are “very interested” in advanced broadband services. In this age group, over 65% are “very interested” in working from home.
- ▶ In the over 54 age group, one third of men and women are interested in advanced broadband services, and over half want to use HD video calls.
- ▶ 11% of fiber to the home users have a home-based business.
- ▶ Fiber service is ranked as the number one factor influencing a home purchase if the buyer already has fiber at their current residence. Fiber is ranked as the number two home buying factor if they do not have fiber service now.
- ▶ Fiber connected homes are perceived as being worth \$5,000 to \$6,000 more than an equivalent home without fiber.
- ▶ Because of the increase in home-based businesses due to fiber availability, fiber can create as much as \$1.1 million in new business revenue to the community for every 1,000 homes passed by fiber.

As the local schools continue to rely more heavily on Internet-based learning materials, usable and affordable Internet access in the home is becoming a critical part of the learning environment. Broadband in Culpeper must have the following characteristics to support economic development and business growth, and to support K12 education.

Accessible — Residents and businesses in the town and the county need to have broadband available to them, preferably with a choice of providers, services, and pricing options.

Affordable — Broadband has to fit within the budgets of citizens and businesses in the county. Cellular data and satellite services may provide Internet access, but often at a very steep price.

Reliable — The aging copper cable plant in rural parts of the county limits the ability of DSL service to provide reliable broadband service. Complaints of service outages during periods of heavy rain are common.

Useful — Residents and businesses need enough bandwidth to meet business, personal, and educational needs.

The Cost of Broadband

“Broadband connectivity is not the infrastructure of the future, it is the infrastructure of the present.”

Mark Peterson, Prof. of Community and Economic Dev., U. of Arkansas

Over the next thirty years, the businesses, residents, and institutions of Culpeper County and the Town of Culpeper will spend an estimated 1.4 billion dollars on telecommunications services--in today's dollars, unadjusted for inflation and unadjusted for price increases.

Some analysts believe that the average household bill for services delivered via broadband may double in the next ten years, which would make the thirty year projection easily exceed two billion dollars. Currently, there exists a substantial opportunity to capture more of these funds and direct them towards greater job creation and business opportunities for the region.

Numerous studies indicate that demand for bandwidth is doubling every two years, and that the FCC expects that the typical bandwidth needed by businesses and residents will exceed 50 megabits in the near future. Indeed, the New Hampshire FastRoads community-owned fiber network is finding that their 50 Meg residential Internet service is extremely popular...in rural and remote New Hampshire.

Community livelihood and the economic future in Culpeper is dependent upon the availability of affordable high speed broadband services--at the bandwidths that will be needed to conduct business in the future (“big” broadband), not at today’s “little” broadband speeds. Businesses large and small are already heavy users of the Internet, and their bandwidth needs will increase dramatically as two business trends accelerate:

Business travel costs are increasing rapidly as the cost of fossil fuel increases. Both the cost of ordinary commuting to the workplace is increasing as well as the cost of out of town business travel by air. Businesses are already investing heavily in HD quality business videoconferencing systems, and will make more use of them to reduce travel costs. These HD quality business videoconferencing systems require dramatic increases in bandwidth that are not affordable or in most cases not even available in certain areas of the region.

In the region, the availability of affordable high performance fiber and wireless broadband services is spotty and still out of reach cost wise for many businesses and residents.

In September of this year, the chief counsel for the FCC, Gigi Sohn, stated:

“Rather than wait for incumbent ISPs to build the network your cities want and need, you can take control of your own broadband futures.”

“Rather than thinking of yourselves as taxers and regulators, which has been the traditional role, you can think of yourselves as facilitators of the kind of services you’ve been begging the incumbents to provide for years.”

In many states and the federal government, the employment commission encourages businesses to allow employees to work from home to help with work-life balance and reduce overhead costs in the office, but the broadband infrastructure must be in place. High performance broadband could have positive effects: it could enable more people to work from home, it could enable more home-based businesses, and it could attract more businesses to the county.

More and more workers and business people are working from home, either on a part time or a full time basis. New work from home job opportunities are growing rapidly, but most of those jobs require a wired Internet and a wired phone connection to qualify. Many corporate and business employees will be seeking permission to work more from home (e.g. one or two days per week) to reduce travel costs. Some major businesses in other parts of the U.S. are already actively planning to have 20% of their workforce work full time from home to reduce employee travel costs and office energy costs. Telework initiatives are becoming more widespread throughout each state, where employees working from home require high bandwidth services to be connected to the office network and to use corporate videoconferencing systems. These corporate network services will require 35-50 megabit connections within five years.

OUTCOMES OF STRATEGIC COMMUNITY INVESTMENT	OUTCOMES OF LEAVING IT ENTIRELY TO THE PRIVATE SECTOR
Increased competitiveness with other counties and regions that have made broadband investments and have driven down the cost of Internet and voice services for businesses and residents.	Communities that lack affordable access to “big broadband” are finding it more difficult to attract and retain businesses. Residents in areas with inadequate broadband are having difficulty selling their homes or are moving to other areas.
Better prepared to attract businesses and jobs to the county.	The Town and the County are at an economic disadvantage without a strategy to ensure that affordable high speed broadband is in place as a business attraction and business retention tool.
Communities that have made investments have seen the cost of telecom services reduced, keeping more money in the community and freeing up business funds for expansion and jobs creation.	Residents and businesses will continue to pay more for voice, TV, Internet, and other broadband services.
A long term strategy of “big broadband” everywhere” gives the area better educational opportunities and improved access to jobs. Fiber and high performance wireless services in the area will also attract entrepreneurs and business people who want to work from home.	The area may see less population growth, loss of younger workers and families, and diminished educational opportunities.
Aggregation of the marketplace for telecom services via shared community infrastructure attracts more providers and helps keep prices for broadband services lower.	Private sector providers will continue to “Balkanize” the region, with higher prices and more limited bandwidth options because of limited competition.
Growth in defined development areas is likely to be more manageable if adequate broadband service is more widely available.	Broadband drives business location decisions. Residents avoid living in areas with poor broadband connectivity. Unplanned or unanticipated growth may occur in areas where better broadband services are available.

Assessing Demand In Culpeper

A market research study was conducted to determine the market for improved broadband access and affordability. The study was an online and paper survey of residents and businesses in Culpeper County and the Town of Culpeper.

The surveying was primarily conducted through an online (Internet) survey. This method was chosen due to a number of advantages which include faster results, lower costs, and a shorter data collection period. Paper forms of the survey were also available to the community if individuals did not have access to a computer or Internet. Paper submissions were mailed back or dropped off at the Culpeper County Planning and Zoning Office. Both the online survey as well as the paper form were available to any business in the Town or County with no specific target group. Paper surveys were distributed at the library and in several other locations to help capture data from residents and businesses who may not have Internet access at home or the place of work.

The study was done to determine the following:

- Satisfaction with current telephone, Internet/data, and TV service
- Demographic information
- Types of Internet connections
- Current Internet usage and purpose
- Importance of Internet access
- Willingness to pay more for faster, higher quality Internet access
- Cost of services
- Current service providers for telephone, Internet/data and TV service
- Information about residents who work from home

This market research can be very useful in setting priorities for next steps, and can be an important part of state and Federal funding and grant opportunities.

RESIDENTIAL SURVEY RESULTS

A total of 532 responses were collected. Not all responders answered every question.

Some of the key data points that resulted in the survey include:

83% of the respondents desired better Internet/data service.

61% of the respondents desired better cellular telephone service.

82% of the respondents are not satisfied with all of their services.

94% of the respondents have an Internet connection.

96% reported that the Internet is “very important” to their household.

71% are paying more than \$61/month for their Internet service, and 50% are paying more than \$80/month.

65% of the respondents who were still on a dial-up connection said that they had no other options in the area to switch to a different or better service.

27% of the respondents who have an Internet connection use wireless Internet.

20% are using satellite service, which typically means they have no or very poor DSL/dial-up service in their area of the county.

Respondents of the survey use the Internet to check and send email, access news and current events, perform homework and schoolwork, work from home, social network, research, shop, and bank online.

48% of the respondents indicated that at least one individual in their household uses the Internet to complete school assignments or job training at least several times a week.

36% of the respondents need nights and weekends access for the company business.

16% are self-employed and trying to work from home part or full time.

20% work for another company and are trying to work from home part or full time.

72% of respondents are trying to use their home Internet connection for work at least part time.

CURRENT SATISFACTION OF EXISTING SERVICES

Overall, the respondents felt a need for better cellular telephone service, Internet/data service, and Cable/TV service. 83% of the respondents desired better Internet/data service and 61% of the respondents desired better cellular telephone service. In addition, over half of the respondents felt the need for better Cable/TV service as well. 82% of the respondents are not satisfied with all of their services. This data indicates that residents generally are in need of better services that can offer reliability, speed, and a better price point.

OWNERSHIP OF COMPUTERS AND CURRENT INTERNET USAGE

From the sample, 20% of the respondents live in a household of three individuals. 25% of the respondents also live in a household of four individuals. 32% of the respondents live in a household with two computer users and 20% of the respondents live in a household with 3 computer users. 94% of the respondents have an Internet connection.

Existing Internet connection type and price

Of the respondents who have an Internet connection, 23% used wireless Internet and 6% were on a DSL line. 1% of the respondents were still on a dial-up connection. 65% of the respondents who were still on a dial-up connection said that they had no other options in the

area to switch to a different or better service. In terms of cost, 13% of the respondents paid between \$41 to \$60 per month for Internet access. Half of the respondents paid more than \$80 per month for Internet access.

USE OF THE INTERNET

The respondents of the survey used the Internet for a variety of reasons. Some of the main uses of the Internet include checking and sending email, accessing news and current events, performing homework and schoolwork, working from home, social networking, researching, shopping, and banking online.

An open response question was asked following this question about any other additional uses of the Internet. Many of the respondents who answered this question commented that they essentially use the Internet for all of the activities listed. 48% of the respondents indicated that at least one individual in their household use the Internet to complete school assignments or job training at least several times a week.

When asked if the respondents work from home, 36% of the respondents need nights and weekends access for the company business. 16% of the respondents work either part time or full time from home remotely.

The survey also indicates that the respondents do not seem to have difficulties in finding help and training on the computer or Internet. 42% of the respondents said that it was not difficult to find help or training on the computer or Internet. Furthermore, 96% of the respondents found accessibility to the Internet to be very important.

The respondents used personal computers, gaming consoles, hand held gaming consoles, e-readers, cell phones, smartphone, and iPads or other tablets to connect to the Internet. 25% of the respondents connected to the Internet via a personal computer like a desktop, laptop, netbook, or tablet. 11% of the respondents also connected to the Internet through a cell phone.

SATISFACTION WITH SPECIFIC SERVICES

Only 38% of the respondents were somewhat satisfied with their current telephone service, and 10% were not at all satisfied with their current telephone services. Similarly, 40% of the respondents answered that they were only somewhat satisfied with their current TV service. 46% of the respondents also answered that they were only somewhat satisfied with their current Internet service and 36% of the respondents indicated that they were not at all satisfied with their current Internet service.

CURRENT COSTS AND PROVIDERS

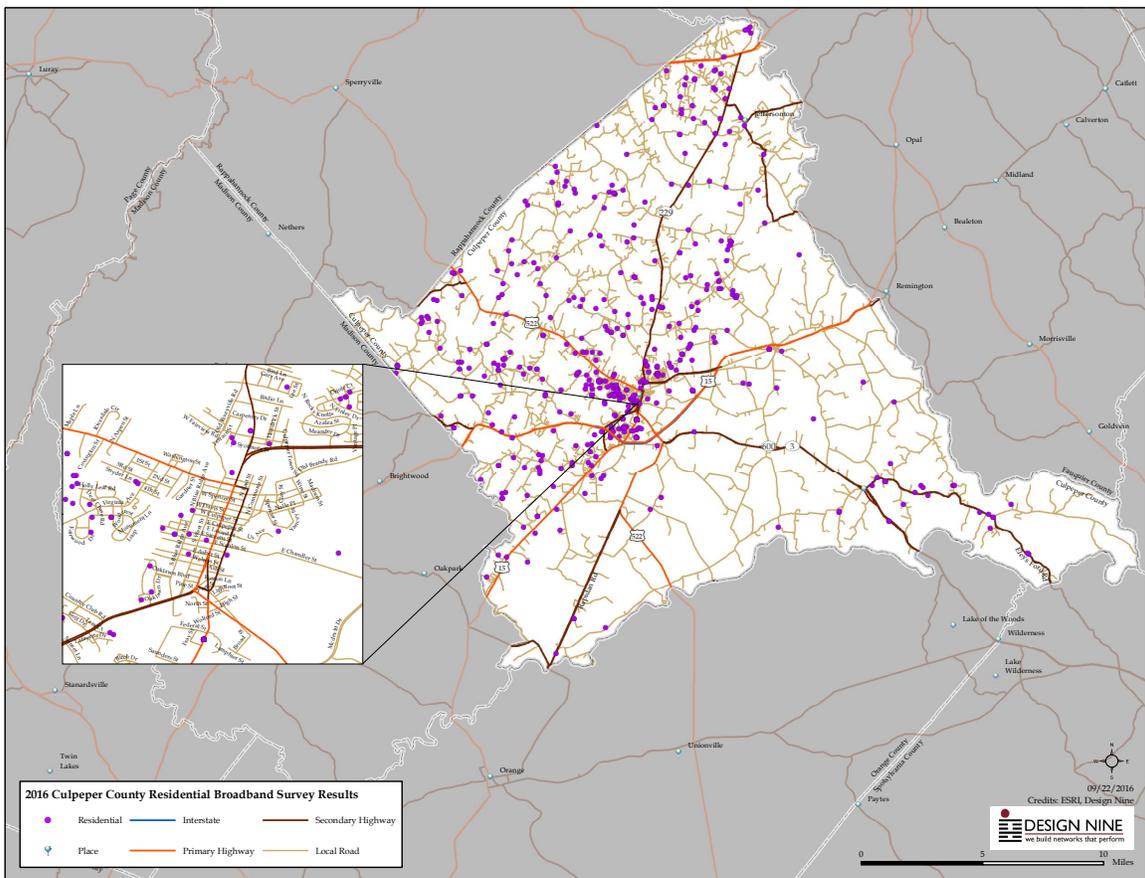
26% of the respondents pay between \$150 to \$200 for local and long distance telephone, TV, and Internet per month. Almost 30% of the respondents pay more than \$200 per month for all three services. 107% of all the respondents use Verizon as their provider for Internet, local dial-tone telephone, and long-distance telephone. 38% of the respondents use DIRECTV as their television provider. The residents of Culpeper County seem to lack satisfactory options in terms of price and providers.

WILLINGNESS TO PAY

When asked if the respondents would be willing to pay more for faster, higher quality Internet access, 41% of the respondents said that they would be somewhat willing and 19% were very willing to pay more.

SERVICE DESIRED

Respondents were asked if there were any additional telecommunication needs that were not covered in the survey. A number of the respondents stated that they desired better, reliable cellular phone coverage. In addition, respondents also desired a higher speed Internet connection to be able to watch and/or download movies that is not limited due to geographic location. Some respondents also desired the ability to access work computers remotely. The map below shows the distribution of residential survey responses in the county.



SUMMARY DATA

Check the items you agree with below.

Question	Yes	No
I need better landline telephone service.	19%	81%
I need better cellular telephone service.	61%	39%
I need better Internet/data service.	83%	17%
I need better cable/satellite TV service.	60%	40%
I am satisfied with all of my services.	18%	82%

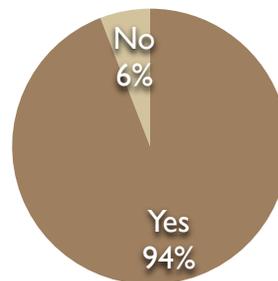
Number of people in household:

1	2	3	4	5	6	7+
28	161	101	129	55	27	13
5%	31%	20%	25%	11%	5%	3%

Number of computer users:

1	2	3	4	5	6	7+
46	167	104	106	53	21	17
9%	32%	20%	21%	10%	4%	3%

Do you have an Internet connection?



If yes, what type?

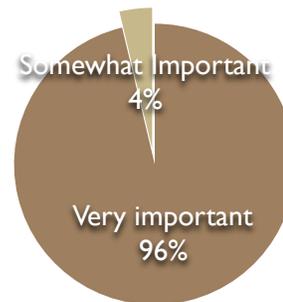
Dial-up	7	1%
Cable Modem	163	33%
Satellite	100	20%
DSL Line	29	6%
T1 Line	1	0%
Don't Know	22	4%
Fiber	21	4%
Cellular wireless	115	23%
Broadband WISP	21	4%
Other	18	4%

How much do you pay now for Internet Access each month:

No Internet	\$10-20	\$21-40	\$41 to \$60	\$61-80	More than \$80/month	Use free local hotspots	Don't Know
21	8	20	67	108	253	4	26
4%	2%	4%	13%	21%	50%	1%	5%

How important is Internet Access to you or your household?

Yes	No
481	30
94%	6%



How satisfied are you with your current telephone service?

Not at all Satisfied	Somewhat Satisfied	Satisfied	Very Satisfied
74	189	189	49
15%	38%	38%	10%

How satisfied are you with your TV service?

Not at all Satisfied	Somewhat Satisfied	Satisfied	Very Satisfied
80	199	161	59
16%	40%	32%	12%

How satisfied are you with your current Internet service?

Not at all Satisfied	Somewhat Satisfied	Satisfied	Very Satisfied
214	182	72	38
42%	36%	14%	8%

If you are still on dial up, why are you?

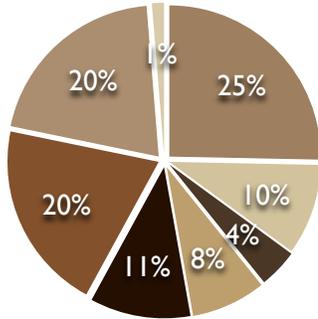
Too expensive	Lack of help/support	Not interested	No other options in my area
4	1	27	60
4%	1%	29%	65%

Would you be willing to pay more for faster, higher quality Internet access?

Not at all willing	Somewhat willing	Very willing	Not sure
93	204	130	71
19%	41%	26%	14%

What equipment do you currently connect to the Internet?

Personal computer (desktop, laptop, netbook, or tablet)	492	25%
Gaming console	189	10%
Hand held gaming console	81	4%
E-reader	155	8%
Cell phone	209	11%
Smartphone	394	20%
iPad or other tablet	398	20%
Other	25	1%



- Personal computer (desktop, laptop, netbook, or tablet)
- Gaming console
- Hand held gaming console
- E-reader
- Cell phone
- Smartphone
- iPad or other tablet
- Other

Other equipment include:

Other (equipment)
Blu-ray player to stream Netflix (low quality, unreliable)
BluRay Player
Cameras, GPS updates (Don't work because my system is too slow) I sometimes have to take my GPS device to a high-speed internet location. This is not equipment, but I am unable to watch streaming videos required to update my work as an online English teacher at EVHS and CCHS..

Cell phone ATT not very good reception
Directv access
Directv boxes
Everything, tv, dvd, fire stick ect.....dumb question
Ham radio equipment
HELP !! In Amissville the internet service is terrible to non at all. Would love to have high speed dependable internet !!!
HotSpot
i cannot connect my television to the internet b/c we have to use Hughes.net satellite internet service and it is too slow. Also we already use too much bandwidth w/o the tv.
in most situations, not all of the above devices are connected at once because the internet services cannot handle it
iPod touch
Kindle
Printers
Roku
roku, chromecast
Roomba
Satellite dish
Security system
Servers
smart tv
television
There is no TV signal in my area. Would like local channels. We have not had signal since everything went "digital". We got a "box"and booster, but still no signal. We pay for Internet via satellite not too excited to pay more for TV. Bundled services-Internet and TV are not avail in my area, by any provider.
TV's, Ham Radio, Weather station.
U.K. Tv boxes and smart tv
Verizon Broadband Fusion is our Internet but it is very expensive at \$120/month as we often go over because I work from home doing word processing. We are unable to stream movies and that is very disappointing. Would love an affordable, unlimited, high-speed Internet option!
Verizon MiFi box

We could only get satellite at our new home. If there is one cloud in the sky, satellite doesn't work. Connection speeds feel slower than with dialup... How can it be possible that this is 2016 and our brand newly built home doesn't have internet available?!?
We have to watch videos and download before 8am cause it eats up the internet after that , my child likes to play school games on it but it has to be limited
We use a Jet pack for our internet. Verizon and it isn't good. When you asked if I would pay more money for another service the answer would be yes however it can't be a lot more. Comcast came out and wanted ME to pay for the lines from the gravel road to my house. LIKE I'M GOING TO PAY FOR THERE EQUIPMENT AND A MO. BILL!!!!!!!!!!!!!!!!!!!!
We use several devices. We have Comcast for all three services. The price is ridiculous.
Would consider VoIP phones

Check all items you use the Internet for now:

Email	508	10%
Access news and current events	450	9%
Homework / Schoolwork	330	7%
Work from home	350	7%
Watch movies and online video	285	6%
Download or listen to music online	312	6%
VoIP (Vonage, Skype, etc)	152	3%
Online Backup (files, photos, music)	268	5%
Telemedicine, telehealth	59	1%
Online Gaming	138	3%
Social networking -- Facebook, Myspace, LinkedIn, etc.	432	9%
Personal research	427	9%
Download books/audiobooks	258	5%
Shopping	462	9%
Online banking	439	9%
Other	19	0%

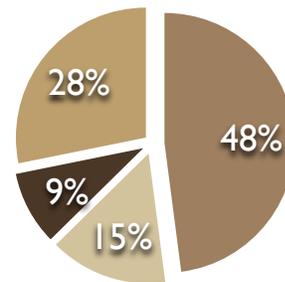
Other uses include:

Other uses:
Because we are limited in the amount of downloads daily via satellite, we often go to the public library and use their computers and wi fi access to accomplish tasks and projects. They close at 9 pm and Internet turns off 10 min before closing.
Business hosted website
Download large files from iTunes purchases. Not streaming. Operating system downloads typically exceed a GB, and I have more than one computer to update.
Everything again dumb question
Ham radio usage.
Home Business Use
I currently cannot work from home and have to rent an office because internet will not support reliable VoIP and reliable speed.
I don` t have a home computer.
I need high speed service to work from home I don't have the option that is affordable
I would do more like download\listen to music, watch movies\online video streaming if my internet was better and I did not have a small data cap.
I would like to have the ability to work from home. Wireless internet is expensive and not reliable.
I would like to use the internet for all these things but particularly I would like to work from home some day. It order to get service fast enough, I would have to have a very expensive satellite. It is very inconvenient and it is ridiculous that our end of the county is in the dark ages.
Instructional videos. Workshop manuals. : "How to....."
Investing
Medical Appointments and medical test results reports. Many doctor offices use systems connected with the internet to relay information and prescriptions to their patients.
Not able to do much downloading since have limited amount of gigs per month without being charged an arm and leg.
online auctions
pay bills
Software programs - Apex Learning and Plato Learning (Online teaching)
storing photos and using them to create calendars, etc.
The second question after this does not make sense as the first few words are missing, so I could not answer it.
Verizon Broadband Fusion is our Internet but it is very expensive at \$120/month as we often go over because I work from home doing word processing. We are unable to stream movies and that is very disappointing. Would love an affordable, unlimited, high-speed Internet option!
Video streaming
Volunteer for library and garden club

We can not stream movies because we do not have unlimited internet access and it is to expensive to increase our data allowance.
we would do movies, videos and other stuff if we didn't have such limited bandwidth using Hughes.net. We pay about \$150 per month for 30MB of data each month and it seems like my kids use all the data during the first week of the month.
We would like to use it for school work but it is too expensive/slow to be used regularly. We pay \$80 a month for 10GB and regularly go over that just with household needs and uses.
We would use the internet for more, except we have limited data available on the cellular network.
Website design
Website for home based business
Well done to think of sotihmeng like that
Work
Working from home
Would love to be able to watch a movie on Netflix or listen to Pandora but streaming videos uses up all our available gigs in less then 40 minutes, then there is no internet for the rest of that day. Pretty disappointing when you realize we live 60 miles from Washington, DC, the capital of the free-world!!
Would use it for much more but our data is limited.

Does anyone in your household use the Internet to complete school assignments or job training course work?

Yes, several times a week	245	48%
Yes, at least once a week	75	15%
Yes, at least once a month	47	9%
No	144	28%



- Yes, several times a week
- Yes, at least once a week
- Yes, at least once a month
- No

How difficult is it to find help and training for things you would like to do on the computer or on the Internet?

Very Difficult	Somewhat Difficult	Not Difficult
85	175	186
19%	39%	42%

For your household, how much do you spend each month for local and long distance telephone, TV, and Internet? (Do NOT include cellphones)

\$50 or less	\$50-75	\$75-100	\$100-150	\$150-200	More than \$200/month
6	46	59	98	129	163
1%	9%	12%	20%	26%	33%

Who is your Internet Service provider?

Blank	38	7%
AOL	4	1%
AT&T	34	6%
Comcast	194	36%
Direct TV	14	3%
DishNet	1	0%
Exede	19	4%
Frontier	1	0%
HughesNet	39	7%
Juno	1	0%
MSN	1	0%
NA	11	2%
None at the House	12	2%
Piedmont	2	0%
Sprint	8	2%
VA Broadband	11	2%
Verizon	135	25%
Wildblue	7	1%

Who is your cable/satellite TV provider?

Blank	37	7%
Comcast	146	27%
DIRECTV	201	38%
Dish Network	85	16%
Excede	2	0%
NA	11	2%
No provider is available	4	1%
None	19	4%
Verizon	20	4%
Regular Antenna TV	7	1%

Who is your local dial-tone telephone service provider?

Blank	87	16%
AT&T	18	3%
Comcast	70	13%
Excede	1	0%
Hughes Net	1	0%
Juno	1	0%
Magic Jack	3	1%
NA	52	10%
None	43	8%
Ooma	4	1%
Sprint	3	1%
Straight Talk	3	1%
Verizon	224	42%
Vonage	6	1%
Use Only Cellphone	16	3%

Who is your long-distance telephone service provider?

Blank	94	18%
AT&T	32	6%
Comcast	61	11%
First Data	1	0%
Hughes Net	1	0%
Magic Jack	3	1%
MCI	1	0%
NA	55	10%
None	37	7%
Ooma	4	1%
Pioneer	1	0%
Sprint	3	1%
Straight Talk	3	1%
Voyage	6	1%
Verizon	194	36%
Use Cellphone	36	7%

What other telecommunication needs do you have that were not covered in this survey?

Responses
affordable unlimited broadband, WISP is 200+ by itself for unlimited
AT&T
ATT and Verizon Mobile Phone Service
better cell coverage in my area
Better cell phone reception.
Biggest road block is data allowance maximums. For one month: 15GB max for daily monthly data; 50GB max for nightly data. Total for month: 65GB. This is usually all used up by the end of the month.
Cable and DSL is not available in our area. Only options are satellite, jet pack through Verizon wireless for our Internet which we pay per GB of data. Very Direct!
Cable service (Comcast, FIOS ans Fiberoptic) runs the entire length of my property but, because my home sits back more than 150 from U. S. Rte. 29, they will not bring the service to my home.
Cable TV is much too expensive! And, why are we forced to pay a "Broadcast TV Fee" and "Regional Sports Fee" when we use neither? There needs to be more competition in the local internet and TV market. In short, quality is not a problem, but cost is.
Cable TV/Internet
cell phone
Cell Phone

Cell phone
Cell phone - AT&T
Cell phone - Sprint
Cell phone (2) - \$140.00
Cell phone ATT
CELL PHONE SERVICE!!!! I HAVE MEDICAL NEEDS THAT I NEED A PHONE FOR WHEN THERE IS NO ELECTRICITY
cell phone signal
cell service
cell service is not strong in my area.
Cellphone
Cellphone coverage has gotten better in recent years for calls, but the data coverage is still very slow and drops off
Cellular phone service
Cost - way too high for retirees on fixed income!!
Everything is done through the net this survey was a waste of money, it's time to upgrade the infrastructure of the county, how about getting Fios or some other high speed installed or get Comcast to upgrade the cable system
fax machine
Fiber Optic Services
Having a choice would be great. Cable is on our street but stops before our house and provider won't extend availability to newer houses (houses that are newer are 10 years old already).
I am of the opinion that the questions cover the subject rather well. A strong and reliable internet connect is no longer a luxury, but a necessity to conduct your personal business and life. The business world wants everyone to do everything online. However, this is impossible to achieve with a connection that continually goes down on a frequent bases. It is far past time to move forward for the citizens of Culpeper County.
I cannot stream movies or use dish hopper
I currently cannot do online backups of data due to bandwidth cap. VPN access, though much better with high speed satellite, still has a lot of latency.
I have been denied a couple of jobs due to the lack of cell coverage and internet access at home.
I need cheaper options that have similar quality of service.
I need faster and reliable internet at a reasonable cost which I do not have. When it rains my telephone gets static, my internet is non-existent unless I use dial-up and my tv comes and goes. How are senior citizens supposed to afford this stuff when it doesn't even work half the time? I cannot afford a cell phone.

<p>I need less expensive access to basic local TV stations and basic internet service. Current costs from COMCAST and now Verizon (FIOS) seem to accommodate the heavy power user and do not provide service for someone who has just basic needs. Also, when looking at the news websites (bbc, cnn, usa today, and others, there is so much force feeding of advertisements and streaming video's that the basic 10 Mbps provided by COMCAST can not handle the throughput rate efficiency. Another point, although COMCAST advertises that they provide 10 Mbps for their basic service, the service actually provided is only 7 Mbps. Perhaps the county should look at this and require the provider to provide the advertised rate customers are billed. Living in Culpeper, it is not possible to pull in the local TV stations (ABC, NBC, etc) with an "over the air" antenna. This makes it necessary for residents to contract with a TV provider such as satellite TV or Cable. Perhaps the town should establish a station that would retransmit over the air TV for residents who do not need or want Satellite or cable. Lastly, the following two questions assume respondents to this survey are employed....I am retired and on a fixed income.</p>
<p>I try to use VPN to remote into work and it's too slow to use it.</p>
<p>I would do anything to get FIOS or Comcast to wire our area. We are stuck trying to share 15G data for 6 people per month and it is so frustrating. We can't stream video or download anything at the house. The Verizon hotspot is our best option, but very limiting for us.</p>
<p>I would like to have cable or a better satellite that provides faster than dial up between the hours of 5-10pm. I would like to stream, or see movies except again the speed is terrible.</p>
<p>I would like to see fiber run into my neighborhood. Currently my only option for broadband is Comcast cable internet which is subject to the failings of all cable internet services such as reduced bandwidth during peak hours, high usage among neighbors reducing bandwidth, etc.</p>
<p>I would love to work at home more but due to the cost and lack of unlimited internet I cant.</p>
<p>If I had high-speed internet, I would explore additional interests. Now, my system is too slow for streaming and other data transmission. I am hoping this survey doesn't "time out" because I have difficulty maintaining communication with the school system because of slow transmission.</p>
<p>If it was a option I would swap to fiber optic due to Comcast's poor customer service. Only issue is there are no options for a 50+ speed connection presently.</p>
<p>Just a reliable Internet connection that doesn't cost an arm and a leg.</p>
<p>Just need cell phone service!!! We have no cell service in our area and we have at&t</p>
<p>Keep big govt out of my life.</p>
<p>less expensive service</p>
<p>Lower costs. Many seniors have to cancel or reduce access and services because of the high costs. Proper and complete training on how to use telecommunications technology is hard to find for seniors.</p>
<p>Mainly would like access, affordable Internet and cell bundle for my area of the county.</p>
<p>Mobile Phone</p>
<p>my biggest beef is that the cellular service - certainly for at&t my provider - is inadequate am often non-existent, which is the case at my house. this keeps me tied to a landline that seems to be mainly used by robocalls or people trying to obtain money or sell me something. voip is not an option as a replacement as yet (wish it was!) because being rural, electrical outages go with the territory.</p>
<p>Object to the Comcast bundle that includes phone that I don't want or need but have to pay for - because they charge more for cable TV and internet service without the bundle.</p>

Our home satellite internet is unreliable and I am sometimes forced to use my Verizon mobile phone as a hotspot in order to continue to conduct business. It is lousy solution and a "Giga-hog", as well as very expensive per gig. Our home's property line abuts Rt 229. Comcast quoted us a minimum of \$11,500 to run cable from their line on Rt 229 to our home.
Really looking for FIOS. Otherwise satisfied with Comcast.
Reliable WIRELESS download and upload speeds that are fast or instant
Speed and bandwidth of internet is critical. Need better cellular coverage thruout the area - eliminate "dead" spots.
Sprint
Sprint for cell phones - CRAP!!
The ability to have options and not locked into a monopolistic program would be beneficial and help keep the overall cost down. I am an IT consultant/project manager. Any assistance that I can bring to this endeavor please feel free to reach out.
The county residents are in need of fast and reliable internet at an affordable price. We have no cable there fore internet options are very limited. I use an ATT wireless box but we have a limit on the data so we can not stream movies or download music or use our Smart TV. I cant do phone and computer updates from home due to the data restriction, I have to take my devices to Culpeper town and use a free hot spot to do those things. Satellite internet also caps data and we are not in the service area for VABB
The Internet and cell service is barely useable
To download music/movies for family and view educational webcasts
Verizon
Verizon wireless Cell signal is poor on a clear day, and almost nothing on a rainy day.
Verizon- cell service
VerizonWireless
We are currently spending over \$200.00 per month just to have internet service. The only ISP options we have are Hughesnet and Virginia Broadband. Virginia Broadband provides an option we would otherwise not have, but it is very expensive. It is however, much better and less expensive than Hughesnet. Together, our internet and TV bill is nearly \$400.00 per month. This is more than double the amount we paid for television, internet and phone services at our location when we had Verizon FIOS. The cable line for Comcast stops less than a mile from our house, but picks up again about a mile or so after our house.
we are unable to use the internet for Movies, or music to to limited bandwidth and slow download times
We desperately need high speed Internet. I am in university and my dad works from home and we are constantly hitting our data limit. The speed is slow and it makes it difficult for my education.
We have comcast but it is always going down and we lose internet connection all the time. Since we now have our land line on it that means our phones go down also and we do not have good cell signal in our area. So we can be without communication
we pay a lot for internet and cable and, because we are in the country, have no ability to bundle and save. also, our internet access is metered and so severely limits what we can do on a monthly basis -- i.e. we can't use skype because it takes up too much of our monthly data.
We use a Mi-Fi device for internet because we are unable to get any carrier to provide anything else.

Well done to think of sotihmeng like that

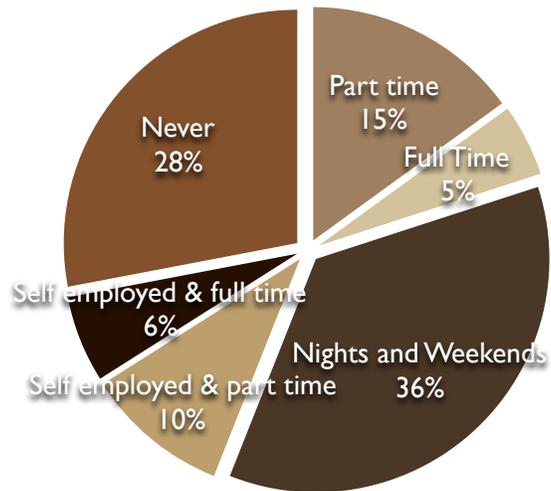
Would like to get a telecommuting job as a nurse but need high speed internet to do so. Husband works for government and needs Internet. All schools pretty much require online homework. I homeschool one child and would like to be able to use online schooling. Work from home full time is what I need to do but can't due to not having high speed and Comcast saying it will charge us \$20,000 to run it to us. Very much need Internet for online college classes as well that my son is hoping to do. Desperate for high speed internet!!!!

Does your employer use a VPN (Virtual Private Network) to allow remote access to the corporate network?

Yes	No	Don't Know
186	149	145
39%	31%	30%

Do you work from home?

I work part time at home for another company.	15%
I work full time at home for another company.	5%
I need nights and weekends access for company business.	36%
I am self employed and work part time from home.	10%
I am self employed and work full time from home.	6%
I never work from home.	28%



Business Survey Results

A total of 42 responses were collected. Not all responders answered every question.

Some of the key data points that resulted in the survey include:

78% of respondents are not satisfied with their services.

93% of respondents answered that they needed better Internet/data service.

100% of respondents stated that they had an Internet connection.

38% of respondents use cable modem service while 26% use wireless Internet.

24% of respondents generally pay between \$61 to \$100 per month for Internet access. 29% spend between \$151 and \$300 for Internet.

Only 5% of respondents answered they were “very satisfied” with the current spend of their Internet service. 33% of respondents replied that they were “not at all satisfied” with the current speed of their Internet service.

78% of respondents indicated that they would be very willing or somewhat willing to pay more for faster, higher quality Internet access.

88% of respondents indicated that they found Internet technology to be a very important factor in the success of their company over the next five years.

75% of respondents answered that finding personnel with the needed computer, software, and Internet skills to be somewhat difficult or very difficult.

83% of respondents indicated that an affordable broadband Internet connection would be beneficial to their organization.

18% of respondents are self employed and work full time from home. 91% are working at least part time from home.

CURRENT SATISFACTION OF EXISTING SERVICES

Overall, respondents felt a need for better telephone service, Internet/data service, and TV service. 74% of the respondents desired better telephone service and 90% of the respondents desired better Internet/data service. 78% of the respondents were not satisfied with all of their services. This data indicates that businesses generally are in need of better services that can offer reliability, speed, and a better price point.

ESTABLISHMENT INFORMATION & EMPLOYEE COMPUTER USAGE

100% of the businesses that responded to the survey indicated that an internet connection existed at the establishment. There are 1956 employees that are employed by the 42 businesses that took the survey. There is an average of 48.9 employees per establishment that took the

survey. Of the 1956 employees, there are 1578 computer users (80%) at these businesses. In addition, each establishment typically has an average of 39.5 employees who use computers.

A variety of establishments responded to the survey, which include professional, government, retail, medical, non-profit, educational and other. Professional (37%) made up the majority of the establishments that responded followed by retail (13%) and other (19%). “Other” establishments included construction, government, manufacturing, and religious

EXISTING INTERNET CONNECTION TYPE, PRICE, AND SPEED

A DSL line provided Internet access to 7% of the respondents. Wireless Internet provided an Internet connection to 7% of the respondents. Half of the respondents pay more than \$100 for Internet access each month. The largest proportion of respondents paid generally \$100 to \$150 for Internet access each month. 2% of the respondents had Internet speeds between 56-256k, while 2% of the respondents had Internet speeds between 1.5-3Mb. In addition, 33% of the respondents were “not at all satisfied” with the current speed of their Internet service, while only 2% were “very satisfied” with their current speed.

USE OF THE INTERNET

Respondents were asked how they currently used the Internet to serve their needs at their respective establishments. The most common uses of the Internet were for communication via email, access to news and current events, research, and ordering and managing inventory. 8% of the respondents used the Internet to maintain a web presence with a blog or other site.

WILLINGNESS TO PAY

While only 15% were “not at all willing” to pay for faster, higher quality Internet access, 51% were “somewhat willing” and 27% were “very willing” to pay.

IMPORTANCE OF INTERNET TECHNOLOGY

Respondents of the 42 business establishments overwhelmingly found Internet technology to be an important factor in the success of their company in the next five years. 0% (none) found Internet technology to be “not important.” Furthermore, 55% of the respondents from business establishments found that it was “somewhat difficult” to find personnel with the needed computer, software, and Internet skills in the local area. 83% of the respondents indicated that their organization would benefit from an affordable broadband Internet connection, and only 18% indicated that an affordable broadband Internet connection would not be beneficial.

EXISTING SERVICE PROVIDERS

Phone: Verizon provided phone service (local and long distance) to 35% of the respondents and Comcast provided phone service (local and long distance) to 45% of respondents. Others service providers included AT&T, Magic Jack and VOIP. 31% of the responses included blank, NA and none for local dial tone and 28% of the responses included blank, NA, none, and not sure for long-distance.

Internet: Comcast provided Internet access to 45% of the respondents with Internet followed by VA Broadband and Verizon with 12%. Other providers included ACC, AT&T, Lumos, and Hughes Net. None of these providers had more than 5% of the respondents use their Internet services.

Television: The largest providers of cable/satellite TV was Comcast. Comcast provided service to 29% of those with television service, while Direct TV provided service to 10% of the respondents. 29% of the respondents either indicated no TV or NA.

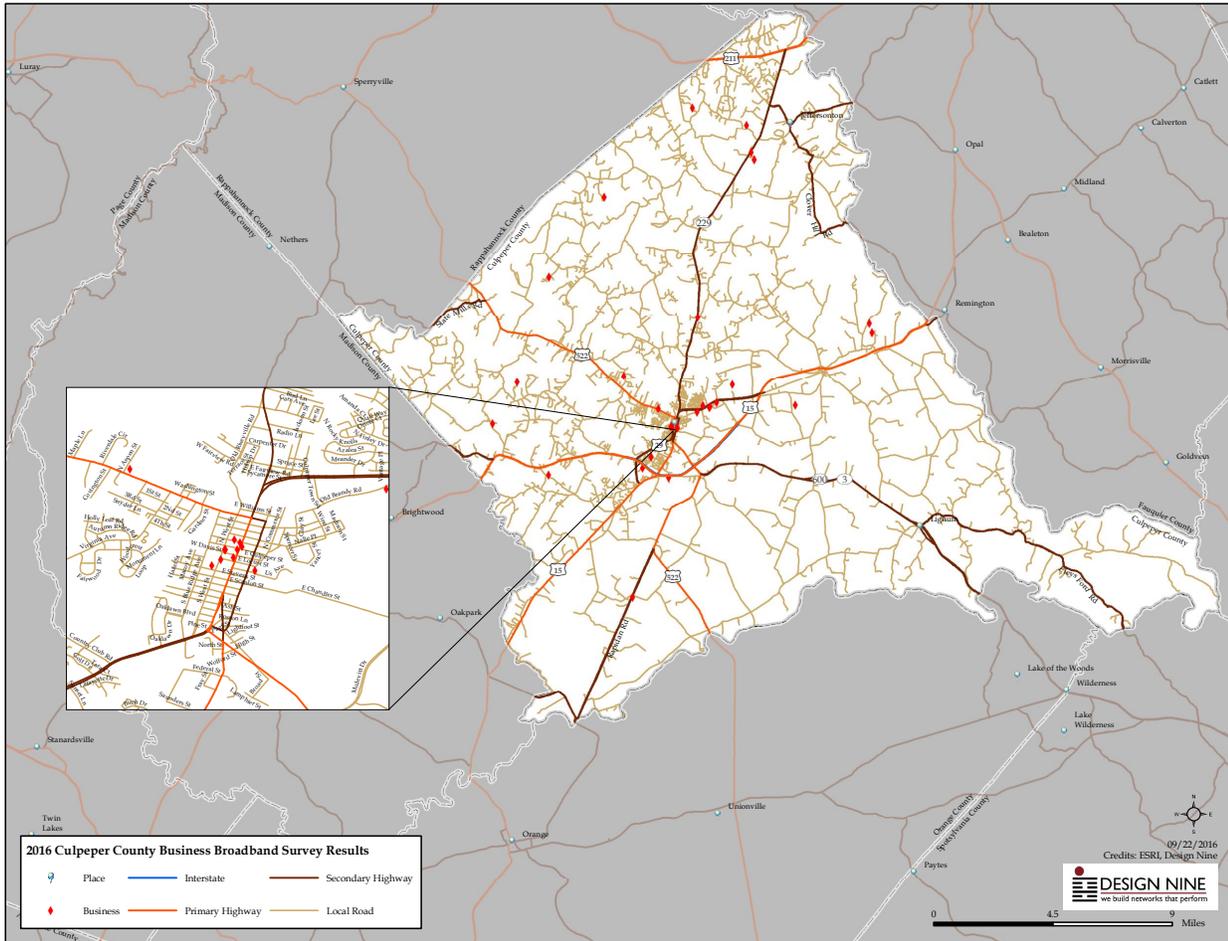
SERVICES DESIRED

Respondents were asked if there were other telecommunication needs that they desired that was not covered in the survey. This was an open ended question. Four respondents desired better cellphone service. One respondent wanted remote access to company computers and the option to VoIP if speeds and service were more reliable.

JOB CREATION AND TELEWORK

32% of the respondents said affordable broadband could allow them create new jobs at their establishments. The survey found that a portion of respondents generally work from home full time or part time. Only 11% of the respondents stated that they never work from home. 18% of the respondents stated that they are self employed and work part time from home. In addition, 18% of the respondents noted that they are self employed and hold full time positions at home.

The map below shows the distribution of survey responses from businesses in the town and the county.



SUMMARY DATA

Check the items you agree with below.

Question	Yes	No
I need better landline telephone service.	38%	62%
I need better cellular telephone service	74%	26%
I need better Internet/data service.	90%	10%
I need better cable/satellite TV service.	67%	33%
I am satisfied with all of my services.	22%	78%

Number of employees:

Total number of employees	1956
Average number of employees per establishment	48.9

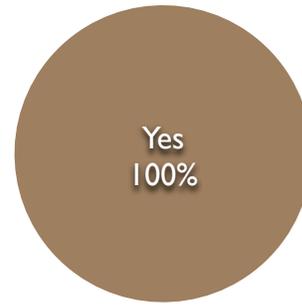
Number of computer users:

Total number of computer users	1578
Average number of computer users per establishment	39.5

Types of organizational activities conducted at this facility:

Retail	13%
Professional	37%
Government	7%
Educational	6%
Medical	6%
Non Profit	13%
Other	19%

Does your organization have an Internet connection?



If yes, what type?

Dial-up	Cable Modem	Satellite	DSL Line	T1 Line	Don't know	Fiber	Cellular Wireless	Broadband WISP
1	16	2	3	1	0	5	3	11
2%	38%	5%	7%	2%	0%	12%	7%	26%

How much do you pay now for Internet access each month?

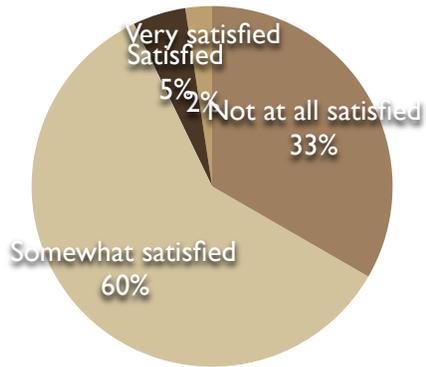
No-Internet	\$0-20	\$21-40	\$41-60	\$61-100	\$101-150	\$151-300	\$301-500	\$501-1000	\$1001-\$5000	\$5000	I don't know
0	0	1	2	10	6	12	0	1	5	0	4
0%	0%	2%	5%	24%	15%	29%	0%	2%	12%	0%	10%

Speed of your Internet Connection?

No Internet	Dial up only	56-256k	256-512k	512-1Mb	1-3 Mb	1.5-3 Mb	3-10 Mb	10-50Mb	50-100 Mb	100+Mb	Gigabit	I don't Know
0	0	1	1	4	3	1	3	5	3	1	1	18
0%	0%	2%	2%	10%	7%	2%	7%	12%	7%	2%	2%	44%

How satisfied are you with the speed of your current Internet service?

Not at all Satisfied	Somewhat Satisfied	Satisfied	Very satisfied
14	25	2	1
33%	60%	5%	2%

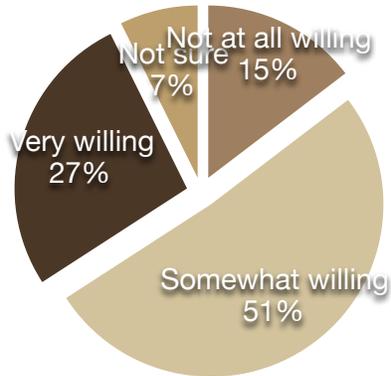


Check all the items you use the Internet for now:

Email	11%
Access news and current events	10%
Business videoconferencing	6%
connect to company VPN (Virtual Private Network)	6%
VoIP (Vonage, Skype, etc)	3%
Online Backup (files, photos, music)	10%
Transfer large files	10%
Monitor / control security, alarms, health, processes, etc.	4%
Telemedicine, telehealth	1%
Communication between headquarters and remote sites	6%
Processing credit card / debit card transactions	8%
Research	8%
Ordering/managing inventory	6%
Maintaining a web presence with a blog or other site	8%
Receiving and processing online orders	3%
Other	1%

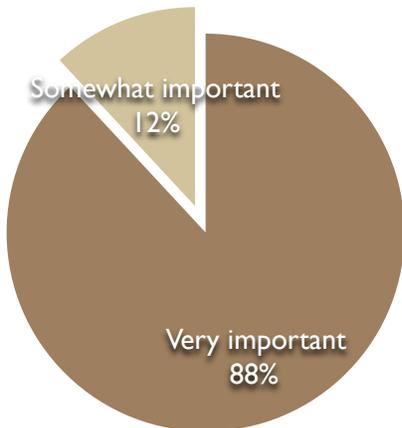
Would you be willing to pay more for faster, higher quality Internet access?

Not at all willing	Somewhat willing	Very willing	Not sure
6	21	11	3
15%	51%	27%	7%



How important do you think Internet technology will be for the success of your company over the next five years?

Very important	Somewhat important	Not important
37	5	0
88%	12%	0%



How difficult is it to find personnel with the needed computer, software, and Internet skills from the local area?

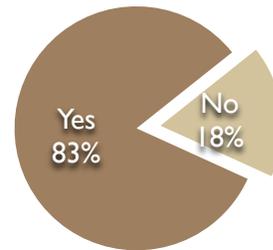
Very difficult	Somewhat difficult	Not difficult
8	22	10
20%	55%	25%

How difficult is it to find and provide the appropriate training for employees in computer, software and Internet applications?

Very difficult	Somewhat difficult	Not difficult
4	18	17
10%	46%	44%

Do you believe your organization would benefit from an affordable broadband Internet connection?

Yes	No
83%	18%



If yes, briefly state what is affordable and at what speed:

Responses
\$100 to \$200 per month
\$200 and below is better.
\$40 or less
100 per month with gigabyte upload and download speeds

Responses
30 - 50 Mbps Up and down at about 100 a month
50-100 mb at \$60 month.
Anything less than 1000+ per month would be affordable-over 10 MB
I am currently paying \$115.00 per month for speed that varies from 3-10 Mbps. I would pay more for consistent high speed service.
I haven't put a lot of thought into it. I had broadband and the internet was limited and so was the speed so I had to cancel since the program I use is cloud based and I need unlimited internet I would like a better speed and stay under 80.00 a month.
I was told that this property had fiber optic service. It does not. It only has cable. I'd prefer a cleaner, faster signal.
I would pay for broadband without data caps
Increase connectivity within our community helps to increase overall health of the community which is the goal of population health.
Increase connectivity within our community helps to increase overall health of the community which is the goal of population health.
less than \$100.00/mo., 50mb speed, 50gb storage/mo.
This is a most useful courtbntion to the debate
We would be thrilled with reliable internet at almost any cost. We have paid over \$600+ a month for a t1 that was unable to deliver reliable service. The reality is we will most likely have to move out of the county due to the lack of adequate services.
With our work, a faster internet connection would increase our process speeds to more timely complete projects.
Yes (other than satellite) \$200-\$250/mo. would be affordable. Preferably Verizon Fios. Greater than 50 MB speed desired.

Who is your Internet Service provider?

Blank	ACC	AT&T	Comcast	Hughes Net	Lumos	NA	VA Broadband	Verizon
3	1	3	19	2	2	2	5	5
7%	2%	7%	45%	5%	5%	5%	12%	12%

Who is your cable/satellite TV provider?

Blank	AT&T	Comcast	Direct TV	Dish Network	Excede	N/A	None	Regular TV Antenna
9	1	12	4	2	1	8	4	1
21%	2%	29%	10%	5%	2%	19%	10%	2%

Who is your local dial-tone telephone service provider?

Blank	AT&T	Comcast	Magic Jack	N/A	None	VoIP	Verizon	Use Cellphone
8	2	10	1	3	2	1	13	2
19%	5%	24%	2%	7%	5%	2%	31%	5%

Who is your long-distance telephone service provider?

Blank	AT&T	Comcast	Magic Jack	N/A	None	Not Sure	Verizon	VoIP	Use Cellphone
5	3	9	1	5	1	1	14	1	2
12%	7%	21%	2%	12%	2%	2%	33%	2%	5%

What other telecommunication needs do you have that were not covered in this survey?

Responses
A stable enough connection for potential video teleconferencing, Remote network access
Cell phone - ATT
Cell phone service is not reliable in this area
Communication in the field (connectivity)
CULPEPER is embarrassingly anti-business when it comes to cell service. The town/county/chamber should have already pushed for better cell reception years ago. Business is not done in 4 walls anymore. It is impossible to be professional when you drop signals 4-5 miles out of town. I'm not sure what the chamber does other than pat those that are involved in the chamber on the back and support downtown businesses...
DOWNTOWN CULPEPER NEEDS BETTER CELL PHONE COVERAGE, ESPECIALLY FOR AT&T USERS
This is a most useful contribution to the debate
We need cell phone service to be able to communicate with area hospitals and the 911 dispatch office.

Would affordable broadband allow you to create new jobs?

Yes	No
11	23
32%	68%

Do you work from home?

I work part time at home for another company.	5%
I work full time at home for another company.	8%
I need nights and weekends access for company business.	39%
I am self employed and work part time from home.	18%
I am self employed and work full time from home.	18%
I never work from home.	11%

Gap Analysis and Current Conditions

BUSINESS BANDWIDTH NEEDS

The table below shows bandwidth consumption for several types of businesses and a projection of the bandwidth needed 5 and 10 years out. The cost of fuel is already affecting business travel decisions, and more and more businesses will invest in HD quality business videoconference systems to reduce the need for travel. These HD systems require substantial bandwidth; a two way HD video conference requires 20-25 megabits during the conference, and a three way conference requires 30-35 megabits during the conference. As more workers try to reduce the cost of driving to and from work by working part or full time from home, the business location must provide network access (Virtual Private Network, or VPN) to the employees working from home. These home-based workers will make extensive use of videoconferencing to attend routine office meetings remotely and to enhance communications with co-workers, including videoconferences with other home-based workers in the company. A VPN network providing remote access to just two or three home-based employees could require 50 megabits of bandwidth during normal work hours.

	Large Business		Small Business		Home Based Worker		Business From Home	
Description	A larger business with about 50 workstations.		A small business with 10 to 15 employees, and 7-10 workstations.		A single employee working at home for his/her company.		A home business with one or two employees working at home.	
	Concurrent Use	Mbps	Concurrent Use	Mbps	Concurrent Use	Mbps	Concurrent Use	Mbps
Telephone	20	1.28	5	0.32	1	0.064	1	0.064
TV		0		0		0		0
HDTV		0		0		0		0
Credit Card Validation	4	4	1	1		0		0
Security System	1	0.25	1	0.25	1	0.25	1	0.25
Internet	20	30	7	10.5	1	1.5	1	1.5
VPN Connection	5	25		0	1	5		0
Data Backup	5	7.5	1	1.5	1	1.5	1	1.5
Web Hosting	1	2		0		0		0
Workforce Training (online classes)	2	20	1	10	0	0	1	10
HD Videoconferencing	10	100	2	20	1	10	1	10
Telecommuting workers	5	15	2	6	0	0	0	0
Totals		205.0		49.6		18.3		23.3
5 years from now (megabits)	615		149		55		70	
10 years from now (megabits)	1845		446		165		210	

RESIDENTIAL BANDWIDTH NEEDS

The table below depicts the bandwidth needed for typical residential services which are available now or will be available in the near future. In a next generation network all services will be delivered over a single network infrastructure which will require an access network that can support providing most services to most consumers simultaneously. Today's shared networks (cable and wireless in particular) rely on the "bursty" nature of traffic to provide services to end users. If all end users were consuming their "advertised" bandwidth today's cable and DSL networks would grind to a halt.

In fact, they already are; some cable providers have begun to receive heavy criticism for undocumented manipulation of data traffic. Existing cable modem network users are overwhelming the digital cable networks that were upgraded as little as three or four years ago, and the firms have had to artificially reduce the bandwidth available for certain kinds of high bandwidth services (e.g. peer to peer file sharing). Some cable providers have even run into capacity issues with the TV portion of their networks, and some consumers have observed that some HD TV channels have been so highly compressed that picture quality has been noticeably degraded when compared to the same channel delivered by satellite.

Description	Residential Daytime		Early Evening		Evening and Late Night		Snow Day	
	Concurrent Use	Mbps	Concurrent Use	Mbps	Concurrent Use	Mbps	Concurrent Use	Mbps
Telephone	1	0.064	1	0.064	1	0.064	1	0.064
Standard Definition TV	1	2.5	1	2.5	1	2.5	1	2.5
HD TV	1	4	2	8	2	8	3	12
Security System	1	0.25	1	0.25	1	0.25	1	0.25
Internet	1	1.5	1	1.5	2	3	3	4.5
Online Gaming		0.25		0.5		1		1
VPN Connection	0	0	1	2	1	2	2	4
Data Backup		0	1	5	1	5	1	0
Telehealth (subscriber)	1	4	1	4	1	4	0	0
Distance Learning / Workforce Training		0	1	10	1	10	2	20
HD Videoconferencing		0		0		0	1	14
Totals		12.6		33.8		35.8		58.3
5 years from now (megabits)	38		101		107		175	
10 years from now (megabits)	113		304		322		525	

LOCAL PRICING DATA

Services and Pricing in the Culpeper Area
Comcast Cable
<p>\$49.95/mo for 10 mbps 10 mbps ↓ and 2.0 mbps ↑ w/ no data cap. Setup: \$15 (Includes standard shipping of self-install kit. Standard professional installation is \$59.99.) Modem: \$10/mo</p>
<p>\$39.99/mo for 25 mbps 25 mbps ↓ and 5.0 mbps ↑ w/ no data cap. 1-year promo rate. Regular rate is \$66.95. Setup: \$15 (Includes standard shipping of self-install kit. Standard professional installation is \$59.99.) Modem w/WiFi: \$10/mo</p>
<p>\$82.95/mo for 150 mbps 150 mbps ↓ and 10 mbps ↑ w/ no data cap. Setup: \$15 (Includes standard shipping of self-install kit. Standard professional installation is \$59.99.) Modem w/WiFi: \$10/mo</p>
Verizon DSL
<p>\$29.99/mo for 3.0 mbps 3.0 mbps ↓ and 0.768 mbps ↑ 1-year promo rate. Regular rate is \$34.99. Setup: Activation: Waived. Modem w/WiFi: \$49.99 one-time purchase</p>
<p>\$19.99/mo for 1.0 mbps 1.0 mbps ↓ and 0.384 mbps ↑ 1-year promo rate. Regular rate is \$24.99. Modem w/WiFi: \$49.99 one-time purchase</p>
Verizon FIOS
<p>\$49.99/mo for 50 mbps 50 mbps ↓ and 50 mbps ↑ w/ no data cap. 1-year promo rate. Regular rate is \$79.99. Contract Term: 2 years with \$165 ETF Setup: Up to \$150 (Setup charge. Up to \$80 waived if you order online.) Modem w/WiFi: \$10/mo or one-time \$199</p>

\$269.99/mo for 500 mbps
500 mbps ↓ and 500 mbps ↑ w/ no data cap.
1-year promo rate. Regular rate is \$299.99.
Contract Term: 2 years with \$165 ETF
Setup: up to \$150
Modem w/WiFi: \$10/mo or one-time \$199

VABB - Virginia Broadband

Virginia Broadband advertises pricing based on the amount of data used with no limits on speed. In areas with good coverage speeds higher than 15Mbps can be achieved.

Casual Internet User:

Emailing, Surfing, Banking

\$19.99 for 1GB/mo *

\$34.99 for 2GB/mo *

\$49.99 for 5GB/mo *

\$64.99 for 10GB/mo *

Install: \$149.99

Typical Internet User:

TV/Movie Streaming, Gaming

\$79.99 for 25GB/mo *

Install: \$100 (discounted)

Super Internet User:

Heavy TV/Movie Streaming, Gaming

\$114.99 for 50GB/mo *

Install: FREE

Additional GB's can be added in blocks
of 10 for just \$10/mo (that's \$1/GB)

Unlimited Plans:

Residential and Small Businesses

\$225/mo with FREE Install

Large Businesses w/multiple connections

\$299/mo

HughesNet Satellite

\$59.99/mo for 10 mbps

10 mbps ↓ and 1.0 mbps ↑ w/ a 10 GB/mo data cap

Contract Term: 2 years with \$400 ETF

Additional 50 GB from 2am - 8am

Setup: \$0 (Free standard installation.)

Modem: \$9.99/mo

\$129.99/mo for 15 mbps

15 mbps ↓ and 2.0 mbps ↑ w/ a 20 GB/mo data cap

Contract Term: 2 years with \$400 ETF

Additional 50 GB from 2am - 8am

Setup: \$0 (Free standard installation.)

Modem: \$9.99/mo

<p>\$79.99/mo for 10 mbps 10 mbps ↓ and 1.0 mbps ↑ w/ a 30 GB/mo data cap Contract Term: 2 years Data Allowance: Business Period (8 a.m. – 6 p.m.) 20 GB, Anytime Allowance 10 GB Setup: \$0 (Free standard installation. Upfront fee is \$99.99.) Modem: \$19.99/mo</p>
<p>\$159.99/mo for 15 mbps 15 mbps ↓ and 2.0 mbps ↑ w/ a 60 GB/mo data cap Contract Term: 2 years Data Allowance: Business Period (8 a.m. – 6 p.m.) 50 GB, Anytime Allowance 10 GB Setup: \$0 (Free standard installation. Upfront fee is \$99.99.) Modem: \$19.99/mo</p>
<p>Exede Satellite</p>
<p>\$59.99/mo for 12 mbps 12 mbps ↓ and 3.0 mbps ↑ w/ a 10 GB/mo data cap 1-year promo rate. Contract Term: 2 years Up to 1-5 Mbps download speeds (morning/daytime) after Priority Data used. Setup: \$99.99 (Includes installation.) Modem: \$9.99/mo or one-time \$199.99</p>
<p>\$79.99/mo for 25 mbps 25 mbps ↓ and 3.0 mbps ↑ w/ a 12 GB/mo data cap Contract Term: 2 years Modem w/ WiFi included.</p>
<p>\$99.99/mo for 15 mbps 15 mbps ↓ and 4.0 mbps ↑ w/ a 20 GB/mo data cap Contract Term: 2 years Setup: \$299.99 (Includes standard installation.) Modem included.</p>

INTERVIEWS AND USER FEEDBACK

Design Nine interviewed a variety of County and Town officials and met with a variety of interested parties and stakeholders.

MANY CULPEPER COUNTY RESIDENTS HAVE NO BROADBAND

John Egertson has been Culpeper County Administrator for only a few months. He had previously been County Planning Administrator for twenty-five years. John acknowledged that many Culpeper County residents have no broadband. Comcast and Verizon FiOS provide broadband service to the Town of Culpeper, with Comcast as the primary provider. Few broadband options exist beyond the populated town center, and the options available are very

expensive. John said that Comcast no longer has any mandated guidelines in their franchise agreement and operates solely by its own business objectives.

John also point out that Culpeper County is one of the fastest growing counties in the nation. As many as 50 per cent commute, mostly to the Washington, D.C. area. More broadband would increase the population and allow more people to telecommute. Residents used to oppose the construction of new cell towers, they now welcome them because such construction implies better communications service.

RESIDENTS STRUGGLING WITH INADEQUATE BROADBAND

Beth Castro and her husband are telecommuters. Mr. Castro grew up in Culpeper and returned to continue a career in foreign exchange and to build a business as a sculptor and furniture designer. Beth is an employee of the International Association of Law Firms. Both require high-speed upstream and downstream broadband access.

The couple's rural residential neighborhood has no wired broadband service. The Castros rely on multiple wireless subscriptions from AT&T which requires cell boosters. The wireless monthly subscription data cap price is: \$80/25GB, \$115/50GB. Unlimited monthly data is \$225. Comcast provided an estimate of \$25,000-\$35,000 to connect their residence to the Comcast network. The couple also has four young children who are moving into prime broadband age.

Dewayne Payne and his wife are another example of a Culpeper couple who represent the county's telecommuting future. Dewayne and his family are long-time Culpeper residents and hay farmers. Dewayne's wife is an attorney for DuPont and commutes on a regular basis to Delaware. The Payne family currently uses satellite Internet since there is no other broadband service available in their neighborhood outside of town.

BUSINESS ATTRACTION AND RETENTION ISSUES

Businesses in the northern and western portions of the county have very few communications options. Verizon provides wireless cell phone service throughout most of the county, but even this service is limited in rural portions of the county. Eight businesses located in the sixty-acre industrial park at the Culpeper Airport have few broadband options and this facility is the focus of much economic development efforts within the county.

Continental Corporation, a major automotive industry supplier, is located in Culpeper and serviced by AT&T. Anecdotal reports indicate that the AT&T broadband service is inadequate.

Tanya Woodward, Director of the Culpeper Regional Airport, has been managing the airport's recent expansion which has been hindered by lack of broadband capacity. Many users cannot even get cell phone reception in the hangers and other locations around the airport. Point of sale machines and other digital devices are constantly resetting themselves because of interrupted communications circuits.

Euro-Composites now has a 20Mb/sec connection servicing 140 employees, many of whom connect to the company from home.

SCHOOLS AND LIBRARIES

Schools and libraries have adequate broadband, but students and library patrons do not.

Windstream fiber provides a gigabit connection to the Culpeper schools. Rob Hauman, Executive Director of Curriculum & Development for the Culpeper County Schools, said that the network has never been taxed to its maximum capacity. The level of use has seldom exceeded 200 Mb/sec. despite an inventory of 7,000 computers and 1,000 digital tablets in the schools.

However, Rob feels that many students may lack basic Internet connectivity at home. The school department recently conducted a student survey, but suspects that students may be reluctant to admit to lack of home broadband connection or computing device. The school system is attempting to correlate the free lunch population (49%) with home broadband access. The E-rate funding level is determined by free lunch population. The county also has a population of 450 home-schooled students who could benefit from better broadband service at home.

Susan Keller, Culpeper Library Director, said that many library patrons make use of the library's WiFi service from the parking lot. The library has now been set up to provide more wireless hot spots. Sixteen Apple docking stations can be checked out for 6 hours of use and seventy-five per cent of these units are in use. Library computers can be used in 30, 60 and 120 minute intervals. The library provides cellular hot spots that can be checked out and are popular with many residents. The library hosts about 33,000 visits per year.

CHAMBER OF COMMERCE

Culpeper Chamber of Commerce members vent their frustration about poor communications options. A self-selected dozen Culpeper Chamber of Commerce members met to discuss how broadband scarcity affected their businesses or influenced their home purchasing decision.

Harry Boyd, local Chairman of the Democratic Party, complained that he could not get FiOS service from Verizon because he lives five miles outside of town. Harry has basic cable and Internet service from Comcast and TV from DishTV. A self-storage facility owner has multiple locations in the area and multiple Internet service providers, including Comcast and Verizon.

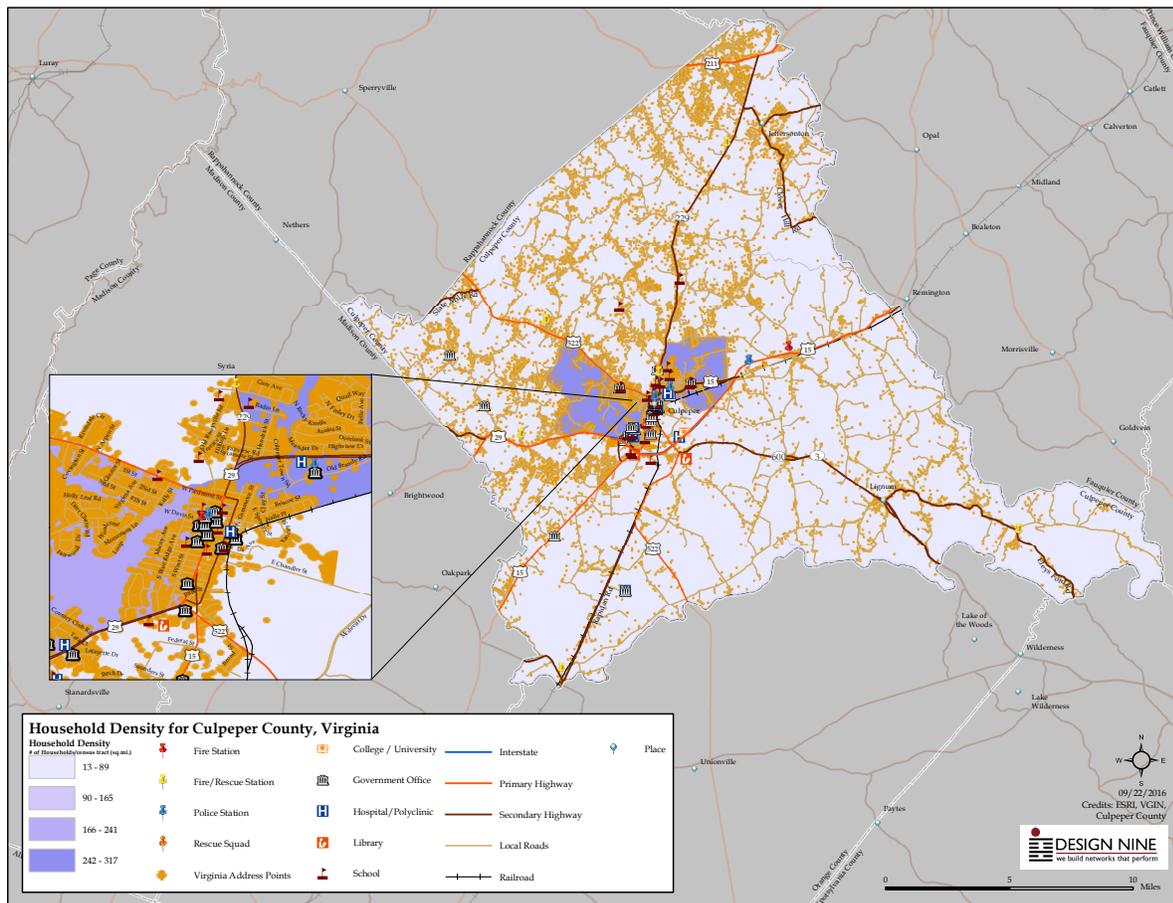
There was general agreement that all data storage and software applications are migrating to the cloud and all struggled with service outages that affected their business operations. John Barker, COO of Attollo Systems, is an IT services provider. He lives in the southern end of the county and thoroughly searched the real estate market before he purchased a home with high-speed, reliable fiber-based broadband. Two real estate brokers at the meeting echoed their disadvantage when trying to market properties with sub-standard connectivity.

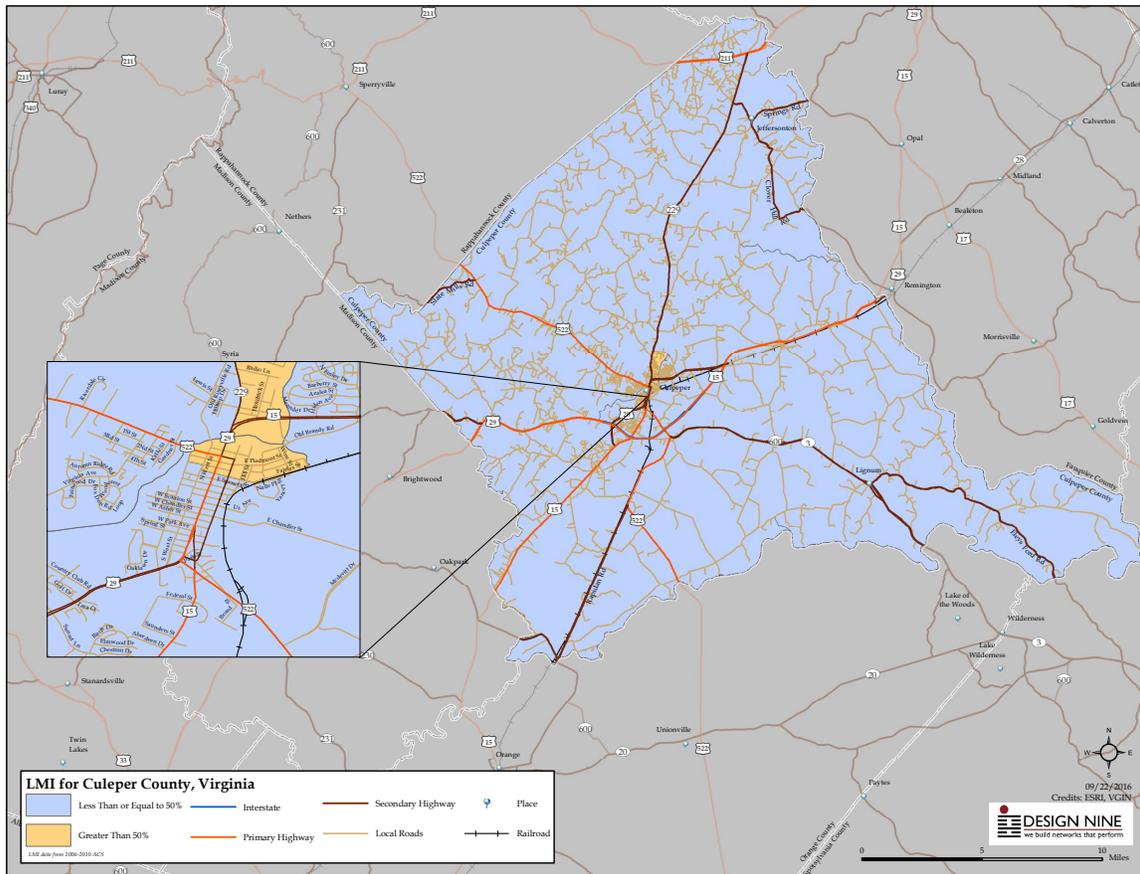
At least one local banker expressed willingness to consider financial support for community broadband.

EXISTING ASSETS AND DEMOGRAPHY

The maps below and on the following pages include:

- Points of interest, including household density (an important factor when evaluating new service areas).
- Unserved areas (data from the NTIA National Broadband Map), and areas of low and moderate income, which can be important when applying for grants. CDBG (Community Development Block Grants) favor projects in LMI areas. Some Federal grants like Community Connect are only available for unserved areas.
- Towers in the various localities. These are taken from the FCC tower registry and include both cell towers and other kinds of towers (primarily public safety towers).
- Fiber routes in the region, where the telcos have been willing to provide that data.

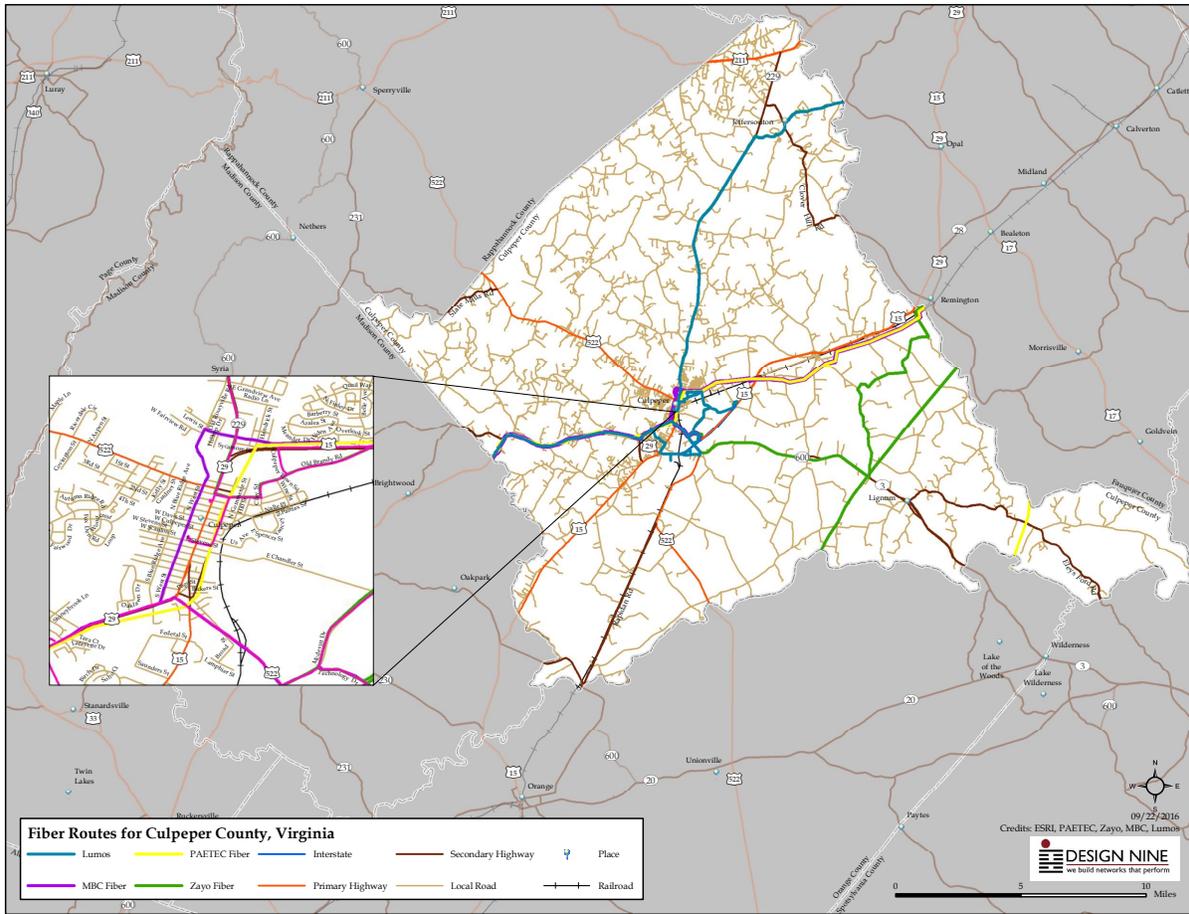




FIBER ASSETS IN THE COUNTY

The map below shows the fiber assets that have been identified in the county. Incumbents like Verizon and Comcast will not share their fiber route maps. The town and the county have excellent access to long haul carriers, including MBC (Mid-Atlantic Broadband), Zayo, and Intellifiber.

Zayo is a Tier One national Internet provider, and Paetec is another large long haul provider with assets from North Carolina up through New England and into the Midwest. Access to the facilities and commodity pricing of these two companies is an important advantage in the county. MBC is a Virginia-based open access fiber provider that brings additional large and medium-sized Internet and telecom providers into the county.

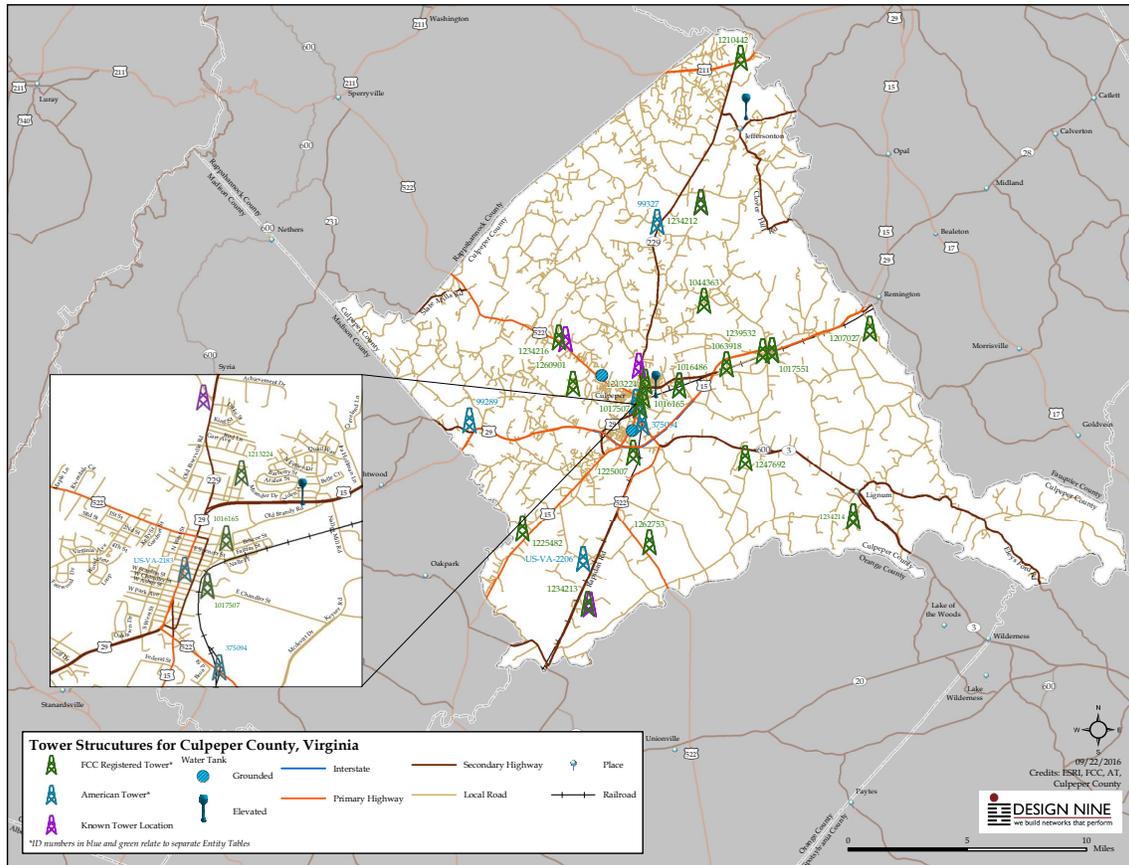


TOWER ASSETS

There are a number of towers in the county, split between county ownership and private ownership. The majority of the cell towers are clustered along the major roads (e.g. Route 29, Route 15). Rural areas of the county, therefore, lack both reliable cell phone service and cellular data service). Cellular data service as the primary home or business means for Internet access can be very expensive. One home-based businessperson we interviewed indicated their monthly cellular bill exceeded \$700 most months. At their location, they had no other option for the bandwidth needed to conduct routine business and meet nominal personal Internet use.

In the map below, one can see that the primary distribution of towers is along the primary routes through the county, especially Route 29 and Route 15. Cell coverage is poor in large parts of the county because household density is low and it is difficult for the cellular companies to make a business case to build additional towers.

The County can play an important role by making space available on existing towers and building additional towers for broadband wireless services.



1016165	SBA Properties, Inc.
1016486	SBC TOWER HOLDINGS LLC
1017507	Alltel Communications of Virginia No. 1, LLC
1017551	Alltel Communications of Virginia No. 1, LLC
1044363	CROWN ATLANTIC COMPANY, LLC
1063918	VIRGINIA DEPARTMENT OF STATE POLICE
1207027	SBA Properties
1210442	SBA Towers, Inc.
1213224	Piedmont Communications, Inc.
1225007	Pinnacle Towers Acquisition LLC
1225482	Community Wireless Structures II, LLC
1234212	CULPEPER COUNTY VA BD OF SUPERVISOR
1234213	CULPEPER COUNTY VIRGINIA BD OF SUPERVISORS
1234214	CULPEPER COUNTY VA BOARD OF SUPVS
1234216	CULPEPER COUNTY VA BD OF SUPERVISORS
1239532	Pinnacle Towers Acquisition LLC
1247692	National Communication Towers, LLC
1260901	Hunter Communications Group, LLC
1262753	National Communication Towers, LLC

99289 American Tower, LEON VA
99327 American Tower, RIXEYVILLE VA
99237 American Tower, CULPEPER VA
99250 American Tower, ELKWOOD VA
310347 American Tower, Culpeper
375094 American Tower, Culpeper VA
US-VA-2183 American Tower, CULPEPER PO VA
US-VA-2206 American Tower, MITCHELLS PO VA

Future Broadband Needs

NEXT GENERATION CONNECTIVITY

“Next generation” is the term used to describe future planning for the next step in network connectivity and infrastructure. There seems to be an emphasis on deploying fiber-to-the-home (FTTH). But why? By pulling fiber deeper into the neighborhood and providing greater access to connectivity, this allows the infrastructure to be in place to accommodate future communication needs, capacities, and innovations. Because of the U.S. demographic bulge that occurred during the baby boom after World War II caused exurban migration, the U.S. is currently the only country where fiber is being deployed in largely suburban areas with single family homes. In countries like Japan and Korea, fiber to the apartment is widely available, in part because the cost of delivering fiber to a high rise apartment building that might have 500 subscribers is much lower than the build cost of fiber to 500 single family homes in a subdivision.

Next generation broadband reaps substantial benefits. There are several key benefits of “Next-Generation Broadband”:

- ▶ Dramatically faster file transfer speeds for both uploads and downloads
- ▶ The ability to transmit streaming video, transforming the Internet into a far more visual medium
- ▶ Means to engage in true-real time collaboration
- ▶ The ability to use many applications simultaneously
- ▶ Ability to maintain more flexible work schedules by being able to work from home on a part time or full time basis
- ▶ The ability to obtain health-related services for an occasional illness and/or long term medical services for chronic illnesses.

Clearly, consumers have a strong interest in a visual medium from when and wherever they are. YouTube is the second most popular search engine after Google, which demonstrates the need to support the infrastructure to transmit streaming video.

In addition to video streaming, true-real time collaboration also provides an effective way for people to interact from wherever they are. People can engage in a two-way, real-time collaboration, so that fruitful, visual conversations can be held between friends, family, business associates from the state, country, or internationally.

Because of fiber networks, employees have the capabilities of working from their home. Findings suggest that if all Americans had fiber to the home, this would lead to a 5 percent reduction in gasoline use, a 4 percent reduction in carbon dioxide emissions, \$5 billion in lower road expenditures, and 1.5 billion commute hours recaptured.

USE TRENDS

The town and the county face a challenge in economic development infrastructure with primarily “little broadband” (i.e. DSL, wireless, and cable services) when many communities, regions, and countries have already made the decision to focus resources on the development of “big broadband,” which is typically fiber with a minimum capacity of 100 megabits or Gigabit to the premises.

- ▶ A third of IBM employees work from home at least part time, and the company has reported annual savings of \$110 million.
- ▶ FTTH users work more from home, reducing traffic congestion.
- ▶ In a 2013 report to the Fiber To The Home Council, Render Research and Consulting reported that fiber to the premises adds \$5000 to \$6000 to the sales price of the house.
- ▶ Fiber to the home users say they are able to work from home more often, averaging 7.3 workdays per month, reducing their carbon footprint and decreasing wear and tear (and maintenance) on roads.
- ▶ By late 2015, about 20% of homes in the U.S. had been passed by fiber, but incumbents like Verizon and AT&T have ceased deploying fiber in smaller and rural communities. Verizon FiOS is being deployed mostly in areas where the company has already built fiber, and Verizon has shown little interest in improving service in rural areas.
- ▶ 9% of home-based businesses report fiber is critical to success (the county has many home-based workers and businesses).
- ▶ Older users want telepresence and telemedicine services.
- ▶ Younger residents want collaboration tools and the ability to work from home.
- ▶ More than 20 million homes now have fiber passing them (about 30% take rate).
- ▶ 82% of home buyers who already have fiber will not buy a home without it.
- ▶ 68% of buyers who don't have fiber now want it (only 62% rate green space as most important).
- ▶ 49% would cancel fiber service last if forced to cut living costs.

FUTURE USE TRENDS

“U.S. homes now have more than half a billion devices connected to the Internet, according to a study by the NPD Group. Furthermore, the overall number of connected devices per household, according to a 2014 OECD study, is 10. This is more than three times the average number of people per household.”

The table below lists these and other services that all represent broadband-enabled applications and services that must be available in at least parts of the county if it is to remain economically viable.

Residential and Business	Videoconferencing
	IP TV (Internet Protocol TV)
	HD streaming video
	Ultra hi-def (BluRay) video streaming
	Video on demand (e.g. Netflix)
	Place-shifted video
	Cloud computing services
	Online and cloud-based gaming
	Smart homes, buildings, and appliances, including smart electric meters, AMR (automated meter reading), and AMI (advanced metering infrastructure)
	Remote computer aided design (CAD)
	Work from home jobs
	Business from home
	3D graphic rendering and CGI server farms
	Remote network management and managed services
Virtual collaboration spaces (e.g. enhanced GoToMeeting, Webex style services)	
Public Safety	Intelligent transportation applications (smart road systems)
	Public safety and first responder networks
	Emergency dispatch and coordination
	Webcast agency meetings (e.g. virtual meetings)
	Online training for first responders, fire, and rescue
Society	Broadcast of local sports events
	Videoconferencing of community and town hall meetings for wider participation
	Wider availability of nonprofit and community organization services

Health Care	Teleconsultations
	Telepathology
	Telesurgery
	Remote patient monitoring
	Remote diagnosis
	Remote medical imaging
	Grid computing for medical research
Education and Research	Distance education
	Virtual classrooms
	Remote instrumentation
	Multi-campus collaboration
	Digital content repositories and distribution (digital libraries)
	Data visualization
	Virtual laboratories
Grid computing for academic research	

When analyzing future service needs, it is important to take into account ALL services that may be delivered over a broadband connection. As we noted in the previous section, “broadband” is not a service—it is a delivery medium. If we think about broadband using a roads analogy, broadband is the road, not the trucks that use the road. Internet access is a service delivered by a broadband road system, and that Internet service is just one of many services that are in demand. Today, congestion on broadband networks is not due just to increased use of email and Web surfing, but many other services.

This means that current DSL, wireless, and cable modem services are completely inadequate for future needs. Current DSL offerings are in the range of 1 megabit to 3 megabits for most residential users, 3 megabits to 5 megabits for business DSL users, and there are severe distance limitations on DSL. Higher bandwidth is possible, but as the DSL bandwidth goes up, the distance it can be delivered goes down.

Typical wireless broadband (i.e. not cellular data service) offerings are in the range of 1 megabit to 5 megabits. Some wireless providers are rolling out 10-15 megabit services, but wireless does not scale up well with respect to cost. As bandwidth increases, the cost of the equipment also increases, and even a 15 megabit service is well short of the FCC projections of the need for 50 megabits of bandwidth in the near term. Wireless performance and capacity is heavily dependent upon backhaul (the local connection to the provider’s core network); if this connection is also wireless, the bandwidth available at the access point is shared among all users, even if the rated capacity of an individual connection is 15 megabits. In other words, if the backhaul capacity is 100 megabits, and twenty local users are sharing that capacity, actual bandwidth available to any single user may be much lower than 15 megabits. If all the users are trying to watch video at the same time (not uncommon in early evening), performance can suffer drastically.

Across the U.S., current average bandwidth for cable modem services is typically 10 to 20 megabits, with cable companies promising “up to...” twenty or thirty megabits. It is important to note that cable providers make heavy use of the phrase “up to” in their advertising, and it is not unusual to see ads promoting cable modem speeds of “up to 30 megabits.” However, that amount of bandwidth is shared among many users (often 200 or more) in a neighborhood, which results in much lower average speeds, and during peak use times in residential areas, the actual bandwidth available to a single household may be less than one megabit.

The challenge for the town and the county is to ensure that the businesses, residents, and institutions have a telecommunications infrastructure in place that will meet future needs.

Distance learning, entertainment, and video conferencing are three major applications of internet video. Distance learning from home with live video feeds will require high performance 2+ megabit connections in the near term (next 2-4 years), and over the next 4 to 7 years, there will be many distance learning courses that will incorporate live HD two-way video feeds, enabling students to participate in classroom discussions at a much higher quality level. Distance learning could be an important home-based application for workforce training and retraining. Some Idaho community colleges offer “hybrid courses” where a student attends several class sessions at the college and the remaining sessions online from their home, the library, or another location.

Massive Open Online Courses (MOOCs) are now being offered by many colleges and universities, and provide an important and affordable way to obtain certifications and/or college credit in virtually any topic. But many of these classes rely heavily on video to deliver course content, and so an excellent Internet connection is a requirement.

Entertainment will also drive bandwidth demand from the home, and the popularity of video sites like YouTube and Netflix provide a good indication of the long term demand for video in many forms, including:

- ▶ Live feeds (e.g. live TV shows, sports coverage, and live news reports).
- ▶ Video on demand (TV shows available for viewing at any time, rather than at scheduled times).
- ▶ Movies on demand (instead of going to the video store).
- ▶ Two way video conversations (family, friends).
- ▶ Video stored on home computers and distributed across the Internet (e.g. videos of grandchildren, family activities).
- ▶ Local video content streamed live or from a server (e.g. high school football games, other sporting events, council meetings, other civic activities).

Getting Started

Successful improvements in broadband access, affordability, and reliability for Culpeper involves several decision points, as outlined in the illustration below.

Government has several “first choice” options.

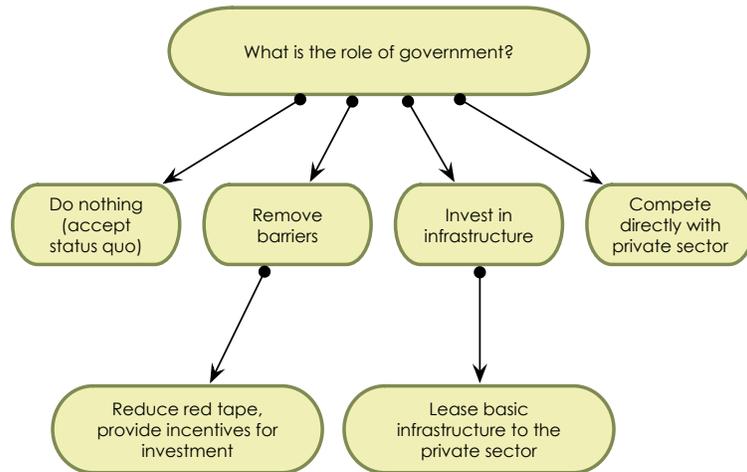
Do nothing is to accept that businesses and residents in the town and the county will have to continue to use whatever is available, despite the cost and bandwidth limitations that limit what many are able to do online.

Government can *remove barriers* to private sector investment. This can be an effective and low cost strategy.

Possibilities include reducing permit fees for fiber construction and tower installation, incentives to developers to install conduit and meet-me boxes in new residential and commercial construction, simplified permit requirements for rural utility pole installation on private property, and identifying areas of residential and business demand and sharing that information with providers.

The County and the Town could choose to make *investments in basic infrastructure* and make that infrastructure available to the private sector via revenue-generating lease agreements.

As has been done in some other localities, the Town or the County could choose to *compete directly with the private sector* by offering retail Internet, phone, and TV services.



RECOMMENDATION

The County and the Town can both remove barriers and make targeted investments in infrastructure. These two activities can be executed in parallel, with infrastructure investments taking place as funding sources are identified. There are a variety of low cost and no cost efforts, mostly at the policy level, that both governments could do to encourage more private investment. As just one example, county planners could work with developers to help them realize that installing conduit and related infrastructure in new subdivisions is an inexpensive way to increase the potential sales price on the homes. No special funding is required of the County, but over time, if residential growth continues in Culpeper County, more homes and neighborhoods would improved broadband infrastructure.

Choosing the Business Model

Governments build and manage roads, but don't own or manage the businesses that use those roads to deliver goods and services. The tremendous versatility of the Internet and the underlying technology bases now allows services that used to require their own, separate (analog) road system (voice telephony and TV services) to be delivered alongside other services like Internet access on a single, integrated digital road system.

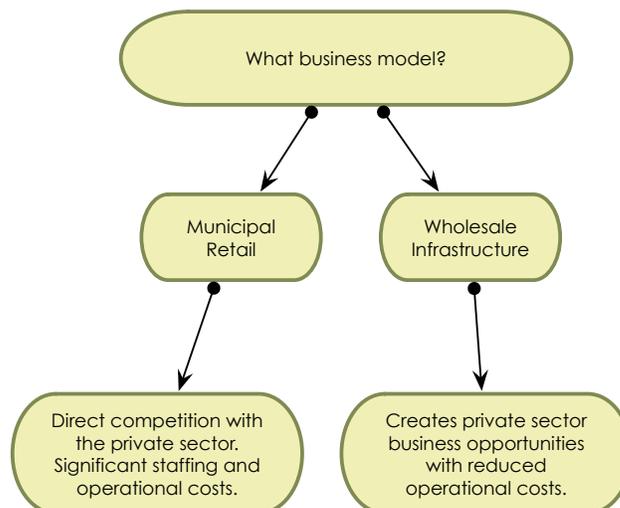


If we managed overnight package delivery the way we manage telecom, UPS and Fedex would only deliver packages to residences and businesses where each delivery firm had built a private road for their exclusive use. We recognize immediately the limitations of such a business model—few of us would have overnight package delivery to our homes because the small number of packages delivered would not justify the expense of building a private paved road.

Before the rise of the automobile, most roads were built largely by the private sector. After cars became important to commerce and economic development, communities began building and maintaining roads because it became an economic development imperative to have a modern transportation system in communities.

Before the rise of the Internet, digital networks were built largely by the private sector. As broadband has become critical to commerce and economic development, communities with digital roads are more competitive globally.

If the County and/or the Town is determined to move forward with a broadband initiative, there are two business model options (which are determined in part by answering the previous question: “What is the role of government?”).



Features	Municipal Retail	Wholesale Infrastructure
Basic Concept	Typically just three services (voice, video, data) with little or no sharing of network capacity.	Improved efficiency because all providers share network capacity.
Government Involvement	Government competes directly with the private sector. Government decides what services are offered.	Government does not compete with private sector. Government provides high performance digital road system that benefits all public and private users. Buyers have rich set of choices.
Governance	Owned and operated by local government. Limited triple play services sold directly by local government.	May be owned by local government or by a community enterprise like a broadband authority or coop. Wide variety of services sold by private sector companies.
Competition	Government picks providers of each service. No incentive to lower prices.	Level playing field creates robust competition. Service providers drive down costs and provide great service to get customers.
Service Options	Limited. Government resells triple play services.	Determined by private sector service providers
Service Area Expansion	Limited by triple play approach, which keeps funds for expansion low.	Expansion developed organically based on funding and revenue from infrastructure leasing.
Risks	Government officials must predict business technology needs years in advance.	If limited to primarily passive infrastructure, operational costs and responsibilities are nominal. It is important to identify prospective service providers early in the process.

RECOMMENDATION

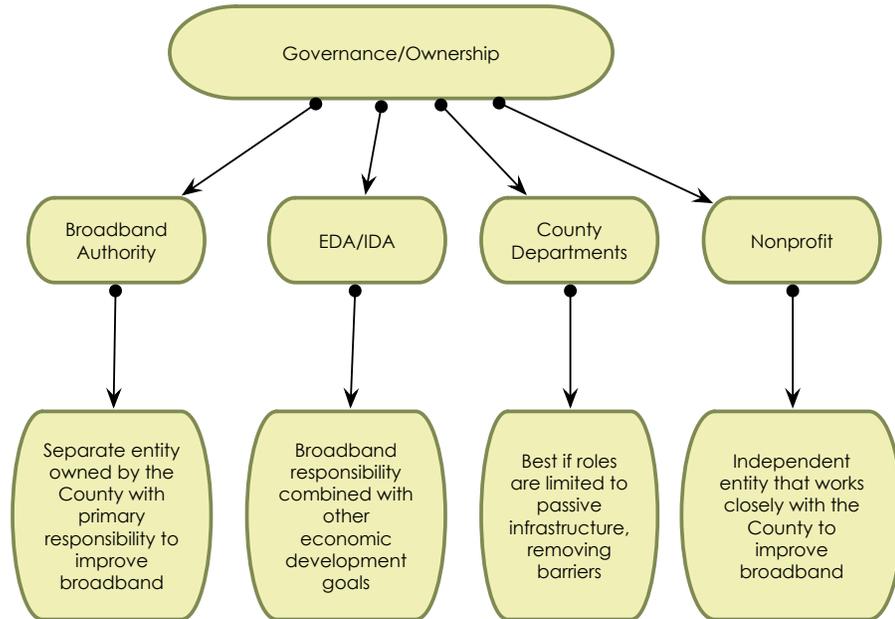
In the wholesale infrastructure business model, local government investments are limited primarily to passive infrastructure (i.e. no network electronics). This is often called the “dark fiber” model, but passive infrastructure can and may include conduit, handholes, cabinets and shelters, and splice closures. This approach is an option that should be considered carefully, especially for the business parks and residential neighborhood projects.

For smaller communities with limited resources and/or a very small market, passive infrastructure only is an excellent approach. The advantages include:

- ▶ Reduced capital costs by eliminating network electronics. Providers lease fiber strands and provide their own network electronics to “light” the fiber.
- ▶ Reduced operational costs. By limiting the infrastructure investment to passive components, there is little to no day to day operational responsibilities. Emergency break-fix repairs and routine repairs and maintenance work can be performed on an as-needed basis by qualified private sector companies.
- ▶ Reduced management and administrative oversight. While fiber strand and asset management tasks, billing, and financial management are still required, these are of limited scope.

Governance Options

For whatever infrastructure improvements the Town and the County may make, there will be a limited number of essential roles. If the improvements are limited largely to passive infrastructure, much of the routine responsibilities could be managed by existing locality staff and departments that might include IT, Public Works, and Planning. If improvements include ownership of significant network equipment assets (e.g. network switches, wireless broadband radios, routers, etc.) an Authority structure may provide more flexibility than managing network assets inside government departments.



If the Town and the County

choose to collaborate, the Authority will provide a better governance approach, with a single Board of Directors that can provide leadership for projects in either locality. In Virginia, creating a Broadband Authority is a simple and straightforward process that can be done quickly. A broadband Authority must create a Board of Directors and develop a charter and set of by-laws. Broadband authorities are treated as a political subdivision, which has some benefits like bonding authority, although only one (the Roanoke Broadband Authority) has bonded for initial construction funds.

FORMING AN AUTHORITY

The primary advantages of an Authority as opposed to the County and the Town pursuing projects independently include:

- A single entity would manage and coordinate a wide variety of activities effectively with less duplication of effort and overlap.
- Coordination and management of grant funding opportunities, preparation of grant applications, and management of grant funds.
- Coordination of expenditures of local government CIP funds when available.

- Work directly with existing incumbent and competitive service providers to assist them in making service improvements, coordinating CAF2 expenditures (Connect America Fund round 2), and coordinating any joint funding opportunities (e.g. DHCD funds).
- Work closely with local government departments (e.g. planning, IT, GIS, etc.) to remove barriers, simplify permitting, and track assets like towers and fiber/conduit.
- Collaborate with public safety initiatives, including shared space on existing towers and shared use of any new towers. Culpeper County is making investments in public safety towers to improve first responder voice communications. These towers could also be leased out to wireless broadband service providers.

The Authority would have a volunteer board of directors, who would need business and management experience. The Authority would also need a budget appropriate to support at least one paid staff person and some additional funds to obtain technical expertise and assistance on an as needed basis. Additional discussion of the Authority option is included in the Strategies section later in this document.

RECOMMENDATION

Elected officials from the Town and the County should hold a joint work session to review their respective broadband goals and objectives to determine if enough common ground exists to move forward with the formation of a Culpeper Broadband Authority. If there is not sufficient interest to form a jointly shared Authority, the County has four options:

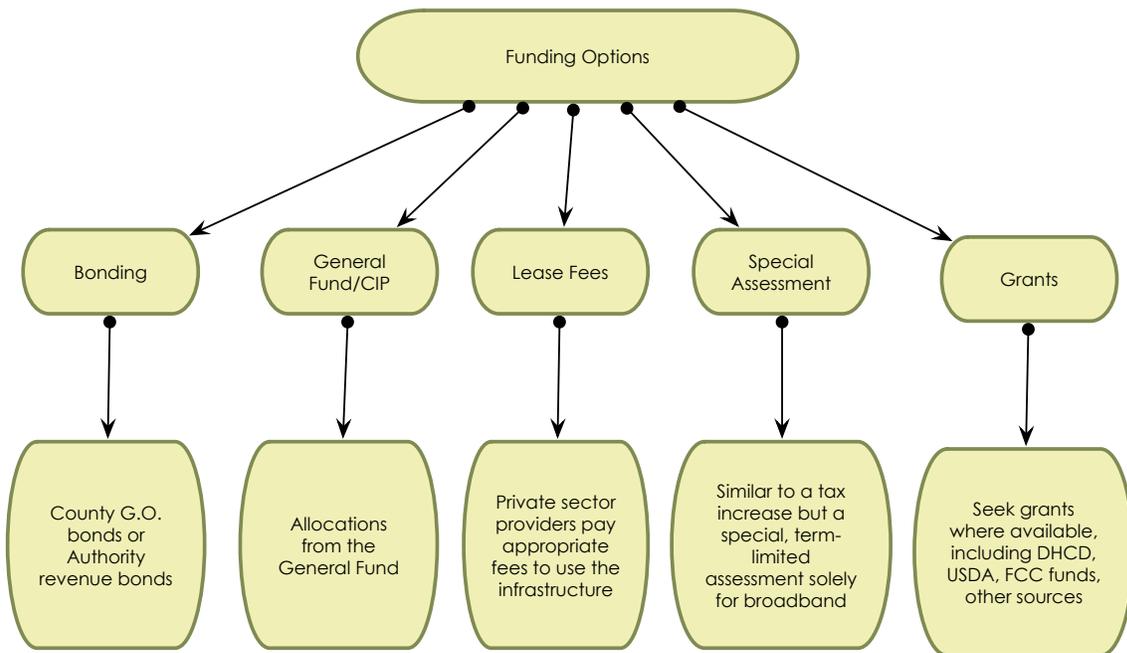
- Form a single jurisdiction Authority.
- Collaborate with surrounding counties to form a multi-jurisdictional Authority.
- Initiate and manage broadband projects within existing County departments.
- Use the existing EDA (Economic Development Authority) as the fiscal agent and asset manager for broadband investments.

To successfully plan and execute broadband investments, the County must have a designated “owner” of broadband initiatives (e.g. the EDA, a County department) and a sufficient annual budget allocation to support planning, grant development opportunities, and some infrastructure improvements.

The County should also consider placing a referendum on the ballot for the next countywide election to measure community support for increased County expenditures for broadband improvements. If the resolution does not receive majority support from voters, then the Board of Supervisors can more comfortably make limited improvements that are focused primarily on business attraction and retention.

Funding Options

It is important to note that the bulk of the region's investment in broadband infrastructure is likely to be passive infrastructure that will have a conservative life span of thirty years or more (e.g. wireless towers, conduit, fiber cable). These types of infrastructure investments create hard assets that have tangible value and can then be leveraged for additional borrowing. The demand for services and the associated fees paid for those services will provide the revenue that will pay back loans over time. There is ample time to recoup not only the initial capital investment, but also to receive regular income from the infrastructure.



BONDING

Revenue bonds are repaid based on the expectation of receiving revenue from the network, and do not obligate the local government or taxpayers if financial targets are not met. In that respect, they are very different from general obligation bonds. Many kinds of regional projects (water, sewer, solid waste, etc.) are routinely financed with revenue bonds. We believe most community projects will finance a significant portion of the effort with revenue bonds. Obtaining funding using revenue bonds requires an excellent municipal credit rating and an investment quality financial plan for the operation and management of the network. In Virginia, broadband authorities can bond, and the Roanoke Valley Broadband Authority used the Virginia Resource Authority to assist with their bonding.

Revenue bonds must be used carefully, and a well-designed financial model is required to show investors that sufficient cash flow exists to pay back the loans.

General obligation bonds are routinely used by local governments to finance municipal projects of all kinds. G.O. bonds are guaranteed by the good faith and credit of the local government, and are not tied to revenue generated by the project being funded (i.e. revenue bonds). G.O. bonds obligate the issuing government and the taxpayers directly, and in some cases could lead to increased local taxes to cover the interest and principal payments. Some bond underwriters have indicated a willingness to include telecom funds as part of a larger bond initiative for other kinds of government infrastructure (e.g. adding \$1 million in telecom funds to a \$10 million bond initiative for other improvements).

In discussions with bond underwriters, it has been suggested that it would be easier to obtain bond funds for telecom if the telecom costs were rolled into a larger water or sewer bond, or some other type of bond request that are more familiar to the bond market.

GENERAL FUND/CAPITAL IMPROVEMENT PLAN

Some local governments are now routinely including a line item for telecom materials and expenditures in their Capital Improvement Plans (CIP). This creates a predictable, long term source of funding for broadband improvements over time. CIP funds might be used to maintain a modest inventory of handholes and conduit that could be placed when other improvements are underway (e.g. sidewalk upgrades, street grinding and resurfacing, etc.).

LEASE FEES

Initiatives like tower access and access to local government or Authority-owned conduit and fiber can create long term revenue streams from lease fees paid by service providers using that infrastructure. The City of Danville has recovered their entire initial capital investment from lease fees paid by providers on the nDanville fiber network.

SPECIAL ASSESSMENT

Communities like Bozeman, Montana and Leverett, Massachusetts have been funding broadband infrastructure improvements with special assessments (in Leverett, \$600/year for five years), and in Bozeman, TIF (Tax Increment Funding) is being used in some areas to add telecom conduit, handholes, and dark fiber.

GRANTS

Grant funding is limited and should be viewed as part of a larger basket of funding. Federal funds from sources like the USDA and the FCC are highly competitive and often come with substantial limitations on who can qualify and how the funds can be used. DHCD (VA Dept. of Housing and Community Development) provides some funding for planning, and they also administer CDBG (Community Development Block Grant) funds. CDBG funds can support telecom infrastructure construction but must be tied to job creation and/or job retention. In 2017, DHCD will have \$1.25 million in funds that can be requested by localities to give to service providers to support their improvements. Rules for how to apply for and spend those funds are still under development.

NEW MARKETS TAX CREDIT

New markets tax credits are a form of private sector financing supported by tax credits supplied by the Federal government. The New Markets Tax Credit (NMTC) Program permits taxpayers to receive a credit against Federal income taxes for making qualified equity investments in designated Community Development Entities (CDEs). The CDEs apply to the Federal government for an allotment of tax credits, which can then be used by private investors who supply funds for qualifying community projects. Substantially all of the qualified equity investment must in turn be used by the CDE to provide investments in low-income communities.

The credit provided to the investor totals 39 percent of the cost of the investment and is claimed over a seven-year credit allowance period. In each of the first three years, the investor receives a credit equal to five percent of the total amount paid for the stock or capital interest at the time of purchase. For the final four years, the value of the credit is six percent annually. Investors may not redeem their investments in CDEs prior to the conclusion of the seven-year period.

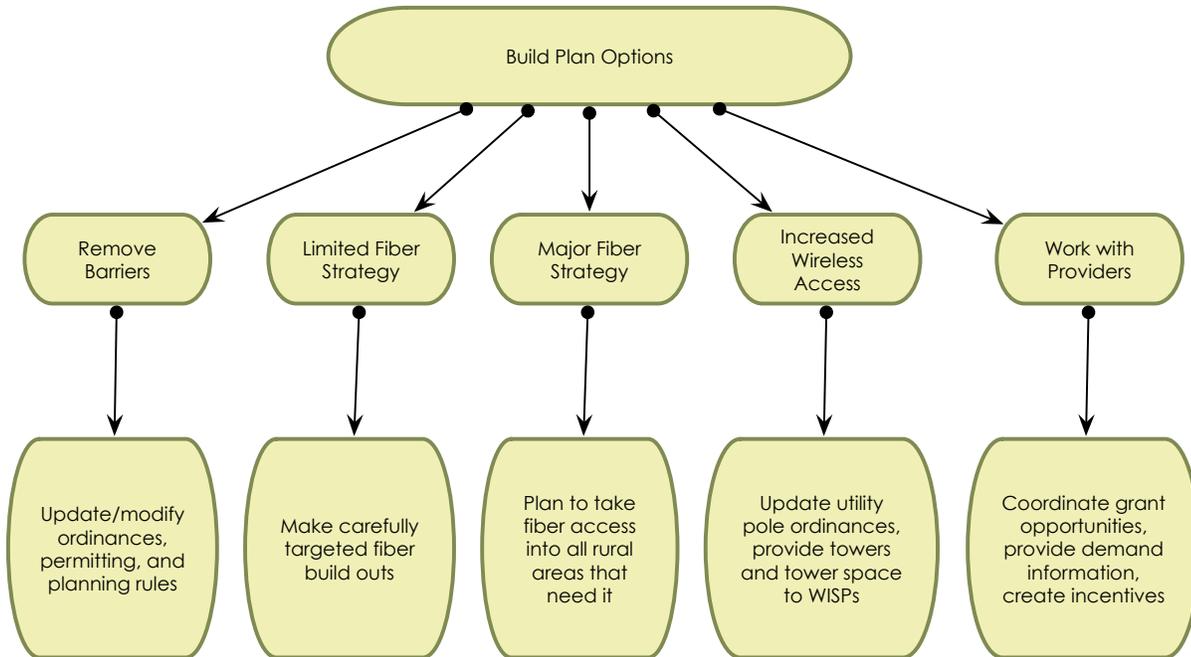
Throughout the life of the NMTC Program, the Fund is authorized to allocate to CDEs the authority to issue to their investors up to the aggregate amount of \$19.5 billion in equity as to which NMTCs can be claimed.

These tax credits can be quite useful, and there may be some areas that qualify. However, it can take up to a year or more to apply and then finally receive NMTC-related cash. This can be a useful long term source of funds.

RECOMMENDATION

Funding is going to be dependent upon the kinds of strategies the Town and the County and/or a new Broadband Authority want to pursue in partnership with the private sector. Grant funds are at best a supplement to local funds, and should not be viewed as a primary funding solution.

Build Plan Options



It is not likely that there will be just one “build plan” for Culpeper. Instead, the Town and the County are more likely to proceed in parallel with several initiatives.

As discussed previously, *removing barriers* can be an effective and early “win” at low cost. For example, providing “by right” ability of rural residents to place wood utility poles on their property (within specified guidelines) would make it easier for service providers to make a business case to offer improved access in rural areas of the region, as well as providing resident and rural businesses with an affordable solution.

A *limited fiber strategy* would identify strategic economic development areas like downtown Culpeper and the Airpark area for fiber infrastructure improvements. Projects like this could attract CDBG grant funds and could be supplemented with local funds. Projects of this type would typically vary in cost from under \$500,000 to \$1 million.

A *major fiber strategy* would be to offer fiber to the home throughout rural areas of the county, using a demand-based strategy that only placed fiber in neighborhoods and down rural roads where residents agreed in advance to buy services. While the capital expenditure for such a venture would be substantial, this would generate a revenue stream over the long term that would pay back bonds or other funds used to support the build out.

Because some areas of the county already have adequate Internet service from the cable provider, we estimate that only about half the households in the County would be candidates for a rural fiber build out. That would indicate about 8,000 households and businesses in the county would be included, and this approach could cost \$35 million or more, spent over several years.

It is worth noting that this could be funded by a “\$1/day” strategy: if each household in an rural “fiber improvement zone” agreed to pay \$1/day for twelve years (about \$32/month), the entire capital cost of the effort would be fully funded.

Increased wireless access is an intermediate strategy that could produce improved access in a year or less, placing new towers in underserved and unserved areas of the region and leasing space to wireless providers. This would be most effective when coupled with ordinance changes that would give rural residents and businesses “by right” ability to place wood utility poles on their property.

In all cases, the County, the EDA or the newly formed Broadband Authority will find it necessary and important to *work with providers*, especially providers that are open about their plans and demonstrate a willingness to be flexible in their approach to collaboration.

Broadband Strategies

Culpeper County and the Town of Culpeper have a variety of options and strategies available to improve broadband availability.

The following pages provide a set of strategies: some can be applied to meet very specific needs in individual areas. Other strategies can be applied more broadly. These include:

Form an Authority — The County and Town would benefit from collaborating on broadband initiatives, and collaboration with adjacent counties could also be very beneficial.

Public/Private Partnerships — All telecom, at varying levels, involve both public and private collaboration.

Implement Comprehensive Plan Recommendations to Improve Wireless — Section 7 of the 2015 Culpeper County Comprehensive plan outlines an excellent set of recommendations to improve access and affordability of broadband.

Conduit/Dark Fiber Strategy — A strategy of steady year by year development of telecom conduit placement in the Town of Culpeper and in areas of growth focus in the County could lead to increased availability of fiber services from private providers who would lease conduit. If the County also placed dark fiber in the conduit, additional revenue could be gained from the investments.

Meet-me Box and Fiber Drop Strategy — Meet-me boxes and inexpensive fiber drops to nearby homes or business/retail locations could attract improved wireless services from service providers and/or promote increased competition.

Cellular Tower Access — Some cell tower owners are beginning to recognize that there are advantages to allowing fixed wireless broadband providers to co-locate on their towers with their cellular customers. The County may be able to play a role in accelerating this process.

Demand Aggregation — A simple ongoing Web-based survey managed by the County that collects customer demand information (including location) could be distributed periodically to service providers.

Referendum — It may be useful to have a public vote on allocating funds for broadband improvements in the county.

Nano-cell Cellular Strategy — In some parts of the county where broadband service to the home is adequate but cellular service is poor, wider use of nano-cell equipment can provide improved cellular phone service in homes and rural businesses.

Service District Funding Strategy — Coupled with the demand aggregation strategy, some areas of the county could be designated as “broadband service districts” to provide a funding mechanism for broadband infrastructure improvements.

FORM A BROADBAND AUTHORITY

In Virginia, broadband authorities are used for broadband network projects that require long term oversight. The Commonwealth of Virginia has created enabling legislation specifically for broadband authorities, and there about twenty that have been formed (about ten are active).

The Authority offers arms-length separation of routine decision-making from local government. A key benefit of an Authority is that provides the oversight and management structure if participation from more than one local government entity is desirable. These regional agreements are widely used by local governments for the ownership and control of essential infrastructure that is better managed regionally.

At a minimum, the County and Town would be members of the Authority, but surrounding localities, including Fauquier, Madison, Orange, and Rappahannock counties may also be interested. Networks do not stop at political boundaries; Culpeper would benefit from being part of a larger regional collaboration to develop better broadband infrastructure through cost sharing and improved grant funding opportunities.

The basic principle underlying this approach is to create an independent management and governance entity that operates on a non-profit/cost-plus basis and which is firmly vested in the community. Some of the advantages of this approach include:

- ▶ A single entity has the primary responsibility for improving broadband access and affordability throughout the area.
- ▶ Broadband authorities have revenue bonding authority, which provides a stable, long term financing solution. Revenue bond financing is particularly attractive as it does not affect the credit rating of the local governments involved and has little or no impact on local property tax rates.
- ▶ The enterprise is firmly vested in the community or region, as opposed to a private venture (e.g. a LLC or coop), and via the board of directors, the local governments can guide the long term goals and objectives of the organization.

OWNERSHIP AND GOVERNANCE

If a regional authority is planned, each participating local government must advertise and pass a resolution to join the Authority. The minimum amount of time needed for this process is sixty to ninety days.

Broadband authorities are registered with the State Corporation Commission, which is a straightforward process with minimal paperwork. The authority has to have a charter document and a set of bylaws. The charter and bylaws could be drafted easily from the documents already developed by other Virginia broadband authorities.

A Board of Directors has to be appointed, with typically five to seven members. In a single county authority, there is often a board member for each magisterial district. In a multi-juris-

dictional authority, each locality typically appoints one or two members. Board members should have substantial management and business experience. Not all members need to have a telecom background.

COST DISCUSSION

The direct cost of forming an authority is nominal. On an ongoing basis, an authority needs to have some funds available for a variety of projects if it is to be effective. Each participating locality should be prepared to provide a fair share of funding, with amounts based on mutually agreed upon projects and initiatives.

If Authority investments are largely limited to passive infrastructure (e.g. dark fiber, conduit, wireless towers), the operational costs and responsibilities will be limited. Conduit and dark fiber would be leased to the private sector and lease prices would be structured to cover most or all of the ongoing operational costs.

FUNDING OPTIONS

Authorities, as a political subdivision, are eligible to apply for many kinds of state and Federal funding. For large projects with an appropriately identified revenue stream, an authority can bond directly. The VRA (Virginia Resource Authority) is able to assist broadband authorities with revenue bond development, but bonding is probably not an early funding possibility.

ARC and DHCD/CDBG grants may be the best “first phase” funding opportunities. Local governments that choose to be members may need to make modest annual contributions. A key reason for the region to form an broadband authority is to be able to show regional collaboration on broadband improvements. There is a marked preference in grant programs at both the state and Federal level for collaborative funding requests.

OPERATION AND MANAGEMENT CONSIDERATIONS

An Authority can be started and managed without any paid staff, but that will depend on the level of support available from the localities and/or funding sources that the Authority can tap for support. The Authority is more likely to have a significant impact if it has at least one paid employee (which could be part time).

Operations and management tasks would be determined by the kind of infrastructure improvements that are made. A focus on passive infrastructure would keep operational responsibilities to a minimum.

RECOMMENDATION

Rural businesses and residents in the region need a strong advocate for broadband. Improvements to broadband access and affordability are more likely to be successful if there is a single entity in the region that has primary responsibility for those improvements. Current activities relating to broadband are spread across several several localities with limited individual resources. The local governments of the region (i.e. Culpeper county and the surrounding counties) should form an Authority and provide an appropriate level of initial funding.

FORMING AN AUTHORITY

The legal formation of the Authority is straightforward, with a simple registration form and fee submitted to the Virginia State Corporation Commission. Other steps prior to submitting the application should include:

- Consensus among leadership on whether or not to pursue a multi-jurisdictional Authority to include the Town of Culpeper, Culpeper County, and some or all of the adjacent/nearby counties of Madison, Greene, Fauquier, Orange, Spotsylvania and Rappahannock.
- Resolution passed by the Board of Supervisors/Town Council in each locality to create the Authority.
- A charter for the authority has to be created. The charter is relatively short, and there are many samples available from existing authorities.
- A set of bylaws are required. As with the charter document, many examples are available from other authorities. Single county authorities typically appoint board members by magisterial districts (e.g. each BoS member appoints a representative from their own district). Multi-jurisdictional authorities typically have one or two members from each participating locality. Authority boards meet monthly or quarterly depending on staffing, operational responsibilities, and funding.
- The Authority will require both initial funding and some ongoing financial support from the participating locality or localities. These funds may be relatively modest, but will be needed to support early costs (e.g. hiring a grant writer on an as-needed basis for grant opportunities, technical advice, and other start up expenses).
- For many Virginia broadband authorities, locality staff often provide significant technical, financial, and administrative support. Staff who are going to be directed to provide support will need direction on amount of time to allocate to the Authority and the kind of support to provide. Some authorities have a part or full time staff member to provide leadership and to manage day to day interactions with service providers, incumbents, County/Town staff, citizens, and other stakeholders (e.g. economic development entities, state agencies, etc.).

PUBLIC/PRIVATE PARTNERSHIPS

Because virtually any modern broadband network (and most older telecom networks) use public right of way for a large portion of network distribution, ALL business models are “public/private partnerships.” The notion of the public/private partnership is not a distinct business model, but rather exists along a continuum, with minimal public involvement on one end (i.e. only use of public right of way) to full public ownership on the other end.

SERVICE PROVIDERS

In the county, service providers have to be part of the solution. No matter what investments the town and the county choose to make, service providers will have to use the new infrastructure to make the local government investments successful. While in many respects telecom infrastructure investments share many similarities with other public utilities (e.g. roads, water, sewer) there is one fundamental difference. Other public utilities like water and sewer have a captive audience and the utility is able to operate as a monopoly—meaning the customer base can be taken for granted. Early discussions with service providers have been positive, with at least several providers expressing a readiness to offer services if the county makes new infrastructure (like tower access for WISPs) available at fair prices.

Regional telecom investments will be a public/private enterprise, and service providers are the primary customers of the infrastructure. Service providers cannot be taken for granted. Instead, a fair fee structure, high quality infrastructure, excellent maintenance and operations (where needed), and flexibility on business agreements and pricing will be required to recruit and retain service providers.

Projects that are not successful in attracting service providers will fail. Affordable lease rates for tower space and/or fiber connections will attract service providers. Other open access projects (Danville, The Wired Road, FastRoads, Utopia) have not had any difficulty getting service providers to use the infrastructure.

COMPREHENSIVE CODE CHANGES

Section 7 of the 2015 Culpeper County Comprehensive plan outlines an excellent set of recommendations to improve access and affordability of broadband. At least two wireless service providers have expressed an interest in gaining affordable access to new and existing county towers. There are five County towers that could be used for colocation by service providers. The Authority could manage the access to those towers on behalf of the County.

Existing county towers that have spare vertical space could be upgraded to support wireless providers on those towers at relatively low cost. In unserved and underserved areas of the county where there are no County towers, new towers could be erected and offered to wireless service providers. Increased coordination among County public service uses, broadband use, and the planned expansion of towers on county school property could also reap benefits, with fewer towers providing better services for public safety, K12 broadband use, and general residential and business use.

Culpeper County shares the same difficult terrain challenges that many other counties in western and central Virginia have: mountainous/rolling terrain and heavy tree cover. The tree cover is a constant problem for rural residents and businesses, as good line of sight is required for fixed wireless Internet services. Even newer technologies like white space and LTE systems work better with clear line of sight to distant towers. The use of wooden utility poles is already common in western and central Virginia, and increased use of this technique to get the customer CPE radio/antenna above tree cover is a relatively simple solution that could provide improvements in access. Rural residents should be allowed to erect 80' wood utility poles by right, which would make wireless broadband more widely available.



OWNERSHIP AND GOVERNANCE

The County already successfully manages numerous towers. There are no special challenges to adding more towers (six to eight as a maximum, and perhaps only three to four new towers to add to existing County towers).

Wooden utility poles would normally be placed on private property, subject to existing or updated county ordinances governing the placement of wooden utility poles. The County would have no responsibility for maintenance and repairs for these.

COST DISCUSSION

A detailed discussion of costs associated with leasing space on new and existing county towers is provided in the next section. Existing county towers can be upgraded inexpensively. New towers would generate modest revenue from lease fees, and payback on the the capital costs could take ten years or more.

The cost of placing an eighty foot pole can range from a low of about \$2,000 to \$7,000 or more, depending on the permitting, any required engineering, location of the pole and local

terrain. Some Virginia counties provide “by right” permitting of these poles if they are placed on private property, which can reduce the cost of installing them. Culpeper County Code Section 17-6 (Standards for Telecommunication Antennas and Towers) does not seem to provide an exception for wooden poles placed on private property.

FUNDING OPTIONS

Because these are placed on private land, the County would not have to provide any direct funding. However, the County could encourage wider use of this option with a public awareness campaign developed in partnership with wireless providers. Local banks could be encouraged to provide low cost financing of the poles so that property owners could make a small interest and principal payment monthly over several years to reduce the financial impact.

OPERATION AND MANAGEMENT CONSIDERATIONS

The County would incur no ongoing operational or management costs for the privately owned wooden utility poles. Maintenance on existing county-owned towers is already budgeted, and new tower maintenance costs could be covered at least in part by lease fees. Routine tower maintenance includes periodic servicing of emergency power generators and grounds maintenance around the base of the tower (e.g. weed and grass control).

RECOMMENDATION AND NEXT STEPS

The wooden utility pole strategy requires minimal financial support from the County and has the potential of improving broadband access in rural areas of the county quickly. The County should consider offering “by right” permitting of wood utility poles in rural parts of the county, including allowing a minimum of twenty feet above existing tree cover and subject to a very limited set of restrictions (e.g. a minimum set back from public right of way).

County support for an awareness campaign developed with local wireless service providers would also be beneficial.

MEET-ME BOX AND FIBER DROP STRATEGY

In certain areas of the county, especially in the Town of Culpeper, some smaller communities and rural neighborhoods and subdivisions, “meet me” boxes could be installed. A meet me box is a telecom cabinet with fiber cables installed between the cabinet and nearby homes and/or buildings. Providers only have to reach the meet-me box, lowering their costs. Both wireline and wireless providers can use this infrastructure. This approach can also be used to provide fiber services in business and industrial parks. Charles City County installed five miles of fiber in their business park and was able to attract a Tier One provider to provide service to an existing business (a Home Depot manufacturing plant that was going to leave if the County did not help them get better Internet service).



A dark fiber approach is recommended to minimize operational costs. Service providers would install their own equipment in the cabinet and would pay a small monthly lease fee for the fiber strands they use to connect customers to their services.

OWNERSHIP AND GOVERNANCE

The meet-me boxes and related fiber, conduit, and handholes could be owned by the County or a broadband authority.

COST DISCUSSION

For a meet-me box installed in a “main street” area (e.g. in an alley behind commercial/retail buildings) with relatively inexpensive and short fiber drop cables into nearby buildings, the lower end of an installation might start at \$35,000. For a box installed in a rural sub-division that requires distribution conduit/fiber and drop cables, the cost to connect 25 homes might start at \$175,000 on the low end and increase as the number of homes connected increases. Larger numbers of homes or businesses will each add to the cost, but adding more connected premises also increases the value of the infrastructure and increases the revenue potential.

FUNDING OPTIONS

In some areas, where it can be shown that this infrastructure is going to keep existing jobs and/or add new jobs, CDBG funds may be available to support the initial capital costs. Some local match (e.g. 10% to 20%) may also be required.

Providers will pay monthly lease fees for the fiber strands they use to connect customers, and these fees will cover some or all of the ongoing operational costs. The greater the number of connected customers, the larger the revenue potential.

OPERATION AND MANAGEMENT CONSIDERATIONS

The cabinet requires electric power and has integrated heating and cooling. Service providers using the infrastructure would install their own equipment and be responsible for the maintenance and repairs of their own equipment.

For routine and emergency break-fix maintenance on the fiber or the cabinet HVAC, a small as-needed repair contract would be required with a firm qualified to make fiber splicing repairs and related service work.

Emergency repairs would be rare, and routine maintenance would also be very limited. It would be possible for the county IT department to support some of the routine management of this infrastructure. Monitoring and repair management could also be outsourced. If an Authority were formed, the Authority would probably choose to outsource all responsibilities except contract management (i.e. contracts with repair and monitoring firms).

RECOMMENDATION AND NEXT STEPS

Because this requires owning and managing infrastructure, the County will need to discuss how to handle the ownership of these assets and the ongoing operational responsibilities.

ECONOMIC/COMMUNITY DEVELOPMENT AREA IMPROVEMENTS

Dark fiber availability in the Town of Culpeper, business parks, and economic growth areas can increase property values, help attract businesses and jobs, and lower the cost of bandwidth. The Meet-Me Box strategy discussed previously is a specific instance of this more general strategy of identifying areas where improved telecom services are desirable to more effectively manage growth—improved telecom infrastructure can attract both businesses and residents to those areas where the improvements exist.

In new residential green field projects, developers should be encouraged through proffers and other planning tools to install the conduit, handholes, and drop conduit as part of their normal utility infrastructure improvements. Conduit would be routed back to a cabinet or small pre-fab shelter, where service providers could “meet” the sub-division customers.

These fiber-connected sub-divisions would become highly desirable places to live and to work. If developers install the infrastructure and turn it over to the County along with other infrastructure (e.g. water, sewer, sidewalks, roads, etc.), the County has little or no capital costs but gains improved property values. Homes with fiber are estimated to be worth \$5,000 to \$7,000 more than homes that lack fiber.



OWNERSHIP AND GOVERNANCE

The County could manage these investments directly, using existing IT department and/or outsourced support, or it could choose to form an Authority (which would likely also outsource most day to day maintenance and support).

COST DISCUSSION

The cost of installing conduit and handholes can vary widely. Installation of the inexpensive plastic conduit (ranging in cost from under one dollar per foot to two or three dollars per foot depending on size and capacity) can be outsourced to qualified private sector firms.

One strategy to minimize the labor cost of installation would be to coordinate conduit installation with other projects like road remediation (install conduit before grinding and repaving), sidewalk and alley improvements, or other joint trenching/construction opportunities—only in previously identified areas where these improvements have been designated as important.

FUNDING OPTIONS

An annual budget allocation in the Capital Improvements Plan would allow the County to keep a small inventory of conduit and handholes on hand and to it installed as needed in

desirable areas. Over time, as shorter segments of conduit are connected together and become valuable to providers, the county could have fiber cable installed and make it available on a lease basis for providers.

OPERATION AND MANAGEMENT CONSIDERATIONS

Conduit and handholes require no routine maintenance. If dark fiber is installed, fiber break-fix repairs should be outsourced. A small as-needed repair contract would be required with a firm qualified to make fiber splicing repairs and related service work.

Emergency repairs would be rare and a qualified break-fix repair firm would be on call for this work. Monitoring and repair management could also be outsourced. If an Authority were formed, the Authority would probably choose to outsource all responsibilities except contract management (i.e. contracts with repair and monitoring firms).

RECOMMENDATION AND NEXT STEPS

A successful implementation of this approach would require a multi-year commitment and annual funding allocations to support it. The County must decide on the management approach (e.g. managed via existing County staff and departments) or if it would prefer to form an Authority.

CELLULAR TOWER ACCESS

Some cellular tower owners are becoming more open to leasing tower space to wireless Internet Service Providers (WISPs) and/or local government. It may be possible for the county to negotiate a lease for vertical space on all towers belonging to one tower company, and then sub-leasing that space to local WISPs. The advantage to this approach is that service providers gain access to several towers at once with pre-negotiated space on each tower. This would make it easier for the providers to expand availability of their services in the county.

OWNERSHIP AND GOVERNANCE

The County would not have any asset management responsibilities. Service providers that took advantage of the bulk lease opportunity would be responsible for climbing the towers and maintaining their own network equipment and radios.

COST DISCUSSION

The cost of this opportunity would be determined by:

- The per tower cost of leasing space. Providers generally want a minimum of ten feet of vertical tower space.
- The number of towers deemed useful to expanding fixed point wireless service. Cell towers tend to be clustered along major roads and arteries (e.g. Route 15, Route 29), so not all towers available from a single tower firm might be useful.



The cost would also be affected by the amount of space leased: a single ten foot segment of the tower, or two ten foot segments (thereby allowing two providers on the same tower).

Preliminary discussions about this approach with a major tower owner suggests that the County might have to subsidize a portion of the cost for some limited period of time while the WISP(s) build up the number of customers they have receiving access from that tower(s).

FUNDING OPTIONS

The County should charge the wireless providers at least some portion of the cost of maintaining the master lease. As providers develop the customer base from a tower or towers, a graduated fee scale could eventually phase out County subsidies.

OPERATION AND MANAGEMENT CONSIDERATIONS

No asset management required. The County would have to manage one or more master lease agreements with the tower companies, and a very small number of sub-lease agreements (probably no more than two) with WISPs.

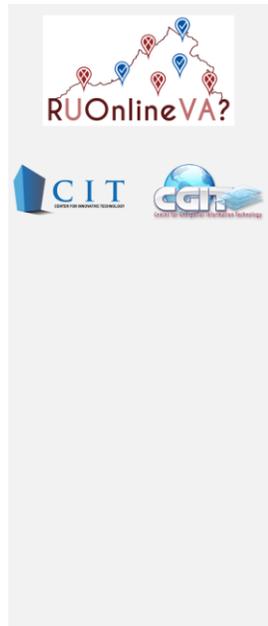
RECOMMENDATION AND NEXT STEPS

The County IT Department could initiate a pricing conversation with one or more companies that own towers in the county.

DEMAND AGGREGATION

A very brief survey that collects address information and bandwidth needs can collect valuable demand data that can be passed on to ISPs and/or help direct County infrastructure investments. For both wireline and wireless services, neighborhoods (often as few as a handful of homes) can aggregate their demand to attract improved service from ISPs. The current broadband surveys that are part of this study have collected responses from more than 544 responses by mid-July.

The Commonwealth recently announced a broadband survey (RUOnline.virginia.gov) that collects similar information. If that data is available from the state or Virginia Tech (Tech is managing the survey site), there may not be a need to duplicate that survey at the county level.



Survey Questions

RUOnlineVA?

Governor McAuliffe and the Commonwealth of Virginia are in need of internet service please take regarding your need. Responses will be mapped to stimulate broadband policy and funding discussion with administration.

Please fill out all required fields and submit.

*** Address**

*** City**

*** Zip**

*** This address is for a**

- Residence
- Residence with a home based business
- Business

OWNERSHIP AND GOVERNANCE

No asset management is required. This effort could be managed by the County IT department. Some additional marketing and public awareness work would be needed to collect enough data from county residents and businesses to be useful.

COST DISCUSSION

A small amount of County staff time would be needed to support the data collection/distribution task and the public awareness effort.

FUNDING OPTIONS

No special funding required.

OPERATION AND MANAGEMENT CONSIDERATIONS

None.

RECOMMENDATION AND NEXT STEPS

Discussion by the Board of Supervisors.

REFERENDUM

It may be useful to have a public vote on allocating funds for broadband improvements in each of the localities. Properly presented to the public, it could be an excellent opportunity to educate the public on the cost of demanding that local government “do something.” This approach could have two very different but positive outcomes.

- If the voters were asked to support a tax increase or special assessment to support improved broadband in rural areas and they voted “no,” it could take some of the pressure off Supervisors and Council members to ‘do something.’
- The special assessment could be allocated by creating service districts. By using the demand aggregation strategy to identify areas where homeowners and businesses are willing to pay an extra fee for improved broadband, the assessment would only be levied based on demand.
- If the voters agreed to support a tax increase or special assessment, then the Council members and Supervisors would have a mandate to fund solutions.

COST DISCUSSION

Staff time would be needed to develop the cost proposition that would be placed on the ballot. Additional effort would be required to provide an appropriate public awareness campaign to educate the public on the meaning and purpose of the referendum.

FUNDING OPTIONS

No special funding required.

OPERATION AND MANAGEMENT CONSIDERATIONS

None.

RECOMMENDATION AND NEXT STEPS

Discussion by the Board of Supervisors and by Town Council.

NANO-CELL CELLULAR STRATEGY

A common complaint in the county is the poor cell service in some areas. In some parts of Culpeper, there may be adequate broadband service via DSL, but poor cellular phone/data service. This problem can be addressed by promoting the wider use of “nano-cell” devices. These small pieces of equipment are connected to the DSL modem and provide improved cell service in the home or business. The working distance of these devices is limited, and service generally drops off once you leave the house itself (it may work for some short distance in the yard).

These devices work very well and do not require a large amount of bandwidth. They would work with both the DSL and wireless broadband services available in the county.

The cellular providers do not always promote the use of these devices, so many cellular users who would benefit from their use are not aware that this option is available. The device averages around \$200 retail, but the cellular providers often provide substantial rebates (50% discount or more) and in some cases may provide them at no charge.



This strategy is interesting because improved broadband service can also improve cellular service *without the need for more cellular towers*, especially in parts of the county where cellular providers have not been able to make the business case for more towers.

COST DISCUSSION

This strategy does not require any direct funding from the County, but if an Authority is formed, the Authority could develop play role educating residents and businesses about this option. Prior to formal development of the Authority, the County could post information on its Web site, and the local libraries could provide information about this as well.

FUNDING OPTIONS

No special funding required.

OPERATION AND MANAGEMENT CONSIDERATIONS

None.

RECOMMENDATION AND NEXT STEPS

This should be developed as a short term strategy whether or not an Authority is formed.

SERVICE DISTRICT STRATEGY

In the Commonwealth, local governments are authorized to form service districts for the purpose of funding various kinds of services and/or infrastructure improvements. If the demand aggregation strategy were used to identify areas of the county where a majority of citizens were willing to pay a special assessment for improved broadband infrastructure, the service district could be created only in that area.

The service district approach allows fees or special levies to be assessed only where voters agree to support it, giving supervisors a tool to selectively develop funding for broadband improvements.



COST DISCUSSION

The county attorney will be required to assist elected officials with the creation of the service district.

FUNDING OPTIONS

No special funding required.

OPERATION AND MANAGEMENT CONSIDERATIONS

Service districts should be created based on defined geographic areas. Some care would have to be taken to define how the funds will be used, and an awareness campaign, coupled with the demand aggregation strategy (e.g. a survey and/or referendum) would be required to determine where the service district(s) would be created.

RECOMMENDATION AND NEXT STEPS

Discussion by the Board of Supervisors and review by the county attorney.

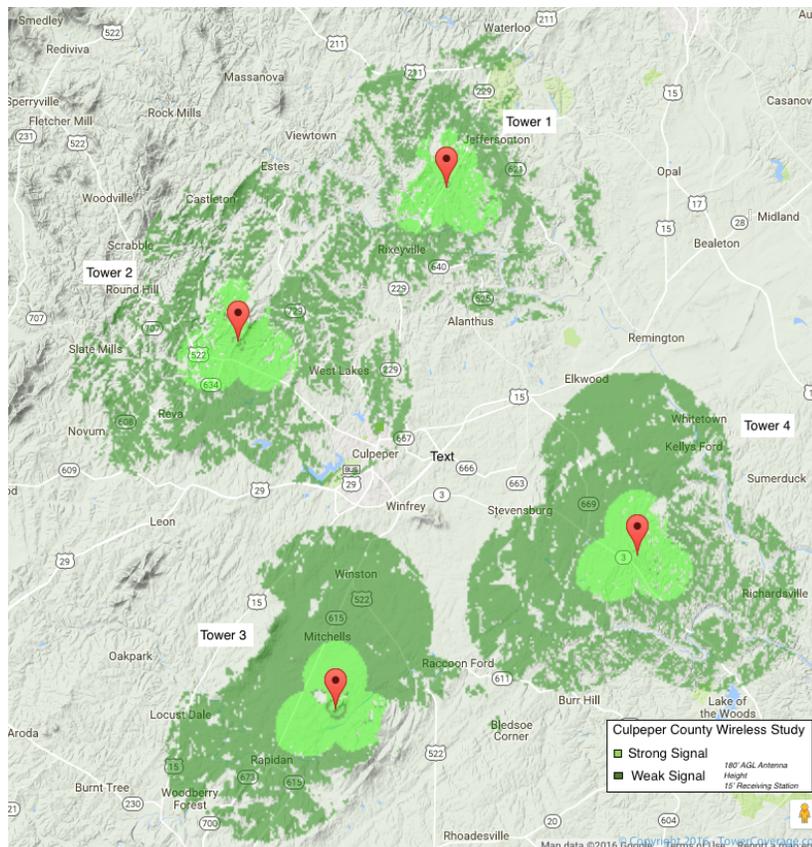
Wireless Tower Cost Estimate Study

Any placement of new towers should be preceded by a careful viewshed analysis (how much area/users are likely to be able to receive service). Site acquisition and site preparation costs can affect the overall cost of such a project. Existing county properties (e.g. fire/rescue stations, county parks, dump transfer sites, etc.) may be candidates for towers.

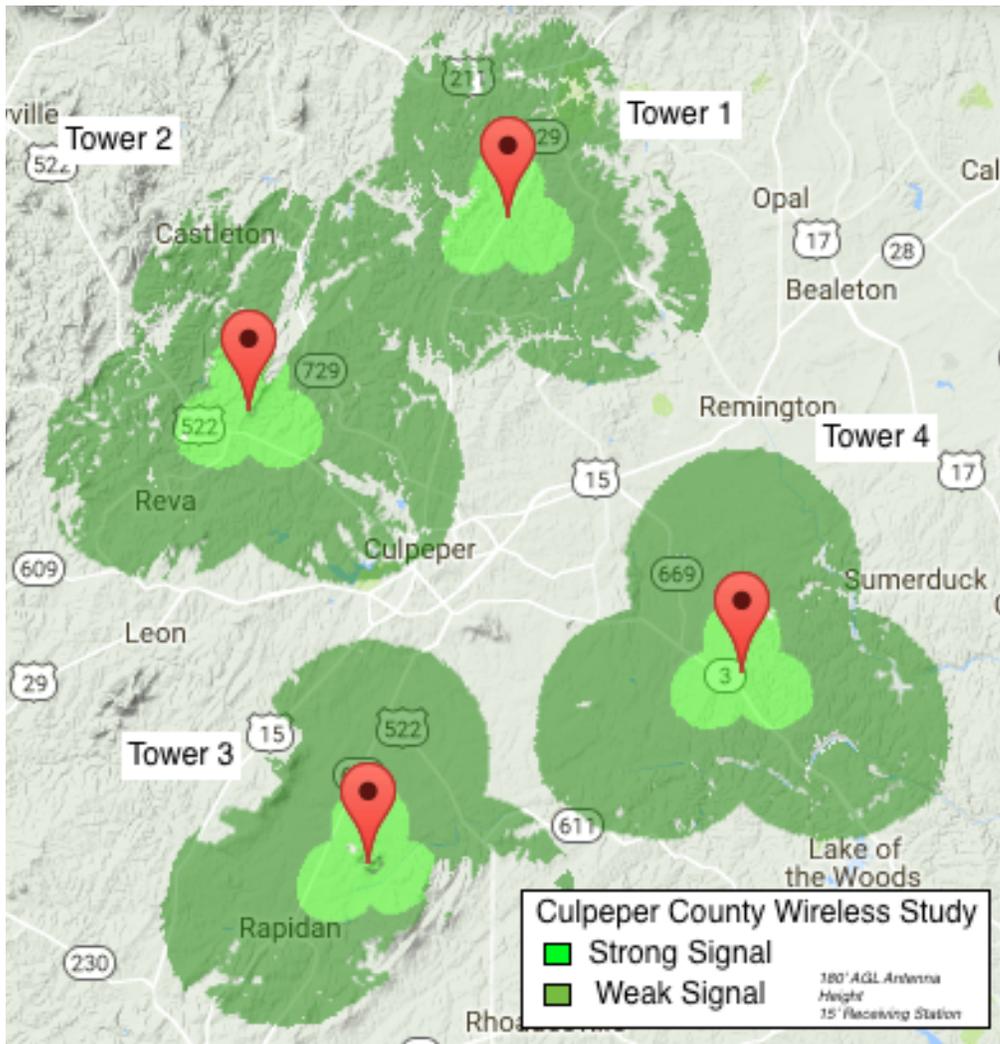
Tower space leased to wireless service providers (WISPs) can generate a small revenue stream, but the high cost of acquiring new wireless customers and the relatively low profit margins for in the wireless business will require only modest fees at best. The payback for the initial cost of a new tower could be fifteen years or more. At least one Virginia county is contemplating providing free or very low fee access to their towers with the goal of rapidly improving broadband access in their underserved areas.

The map on the next page shows what might be possible placing new towers on existing county-owned sites (fire/rescue locations and county parks). If some existing county towers have available space that could be made available to wireless providers, the number of new towers could be reduced.

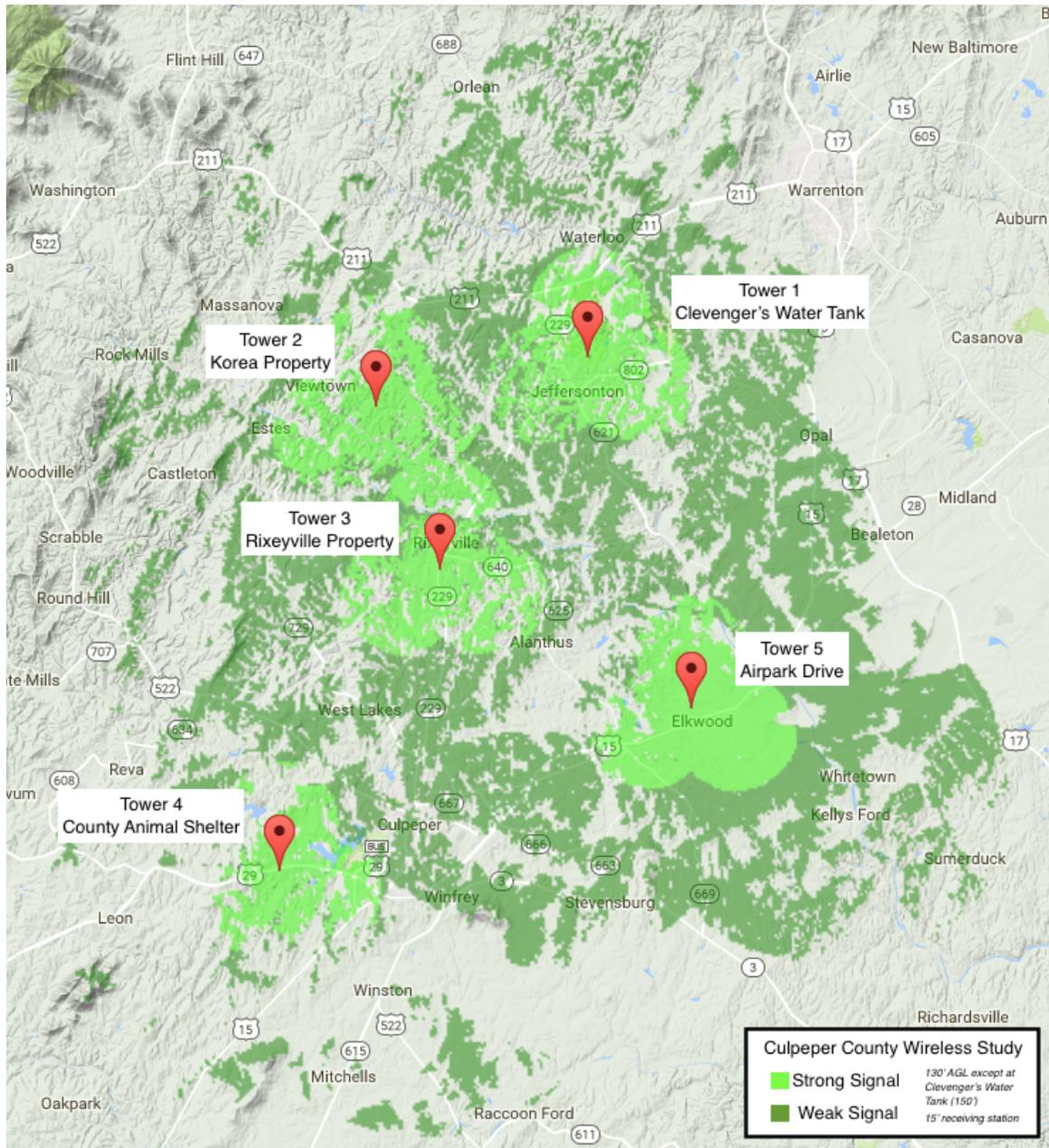
The map below shows the potential coverage areas for 180 foot towers in the rural parts of the county when the customer receiving antenna is located 15 feet off the ground.

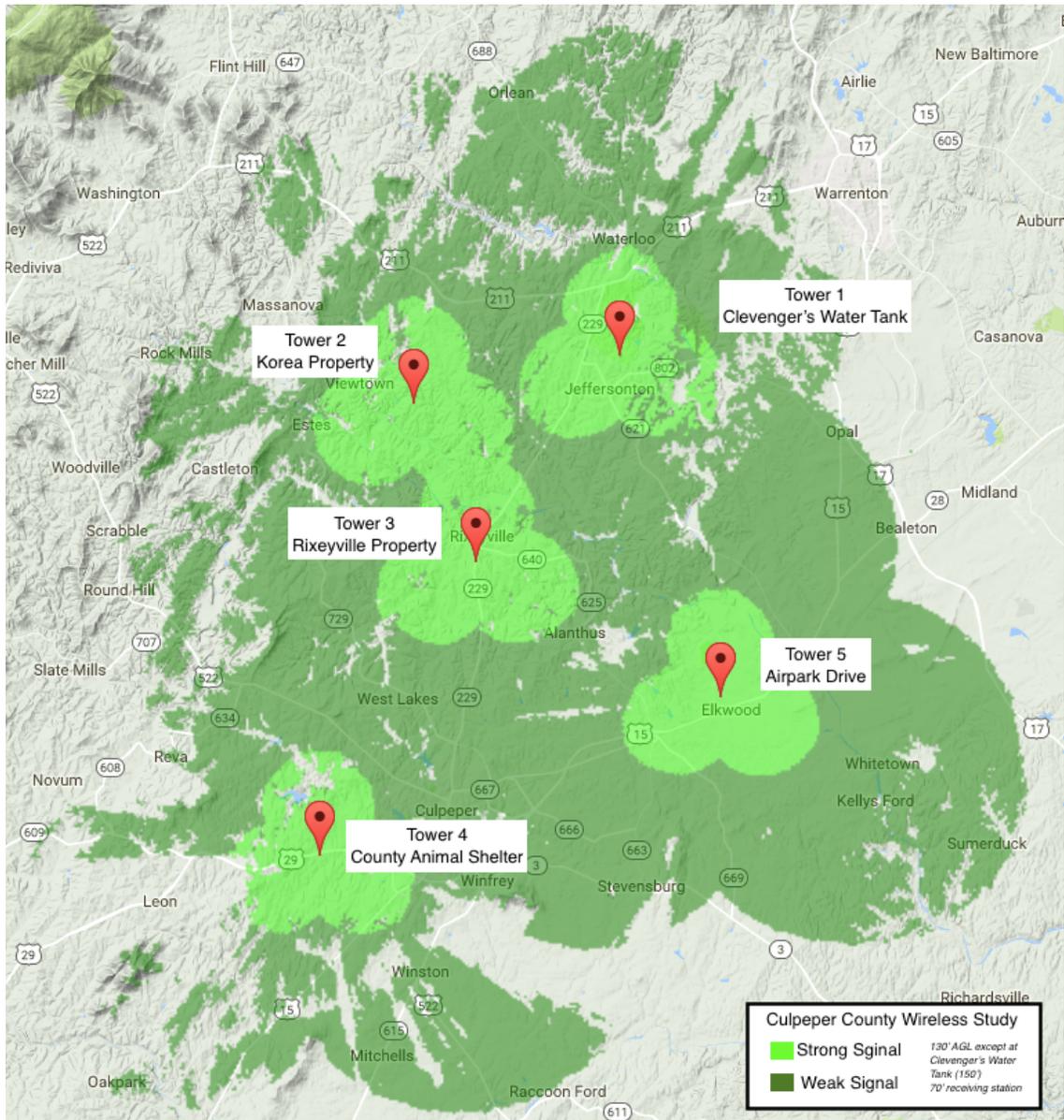


The map below shows the potential coverage areas for 180 foot towers in the same locations as the previous map, but this study assumes that the customer receiving antenna is located 70 feet off the ground—attached to a wooden utility pole. The area covered by the towers is significantly increased when the receiving antenna can be located above existing tree cover.



A second wireless study, using several County-properties and areas of interest yielded excellent coverage results.





COST DISCUSSION

Upgrades to existing towers typically may include adding or upgrading generators, additional cabinet or shelter space for service provider equipment, and sometime fencing and physical access changes.

TOWER UPGRADE COST TABLE

I	ITEM/PROJECT	UNITS	Estimated Cost (Conservative)	BEST ESTIMATE (WEIGHTED AVERAGE)
2	Small Telecom Cabinet	1	\$6,000	\$6,000
3	10kW Liquid Propane Generator	1	\$6,000	\$6,000
4	Cabinet Foundation and Installation	1	\$800	\$800
5	Spare Fuses	1	\$20	\$20
6	Power System Installation Materials	1	\$40	\$40
7	Samlex 1000W Inverter	1	\$450	\$450
8	Samlex SEC1230-UL Battery Charger	1	\$300	\$300
9	100ah 12v Non Spillable Backup Battery	1	\$350	\$350
10	DC Voltage Monitoring Device	1	\$60	\$60
11	Unmanaged Rack Mount PDU (6O)	1	\$45	\$45
12	Cabinet Installation Labor	1	\$1,000	\$1,000
13	Power System Installation Labor	1	\$500	\$500
14	Generator Installation Labor	1	\$1,700	\$1,700
15	Project Management		18%	\$3,108
16	Estimated Construction Cost			\$20,373

New towers have a range of configurations and cost options. If located on existing County property, the time needed to plan for construction can be shortened. If site acquisition or a site lease (of private property) is required, purchase or lease negotiations can add several months to the process.

NEW TOWER COST TABLE

I	ITEM/PROJECT	UNITS	COST(HIGH)	BEST ESTIMATE (WEIGHTED AVERAGE)
2	Small Telecom Cabinet	1	\$3,000.00	\$3,000
3	10kW Liquid Propane Generator	1	\$6,000.00	\$6,000
4	Cabinet Foundation and Installation	1	\$800.00	\$800
5	New Power Service / Installation	1	\$1,250.00	\$1,250
6	180' Self Supporting Tower Construction Materials	1	\$22,000.00	\$22,000
7	Spare Fuses	1	\$20.00	\$20
8	Power System Installation Materials	1	\$40.00	\$40
9	Samlex 1000W Inverter	1	\$450.00	\$450
10	Samlex SEC1230-UL Battery Charger	1	\$300.00	\$300
11	100ah 12v Non Spillable Backup Battery	1	\$350.00	\$350

12	DC Voltage Monitoring Device		\$60.00	\$60
13	Unmanaged Rack Mount PDU (60)		\$45.00	\$45
14	Tower Site Land Clearing and Site Development		\$12,500.00	\$12,500
15	180' guyed Tower Construction Labor		\$26,000.00	\$26,000
16	Cabinet Installation Labor		\$1,000.00	\$1,000
17	Power System Installation Labor		\$500.00	\$500
18	Generator Installation Labor		\$1,700.00	\$1,700
19	FCC License Coordination		\$1,500.00	\$1,500
20	Construction Total:			\$77,515
21	Project Management, Network Engineering, Testing			\$23,260
22	Site Engineering, Surveying, viewshed analysis Etc.			\$9,500
23	Misc Fees, Technical Services			\$7,500
24	Bookkeeping and Administration			\$5,000
25	Contingency			\$12,280
26	TOTAL:			\$135,055
27	<p>Notes/Assumptions:</p> <p>Site work - Land acquisition and leases are not included in tower estimate. Site preparation is estimated and assumes a typical site with some small vegetation and work needed. If a site will require more extensive land clearing or road improvement work it should be estimated on a site by site basis.</p> <p>Generator - a small liquid propane generator is included in the estimate for this tower. The estimate does not include a tank and tank install because in our experience this cost is typically covered by the local gas company as long as there is a service contract.</p> <p>Cellular Carriers and Upgrades - Towers at this size must be specifically engineered for their location and equipment load. The pricing shown above is estimated at a size which will support WISP and Public Safety equipment. Designing to accommodate cellular providers should be expected to increase the cost by \$75,000 to \$150,000.</p>			

NEW TOWER SITING CONSIDERATIONS

There are many factors in choosing sites to develop for towers. The cost of site prep in an area with unfavorable conditions can quickly outweigh the cost of the actual tower.

- Favorable site leasing or purchasing conditions such as County properties, infrastructure sites, industrial areas, or areas with other towers.
- The site must be useful to the network from the wireless engineering standpoint. Evaluate how the new site will fit into the wireless network and determine if it desirable early in the process.
- Proposed tower sites should be close to a road and accessible by truck. Improving access to a site and repairing damage caused by construction is expected, but constructing new roads on a site will increase costs dramatically.
- Proposed sites should be close to grid power. While evaluating a site locate the nearest utility poles or pedestals. If there is no transformer near the site, within 500 feet, there will likely be higher costs to bring power in.
- Mostly flat, or gently sloping sites cost less to develop than sites with steep terrain. When considering tower sites look for flat areas to place the tower and compound. It may be

worth sacrificing some altitude or doing some additional clearing to avoid major ground disturbances and earth work.

- It is common to clear some trees and vegetation while developing a tower site, but excessive clearing requirements will raise costs. If sites are in a wooded area look for locations where vegetation is sparse and the tree growth is somewhat young (e.g., 8-10" in diameter). Large trees or very dense brush will be more expensive to clear.
- Look for secure sites with limited access. Sites are better off in an area that doesn't get frequent visitors.
- Look for tower sites with the potential to connect to fiber networks. Access to multiple fiber providers on a wireless network will be very important to potential tenants and the economic viability of the network.

Things to avoid

- Avoid dense residential areas and retail areas when evaluating tower sites.
- Avoid parcels with creeks or other water features that could be an impediment to construction.
- Large concrete trucks will have to access the site while constructing the towers. During site evaluation consider the entire route that trucks will have to take.
- Avoid locating tower sites near areas where permitting could be an issue. Historic Districts, airports, scenic locations, and areas with strict zoning should be avoided.

FUNDING OPTIONS

The relatively low cost of tower upgrades and new tower construction suggests the most expedient funding is direct financial support from the County. If grant funds are needed (e.g. several new towers are proposed), working with public safety officials to combine public safety grant opportunities and public safety capital funds could be very beneficial.

OPERATION AND MANAGEMENT CONSIDERATIONS

Towers are passive infrastructure, and if properly designed and constructed, require minimal maintenance. Leasing space to the service providers, who will install their own radios, antennas, and electronics relieves the County of any responsibility for equipment management and configuration, and equipment repairs and replacement. Service providers will be required to do their own tower climbs and repairs to equipment on the tower; the County would not be responsible for any equipment placed on the tower itself.

RECOMMENDATION AND NEXT STEPS

An preliminary analysis of existing county towers and potential county-owned sites for new towers suggests that good coverage could be obtained with careful site analysis. If the County moves forward with this initiative, line of sight and viewshed studies are recommended for

existing towers and for any possible new sites. Discussions with wireless service providers to get their input on where they see benefits for improved tower access are also recommended.

Next steps would include securing funding, line of sight and viewshed analysis of existing sites, identification of county-owned property for new towers, line of sight and viewshed analysis of the new sites, determination of tower type for new towers (guyed or self supporting), and discussions with service providers. final identification of sites, complete detailed network engineering including site layouts and Line of Sight engineering, and work with local Service Providers.

TYPICAL CONSTRUCTION SCHEDULE

The timeline and activities describe the typical process for constructing a tower. Combining multiple sites into a single construction project will expand the timeline below but overall will save time and expense. Delays in the site identification and procurement stages of a project are the most common delays for counties and cities.

• MONTH ONE

- Project kick-off
- Site identification
- Network design

• MONTH TWO

- Pre-construction site planning
- Lease / MOU negotiation
- Procurement

• MONTH THREE

- Site layout and planning
- Site clearing and preparation
- Tower materials shipping

• MONTH FOUR

- Foundation construction
- Inspection
- Tower construction
- Construction wrap-up

• MONTH FIVE

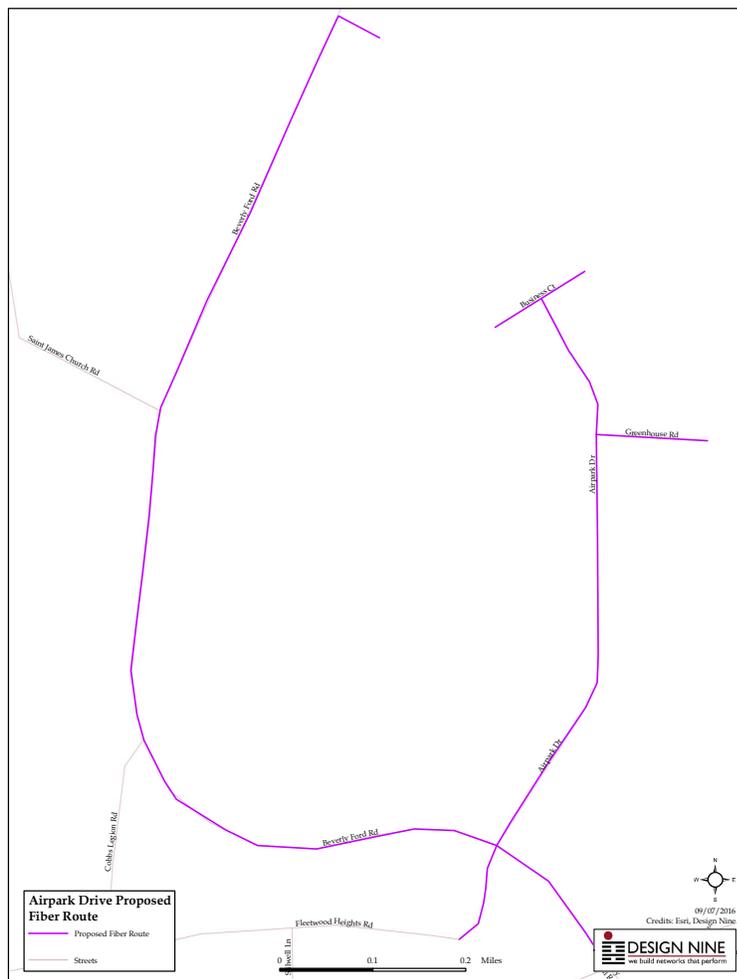
- Equipment installation and network testing
- Project close out

Fiber Deployment Cost Estimates

Preliminary cost estimates for deploying fiber infrastructure in the Town of Culpeper and the Airpark area are provided in this section. These estimates provide specific examples of the Meet-Me Box and Conduit/Dark Fiber strategies discussed previously.

AIRPARK

This estimate has been designed to provide dark fiber availability and a meet-me box in the Airpark area near the airport and includes fiber to airport terminal itself, where WiFi could be provided to air travelers. As seen in the Infrastructure Overview table on the next page, this includes about a mile and a half of conduit and dark fiber, twenty-five handholes for customer drop cable access, and this could provide access to 100+ customers. The cost per building is relatively high because of the small number of buildings connected and the need for a relatively large amount of distribution conduit and fiber relative to the number of connected premises. If more buildings/customers were added incrementally once the initial “phase one” is complete, the cost per building would decline.



Airpark Summary of Costs

1	ITEM/PROJECT	ESTIMATED
2	Airpark Dark Fiber Construction Materials	\$46,714.97
3	Airpark Dark Fiber Distribution Labor	\$79,154.40
4	Airpark Dark Fiber Structures, Cabinets, and Equipment	\$22,215.00
5	Airpark Dark Fiber Drop Construction	\$20,625.00
6	Network Construction Subtotal	\$168,709.37
7	Project Management, Network Engineering, Integration, and Testing	\$20,245.12
8	Engineering, Permitting	\$25,306.41
9	Misc Fees, Advertising, Technical Services	\$10,000.00
10	Bookkeeping and Administration	\$5,000.00
11	Other Costs Subtotal	\$60,551.53
12	Project Total (No Contingency)	\$229,260.90
13	Contingency at 10%	\$22,926.09
14	Project Total (with contingency)	\$252,186.99

Infrastructure Analysis

1	ITEM/PROJECT	ESTIMATED
2	Total cost per mile	\$178,410.07
3	Distribution construction cost per mile	\$119,619.68
4	Distribution cost per mile (no drops)	\$105,492.97
5	Total Cost per building connected	\$10,419.15
6	Drop Costs per building connected	\$825.00

Airpark Infrastructure Overview

1	ITEM/PROJECT	VALUE
2	Miles of Fiber / Conduit Installed	1.46
3	Number of Handholes Installed	16
4	Splice Closures Installed	9
5	Cabinets Installed	1
6	Number of Customers Connected	25

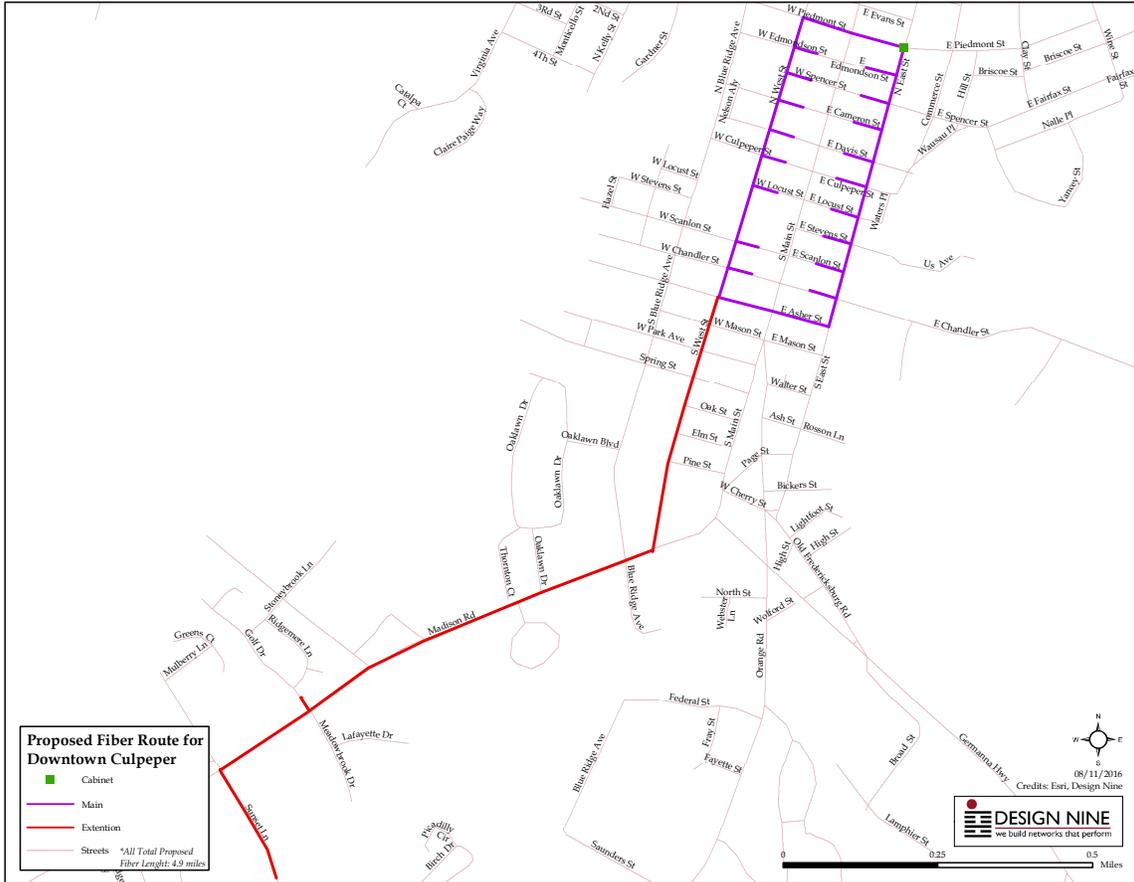
TOWN OF CULPEPER

This study includes more conduit/fiber route miles (2.1 miles) than the Airpark study and includes a complete loop, which can provide network redundancy—a highly desirable design element of fiber networks—a fiber cut on a redundant fiber loop will not cause loss of service.

This estimate also assumes a “first phase” connection to 120+ businesses and homes and a single meet-me cabinet where service providers would connect to the dark fiber network. The cost per building pass is high because of the larger amount of conduit/fiber routes miles, but like the Airpark analysis, adding more connected premises would bring that amount down.



The map below shows a fiber extension that would continue from the downtown area to the hospital and then on to the wellness center. This increases the cost of the downtown project but the fiber extension (the red line) passes more businesses and several residential neighborhoods that could provide more connections.



Town of Culpeper Infrastructure Overview

1	ITEM/PROJECT	VALUE
2	Miles of Fiber / Conduit Installed	4.91
3	Number of Handholes Installed	87
4	Splice Closures Installed	40
5	Cabinets Installed	1
6	Number of Customers Connected	120

Town of Culpeper Infrastructure Analysis

1	ITEM/PROJECT	ESTIMATED
2	Total cost per mile	\$201,500.83
3	Distribution construction cost per mile	\$141,117.32
4	Distribution cost per mile (no drops)	\$120,954.38
5	Total Cost per building connected	\$8,244.74
6	Drop Costs per building connected	\$8,244.74

Town of Culpeper Summary of Costs

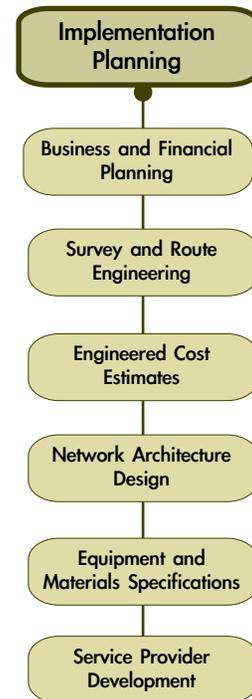
1	ITEM/PROJECT	ESTIMATED
2	Culpeper Dark Fiber Construction Materials	\$182,659.02
3	Culpeper Dark Fiber Distribution Labor	\$389,012.00
4	Culpeper Dark Fiber Structures, Cabinets, and Equipment	\$22,215.00
5	Culpeper Dark Fiber Drop Construction	\$99,000.00
6	Network Construction Subtotal	\$692,886.02
7	Project Management, Network Engineering, Integration, and Testing	\$83,146.32
8	Engineering, Permitting	\$69,288.60
9	Misc Fees, Advertising, Technical Services	\$10,000.00
10	Bookkeeping and Administration	\$5,000.00
11	Other Costs Subtotal	\$167,434.92
12	Project Total (No Contingency)	\$860,320.95
13	Contingency at 15%	\$129,048.14
14	Project Total (with contingency)	\$989,369.09

Moving Forward: Implementation and Operations

IMPLEMENTATION PLANNING PHASE

This phase produces the equipment and construction specifications needed to bid out the work of constructing the infrastructure—typically towers and dark fiber routes (e.g. the meet-me box concept).

- ▶ **Business and Financial Planning** – Develop a detailed business and financial plan.
 - ▶ Governance Model - formal governance model is determined and legal arrangements between governing entities are negotiated and contracts signed. In Culpeper, this could take the form of an Authority, or it could be done as an internal project of the Town/County.
 - ▶ Funding Sources - Funding sources are identified and fund raising commences.
 - ▶ Business Administration Planning - Identify roles and responsibilities for participating staff and leadership.
- ▶ **Survey and Route Engineering** – An on the ground survey is needed to complete a final route design or tower site assessment. This work is performed by an firm that also has the responsibility to produce the engineered design and obtain required permitting. The field survey confirms that the final route or tower site can be built to the necessary standards and regulations.
 - ▶ Construction Methodology selected (Design vs. Design/Build) - One method to shorten the design and build phases of a project are to award up front a “design build” contract where the project management firm is also responsible for construction. This can shorten the project (because of simplified procurement) and is often recommended for projects where time is of the essence.
 - ▶ Engineering Drawings - After the survey work is completed, engineers produces a complete set of engineered drawing that meet DOT and other local requirements.
- ▶ **Engineered Cost Estimates** – A detailed cost estimate is developed from the engineered drawings. The full drawing set is attached to the construction bid documents and becomes the basis for the awarded construction contract.

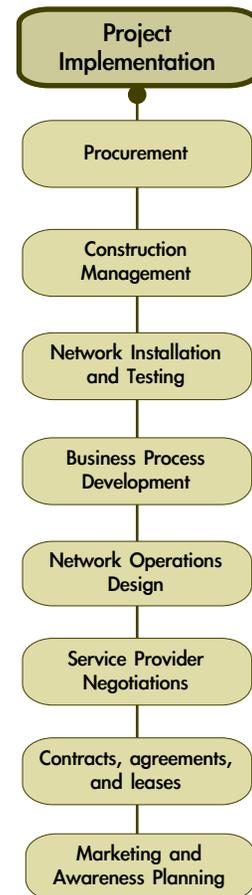


- ▶ Permitting - The engineer will prepare all required permit forms and submit the permits with the plans. It is important to start the permitting process early to avoid delays.
- ▶ **Network Architecture Design (Detailed)** – Final analysis of vendor equipment is performed and selection is made.
 - ▶ Materials and Equipment Selection -Analysis is performed to determine which equipment offers the lowest Total Cost of Ownership (typically analyzed over ten years or more).
 - ▶ Detailed Network Design - The detailed network design starts with the completed network architecture and completely specifies all of the conduit, handholes, cabinets, patch cables, power supplies, generators, batteries, and all other necessary parts and equipment needed to complete the engineered design.
- ▶ **Equipment and Materials Specifications** – The engineer also completes a detailed list of all equipment required for the construction.
 - ▶ Bill Of Materials produced for fiber, conduit, handholes, fiber splice enclosures, and related hardware needed to install the fiber cable underground and/or on utility poles. If towers are being built, the Bill of Materials specifies all of the tower-related equipment needed (e.g. cabinet, generator, electric service, etc.).
- ▶ **Service Provider Development** – In an open access network, service providers have to be recruited and formally signed to a contract to lease space on a tower or to lease dark fiber. Providers usually need “coaching” because they are typically unfamiliar with open access networks and need help understanding the unique business opportunities they represent for private sector companies.

CONSTRUCTION PHASE

The documents produced in the Implementation Phase are used to bid out the construction work and to procure the network equipment needed to produce an operational network.

- ▶ **Procurement** – At the beginning of the construction phase the County or the newly formed Authority will bid out the project construction.
- ▶ **Construction Management** – The construction work is bid out and an award is made to a qualified contractor with the best price. It is common to negotiate the final cost of this work once a firm has been selected.
- ▶ **Network Equipment Installation** – Network equipment is ordered from a vendor that meets the technical specifications. Equipment must be tested, installed in cabinets or shelters, powered up, and connected to the fiber cable. After installation and
- ▶ **Business Process Development** – During the construction phase, business and operational decisions must be made to produce a set of business processes that will guide the day to day operations of the network.
- ▶ **Service Provider Negotiations** – Negotiations with qualified service providers continues.
- ▶ **Contracts, Agreements, and Leases** – The construction phase will generate the need for a variety of legal documents. Some will be related directly to the construction (e.g. an easement agreement to have conduit cross property). Typical documents include the development of the Master Network Agreement that is used to sign service providers to the network. Other contracts would include the development of a draft network operations agreement if network operations is outsourced, and a similar agreement for outside plant maintenance and repairs.
- ▶ **Marketing and Public Awareness** – As the network is constructed, a modest but ongoing public awareness and publicity effort is required to ensure that business customers, schools, local government agencies and other potential users of the network are aware of the project and the possibility of reducing costs and obtaining more and better services.



Appendix A: Glossary

Active network: Typically a fiber network that has electronics (fiber switches and CPE) installed at each end of a fiber cable to provide “lit” service to a customer.

Passive network: Refers to infrastructure that does not have any powered equipment associated with it. Examples include wireless towers, conduit (plastic duct), handholes, and dark fiber.

Dark fiber: Dark fiber is fiber cable that does not have any electronics at the ends of the fiber cable, so no laser light is being transmitted down the cable.

Lit network: A “lit” network (or lit fiber) is the same as an active network. “Lit” refers to the fact that the fiber equipment at each end use small lasers transmitting very high frequency light to send the two way data traffic over the fiber.

FTTH/FTTP/FTTx: Fiber to the Home (FTTH), Fiber to the Premises (FTTP), and Fiber to the X (FTTx) all refer to Internet and other broadband services delivered over fiber cable to the home or business rather than the copper cables traditionally used by the telephone and cable companies.

Symmetric connection: The upload and download bandwidth (speed) is equal. This is important for businesses and for work from home/job from home opportunities.

Asymmetric connection: The upload and download bandwidth (speed) are not equal. Cable Internet and satellite Internet services are highly asymmetric, with upload speeds typically 1/10 of download speeds. Asymmetric services are problematic for home-based businesses and workers, as it is very difficult to use common business services like two way videoconferencing or to transfer large files to other locations.

IP video: Video in various forms, including traditional packages of TV programming, delivered over the Internet rather than by cable TV or satellite systems.

Latency: The time required for information to travel across the network from one point to another. Satellite Internet suffers from very high latency because the signals must travel a round trip to the satellite in stationary orbit (22,500 miles each way). High latency makes it very difficult to use services like videoconferencing.

Fiber switch: Network electronic equipment usually found in a cabinet or shelter

CPE: Customer Premises Equipment, or the box usually found in a home or business that provides the Internet connection. DSL modems and cable modems are examples of CPE, and in a fiber network, there is a similarly-sized fiber modem device.

Handhole: Handholes are open bottom boxes with removable lids that are installed in the ground with the lids at ground level. The handholes provide access to fiber cable and splice closures that are placed in the handhole. Handholes are also called pull boxes.

Pull boxes: Pull boxes (also called handholes) are used to provide access to fiber cable and splice closures. They are called pull boxes because they are also used during the fiber cable construction process to pull the fiber cable through conduit between two pull boxes.

Splice closures: Splice closures come in a variety of sizes and shapes and are used to provide access to fiber cable that has been cut open to give installers access to individual fiber strands. Splice closures are designed to be waterproof (to keep moisture out of the fiber cable) and can be mounted on aerial fiber cable or placed underground in handholes.

Splicing: The process of providing a transparent joint (connection) between two individual fiber strands so that laser light passes through. A common use of splicing is to connect a small “drop” cable of one or two fiber strands to a much larger (e.g. 144 fiber strand) cable to provide fiber services to a single home or business.

SCADA: Supervisory Control and Data Acquisition. Used by the electric utility industry and some other utilities (e.g. water/sewer) to manage their systems.

Colo facility: Colo is short for Colocation. Usually refers to a prefab concrete shelter or data center where network infrastructure converges. A colo or data center can also refer to a location where several service provider networks meet to exchange data and Internet traffic.

Backhaul: Typically refers to a high capacity Internet path out of a service area or locality that provides connectivity to the worldwide Internet.

Appendix B: Broadband Technologies

In Culpeper County, there is no one technology that is going to provide a “one size fits all” solution for homes, businesses and institutions. In places like the town of Culpeper and some smaller communities and neighborhoods, fiber build outs will be an important economic development and quality of life requirement.

In other parts of the county, improved DSL and one or more wireless technologies will continue to be important for some years. Over time, fiber connections will become more widely available, just as basic telephone and electric service became more widely available over a period of years in the early part of the twentieth century.

TELEPHONE/DSL

DSL (Digital Subscriber Loop) technology utilizes existing copper twisted pair telephone lines to provide broadband services. There are many variants of DSL, and the differences among them are primarily bandwidth and distance. Most DSL systems are limited to a maximum of 18,000 cable feet from a telephone switch or remote access module (DSLAM). Faster variants of DSL are limited to as little as a few thousand feet, making the service areas inconsistent from a subscriber perspective. A neighbor a few houses away from a home with DSL service may be told that no DSL service is available (because of the cable limitations). Current low cost DSL residential service offerings are priced competitively compared to cable modem service, but also tend to be much slower.

Because of the requirement to deploy DSL equipment close to subscribers, many areas of the country with older telephone copper-based local cable are at a distinct disadvantage for DSL. It is not uncommon in rural areas to have cable runs of many miles (from a telephone switch), making DSL impractical without substantial equipment upgrades. Even if a home or business is located within the prescribed distance to DSL equipment, older copper twisted pair cable may not be capable of handling the DSL signal properly. In some cases, speed of the service is degraded, and in other cases, DSL may not work at all.

The primary problem with DSL is the lack of capacity over the long term. In an optimum DSL situation, with high quality cable plant and subscribers close to DSL switches, the fastest DSL is limited to 15 to 20 megabits under these optimum conditions and short distances from network nodes or switches. Most homes will never be able to receive DSL services at those speeds because of sub-optimal service conditions, including old physical plant and distance. DSL cannot provide the capacity needed by businesses and residents in the near future.

From a local network investment standpoint DSL is a mediocre option at best given several limitations. In addition to the limitations above, DSL supports a single service (typically Internet) and a single Service Provider. While additional services may be provided “over-the-top” of the DSL Internet connection, those services are limited by the capacity of the primary service.

DSL CHARACTERISTICS

<p>Bandwidth DSL is particularly plagued by line noise and distance limitations. As such the bandwidth in this table should be viewed as an "up to" limit and delivered bandwidth may be less.</p>	<p>DSL - 1.544Mbps (ITU-T G991.1) ADSL - 8 Mbps/640 Kbps (ANSI T1.413) ADSL2 - 12 Mbps/768 kbps (ITU-T G992.3) ADSL2+ - 24 Mbps/768 kbps (ITU-T G.992.5) VDSL - 52 Mbps/2.3 Mbps (ITU-T G993.1) VDSL2 - max sum in both directions 200 Mbps @ 1600' G.Fast - max sum in both directions 1 Gbps @ 328'</p>
<p>Line sharing</p>	<p>Individual subscribers do not share their upload/download speeds, but each cabinet will only support up to a maximum of what it is provisioned for. This is particularly important in rural networks where the cabinet are often provisioned with synchronous telecommunications services which are severely limited in bandwidth.</p>
<p>Latency</p>	<p>Latency is not an issue in DSL last mile connections, but due to bandwidth limitations at the cabinet, may be a factor due to queueing and competition for bandwidth at the middle mile. DSL with a fiber optic middle mile connection would reduce latency problems.</p>
<p>Symmetric/Asymmetric</p>	<p>DSL - Symmetric ADSL - Asymmetric ADSL+ - Highly Asymmetric ADSL2+ - Highly Asymmetric VDSL - variable and provisioned according to provider VDSL2 - variable and provisioned according to provider G.Fast - variable and provisioned according to provider</p>
<p>Effective Distance Distance in this table is cable distance and subject to the age and quality of the plant. The distances listed are for the bandwidth listed in the first row of this table.</p>	<p>DSL - 12,000' (2.3 miles) ADSL - 9000' (1.7 miles) ADSL2 - 5000' (0.95 miles) ADSL2+ - 2000' (0.38 miles) VDSL - 1600' (0.30 miles) VDSL2 - 1600' (0.30 miles) G.Fast - 328' (0.06 miles)</p>
<p>Services Support</p>	<p>Single Service, Single Provider</p>
<p>Typical per subscriber build cost</p>	<p>\$655 - \$1100 depending on site utilization</p>

CABLE SYSTEMS

Cable systems that provide broadband in most U.S. communities use what is called HFC systems, or Hybrid Fiber Coaxial systems. Typically, fiber delivers television and broadband signals to equipment located in or near a neighborhood, and copper coaxial cable is used to connect the subscriber’s home or business with the equipment fed by fiber. Cable systems have never been widely deployed outside community boundaries (residential neighborhoods and business districts) because of the high cost of placing equipment near subscribers. In this regard, cable systems have some of the same limitations as DSL, and rural communities are at a distinct disadvantage because of the lower density of homes and businesses.

Cable systems also cannot provide the future capacity that will be required by homes and businesses in the near future. Some cable companies have begun to announce pilot projects offering Internet access at speeds “up to 50 megabits.” While this is an improvement over current offerings advertised typically at bandwidth “up to 6 megabits,” this bandwidth is always shared among all users on a node. It is not unusual to have between 100 and 500 users (typically residential homes) on a single node. The advertised bandwidth (e.g. “up to 6 megabits”) is shared among all users on a node, meaning that the usable per household bandwidth during peak use times like early evening is much lower.

Cable modem service typically has asymmetric bandwidth, meaning that the advertised bandwidth (“up to 6 megabits,” or “up to 50 megabits”) is only available on the downstream side coming into a home. The upstream bandwidth available to users to send data is often 1/10th of the downstream capacity. This makes most cable modem systems unsatisfactory for many kinds of work from home services and applications that require more balanced upstream and downstream bandwidth, like videoconferencing, which works best if the bandwidth is symmetric (the same capacity in both directions). This issue of symmetric bandwidth will become increasingly important as commuting patterns change and more people want to work from home part or full time.

CABLE MODEM SYSTEM CHARACTERISTICS	
Bandwidth	DOCSIS 1 - 42 Mbps/10 Mbps (shared), DOCSIS 2 - 42 Mbps/30 Mbps (shared) DOCSIS 3 - 171 Mbps/122 Mbps (shared, 4 bonded channels)
Line sharing	All subscribers on a given CMTS (Cable Modem Termination System) channel share both upstream and downstream capabilities.
Latency	Latency is not typically an issue with DOCSIS
Symmetric/ Asymmetric	All versions of DOCSIS are highly asymmetric
Effective Distance	The effective distance of DOCSIS can be up to 100 miles from the CMTS to the farthest cable modem.
Services Support	Single Service, Single Provider
Typical per subscriber build cost	\$2500 to \$3500

FIBER SYSTEMS

Fiber is a future proof investment. The upper limit of fiber capacity has not yet been found, and off the shelf hardware can handle thousands of times the needs of an average home or business well into the future. Fiber has a life expectancy of thirty to forty years, and may last much longer than that; every year, the number goes up as fiber systems installed in the 1970s continue to perform adequately. A single fiber can carry all the traffic and services needed by a home or business, including voice telephone service, television programming, live videoconferencing, and HD television.

Fiber's primary drawback is its apparent high cost compared to other systems. Fiber is often unfairly compared to wireless, with the misleading conclusion that wireless is much cheaper. Regrettably, most fiber versus wireless studies compare the start up costs for wireless to the thirty year life cycle costs of fiber infrastructure. During a thirty year period, fiber is installed just once, while wireless systems will have to be replaced entirely several times. Properly costed over a thirty year period, fiber is actually less expensive than wireless, with many times the capacity.

Metro Ethernet is a point-to-point service provided over fiber. Metro Ethernet networks can deliver service as far as 50 miles from network element locations and provide speeds up to 10 Gigabits per second (10GB Metro Ethernet circuits are now commonly available from some providers).

Carrier Ethernet is the term used to describe Active or Metro Ethernet deployed to the premises. Carrier Ethernet is available in 100 Mbps and 1 Gbps utilizing a pair or a single fiber strand and speeds of 10 Gbps over a pair of fiber optic strands. Carrier Ethernet can be deployed at distances of up to 50 miles (80km) from the central office.

A Passive Optical Network, or PON, is a fiber optic network based upon a splitter technology. A single PON port can support up to 64 customers utilizing either daisy chained splitters or a central splitter location. For service providers PON is cost effective as it allows the service providers to create "fiber light" networks and fewer network elements. However, PON has many drawbacks including bandwidth limitations due to the shared nature of the feeder fibers as all customers fed from a splitter share bandwidth over a single fiber (or single pair in some networks). A major drawback of PON, if field splitters are used, is the upgradeability of the network which usually requires additional feeder fiber to be deployed which is costly as it is considered a "forklift upgrade."

CARRIER FIBER (ACTIVE) ETHERNET CHARACTERISTICS

Bandwidth	1 Gbps standard
Line sharing	Each user has a dedicated 1Gbps between the premises and the core location.
Latency	Not latent
Symmetric/Asymmetric	Symmetric
Effective Distance	up to 50 miles (10km, 20km, 40km, and 80km optics available)
Services Support	Multiple services, multiple providers
Typical per subscriber build cost	\$3250 - \$3500

PON FIBER (PASSIVE) CHARACTERISTICS

Bandwidth	2.4 Gbps/1.24 Gbps (shared between users on a port). A few 10Gig PON systems are now being deployed because the older PON systems are running out of bandwidth.
Line sharing	Each port is shared by a power of 2 premises (2, 4, 8, 16, 32, or 64) depending on how the network is configured.
Latency	Minimal latency.
Symmetric/Asymmetric	Asymmetric
Effective Distance	up to 25 miles (40km)
Services Support	Multiple services, multiple providers
Typical per subscriber build cost	\$3250

We are now seeing even small and medium-sized businesses asking for fiber connections. Fiber is the only transmission system that will be able to deliver all the services businesses and residents will expect and demand in just a few years. Communities that choose to delay fiber infrastructure investments will be at a severe disadvantage in the next several years when trying to attract and retain businesses and workers.

In business areas of the county, fiber is an absolute requirement to retain existing businesses and to attract new ones. Many of subdivisions could have fiber within the neighborhood and wireless backhaul, and multiple services (e.g. video, Internet, voice, data backup) could be delivered within the neighborhood by fiber. In growth areas, retail and office space would become more valuable with high performance fiber availability.

FIXED POINT ACCESS WIRELESS

Fixed point wireless Internet access via private sector providers is already available in some areas of the county. This service introduces additional competition for Internet access customers, which can lower prices and create incentives to offer better customer service from the providers. Over time, most fixed point Internet users (five to seven years out) will want to migrate to fiber connections which will have the capacity to provide a much wider range of services, including HD TV, telemedicine, and tele-health, among other applications.

Fixed point wireless infrastructure investments (e.g. locations for towers, towers, fiber and duct backhaul connections) can be re-used over time to support mobile wireless services and long term public safety voice and data services.

The goal would be to identify existing tower sites that could be reached affordably with fiber. Fiber access to these towers will lower the cost of backhaul for local wireless broadband providers while simultaneously allowing them to increase bandwidth and overall performance.

Wireless broadband services will be important in rural parts of the county. And wireless is not going away; it will remain as an important component of a well-designed community broadband system--as a mobility solution. As we travel around the community, we want to be able to access the Web, check email, make phone calls, and do other sorts of things. Wireless services enable that, and in rural areas, wireless services are an important step up from dial-up.

WiMax and LTE capacities and distances are widely exaggerated. It is very common to see promises of “up to 80-100 megabits” of capacity and distances of “10 to 20 miles.” With respect to bandwidth, that 100 megabits of capacity will be shared among all connected users, so if 100 households are trying to access the network via a single WiMax access point, the usable bandwidth may be more like 2-4 megabits per household or per user. Distances are limited by line of sight.

Both WiFi and WiMax signals will work over many miles, but only with narrow angle antennas and clear line of sight. While WiFi can easily reach ten miles or more with clear line of sight, and WiMax can reach twenty miles with clear line of sight, in practice these optimum distances are rarely achieved; it is more realistic to consider WiFi usable over 2-4 miles and WiMax over 4-8 miles. Tree cover is particularly problematic, and it is often necessary to remove tree limbs, an entire tree, or to relocate the antenna in order to get a good signal.

LTE and television “white space” systems are emerging standards that can provide connectivity at much longer distances (five to ten miles is possible under ideal circumstances) and the radio frequencies used are better able to penetrate at least some foliage. Bandwidth of several megabits are possible, and compare very favorably with copper-based systems like DSL. But even these systems will have a limited ability to handle TV programming, interactive videoconferencing, and other business class services.

FIXED POINT WIRELESS CHARACTERISTICS

Bandwidth	5Mbps - 10Mbps on average for rural/residential service. Higher speeds available at higher cost.
Line sharing	In most Wireless ISP (WISP) architectures customers share a point to multi-point connection with an access point. Service can be affected when too many customers are on an access point.
Latency	Minimal latency issues
Symmetric/Asymmetric	Symmetric
Effective Distance	The effective range of an access point depends on the frequency chosen.
Services Support	Internet, VoIP, and streaming video can be supported by WISP architectures. A multi-provider environment can be configured on a WISP network, but is less commonly found compared to fiber networks.
Typical per subscriber build cost	\$370 to \$550, and costs could be much higher if a pole has to be installed (\$2000 to \$7000). High operating costs should be considered as a factor because of the high failure rate for wireless equipment.

CELLULAR DATA WIRELESS

Wireless access to the Internet and other mobile services like cellular telephone providers is a long term need that will not be replaced by fiber access. In fact, over the next five to seven years, the most common use for wireless Internet access will be for mobility--casual business, personal, and government access away from the home or office. In the rural areas of the county, fixed point cellular data services (e.g. "air card") can provide substantial improvements over DSL, satellite, or dial up.

Mobile wireless access to voice and data services is already widely available from multiple providers in most of the U.S. Nationwide, Verizon, Sprint, and AT&T have already begun an aggressive expansion and upgrade to LTE (the so-called 4G/5G networks). However, the bandwidth caps and bandwidth overage charges make cellular data services too expensive as a primary residential or small business connection.

Perhaps more alarming, some telephone companies, including Verizon and AT&T, are abandoning their copper line plant in many rural areas of the country, and are only offering cellular-based dial tone for home and small business use.

Cellular data plans, because of the bandwidth caps and overcharges that are included with typical plans, can be a poor solution for rural residents who may be trying to use it for business purposes, for K12 school assignments, and/or personal use. Households with children report that it is very difficult (and/or expensive) to keep within data caps.

CELLULAR DATA SERVICE CHARACTERISTICS	
Bandwidth	2Mbps-12Mbps and up, but actual bandwidth can vary widely.
Line sharing	In a mobile wireless broadband network the access point is in a point to multi-point configuration, meaning access is shared.
Latency	Latency is generally not an issue
Symmetric/Asymmetric	Symmetric
Effective Distance	The effective range of an access point depends on the frequency chosen.
Services Support	Internet, VoIP, and streaming video can be supported but service may degrade at peak times.
Typical per subscriber build cost	\$80 and up, depending on data plan, bandwidth caps and overage charges.

EMERGING WIRELESS TECHNOLOGIES

MIMO WIRELESS

MIMO (Multiple Input, Multiple Output) describes a variety of technologies that can be summarized as using more than one receive and transmit antenna for wireless data applications. Wireless protocols that are using the MIMO concept include IEEE 802.11n (Wi-Fi), IEEE 802.11ac (Wi-Fi), 4G, LTE (Long Term Evolution), and WiMAX. Each of these protocols use the MIMO technology to increase the amount of available bandwidth in a given section of radio frequency spectrum.

New hardware is required to make effective use of MIMO. While the technology increases wireless bandwidth, the typical amount of bandwidth being used by wireless devices is also increasing rapidly. Some applications where MIMO is likely to provide noticeable improvements are in home wireless routers, where the effective throughput will be able to better handle the demanding bandwidth requirements of HD and 4K video streams. MIMO is slowly being developed for use with cellular smartphones, but both the phones and the cell tower radios have to be upgraded to support MIMO.

LTE/4G/5G

LTE (Long Term Evolution) is a set of protocols and technologies designed to improve the performance of voice/data smartphones. Like MIMO, both the user phone and the cell tower radios have to be upgraded to support LTE improvements. In 2013, only 19% of U.S. smartphone users were able to take advantage of LTE speeds, although that percentage has been increasing rapidly since then, and more than 85% of the U.S. cellular towers are expected to be upgraded to LTE in the next two years. As noted previously, the actual bandwidth available to a smartphone user is highly variable and depends on distance from the cell tower, the number of smartphones accessing the same tower simultaneously, and the kinds of services and content being accessed by those users.

The primary purpose of cellular bandwidth caps is to keep cellular users from using too much bandwidth and degrading the overall service. While LTE and MIMO improvements will improve overall cellular service, these technologies are not going to replace fiber to the home and fiber to the business.