Moving Forward at the Speed of Light:

Fiber Infrastructure for the 21st Century

Volume III: Findings and Recommendations

Prepared for the
Roanoke Valley Region

DESIGN NINE
we build networks that perform

Copyright © 2012 Design Nine, Inc. Provided for the exclusive use of the Roanoke Valley Alleghany Regional Commission. All other rights reserved.

Disclaimer

The telecommunications business is continually evolving. We have made our best effort to apply our experience and knowledge to the business and technical information contained herein. We believe the data we have presented at this point in time to be accurate and to be representative of the current state of the telecommunications industry. Market changes and new technology breakthroughs may affect our recommendations over time.

Design Nine, Inc. presents this information solely for planning purposes. This document is not intended to be a replacement for formal engineering studies that are normally required to implement a telecommunications infrastructure. No warranty as to the fitness of this information for any particular building, network, or system is expressed or implied. Design Nine, Inc. will not be responsible for the misuse or misapplication of this information.

For more information:

www.designnine.com

The **Star City** has always been **a connector** and *connected*

In 1720, it was the Roanoke waterways that were the connectors . . . connecting eastern Virginia with western Virginia . . .

In 1880 the railroad connected Roanoke with the rest of the eastern USA . . .

In 1930, Roanoke's Woodrum Field connected Roanoke with the whole country . . .

In 1970, Interstate 81 connected Roanoke to the national economy . .

And today, how is Roanoke going to join the connected world?

It would take over 5 years to watch the amount of video that will cross global IP networks every second in 2015.

Every second, 1 million minutes of video content will cross the network in 2015.

Cisco System Visual Networking Index, 2011

A note to the readers of this report

Design Nine has been working with the Roanoke Valley Alleghany Regional Commission and leaders from around the Valley since mid-fall to review the region's current telecommunications systems, to survey the degree of interest residents and businesses have in broadband services, and to identify what investments will be needed if a decision is made to follow a path of telecommunications infrastructure improvements designed to accelerate economic development and enhance job and educational opportunities in the Roanoke Valley in the coming decade. This report contains our findings on these subjects and recommends a path forward.

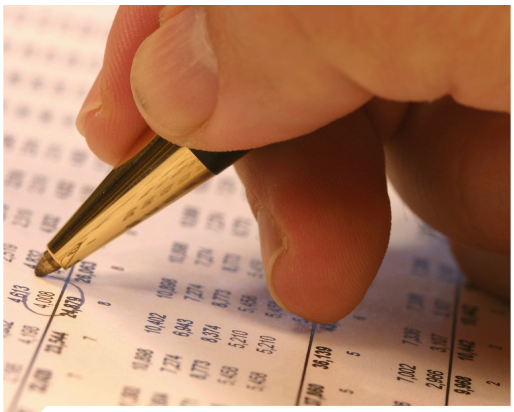
We recognize that the readers of this document include a broad variety of stakeholders with a range of understanding of the inner workings of telecommunications. The astonishing growth and rapid evolution of the Internet and related technologies in recent years makes staying current a challenge. The degree to which the Internet, smart devices and cloud computing are impacting business, education, health care, and a host of other aspects of life is literally breathtaking. Projections for the future make clear this trend, and the changes it is bringing to our communities and to people around the world are not expected to abate. A brief review of some of the more salient facts will provide a helpful context to understanding the importance that underlies the report. We think it represents a good way to begin.

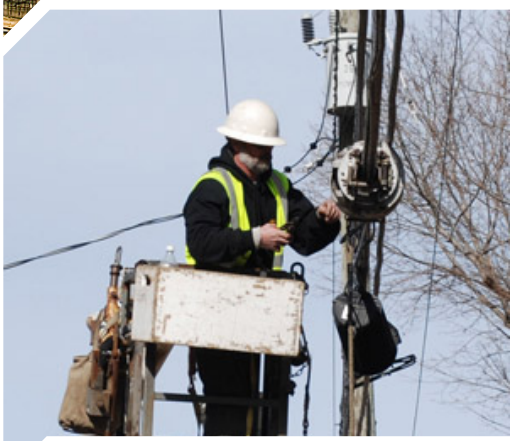
This report is Part Three: **Findings and Recommendations**. This document provides key findings and the broader context that led to the recommendations summarized in this report (the Executive Summary). The Findings report also contains a series of **Appendices** that step through the main topics presented in the Findings, in an order that parallels portions of the Findings, but are presented in significant detail.

Part One is the **Executive Summary** document. This report provides a high level overview of key findings and recommendations

Part Two of the study contains a **Needs Assessment** and the **Business and Residential Survey** results. That document reviews the essential background information: what we have learned about the region and its businesses and residents and how this relates to other communities from around the country with similar characteristics.

Part Four contains **Detailed Cost Estimates, Pro Formas, and Maps,** including a financial analysis of a "Phase One" option and a wide area build out. Due to the large size of the complete set of maps, all maps developed are available online at : http://roanoke.designnine.com/





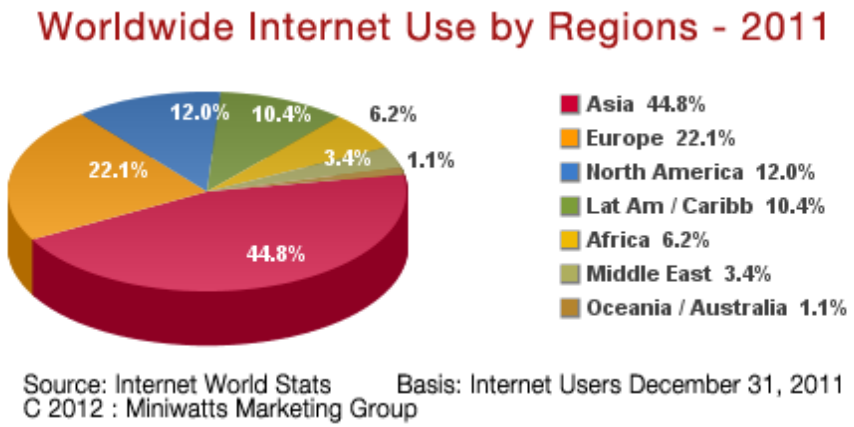
Findings

21st Century Telecom from 10,000 Feet

The World is Increasingly Online

A good place to begin is with the sheer magnitude of the Internet today. Even if you think you know how big the Internet has become, these numbers will floor you.

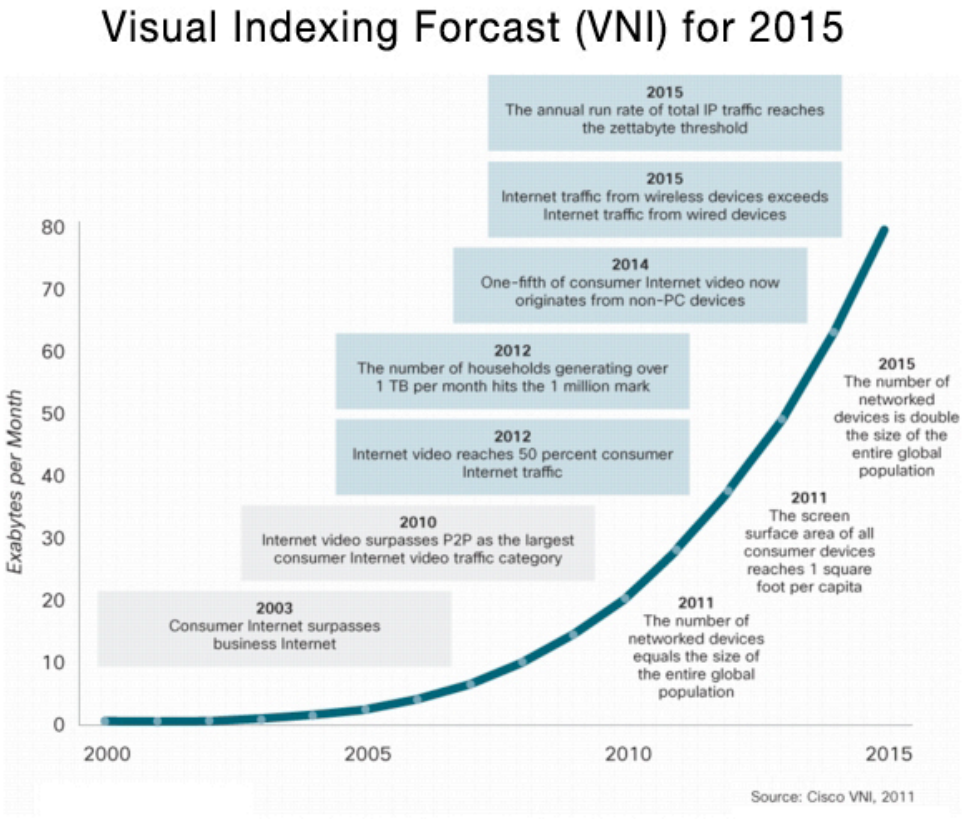
- In 2000 there were an estimated 361 million users worldwide. As 2011 came to a close that number had grown to **2.2 billion Internet users**. This represents a 528.1% increase, or *1.8 billion new users in less that 12 years*. 30.3% of the population worldwide is now online. (InternetWorldStats.com data)



Staggering Growth Still to Come

These numbers, as enormous as they are, almost pale in comparison the growth projections for just the next three years made by Cisco Systems Visual Networking Index (VNI). Together with a few dozen top consulting, analysis, and strategy firms, Cisco projected broadband connections, video subscribers, mobile connections, and Internet application adoption for the year 2015 using data from service providers, current technology trends, and knowledge of evolving hardware dictating enabling factors such as broadband and computing speeds.

- **Annual global IP traffic will reach the zettabyte threshold** (966 exabytes or nearly 1 zettabyte) by the end of 2015. (*A zettabyte is a measure of storage capacity. 1 zettabyte is approximately equal to a thousand exabytes or a billion terabytes.*)
- **The "terabyte club" will reach 6 million by 2015.** In 2015, there will be 6 million Internet households worldwide generating over a terabyte per month in Internet traffic, up from just a few hundred thousand in 2010. There will be over 20 million households generating half a terabyte per month in 2015.
- **Global IP traffic has increased eightfold over the past 5 years, and will increase fourfold over the next 5 years.** Overall, IP traffic will grow at a compound annual growth rate (CAGR) of 32 percent from 2010 to 2015.
- **A growing amount of Internet traffic is originating with non-PC devices.** In 2010, only 3 percent of Internet traffic originated with non-PC devices, but *by 2015 the non-PC share of Internet traffic will grow to 15 percent.* PC-originated traffic will grow at a CAGR of 33 percent, while TVs, tablets, smartphones, and machine-to-machine (M2M) modules will have growth rates of 101 percent, 216 percent, 144 percent, and 258 percent, respectively.



- **Traffic from wireless devices will exceed traffic from wired devices by 2015.** In 2015, wired devices will account for 46 percent of IP traffic, while Wi-Fi and mobile devices will account for 54 percent of IP traffic. In 2010, wired devices accounted for the majority of IP traffic at 63 percent.
- **Busy-hour traffic is growing more rapidly than average traffic.** Busy-hour traffic will increase fivefold by 2015, while average traffic will increase fourfold. During an average hour in 2015, the traffic will be equivalent to 200 million people streaming high-definition video continuously. *During the busy hour in 2015, the traffic will be equivalent to 500 million people streaming high-definition video continuously.*
- **Internet video is now 40 percent of consumer Internet traffic, and will reach 62 percent by the end of 2015,** not including the amount of video exchanged

through P2P file sharing. *The sum of all forms of video (TV, video on demand [VoD], Internet, and P2P) will continue to be approximately 90 percent of global consumer traffic by 2015.*

- **Globally, mobile data traffic will increase 26 times between 2010 and 2015.** Mobile data traffic will grow at a CAGR of 92 percent between 2010 and 2015, reaching 6.3 exabytes per month by 2015.
- **Business IP traffic will grow at a CAGR of 24 percent from 2010 to 2015.** Increased adoption of advanced video communications in the enterprise segment will cause business IP traffic to grow by a factor of 2.7 between 2010 and 2015.
- **Business video conferencing will grow sixfold over the forecast period.** Business videoconferencing traffic is growing significantly faster than overall business IP traffic, at a CAGR of 41 percent from 2010-2015.
- **Global mobile data traffic will grow three times faster than fixed IP traffic from 2010 to 2015.** Global mobile data traffic was 1 percent of total IP traffic in 2010, and will be 8 percent of total IP traffic in 2015.

The Internet and The Web

This may seem overly basic, but working definitions we can agree on are important to insure good communication is taking place. In this instance, there are a few key terms that are often misused or misunderstood.

The **Internet** and **the Web** are not the same. And **broadband** is more than one thing.

- **The Internet is a global system of interconnected computer networks**–a vast network of networks–consisting of millions of separate government, business, academic and private networks that are linked together by a complex of wired and wireless technologies. The Internet is where we go when we login to our

computer to download a report, ask our Android phone for a nearby restaurant, watch a movie on our iPad.

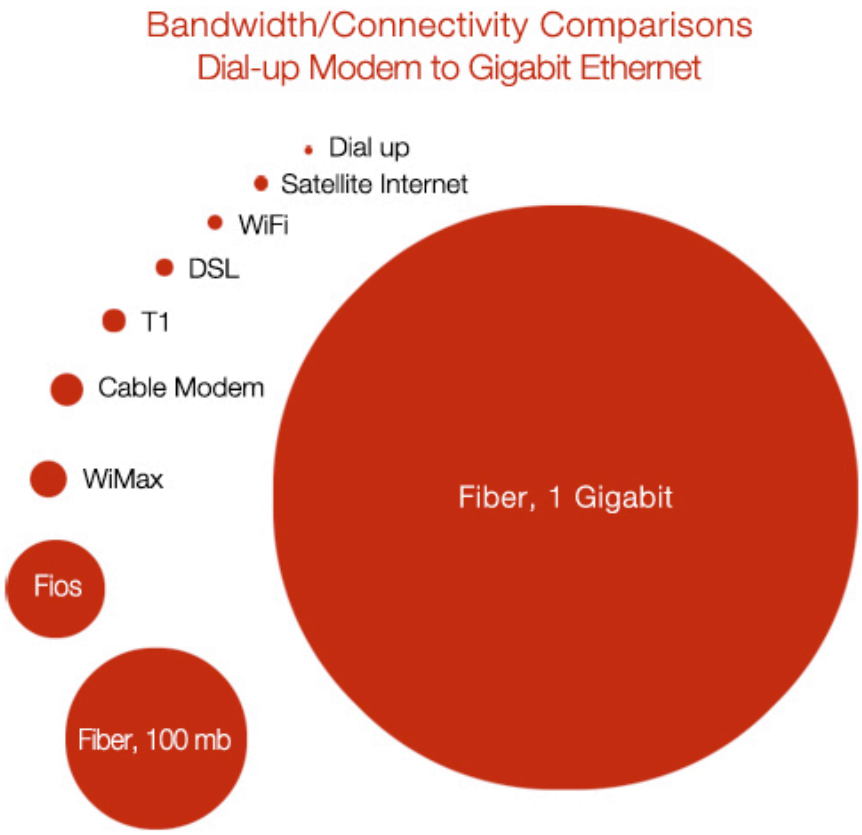
- It's where a nurse goes to remotely monitor the heart of a patient at home 30 miles away, were a university researcher collaborates on a shared computer screen whiteboard and Skype connection with a colleague in Mumbai, and where regional planners from neighboring states join a High Definition Video Conference on best practices for urban renewal. *Like it or not, more and more the Internet is where the world goes to work and to play.*

- **The Web** (or World Wide Web) is a system of linked documents that can be viewed and read on the Internet by using a web browser. What makes the Web work and the Internet so powerful is *hypertext*– the underlying concept defining the structure of the Web. **Hypertext Transfer Protocol (HTTP)** is the foundation of data communication for the Web. What began as a technical language that allowed "pages" of text and images to be transferred between computers and viewed in form we humans can read and see now also makes possible streaming and downloading music and video, remote medical services, remote home security and energy management, and something as trivial and amazing as Massive Multiplayer Online Games.

Connectivity, Part I – Not All Broadband is Created Equal

What is broadband? This widely used term means different things to different people. Why? Because this same label is attached to a variety of technologies with vastly different attributes and performance characteristics that have only two things in common: first, broadband technologies connect to the Internet at speeds faster that "dial-up" service; and second, broadband connections are "always on."

To add further fuzziness, *broadband* and ***high speed Internet*** are used interchangeably – with neither term saying very much about capabilities. In 2012, saying *better than dial-up* is not saying much. At the end of the day, broadband is really a marketing slogan much more than a useful technical definition.



The term **Broadband** is used to describe various Internet connectivity technologies, beginning with a satellite Internet connection, providing only slightly better service than dial-up at relatively high cost, and advancing with improving connectivity speed to Fiber-to-the-Premises (FTTH) at the top of the list.

A good analogy can be made between the volume of data an Internet connection is able to manage and the carrying capacity of a water pipe. The diagram above illustrates the relative capacity of each of the so-called broadband technologies.

Fixed wireless, satellite and cable are thought to have very little additional future capacity through advances in engineering. Cable is believed capable of achieving somewhat greater bandwidth capacity in the future.

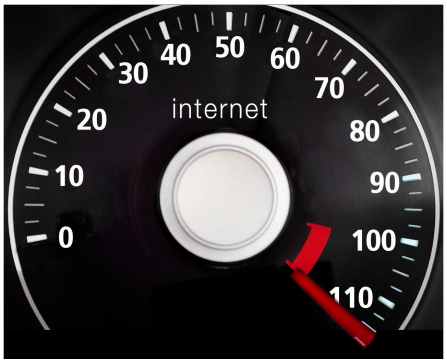
Optical fibers themselves transmit at the speed of light so the speed limitation on a fiber network is a function of the electronics that power the lasers. Today, there are real-world networks offering Gigabit-per-second Internet connections and one of them Chattanooga, Tennessee. Lab experiments are underway at even faster speeds.

Connectivity, Part II – The Need for Speed

When people talk about their Internet connectivity, they are referring to performance– to reliable fast uninterrupted access to data, to reports, to sending or receiving family photos, to streaming content. Broadband service should be about connecting to the network at the speed you need for work or for play, no matter the application or service you seek no matter how serious or silly.

> *"It would take over 5 years to watch the amount of video that will cross global IP networks every second in 2015. Every second, 1 million minutes of video content will cross the network in 2015."*
>
> – Cisco–Visual Networking Index (VNI)

The Cisco projections tell us that Internet traffic will continue to increase dramatically in the coming years as new users come online and as bandwidth intensive applications like HD television programming, to name only one of many, continue to attract new viewers. Still other innovative high bandwidth services that have yet to be invented will be coming online in the years to come to compete for users attention and suck up even more bandwidth.



The message sent by the data, by projections from Cisco and other trusted research source, is simple and clear: to fully participate in the burgeoning 21st century online world,

individuals, businesses and governments will need far higher bandwidth connections that currently exist in rural areas, in most most suburbs and even in many cities.

Key Trend #1 – Globalization and Education

In this flat, hyper-connected world, capital can flow anywhere and so can the job creation that comes with leadership in innovation and investment.

– Julius Genachowski, FCC Chairman

Globalization is far from new or news, but this force–so well captured by Tom Friedman's notion of a Flat Earth–is the new normal. It mean every region in every states competes in a marketplace that no longer recognizes borders. This has implications that transcend the todays market conditions. Most particularly, it should cause us to focus on at what we are doing to prepare today's children for tomorrow's jobs.

Key Trends #2 – The Cloud

Not long ago, cloud computing was not part of the lexicon. It was sort of there, in an immature state, and under a different alias, like managed hosting or virtualization. Today the Cloud has arrived and it's hot. Here is a sampling of facts that help explain what is driving growth of the cloud.

- **Among the most important recent Internet trends is the maturation of business applications and services available in the cloud** and the embrace of the business community to this alternative. Amazon, Microsoft, Google, Salesforce.com and others are offering software as a service in the cloud that has the attention of both the Enterprise and small business.
- **Gartner describes public cloud as one of the "hottest topics in IT"**. Spending on public cloud services is growing four times faster than overall IT spending, says Gartner. They are forecasting $89 billion in spending this year and $177 billion by 2015.
- Referring to Small Business, Cisco had this to say: "Any opportunity to hand over both the problem and solution to a third party is welcome, and frees up

SMB leaders to focus on running their businesses. This commonsense assumption is confirmed by a recent McKinsey report that notes that *SMBs represent two-thirds of the public cloud market,* and that the SMB segment is outpacing the growth of enterprise cloud adoption by about 10 points."

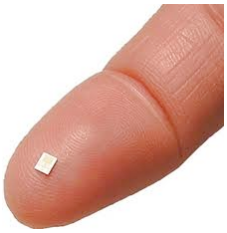
- In addition to software as a service as the attractor for business users, consider as well where all the entertainment and social media applications and services we consumers are addicted to resides–that's right, in the cloud. Here are some names you probably know: YouTube, Netflix, Facebook, Amazon, Spotify, Twitter, Hulu, Pandora and Vimeo.
- A recent AJ Nielsen study estimated the typical Netflix customer is streaming around 11 hours of video their website per month–though this data is based on PC and laptop usage only. *This certainly understates Netflix impact on bandwidth usage as this figure leaves out streams accessed from iPads*, *Roku set-top boxes, Blu-ray players* or any of the other 250 devices you can stream Netflix's content on.
- Mobile devices have memory and speed limitations that might prevent them from acting as media consumption devices, were it not for cloud applications and services. Cloud applications and services such as Netflix, YouTube, Pandora, and Spotify allow mobile users to overcome the memory capacity and processing power limitations of mobile devices.
- Mobile cloud traffic will grow 28-fold from 2011 to 2016, a compound annual growth rate of 95 percent.

Key Trend #3 – The Internet of Things (IoT)

The next logical step in the technological revolution connecting people anytime, anywhere is to connect inanimate object. This is the vision underlying the Internet of things: anytime, anywhere by anyone and anything.

ITU (International Telecommunication Union), November, 2005

The Internet of Things is about **hyperconnectivity**. **Hyperconnectivity**? Imagine any asset communicating effortlessly and seamlessly, sharing content and making collaboration possible between anything IP addressable and you have the idea.



During 2008, the number of smart devices (things) connected to the Internet exceeded the number of people on the earth. In 2020, Cisco and several other organizations estimate there will be 50 billion Internet connected devices. Many of these devices will report to central servers and databases, while other devices may communicate directly with each other and develop their own intelligence. Most of these Internet of Things devices will be extraordinarily small and in many cased unseen.

- Cymbet, a clean technology company

Sam Palmisano is CEO of IBM, the company that has done more than any other to develop "smart systems." He says, *"The Internet of things is about sensors putting computational power into things no one would recognize as computers. Things like cars, appliances, roadways and rail lines, power grids, clothes."* According to Palmisano, processes and global supply chains, some of the non-sexy markets that have proven to be early commercial successes for IMB in this area. "We now have the processing power and advanced analytics to make sense of it all."

Key Trend #4 – Big Data

We are just now witnessing the emergence of Big Data–streams of information in unimaginable proportions. The Internet of Things and Big Data go hand in and hand. So does Social Media and Big Data. In a world where an expected three billion people will be online and two networked devices per capita, new possibilities for productivity, innovation, and the flow of information will arise if the data can be managed and made understandable.

- *It is estimated that there will be 44 times as much data and content coming over the next decade* . . . reaching 35 zettabytes in 2020. (Remember, a zettabyte is a 1 followed by 21 zeros.) And thanks to advanced computation and analytics, we can now make sense of that data in something like real time.
- **"These are the mountains of data coming out of all these digital interactions, which can then be collected, sifted, mined and analyzed** — like raw materials of old — to provide the raw material for new inventions in health care, education, manufacturing and retailing." Thomas Friedman, New York Times, January 2, 2012
- According to "The Business Impact of Big Data," a new global survey of C-level executives and IT decision makers, *this data deluge is creating very real challenges for business leaders.* – Tyson Hartman, Xconomy.com
- Companies must develop a "data culture," in which executives, employees and strategic partners are active participants in managing a meaningful data lifecycle. Data is produced, edited, released, searched, indexed, archived, purged, reformatted and the lifecycle goes on, but companies don't think about educating their employees on how to best participate in that cycle. – Tyson Hartman, Xconomy.com
- Tomorrow's successful organizations will be equipped to use new sources of information and take responsibility for accurate data creation and maintenance. This will enable businesses to turn data first into usable information and ultimately into true business insights. – Tyson Hartman, Xconomy.com.

Why Big Bandwidth is Critical for Our Future

Speaking at the Consumer Electronics Show in Las Vegas in January of this year. FCC Chair, Julius Genachowski connected the importance of bandwidth to the unmistakable trends in consumer electronics and beyond to the economic health of the nation.

- Virtually every new product on the CES floor is fueled by broadband Internet – by connectivity and bandwidth, wired and wireless. If you shut off the Internet, virtually nothing on the CES floor would work.

- The value of almost every technology innovation at this show goes up as bandwidth goes up.
- As Netscape founder Marc Andreessen has noted, increased bandwidth dramatically enhances the increasing power of software, which lowers the cost to start and run businesses and vastly expands the market for online services.
- As the quality of network-connected apps, services and devices goes up, they generate increasing consumer demand, which drives increased investment in networks – creating a virtuous cycle with a growing broadband economy and ongoing job creation.
- We need universal broadband adoption, so that every American is taking advantage of our 21st century communications platform – for finding and landing jobs, for connecting to education in and out of the classroom, for obtaining health care information, diagnosis and even treatment, and for participating in your community.

By the end of 2012, South Korea intends to connect every home in the country to the Internet at one Gigabit per second. "That would be a tenfold increase from the already blazing national standard, and more than 200 times as fast as the average household setup in the United States," The Times reported last February.

If You Thought Fiber Is Only Important at the Office . . .

Wilmington, North Carolina

The city of Wilmington, North Carolina **uses its fiber network to turn the lights off at sports parks at night.** Cameras have been placed at every sports and recreation field, along with remote control light switches. A single city employee can quickly check the cameras to see if anyone is still at a field, and if not, a couple of mouse clicks turn off the lights. *The city expects to save $800,000 per year on electricity costs.* Oh, we forgot to mention . . . employees can turn off the lights from home. This single savings could build a lot of fiber to a lot of underserved neighborhoods.

Great Barrington, Massachusetts

In Great Barrington is a small town of little more than 7,000 in rural western Massachusetts. It is a region of small farms and shuttered 19th century mills with a struggling local economy. Jane Iredale Cosmetics is headquartered in Great Barrington and serves customers in the US and 40 countries around the world. With 190 employees, high paying jobs and great benefits and growing, it is the kind of company any small town dreams about and wants more of. The company is so dependent on the Internet to conduct business they have created an emergency plan to operate the business from employees homes if anything unforeseen were to happen. *The problem: very few employees can get the level of service needed in this rural area for the plan to work.* Iredale management is pressing the city manager and elected officials hard. **If regional infrastructure is not upgraded to fiber in the next several years, Iredale Cosmetics and its 190 employees will have to move elsewhere.**

Planning for 21st Century Infrastructure

> *"In the next 10 years, I expect at least five billion people worldwide to own smart phones, giving every individual with such a phone instant access to the full power of the Internet, every moment of every day."*
>
> Marc Andreessen, inventor of the Netscape Web Browser, Silicon Valley Venture Technology Investor

The entire world is moving online at an accelerating pace. In nearly every area, the benefits are clear and compelling. For business development, education, energy efficiency, medicine, cultural enrichment and on and on. These facts presents both a serious challenge and a great opportunity for leaders from the statehouse to city hall.

In many ways, for regions across America that are not robustly connected to the Internet, the future will be tied to how successful planners, legislators and community leaders are in bringing 21st century communications infrastructure to their regions. Real high speed broadband to all who want it, for their businesses and homes, by itself, cannot guarantee that a region will fulfill its aspirations, but without it, full participation in 21 century life will be a difficult challenge.

Last Mile and Open Access

Last Mile is the First Mile

It is indeed unfortunate that the telecom industry has dubbed the most important part of the network "the last mile." The so-called "last mile" is the way customers of broadband services get access to the network; the correct term should be "the first mile." Indeed, the overwhelming problem with broadband assets in the Valley is the lack of "first mile" connectivity to existing fiber assets–there is very little.

Some providers in the region do make the legally truthful claim that they can provide fiber anywhere it is needed, but what is typically left out is the cost of doing so. A business or school that wants a fiber connection but is not directly on an existing fiber route (most places in the Valley) will typically be charged the full cost of constructing new fiber to that location, even if the provider now has the opportunity to offer fiber services to other customers now passed by the new fiber. These charges can often be hundreds of thousands of dollars for even just a mile or two of construction.

About Fiber Networks

Fiber network designs have five primary components that must be considered when developing a strategy for fiber investments.

- **Backhaul** – Backhaul fiber constitutes the routes in and out of the region. In the Roanoke Valley, most of the backhaul fiber entering and leaving the region traverse the I-81 corridor, which reduces path diversity and redundancy. The MBC connection at Bonsack provides a new route out of the region to the east, greatly improving the resiliency of fiber networks within the Valley.
- **Core Network** – The most desirable core network design is at least one "ring" of fiber around the community, so that if the fiber cable is cut at any point, data traffic can be automatically re-routed in the opposite direction without creating

a failure. In an area the size of the Roanoke Valley, a redundant regional ring would ideally connect a series of smaller redundant rings to provide a higher level of protection against fiber cuts. We know of a business in the mid-west that has calculated the loss of Internet access at one million dollars per minute--the firm processes a very large number of online transactions. Relocating businesses are typically keenly interested in the design of a regional core network, and want to see both redundant rings and path diversity in and out of the region.

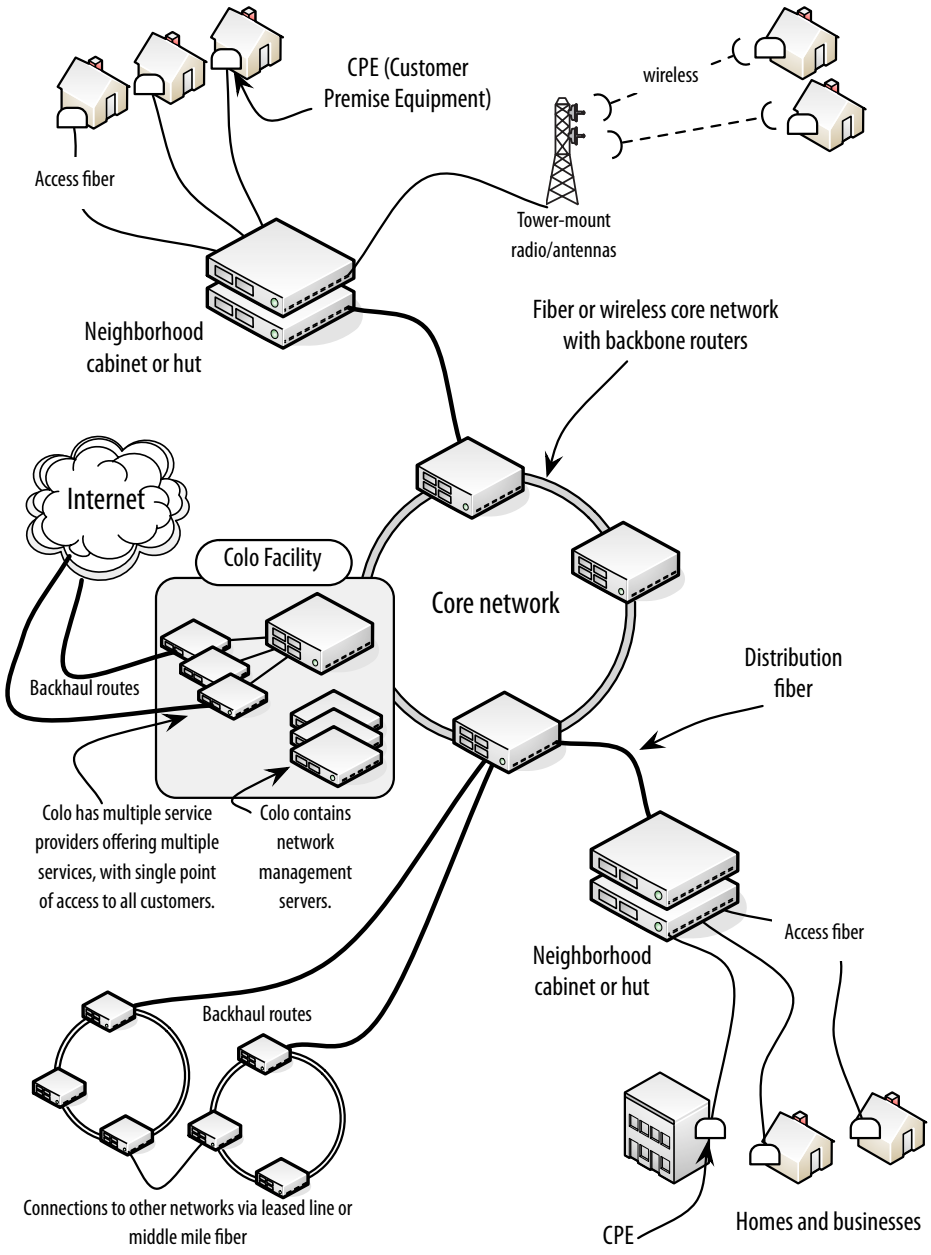
- **Distribution** – Distribution fiber constitutes the fiber cables that go up and down the streets of the community, passing homes, businesses and institutions. The Roanoke area has a limited amount of privately owned distribution fiber. Distribution fiber can be the most expensive portion of a community-wide network design. Private providers typically cannot make a business case to build large amounts of distribution fiber; instead, they build distribution fiber only to the largest customers (e.g. schools, large businesses, etc.). Homes and most smaller businesses and retail stores are left out.

- **Access** – Access fiber is the connection from the street to the premises. Once a business, school, or home has been passed by distribution fiber, the crucial "first mile" fiber is needed to connect the premises to the network.

- **Colocation/Data Center** – A colocation or data center is needed to provide a meet point for various public and private fiber cables and network to inter-connect. In the past, the telephone company switch office (Central Office, or CO) has provided that function. Today, many communities have either a community-owned data center or a privately owned data center that offers an affordable range of options for customers of broadband services. The rise of Software as a Service (SaaS) and cloud-based computing and data services has increased the need for affordable data centers. Many companies now backup company data in multiple, geographically diverse data centers to reduce the likelihood of any data loss. We know of one company that uses multiple data centers for storage of corporate data and enforces a rule that any two data centers must be a minimum of twenty miles apart to reduce the likelihood of a natural disaster (e.g. flood, wind storm, earthquake, etc.) would affect both data centers at the same time. The Rockbridge Area Network Authority is building a

$3 million dollar data center in Lexington that will be largest facility of its kind in western Virginia.

The illustration below shows how the parts of a broadband network fit together.



Wireless vs. Fiber

We do not subscribe to the "fiber vs. wireless" argument that one technology or the other is adequate. A modern broadband network requires both fiber and wireless assets, and in fact, the two systems are complementary.

- **Wireless** is essential for mobility access to the network. Smart phones and tablets are changing the way we work and interact when away from home or the office. Many businesses are now entirely dependent upon wireless for efficient delivery of goods and services. Almost any item delivered in a truck, from bread to Fedex packages, requires a robust wireless network to get to the right place at the right time.
- **Fiber** is needed to for fixed point access to the network from homes, businesses, schools, and institutions. Video in all its forms is putting relentless pressure on existing copper-based legacy networks from the last century, which were never designed to support multiple HD video streams to a single home or business. Fiber is needed to cell towers and other wireless antennas and towers to improve the performance of wireless networks, which must move all data to and from the wired network.

Characteristics	Wireless	Fiber
Mobility	Provides mobility access to portable devices like phones, PDAs, and laptops.	No mobility.
Capacity	Limited capacity. Vendors use very large, theoretical capacity when discussing wireless products. Actual capacity is often as little as 10-20% of vendor claims.	Actual capacity of active fiber systems is usually about 80% of published capacity. PON capacity is calculated by dividing published capacity by the number of users on a single splitter. Typically this number is 16 or 32.
Cost	Lower initial cost, but total life cycle cost over 30-40 years is higher than fiber.	Higher initial cost, but total life cycle cost of 30-40 years is lower than wireless.
Utility	Wireless services are needed for our mobile phones, PDAs, and laptops.	Fiber services are needed to power high bandwidth services like video, telemedicine, business applications, and home security.

Wireless networks, despite regular improvements in bandwidth, do not have the capacity to meet future broadband service needs. The Roanoke Valley needs a robust fiber network with a redundant core ring design and a long range strategy for getting fiber to most homes and businesses over the next six to eight years.

Comparative Pricing

The data below provides actual pricing available on other community-owned fiber infrastructure, and offers an excellent illustration of the kind of decreased cost and increased performance that results from targeted infrastructure investments.

FiberNet Monticello

Business Services

Basic phone	$43.85
10 Mbps symmetric	$41.95/mo.
20 Mbps symmetric	$69.95/mo.
30 Mbps symmetric	$99.95/mo.
100 Mbps symmetric	$199.95/mo

Residential

Internet	
10 Mbps symmetric	$29.95/mo.
20 Mbps symmetric	$34.95/mo.
30 Mbps symmetric	$52.95/mo.
50 Mbps symmetric	$93.35/mo
Telephone	
Standard line	$21.20 (most features are
$1/feature	
	per month; e.g. call
forwarding is $1/month)	
TV	
Basic	$13.80
Expanded	$46.85
Expanded Plus	$56.80

Palm Coast FiberNET

Business Services	
2 Meg symmetric	$175
3 Meg symmetric	$270

4 Meg symmetric	$360
10 Meg symmetric	$625
2 Meg plus 2 phone lines	$199

Chattanooga

Residential

Internet	
30 mbps fiber	$57.99
50 mbps fiber	$69.99
100 mbps fiber	$139.99
1,000 mbps fiber	$349.99
TV	
Basic	$11.99 (local channels)
Expanded	$54.99 (80+ channels)
HDTV	$65.99 (180+ channels)
Basic triple play	$80.82
30 mbps, unlimited phone, TV	$120.52 (180+ channels)
Phone	
Basic	$22.99
Unlimited local/long distance	$39.99

The Wired Road

Residential

Internet	
2/1 Meg wireless	$34.95

Business Services

Internet	
2 Meg symmetric	$207
5 Meg symmetric	$425
10 Meg symmetric	$750
15 Meg symmetric	$975

Powell, Wyoming

Residential

Telephone local/long distance	$24.95
Online backup	$2.50/Gig
Basic TV/phone	$24.95 (40+ channels)
Value TV/phone	$42.95 (80+ channels)
Expanded TV/phone	$49.95 (150+ channels)

Lafayette, Louisiana

Residential

Internet

10 Meg symmetric	$28.95
30 Meg symmetric	$44.95
50 Meg symmetric	$57.95
100 Meg symmetric	$199.95
Phone	
Basic line	$15.95 (Includes 3-Way Calling, Call Waiting, and 5 cents per minute long distance)
Unlimited long distance	$15
Phone features package	$5 (Adds: Automatic Recall, Various Call Forwarding, Do Not Disturb, Outgoing Call Blocking, Selective Call Rejection, Selective Call Acceptance, Speed Dial)
TV	
Basic	$17
Expanded Basic	$46.95 (80+ channels)
Digital Access	$54.95 (150+ channels)
Digital Plus	$67.82 (250+ channels)

Competitive Advantages and Disadvantages

Regional Advantages

The Roanoke region has some significant advantages, with respect to telecommunications infrastructure but also in terms of related assets and advantages that can complement a new direction in regional broadband investments.

- **Competitive Fiber** – The region already has some competition in the fiber marketplace, with Lumos, Level(3), and Citizen's Coop already a presence in the marketplace.
- **MBC Fiber** – The availability to tap the Mid-Atlantic Broadband Coop fiber at Bonsack is a significant advantage not available to many other areas of Virginia.
- **Allied Fiber** – Allied Fiber is a new business venture that is building new fiber from Washington, D.C. to Atlanta, Georgia along Norfolk Southern right of way. This new cable will pass through Roanoke, will provide path diversity, and will give the region a new route in and out for broadband traffic. This will reduce the over-reliance on fiber cables traversing Interstate 81.
- The **Western Virginia Water Authority** has indicated it would like to have most pumping stations and facilities connected with fiber to reduce operating costs. The Authority could be a critical partner in any new regional fiber venture.
- The Roanoke area scores well on **affordable housing**, which is an advantage when trying to attract new businesses and entrepreneurs to the area. Quality of life issues are becoming a more important part of relocation studies (e.g. the brewery opportunity), and being able to promise employees a wide selection of urban, suburban, and rural living choices is important.

- **Downtown improvements** like the newly renovated City Market, the Taubman Museum, the Science Museum and Center in the Square renovations, and the trend of creating more live/work apartment and loft space downtown are all important in addressing quality of life as part of relocation decisions.
- **Abundant recreational opportunities** both directly in the region (e.g. expanded bike ways and green ways) and the ability to quickly reach destinations like National Forest areas, state parks, the Appalachian Trail, and the Blue Ridge Parkway are all important assets when marketing the area. In particular, for young workers--the Millennials--what they can do outside of work is often as important as the job and work opportunities.
- The region is blessed with **excellent transportation**. Interstate 81 has played a large role in the growth of the region, and the Roanoke Airport is an important asset. Convenient access to air travel is even more important even as technology like HD videoconferencing is reducing travel needs for some businesses. Business travel is not going away, and when it is required, it is even more important.
- The region has an amazing breadth of **two and four year colleges**, including Roanoke College, Hollins College, the Higher Ed Center, and Virginia Western Community College. Radford University, Virginia Tech, and New River Community College also play an influential role in the region. Virginia Tech provides a steady stream of engineering and science graduates for companies that are already in the area and need qualified employees, and for relocating high tech firms, assurance that the area has workers with the right job skills.
- The **Roanoke-Blacksburg Technology Council** plays an important role in the region, serving as a bridge between the Roanoke Valley and the New River Valley, with regular monthly meetings in both locations. More importantly, the RBTC plays a critical role as a connector: a connector of people, a connector of business skills and services, a connector of investment opportunities, and as a connector of employees and employers.

Regional Challenges

Despite the region's long list of advantages, the Roanoke valley has some challenges to overcome.

- Virtually **no distribution or access fiber** – Despite the presence of some competitive fiber providers, very little access or distribution fiber exists. The competitive providers can only afford to build distribution and access fiber to the larger customers in the area, leaving wide portions of the Valley limited options for broadband services and virtually no competition.
- The competitive fiber that does exist does not provide the region with a **coherent, fully redundant core fiber ring**, which is essential for many businesses that might want to relocate to the region. The lack of an open access core network ring also keeps prices for broadband services higher than they would be if it existed. This is a particular burden for local governments and higher education facilities, which depend wholly or partly on tax dollars to fund telecom needs.
- **Lack of path diversity** is also an issue, with too much reliance by existing providers on fiber cable exiting the region on Interstate 81. This situation is improving (.e.g. MBC presence at Bonsack, future Allied Fiber route), but these two new routes out of the area cannot be fully utilized without a fully redundant core fiber ring within the valley.
- The network does not recognize **political boundaries,** and improved access to affordable broadband will only be solved by a strategy of aggregating customers across political boundaries. Collaborating with other regional efforts such as the New River Regional Open Access Network helps create efficiencies that can't be achieved by one or two local governments.

The Competition

From an economic development perspective, the Roanoke Valley faces competitive threats from two different sources: in-state communities and out-of-state communities. Other regions, towns, and cities in Virginia and elsewhere are already

building and operating high performance, low cost fiber networks for public and private benefit.

- Fiber provided by the Wired Road is available now in most parts of downtown Galax, and new fiber extensions are under construction to take fiber to Hillsville (Carroll County) and Independence (Grayson County). The Wired Road is finishing construction of Fiber To The Home (FTTH) in Grant, Virginia.
- The City of Danville has built more than 150 miles of fiber in the City, including the downtown area and all five business parks. Every parcel in all five parks is passed by nDanville fiber. nDanville is constructing a 1500 home FTTH deployment in several city neighborhoods.
- Lexington, Buena Vista, Rockbridge County, and Washington and Lee University are building a $3 million dollar data center and Lexington and constructing 65 miles of fiber connecting the two cities, Glasgow, and the county's entire economic growth corridor in the northeast area of the county. More than 10,000 homes are passed by this fiber, and any resident on the routes will be able to order fiber connections.
- There are numerous other fiber networks in operation or in construction around the state, including the Northern Neck, Page County, Nelson County, Bristol, and the Eastern Shore.
- From outside the state, more than one hundred other community fiber projects are in operation, with an estimated one hundred more under way (many of these received broadband stimulus funds). Cities like Chattanooga, Jackson, Mississippi, and Lafayette, Louisiana have embarked on or have already finished fiber construction to tens of thousands of homes and businesses.

Best Practice

Few community-based broadband projects have been in operation for more than six or seven years, but there are some rules of thumb and best practice concepts emerging.

- Aggregate the largest possible market space to achieve maximum cost reductions and the widest array of services
- Address both backhaul (into and out of the area) and local ubiquitous access as two concurrent and complementary activities.
- Know where you need fiber before building. Some communities have eagerly spent funds without tying those expenditures to broader community and economic development goals.
- Use local government and institutional anchor tenants to achieve rapid financial sustainability. Keep as many anchor tenants as possible in the buying pool to achieve maximum economic development benefits. Potential Roanoke Valley anchor tenants include K12 schools, two and four year colleges, the Water Authority, and health care facilities.
- Business start ups and entrepreneurs are increasingly work out of their homes. Neighborhoods have to be treated as business districts, with affordable, business class broadband services. Residential DSL and cable modem services can't always meet business needs, especially as the need for two way business videoconferencing increases.
- Local champions for investment are critical to success. Elected officials need to know the community supports the initiative.
- Support for entrepreneurial start-ups is essential for job creation. Low cost broadband is necessary but not sufficient.

- Asset ownership creates control over future economic development.
- Broadband is “enabling infrastructure.” Investments in what appears to be excess capacity (i.e. more than what is needed today) spurs innovative new services and business opportunities that would not otherwise develop.
- Open access networks level the playing field and create service equality between large and small service providers. Businesses see substantial benefits in the form of lower costs for telephone, Internet, and other services (e.g. videoconferencing, Software as a Service--SaaS, cloud-based services).
- Give away bandwidth (or provide it very cheaply) and charge for services. Legacy triple play model is to give away services and charge for bandwidth, which discourages innovation, new service development, and use of broadband.
- Tele-work is a quality of life issue; it enables more flexibility in work hours, reduces commuting time and saves gas costs and emissions, makes it easier to attract and retain staff, and reduces real estate costs.
- Public benefits include increased economic development, bridging the digital divide, improved public and emergency services, easing of traffic congestion through smart road technology and increased tele-commuting, increased revenue to local government through right of way fees, and minimization of street cuts and street repairs.
- Don’t try to fund the entire build out all at once. Projects that succeed identify a “Phase One” effort that can actually be funded without hoping for some vast external grant (e.g. the Google fiber initiative--one grant, 1100 hopeful cities). The most important funding lesson is to build something, connect users, and get an operating network going. Once an operating network is in place, it becomes much easier to acquire additional funds for expansion.
- Don’t stop building. Many projects falter because they accomplish their Phase One goal and then fail to follow through on additional funding. This usually causes financial stress, because not enough customers are connected, meaning revenues don’t rise to cover long term operating expenses. The Wired

Road started with just $635,000, and four years later have been able to raise nearly $3.5 million in additional funds.

- Be bold. Chattanooga was able to get a $111 million U.S. Department of Energy grant because they had the "big idea" of building a single network that would do both energy management and deliver broadband services. Chattanooga has also announced the "Gig Tank," which will award more than $300,000 in cash prizes and seed capital to 25 top technology start up ideas. The city is pushing aggressively to rebrand the region as "Gig City" with the goal becoming the premier location of business start ups in the U.S. A major U.S. city is planning an initiative to attract 10,000 new families to the city to live in revitalized city neighborhoods; fiber to every home in those neighborhoods has been identified as a key strategy for attracting young and first time home buyers.

Examples of Broadband Use

Community	Primary Purpose
Chaska, MN	Digital divide for schools, businesses and residents
Cheyenne, WY	Traffic-signal management
Corpus Christi, TX	Automated meter reading for city-owned utilities
Lewis & Clark County, MT	T1 replacement; access to remote county buildings
Medford, OR	CDPD replacement public safety
Ocean City, MD	Integrated digital, voice and video for city buildings
Piraí, Brazil	Municipal field-force productivity; promotion
Portsmouth, UK	Bus passenger information dissemination
San Mateo, CA	Police field-force productivity improvement
Shanghai, China	Police field-force productivity improvement
Spokane, WA	Municipal applications and e-Government initiatives
Westminster, UK	Video surveillance and enhanced security

Typical Uses

Citizens and Business Uses	Government Use
Police accident reports	Site locates/GIS maps
Parking-ticket payment	Maintenance orders
Tax payments, ID Numbers	Record management
Licensing and permits	Firefighter locator chips
Utility payments	Security cameras
Emergency response	Public-works work orders
Tourism and recreation services	Remote video surveillance

Business Models

Open Access Networks and Why They Work

One could reasonably ask, "*If the incumbent providers have not been able to make a business case to 'build fiber everywhere,' why would some alternative approach like a regional authority a public/private venture succeed?*"

It is a reasonable question. The table on the next page summarizes the differences between the three most common business models used for broadband and legacy telecom networks. Some of the early community projects (e.g. Bristol, Virginia, Lafayette, Louisiana) have pursued the Municipal Retail model, but because residents and businesses buy telecom services directly from the local government, a legal challenge usually follows the announcement of such a plan. Both Bristol and Lafayette were sued. Both cities prevailed in court, but only after long delays and expensive legal fees.

In North Carolina, the city of Wilson pursued a retail model with some success, but it led to a statewide ban by the legislature on government-owned networks.

We are recommending an open access network because:

- It creates a business structure that allows private and public interests to collaborate rather than compete. In an open access network, local governments do not sell any services to residents or businesses; all services are offered by private sector service providers. In this model, incumbent telephone and cable companies are invited to use the new, high performance network to sell services to their existing customers as well as market to new customers with new and enhanced services that they were not able to offer in the past.
- It reduces costs. An open access network functions like a road system or an airport: the community builds a single transportation system shared by all

public and private users. This reduces the cost of construction as it eliminates duplication of facilities (in this case, duplication of distribution and access fiber) and reduces operating costs (e.g. one airport instead of two or three airports, one for each airline).

- It encourages innovation by reducing the cost to service providers to try out new services.
- It brings a wider choice of services to public and private users of broadband services. Costs are lower both because of the shared nature of the infrastructure and because competition among providers.
- It helps attract and retain businesses because they know that they have access to a wide choice of services at attractive prices.

Features	Traditional Triple Play	Municipal Retail	Open Access Infrastructure Only
Basic Concept	Three separate services (voice, video, data) with little or no sharing of network with other providers and services.	Typically just three services (voice, video, data) with little or no sharing of network.	All providers share network capacity, which aggregates a larger customer base and increases overall revenue,
Government Involvement	No government involvement. Private sector decides where and when to offer services. Some areas get little or no service.	Government competes directory 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 by a private company. Community must accept whatever services are offered.	Owned and operated by local government. Limited triple play services sold directly by local government.	May be owned by local government or by a broadband authority or coop. Wide variety of services sold by private sector companies.
Competition	Little or none in most areas. Cartel-like pricing keeps prices high.	Government officials pick 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.

Features	Traditional Triple Play	Municipal Retail	Open Access Infrastructure Only
Service Options	Limited. Providers can offer triple play at most.	Limited. Government resells triple play services.	Unlimited. Low cost of market entry and high level of service automation attracts service providers and encourages innovation.
Revenue	Limited by low returns on the individual services.	Limited by low returns on the triple play services.	Substantial potential for long tern growth, Revenue directly linked to demand. Revenue tends to increases with demand.
Service Area Expansion	Limited to high density population areas. Rural areas at a structural disadvantage.	Limited by triple play approach, which keeps funds for expansion low.	Unlimited. Expansion completely supported by revenue sharing or use fees. Open services network can provide become financially sustainable relatively quickly.
Risks	Some areas do not get adequate service or affordable pricing.	Government officials must predict business technology needs years in advance.	More complex network management required, but reduces costs sharply for service providers, which encourages competition.

Organization and Governance

The ownership and governance of community-based broadband initiatives varies widely from state to state, largely because the laws governing broadband vary widely from state to state. For example, in Massachusetts, the WiredWest initiative in the western part of the state used a one hundred year old law governing the formation of electric lighting plants to create a regional municipal coop.

In Utah, sixteen cities joined together to form Utopia, one of the largest community-based projects in the country (more than seventeen providers sell services on the network). The governance entity is called the Utah Telecommunications Open Infrastructure Agency; the project has used bonds guaranteed by sales tax revenue to build and operate a network worth more than $120 million.

In New Hampshire, the FastRoads project is a consortium of 43 towns that formed an LLC that is owned by the non-profit Monadnock Economic Development Corporation (MEDC). New Hampshire FastRoads LLC has its own Executive Director and Board of Directors, but receives finance and accounting support from MEDC.

In Virginia, the legislature has specifically authorized the formation of broadband authorities with the same statutory rights and privileges of any other authority in the Commonwealth (e.g. solid waste, water authority, sewer authority, etc.). At last count, twenty broadband authorities have been formed in Virginia, although only about half of them are active. To the north, Rockbridge County, the cities of Lexington and Buena Vista, and Washington and Lee University formed the Rockbridge Area Network Authority (RANA) in 2009, and that project will connect the first customers in the summer of 2012.

To the south, The Wired Road was formed in 2008 by Carroll and Grayson counties and the City of Galax, and the network is in its fourth year of operation. In the east, Accomack and Northampton Counties formed the Eastern Shore of Virginia Broadband Authority in 2009, and that network has been in operation for two years.

For the Roanoke region, we considered the eight governance/ownership structures summarized the table below.

Governance Entity	Definition
Municipal Department	A local government creates a town or county department for the purpose of offering broadband.
Regional Authority	An independent entity jointly owned by several local governments for purpose of offering a shared service.
Private Coop	A private sector coop owned by the customers receiving services.
Non-profit	A 501(c)3 private corporation formed for a specific charitable purpose.
LLC/LLLC	A general purpose private sector corporation owned by the participating partners.
Public/Private Partnership	A private company working in close cooperation with participating local governments.
Ad Hoc	An informal committee formed for a specific purpose.
Economic Development Corporation (EDC)	A public or private corporation formed to promote economic development in a geographic region.

We see three viable alternatives for the region:

- **Regional Authority** – A regional authority has certain funding advantages, an authority can use revenue bonding to raise fund for a network build out. However, start up authorities with no track record of operations will have more difficulty selling revenue bonds in the current economic climate. A regional authority will require a resolution from each governing body that decides to join (e.g. City of Salem, Roanoke County, etc.). The Western Virginia Water Authority could be a member as well. Another advantage of an authority is that it can start with a small number of members (e.g. two) and expand over time as more localities choose to join. Authorities are well understand governance mechanisms and are generally well-respected. Challenges that an authority would face include selection of board members that have the requisite business

and management experience to run a telecommunications enterprise. In the first two or three years, the time commitment for a board member is significant. Serving on a broadband authority board is substantially different than serving on the board of a typical community non-profit, and board members need to be vetted carefully.

- **Public/Private Partnership** – The exact corporate structure of a public/private partnership could take several forms (e.g. stock corporation, LLC). Given the existing telecom providers in the area, a private sector company with strong support from area local governments could facilitate a higher level of support from the private sector. The Google fiber initiative with Kansas City, Kansas and Kansas City, Missouri is an example of a tight public/private partnership, in which the two city governments agree to assist Google with expedited permitting, expedited construction and work inspection, and cooperation with traffic management when construction in roadways is required. In return, the two cities receive a certain amount of fiber dedicated to government use. In the Roanoke area, such a partnership might also be able to make better use of existing private fiber with less overbuilding of that fiber.
- **Coop** – Coops are a special private sector entity that firmly vests ownership in the community via the customer/owner model, in which every buyer of services becomes a member (owner) of the coop. Coops enjoy special protections from Congress, and because they are a private sector organization (501(c)12), there are no issues with respect to government ownership. Coops have to be formed with care to ensure that the right kind and number of membership levels, but once formed, a managing board and paid staff handles day to day operations. Coop membership fees can be collected in advance of having services available, and so early membership fees can be used to raise funds for initial capital and operating expenses.

The table below provides some comparison of the various advantages and disadvantages of the three governance options.

Characteristics	Private Coop	Authority	Public/Private Partnership
What It Allows	A private sector coop owned by the customers receiving services. Every customer is an owner, and excess revenue is typically returned to customers via a distribution on a periodic basis (e.g. every two or three years).	An independent entity jointly owned by several local governments for purpose of offering a shared service. An authority is a political subdivision, and is generally subject to all rules and regulations required of local governments.	Typically a private sector company with a contractual agreement from participating localities to provide expedited right of way access, expedited permitting, and agreements to purchase some services.
Governance	Strongly vested in the community.	Strongly vested in the community.	Less community control, but can be mitigated via local investment.
Financing	Can use membership fees, can have some private investment, can tap RUS funds.	Revenue bonding is fully authorized by the legislature. Start up broadband authorities often have some difficulty attracting capital because of a lack of a track record. Experienced management team is essential.	Can access commercial capital from a wide variety of sources. Some pass thru bonding is also possible.
Taxes	Pays taxes, but coops usually return excess funds as a distribution to members.	No tax obligations.	Taxable on all profits.

Characteristics	Private Coop	Authority	Public/Private Partnership
Staffing and Leadership	Selecting the right board members is critical. Essential that board appointments are not political in nature.	More difficult to get correct mix of leadership and staffing. Local government telecom projects tend to hire too many and wrong kind of staff.	A new start up with some local investment is most likely to get the right mix of leadership and staff on the first try.
Advantages	Immune to incumbent challenges. Can access USDA RUS funds. Long and well-established history of providing well-run telecom services.	Provides arms length separation from elected officials. Provides a vehicle for offering quasi-government oversight across political boundaries.	Organizational flexibility, with fewer controlling entities participating in decision making.
Disadvantages	Requires care in writing bylaws, defining membership fees and levels. May have difficulty borrowing funds compared to an authority or private sector entity.	Requires resolution or ordinance from each participating locality. It is critical that volunteer board members have proven enterprise and private sector business skills to provide adequate oversight.	Community has less control over management-- company objectives may not be fully aligned with community goals. Any partnership agreement must obtain a long term up front commitment.

Whatever form of governance is chosen, leadership by the local governments will be needed, as well as commitments from local governments and schools to use the new network facilities as anchor tenants. In the first two or three years, participation in the project as customers will be essential to getting the project into the black quickly.

Funding Strategies and Financial Analysis

"There is no money for broadband…."

The financial analysis on the next page demonstrates 30 year expenditures for routine and normal telecom services for businesses, residents, schools, and institutions for the Roanoke Valley region. These numbers are based on the combined data for Botetourt, Roanoke Co, the City of Roanoke, and the City of Salem. Over the next three decades, about $6.3 billion dollars will be spent on telecom services. This is a very conservative estimate that does not take into account the ever expanding demand for new kinds of services. The model looks only at current demand. A community investment in a community-owned and managed digital road system, where all services are provided by the private sector, would have substantial benefits.

What the table shows is that the region is already spending substantial sums of money on broadband–about $210 million year, This amount represents an estimate of what is being spent by all public, residential, institutional, and business customers for landline services, including telephone, TV, and Internet access.

The table is a flat rate projection, in today's dollars, with no increases for inflation or for the typical annual rate increases that many companies include. In fact, just the money spent in a single year in the four localities would come very close to paying for the complete cost of building an entirely new all-fiber network to most homes and businesses in Botetourt County, Roanoke County, and the cities of Salem and Roanoke.

Roanoke Valley 30 Year Telecom Expenditure Analysis			
	Households still on dial-up	Households with "little" broadband cable modem/ DSL/wireless	Households with no Internet
Total households	104,387		
Total businesses	11,389		
Percentage of households	6%	80%	14%
Number of households	6,263	83,510	14,614
Average monthly telecom expenditures	Local phone: $25 Long distance: $25 Cable/satellite TV: $55 Dial up Internet: $20	Local phone: $25 Long distance: $25 Cable/satellite TV: $65 Broadband Internet: $40	Local phone: $25 Long distance: $25 Cable/satellite TV: $55
Annual telecom cost/ household	$1,500	$1,860	$1,260
30 year telecom expenditure	$281,844,900	$4,659,835,680	$552,416,004
Total residential expenditures	$5,494,096,584		
Total telecom expenditures[1]	**$6,318,211,072**		

[1] Business, schools, institutions, and government costs estimated conservatively at 15% of residential expenditures
Source: Mediamark Research, Inc. *Includes figures for Botetourt County.

Funding a New Network

A wide variety of funding strategies are available for building new telecom infrastructure, but there are some emerging rules of thumb:

- The first money is the most difficult, and some local funds are almost always required.
- Most granting agencies want to see collaboration across political boundaries, as the market for network services usually spans those boundaries.
- Once even a modest network infrastructure has been built and has some customers and service providers, it becomes much easier to raise additional funds. So the most important funding strategy is ***to fund something and get it built.***
- It is quite feasible to finance a large part of expansion with funds directly from customers (i.e. property owners) that receive fiber connections. The Utopia project has been very successful with the approach in suburban communities in the Salt Lake City area. Those local funds can be leveraged to acquire the additional capital needed to support network expansion. The one time connection fee is identical in concept to the use of pass-by and tap fees used to help finance water and sewer construction.
- Partnerships with entities like K12 schools and the local governments are critical funding sources, especially for a "Phase One" initiative. The opportunity is to dramatically improve the quality of service (e.g. 10x to 50x bandwidth increases for local K12 schools for what they are paying now), and/or the opportunity to reduce the overall cost of telecommunications by improved efficiencies for combined voice and data uses. One funding approach used by other projects is to get an up front cash payment from local anchor tenants that is equivalent to several years of savings from their telecom budget.
- Many public safety agencies are embarking on extremely expensive upgrades from analog voice radio systems to digital voice radio systems. By partnering with the fiber initiative, the cost of these upgrades can often be reduced and/or some public safety funds can be used to build fiber that enhances the public safety network.

Funding Source	Description	Notes
Revenue Bonds	Long term debt instruments guaranteed with revenue from the network.	Requires some equity/funding from other sources.
General Obligation Bonds	Long term debt guaranteed by local taxes.	Generally more difficult to get approval from elected officials and voters.
Revenue Bond Guarantees	Third party guarantees on revenue bonds, so that if revenue fails to meet financial targets, bond guarantor makes debt payments.	Guarantors could be local or state governments. Does not require a direct cash outlay. Guarantor must have a good credit rating.
RUS Loans	Excellent source of low cost, long term loans for rural telecom initiatives.	RUS loans have a complicated application process that can require substantial expense to prepare. RUS favors rural coops, but does not have a strong track record of supporting start up ventures.
New Markets Tax Credits	Tax credits are sold to investors, and funds are used for the network.	Project must meet eligibility requirements and typically takes a year to plan and to receive approval.
State Funds	State agencies may be a source of planning and capital funds.	Capital funds are usually relatively small, but direct financial grants from the legislature are possible.
Federal Funds	Grants and loans of various kinds are often available from Federal agencies.	Federal grant programs and funding levels tend to change with changes in administration. Can often take 1-2 years for approval.
Municipal Leasing	Local governments can borrow money and pledge the asset as collateral.	Can be used for funding specific (limited) projects, like fiber to a school system or government offices.
Commercial Loans	Local banks are often willing to assist with funding.	Usually requires pledging network assets as collateral. Must be able to show a revenue stream to pay back the loan. Good for small, high priority network extensions with guaranteed customers.

Funding Source	Description	Notes
Private Sector Financing	A public/private partnership approach offers the possibility of attracting a mix of private investors as well as some local government financial support.	It depends on the corporate structure, but local businesses and investors could become shareholders or partners in the new telecom firm, effectively vesting community control for the effort. Because most of the funds will be used to create hard assets, it will be possible to attract institutional investors for larger amounts if a good business case is constructed.
Grants and Donations	Citizens and local foundations will sometimes provide grants.	Local foundations may require tying funds to a specific purpose.
Sales Tax	Assess a small increase in the local sales tax to pay for construction, or use existing sales tax revenues as a bond guarantee.	May require a voter referendum.

Why a Data Center?

If the Roanoke region makes targeted investments in broadband infrastructure, including incentives to attract a private sector funded data center, the area can expect increased economic growth through increased business attraction, increased local business expansion, and an increase in good-paying job opportunities. An open access fiber network would be a very strong attractor for private sector investment in a data center.

It is important that the localities and the business community evaluate the risk of doing nothing. The Roanoke Valley is competing for jobs and businesses with more than 100 other communities in the U.S. that have already begun to make significant investments in broadband infrastructure (as listed in Broadband Properties magazine, spring 2010). These communities are aggressively promoting their broadband infrastructure, quality of life, and other community assets. As one example, the City of Chattanooga, Tennessee recently announced citywide availability of Gigabit service for businesses and residents and quickly gained nationwide attention, even though Chattanooga is not the first city-owned network to provide Gigabit services.

Data centers, over the past decade, have become building blocks of the Knowledge Economy. The steady and geometric growth of demand for bandwidth has been doubling every two years for wired connections, and AT&T recently indicated smartphone users on their network have been doubling their bandwidth use annually. Behind the bandwidth growth is content and services of all kinds, and that content (data) and services have to be stored somewhere--ideally as close to users as possible to reduce the cost of hauling that data long distances.

Companies like Akamai have built extensive networks of servers located throughout the country, and Akamai servers really only do one thing: provide copies of other company's content and services close to users. Many large news and entertainment Web sites have enhanced the performance of their Web sites by using the Akamai

server network to reduce the amount of time it takes to get a Web page or some kind of service to a user.

The rapid growth in hosted services has also spurred the growth of data centers. Companies like Microsoft, Apple, and Google have been building massive data centers throughout the United States to support their online services (e.g. search services, music downloads via iTunes, movies and TV on demand). These data centers are generally located near sources of affordable electric power and where there is abundant non-incumbent fiber available. As one example, the city of Danville, Virginia recently attracted a commercial supercomputer to a renovated downtown building, along with some very high-paying jobs, and the two key factors were affordable and resilient electric power and a City-owned fiber network. Google's data centers also tend to be located in communities with those characteristics. It is also worth noting that while some of these data centers have been located in rural areas (where power costs are often lower), attracting and retaining skilled technical staff has been a challenge in some cases. The region can offer a large and varied skilled workforce for a firm interested in locating a data center in the area.

The Akamai server network is just one example of a multitude of data, network, and server needs that are fueling a rapid increase in the number of colocation facilities (which are also referred to variously as data centers, colos, and carrier hotels). There is another trend that has contributed to the growth of data centers throughout the country. In the aftermath of 9/11 and Hurricane Katrina, companies throughout the U.S. have been decentralizing their data center operations to be able to better cope with disruptions caused by terrorism and/or natural disasters (e.g. floods, hurricanes, earthquakes, etc.). This decentralization includes:

- Duplication of data centers, with many firms building not just a second data center but three or more in different parts of the country to provide diversity. This is also driving demand for more fiber and competitive pricing for fiber.
- Companies that are not building private data centers are using either commercial data storage services or are leasing space in data centers for remote backup of company data. And this data is usually being backed up in more than one location.

As one example of the size and scope of this effort, New York, New Jersey, and Pennsylvania embarked on a massive data center project in eastern Pennsylvania called Wall Street West. The intent is to maintain, in real time, a complete backup of every single financial transaction that takes place on Wall Street and the nearby financial districts and companies. This location was driven in part by the requirement for affordable fiber links between the New York area and eastern Pennsylvania; without those fiber links, the data storage facilities have little value. Economic developers in eastern Pennsylvania expect a significant opportunity to attract satellite offices, high tech workers, and finance-related jobs to an area that has been part of the Rust Belt for decades.

The Gartner Group notes that 49% of data centers are more than 16 years old. These older data centers have aging electric cabling and cooling systems that are often not able to meet the power and cooling needs of modern high density servers and network equipment. It is often regarded as less expensive to build a new data center than to rehab an older one.

Such a facility would not only provide better and more secure space for servers and data storage, but would also help drive down the cost of Internet access and other broadband services for Roanoke area businesses. Data centers, by their nature, concentrate customers and thereby attract long haul data and Internet carriers--companies like XO, Level 3, Zayo, Cogent, and others, as well as incumbent long haul carriers, including AT&T, Century Link (formerly Embarq/Sprint), Qwest, and Verizon. In effect, a data center creates a marketplace where buyers of Internet and long haul data services (i.e. Roanoke area businesses) can conveniently shop among sellers of such services (e.g. the companies listed above, among many others).

A multitude of buyers and a choice of sellers creates competition that can and does quickly drive down the cost of services, often by 50% or even more. It is not unusual to see the cost of Internet access decline by 80% when competition among several Internet access firms is introduced in a community. These kinds of savings are substantial and apply directly to the bottom line of area businesses, freeing up capital to invest in business expansion and jobs and to reduce overall costs.

The availability of such a facility and the reduced cost of both data/server storage and Internet access enhances the region's ability to both attract new businesses and to

retain existing businesses. The importance of business retention is often under-estimated. We regularly meet business people who are contemplating, planning for, or have executed business relocation plans based solely on the local cost of Internet access and bandwidth. A data center that provides secure space for servers and network equipment, coupled with a competitive market for Internet access and services can be a powerful economic development tool.

Most data centers are privately owned and managed, but some communities have already made public investments in such facilities to enhance economic development. And over the next two years, many more communities will be adding data centers and colocation facilities via funding provided via the ARRA broadband stimulus program. Coupled with local open access fiber infrastructure, data centers are rapidly becoming essential infrastructure for economic development, just as water and sewer capacity were regarded as essential economic development infrastructure decades ago.

The area has some significant local and regional advantages for such a facility, with major north-south fiber on Interstate 81, the new MBC fiber coming from the east, and the new connection to Blacksburg via Craig and Giles counties.

Benefits

A data center in Roanoke can offer a variety of economic development benefits. Angelou Economics, an economic development strategy firm, has identified the following benefits (http://www.angeloueconomics.com/datacenters.html):

- Short term growth benefits from the substantial construction costs. If the area were to attract a 100, 000+ square foot data center, it would be a major project with numerous construction jobs and spin-off benefits for local businesses during the construction period.
- Increased opportunities for local businesses after the facility is built, including numerous maintenance and small business opportunities, including landscaping, cleaning, and security services.

Angelou notes that a 100,000 square foot facility could employ 100 or more people, but the number of jobs created can vary widely. Some data centers have few on site

employees.. Specialized services like disaster recovery, public safety support, call center support, and data storage services can create additional jobs.

Data centers tend to attract clusters of other related high tech businesses that benefit from being physically near a data center, bringing more jobs to the community.

There are more generalized benefits for improved availability and affordability of broadband services. An analysis (http://ncbroadband.gov/broadband-101/research) of the economic benefits of broadband infrastructure (which would include not only fiber infrastructure but data centers) by e-NC, a North Carolina initiative, listed the results of several studies:

- A analysis by the Canadian firm SNG found that for every dollar spent on broadband infrastructure there is a tenfold return to the community in increased economic activity.
- A study (http://www.aestudies.com/library/econdev.pdf) of Lake County, Florida, where the local government opened its fiber for business use found a 100% increase in economic activity over time.
- A study of broadband use in Japan found that wide availability of symmetric fiber services of 100 megabits or better created a “dramatic” surge in new applications and that high speed broadband attracts an entirely new class of “heavy hitter” users.
- Several other comprehensive studies have found a minimum of 1% higher annual economic growth in communities with affordable high speed broadband infrastructure. Over a period of years, this translates into a permanent and significant increase in economic activity compared to communities that lack such infrastructure.

In summary, if the region makes targeted investments in broadband infrastructure, including incentives to attract a data center, the Roanoke area can expect increased economic growth through increased business attraction, increased local business expansion, and an increase in good-paying job opportunities.

Finally, the region must evaluate the risk of doing nothing. Other communities in America are making significant investments in broadband infrastructure and are

aggressively marketing their communities to leverage those investments. This is best illustrated by the recent announcement by the City of Chattanooga, Tennessee's new Gigabit service and the Web site that the economic developers rolled out to promote the City-owned network (http://chattanoogagig.com/). The Roanoke Valley is competing for jobs and businesses with more than 100 other communities in the U.S. that have already begun to make significant investments in broadband infrastructure (as listed in Broadband Properties magazine, spring 2010).

Goals for a Data Center

A data center in the region can meet several (but perhaps not all) of the following goals.

- Meet the needs of area businesses – Any data center, even one of modest size, will provide businesses with more choice in service providers and lower costs for various kinds of telecom services. Based on the feedback we have received, a low end size for a Roanoke area data center should be on the order of 15,000 to 20,000 square feet, but the market potential is there for something larger if the right private investment can be attracted.
- Enhanced economic development opportunities – A data center in Roanoke, coupled with good fiber routes into that data center, would give the region a powerful economic development tool for both retaining existing businesses and attracting new ones.
- Local and regional disaster recovery options – As planning for an area data center moves forward, a parallel effort by nearby local and regional governments and agencies could help improve the ability of the region to survive various disasters by duplicating government data and services at the facility.
- Wider choice of providers and services – A data center will attract local, regional, and national service providers of all kinds. This will help lower the cost of telecommunications for businesses and local government because of increased competition.

Data Center/Colo Design Characteristics

A well-designed colocation facility has numerous requirements that typically dictate a purpose-built design. While existing buildings or areas of existing buildings can be re-habbed to provide colocation space, the specialized needs of a colocation facility usually make such modifications cost-prohibitive.

Among the specialized needs, the following are critical:

- A "Tier III" facility is probably the minimum design that would achieve the region's broader economic and business development goals. A Tier III design has numerous redundant components, and a Tier III design (or a fully fault tolerant Tier IV design) will be necessary to have a facility be taken seriously as an alternative to the current (limited) facilities.
- Single or dual electrical utility feed to the data center facility. Large facilities that cannot handle power outages entirely with on-site generators will typically require electrical feeds from two different sub-stations and/or two separate power grids.
- One or more stand-by diesel emergency generators to provide power to the facility during adverse power conditions. As noted above, generator size and capacity will depend on the overall size and power requirements of the building, and should be sized to provide power to the cooling equipment.
- Dedicated diesel fuel tank(s) to support continuous generator operations for a minimum of 5 to 7 days at full load, as well an agreement with a local fuel oil supplier to refill the tank as needed.
- Raised floors in at least some areas of the facility are desirable, and and overhead cable racks are a basic requirement throughout. High ceilings will be needed to accommodate overhead cooling ducts and distribution systems.
- The facility should have environmental and security sensors throughout (water leak detection, security cameras, etc.).
- Dual automatic transfer switches and dual main electrical distribution panels to transfer between utility and emergency power, so that there are no power interruptions during a change-over to emergency UPS or generator power.

- A single centralized uninterruptible power supply to provide fail-over reliability to existing rack mounted power supplies and critical network equipment.
- Dual power distribution units to provide dual paths of power to the data center floor, cages, and shared rack space, including dual power circuits to each hardware rack to take advantage of dual power supplies within the processing hardware.
- Dual water or air cooling units to provide redundancy in event of a single unit failure or because of preventive maintenance. Dual pumping systems are also needed to provide redundancy in event of a single unit failure or routine maintenance. Dual water supplies (e.g. WVWA water and an on-site well) are also desirable.
- Precision temperature and humidity control within the data center area.
- Primary FM-200 gaseous fire suppression system within the data center, and a secondary fire suppression system within the data center and support areas (hallways, meeting rooms, offices, etc.).
- Structured data and voice cabling system that is planned for future growth and expansion.
- Facility monitoring system that continuously monitors the data center infrastructure and alerts appropriate personnel in event of an alarm condition (water, cooling failure, power fluctuations, intrusions, etc.). This includes access control systems for monitoring and controlling all access to the facility by tenants, contractors, equipment maintenance staff, and other visitors.

Other general design and feature characteristics that should be considered:

- Improved power and cooling management – Changes in the way servers are managed (i.e. server virtualization, high density blade servers) is changing data center design. The increased density and smaller size of servers and network equipment has forced changes in power distribution and cooling within the data center. These new power and cooling requirements have made the construction of new data centers more competitive due the high cost of

upgrading older facilities. Any data center in the region should be designed to meet these new power and cooling requirements.

- Green design – Several companies have developed improved cooling systems that can reduce the overall power costs for data centers. Lower power costs translate into lower cost of locating and operating equipment within such a facility, and so a well-designed "green" facility would be attractive from a business attraction perspective. Some customers of the facility may find a LEED (Leadership in Energy and Environmental Design) certification desirable.
- Support for pods – Spec-built shipping containers can provide additional capacity at much less cost than traditional expansion construction. It may be desirable to design a facility that can accommodate some pod containers.
- Diverse path routing – A data center with diverse path fiber routes in and out of the facility is more valuable than one that relies primarily on incumbent fiber circuits and/or limited competitive fiber. Community-owned duct and fiber to create diverse path fiber routes to a planned facility will be a powerful incentive to attract private investment and will make the facility more attractive for both public and private users.
- Provider neutral – Most carrier hotels and data centers are, by business plan, provider neutral, but as stakeholder and economic developers interact with prospective data center firms, it is worth reviewing their business model to make sure the facility will be managed on an open access basis.

Potential Partners and Customers

If the region were to pursue the strategy of attracting the private sector investment needed to build a data center, there are several different kinds and types of possible partners and users. Note, however, that the needs of the partners described below vary widely, and in advance of a definite plan to build a facility, we believe it will be difficult to get firm commitments from interested parties.

- Long haul carriers – Companies like XO, Level 3, and others build and operate data centers to enhance the value of their long haul fiber networks. Concentrating customers in a data center creates a synergy between the two

lines of business (long haul fiber and colocation) that makes both more valuable.

- Data center companies – There is a wide variety of firms that specialize in the financing, construction, and management of data centers. Many of these firms specialize in "carrier hotel" facilities of tens of thousands or hundreds of thousands of square feet, and these large buildings come with price tags of tens of millions or hundreds of millions of dollars. In a discussion we had with a firm in this category, a direct financial investment by local governments was of limited interest, given the overall probable cost of the project ($7 million to $15 million). Dual power feeds from two substations or two separate grids was regarded as desirable but expensive. The availability of community-owned fiber is regarded as a major advantage.

- Local incumbent and competitive network and service providers – Local and regional incumbent and competitive service providers (e.g. Comcast, Cox, 1Point) may be interested in placing equipment and network connections in an regional facility.

- Major businesses – The area has some large firms would likely be of interest to several of these companies, who would be interested in a variety of uses, including off-site back up and data storage, expansion space for business operations, and improved access to lower cost long haul Internet and data transport services.

- Small and medium businesses – Small and medium-sized businesses will benefit from improved options for specialized Web hosting, lower cost data backup and storage options, and lower cost Internet access for hosted servers. If community-owned fiber is available for business use between some area business and commercial areas and the data center, many more businesses would benefit from the increased service options and competition.

- State agencies – As part of a larger disaster recovery planning effort, it is possible some state agencies would be interested in space in the data center. If the center had connections to a new southern fiber route for improved route redundancy and diversity, the facility would likely be of more interest. However, state budgets are tight and planning horizons tend to be long.

- Higher education – Most colleges and universities have their own data centers, but there may be some interest in an additional facility for backup and redundant data storage.
- Data container/pod users – A growing trend among larger data center customers is to expand via "pods," which are standard steel shipping containers that are outfitted with equipment racks, cable racks, electric power distribution, and integrated cooling systems. While these pods are expensive, they are much less expansive than building additional permanent floor space, and allow for expansion in much smaller increments than a typical data center expansion design. These pods are also likely to have a growing role in disaster recovery and public safety, as pre-outfitted pods could trucked to a data center and turned up within a few hours, bringing critical systems online from an alternate location. New data centers that want to be able to accommodate pod systems will need an area where these can be parked to access electric power and network connections.

Next Steps

Long Term Goals

Long Term Goals	Description
Encourage Public/Private Partnerships	Partnerships among local governments, service providers, schools, public safety agencies, water authorities, major businesses and health care institutions will assist with business attraction and lower telecom costs for all partners.
Create New Business Opportunities for Existing Service Providers	Local government should provide only basic infrastructure and transport, and should not compete with existing providers by selling services to businesses and residents. This is best done by the private sector.
Fiber Should Support Economic Development	Investments in broadband should be targeted to promote business growth and jobs creation.
Reduce Cost, Improve Quality of Government Services	A shared regional network will reduce the cost of telecom services for local governments while simultaneously improving service delivery.
Reduce Costs for Small and Large Businesses	A shared regional network will reduce the cost services for entrepreneurs, business start ups, and existing businesses.
Wireless Everywhere	Fiber and wireless infrastructure are complementary. The cost and performance of cellular wireless can be improved with affordable fiber access, and WiFi in retail areas and downtowns can enhance tourism.
Don't Wait	Many other communities have already made investments and aggressively promoting their infrastructure as part of their economic development strategies.

Encourage Public/Private Partnerships

The size of the region and the diversity of public and private interests in the region will require a commitment to regional collaboration if this effort is to be successful. The network does not stop at political boundaries. From a network perspective, the entire

region is a single, large (and attractive) market. While it is entirely possible for the individual governments to each pursue an independent course, this is a situation where the whole is much greater than the sum.

Important and critical partners include:

- Local governments
- Higher education institutions, including all two year and four year colleges and universities.
- Large institutional users of broadband services, especially health care and medical facilities in the region.
- K12 school systems are essential partners because they are among the largest users of broadband connections.
- Major public and private providers of other critical infrastructure, including gas, water, sewer, and roads (traffic control),
- Existing incumbent and competitive telecom service providers.

By taking the time to develop the partnerships needed for a regional approach:

- Costs are spread across a larger market area, making the long term financial sustainability much more likely.
- The larger market base will attract more providers and services, leading to even lower prices and a greater diversity of service offerings.
- The larger market base will also encourage more private investment, especially in building new and diverse fiber routes in and out of the region.
- It will be possible to raise more funds more quickly and thereby build to more businesses, residents, and institutions more quickly.

Create New Business Opportunities for Existing Service Providers

Any local government investment in telecom and broadband infrastructure should be at the physical layer and the transport layer of the network. Local government should avoid selling services to businesses and residents. Providing basic infrastructure and transport will allow them to reach new customers at much lower cost and allow them

to offer improved services to their existing customers. An important goal of any local government investment should be to create new business opportunities for existing incumbent and competitive providers,

Build Fiber in Support of Economic Development Goals

The region needs more distribution and access fiber, which is essential for meeting future demand for broadband services. The Valley needs a carefully designed redundant core fiber network with a ring design that gives public and private broadband users maximum access to competitive services from a wide variety of providers, including Lumos, Level(3), Zayo, Citizen's, Cox, Comcast, Verizon, 1Point, and any other interested provider. The core network should also extend north into Botetourt county to support identified economic and residential development growth zones.

To the maximum extent possible, this core network should avoid over-building existing privately owned fiber assets, and any construction should be preceded by an effort to obtain long term leases of fiber where it is available. The core network should include a connection to the MBC network Point Of Presence (POP) at Bonsack. This would also provide a route into the New River Valley via the MBC/VT fiber route through Craig and Giles counties.

- Fiber to the home is needed to support work from home opportunities.
- Fiber to the home is needed to support business from home ventures, especially small business start-ups and entrepreneurial ventures.
- Fiber is needed to every economic development area and corridor in the region, and open fiber is needed within every business park to reduce the cost of broadband services for businesses located in those parks.
- Fiber is needed in downtown areas (Main Street) to support economic revitalization efforts and to meet business needs in those core areas.
- Open fiber is needed to every school to help drive down the cost of K12 and higher ed telecom costs and to improve the delivery of learning resources and online classes.
- Fiber is needed to both improve the delivery of government services and to reduce the cost of those services.

- Fiber is needed to provide improved efficiencies in the management of regional water and sewer facilities and to support automated meter reading.

Reduce Cost, Improve Quality of Government Services

A shared regional network will help reduce the cost of telecommunications and broadband services for local governments through increased competition and the cost advantage of shared infrastructure. Critical services like public safety, water, and sewer will benefit from a long range plan to make fiber available to most local government locations (e.g. fire and rescue, police stations and sheriff's departments, pumping stations, parks, intersections (for improved traffic control),

Reduce Costs for Small and Large Businesses

A single, shared, high performance network will reduce the cost of telephone, Internet, data back up, videoconferencing, and other business services through reduced cost of infrastructure and increased competition. The region is competing for jobs and businesses with other communities in Virginia and communities in other states that already have this kind of infrastructure in place--and most of those communities are aggressively promoting it as part of their economic development business attraction and retention strategies.

Wireless Everywhere

For the foreseeable future, the primary means of mobility access to the network will be via the existing private sector cellular network. But that system will require additional expansion and investment to meeting the drastically increasing demand.

- Open fiber to cell towers will simultaneously reduce carrier backhaul costs while improving service from those towers.
- Local governments can adopt uniform tower permitting and design requirements to simplify the process of adding more towers.
- Tourist areas of the valley, downtown areas, and recreational locations will benefit from "visitor WiFi" access. Visitor WiFi would be free but would have limits on bandwidth and hours of use per day. Visitor WiFi would encourage longer tourist stays in shopping and dining areas while simultaneously reducing the load on the local cellular networks. In some areas, the visitor WiFi might also include access to other networks (e.g. in downtown Salem, Roanoke

College faculty, staff, and students might be able to access the private Roanoke College network with a userid and password).

Don't Wait

As we have described in more detail in Findings report, many other regions, some very close by, are well ahead of the Roanoke Valley in their plans to acquire 21st century broadband infrastructure.

- Kansas City, Kansas and Kansas City, Missouri have construction underway in their Google partnership, which will connect hundreds of government locations, thousands of businesses, and tens of thousands of homes.
- The Utopia project in Utah is investing more than $60 million to expand its community-based fiber network from 9,000 homes and businesses to a planned 25,000 homes and businesses.
- The Rockbridge area's $3 million data center opens in June, and fiber customers will begin receiving service on the $7 million fiber backbone before the end of the summer.
- The Wired Road will have completed more than $3 million in fiber and high performance wireless to that network by the end of the year.
- Danville's nDanville network will have completed a 1500 home multi-million dollar fiber to the home expansion by the end of 2012.
- More than 200 other communities in the United States have operating networks or have substantial network construction underway.

How will Roanoke's businesses, schools, health care facilities, and government agencies be connected? And what will bring businesses to Roanoke?

Short Term Goals

A variety of short term goals should be considered as next steps in this effort.

Short Term Goals	Description
Continue the Current Broadband Exploratory Committee Initiative	The current group of public and private stakeholders and interested parties should continue development of this initiative.
Select a Governance and Ownership Model	Answering the question, "What entity will own and manage the infrastructure?" is an essential first step.
Commitment from Local Governments to Support the Effort	Regardless of the type of governance structure selected, support of the local governments is essential to success.
Consistent Message and Coordinated Public Awareness	If a decision to move forward is made by local governments, stakeholders, and interested parties, a consistent message about the benefits and advantages will be critical to gain public support.
Develop a Strategy for Attracting a Regional Data Center/Colocation Facility	A regional colocation/data center is an important component that makes the fiber network more valuable, and the fiber network will make the data center more valuable.
Explore Public/Private Partnership Options First	Prior to making a decision on community investments, consider issuing an RFI that asks private sector telecom providers to submit a proposal for a public/private partnership to meet the region's broadband goals and objectives.
Explore Possible Smart Grid and Utilities Partnerships	Automated meter reading (e.g. electric, water) and energy conservation (e.g. Smart Grid initiatives) can save power and reduce costs to the partner utilities. Such partnerships can also assist with paying for both capital and operating costs of the network.

Short Term Goals	Description
Develop a Common Fiber Overlay Plan and Open Ditch Policy Across the Region	Duct and handholes should be included where appropriate in all new public and private construction. Opportunities for shared trenching should be vigorously pursued.
Reach Go/No Go Decision on a Phase One Fiber Project	The localities must agree on the size and scope of a modest "Phase One" build out that provides immediate economic development benefits.
Coordinate Broadband Infrastructure Improvements with Public Safety Spending	Coordinate upgrades to public safety communications systems with planned fiber and wireless improvements to reduce the cost and improve the quality of public safety voice/data traffic.

Continue the Current Broadband Exploratory Committee Initiative

The current group of local government officials, private sector business people, and institutional stakeholders should continue to meet regularly, identify key decision points, recommend an overall strategy, and advise local governments on next steps.

Select a Governance and Ownership Model

The advantages and disadvantages of three different governance/ownership models are discussed in detail in the Findings report. These three options are:

- Form a regional broadband authority.
- Issue an RFI to solicit proposals for a public/private partnership.
- Form a broadband coop.

Without consensus on what form of enterprise will own and manage the proposed infrastructure, raising the funds needed for a Phase One effort will be extremely difficult. If there is agreement that shared infrastructure for the valley is desirable, then choosing and creating the ownership/governance entity becomes the essential next step.

Commitment from Local Governments to Support the Effort

Local government support may consist of assistance with financing, commitments to buy services once the network is constructed, and commitments to provide expedited right of way and construction permit processing. The commitment to buy services for local government facilities and agencies is particularly important for early financial sustainability and stability. Over time, as more private sector businesses and residents are connected, government purchases of services have less financial impact on the enterprise, but early commitments from local governments to be anchor tenant customers can ease financing (both for public and private ownership) and can help attract service providers.

K12 school commitments to buy services on the network are particularly important, as K12 schools are often the single largest public or private purchaser of broadband services in a locality. Regrettably, K12 schools often choose not to support community broadband initiatives, so early commitments of support from K12 schools have an outsized impact on the project.

During the planning stages of an early phase build out, it is also important that local government IT managers and directors not purchase or renew long term broadband and telecom service contracts with providers (and in fact, this is true for large business and institutional customers as well). Large “anchor tenant” customers for the new network can use their purchasing power to encourage local incumbent and competitive service providers to amend their contracts to allow a graceful transition to the new open network.

The community broadband projects that have succeeded have all had consistent long term support from local governments--even across local elections. Candidates for local offices should be asked about their commitment to current and future community broadband plans prior to the election to prevent erosion of political support over time.

Consistent Message and Coordinated Public Awareness

Public support for the project will be important to the long term success of the effort. All parties involved in the effort must be able to address key talking points clearly, succinctly, and consistently to avoid confusion and negative rumors. Incumbents often embark on extremely negative and mis-leading public relations campaigns that

seem to suggest a wide range of poor outcomes to such an effort. Citizens often assume that taxes will be increased to support the effort. A well-managed public awareness campaign that includes helping elected and appointed officials both understand and discuss key parts of the project will be very important.

Develop a Strategy for Attracting a Regional Data Center/ Colocation Facility

The region needs a state of the art, modern data center that can be certified, at a minimum, to meet the Tier III data center standards. The facility should be located to maximize the number of carriers that can affordably bring private fiber into the facility at minimum cost (i.e. locations on or near existing fiber routes are most desirable).

- Option One – Develop an incentives package to attract private investment for a modest facility designed primarily to meet carrier needs, with a modest amount of additional floor space for local government, institutional, and business needs (e.g. 10,000 to 20,000 square feet of space).
- Option Two - Develop an incentives package to attract private investment for a larger data center designed to meet the needs of a larger portion of southwest Virginia, including the New River Valley. This facility would offer 50,000 to 100,000 square feet of space. This option would only succeed if the region had already developed an open fiber strategy that would provide affordable local access to the data center.

Regardless of whether Option One or Option Two is chosen (and the two are not mutually exclusive), the facility must have convenient 24 hour/7 day/week access for service providers, and it must be of sufficient size to meet early demand for growth.

Explore Public/Private Partnership Options First

Prior to making a decision on community investments in broadband infrastructure, consider issuing an RFI that asks private sector telecom providers to submit a proposal for a public/private partnership to meet the region's broadband goals and objectives. The RFI should ask for innovative proposals from qualified private sector companies. The RFI should outline the goals and objectives that must be met. For example:

- Affordable, high performance “big broadband” fiber connections to most homes and businesses in the region.
- Network build out in a reasonable period of time.
- What kind of support is needed from local governments to form the partnership.
- A network that will offer a wide range of both traditional “triple play” services along side a wide offering of new and innovative services from many small and large service providers.

Such an RFI could be issued in early summer 2012, and responses could be evaluated quickly so that the overall effort keeps moving forward without a long delay.

Explore Possible Smart Grid and Utilities Partnerships

Automated meter reading (e.g. electric, water) and energy conservation (e.g. Smart Grid initiatives) can save power and reduce costs to the partner utilities. The regional water authority and the local electric utility providers (e.g. City of Salem, AEP) are potential partners. These partnerships could take a number of forms, including an up front payment in return for long term use of the network for meter reading and utility management at no charge, or a long term contract to pay a monthly per subscriber fee in exchange for use of the network. These partnerships can play a major role in developing a robust financial plan to cover both capital and operating costs of the network.

Develop a Common Fiber Overlay Plan and Open Ditch Policy Across the Region

A fiber overlay plan is an essential part of any next steps. The four localities should agree to develop a shared GIS layer that identifies desired fiber routes and connected facilities, and any road reconstruction or repairs, water or sewer expansion, and any other civic construction or utility work should be compared to the overlay plan to determine if the new work is on a desired fiber route. If it is, funds should be budgeted during the planning phase of the effort to include adding duct and fiber along that route.

Planning departments in the Valley should update new project guidelines and checklists to encourage both public and private development projects to include

conduit, duct, and handholes where appropriate, just as private developers routinely provide shared infrastructure like roads, sidewalks, water and sewer.

Public works departments should be trained to install duct so that incremental build opportunities can be pursued at least cost.

Coordinate Broadband Infrastructure Improvements with Public Safety Spending

Public safety can benefit substantially from cost sharing with a regional open access network. Fiber can be reserved specifically for public safety use so that those agencies have secure data transmission with no information co-mingled with commercial and residential data. Public safety radio networks can be enhanced by running fiber to all repeater towers, improving the quality of voice transmission and potentially reducing the overall number of towers and repeaters needed.

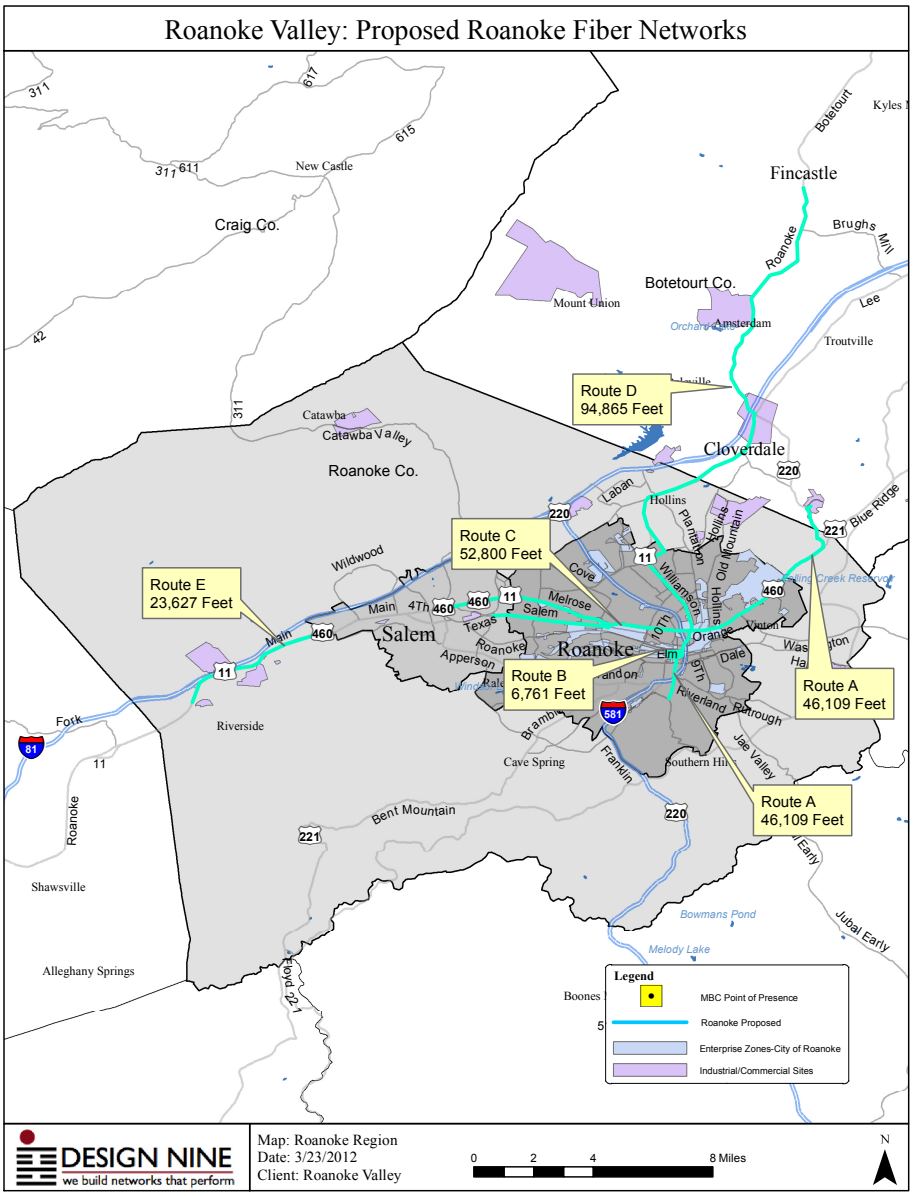
Reach Go/No Go Decision on a Phase One Fiber Project

The question of where to start is an important one. Business, commercial, and government uses (e.g. schools, critical public infrastructure) should have a high priority. The map below is a potential "Phase One" effort.

The initial routes identified in the map below have the following characteristics:

- The extremely important connection to the MBC fiber in Bonsack.
- A route from Bonsack into the downtown area, where there are many large, medium, and small businesses.
- An approximately six to eight square block area of downtown that could take fiber to virtually any customer in any building in that area.
- The fiber continues down Jefferson past many Carilion facilities and would connect the medical school.
- Two routes west that connect with existing City of Salem fiber and would also form a redundant loop.
- A route to the northwest into Botetourt County that would connect some important development areas in Botetourt.

- Fiber should be extended to the western part of Roanoke County to provide open access connectivity to the County's Center for Research and Technology.



Appendices

Last Mile and Connectivity Solutions

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, rural areas 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. Another problem in rural areas is the age of the telephone cable plant. 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. Most homes will never be able to receive DSL services at those speeds because of sub-optimal service conditions. DSL cannot provide the capacity needed by businesses and residents in the near future.

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 back to the neighborhood equipment node. 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 are limited in the same way that DSL systems are limited, 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 also 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 and content 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 the cost of fuel changes commuting patterns and more people want to work from home part or full time.

In Salem, the cable TV system is an older analog system that does not support broadband Internet services. Comcast has not indicated when or if the company intends to upgrade the system.

Satellite

Satellite broadband is a wireless technology, and to avoid confusion, systems like WiFi are often referred to as terrestrial wireless. Satellite broadband uses geostationary satellites located 22,500 miles above the earth, and data traversing a satellite system has a 45,000 mile loop (up and down). As fast as radio signals are, this distance still introduces latency (time delays) that can cause problems with real time transmission of telephone (VoIP) and videoconferencing. Bandwidth is generally less than what is available from DSL or cable systems, with a typical residential service offering 700 kilobits/second downstream and 128 kilobits upstream for between $55 and $65 per month. Higher speeds (e.g. 1 megabit/second downstream and 200 kilobits upstream) are also available for $10 or $20 per month additional.

If a home or business already has satellite television service, a second small dish antenna is needed for broadband service. Some companies have tried combining both services on a single dish, but this has usually had poor results because of signal and satellite position issues. Inclement weather (e.g. heavy rain, snow) can degrade or temporarily cut off satellite signals.

There are two primary providers of satellite broadband in the United States: Hughes Network Services and Wild Blue. Wild Blue has partnered with many rural electric coops, with the coops acting as sales agents and installers. Hughes uses independent small businesses as installers and resellers. Despite some limitations, satellite is an excellent broadband service option in underserved areas; no major infrastructure investments are required to obtain service, and speeds are much better than dial up, and in some cases may be equal to or better than entry level DSL service

packages. Satellite is not a business class service option in the valley, and satellite still remains relatively expensive compared to wired or terrestrial wireless service.

BPL

Broadband over Power Lines (BPL) has been available for several years and can be used in several different ways. Some BPL equipment is designed for in home use, where a broadband signal delivered by DSL or cable is delivered to different rooms in a home or business using the electric wiring. To provide service to a neighborhood, some electric companies use a system similar to cable systems, where fiber is used to get broadband near a cluster of homes, and then the signal is carried over electric lines for the last few hundred yards or last mile or two. In some other systems, the signal is carried via electric cables all the way from a broadband head end.

BPL has many of the same limitations as DSL and cable modem services. It is copper-based, and is limited in the amount of bandwidth that the technology can deliver. It requires technicians who have extensive training and experience working with high voltage systems, since special bridges are installed at every neighborhood transformer (which also makes it a relatively expensive service). Some electric coops are considering BPL as a way to quickly provide some form of broadband to their rural customers. BPL's main advantage is that no new cable must be laid to deliver the service to a home or business. However, like DSL and cable systems, BPL is not a long term solution.

In a recent conversation with a rural electric coop that has been "experimenting" with BPL for more than two years, the coop representative shared that they were only able to achieve about 250 kilobits of throughput over distances of twelve miles. While 250 kilobits is better than dial up, it will not meet the long term needs of rural residents and businesses.

Fiber

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 two fiber optic strands (single fiber technology is available but the hardware is quite expensive and still relatively unused). Metro Ethernet networks can deliver service as far as 25 miles from network element locations in speeds up to 10 Gigabits per second (10GB Metro Ethernet circuits may be available from some providers).

SONET or Synchronous Optical Network is a point-to-point technology usually deployed in a bi-directional redundant ring. Most carrier and tier 1 service provider backbones are configured in a redundant ring. A SONET ring is self healing (provided that only one link is cut). SONET circuits are considered expensive and are usually a last resort if other fiber optic services are not available.

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 some 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 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."

Every business in the Roanoke region will eventually want fiber connections. Without ubiquitous fiber infrastructure, communities will not be economically competitive. Communities that already worry about losing too many young people to other areas have much more to worry about. In a recent college class, a professor asked 30 students how many would live in a community without broadband, and not a single student raised a hand. 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.

The Wireless Broadband Debate

We do not subscribe to the wireless vs. fiber debate. We believe both wireless and fiber systems are required in communities. Virtually everyone,within a few years, will have a very capable wireless device that supports phone service, email, Web browsing, gaming, TV, music and a host of other services. Residents and businesspeople will expect these devices to work everywhere; this means communities will need a well-designed wireless network of towers, antennas, and related systems, including fiber backhaul (fiber backhaul--some connection is needed to get the wireless signals onto the Internet from local wireless access points; fiber can be used to dramatically improve wireless performance by providing a very fast connection from the wireless radios to the rest of the network). Wireless systems work best when supported by a fiber backbone to carry traffic to and from its destinations. Fiber and wireless systems are complementary, not competitive.

Wireless is often touted as a broadband panacea. Across the country, many communities are rushing to offer some kind of wireless system. These municipal wireless systems often lack sustainable business plans, and many well publicized projects are beginning to have problems. St. Cloud, Florida offers free wireless broadband throughout the city, but the quality of the service tends to be inconsistent, and many residents have refused to give up paid cable and DSL service. Philadelphia's well known project found that more access points are needed than originally anticipated, and the private firm that promised to operate and maintain the

network pulled out, forcing the City government to take over an expensive system that was not able to deliver the connectivity that residents expected.

Current wireless systems lack the capacity to handle high bandwidth services like video when more than a few people are using the same access point. Systems like WiMax are very expensive, and while prices will decline, when costed over a reasonable life cycle, wireless systems are relatively expensive. Wireless systems are inherently less secure than cable based systems, and we never recommend that a business uses a wireless connection for its primary access unless no other alternative exists. The primary future use of wireless will be for mobile access to services, rather than fixed point access. In under-served areas, properly designed wireless systems are an excellent first step, but are not a complete solution over the long term. Over time, wireless to the home will have to be replaced with fiber connections to meet demand, but wireless will remain important for mobile access to broadband (e.g. access to the Internet and email from mobile phones and laptops).

Wireless Technology Trends and Issues

Over the past several years, numerous communities large and small have attempted to build and operate municipal wireless Internet services. Large cities like San Francisco and Philadelphia announced ambitious plans to build WiFi “blankets” to provide wireless Internet access to most homes and businesses. Smaller cities like St. Cloud, Florida and Sandoval County, New Mexico have also built municipal WiFi systems. There is now a wealth of lessons learned from these early efforts:

WiFi is expensive if you truly want total coverage. Many WiFi projects have underestimated the number of access points that are needed--something that is causing problems with the much touted Philadelphia WiFi effort. Some contractors and vendors may be underestimating the number of access points to keep costs lower, so it is important to be realistic during planning stages about what a community can afford to do in terms of deployment of access points.

WiFi is not a first choice for business class services. Few businesses of any size are willing to run their business on a WiFi connection unless the only other option is dial-up. It may be adequate for small one or two person businesses, but most businesses want a more secure and more reliable wired connection.

Wireless vendors have to be selected carefully. Sandoval County, New Mexico experienced severe problems with two different wireless firms hired to build a wireless Internet system--both firms were unable to provide a working system and within budget.

WiFi has reliability problems. Even if you are in range of an access point, foliage on trees, building walls, rain, snow, and other access points can degrade the signal. Because WiFi is an unlicensed service, anyone can run an access point. The popular and very common home wireless routers can cause interference and slow down other access points.

WiFi, even the newer G and N services, can't handle video very well, and this limits the potential of such a service to be financially viable. A community broadband system has to have a solid business model that is financially sustainable, and that means being able to carry business and residential video services.

WiMax is a newer set of frequencies and power standards that are widely advertised as a silver bullet for broadband, but there is nothing magic about WiMax. It uses many of the same frequencies that WiFi does, meaning that it still requires clear line of sight to get an adequate signal. WiMax radios can use both licensed and unlicensed frequencies, and the unlicensed frequencies will suffer from the very same interference problems from which WiFi suffers. WiMax has not been widely deployed and is likely to be superseded in some areas by LTE (Long Term Evolution), a cellular wireless technology that offers equivalent bandwidth and has the advantage of supporting traditional cellular voice services.

Licensed WiMax frequencies perform better because there is less interference, but this presumes the licensed frequencies are available (some other private or public entity may have licensed the frequencies for a particular geographic area). The licenses, if available, may cost several thousand dollars to purchase and then there is an annual renewal fee.

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 will be possible, and will compare very favorably with copper-based systems like DSL. But even these systems will have a very limited ability to handle TV programming, interactive videoconferencing, and other business class services.

Wireless services will remain important and essential in the Roanoke Valley. 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.

The limitations of wireless networks are easily demonstrated by trying to use a smartphone in Blacksburg on a football weekend or during any other time of the year when there are a significant number of visitors in town. Data service during those times becomes completely unusable, and voice calls are not completed or are dropped after a minute or two. In areas where fixed point wireless is used (e.g "air cards") as the primary means of residential access, it is common for customers to move back to a landline (typically a DSL connection) after just a few months. As more customers begin using wireless for streaming video (business videoconferencing during the day, or Netflix/Hulu style video on demand services in the evening), the available bandwidth diminishes rapidly to the point that a "slower" DSL connection provides more predictable service.

Communities need to regard telecom as essential public infrastructure, critical to community and economic development. And that well-designed community infrastructure includes both wireless access and eventually fiber to every home and business. With the right business and financial planning, such systems can pay for themselves and provide new revenue streams to local government, while lowering the cost of telecom services.

Fixed Point Access Wireless

Community investments should be limited to tower sites and towers, which can be leased to the private sector. Cellular data service (e.g. 3G, 4G, and the newer LTE-based services) are a substantial improvement over dial up; prices for mobile data plans are not cheap (the typical monthly fee for a data plan is is $25 to $40), on top of $25 to $40 for a voice plan.

This kind of service can introduce 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. If local governments in the Roanoke Valley make investments in new towers, it should be in close coordination with public safety and rescue services to ensure that public safety voice communications benefit as well.

A well-designed regional fiber network will help increase the availability and affordability of wireless broadband services, especially if existing wireless providers are included early in the planning process. 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.

Mobile Access 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 Roanoke Valley, mobile wireless access to voice and data services is already widely available from multiple providers. Verizon Wireless has already begun an aggressive expansion and upgrade to LTE (the so-called 4G network). Sprint and AT&T also offer similar network capacity.

Any community wireless investments should be made with care as there is some risk of spending too much too quickly; wireless systems, frequencies, and capacities change quickly, and there is always some danger of making a commitment to a protocol (e.g. WiFi, WiMax) that is superseded by another set of incompatible protocols and equipment. If investments are made, risk can be reduced by investing primarily in tower sites (real estate), towers, equipment shelters, and other passive network facilities that require little maintenance and that have long life spans. Space on towers can be leased to private sector service providers, which will provide a revenue stream to support ongoing maintenance costs.

Best Practice Analysis

Danville, Virginia

The City of Danville, Virginia is operating an open access, open services network (www.ndanville.net) focused on creating the right kind of economic development incentives and accompanying infrastructure that will help retain existing businesses and help attract new ones. Danville has a City-owned electric utility, and the growing fiber network is being managed as part of the electric utility operations.

Using a multi-phase approach, the City first hooked up government offices and local schools in 2004, and in 2006 began planning for extending the high performance all fiber network to local businesses and residents throughout the electric service area, which includes a large part of very rural Pittsylvania county. The first businesses began to get hooked up in late 2007, and Danville had fiber passing parcel in its business parks before the end of 2008. The City-County business incubator was one of the first locations to receive the fiber services. The City has completed the planning for taking fiber to some of its residential neighborhoods (a total of about 1600 premises), and construction for this Fiber To The Home initiative is expected to start in the fall of 2010.

The City is not selling any services to businesses or residents; all services are offered by private sector service providers that use the network and pay the City for the use of the network via a revenue sharing agreement.

Danville recently sold (2009) an abandoned textile mill to a firm that is renovating it to create office space and business incubator space. The availability of an open community-owned peering point (the Danville MSAP) and nDanville fiber at the location was essential to the deal. The data center will be a significant boost to the downtown area of Danville, as the building is within walking distance of the Main Street commercial area of town. Local businesses expect to benefit from the increased foot traffic.

In 2011, the City announced that it had successfully attracted the first commercial supercomputer facility in the United States. The supercomputer will be located in renovated office space in the historic Tobacco Warehouse District in downtown Danville; the presence of nDanville fiber at the building was essential, as the system requires large amounts of bandwidth to move data back and forth to its customers.

Attribute	Description
Governance	nDanville is part of the City of Danville Utilities Department.
Funding	The City of Danville Utilities Department has used a combination of loans and revenue to fund the construction of the network. Revenue from key institutions like the City and County schools have been a significant factor in the development of the network.
Business Model	nDanville is an open access, open services network. All services provided to residents and businesses are offered by private sector providers.
Management	Network operations are managed by the City. Some outside plant maintenance is performed by City utility crews, and some work is outsourced to qualified private sector firms (e.g. splicing, some construction work).
Technology	nDanville is an active Ethernet fiber network, providing a 100 megabit symmetric connection as the standard service. Gigabit and 10Gigabit point to point connections are also available. nDanville has two colocation facilities available to businesses and providers, and the nDanville MSAP (Multimedia Services Access Point) provides access to more than twenty-five local, regional, and national service providers.

Lafayette, Louisiana

Lafayette, Louisiana is perhaps one of the best known community broadband projects in the United States. The City announced its intentions to go into the broadband

business in 2004, and was promptly sued by the incumbent cable provider. The court case ground on slowly, and it was not until the City had spent nearly $4 million on legal fees that the Louisiana Supreme Court decided that the City had the right to compete directly with private sector telecom companies.

Since then, thousands of customers have been connected and Lafayette is now famous for having some of the lowest rates for Internet access in the United States, with a 50 megabit symmetric package of Internet access for only $58/month. The network has now been operational since early 2009.

Cox Communications, famous in Louisiana for regular rate increases, froze its rates in Lafayette for several years following the city's initial announcement that it would offer telecommunications services. Meanwhile Cox continued to raise its rates in other parts of the state. The result was that even before Lafayette's system began operating it had saved its residents and businesses nearly $4 million.

Attribute	Description
Governance	The network is owned and operated by the City of Lafayette and is part of the Lafayette Utilities Department.
Funding	The City raised $110 million in funding to build the network. The long term plan is to pass all 57,000 homes in the city.
Business Model	Services are sold directly by the City in a traditional triple play retail model.
Management	The City Utilities Department operates the network and handles outside plant maintenance.
Technology	LUSFiber is an active Ethernet system with a standard 100 megabit symmetric fiber connection. Gigabit connections are also available.

Eastern Shore of Virginia Broadband Authority

Accomack and Northampton counties, on the Eastern Shore of Virginia, have formed a broadband authority and have completed construction of a 80 mile high

performance fiber backbone that reaches from the northern border of Maryland and extends across the 17 mile Chesapeake Bay-Bridge Tunnel to meet other regional fiber networks in the Norfolk area.

The authority was formed in the spring of 2008, and construction on the fiber backbone was completed in 2010. The region made the commitment to form the authority to provide fiber services to private sector firms that were demanding better connectivity to both the NASA Spaceport and Navy facilities in Chincoteague, Virginia and to provide higher performance and less expensive fiber routes off the Shore. The Authority is currently developing plans for the deployment of wireless and fiber services throughout the region. The connection across the Chesapeake Bay gives users on the network access to a large number of commercial providers. On the northern end of the network, the ESVBA connects with fiber in Maryland, enabling a completely redundant fiber loop around the entire Chesapeake Bay. Businesses will be able to locate in the ESVBA service area and have carrier class network redundancy for essential business services.

Attribute	Description
Governance	The Eastern Shore of Virginia Broadband Authority (ESVBA) is a regional authority owned by the counties of Accomack and Northampton. The Authority has an independent, five person board of directors.
Funding	The Navy and NASA both have large installations on the Eastern Shore, and both agencies provided some seed funds for construction of the backbone. The Commonwealth of Virginia also provided additional start-up funds.
Business Model	The network is being operated as an open access network with an initial focus on business and institutional customers. Private sector service providers will offer all services to residents and businesses. Long term plans include expanding fiber services into the many small towns in the two counties, and several towns have begun planning for the effort.
Management	The Authority has one full time project manager and two part time staff providing administrative and some technical support. Outside plant maintenance has been outsourced to qualified private sector firms.

Attribute	Description
Technology	The ESVBA network uses active Ethernet and provides symmetric 100 megabit, Gigabit, 10Gigabit, and DWDM connections. The Authority is also actively working with some wireless broadband providers to get fiber to some tower locations to improve access to broadband wireless services in the region.

The Wired Road

The Wired Road is an open access, open service network jointly owned and managed by Carroll and Grayson counties and the City of Galax (Virginia). The three localities formed a regional broadband authority and began construction in September of 2007. The first institutional customers were added to the network (Carroll County Public Schools, Carroll County, Crossroads Institute) in March of 2008. The Wired Road is not selling any services to businesses or residents; all services are offered by private sector service providers that use the network and pay the Authority for the use of the network via a revenue sharing agreement. The three governments see the network investments as a way of differentiating the region and providing a valuable economic development marketing tool. The Wired Road is being designed as an integrated fiber and wireless network, with fiber in the three major towns and all business parks, and wireless services as the initial offering in under-served rural areas where many residents are still on dial up. The long term vision is to provide fiber to every home and business that requests it.

The Wired Road has installed fiber to 60 buildings in downtown Galax, the regional commercial and business community. Fiber availability and the open access business model have created a dramatic reduction in the cost of Internet and phone services for businesses using the Wired Road network--with the savings reaching 70% for some businesses. The Galax fiber was installed using City public works department staff and took only two weeks, including two days of training. City crews now routinely are able to extend fiber to additional buildings as needed, and 25 new jobs were brought to downtown just months after the fiber was installed. The new jobs

were placed in a formerly empty building, and the jobs were moved there because of the fiber availability.

The project has attracted additional funding, and more than $3 million of additional middle mile and last mile fiber construction will be completed in 2011 and 2012. This work will include fiber to all lots in all three regional business parks, new fiber in Hillsville and Independence downtowns, and additional fiber in Galax.

Attribute	Description
Governance	The Wired Road Broadband Authority is a regional authority set up under Virginia law. It is owned by the counties of Grayson and Carroll and the City of Galax. It has a five member independent board of directors.
Funding	The first phase of The Wired Road (completed in 2008) was funded with a mix of local government funds, a grant from the Virginia Dept. of Housing and Community Development, and a substantial contribution from the Carroll County Public Schools. The Wired Road has since raised almost $3 million in state and Federal grants to fund additional fiber to businesses and fiber to the home in Grant, Virginia.
Business Model	The Wired Road uses an open access, open services model, with all services to homes and businesses provided by private sector providers. Two wholesale providers and three retail providers are currently competing for services.
Management	The Wired Road has one full time project manager, and the Authority has a contract with a private sector firm that provides network operations and outside plant maintenance and repairs.
Technology	The Wired Road is the first fully integrated fiber and wireless open access, open services network in the U.S. Fiber is deployed in the downtown commercial areas of Galax, Hillsville, Independence, and Grant, and The Wired Road has twenty-six wireless access points that covers about a third of the 1,000 square miles of mountainous terrain that comprises the service area. The standard fiber connection is a symmetric 100 megabit pipe, and wireless services vary, including 1, 3, and 5 megabit symmetric services.

Palm Coast, Florida

In 2008, the City of Palm Coast began exploring the potential of making existing City-owned fiber assets available for business and commercial use. Existing Palm Coast

businesses were expressing concern to City leaders about the high cost of Internet access and the limited bandwidth available in the City. After a six month study of various business and financial options, the City decided to focus on developing the network as a "carrier class" commercial network capable of supporting virtually any level of business service that might be needed.

In 2010, three of four redundant fiber loops had been completed, with the final loop completed in 2011. The City invested in a dedicated colocation facility with both shared rack space and private cages for service providers, and purchased "carrier class" network switches and routers to light up the fiber. Palm Coast FiberNET was made available for service in May, 2010 (http://www.ci.palm-coast.fl.us/PalmCoastFiberNET/), and had three service providers committed on day one.

Palm Coast FiberNET provides service to City buildings and locations, and successfully won a bid to provide services to Flagler County Public Schools. The local hospital has also agreed to use the network to connect hospital medical records and data services with several local health clinics and medical offices. FiberNET was able to operate in the black in year one.

Attribute	Description
Governance	Palm Coast FiberNET is owned by the City of Palm Coast.
Funding	City enterprise funds were used to pay for the initial $2.5 million in fiber construction, equipment, and the colocation facility.
Business Model	FiberNET is operated as an open access network. Providers pay a monthly fee per customer, based on connection size.
Management	The City IT Department manages network operations, and private sector contractors are used for outside plant maintenance and construction work.
Technology	FiberNet is an active Ethernet network that provides symmetric 100 Meg, Gigabit, and 10Gig connections as standard.

The Utopia Project

Planning for the Utopia project was begun in 2004, and the effort includes fourteen cities and towns in Utah and a total population of 300,000 people. Although the

project had some early funding problems, the towns involved were so pleased with early results of the all fiber service that they voted overwhelming in 2008 to provide additional bond funds to complete the build out of the network. Utopia has reported a lower than expected cost of maintenance on the system, which is attributed to high reliability of fiber.

Utopia is operated as an open services network, meaning that private sector service providers offer telephone, TV, Internet, and other services. Utopia has a very low churn rate of less than 1%, meaning very few customers leave once they have been hooked up. As of late 2011, seventeen different companies offer services on the network, and Utopia is delivering 100 megabit connections to homes and businesses in the 14 Utopia communities. In rural areas, Utopia is achieving a customer take rate of more than 50%, and since switching to a service-oriented architecture, the number of service providers on the network has increased from three to seventeen. Bonds have been used to provide most of the financing for construction, and the project says it can break even with a 30% take rate. The member cities approved $60 million in new bond funding in 2011 that is expected to expand the network from 9,000 customers to about 25,000 customers.

Attribute	Description
Governance	Utopia is owned by a consortium of fourteen Utah communities. The Utopia board has representation from all participating communities.
Funding	The communities that formed Utopia have used revenue bonds to provide over $60 million in funding. Early problems with the private sector network operator led to higher than anticipated operating costs. In 2008, network operations and management were taken over by Utopia staff, which has led to the development of a favorable long term financial plan.
Business Model	Utopia is an open access network with seventeen providers. Utopia started with a revenue share model (providers paid a share of revenue), but the network is currently beginning a long term plan to switch to one time connection fees and monthly flat rate usage fees that are paid by the customers receiving service. Under this new plan, service providers would pay NO fees to Utopia for use of the network.
Management	Utopia has in-house planning and network operations staff. Outside plant maintenance and construction is handled by private sector providers.

Attribute	Description
Technology	Utopia is an active Ethernet fiber network. The standard fiber connection is a symmetric 100 megabit connection, and Gigabit and 10Gigabit service is available.

Chattanooga, Tennessee

EPB is the electric power utility agency of the City of Chattanooga. Originally established decades ago to provide electricity to the city, in 2008 the agency was given the green light to begin running fiber to support the utility's smart meter initiative. In 2009, the initiative was expanded to include providing broadband services over the same fiber that was going to support the Smart Grid. That year, the U.S. Department of Energy awarded the City a $111 million grant, which was used to speed up deployment of fiber.

In 2010, EPB rolled out Gigabit to the home broadband service, based on a traditional triple play model. Voice, TV, and Internet are purchased directly from EPB. Nearly 400 channels of traditional TV is offered, including over 100 HD channels. The network is based on a PON architecture.

The City has been extraordinarily successful in promoting itself as a "Gigabit City," with a variety of marketing strategies and economic development initiatives; a special Web site was created (www.chattanoogagig.com) for the express purpose of promoting the availability of fiber in the City. In early 2012, $300,000 in prizes and seed capital were announced as part of a "Geek Hunt." The Geek Hunt is aimed at attracting entrepreneurs and business people to Chattanooga. Chattanooga has been able to sign some very high profile business deals, including a new Volkswagen manufacturing plant and an Amazon distribution center. Chattanooga is ranked 8th out of America's 100 largest metro areas for the best "Bang For Your Buck" city, according to Forbes magazine. The study measured overall affordability, housing rates, and more.

The network also supports critical city safety functions such as police and fire communications infrastructure, equipment and applications, including wastewater management, storm water management, traffic control and medical diagnostics

applications, and a smart lighting and camera system that allows the police to control public lighting and see what is happening in heavy crime areas.

Attribute	Description
Governance	The network is owned by the City of Chattanooga's electric utility.
Funding	Internal funding from the utility department and a grant from the U.S. Department of Energy have paid for the network. Energy cost savings from the Smart Grid portion of the project have been used to justify some of the expense.
Business Model	EPB customers can buy a variety of triple play packages directly from the utility, and business customers can select from a range of Internet and phone service offerings. The network also supports automated meter reading and energy conservation/Smart Grid control. EPB serves approximately 170,000 households and businesses.
Management	EPB has in-house planning and network operations staff. Outside plant maintenance is handled by the utility department work crews.
Technology	The network is based on a PON (passive optical network) design. The standard fiber connection is a Gigabit connection shared among a number of households.

Business Model Analysis

Traditional Triple Play

The “leave it to the private sector” model has obvious shortcomings, which is why so many communities are now beginning to consider telecom as essential public infrastructure. Private sector firms have a primary responsibility to preserve and enhance shareholder value. They do not make operational and service area deployment decisions based on community and economic development needs. For many communities, this has meant that broadband services have lagged well behind the rest of the world (e.g. Salem) and places those communities at a competitive disadvantage when trying to attract or retain businesses.

The private sector model requires overbuilding, which means that each service provider must build its own network end to end to serve customers. This leads to completely duplicated networks, which increases costs and makes it more difficult for these firms to make a business case for enhanced services in many areas. This business model is a fundamental weakness, because these private networks are not only expensive, but typically underutilized. Residential networks are only used heavily in late afternoon and evenings, and are virtually unused overnight and during the work day. Business networks that are only used heavily during work hours typically have very low utilization for the other two-thirds of the day. School and education networks are used only 8 to 12 hours per day, and are empty the rest of the time.

Community broadband projects overcome this fundamental weakness and substantially reduce the operating cost of networks by using a shared model, rather than a private model.

Municipal Retail

Also known as Muni (Municipal) Triple Play. Local government builds the network and sells services in direct competition with the private sector, offering only traditional “triple play” voice, video, and broadband. Muni triple play systems are usually closed

systems that offer little choice to customers. Muni triple play systems compete directly with the private sector, and tend to have very low take rates. Opponents of community broadband often cite the low take rates of muni triple play projects to "prove" that community broadband is a poor investment. But the low take rates only show that muni triple play business models are not financially viable over the long term.

The two key issues with this model are:

- It requires local government officials and leaders to sign long term contracts (typically 5 to nine years) with the providers whose services will be resold over the network. This means that those local leaders must have a high degree of confidence that they can accurately predict, seven to nine years out, what level and quality of services the businesses and residents of the community will require. While contracts can be renegotiated as needs change, prices are likely to rise during that renegotiation.
- This model does place the local government in direct competition with incumbent providers. This not only tends to keep take rates low, which threatens financial viability, but adoption of this model also encourages lawsuits from the incumbents (Bristol, Virginia, Lafayette, Louisiana, Geneva, Illinois, and Monticello, Minnesota are examples of communities that were sued after selecting the muni retail model).

Open Access Infrastructure Only

Customer aggregation is a key advantage to a shared, community-owned telecommunications infrastructure. By building fiber to homes and businesses, the community maximizes the market potential for private providers who want to sell services. For the Roanoke region, the early focus should be on areas where business and jobs growth is most likely to occur--downtowns and the business parks. Residential fiber build outs can occur over time as the network expands. The community investment allows these businesses to reach more customers than any single company could reach on its own. Some of the outcomes are:

- More customers -- When a community builds the transport layer of a digital road system (the roadway), each provider has a much lower cost of infrastructure needed to enter a market. In smaller towns and regions, this is a critical difference. Community investments allow more companies to profitably offer services in smaller markets than a firm could do on its own.
- Lower costs -- When a firm can reach more customers via a community broadband system, lower costs of service usually results. Typical reductions in cost in open access systems are usually on the order of 15%, and are frequently much more than that. It is not unusual to see the cost of telephone service decline by 40% or more.

Services aggregation occurs when communities build open networks, meaning that any qualified service provider can offer services using the community digital roadway. In this business model, there are usually several service providers competing for customers in each category of services (e.g. voice telephone service, TV, Internet access).

- More choice-- A natural outcome of more services is more choice for purchasers of services. Instead of a single monopoly provider of telephone or television, customers can pick and choose among a variety of service plans at various price points.
- More competition -- When more services are available, there is more competition for customers, which requires that service providers sell services for the lowest possible price, and also creates incentives to provide excellent service to customers. Compare this to a monopoly environment where there is no competition and hence little pressure for a company to provide good service--customers have no other service options.
- More services -- When there is a wider choice of services on the community system, there is more opportunity to use more services. This is, in part, what makes open service provider networks financially sound investments for communities: Open systems create a bigger market for telecom services, and thereby creates more revenue flowing through a community revenue sharing plan.

Organization and Governance Analysis

Government Ownership

Many communities in the United States have municipal departments that offer services to the general public. The most common services are water and sewer, and are administered operationally either as a department of the government or as an authority. Typical water and sewer authorities are quasi-public entities that operate independently of direct local government oversight but operate as a nonprofit.

Also common are municipal electric service operations; Salem and Danville are examples of Virginia cities that own and manage their own electrical distribution system. Several hundred communities in the U.S. have municipal electric power, and some have moved into the telecommunications arena, largely because it is convenient to do so--the organization already has utility pole access, experienced staff, and equipment like bucket trucks. However, the direct municipal approach is not likely to work for the effort because the local governments have already indicated that they are not interested in owning and administering the system directly.

Government operated networks using the muni retail model attract legislation forbidding localities from offering telecommunications services. Several states, including Pennsylvania, Nebraska, South Carolina, and Virginia, have enacted legislation making municipal telecom services illegal within the state shortly after a municipality or public service company started a data service. The Virginia bill was overturned by the Federal Circuit court in a remarkably brief decision that seems crystal clear:

I find that the broad and unambiguous language of § 253(a) [the Federal Telecom Deregulation Act] makes it clear that Congress did intend for cities to be "entities" within the meaning of the Telecommunications Act. Therefore, § 15.2-1500(B) [the Virginia legislation in question] is in direct conflict with federal law, and is void under

the Supremacy Clause. Section 253(a) is a concise mandate that no state "may prohibit or have the effect of prohibiting the ability of any entity to provide any interstate or intrastate telecommunications service." 47 U.S.C.A. § 253(a) .....Simply put, it strains logic to interpret the term "any entity" in § 253(a) to mean "any entity except for municipalities and other political subdivisions of states." While it is true that such an interpretation is possible, the Supreme Court has cautioned that "[a] statute can be unambiguous without addressing every interpretive theory offered by a party." .....The federal statute, therefore, not only mandates that no state statute "may prohibit" telecommunications competition, but also that no state statute "may have the effect of prohibiting" telecommunications competition. 47 U.S.C.A. § 253(a).

While most communities that have been challenged by lawsuits have eventually won in court, the legal battles usually add years and significant expense to such efforts. Lafayette, Louisiana, as one example, spent substantial sums of money and nearly two years in court to defend the right to build a community-owned network. The city eventually prevailed and now has an outstanding network offering some of the lowest telecom service prices in the U.S., but the effort was delayed for years by the lawsuit from the incumbents. It is worth noting that Danville's City-owned fiber network, nDanville, has been in operation for more than four years without an incumbent challenge or lawsuit.

Regional Authority

Regional authorities are widely used for regional projects that require long term oversight and involve participation from more than one local government entity. These regional agreements are widely used by local governments for the ownership and control of essential infrastructure that is better managed regionally. Typical regional projects include solid waste authorities and water and sewer authorities.

The concept of several local governments collaborating on a shared facility or utility has different names and different legal restrictions and privileges, depending on the state in which they are located. The term used for these agreements varies widely, and these terms include Joint Municipal Agreements, joint powers agreements. intergovernmental agreements, or inter-municipal agreements. Some community projects in Virginia use this approach because the Commonwealth of Virginia has

created enabling legislation specifically for broadband authorities. A Virginia broadband authority automatically receives revenue bonding privileges by law, which is a significant advantage.

Despite the differences in terminology, 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:

- Professional managers recruited and hired because they have the appropriate skills and experience to manage a dedicated enterprise.
- Elected officials do not have direct, day to day involvement in management issues.
- The regional entity usually has either general obligation and/or 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, and via the board of directors, the local governments can guide the long term goals and objectives of the organization.

Private Coop

Cooperative business enterprises as formal entities date from the mid-1800s. The first cooperative was set up in England to serve customers unhappy with local merchants. In the United States, the Grange movement began setting up cooperatives in rural areas to sell needed items to members and to help sell produce and other agricultural products that were produced by members. Today, credit unions are the most common form of coop business in the United States, with more than 65 million people obtaining services from over 12,000 credit unions.

Telephone and electric coops continue to be very common in rural parts of the U.S., and in fact, the majority of telephone companies in the United States are coops, but

most have very small numbers of customers--often less than a thousand subscribers. Telephone coops serve more than a million subscribes in thirty-one states. The True Value and Ace Hardware chains are actually buying coops that help keep independent hardware stores competitive with the large chain stores.

The U.S. Department of Agriculture (USDA) provides extensive support for existing coops, and also helps communities start coops. One of their publications lists the principles of the coop:

- User-Benefits Principle -- Some purposes of a coop are to help members get services that might otherwise not be available, to get access to markets, or for other "mutually beneficial" reasons.
- User-Owner Principle -- The users of the cooperative own it.
- User-Control Principle -- The owners of the coop (i.e. members) control the coop through voting (annual meetings, etc), and indirectly by electing a board of directors to manage the enterprise. Large users who make high volume purchases of goods or services may receive additional votes.

Because cooperatives are user-managed, control of the enterprise is vested in the community or region where the users reside. Cooperatives also return excess earnings to its members; these refunds are called patronage refunds, and are typically computed at the end of the fiscal year. The expenses and income of the coop are calculated for the year, and any excess is returned to members, based on the percentage paid in by each member (e.g. a member that paid in 1% of total earnings would get a refund of 1% of any excess earnings).

Most cooperatives do not pay dividends on capital. This helps keep outsiders from taking control of the company, which would result in the community losing control over the quality of services and direction of the enterprise.

Coops are organized in part based on the territory they serve, and there are several classifications that may be relevant for community broadband efforts. A local coop serves a relatively small area that may be a single town or county and/or a radius of ten to thirty miles. A super local coop serves two or more counties. A regional coop may have a service area of several counties up to an entire state (or multiple states). For projects that involve several local government entities that are already trading

services like local public safety dispatch, a super local coop may be the most appropriate designation.

Most local and super local coops use the centralized governance structure, which means that individuals and businesses represent the bulk of members.

Cooperatives offer one or more of three kinds of services:

- Marketing coops help sell products or services produced by members.
- Purchasing coops buy products and services on behalf of members.
- Service cooperatives provide services to members, and service coops include the credit unions, the electric coops, and the telephone coops.

Equity is typically raised for coops by direct investment from members. In return for an investment, members receive a membership certificate. The member may also receive shares of stock if the cooperative issues stock (some do, and some do not). Once a member has invested, they gain the right to vote in elections. As an example, if the local governments made a large initial investment in the cooperative, they could gain substantial influence in the affairs of the organization by gaining multiple shares and increased voting rights. Property owners (residential property owners and business property owners) who paid an initial connection or pass-by fee would also gain shares in the business, so every property owner that pays the connection fee gains ownership in the enterprise--an important selling point when encouraging property owners to, quite literally, invest in the project.

Although cooperatives are typically constrained by both Federal and state laws to do a majority of business with members, in most cases, cooperatives are able to do business with nonmembers up to some percentage of business income that can be as high as 49 percent. Note that this may be affected by the underlying legal incorporation of the cooperative--if incorporated as a 501(c)(12), the IRS requires that 85% of income must come from members for the purpose of meeting ordinary expenses.

In summary:

- Coops are member (subscriber) owned, meaning they are strongly vested in the community. Any effort by the coop board to dispose of assets or to sell the coop would have to be approved by a majority vote of the members.
- Members play an active long term role in governance by nominating and electing board members. So members have a straightforward way of influencing decision-making by the board.
- Coops generally operate on a cost-plus basis. Income that exceeds some preset level is returned to members periodically as a distribution of funds.
- Broadband coop bylaws must be carefully written, especially if there is an interest in several classes of membership. Each class of membership can be charged a different membership fee, and this can be a valuable source of start up funds, but membership categories are difficult to change later.
- Coops are largely immune to challenges by incumbent telecom providers due to the long history of existing coops and because of special legislation passed by Congress.
- Coops can tap USDA funds, but the application process would be time-consuming and expensive for a start up coop.

Non-profit

There are various kinds of nonprofit businesses. The most common is the 501(c)(3), which is limited to strictly charitable efforts. A 501(c)(3), according to IRS rules, must have a well-defined charitable purpose targeted toward a specific need and/or a specific target population. In other words, a 501(c)(3) cannot, according to IRS rules, operate as a nonprofit business that provides services to the general public.

Many of the first community networking projects in the early and mid-nineties were formed as 501(c)(3) organizations; it was common for these entities to offer dial-up Internet access to the general public at a time when Internet service providers were still relatively uncommon. But by 2000, most of these organizations had closed their doors and/or discontinued their Internet access services because of IRS challenges.

Today (2010), we see new 501(c)(3) organizations repeating this approach by offering broadband services either directly or indirectly (using an open access business model). It is our view that eventually all these organizations will receive letters from the IRS challenging their status.

However, one or more nonprofit businesses may be useful as part of the overall effort. A 501c3 may be desirable as a mechanism to accept charitable donations, and more importantly, to apply for certain kinds of grants. Once the funds have been received by the 501c3, and the donors have received the tax credit, the nonprofit can, in turn, give or loan those funds to another organization (e.g. an authority or coop chartered specifically to provide services).

LLC/LLLC (L3C)

Limited Liability companies are private sector ventures that typically have two or more member/owners. A key advantage of Limited Liability ventures is that they are private sector entities that would not be subject to current legislative restrictions on direct municipal involvement in broadband infrastructure projects. Local governments can be partners in and have some equity in an limited liability venture but the entity itself would be entirely a private sector operation. Local governments and private sector companies can be partners, with different levels of equity and differing levels of responsibility. For example, an LLC could have a mix of partners, including local government, service providers, major institutions like a hospital or university, and some major business users of broadband.

An L3C, or LLLC, is a variant of the popular LLC (Limited Liability Company). The third 'L' stands for 'Low profit,' or Low-profit Limited Liability Company. LLCs are a private sector business option that combines some parts of a simple partnership with some of the legal advantages of a corporation. L3Cs can be formed in Vermont and Delaware, and Vermont was the first state to allow this form of business in 2008. Not all states recognize the validity of the L3C variant, and it might be necessary to simply use an LLC.

The L3C company must have a "socially beneficial" purpose, and the company's primary purpose must be something other than simply making a profit. However, the company is allowed to have profits; those profits are subject to taxation, just like any

other private sector company. One unique advantage of an L3C is that they can receive program related investments from private (charitable) foundations, unlike an LLC or normal private sector corporation. Each year, private foundations are required to contribute 5% of their capital for charitable purposes, and an L3C qualifies to receive these funds.

If an L3C is adopted as an appropriate ownership entity for a project in Virginia, the company would incorporate in Vermont or Delaware and would register as a foreign corporation in Virginia (note that some states will allow this type of foreign corporation, and others do not). Successful use of an LLC or L3C depends heavily on careful design of the company's operating agreement, which defines the roles, responsibilities of each partner and how any profits will be distributed. Both an LLC and the L3C are subject to taxes, but if the enterprise is operated on a cost-plus basis, tax liabilities may be nominal, but there is some additional financial accounting and reporting burden. Note that an LLC would not have any direct bonding authority, although an LLC partner might be able to issue bonds and pass the funds through the LLC.

Finally, an LLC operating agreement would have to be written with great care to ensure that there are proper procedures in place for the disposition of assets or if the LLC is sold or closed down. The operating agreement has to protect the broader community interest.

As one example, forty-three towns in rural New Hampshire formed New Hampshire FastRoads as an LLC; FastRoads is a wholly owned subsidiary of the Monadnock Economic Development Corporation (MEDC). MEDC is a non-profit, so that eliminates any tax liability, and the MEDC board already has appropriate regional/ community representation, which protects the interests of the forty-three towns that comprise the FastRoads region.

Public/Private Partnership

A public/private partnership could be structured in a variety of ways, but the characteristics of such an enterprise might include:

- A private sector company is formed to build, own, and operate the network.

- Local governments agree to provide expedited permitting, construction inspection, and a minimum of red tape during the construction phase of a network build out.
- Local governments may agree to provide assistance with financing through a variety of mechanisms,including pass through bonding assistance, up front cash payments in return for long term access to network assets (e.g. dark fiber), or long term contracts for network capacity (e.g. leased circuits) that would assist the private entity with borrowing.

The Google agreement with Kansas City, Kansas and Kansas City, Missouri is an example of a public/private partnership.

There are various types of for profit business organizations: individually owned businesses, partnerships, general business corporations, and limited liability companies. Local control vested in the participating communities is required to protect public investments in the project (private, for profit enterprises are not vested in the community). Any public/private partnership should be structured to provide some local input and oversight over the long term to protect community and local government investments.

Ad Hoc and Informal Partnerships

Some local governments have deployed duct and/or dark fiber and have made ad hoc arrangements to provide capacity to other institutions like K12 school systems or adjacent local governments. In some cases, they have a policy for leasing duct or fiber to the private sector (the city of Sacramento, California has leased duct for over a decade) but have not developed a comprehensive plan for management and expansion. Given the size of the Roanoke area and the need for a long term strategy for build out to hundreds of business and government locations, this approach is not viable.

EDC/IDA Ownership

As noted in the discussion about LLCs, the New Hampshire FastRoads venture is an LLC owned by the Monadnock Economic Development Corporation. In Virginia, an

IDA or an EDC could build, own, and operate a community-wide broadband network, but the organization would have to be committed to taking on the long term responsibility for ensuring that the appropriate oversight and staffing is in place to support the effort. Because Virginia has specifically created legislation for broadband authorities that largely mirror the organization structure of an economic development corporation, there is little reason to pursue this approach.

Funding Strategies Analysis

Revenue Bonds

Many community projects are already being financed with revenue bonds, including Monticello, Minnesota, Powell, Wyoming, and the Utopia project (14 towns and cities in Utah) have used revenue bonds to finance their broadband efforts. 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.

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. Some issues to consider are:

- Revenue bonds are paid back solely from system revenue.
- A very solid business plan is needed.
- Management, marketing, and operations of the network must be professional and with careful attention to meeting operational and financial targets.

A government-led Roanoke region venture will need some local fund-raising to support the credit rating/credit enhancement needed for the initial borrowing. This local fund-raising should be targeted to support some initial construction and operations to show that the region can plan, construct, and manage a state of the art network, and that the project can attract both customers and service providers.

Market conditions at the time the initial bonding is attempted can affect the cost of the bonds and the success in selling those bonds.

General Obligation Bonds

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.

Even though G.O. bonds are quite common for more traditional community infrastructure, local leaders and taxpayers have typically been resistant to using them to finance community telecom projects. G.O. bonds often require a voter referendum, which raises the bar even higher, but some community telecom projects, notably the City of Lafayette, Louisiana, prevailed in a voter referendum to build a city fiber network despite heavy advertising against the referendum by incumbent providers.

Revenue Bond Guarantees

Revenue bond guarantees are not a direct source of funds but can be extremely valuable as part of a revenue bond offering. A bond guarantee could come from local governments that are involved in the network development, a state financing authority that helps underwrite municipal bond offerings, or as a special authorization from the state legislature. Some community network project bond offerings have been guaranteed by tax revenues from the local communities (e.g. the Utopia project in Utah).

RUS Loans

The USDA Rural Utilities Service agency has been making low cost loans for telecommunications for decades. Those funds have traditionally been supplied primarily to rural telephone companies and coops, but the agency has recently begun looking at assisting community broadband projects. However, it seems unlikely that with the possible exception of some portions of Botetourt county, the region would be able to qualify for this source of funds. The RUS application process can be expensive

and time-consuming, and it may take six months to a year and some fundraising to develop a competitive application.

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.

State Funds

Many local broadband projects are receiving help from state sources of funding, particularly for early stage planning, but some funds are often available for pilot projects and specific expansion projects that meet certain kinds of public safety or economic development criteria. As a couple of examples, the Virginia Department of Housing and Community Development (DHCD) has been providing early phase planning funds to communities that commit to following a specific planning process supplied by DHCD. The South Carolina Department of Commerce has also been providing some support for similar local efforts in that state. The Virginia Resource Authority (VRA) may be able to provide bond guarantees, which would be extremely

valuable for the initial bond offering. This would not require the state to make a cash outlay at the time of the bond offering.

State agencies may also be able to assist with applying for Federal funds. Community Development Block Grants (CDBG) are now being provided for some kinds of local broadband efforts. CDBG grants have to meet eligibility requirements (e.g. Low and Moderate Income areas, distressed downtown areas, etc.). Some community broadband projects have also successfully received direct grants from the state legislature.

Federal Funds

Several different Federal agencies provide some support for community or regional broadband efforts. The Appalachian Regional Commission has been making some funds available for broadband education efforts and some modest pilot projects. Some other Federal agencies also provide funds for telecom, and the region may be able to qualify for some of them by collaborating with the right mix of partners. The FCC recently distributed $400 million for community and regional telehealth and telemedicine projects across the U.S.

Of particular interest for early funding is the USDA Community Connect grant program, which makes grants of up to $1 million for rural broadband infrastructure; however, the Community Connect grants are generally aimed at rural areas. It is possible that some portions of Botetourt county might be eligible.

Earmarks can be a valuable source of funding, albeit a highly unpredictable one. The Eastern Shore of Virginia Broadband Authority was able to obtain several million dollars in earmarks funds to help build its 80 mile fiber backbone, but it took more than two years to get the funds approved and allocated. Earmark funds can be approved but not allocated, which has sometimes caused problems–approval by Congress for the earmark does not automatically ensure that the Federal agency serving as the administrator of the funds receives a budget allocation. In some cases, earmark funds that have been allocated can be re-allocated by the receiving agency for a related purpose. Strong Congressional support is needed for earmarks.

Federal funds usually require long lead times to obtain (12 to 18 months is typical) and are best used for specific opportunities where the funding guidelines match well with a specific local need or opportunity. It seems unlikely that there will be another round of ARRA-style broadband stimulus funds, given the budget difficulties of the Federal government.

Municipal Leasing

Communities routinely use municipal leasing to fund a wide variety of needs, including water and sewer projects, buildings, equipment, and vehicles like police cars, fire trucks, and public works equipment. Municipal leases can take the form of a straight loan, but for telecom projects, one option called a "moral obligation" lease may be more appropriate. In a moral obligation lease, the network itself is used as collateral to guarantee the loan, rather than requiring the use of general funds to pay back the loan if the network does not perform as expected. Obtaining approval for a moral obligation loan requires an excellent municipal credit rating and an investment quality financial plan for the operation and management of the network. This approach would be more appropriate for building extensions of the network related directly to local government needs. It is not likely to be viable as a primary means of financing.

Private Sector Financing

If a public/private partnership approach is chosen, a substantial portion of the early development funds would likely come from private sources, which could include local investors and partners, larger institutional investors (e.g. pension funds), or groups of private equity investors. For early fundraising, long term notes offered to local investors is an option. In this approach, the network offers long term notes (e.g. fifteen or twenty year terms) with interest-only payments for several years; repayment starts after the interest-only period. This enables the network to raise funds relatively quickly and the interest-only period allows the network to develop adequate cash flow before having to make loan payments.

Commercial loans from local banks are an option that could provide funds for small, urgent short term opportunities (e.g. building a short fiber run to reach a business that needs improved connectivity to add jobs). If a business case can be developed that

shows how the improvements or extensions will increase revenue to repay the loan, this form of financing should be easy to obtain.

Business Contributions

Some businesses recognize the value of having community fiber at their premises because they may be able to obtain previously unaffordable services and/or lower the cost of existing services. If the savings are substantial, some businesses may be very willing to pay pass by and connection fees to obtain access to the community fiber, and we have spoken to businesses in other communities that have expressed willingness to make no strings attached contributions to the local effort. However, such contributions are usually linked to specific plans to pass the businesses with fiber within a reasonable time frame.

Grants and Donations

Grants and donations can provide funds for planning and for targeted construction projects (e.g. fiber to a local hospital, a community institution, etc.). Community foundations will often contribute funds to local technology projects. Sometimes the expenditures have to be tied to specific foundation goals (e.g. improved K12 education), but often local foundations will accept grant applications for a wide variety of local projects. Some community efforts have also received private donations, although these are usually modest, and have also usually been provided to support a specific need or project.

Sales Tax

The Arrowhead Electric Coop in rural Minnesota is paying for a full fiber build out to all homes and businesses by working with the local county government (Cook County) to collect a special 1% sales tax. The tax is actually used for a variety of infrastructure improvements, with the broadband build out using about 48% of the funds collected. The broadband portion of the sales tax is used to underwrite the cost of the CPE (Customer Premise Equipment), which is the device installed at the residence or business. This approach lowers the overall capital cost and reduces the financial risk

for the electric coop. The Utopia project in Utah has been financed in large part by using loan guarantees backed by existing local sales tax revenue. This approach does not require changes in how existing sales tax revenue is used unless the fiber project runs into financial difficulties; in that case, the localities collecting sales taxes would be obligated to use some of the sales tax collected to make loan payments.

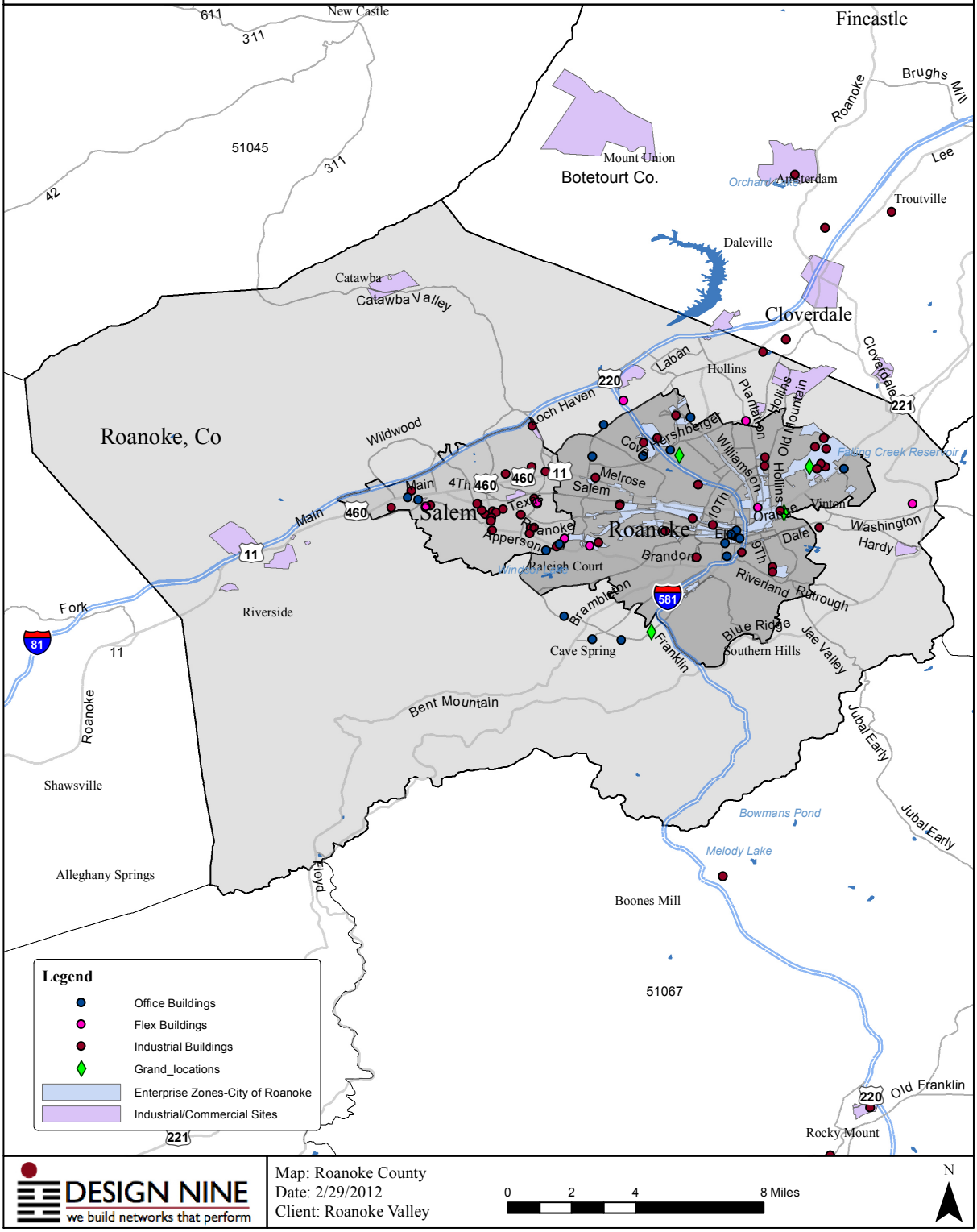
Selected Maps

The following maps have been developed as part of the study work, and are available as needed as online PDFs or as a separate map book (all the maps can be downloaded at http://roanoke.designnine.com/). Several maps of particular interest follow this list.

- 120323-Proposed Roanoke Fiber Network.pdf
- 120316-Roanoke Region Fiber Networks.pdf
- 120316-Roanoke County WVWA Locations.pdf
- 120316-Roanoke County Fiber Networks.pdf
- 120316-Proposed Fiber Routes_v2.pdf
- 120302-Zayo Fiber Network.pdf
- 120509-Various Private Fiber Networks.pdf
- 120302-MBC Fiber Network.pdf
- 120302-Lumos Fiber Network.pdf
- 120302-Level 3 Fiber Network.pdf
- 120302-Citizens Fiber Network.pdf
- 120228-Salem Schools and Community Centers.pdf
- 120228-Salem Public Safety Locations.pdf
- 120228-Salem Fiber Networks.pdf
- 120228-Salem Existing Tower Locations.pdf
- 120228-Salem Business Areas.pdf
- 120228-Roanoke Region Schools and Community Centers.pdf

- 120228-Roanoke Region Public Safety Locations.pdf
- 120228-Roanoke Region Fiber Networks.pdf
- 120228-Roanoke Region Existing Tower Locations.pdf
- 120228-Roanoke Region Business Areas.pdf
- 120228-Roanoke County Schools and Community Centers.pdf
- 120228-Roanoke County Public Safety Locations.pdf
- 120228-Roanoke County Existing Tower Locations.pdf
- 120228-Roanoke County Business Areas.pdf
- 120228-Roanoke City Schools and Community Centers.pdf
- 120228-Roanoke City Public Safety Locations.pdf
- 120228-Roanoke City Fiber Networks.pdf
- 120228-Roanoke City Existing Tower Locations.pdf
- 120228-Roanoke City Business Areas.pdf
- 120228-Botetourt County Schools and Community Centers.pdf
- 120228-Botetourt County Public Safety Locations.pdf
- 120228-Botetourt County Fiber Networks.pdf
- 120510-Botetourt County Existing Tower Locations.pdf
- 120510-Botetourt County Business Areas.pdf

Roanoke Valley: Business Areas



Roanoke Valley: Fiber Networks