



THE IMPORTANCE OF BROADBAND

Why this Matters

Advanced Broadband Service is no longer a luxury. It is a utility that is as important as water or electricity. This paper discusses why we should care about broadband infrastructure for our communities.

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The Importance of Broadband

Technology is impacting every part and parcel of our lives in our rapidly changing world – from where and how we conduct work, to whether or not we thrive economically and socially. Technology and broadband can, when available, improve and enhance the way we work and live. With the introduction and accelerated advancement of technologies, having access to affordable, redundant and abundant broadband is quickly becoming the most critical infrastructure of our time, just like electricity, transportation, and roadways were early last century.

To address the possibilities and potential of broadband, both the private and public entities are building networks all over the globe to support the Internet needs of both today and the foreseeable future.

We do not yet know the far-reaching impacts that the Internet will have on our lives and on generations to come. However, it is certain that NOT having access to advanced broadband networks would be equivalent to being in the dark without electricity.

Many communities in Colorado find they are lacking adequate Internet service or do not have access at all, creating a “digital divide” among those with access and those without. The digital divide¹ typically exists between those in cities and those in rural areas. Rural areas are costlier and difficult to provide advanced broadband networks. However, even in Colorado’s metropolitan areas, many citizens lack access to abundant, affordable and reliable advanced broadband services.

For **businesses**, robust bandwidth is the foundation for innovation as well as the key infrastructure needed to succeed and capitalize on the Internet’s applications and benefits. Research demonstrates a direct correlation between businesses’ use of Internet applications and revenue growth and productivity.

With today’s economy more dependent on innovation and connectivity to survive and thrive, providing businesses with high speed Internet is critical to keep businesses competitive.

The Benefits of Broadband

For **households**, better broadband delivers opportunities beyond an enriched lifestyle and entertainment.

Enriched Education – In addition to providing a stronger link to their own teachers and school resources, high speed broadband brings with it the ability to video-link students to anywhere in the world. Video-conferencing breaks down the walls of the traditional educational system and takes students inside operating rooms, to engineering labs, or across the globe to speak with their peers in another country. These experiences will strengthen a region’s workforce of tomorrow.

¹ whatis.techtarget.com/definition/digital-divide

World-Class Healthcare – A robust broadband network helps medical professionals collaborate with the world’s top medical doctors, in real time. Only through high speeds can medical images be shared in real time to enable telemedicine to work “side-by-side” with global specialists and deliver citizens the best care available.

Improved Public Services and Safety – The power of high speed broadband can help make streets safer and government services more efficient. Deploying Internet services in police cruisers, fire and safety vehicles provide professionals with the resources they need to better serve and protect citizens.

Internet of Things – You may have heard of this increasing trend as homes and appliances become “smart.” Beyond smart-phones, tablets, watches, and computers, every day more and more connectivity is being developed into smart home electronics, applications and appliances.

Telework – Digital connectivity empowers rural professionals to telework, providing the opportunity to work for urban organizations anywhere in the world from a rural residence. Additionally individual and small and home-based businesses can be established and grown with high-speed Internet connectivity.

What Exactly is “Broadband?” In 2015, the Federal Communications Commission (“FCC”) revised its definition of Broadband) as having the ability to download at 25 Mbps and upload speeds of 3 Mbps. Having access to “advanced broadband,” means, at a minimum, having broadband speeds that at least meet the FCC definition. There are many types of broadband connections:

DSL (Digital Subscriber Line) uses existing copper phone lines to deliver download and upload broadband speeds typically of 1.5 Mbps to 7 Mbps. DSL speeds diminishes as distance increases from the telephone company’s central office. Homes or businesses located more than three miles from the central office will not receive as fast of speeds. There have been many improvements to DSL technologies to improve the speed available. In general, most forms of DSL service improvements support up to 10 Mbps. VDSL (Very High Bit Rate Digital Subscriber Line) can support up to 30 Mbps, but most Internet service providers do not support this type of service, including providers in the Roaring Fork region.

Cable modem service uses coaxial cables already installed by the cable TV operators to provide broadband service. Most cable networks support speeds comparable to DSL. Cable operators are upgrading their cable networks by installing fiber optic cable closer to neighborhoods. These network improvements allow cable modem service to be able to support up to 30 Mbps. This connection type is a shared service, meaning, as more people are on the network within a neighborhood, the speed available to each customer diminishes.

Fiber optic technology converts electrical signals carrying data to light and sends the light through glass fibers about the diameter of a human hair. Fiber transmits data at speeds far exceeding current DSL or cable modem speeds, typically by tens or even hundreds of Mbps.

Fiber is the best way to provide abundant broadband, but it often is the most capital-intensive to build.

Wireless broadband connects a home or business to the Internet using a radio link between the customer's location and the service provider's facility. Wireless technologies using longer-range directional equipment provide broadband service in remote or sparsely populated areas where DSL or cable modem service would be costly to provide or fiber network installations may be too capital intensive.

Wireless broadband can be mobile or fixed. Wireless speeds are generally comparable to DSL and cable modem. Wireless services can be offered using both licensed spectrum and unlicensed devices. Wi-Fi networks typically use unlicensed spectrum. Wi-Fi networks use wireless technology from a fixed point and often require direct line-of-sight between the wireless transmitter and receiver. Wi-Fi networks can be designed for private access within a home or business, or be used for public Internet access at "hot spots" such as restaurants, coffee shops, hotels, airports, convention centers, and city parks. Using licensed spectrum, greater amounts of bandwidth can be delivered and often do not require direct line-of-sight.

In some communities, especially sparse, geographically diverse rural communities, small providers build out a wireless solution since wireless infrastructure is not as capital-intensive as building out a fiber optic infrastructure. While wireless technology does have its limitations, needing to be designed to get around "line of sight" requirements as well as to support "shared" bandwidth on the network, smart engineering can deliver good connectivity.

Wireless Local Area Networks (WLANs) provide wireless broadband access over shorter distances and are often used to extend the reach of a "last-mile" wireline or fixed wireless broadband connection within a home, building, or campus environment. An in-home Wi-Fi network is a WLAN – it does not use spectrum, rather it sends radio waves at a limited range. Mobile wireless broadband services are also becoming available from mobile telephone service providers. These services are generally appropriate for highly-mobile customers and require a special wireless card with a built-in antenna that plugs into a user's laptop computer. Generally, they provide lower speeds, in the range of several hundred Kbps.

Satellite broadband is another form of wireless broadband, and is also useful for serving remote or sparsely populated areas. Typically, a consumer can expect to receive (download) at a speed of about 500 Kbps and send (upload) at a speed of about 80 Kbps. These speeds are slower than DSL and cable modem, but they are about 10 times faster than the download speed with dial-up Internet access. Service can be disrupted in extreme weather conditions and are typically oversubscribed.

Advanced Broadband is Critical Infrastructure. Advanced broadband infrastructure has the potential to create more jobs, increase the community's competitive ability globally, create new technologies, increase opportunities for our community's companies, enhance public safety, provide better and less expensive healthcare, and provide greater educational opportunities throughout our communities.

Advanced broadband networks are creating seismic changes in local, state, national and global societies, as well as markets, business and in institutions around the world. Access to social media and the Internet has shifted governments, threatened political boundaries and changed us culturally. Advanced broadband networks are fundamentally changing our world in ways that were not expected or anticipated. Much like electricity, advanced broadband networks are the enabling technology in which all things are impacted. Electricity was invented to turn on the lights, but empowered – literally, the transformation to an industrial society.

Just as it was impossible to predict the impact that electricity would have to power modern appliances, computers, health monitoring systems, manufacturing facilities, computers, radio and television, and financial markets; so too, is it impossible to predict the impact and reach of advanced broadband networks.

Speed Matters. Global network traffic has quadrupled from 2009 to 2015. Both commercial and residential Internet bandwidth consumption are doubling every year.

In the early days of the Internet, text messaging, email and web sites were not data-rich or bandwidth intensive and the average consumer did not need more than 7 Mbps of bandwidth (upload or download) to accomplish most, if not all tasks. Universities, financial institutions and business enterprises were the key drivers for higher amounts of bandwidth.

FIGURE 1: EARLY INTERNET CONSUMPTION

Early Internet Consumption	
Application	Rate
Personal communications	300 to 9,600 bits/second or higher
E-mail transmissions	2,400 to 9,600 bits/second or higher
Remote control programs	9,600 bits/second to 56 kbits/second
Digitized voice phone calls	64,000 bits/second
Database text query	Up to 1 Mbps
Digital audio	1 to 2 Mbps
Access images	1 to 8 Mbps
Compressed video	2 to 10 Mbps
Medical transmissions	Up to 50 Mbps
Document imaging	10 to 100 Mbps
Scientific imaging	Up to 1 Gbps
Full-motion video	1 to 2 Gbps

When YouTube burst upon the scene in 2005, this dramatically changed things. Consumers, small businesses and residential users started to also drive Internet bandwidth demand. One video download was the equivalent of downloading 30,000 web pages. Since that time, videos

and picture-rich content have been downloaded and uploaded on a regular basis by the masses. The sum of all forms of Internet Protocol (IP) video (Internet video, video on demand, video files exchanged through file sharing, video-streamed gaming, and videoconferencing) was 64% in 2014 and is predicted to be 80 percent by 2019.² In the coming years, the sum of all forms of IP video will reach 86 percent of the total Internet traffic. The applications we use on the Internet are becoming much more feature-rich and bandwidth intensive and existing networks cannot keep up with the demand for networks that support these applications.

FIGURE 2: AVERAGE RESIDENTIAL BANDWIDTH

Average Residential Bandwidth Needed, Applications 2015				
Service	Bandwidth	Number of Devices	Bandwidth Home Area Network	Bandwidth Residential Gateway to Network
TV	2 to 20 Mbps	3.5	2 to 70 Mbps	2 to 70 Mbps
DVR	2 to 20 Mbps	2	2 to 40 Mbps	0
Home Theater	1 to 6 Mbps	1	1 to 6 Mbps	0
Internet Browsing	1 to 20	1 to 5	1 to 100 Mbps	1 to 10 Mbps
Printer	.5 to 1 Mbps	1 to 5	.5 to 5 Mbps	0
Digital imaging	1 to 20 Mbps	1 to 3	1 to 60 Mbps	0
On-line Gamine	.5 to 1 Mbps	1 to 3	.2 to 3 Mbps	.2 to 1 Mbps
Video Capture	.1 to 1 Mbps	1 to 10	.1 to 10 Mbps	.2 to 3 Mbps
Portable Audio	1 to 20 Mbps	1 to 3	1 to 60 Mbps	0
Video Steaming	10 to 1000 Mbps	3.5	35 to 3500 Mbps	35 to 3500 Mbps
Smart TV	35 Mbps	1	35 Mbps	35 Mbps
Total	54 to 1,163 Mbps		79 to 3,339 Mbps	74 to 3,619 Mbps

The Fiber to the Home Council (FTTH) stated its position clearly in a brief to the FCC. “Even today, with most users still operating on last-generation broadband technologies, the capabilities of advanced video, cloud-based services, and other bandwidth-intensive applications are growing at a pace beyond what our existing networks are capable. Cisco and other scientific companies talk about the network in terms of “terabytes” of capacity in the network center, or “core.”³

Commercial and residential Internet bandwidth consumption are doubling every year, as video, cloud computing, advanced storage solutions, telemedicine, and telecommuting are becoming more accessible and available to end users. Applications today are more bandwidth intensive with more devices being used both in the home and for business purposes. The driver of this is not only smart-phones, tablets and computers, but even more so, the “Internet of Things” – things such as wearables (clothing with Internet connections) and smart home applications and appliances. In addition, Internet-connected televisions, radios, cameras and picture frames, have created the demand for reliable, consistent Internet. The number of hours spent viewing entertainment applications online (i.e. movies and TV) have surpassed the number of hours spent viewing entertainment from traditional broadcast TV. As of 2013, the number of Internet-

² <http://www.digitaltrends.com/home-theater/online-video-will-dominate-internet-traffic-by-2019/>

³ Fiber to the Home Council, “America’s Petition to the Federal Communications Commission for Rulemaking to Establish a Gigabit Communities Race-to-the-Top Program,” July 23, 2013.

enabled devices outnumbered the number of people in the world. Applications supported by cloud-based services through multiple devices have created the need for always-on connectivity and advanced broadband network bandwidth.

There have been tremendous improvements in wireless communications, and in technologies that beef-up existing cable networks, to help deliver broadband and address unserved- or under-served regions. At the same time, fiber optic network technologies are being extended where it is financially feasible further and deeper into neighborhoods, business parks and industrial centers. As more devices are connected to the Internet and applications are more bandwidth rich, there is momentum pushing for the highest bandwidth possible, which can favor fiber connections to homes and businesses while wireless serves as an excellent supplement/solution for harder to reach geographies. The "gold standard" for bandwidth capability today is quickly becoming offering Gigabit services (1000 Mbps). Many cities are either investigating or have already seen gigabit service come to their metro areas, but for rural areas where building an all-fiber optic network is cost-prohibitive, a combination of wireless and fiber optic cable may be the most economical and feasible solution.

While Internet bandwidth use is doubling, cellular networks are also greatly overextended.

In addition to explosive growth in Internet consumption from homes and businesses, mobile Internet use has also advanced dramatically. Smartphone applications are spurring higher consumption of multimedia services. With tablet computers and smartphones having easy access to games, e-books, TV programs, email, shopping, banking and social media sites, wireless service providers have been scrambling to upgrade their networks and support the growing need to connect mobile and portable users.

The need for advanced broadband connectivity must include both a consideration for fiber, connecting our businesses, homes and offices; as well as wireless and cellular, allowing for mobile and portable access as we travel, move about and commute.

Communities are Investing in Broadband Infrastructure to Enable Economic Development and Vitality

Communities deploying the gold standard of 1 gigabit are already realizing great rewards for being early adopters. Communities including Chattanooga, TN; Lafayette, LA; and Kansas City are seeing great benefit and advancements in terms of social and economic advancement. And the numbers of gigabit cities is rapidly growing as each week sees announcements of gigabit networks to be available in a community within the US.

States, municipalities, communities and regions that have deployed higher-speed, next century broadband have already seen the tremendous economic impact of building networks. These communities have fostered an environment of innovation, economic development, collaboration, and creative activities. *According to a 2012 survey of economic development professionals, 60 percent said that 1 Gigabit of service had a "definite impact" on new businesses that moved to an area.* Communities understand that advanced broadband networks are

essential for economic development and innovation. City and local government officials the importance of having better broadband infrastructure – whether it is fiber-based or wireless, to retain businesses and employees and to provide critical infrastructure to visitors, part-time homeowners, and permanent residents.

The chart below breaks out the impact various speed options have had on economic success factors, such as attracting new businesses, helping local businesses grow, increasing home-based businesses and reviving depressed business districts or communities.

FIGURE 3: BROADBAND'S IMPACT ON ECONOMIC OUTCOMES FROM THE PERSPECTIVE OF SPEED⁴

Broadband's Impact on Economic Outcomes							
	2-4 Mbps	10-12 Mbps	20-25 Mbps	100-120 Mbps	500 Mbps	1 Gigabit	Total
Attract new businesses to your area	3.10%	4.87%	9.73%	26.55%	13.27%	42.48%	
	7	11	22	60	30	96	226
Help local companies grow	4.87%	7.52%	20.35%	29.20%	9.29%	28.76%	
	11	17	46	66	21	65	226
Increase home-based businesses	5.80%	13.84%	26.79%	25.89%	12.95%	14.73%	
	13	31	60	58	29	33	224
Individuals' income earning increases	8.64%	1682.00%	23.18%	25.91%	11.36%	14.09%	
	19	37	51	57	25	31	220
Revive depressed business districts	6.31%	11.71%	18.92%	27.48%	12.61%	22.97%	
	14	26	42	61	28	53	222
Revive depressed communities	7.14%	16.52%	1786.00%	27.23%	12.95%	18.30%	
	16	37	40	61	29	41	224

According to The Tennessean, an online publication, Chattanooga’s mayor, Andy Berke attributes the city’s Gigabit network as a significant source of the community’s new vibrancy. In the past three years, the city’s unemployment rate has dropped to 4.1% from 7.8% and the wage rate has also been increasing. Gigtank, a startup accelerator, emerged, and startup and tech events popped up as the city began taking advantage of its high-speed access. Berke described a Chattanooga company that developed during an entrepreneurial event and was eventually bought by OpenTable. Now, OpenTable has an office in the city’s Innovation District and it has doubled its local presence, part of the city’s downtown revitalization efforts.

Downtown has doubled its residents and landlords often advertise gigabit speeds that are included in monthly rents. “It’s an explosion of growth in our technology sector,” he said. “That

⁴ Settles, *Building the Gigabit City*.

has sparked not only this (downtown) living but restaurants and bars and music and the quality of life that truly makes a city interesting, cool, hip, vibrant and energetic."⁵

In Summary. For Colorado communities, having access to affordable, abundant, high capacity Internet is no longer a luxury, it is essential. Access to abundant broadband:

- provides equality and reduces the digital divide
- creates more jobs,
- creates vibrant communities that are economically stable,
- provides for new opportunities,
- fosters an entrepreneurial-friendly environment,
- improves technology advancement,
- provides for better and less expensive healthcare,
- creates educational opportunities,
- improves public safety and better access to e-government services,
- incentives telework and telecommuting
- provides flexibility for affordable housing for the workforce
- attracts the New Knowledge economy to our community.

Advanced broadband networks are creating enormous shifts in local, state, national and global societies, as well as markets, business and in institutions around the world. It is critical for our communities to develop the infrastructure that provides equitable access to advanced broadband services for its citizens, its workforce and its visitors.

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⁵ The Tennessean, "Chattanooga Mayor: Gigabit speed Internet Revives City," Jamie McGee, June 14, 2016.