<div align="right">**Chapter Two**</div>

Overview of High-Speed Broadband

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Broadband 101

First, just a little background about broadband, a technology full of enough jargon and acronyms to make anyone's head spin.

Bandwidth

When talking about high-speed broadband, you see a lot of numbers thrown around. These numbers refer to bandwidth, or the amount of data that can be transmitted in a fixed period of time. For digital devices (like computers and cell phones), bandwidth is usually expressed in bits per second (bps). Essentially, its the amount of data (expressed as "bits", which are the basic unit of computing) that can flow across your connection in one second. Most Internet connections are rated in mega bits per second (Mbps), or a million bits per second. A gigabit per second (Gbps) is 1000 Mbps.

Broadband

The word "broadband" refers to any technology that transmits data across the Internet at high speeds. Transmission is two-way: downloading to your computer and uploading data to the Web site or service you are using. A broadband connection is always "on", unlike dial-up where a new connection is made every time the user wants to go online.

"Basic broadband", as defined by the FCC in 2010, is download speeds to your computer of 4 Mbps and 1 Mbps upload from your computer. For streaming movies (i.e. those you view instantly as they download) through your computer, or gaming console, Netflix recommends at least 3 Mbps for DVD quality video and audio and up to 10 Mbps for HD quality video.

Here's some information that gives you an idea of various speed requirements:

Top Bandwidth Speed Required for Various Digital Content Applications

High Definition Television	*18 Mbps*
Online Games	*14*
Video on Demand	*13.5*
Internet Protocol TV	*13.5*
Video Conferencing	*13.4*
Virtual Worlds	*9*
Web Browsing	*4*
Audio Streaming	*1.5*
Voice Calls	*0.5*

"The California Broadband Task Force (2008) predicts that telemedicine, education distance learning, and digital medicine will require speeds between 10 and 100 Mbps. It

furthermore concludes that high definition telemedicine, virtual reality, supercomputing and advanced research applications will require broadband speeds of over 100 Mbps."

Source: An International Look at High-Speed Broadband by the Brookings Institution [1]

The "Network"

Wikipedia defines a network as follows.

"A computer network, often simply referred to as a network, is a collection of computers and devices interconnected by communications channels that facilitate communications and allows sharing of resources and information among interconnected devices." [2]

A **backbone** network ties together various networks together, such as across a university campus or across geographical areas.

The **middle mile** lies between the **backbone** network (such as the large bandwidth network CenturyLink provides for Chaffee County) and the local access point, such as an **ISP** (Internet Service Provider) from whom you buy your service. These middle mile links are typically large-capacity connections and can range from a few miles to a few hundred miles. They often consist of fiber optic lines, but microwave and satellite are also used. The middle mile provides both the local access or distribution method to get data to your computer and a **backhaul** component to return data to the Internet site or service you are using (such as data sent from web site order forms, sending email, updating Facebook and posting a YouTube video).

The **last mile** represents how service gets from your local access point such as your ISP's equipment to your home or business. It's not really a "mile", and in rural areas can be a distance of many miles.

Last mile broadband service is typically delivered by telephone companies on **DSL** (digital subscriber line), the generic term service using the phone lines; by cable TV providers over coaxial cable; or fiber-optic cable through ISPs (Internet Service Providers). There are also fixed wireless options such as **microwave** solutions (which require the use of licensed frequencies and has distance limits), **Wi-Fi** (used locally within a business or home) or **Wi-MAX** (Worldwide Interoperability for Microwave Access, typically used in a metropolitan area).

DSL is typically provided as **ADSL** (asymmetric DSL), where download speeds are faster than upload speeds. The assumption is that you need faster download times (for services like video streaming from Netflix) and can live with slower upload speeds (for activities like email). The downsides to DSL include proximity to the phone company central office - subscribers living

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[1] http://www.brookings.edu/~/media/Files/rc/reports/2010/0223_broadband_west/0223_broadband_west.pdf

[2] http://en.wikipedia.org/wiki/Computer_network

farther away will have slower service - and there are upper limits to the amount of bandwidth that can be delivered. With cable Internet service, the number of users who are active at any given time can affect bandwidth availability and result in slower service. Both DSL and cable service require a modem.

Challenges of Deploying High-Speed Broadband

Many of the technologies needed to deploy broadband in rural areas exist today, each offering different cost and performance attributes. However, there are some basic challenges for providing higher speed bandwidth.

No network can run faster than the speed of its **last mile**, from the neighborhood access point to your house or business. This is the most expensive place to lay physical networks, and of the two methods commonly used, coaxial cable (e.g. from your cable TV company) is faster than a copper wire (e.g. DSL or phone line), but both have upper limits to the technology.

In most areas, access speeds are limited by the equipment that is installed at the provider's central facility, and service providers may use speed caps on the amount of bandwidth residential customers can use in order to reduce the chance of network slowdowns. You can test your actual speed[3] and compare it to what your provider says you should get. In reality, networks seldom run as fast as advertised.

With regards to the **middle mile** there are several challenges. Rural broadband networks are built in areas far away from the Internet backbone. Because of that distance, middle mile providers often need to buy backhaul service from more than one provider to get to the backbone access point. Many of these backhaul services are over systems designed for telephone or cable TV, some of which have insufficient capacity to carry the additional Internet traffic, causing the end customer speeds suffer. Local providers often do not have access to the capital required to build out their own middle mile infrastructure, and the cost of buying service from existing providers can be significantly higher than in other, highly populated areas.

The Current Need for High-Speed Broadband

What's available now that is driving the need?

Businesses expect to have 24x7 access to basic applications like banking, VoIP phone services (Voice over Internet Protocol), credit card and payroll processing. Redundancy in the network is critical for businesses to avoid down times if any one part of the physical network components fails.

Specialized business software often requires large bandwidth to move video and data easily, or to support collaborative software, including:

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[3] http://www.colorado.gov/BroadbandSWF/speedtest.htm

- Real estate offices providing virtual tours
- Construction firms sharing schematics
- Health care facilities providing remote monitoring and diagnosis
- Emergency management responders sharing data and information
- Utilities employing smart power grids

Consumers continue to engage in general Web-surfing, blogging, social networking and consumer online shopping, where web sites that are providing the content are growing in size and complexity.

Consumers are also driving high-growth in use of **high-bandwidth services** such as video calls (e.g. Skype), on-demand movies (e.g. Netflix), downloadable books (e.g. Amazon or Barnes and Noble), music (e.g. iTunes) and multi-player online games (e.g. World of Warcraft).

New consumer products (including cell phones) appear daily, with features like HD video and high-resolution photographs. Consumers want to use these features to post files to YouTube or Facebook or send to friends and family via email.

All levels of **government are providing increased access to services** from e-filing taxes, searching land information databases to emergency management.

Increased Demand in the Near Future

What's coming to put demands on existing infrastructure?

Mobile products are signaling the end of the PC as we know it. Mobile devices are just that, mobile. Consumers expect them to be lightweight, portable and able to go online anywhere, along with providing an ability to access their personal files. At home, in a coffee shop or at a friend's house, they want untethered access to show their latest video, check email or post a blog entry. The same untethered requirements are true of business people, whether at work or on the road.

The "Cloud" is coming.
- Google has created its Chrome OS which supplies a superfast browser, with the assumption that Web-based applications ("apps") and services will provide all the functions that you need. No more running applications on your personal laptop, but "in the cloud".

- Apple has just announced iCloud as a way to sync and share all personal files on your various Apple hardware (such as iPad movies and books, iPhone messages, iPod music and MacBook files).

- The market for iPads, tablets and other mobile devices will continue to grow. And with it, the bandwidth demand for downloading books, Netflix movies and the like will continue to grow. In addition, these mobile devices are not designed to store huge amounts of data, such as videos, so consumers will need to store their collection of personal stuff elsewhere.

- Weary of PCs getting hacked or losing data to crashes, consumers and businesses will embrace the idea to put their data and software packages somewhere else in return for peace of mind. Cloud-based solutions won't need the level of systems administration as current PC-based software.

More **online and distance learning** opportunities are available for education. Students in a class might run simultaneous multimedia content with embedded assessments or take specialty classes, such as foreign languages, not taught locally. As education gets more expensive, schools and students will contract with larger institutions to provide curriculum not available locally, including interactions with remote instructors.

Bigger, better products will keep appearing, such as 3-D TVs, 100-inch TV screens, and 3-D gaming, all with increasing bandwidth needs.

The next new thing that we don't see today, but might be available in 6 months, will need even more bandwidth. Try Wired Magazine's http://www.webmonkey.com/ or ZDNet's http://www.zdnet.com/blog/emergingtech for examples of what's coming next.

The Bottom Line

High-speed broadband is the basic infrastructure of the digital age, just like power, streets and water. Access to high-speed broadband will be a requirement for all aspects of our lives, including education, health, business and government transactions and our social connections. Lack of access to high-speed broadband will have a crippling effect[4] on a region's economic future.

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[4] http://www.utexas.edu/know/2011/04/08/strover_sharon_yonder/