

**MAKING BROADBAND INTERNET SERVICE AVAILABLE FOR  
RURAL SMALL BUSINESSES**

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## **Abstract**

A large number of small businesses are located in rural areas of economically developed nations where they perform many of the same commercial functions as their urban equivalents, e. g., wholesale distribution and retail trade, manufacturing, technical and professional services, healthcare services, etc. Given the growing role of the Internet in domestic and international commercial activity in the new millennium, it is important that all small businesses obtain access to broadband Internet services so they can actively participate in the emerging “new world economy.”

This paper examines the availability of broadband Internet service to rural small business in the U.S. and to determine if government actions are required to assure equal access. The U. S. is widely recognized as the nation with the greatest access to and use of the Internet as a mechanism for more efficient commercial activities. The U.S. is also recognized as the nation with a large small businesses sector, approximately 24 million small businesses with an output equal to almost 50 percent of the nation’s gross domestic product (US Small Business Administration, 1998).

Our research finds ample evidence that broadband availability in the rural U.S. is not equal to the urban areas. We find that rural small towns in the U.S. have telecommunications systems with the technical capacity to deliver broadband service. However, market based incentives by themselves are not adequately stimulating the telecommunication suppliers to make the incremental investment in the additional equipment required for broadband. It is therefore probable that government policy will have to be formulated to overcome the inequitable distribution of broadband Internet access. Our observations and recommendations may prove helpful to other nations with broadband distribution problems for rural small businesses.

## 1. Introduction<sup>1</sup>

A large number of small businesses are located in rural areas of economically developed nations where they perform many of the same commercial functions as their urban equivalents, e. g., wholesale distribution and retail trade, manufacturing, technical and professional services, healthcare services, etc. Given the growing role of the Internet in domestic and international commercial activity in the new millennium, it is important that all small businesses obtain access to broadband Internet services so they can actively participate in the emerging “new world economy.”

Although the U.S. is not typical of all economically developed nations, it is an economy with a large small business sector with many of these in rural areas. The small businesses sector in the U.S. consists of approximately 24 million small businesses with an output equal to almost 50 percent of the nation’s gross domestic product (US Small Business Administration, 1998). And, it is widely recognized as the nation with the greatest access to and use of the Internet as a mechanism for more efficient commercial activities. Thus, its problems with availability of broadband services to rural small businesses may portend similar problems in other nations.

There is growing concern among public policy makers in the U.S. that some segments of American society may fall behind others in social development and economic progress because they lack reasonable access to the latest telecommunications technology -- high-speed access to the Internet, hereafter called “broadband.” One target of concern is the small business community because independently owned businesses with fewer than 100 employees are documented as major creators of net new jobs and market innovations in the U.S. economy (Kirchhoff, 1994). If lack of broadband Internet access causes small businesses to fall behind economically, the economy of the entire nation could be hurt significantly. This problem is

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may be equally significant for rural small businesses throughout all the economically developed nations of the world.

The Internet has emerged in the last five to six years as a rapidly growing source of commercial activity for big, small and new businesses of many kinds. It provides access to a wide cross-section of information resources that facilitate commercial activity. It serves as a mechanism for selling and purchasing a wide array of goods and services. As a new, potentially highly efficient distribution system for wholesale and retail activities, it promises to create a more competitive market place. The burgeoning commercial activity calls out to every business that hopes to improve efficiency and effectiveness in serving customers, including small businesses.

#### Definition and Scope of the Problem

As the following analysis reveals, universal access to telecommunications technology historically has been considered an important infrastructure component for economic growth and development. As a result, communications technology access has been a public policy agenda for all economic development organizations through out the world. The same is true for the U.S. where the first legislation identifying the importance of communications technology access was the Federal Communications Act of 1934 that among other things created the Federal Communication Commission (Patten, 2000).

The technical problem of Internet access is one of providing “high-speed” access, which we define as synonymous with the term “broadband.” Herein, we use this term to mean the delivery of 400 kilo bits (kbs) of data per second. Many small businesses have telephone modem access but it is so slow (typically 33 kbs) that most users tire of searching long before useful information is found and transferred. Telephone modem access for businesses seeking to sell on the Internet is too slow to deliver adequate information to potential customers, so competitors with high-speed access will move ahead of those with slow speed access.

Lack of broadband is especially acute for small businesses since large international firms are using the Internet as a major mechanism of commercial activity, e.g. marketing, purchasing, production, and many other functions can be made more efficient and effective through the Internet. And, lack of broadband access may become an acute problem for rural small businesses if profit making firms, both large and small, located in urban and suburban areas gain access before rural areas and cause rural areas to fall behind in access and adoption.

### Purpose and Organization of This Report

In the context of the problem definition, the purposes of this report are two. One purpose is to examine the technological problems that may cause a difference between urban and rural installations of high-speed Internet access. The other purpose is to assess whether rural/urban differences are serious enough to require public policy initiatives to avoid the “digital divide” that could cause the decline of rural small businesses. If so, what public policies might be implemented to assure that appropriate mechanisms, either market or public actions, to provide equal Internet access to rural small business through out the economically developed world?

This report is organized as follows. First, in Section 3 a simplified description of the technologies providing high-speed Internet access outlines advantages and limitations of each technology. Some basic understanding of these technologies is essential to understand the limits of market forces in creating high-speed Internet access. Next in Section 4, we describe the reasons why small businesses need to have broadband access to assure operating efficiency and competitiveness in the emerging markets of an Internet world. In section 5 we assess the probable availability of broadband access in rural small towns. Finally, in Section 6, we provide recommendations for policy advocacy on behalf of rural small businesses.

## **2. Telecommunications Technologies and Broadband**

The nature of the universal broadband technology access gap is being referred to as the “digital divide.” In the U.S., data on the distribution of broadband access differentiated by business character and size are not available. Current analyses concern overall society’s access and therefore focuses on households. For example, a recent report on access to the Internet issued by the U.S. Department of Commerce (2000) identifies the digital divide by individual characteristics (gender, race, age, education, etc.) or geographic location (central cities, urban, rural), and concludes that race and education define the digital divide. At this time, gender is not a defining characteristic and geographic location is but a minor indicator. In another report, focused upon rural America’s access to high-speed, or broadband, access to the Internet argues that there is a difference between rural and urban America and concludes that there is some question that competition in conjunction with the existing government policies and programs can provide affordable broadband services to rural America in the near term (US Dept of Commerce, 2000). The Federal Communications Commission (FCC) goes farther in its recent analysis, concluding “...in all likelihood, market forces alone will not guarantee that many rural Americans will have access to advanced services” (FCC, 2000, p. 40). At the same time, this FCC report describes research showing that 72 percent of the small town population lives in rural zip codes where there is a least one subscriber to broadband services. In other words, broadband services are available therein. These reports all differ because their purposes are different, they operationalized broadband differently and they measure household access, not business access.

Since this analysis is focused on business, not household use, we assume that small businesses located in urban and suburban areas have approximately the same access as households and that household data can be used to approximate their access. This assumption is realistic because the major mechanism for Internet communication is the telephone modem

that uses the existing household or business telephone connections. However, in rural areas, the small businesses are in small towns rather than the remote areas where household density is lower. Thus, the problem as it relates to small businesses in rural areas focuses on household access in rural small towns rather than household access in all of the rural areas.

What is most important to recognize about the problem definition and scope is that the problem affects all small businesses everywhere. Thus, what is said in this report applies to the entire small business community. Large firms can afford the cost of special installations of lines and equipment to obtain broadband service. Thus, the problem definition goes beyond geographic location to include resources needed to adopt and use the technology for competitiveness. These concerns will be reflected in the analysis that follows.

### Broadband Technologies<sup>2</sup>

Throughout this report, you will read about two kinds of technology used in telecommunications, (1) analog and (2) digital. These two technologies are so different yet so important to explaining the digital divide that it is necessary to understand their highly different functional characteristics to identify the problems of Internet communications to rural areas. We begin by describing these two technologies and then expand this to an understanding of the public networks of cable TV and telephone.

#### Analog Telecommunications: Telephone and Cable TV

The original 100 year old telephone systems are analog technology. In this technology, two copper wires, twisted around each other (the twisted pair) connect one telephone to another telephone. This means that a dedicated phone line consisting of two continuous copper wires link one phone to another. These two copper wires have electrical current in them. The microphone wire in phone one is connected to the speaker (ear piece) in phone two and vice versa. The vibration of your voice as you speak into the originating phone's microphone

vibrates a diaphragm that creates a vacillating electrical current carried to the receiving phone by the copper wire. The vacillating current vibrates a diaphragm in the speaker of the receiving phone thereby replicating the sound of your voice. The two wires make it possible to both speak and hear the other speaker simultaneously.

All analog phones are driven by electrical current. Touching both wires with your fingers will give you an electric shock, especially if the phone is ringing since the ring is an extra strong voltage sent down the line by the telephone company to ring your bell. This two-line system is called a duplex system since both phones can talk and hear simultaneously. For a telephone conversation to take place, two wires must be dedicated to carry the electrical current from one phone to the next.

Conventional radio and TV signals are also analog system electromagnetic signal (radio or TV frequency) from a broadcasting station to homes, schools and offices. However, since these are only one-way transmissions, there is no need for duplex transmission and users are comfortable with that form of communication for radio and TV. The conventional TV *coax cable* that enters the user's premises is a single copper wire surrounded by an insulator and then either aluminum or copper mesh. This surrounding mesh shields the copper wire so that outside radiation (other airborne radio and TV signals) does not interfere with the frequencies traveling down the copper wire. And, it shields the airborne electromagnetic signals from being interfered with by those in the copper wire. A dedicated coax cable enters each user's office/house linking the transmitter to the user's TV. But, there is no electrical current in the TV coax cable, only electromagnetic radiation. You can handle the bare wires without fear of electrical shock just as you can touch the radio antenna of your car when the radio is on. The single coax cable can carry many different signals, each with its own unique frequency (e.g., channel one, channel two, NBC, FOX, etc.), and any coax cable connected to

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<sup>2</sup> This entire section has been taken from: Patten, 2000.

this line will pick up all the frequencies and transmit the entire range of signals. This is why you are able to receive so many channels on a cable TV system. And why it is so easy to add a new TV by installing a simple cable splitting device on the line.

In truth, dedicated copper wires do not connect locations in any telephone or TV cable network. Imagine how many wires you would need connected to your office if you had to have a twisted pair of wire for everyone you called? Instead, in the old switching systems, a twisted pair of wires from each phone goes to a central office switch somewhere in your neighborhood and every call you make is switched to a connecting pair of lines at this central office. The switching takes place as you push the buttons (or rotate the dial) on your phone thereby telling the central office where you want your call to go. If you call your next door neighbor, the electrical current flows to the central office, is connected to your neighbors twisted pair and sent back to your neighbor's phone. The signal may travel miles to and from the central office to simply go less than 100 feet to your neighbors phone.

Nearly all areas of the economically developed countries have been wired with *twisted pair* (or *local loop*) telephone wires and *coax cable* TV systems and the switches that make these telecommunication systems useful. The most expensive part of any telecommunications system is the installation of individual lines connecting each phone and/or TV to the central switches. And, existing systems of individual lines offer the most inexpensive Internet communication opportunity. For example, many users rely on telephone modems that are relatively inexpensive. And, no change in the telecommunications infrastructure, either in a house or out on the pole are required for any phone to have Internet access. Although downloading web pages that include color photos may take forever, an Internet connection exists.

## Digital Communication

Digital communication is far more complex than analog. To achieve digital voice communication from an analog telephone source, the analog vacillating voltage output of the microphone in a telephone is passed through a digital converter that creates a digital signal consisting of a string of zeros and ones. When this string of zeros and ones is received by a digital converter on a second phone, it is re-converted into a vacillating voltage that drives the diaphragm of the speaker in the earpiece and the voice is heard. This conversion to/from a digital signal is required for all digital transmission for either electrical wire or electromagnetic radiation carriers. In a way, the only difference between analog and digital is the analog uses a vacillating voltage and digital uses a stream of zero and one bits. The telephone is still analog, but the transmission is digital.

There would be no justification for the trouble of converting analog to digital voice format except for the phenomenal increase in voice transmission efficiency and quality. This is because a digital data stream can be broken into pieces at the transmitting end and reassembled at the receiving end so as to appear to the receiver as a continuous string of sound just as it originated. Thus, if a high capacity line is available, multiple phone calls can be sent down that line simultaneously using electromagnetic digital signals. And, the use of electromagnetic radiation in a digital line means that a broad band of frequencies are available for carrying the digital data.

### The Switching System - Telephone

The plain old telephone system consisted of a network of electrical *circuit switches* that switched the electric currents from twisted pair to twisted pair. But, beginning in the early 1980s, these switches in the US were gradually upgraded to digital switches *with packet switching*. What packet switching means is that the analog (varying voltage) signals of a telephone call were converted into digital code and a series of these codes are bunched to-

gether into a packet of digital data that is labeled with its destination number. The packet is sent very rapidly (near the speed of light) along a broadband line from switch to switch where each switch is guided based upon the packet's destination address. At the destination central office switch, the packets are reassembled into the digital series and converted back to analog voltage variations and sent to the destination address telephone.

The advantage of this technology is that every telephone line from switch to switch can handle many more calls because the line can simultaneously carry packets from many different telephone calls. Copper lines can carry more digital data since they do not have to be dedicated to a single call. And, glass fiber lines can carry even more data than copper lines. And, because digital signals are nearly immune to various forms of electrical interference, the quality of telephone sound is improved significantly.

The application of packet switching technology allowed telephone companies to greatly expand the capacity of their existing wiring systems without adding new wires. Over time, the switch-to-switch lines have increasingly become glass fiber where packet transmission is electromagnetic radiation in the range of visible light that can transmit hundreds of calls simultaneously. But, the transmission is still switch to switch and then conversion to analog before going to the destination phone on the local loop – the old fashioned twisted pair of copper wires.

Glass fiber (fiber optic) transmission lines and many high capacity (broadband) copper cables are used for carrying both voice and data transmission all over world. These high-speed, packet switching, broadband lines make up the *backbone* of telecommunications systems today.

#### The Cable TV Switching System

Both cable TV and satellite TV systems are unidirectional transmission systems, i.e., these systems have central offices that send signals to your TV but you cannot send signals to

the central office. Cable TV systems are local or regional systems in the U.S. but other nations have national systems. All current systems operate with unidirectional transmission. Each cable system has central switches that transmit the signals out to neighborhood distribution nodes. At the neighborhood node, the entire signal is copied to and sent down individual coax lines that enter individual homes, schools or offices. The path from switch to TV set is defined in advance. There are no changes at the reception point that are not predefined and made with software in the central office switch or, in many cases, with hardware installations such as coax cable to individual TVs and predefined set boxes. All TV cable systems began life as analog systems (vacillations in electromagnetic radiation). Recently, some of these have been updated to add digital TV signals.

In most cases, both analog and digital TV are carried on the same cable. This is possible because the digital TV signal is transmitted as packets of digital data. These packets can travel along the same wire as the analog signals on a separate electromagnetic frequency without interference and then be captured by those set top boxes that are defined as the locations to which the packets are addressed. Needless to say, set top boxes for digital signals contain the electronics to convert the digital packets into a continuous stream of analog electromagnetic radiation that your TV can understand.

Satellite TV broadcasting systems are digitized packet data transmission systems. These systems transmit on a dedicated frequency assigned to them, a frequency that will not interfere with other airborne frequencies used for radio and TV transmission. The earth-bound antenna/receiver collects the signal from the satellite, converts it into the analog TV frequencies your TV set can use and sends it to your TV. In other words, the satellite TV system owner saves the cost of installing a wire from a broadcasting station to your home or office. Instead, the owner incurs the cost of the satellite and the ground based antenna.

Another potential wireless system of interest for high-speed Internet transmission is cellular phone of the digital type. The most important cellular phone digital system is frequently referred to as third generation cellular service. This service is not analog but instead uses packet audio data transmission from each phone to the central switch. By using a complex packet compression and transmission system, transmission speed is greatly improved and the phone is duplex, i.e., you can send and receive simultaneously. In addition, this system has the full capability of sending and receiving digital data packets at relatively high speeds. These third generation cell phones are now being advertised for use with high-speed Internet e-mail, games, web sites and more. Second generation phones (PCS) also are digital but do not have the compression technology so their transmission speeds are much slower.

#### The Broadband Public Switched Telephone Network

In 1984, the International Telecommunications Union (ITU) published the standards describing the “broadband telephone network.” This network is a fast packet network able to switch integrated services (voice, data, video, etc.). The ITU envisioned that the network would require fiber optic transmission facilities and broadband switches able to switch transmitted traffic at speeds greater than 45,000 kilo bits per second (kbps) which means the same speed as 45 mega bits per second (Mbps).

There is no single definition of broadband. The ITU defines broadband as transmission greater than 45 Mbps. This is quite different than how the cable companies define broadband as services transmitted at greater than 1500 kbps (1.5 Mbps). The broadband network envisioned by the telecommunications visionaries in 1984 is now being deployed. In the U.S., the Inter-Exchange Carriers (IECs or long distance carriers) have completed deploying asynchronous transfer mode (ATM) packet-switched networks using fiber optic transmission. In the U.S., the larger incumbent local telephone carriers delayed spending the money deploying ATM switches in their backbone infrastructure unless they could find customers willing to

pay for deployment. Today, many companies that are not part of the packet switched telephone network have entered the business of building additional backbone. For example, WorldCom and Global Crossings and many other private corporations are building fiber optic packet-switched networks and selling capacity on them to all who want high-speed broadband capacity. The Swedish government is installing broadband networks through out the country.

Interestingly, the speed of an electromagnetic signal is surprisingly constant (depending on the transmission medium) – close to the speed of light in glass fiber. All electromagnetic signals travel at about the same speed in a specific medium. So the only way to increase the quantity of data transmitted per unit time is to broaden the capacity of the signal. Since faster signals are not possible, computer specialists talk about using “bigger pipes” to deliver data faster. In other words, the term “data speeds” is misleading; data “speeds” are actually measured in number of data bits (quantity of data) received per second (kilo bits per second) at a destination, not in kilometers per second of signal speed as the term implies.

Broadband lines do not move data bits down the line faster but are bigger pipes, operating at or near the speed of light, and therefore deliver a larger quantity of data per second than narrow band lines. That is why all new long distance telephone and Internet data transmission lines are glass fiber, the technology with the broadest band since the electromagnetic light spectrum is huge. It can be divided into one hundred, or even as claimed recently over 1000 broadband segments. The Internet especially needs this broadband capacity to transmit huge data bit content like catalog color photos and art work, purchase order information, music, voice and video teleconferencing and other content that makes it a viable medium for transacting business -- retail, wholesale and business to business. The volume of digital data packets necessary to paint a screen with multiple colors, action figures, and flashing images is very, very large.

Through out this report, we use the term “*broadband*” to mean *high-speed access* to the Internet. High-speed herein means transmission rates in excess of 400 kbps downstream and at least 200 kbps upstream. *Downstream* means transmission of data from a source to a receiver (e.g., personal computer). *Upstream* means transmission of data from a terminal to a Internet service provider (e.g., AOL, EROLS, etc.).

The National Telecommunications and Information Administration together with the Rural Utilities Service published a report in which they presented a table to demonstrate the speeds (pipe sizes) required for several commonly known services. Table 1 below shows these speeds.

**Table 1. Speeds Required for Commonly Known Services.**

Application	Representative Rate Kilobits per second
28.8 bit Modem over Telephone Voice Circuit	<b>33</b>
Inter-office Digital Telephone Voice Circuit	<b>64</b>
Low-resolution Conference-Quality Video (Compressed)	<b>200</b>
Compact Disc Audio	<b>1,400</b>
VCR Quality TV (Compressed)	<b>1,500</b>
Broadcast Quality TV (Compressed)	<b>5,000</b>
High Definition TV (Compressed)	<b>20,000</b>

Source: *Advanced Telecommunications in Rural Areas*, National Telecommunications and Information Administration and Rural Utilities Service, Washington, D.C., October, 2000; p. 6.

Anyone who has accessed the Internet for information other than e-mail knows the advantages of broadband communication. The major problems with broadband communication occur when the transmission of packets reaches the *last mile*, i.e. the last mile of analog telephone wire or TV coax cable wire. Dial up 56.6 kilo bit per second (kbps) telephone modems use the maximum analog telephone technology available but still take a very long time to deliver a full screen image sent from a broadband computer server.

There are, however, ways of bringing broadband Internet signals through the last mile of analog wire. Large corporations and other organizations purchase or lease dedicated broadband (broadband) data lines such as ISDN or T1 lines. ISDN works using two twisted pair. T1 lines use shielded twisted pairs. Users that need more capacity use glass fiber lines.

However, with few exceptions, small businesses find the cost of such lines to be prohibitive and few would use the large capacity available. Instead, small firms must rely upon their available telecommunications connections, i.e., the telephone twisted pair, TV coax cable or satellite transmission. The three most widely discussed available technologies to deliver broadband Internet data through the last mile are cable modems, digital subscriber lines (DSL) and wireless communications.

### Cable Modems

As mentioned earlier, coax cable has a broadband capacity because of its use of shielded cable electromagnetic frequencies. However, most frequencies and in many cases the entire band is used up by the TV stations sent to users' TVs. A cable company can however, transmit digital data in packet form (Internet packets) along one frequency in this cable without disturbing the analog transmissions on other frequencies. All that is necessary to receive this in a user's facility is a modulating device that has an address that matches the packets' addresses. The *cable modem* converts the digital packets to a form that can be read by a personal computer. Such cable modems have the capability to deliver very high volumes of bits – 50 to 100 times more than the best telephone modem. Data packets travel outward from the central office on the network through all nodes but are recognized and modulated solely at the properly addressed modem. However, since the data packets are transmitted on a single frequency, as more users begin to use the system (most neighborhoods in the U.S. have 500 to 2000 users on each neighborhood node), the assigned frequency becomes more and more crowded with data packets for a larger and larger number of simultaneous users. This slows the traffic on the highway just as auto density slows traffic on expressways during rush hour. In other words, data transmission speeds slow down for all users.

Furthermore, most cable TV systems are designed to be one way – i.e. from central switch to user, a process called *downstreaming* – and that means another method is necessary

for transmitting from the user's PC to the central office. Early cable modems include 56.6 kbps telephone modems as part of their operation thereby using the telephone system to send Internet data from the PC to the station, a process referred to as *telephone facilitated upstreaming*. More recently, some systems have added lower range frequencies (otherwise unused) to the cable system for upstreaming so that both downstreaming and upstreaming use the cable system. Still, increased user density can slow the system and discourage avid Internet users. At busy times, the speed of downstreaming and upstreaming can approach that of a telephone modem.

### Digital Subscriber Line (DSL)

This technology provides an electromagnetic signal transmitted over the telephone company's twisted pair line to each user. This is actually an old technology for which there was little use until access to the Internet via the local loop became important. Depending upon the type of DSL installed and the user's distance from the telephone central office where the DSL equipment originates its signal, DSL can provide transmission speeds of up to thirty times that of a telephone modem. At 5450 meters from the central office, DSL can provide 1,500 kbps downstream speed compared to 56.6 kbps for a telephone modem. At 2730 meters from the central office, DSL provides over 8,000 kbps.<sup>3</sup>

The reason for these distance limitations is that the electromagnetic signal decays over the unshielded copper lines and loses its useful power in most cases after 5450 meters of twisted pair copper line. In addition, the twisted pair from the main office to the user must be free of any telephone equipment that may be installed on the loop to improve analog voice transmission quality. Such equipment is a major limitation for longer distance applications between central offices and users' locations. In U.S. urban areas with a high density of telephones, the local telephone companies have frequently used neighborhood equipment that re-

ceives and sends digital signals on glass fiber. These neighborhood digital/analog converter nodes receive digital via glass fiber from the central office and convert these signals to analog transmission along the twisted pair to the businesses -- and vice versa. In such neighborhoods, DSL is not available at all because DSL originates in the central office and cannot cross the neighborhood converter.<sup>4</sup> Major equipment changes are necessary to provide DSL in such neighborhoods.

### Wireless Transmission

As noted above, wireless transmission of packet digital data from satellites to ground stations is already being done for TV programs. This is broadband transmission that offers the same potential as cable TV. However, because the wireless transmission is sent through the air, the frequency range used by this system must not interfere with existing airborne broadcasting frequencies. Therefore, satellite systems, just like radio and TV stations, have a unique frequency bandwidth about the same as cable TV. But, Internet data transmission cannot be simply added onto a TV satellite system since the satellite may not be equipped with the proper equipment to provide both downstream and upstream connections to the Internet backbone. For this reason, early use of TV satellites for Internet use provide downstream service only. Up load was done by telephone just like early cable TV Internet service.

For practical purposes, this means new satellites are required for broadband, duplex service. Full satellite based Internet systems are now in operation in the U.S. StarBand now offers digital Internet broadband satellite service, both downstream and upstream. Others are not far behind. StarBand claims that any satellite antenna in the U.S. with a clear view of the southern sky can have broadband Internet communication now. StarBand believes this should

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<sup>3</sup> The DSL described here is the most commonly deployed to date, asymmetric digital subscriber line (ADSL). This service provides a greater downstream speed than the upstream speed.

<sup>4</sup> There is a technological solution to this problem. However, it requires installation of additional equipment at every fiber-to-analog location in the system. Expensive but not impossible. Source: Conversation with Karen Patten on January 9, 2001.

encompass 90 percent of the U.S. land area (CBS, 2000). StarBand is now advertising the availability of TV service as well.

Other land based wireless systems are technically feasible but not yet widely applied in commercial applications in the U.S. (National Telecommunications, 2000).

### Broadband Transmission Speeds

Table 2 below gives the data transmission speeds for the various available systems. The list of technologies is in rank order of their downstream kbps from least to most.

**Table 2. Transmission Speeds of Alternative Connecting Technologies<sup>5</sup>**

Technology	Downstream Typical (max) Kbps	Upstream Typical (max) kbps	Range Miles	Availability	Deploy- ment
Cellular/PCS dial up	<b>9.6 (20)</b>	<b>9.6 (20)</b>	<b>10</b>	<b>Recent</b>	<b>1000s</b>
28.8 Modem-dial up	<b>28 (34)</b>	<b>28 (34)</b>	<b>3.5</b>	<b>Common</b>	<b>34-40 million</b>
56.6 Modem-dial up	<b>45 (53)</b>	<b>28 (34)</b>	<b>2.5</b>	<b>Common</b>	<b>Millions</b>
DBS satellite (TV system)	<b>350 (400)</b>	<b>Via phone</b>	<b>NA</b>		<b>10,000s</b>
Internet satellite systems	<b>100s (1000s)</b>	<b>100s (1,000s)</b>	<b>NA</b>	<b>Developing</b>	<b>None</b>
3 <sup>rd</sup> Generation Cellular	<b>100s (2,000)</b>	<b>100s (1,000s)</b>	<b>10</b>	<b>Developing</b>	<b>None</b>
Dedicated T1 line	<b>1,544</b>	<b>1,544</b>	<b>1.1</b>	<b>Common</b>	<b>10,000s</b>
ADSL (G.lite)	<b>400 (1,500)</b>	<b>64-256 (500)</b>	<b>3.5</b>	<b>Recent</b>	<b>0.5 Mil.</b>
Cable TV modem	<b>1000 (27,000)</b>	<b>200 (10,000)</b>	<b>3</b>	<b>Recent</b>	<b>1.5 Mil.</b>
Local multipoint dist. System	<b>(155,000)</b>	<b>(155,000)</b>	<b>4</b>	<b>Recent</b>	<b>1,000s</b>
Fiber to the business	<b>Millions</b>	<b>Millions</b>	<b>100s</b>	<b>Recent</b>	<b>1,000s</b>

Source: Adapted from: un-numbered table, *Advanced Telecommunications in Rural Areas*, p. 45. Availability and deployment information in this table is accurate for December, 1999.

Clearly, fiber to the business is by far the fastest system. However, this solution is a long way off for technical reasons. For the purposes of this report, it shall suffice to say that the technical requirements of installation of fiber requires \$1,000 to \$1,500 of user owned equipment per connection and the business owner needs to supply an uninterruptible power supply since power cannot be supplied over the fiber line. Battery back-up power systems may be a problem due to the low frequency of test and use. In addition, optical fiber cable would have to be installed from the central offices to each and every business. Because tele-

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<sup>5</sup> The table shows U.S. transmission speeds that in some cases are different than those in other countries because of the way the FCC has allocated electromagnetic frequencies.

phone plant lasts a long time and companies try to avoid rebuilds, fiber trials have generally been in new housing developments where the excess cost is primarily in the customer owned terminal equipment because the telephone company needs to install new cable anyway (National Telecommunications, 2000, p. 25 and footnotes no. 81 and 82).

#### Data Packet Transmission

It may be obvious that the Internet is simply another form of digital packet transmission of data. Internet digital packet transmission is referred to as Transmission Control Protocol/Internet Protocol or *TCP/IP*. Most telephone transmission uses Asynchronous Transfer Mode or *ATM*. The fact that these have become worldwide standards enables everyone everywhere to communicate with each other electronically on either standard.

### **3. Broadband Internet Communications for Small Businesses**

The Internet provides such easy, worldwide communication that more and more users have adopted this and the amount of data transferred in TCP/IP is growing rapidly. Moreover, since the telecommunications system has become so much faster (bigger pipes), creators of content have adopted more complex content and the volume of data associated with most applications has increased. For example, the home pages of businesses are no longer simple text descriptions but include photos, artwork and frequently moving or flashing images. And the web sites of corporations and retail sales organizations have become phenomenally complex with each page another sensational (though often confusing) vision. Such enhancements make the web sites more interesting and where commercial activities are involved, these enhancements may make a difference in sales.

Therefore, commercial applications today require high transmission rates to assure competitive viability in a world where flashing signs, color variations and moving figures are standard methods of attracting user attention and encouraging a sale (Patten, 2000, p 312-313). And, this expanded content makes Internet searches extremely slow unless broadband

reception is available. Broadband services are vital today and will be absolutely necessary tomorrow for communication on the Internet.

We begin this section with a description of how small businesses perceive their needs for Internet use and broadband access. This is followed by a description of the many types of existing and new services available on the Internet that offer useful assistance to small businesses. In summary, small businesses need to become actively involved in Internet applications and recognizing this will require that they obtain broadband access to the Internet.

#### Small Businesses' Perceived Need for Broadband Internet Service

The important issue is whether broadband Internet connections are needed by small businesses, especially rural small businesses. Results of a recent U.S. survey by the National Federation of Independent Business (NFIB) show that small businesses have little direct interest in the Internet and the problem of broadband access. Yet, an evaluation of their interests reveals that many of their high priority concerns can be addressed by services available on the Internet.

These results are published in the fifth edition of *Small Business Problems and Priorities* that reports the result of a survey of U.S. small businesses (Dennis, 2000). Of the 75 problems in the survey, "Effective business use of the Internet" was ranked 67<sup>th</sup>. This is not a strong response. However, one can see that more highly ranked problems are closely related to Internet use. Locating qualified employees (Rank 8<sup>th</sup>), telephone costs and services (Rank 10<sup>th</sup>), keeping skilled employees (Rank 31<sup>st</sup>), training employees (Rank 38<sup>th</sup>), purchasing and using computers or new technology (Rank 42<sup>nd</sup>), and getting useful business information (Rank 57<sup>th</sup>) are all potentially solvable through the use of the Internet. Clearly, small business owners in the US neither recognize the role that the Internet can play in resolving problems and changing their business practices nor the potential for new opportunities and new competition generated by the Internet.

Small businesses' need for broadband Internet service remains latent at least partially because of the lack of available broadband access. With dial up telephone modems, access to today's complex content web pages is excruciatingly slow such that users become bored and cease efforts to use the system. Although demand for services is usually the driving force for supplying services in a market economy, for new technology based services, demand may not appear until the service demonstrates apparent value to the user. Thus, demand arises only after the service becomes available and the user recognizes its value. So, unless a broadband supplier believes that an untapped market exists and is willing to install broadband in anticipation of economically sufficient demand, market forces will not provide a service that may not materialize.

This is a real threat in the US today, even in urban environments. According to *Business Week*, this is the current plight of DSL and cable modem providers. Last year, three major suppliers of DSL service, NorthPoint Communications Inc., Rhythms NetConnections and Covad Communications Group, lost a combined \$1.15 billion on sales of \$279 million. And the major cable modem service @Home is expected to lose money until 2002 at least (Shinal, 2001). And, NorthPoint is now in bankruptcy. The market failure experiences of these firms that are solely in urban areas with high-density populations are likely to add further delay to implementation of services for small businesses, especially in low population density rural areas.

### Internet-Based Business Applications

Even though small businesses owners have not yet recognized the importance of the Internet to their businesses, there is a plethora of new applications existing and emerging on the Internet. The "burst bubble" of the business to consumer (BtoC) dot.coms suggests a decline in Internet applications but this is not true for businesses. More and more business to business (BtoB) applications are emerging to dominate Internet transmission. Those worthy

of mention at this time are tele-conferencing, electronic data interchanging, e-commerce, mobile computing, and application service providers. Although widely discussed and well known, these applications are only realistic when broadband access is available and used.

#### 4. **Currently Available Broadband in the US**

In the US, focusing upon broadband access in rural towns fails to resolve the broadband access problem for rural small businesses since neither telephone nor cable modem based broadband services are uniformly distributed among small cities and towns. Telephone enabled DSL is biased in its deployment to larger towns. The regional telephone operating companies report that fewer than five percent of towns they serve with less than 25,000 population have DSL deployed. And less than 0.1 percent of towns with under 2,500 people have DSL (National Telecommunications, 2000, p 21). However, it is not clear whether the regional Bell operating companies' analysis is a reliable indicator of deployment since there are many more rural towns with independent local exchange carriers (ILECs) than there are regional bell towns.

As of March 2000, the *Advanced Telecommunications Report* examined a sample of cities and towns and found that large cities all have some deployment of cable modems whereas fewer than ten percent of towns with less than 25,000 population have broadband deployment of any kind. Less than one percent of towns with less than 2,500 people have cable modem deployment (National Telecommunications, 2000, p 18).

The FCC conducted a survey of broadband service providers in 1999 and divided the U.S. by postal codes and population density of these postal codes. They define a small town as a postal code that meets these criteria:

1. between 1,000 and 15,000 population;
2. between the 25<sup>th</sup> percentile and 75 percentile in population density;
3. no adjacent postal codes have more than 10,000 population;
4. adjacent postal codes have no more than 80 % of the population density of the small town's postal code.
- 5.

Using a survey of broadband suppliers, they estimate that 57 percent of postal codes in small towns have at least one high-speed services subscriber. Furthermore, they estimate that 72 percent of the small town population across the country lives in postal codes with at least one “high-speed” subscriber.(FCC, 2000, paragraph 91 and footnote 122). The population percent suggests a greater coverage of small town population than reported by the numbers from *Advanced Telecommunications*. However, the population coverage is biased towards the larger towns so it is difficult to be sure which number accurately describes reality. However, it is likely that the smallest towns have the least access to broadband.

Currently, small rural independent local exchange carriers (ILECs) in the US are deploying broadband services. The National Telephone Cooperative Association (NTCA) reports that many of the small incumbent ILECs are deploying the services based on market demand, not just economics (Bridges, 2000). NTCA studies show that small, ILECs’ markets are more technically advanced than the rural markets served by the largest ILECs (Wacker, 2000). In fact, small rural ILECs in the US have a reputation of deploying the latest technologies faster than the large regional companies. For example, small rural ILECs deployed digital switching into their local central offices in the 1970s and 1980s. By 1997, rural central offices were over 99% digital while the large regional carriers still need to upgrade 15% of their central offices (Reiter, 2000). Thus, the small rural ILECs with their digital switching central offices are well prepared to pass broadband digital Internet onto the trunk lines and into the Internet backbone.

The National Exchange Carrier Association (NECA) estimates that it would take at least \$10.9 billion to completely deploy a broadband-capable network in rural areas. Half of that will be needed to upgrade lines in isolated areas (Bridges, 2000), areas in which there are few small businesses. Undoubtedly, the rural ILECs will need financial assistance to be able to deploy broadband services to the isolated areas.

Because of their customer needs, especially for Internet access, the rural ILECs are deploying alternatives to the public switched telephone network (PSTN) to handle the demand for data only traffic. These are the so-called non-PSTN advanced services such as wireless telephony long distance, cable television, and direct broadcast satellite services (Denes, 2000).

### Connecting to the Backbone

It is useful to note at this time that connecting these small town networks into the backbone (broadband trunk line transmission system) is not a problem in the US as there is a surplus of unused glass fiber (dark fiber) linking central offices and the backbone (FCC, 2000, paragraphs 22 and 27).

### Potential for Broadband Services in Small Towns

Small businesses in the small to smallest rural towns have problems obtaining broadband service. But, interestingly, the smallest towns are uniquely positioned to take advantage of DSL service. As noted by *Advanced Telecommunications*,

“Most customers in cities and towns, even very small towns, are served by plant that is inherently advanced services capable given the addition of DSL equipment because they are serviced by these short loops” (National Telecommunications, p. 13).

This is true because these small cities and towns are served by local loops extending less than 6000 meters (3 ½ miles) feet from the central office. And these loops are not “loaded” with voice enhancing equipment common in large cities and along longer loops such as those extending to remote farm houses. Moreover, the FCC has had a Synthesis Cost Model that does not use loading (addition electrical enhancements for voice transmission) of local loops. And, since 1993, the Rural Utilities Service has required use of the Synthesis Cost Model by all ILECs using RUS borrowed funds for expanding or remodeling their facilities (National Telecommunications, 2000, p. 13).

### Local Exchange Carriers’ Opportunities

Another response to the small town dilemma is that some of the smaller rural ILECs can and have consolidated their services into larger companies. This allows them to provide

more services and improve the quality of all services. On the other hand, as the smaller ILECs consolidate, they risk losing a major competitive advantage against the large regional Bell operating companies, which is a community-based service built on the knowledge and needs of specific customers in each community. So, a major issue is how can these smaller, community-based ILECs keep their competitive edge and at the same time be able to take advantage of the economies of scale for new technology implementations? One solution may be the ability to form alliances or joint ventures with other smaller ILECs allowing them to share expertise, purchasing clout, and, possibly, even centralizing some key facilities (Schadelbauer, 2000).

Overall, it appears that since the vast majority of rural small businesses are in small towns, they are well situated to have access to broadband services if and when the ILECs find it appropriate to install the DSL service.

#### Impending Competition for the Rural Telecom Companies

Economic theory states that market driven economies depend upon competition to allocate resources among various segments of society. Therefore, it is useful to assess the type and extent of competition that may affect the availability of broadband services in rural small towns. There are several possible sources of future competition not only in the broadband services but also in telephone services. These are rural satellite services, cable TV operators, the large regional telephone companies, mergers and acquisitions of independent LECs, and development of wireless communication.

Satellite television service is well established in rural areas of the US and the technology exists for these services to offer broadband connections to the Internet (Higgins, 2000). Cable TV is widely available in small towns and the technology exists for high-speed connections to the Internet (Arnason, 2000).

### Telephony and Broadband by Rural Cable TV Operators

Cable TV has been deregulated in the US and the industry is looking for ways to increase its revenue. The cable industry has developed a third “broadband” standard called data over cable service interface specifications that will make broadband services even faster (Arnason, 2000). In addition, cable operators are interested in providing telephone service over their cables. However, significant investment in infrastructure will be required to add telephone and Internet services, as cable systems remain largely single direction, simplex transmission systems (Kahner, 2000).

### Increased Concentration and Control by Large Firms

Over the last five years, the largest telecommunications companies in the US have spent much time merging with or acquiring each other in the name of competition. Instead of having more companies to choose from, there are fewer large companies. The argument for these mergers is that the companies must become larger in order to trim costs, be more efficient, and share networks so that they can compete on an equal basis with the other large companies. A key concern of the mega-mergers is how will they affect the small ILECs and what should be done about it? An initial reaction may be fear and helplessness trying to compete head-to-head with the giants. It is not just a matter of retaining existing customers with their service, but being able to acquire and install the newest technologies, which may be under the control of the giant telecommunications companies (Kahaner, 2000).

### Acquisitions and Mergers Among Independent LECs

One impact that may be both positive or negative depending on the eventual outcomes is the buyout of key or strategically located small rural ILECs by the larger ILECs. If the operator of the small ILEC wants to sell out this may be beneficial. However, it may not be beneficial for the end subscriber. More that likely, the large ILEC will selectively attempt to

buy out only the best of the small rural ILECs. Other small ILECs are more likely to merge or buy out each other (Kahaner, 2000).

Some subscribers may feel that larger companies will be able to offer lower prices and more services. However, the loyalty of long-term customers is becoming less, as phone service becomes more of a commodity. Some customers are more willing to trade the quality of their services for lower costs (Kahaner, 2000).

## **5. Public Policy Where US Markets Fail**

The tradition in America is to let markets provide goods and services with government stepping in when markets fail. Market forces focus attention on the potential for big profits from heavily populated areas while those in rural and even many suburban areas are unable to get connected due to the costs of developing infrastructure for delivery to consumers' homes and businesses (Wildstrom, 2000). For a market purist this situation may be justifiable, but another US tradition, that of equal opportunity in the form of access, requires consideration of those left out of the market. This is especially true when those left out are significant contributors to the social and economic well being of this nation, i.e., rural small businesses. Being "left out" becomes a matter of not being able to compete effectively, a condition that can develop into a downward spiral of negative economic growth. In such situations, public policy tools often are used to "level the playing field," that is, ensure equitable access to those who otherwise might be unable to compete.

A review of US history reveals that similar problems emerged for earlier technologies, for example, telegraph, electrification, telephone and even television. The pattern of public policy that has emerged for resolving these market failures has been the Federal government acting with combinations of incentives to bring services to and to stimulate further economic development in these the ignored area markets. In some cases, public policy formation was driven by elites, sometimes it was catalyzed by vigilant government agencies on behalf of

constituencies, and sometimes it emerged from grassroots political activity through the persistence of sympathetic congressional representatives.

Advocating universal access to a still-evolving, new technology, is risky. Recommendations that will help rural small businesses, indeed all small businesses, must be cognizant of the point in time and degree of uncertainty, yet be true to historical preferences for indirect mechanisms stimulating private sector competition on the one hand and business economic demand on the other hand. We offer the following recommendations:

1. Recognize that the early date in the history of this technology and its continual evolution generates great uncertainty requiring flexibility.
2. Advocate the collection of data on the use of and availability of broadband services among rural and urban small businesses so as to more accurately define the existence of a digital divide.
3. Partner with other rural and small business technology advocates to assist ILECs in making infrastructure choices based on appropriate criteria.
4. Assess, define, articulate and promote small business education, knowledge, motivation and readiness for broadband technology use.

Other nations may well find some of these recommendations appropriate for their own problems with rural small businesses. Recommendation 1 above is definitely appropriate; however, in this rapidly changing technology driven world market, delaying too long before assuring access by all small businesses in any nation may bring about a catastrophic failure of many who are too late to enter the high-speed Internet world.

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