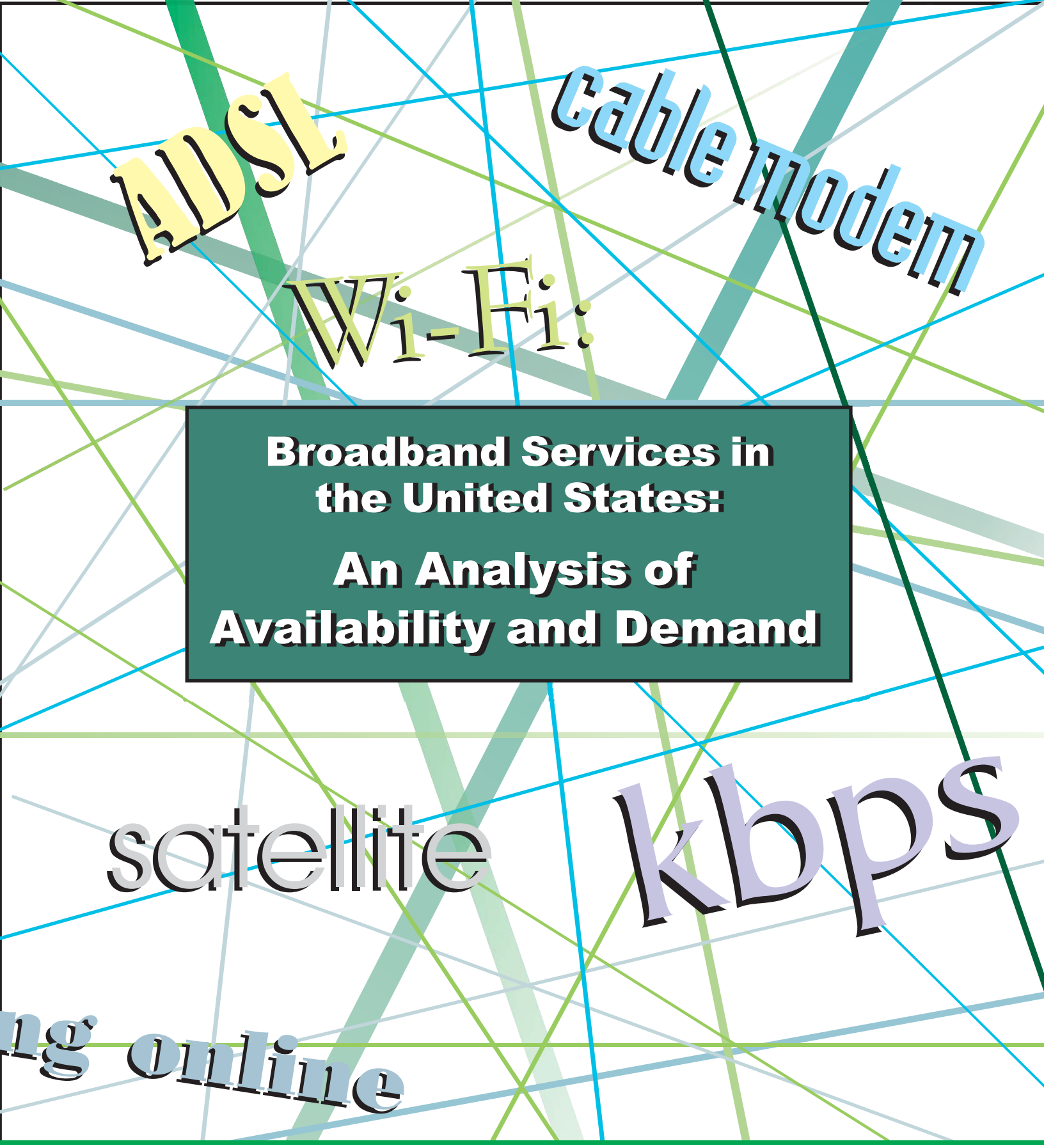


# Broadband Services in the United States:

# An Analysis of Availability and Demand

PREPARED BY:

The Florida Public Service Commission
Office of Market Monitoring and Strategic Analysis
on Behalf of The Federal-State Joint Conference on Advanced Services

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BROADBAND SERVICES IN THE UNITED STATES:
AN ANALYSIS OF AVAILABILITY AND DEMAND

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## EXECUTIVE SUMMARY

Not so long ago, the main debate over broadband centered on what many perceived to be slow deployment. If only broadband were available, it was thought, subscribers would sign up in droves and America's economy would not only be rescued, but propelled to new levels of prosperity. The latest data show that rollout of broadband services has not been slow, but has progressed at an incredible pace. It has taken just five years for 80% of American households to have cable or DSL broadband available. Demand for broadband services, however, has not kept pace, causing the debate to shift from deployment to what many now perceive to be low demand. Recent estimates of broadband penetration range from 10 to 15 percent of U.S. households, leaving quite a gap between broadband supply and demand.

The current household penetration level for broadband naturally seems low when compared to its high availability. Disappointment over the gap in demand may stem from unreasonable expectations mirroring those that fueled the telecommunications boom following the 1996 Telecommunications Act. New services and technologies are not accepted overnight, especially those requiring some sophistication of knowledge and skill to install and use. It is therefore helpful to analyze broadband penetration from a historical perspective, comparing it to consumer adoption of previous technology rollouts. When examined in this perspective, demand for broadband is found to be extremely strong, exceeding demand for previous technology rollouts. Penetration appears low at this point, because deployment has simply outpaced demand.

This is not to say that the present level of availability and demand is sufficient. Rural deployment significantly trails urban deployment, and a number of factors are hindering consumer acceptance of broadband. This study has found a number of barriers that will need to be overcome in order to improve the current level of deployment and demand:

<u>Barriers to Deployment in Rural and Low Density Areas</u>

- High deployment cost
- Low demand
- Lower revenue opportunities

<u>Barriers to Consumer Acceptance of Broadband</u>

- High prices
- Lack of compelling applications
- Over 1/3 of U.S. households lack personal computers and Internet connections
- Low consumer awareness of broadband
- Other supply-side factors

This study finds that innovative solutions to the unique problems of rural deployment are being implemented by both private and public interests. In fact, there are a multitude of examples

of rural deployment barriers being overcome by entrepreneurs, cooperatives, municipalities and public-private partnerships. Many creative solutions have resulted from local "grass roots" community efforts when local telephone or cable companies could not be convinced to serve.

As to demand, many of the barriers hindering consumer acceptance of broadband will be overcome by the competitive marketplace. After a steady string of price increases the past couple of years, providers are beginning to respond to slowing demand by offering better prices or value of service. The number of broadband subscribers will soon reach mass market proportions, thus spurring the development and marketing of new applications. There are still large numbers of households, however, that have not yet joined the Internet and broadband revolution. In order to reach this segment, barriers of age, income and education must be overcome. This will require the concerted efforts of and creative solutions by policy makers and broadband providers alike.

The most important role federal and state governments can play in fostering deployment and demand for advanced services is in the following areas:

- Avoid regulations that would determine market outcomes
- Provide regulatory certainty through a consistent regulatory scheme
- Avoid "one size fits all" approaches
- Expand e-government
- Take proactive steps to foster and facilitate local "grass roots" solutions that eliminate roadblocks, align interests and implement best practices
- Facilitate efforts to equip those who are not online with the knowledge and resources to participate in the digital revolution

Regulators must be careful not to hasten to judgement and impose "remedies" for increasing deployment and demand that would interfere with the dynamic and growing broadband market. Providing regulatory certainty through a consistent regulatory scheme should be a priority, as it will hasten competitive responses to supply and demand obstacles. The most effective solutions have been market driven, and many have resulted from efforts at the local level involving municipalities, cooperatives, public-private partnerships and the like. This study provides only a few of the numerous examples of entrepreneurial as well as local "grass roots" efforts that have overcome barriers to deployment.

Case studies of these "best practices" are being compiled separately on behalf of the Federal/State Joint Conference on Advanced Services. These case studies will include state government initiatives to reach out and help local communities assess their needs and build a business case for deploying broadband locally. These proactive outreach efforts are one of the most effective ways state governments can help expand broadband coverage to underserved areas. Public-private partnerships have also been effective in equipping consumers with the knowledge and resources to participate in the digital age. Best practices at both the state and local level can be

replicated with success around the country if there is a dedicated effort to do so.

## I. INTRODUCTION

Broadband access to the Internet has captured the attention of Americans since consumer availability arose half a decade ago. Broadband service provides some fundamental improvements in how we interact with information and with each other. In this paper, service is considered broadband when the end-user connection is greater than 200 Kbps in at least one direction. This is not often a binding constraint since market offerings typically have a floor of 256 Kbps.

The increase in bandwidth provided by broadband service (in contrast to dial-up service) allows a leap forward in two-way interactivity. Rather than just downloading web pages, broadband users tend to create and share online content more so than dial-up users. Broadband, in its wireless form, also allows for greater flexibility in regards to where and how we work and communicate. The critical productivity and knowledge enhancement potential of broadband makes it clear that access to this technology can enhance the lives of all Americans.

This leads to key questions. How available are broadband services to American consumers at this stage in the technology's expansion? How strong is the demand for broadband services in the U.S.? How can assistance be provided without hindering natural expansion through the workings of the marketplace? We will examine the issues and highlight innovative solutions implemented by a dynamic mix of innovators, small entrepreneurs, large corporations, cooperatives, municipalities, universities and state and local governments all looking to determine what type of broadband services are demanded by consumers and how they can be made available.

An examination of availability is the first step in this analysis of the market for broadband services. Various technologies and their respective abilities to provide broadband Internet service to the consumer are examined. While cable modem and DSL service are the most widely utilized broadband technologies, other technologies are emerging as competitors or substitutes. The level of deployment for each technology is presented in order to gauge availability to consumers and the degree of competition in the marketplace. Broadband deployment in rural and other underserved areas is another consideration. Differing technologies are analyzed in terms of attributes which are useful in addressing local deployment needs.

Once the state of availability is established, attention naturally turns to an analysis of the demand for broadband services. Broadband subscriber growth is examined from a historical perspective, followed by estimates for future growth. More specifically, demand for broadband services is scrutinized both in terms of current limitations and factors enhancing demand levels.

A section on case studies discusses broadband success stories across the nation. These are

presented in the hope that positive elements may be replicated. Finally, guidelines are developed, based on the experiences described in this paper, which may further refine government's role in supporting competitive broadband service and adding assistance where possible.

## II. BROADBAND AVAILABILITY

Estimating broadband availability in the U.S. is a difficult task in this dynamic market. Numerous sources provide varying estimates on the availability of broadband service. In identifying the most accurate estimate possible, we examine several available sources and analyze the limitations of these data.

Broadband deployment and subscriber growth have recently experienced slower expansion rates. In light of the recent economic downturn, however, many consumer products with strong historical growth patterns have seen unprecedented declines. In comparison, broadband growth still appears rather vibrant.

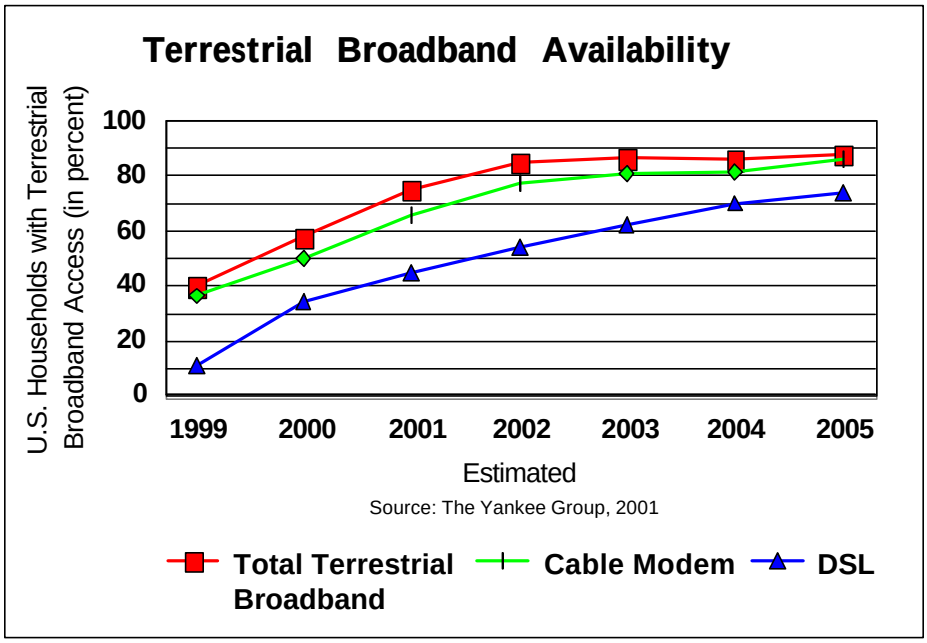
- Shipments of PCS declined 5.1 percent worldwide in 2001 compared with the previous year, according to figures released by market researcher IDC. At the same time, shipments in the United States dropped by 12.2 percent. This was only the second annual drop for the sector in its history and the first since the 1985-86 time period.

- Worldwide mobile phone sales declined in 2001 for the first time in the industry's history. Sales dropped 3% in 2001 in contrast to a compound annual growth rate of almost 60% from 1996 to 2000.[1]

By contrast, as Figure 1 demonstrates broadband is already widely available and expected to continue its expansion for the next few years. While there has been a decline in the growth rate in broadband service availability, deployment has remained strong despite the economic slowdown.

[1] Gartner Dataquest estimates as quoted on CommWeb.com, "Industry First: Mobile Phone Sales Declined in 2001," 3/17/2002.

**Figure 1**




- The Yankee Group reports that terrestrial broadband availability stood at 75% of U.S. households in 2001 and is estimated to rise to 85% coverage by year end 2002. Cable modem coverage is estimated to rise from 66% to 77% by 2002, and DSL is shown to rise from 45% to 54%.[2] In a more recent report, Morgan Stanley Dean Witter estimates cable broadband availability alone will be 86% of U.S. households by the end of 2002.[3]

- The Federal Communications Commission (FCC) has reported that high-speed service was available in 79% of the nation's zip codes at the end of 2001. This compares with 78% availability six months earlier and 73% at the end of 2000.[4] High-speed service subscribers were reported in 98% of the most densely populated zip codes at the end of 2001, the same percentage as a year earlier, and in 43% of the least densely populated, compared with 28% a year earlier.

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[2] The Yankee Group, "Broadband Access Technology: Whose Number is Up?" Sept. 2001.

[3] Morgan Stanley Dean Witter, "Broadband Update: Raising Long-Term Modem Forecast," April 8, 2002.

[4] Federal Communications Commission, "High Speed Services for Internet Access," released 7/23/02. Data current as of 12/31/01. These figures do not indicate full coverage within each zip code but the presence of at least one high-speed customer and therefore at least one supplier.

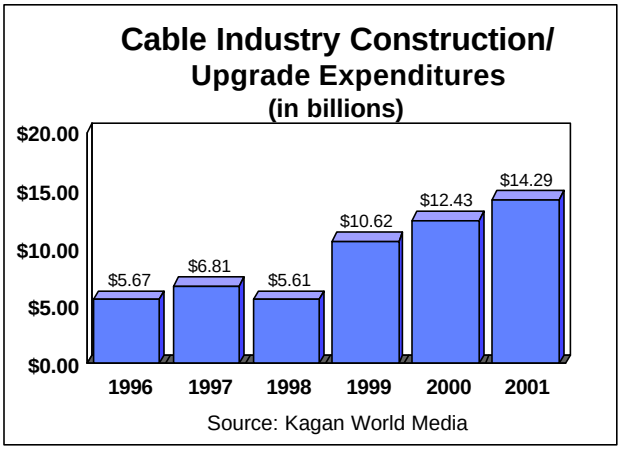
## A. An Overview of Broadband Deployment by Technology

In reviewing the various technologies used to deploy broadband services, cable modem and DSL are by far the most widely deployed terrestrial technologies. Many rural areas, however, require use of technologies other than cable or DSL. In areas where incumbent telephone and cable companies cannot justify the investment, emerging wireless technologies are increasingly being used by rural ISPs, local entrepreneurs and municipalities to deploy in such areas. Also, the declining cost of many technologies has changed the mix of which technologies are most applicable. (For examples, see Section IV, Case Studies.)

### 1. Cable Modem Availability

The cable industry has nearly completed its massive infrastructure upgrade to digital systems using hybrid fiber/coaxial cable. Construction and upgrade expenditures for the industry were approximately $14.3 billion in 2001 and an additional $12.9 billion is expected for 2002.[5] According to some reports, during the past six years the cable industry has invested $65 billion in network upgrades.[6] These upgrades, which included broadband infrastructure, are nearly 80% complete.[7]

**Figure 2**




[5] Cable & Telecommunications Industry Overview 2002.

[6] Wall Street Journal, "More Consumers Answer Cable's Call on Phone Service", Peter Grant, pg. B1 September 5, 2002.

[7] Robert Sachs, "The Broadband Decade" Remarks to the Cable Telecommunications Public Affairs Association Forum, March 12, 2002.

The potential revenue opportunity for a combined digital TV and cable modem service offering has provided the cable industry with a significant incentive to upgrade their systems. In fact, the digital upgrade also creates the potential for cable telephony service offerings, leading to what many analysts are calling the Triple Threat for cable companies: the ability to market to consumers one bundle consisting of telephone, Internet and digital TV services.[8] Multiple service offerings provide an opportunity for spreading out the high fixed costs of deployment. Once the system is upgraded, the variable cost of providing cable modem service is relatively low. Cox Communications, for instance, reports 44% incremental margins on their high-speed internet service.[9]

We have constructed an estimate of broadband availability via cable modem service by looking at the six largest U.S. cable companies (see Table 1). These Big Six companies represent 87% of all households with cable television service available.[10]

**Table 1: Cable Broadband Service as of 1st Quarter 2002**

| | Homes Passed Cable TV | Homes Passed BB Access | Broadband Coverage[11] | Broadband Subscribers | Customer Take Rate |
|---|---|---|---|---|---|
| AT&T | 24.9m | 15.3m | 61% | 1.6m | 11% |
| Time Warner | 21.0m | 20.0m | 95% | 1.8m | 11% |
| Comcast | 13.9m | 11.3m | 81% | 1.0m | 9% |
| Charter | 11.8m | 8.2m | 70% | 747k | 9% |
| Cox | 10.0m | 9.3m | 93% | 1.0m | 10% |
| Cablevision | 4.3m | 3.1m | 72% | 560k | 18% |
| Total | 86.0m | 67.2m | 78% | 6.8m | 11% |

Source: 1st Quarter, 2002 earnings reports of the individual firms.

[8] Xchange Magazine, "The Cableco Triple Threat, This Time It's Real" by Fred Dawson, May 2002.

[9] Jimmy Hayes, Executive Vice President of Finance and Chief Financial Officer, Cox Communications, speaking at the Morgan Stanley Communications Conference, 9/9/2002.

Incremental margin is derived from subtracting the following costs from avg. revenue/user: provisioning, customer support, marketing, bad debt, billing and cost of goods sold.

[10] Cable Industry Facts at a Glance: 98.6 million homes passed by cable as of 12/2001.

[11] 'Broadband coverage' refers to 'Homes Passed (with) BB Access' as a percentage of 'Homes Passed (with) Cable TV'. Therefore, Total 'Broadband Coverage' refers to the percentage of cable TV homes with cable modem availability, not the percentage of all U.S. households with such availability.

Combined, these companies provide 86 million homes with cable TV availability, 82% of all U.S. households. Including smaller cable companies and municipal operators (who are also upgrading systems), cable lines cover approximately 94% of all households.[12] These data demonstrate the potential for broadband service availability to most Americans through cable modem technology.

For the Big Six, 78% of their cable TV homes passed have broadband availability. In other words, cable modem service is available to 64% of all American households from these carriers alone. Including all cable systems, broadband cable modem service is now available to over 71% of U.S. households.[13] This snapshot shows the tremendous strides the cable industry has made with respect to broadband penetration.

Time Warner and Cox Communications are the farthest along in their respective upgrades. They provide cable modem access to 95% and 93% of their respective homes passed. AT&T Broadband trails the pack with only 61% cable modem coverage. As the largest cable operator, AT&T's lower penetration rate lowers the national availability average significantly.

Updated statistics for cable modem subscribers presented in Table 1 and the DSL subscribers presented in Table 2 were released as this paper neared final revisions. The Appendix provides a summary of this information.

**2. DSL Availability**

The nature of the copper line telephone infrastructure makes measurement of DSL availability a difficult task. Estimates differ widely in regards to which lines are truly DSL capable. According to the Pinkham Group, reports issued by various research firms indicating DSL availability at over 70% of U.S. homes are categorically wrong, and do not take into consideration DSL's technical limitations. Pinkham claims that less than half of American households, possibly as low as 40% to 45%, are able to obtain service due to technical limitations in current network technology. The Yankee Group estimate of 45% availability in 2001 (previously displayed on Figure 1) is closer to Pinkham's. This graph further shows DSL availability increasing to 74% of households by 2005.

Estimates regarding availability vary significantly when technical limitations are not considered. Homes passed are more liberally counted as having DSL service available based on DSLAM deployment in Regional Bell Operating Companies (RBOC) central offices. In this case,

[12] Optinel Systems and Cable Industry Facts at a Glance.

[13] Robert Sachs speech, May 6, 2002. Broadband cable is now available to nearly 75 million homes in the U.S.

homes passed by BellSouth, SBC, Qwest and Verizon at the end of 2001 were estimated at 82.1 million, up 33% from 61.6 million at the end of 2000.[14] According to these estimates, 78% of households could obtain DSL service in 2001 from the RBOCs alone, compared to 59% of households in 2000 (see Table 2).

**Table 2: DSL Service as of 1st Quarter 2002**

| | DSL Homes Passed | Broadband Subscribers | Customer Take Rate |
|---|---|---|---|
| Verizon | 32.0m | 1.4m | 4.4% |
| SBC | 25.6m | 1.5m | 5.9% |
| BellSouth | 15.5m | 729k | 4.7% |
| Qwest | 9.0m | 464k | 5.2% |
| Total | 82.1m | 4.0m | 4.9% |

Source: 1st Quarter, 2002 earnings reports of the individual firms.[15]

BellSouth reports strong DSL deployment estimates. The company claims that 71% of the households in its 9 state region had DSL availability as of March, 2002. This is up from 45% coverage at the start of 2001. The company reports 1,100 central offices and 9,000 remote terminals with DSL availability. BellSouth estimates that 64% of lines had DSL service available at the end of 2001, up from 42% access one year earlier.[16]

With the exception of BellSouth, RBOC DSL expansion has slowed dramatically since 2000 (see Figure 3). As mentioned, BellSouth's DSL footprint grew from 45% in the first quarter 2001 to 71% in the first quarter 2002. By contrast, DSL footprints expanded from 54% to 63% for SBC, from 48% to 56% for Verizon, and from 28% to 33% for Qwest during the same period.[17] This slowing deployment can be attributed to a number of factors including the economic downturn, poor capital markets, lagging demand, increasing deployment costs and regulatory uncertainty.

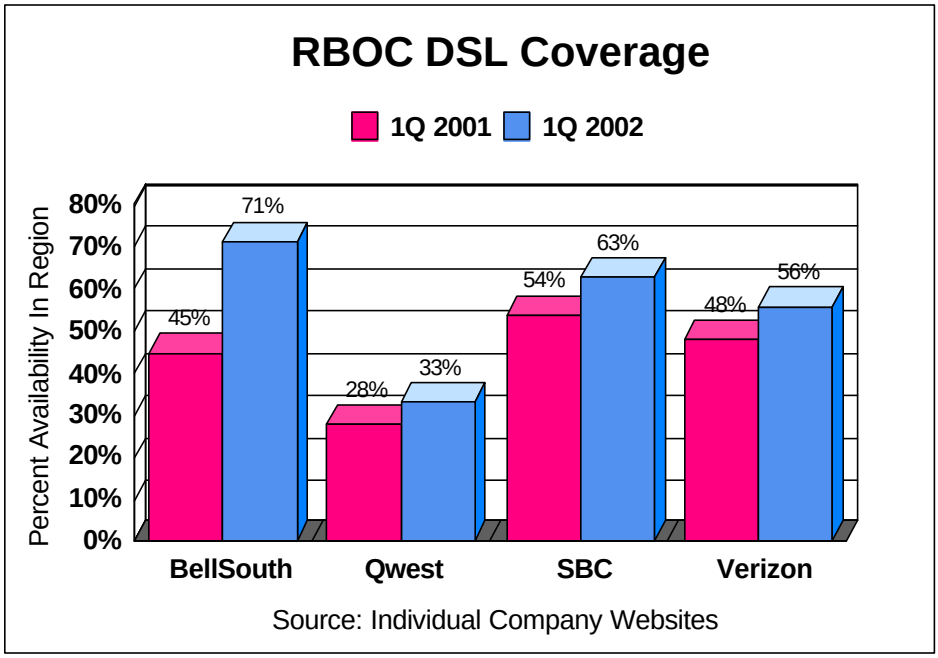
[14] DSL Worldwide Retail Directory Ed. 5, April 2002 Point Topic Limited.

[15] DSL Homes Passed data is as of the 4th quarter, 2001. DSL Homes Passed data is from the DSL Worldwide Retail Directory.

[16] BellSouth "Investor News," BellSouth website.

[17] Individual company web sites and quarterly earnings reports.

**Figure 3**




The Incumbent Local Exchange Carriers (ILECs) are the major providers of DSL service nationwide (see Figure 4). When looking at the number of DSL lines in service across the U.S., ILECs account for 89% of these lines while Competitive Local Exchange Carriers (CLECs) account for 11%.[18] The amount of residential DSL is even more heavily weighted towards the ILECs since 82% of their DSL lines are residential, while only 39% of the CLEC DSL lines are residential. Covad is the largest CLEC DSL service provider with 66% of all CLEC DSL lines.[19] Figure 5 shows that CLECs' DSL line growth during the past two years has slowed while RBOC DSL line growth (particularly residential lines) continued to grow at a rapid pace.

[18]Telechoice, DSL Deployment tracking survey, 1Q 2002. CLECs account for the large majority of this 11% figure, however Interexchange Carriers (IXCs) have a small presence. For the last quarter in which Telechoice separates the two components, 4Q 2001, CLEC DSL lines were 484,060 while IXC DSL lines were 51,781.

[19] Telechoice, "North American DSL Market Reaches 6.2 Million" May 15, 2002.

Figure 4

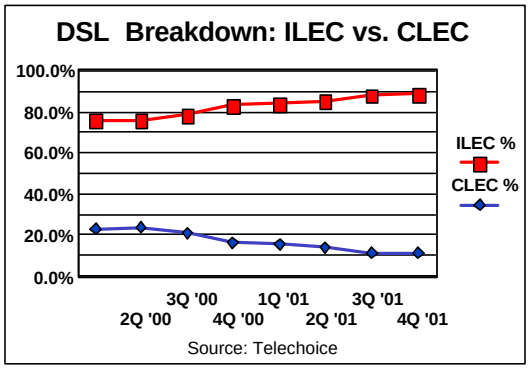
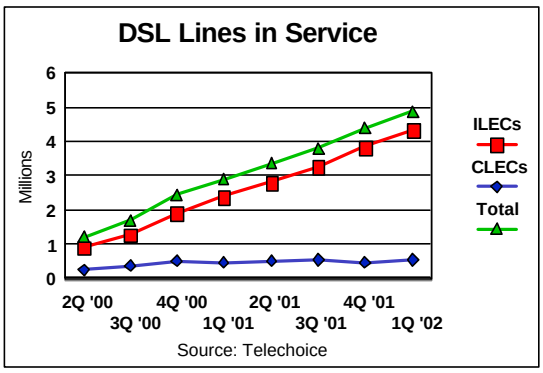



Figure 5




## 3. Wireless Availability

Wireless Internet connections comprise a small percentage of all broadband connections, but the technology is proving itself to be increasingly flexible. Case studies (discussed in Section IV) show that in areas where no established landline broadband connection exists, wireless is the quickest, and in many cases, most economical method of deployment. Wireless is emerging as the platform of choice in these difficult to serve communities because the start-up costs are so much lower than landline options. Problems with right-of-way management are reduced and infrastructure costs are relatively small compared with cable, DSL, or fiber networks. Wireless is also growing most quickly in the unlicensed frequency bands where there is one less hurdle for new deployment. Wireless networks, as they continue to expand, will provide further redundancy and choice, thereby bringing more competition to bear on the dominant broadband platforms.

### a. Fixed Wireless

Reflecting the fast paced world of broadband deployment, an altogether new classification of provider has emerged in the past few years. WISP is the new term for wireless Internet service providers who use wireless techniques to provide broadband services to customers. Fixed wireless is the usual method of deployment but Wi-Fi (discussed in the next section) is increasingly used in complement. WISPs are often most effective in providing service in rural areas and smaller cities which are not offered landline broadband service.[20] According to Broadband Wireless Exchange Magazine, there are more than 1,200 WISPs operating in the United States. It seems important to note that while the larger, national fixed wireless players have had substantial financial difficulties

[20] Tech Update, "Fixed Wireless or 802.11b access?" by Lamont Wood, June 27, 2002.

in the past year and have scaled back or discontinued deployment, small regional service providers have had continued success.

This may be due to a key new technology development. Fixed wireless has been around for over a decade. Just recently, however, non-line-of-sight technology has been significantly refined. This has reduced cost and increased flexibility of new systems. The older line-of-sight technology requires precise calibration of the sending and receiving systems with no buildings or trees between the two. This has typically made the service too expensive to be commercially feasible. Typical range for line-of-sight fixed wireless is 15 miles and this can presently be extended to about 25 miles. Data rates range from 128 Kbps up to 2 Mbps while prices adjust accordingly from $40 up to $800 per month for top bandwidth users.[21] Such deployments from AT&T, Sprint, Teligent and Winstar have stalled or ended in bankruptcy.

Non-line-of-sight technology on the other hand allows for relatively quick installation without expensive technical alignment. The standard used for this technology, called Orthogonal Frequency Division Multiplexing, allows for signals to transmit more effectively through interference and congestion.[22] The tradeoff is less bandwidth than the older technology. However, the price/bandwidth intersection may just be ideal for meeting current rural broadband deployment needs and consumer bandwidth levels. (See discussion on Pocahontas, Iowa, Section IV D.)

b. Wi-Fi

Perhaps the most exciting broadband technology right now is Wi-Fi. It continues to generate new interest and reminds many of the early days of mainstream Internet acceptance. A Wi-Fi network consists of the following components: (1) a Wi-Fi compatible laptop, cell phone or other communications device; (2) an access point or base station which transmits and receives data; (3) a router for switching and signaling if this is not incorporated in the access point; and (4) a backhaul link to the public Internet.[23]

Enhancing the Internet experience, Wi-Fi provides two key features which make it irresistible to many new users. First, it provides data rates not easily matched by other consumer broadband technologies - approximately 11 Mbps for the most popular version of Wi-Fi. In addition, there is the added benefit of portability. Wi-Fi allows laptops or other wireless devices to be used anywhere within a distance of approximately three hundred feet from a base station. This makes home networking much more feasible for a family with multiple computers. It provides office workers with

[21] Tech Update, "Wireless Options for Remote Offices" by Jonathan Blackwood, June 27, 2002.

[22] Forbes, "The Sky is Calling" by Scott Woolley, 5/13/2002.

[23] Legg Mason Equity Research, "Wi-Fi: Hype and Hope," July 2002.

the ability to leave their desks and still take information with them. It also gives public gathering places such as airports, cafes, hotels and parks the potential to be wireless broadband access zones, or "hot spots" as they are known. As of July, 2002, there were just under 2000 hot spots in the United States, according to Legg Mason Equity Research. But analysis from the media research firm Kagan predicts a hundred fold explosion in the number of public access points in the next ten years.

Wi-Fi technology works in conjunction with other broadband technologies, using them as a link to the Internet backbone. Wi-Fi then provides an effective method of expanding broadband service over a local area cheaply and quickly. A public hot spot can be set up for $500 to $8,000, depending on the number of users supported and the levels of service, security and authentication provided. A $4,000 investment in an access point will provide service to 60 users within a 300 foot radius. The additional monthly fee for high-speed HDSL Internet access to the hot spot provider would be around $200. This is significantly below the estimated $50,000 to $80,000 for a third-generation (3G) mobile wireless base station.

It is also significant that Wi-Fi equipment continues to drop in price. Access points have dropped from $245 in early 2001 to $163 in June, 2002. Wireless cards are down from $122 to $74.[24] Wireless cards interface with the communications device to enable Wi-Fi compatibility and wireless data access.

**Table 3: Worldwide Wi-Fi Equipment, Growth in Units Shipped and Revenues**

| | 2000 | 2001 | 2002 |
|---|---|---|---|
| Home Use (units) | .4 million | 2.6 million | 5.2 million |
| Business Use (units) | 2.55 million | 7.0 million | 10.8 million |
| Global Revenues | $811 million | $1.8 billion | $2 billion |

Source: Cahners In-Stat

Extending the trend seen in Table 3, global revenues are expected to jump to $5.2 billion by 2005 from just $2 billion in 2002. The number of public broadband access sites is estimated to grow from 2,000 worldwide in 2001 to 42,000 in 2006, with the United States and North America dominating the market during this time period.[25]

[24] In-Stat/MDR as stated in the Wall Street Journal, "Cordless Computers Get Affordable...But Should You Jump In?" by Walter S. Mossberg, 6/22/2002, p. D1.

[25] In-Stat/MDR report, "Revealing the Labyrinth: Hotspot Providers, Models, & Venues" May 2002.

c. Satellite

Broadband via satellite is generally available throughout the United States.[26] Satellite availability does require a clear view of the southern sky; however, this technology provides a welcome alternative for many areas where landline or other broadband connections are not currently available or feasible. While the service initially was limited by the need for a phone line for upstream communications, this is no longer the case, making satellite Internet access feasible for many in extremely remote areas without even phone line availability.

Downstream speeds of 150 Kbps to 500 Kbps are comparable with other broadband technologies but upstream speeds of 60 Kbps can be limiting for some consumers. Price is higher than landline broadband, with competitors charging $60 to $80 per month and setup fees of around $600.[27] Satellite provides some unique broadband characteristics which make it a useful solution in some situations. Three of the documented benefits are[28]:

- Satellite offers the most complete coverage of any broadband technology.
- There is no landlocked infrastructure conflict.
- Satellite serves rural, suburban and urban communities equally.

There are also some key challenges for the technology:

- The bandwidth capacity of satellites needs to be increased and outages minimized.
- The digital satellite television market will to some degree be the available population base for broadband satellite.
- Price levels and initial setup fees need to be lowered in order to compete effectively where broadband competitors exist.

Alaska merits special attention with respect to satellite service given its heavy reliance on this technology. Alaska's largest communities currently have fiber access to the lower 48 contiguous states, however, in many communities in rural Alaska, satellite communications is still the only option for the delivery of broadband services. These communities are sparsely populated, experience harsh geographic conditions and lack a highway system, making transportation difficult and making

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[26] Many Alaskan communities cannot receive adequate signals from DBS satellites that are generally located over or near the contiguous 48 United States due to insufficient signal strength or antenna elevation angles which are less than 5 degrees.

[27] Broadband Speed and Description Chart, BroadbandBuyer.com.

[28] Futron Corporation, "Satellites – The Answer to Universal Broadband Services?" Presented by Janice Starzyk, May 15, 2002.

communications even more important for basic education and public health. Alternative forms of broadband service (cable modem and DSL) are not currently available in many of these rural communities.

Direct Broadcast Satellite (DBS) is one potential option for delivery of broadband services to small businesses and consumers in some of these areas. The Starband system provides broadband access at downstream speeds of 500 Kbps and upstream speeds of 150 Kbps under ideal conditions. This system uses one satellite dish antenna at the customer premises to both receive and transmit data, with no phone line required. Starband offers service to most of the state, however, service may be limited in the western and northern sections of the state. Where it is available, set up costs can make this service economically infeasible. Initial setup for Starband service is approximately $1,600 in urban areas of Alaska.[29] Installation in rural areas is costlier. In comments regarding the potential Echostar/Hughes merger, the Regulatory Commission of Alaska made a strong statement for the need for competition in the satellite market or at least the requirement that a merged satellite competitor provide ubiquitous coverage of the state.

Other broadband solutions in rural Alaska combine common carrier satellite services (such as frame relay service) with innovative uses of wireless technology or in conjunction with upgraded Local Exchange Carrier plant (generally DSL). Toksook Bay[30] and McGrath[31] provide innovative uses of wireless technology to individual communities in Alaska. In both cases, satellite serves as the high-speed link and is then spread throughout the community with the use of unlicensed wireless technologies. On a broader scale, Internet service has also been extended regionally to portions of northwest Alaska using a combination of traditional satellite service and DSL or wireless technologies for the last mile.[32] Such examples are rare, however, and involve special circumstances and synergies not typically found in most small remote Alaskan communities.

**4. Fiber-to-the-Home Availability**

Fiber optic technology provides the highest capacity bandwidth available today. Because of this, it has long been the medium underlying the Internet backbone, enabling the exponential growth in worldwide data and telecommunications traffic. Manufacturing techniques have continually reduced the cost of fiber, driving deployment steadily towards the edge of the network. New network extensions today see the utilization of fiber optics as only an incremental cost increase in return for the most scalable network available. Fiber-to-the-home is becoming more prevalent in new housing developments, something unimaginable several years ago. According to a recent study conducted

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[29] Generally, DBS antennas used in Alaska are much larger than the smaller offset antennas used in the contiguous United States. The larger antenna is needed to efficiently receive the DBS signal from satellites because the Alaska locations are on the periphery of the DBS footprint.

[30] http://members.aol.com/wirelessak/

[31] http://www.mcgrathalaska.net/, http://www.alaskajournal.com/stories/082001/loc_isp_denali_park.shtml

[32] http://www.inutek.net/info.html

by research firm Render, Vanderslice & Associates, fiber-to-the-home installations increased more than 200% over the last year.[33] They are expected to gain an additional 330% in 2003, jumping from 72,100 homes passed to 315,000 homes passed. In 2004, this figure is expected to rise to between 800,000 and 1.4 million homes.[34] Regarding the services offered to homes with fiber availability, the study noted that almost all these homes were offered high-speed Internet, three-fourths video, two-thirds voice, and 60% were offered all three services. In regards to demand, the study found the average take rate for high-speed Internet services in these fiber-to-the-home projects was 21%.

A declining cost structure is putting fiber on par with traditional communications networks such as copper or coaxial cable. According to figures from Optical Solutions Inc. CEO Daryl Ponder, "Lasers are down from $400 to $100; splitters are down from $150 to $35. Now, fiber can cost $300 less per home than coax."[35] However, this is only when comparing green-field network buildouts. "Green-field" refers to new construction of office space or housing developments, along with the new telecommunications infrastructure to accompany such projects. This makes cutting-edge technologies more feasible, in part, because they do not have to compete with upgrades to existing telecom infrastructure or a competitor with an entrenched customer base. While becoming more popular in new developments, few consumers in existing homes today have a choice of broadband via fiber.

An overview of the various forms of fiber-to-the-home network architectures, such as Passive Optical Networking (PON), is provided by the Digital Rivers Report.[36] An examination of the deployment cost per home based on rural vs. urban demographics is also provided.

**B. Broadband Deployment in Rural Areas**

While overall U.S. availability stands at approximately 80%, rural availability is somewhat less than this. Precise availability figures are difficult to obtain on a nationwide scale. Separating rural areas from urban and determining true rural availability is an even more difficult task. However, there are various studies which together paint a relatively clear rural scenario.

FCC data as of year-end 2001 showed the presence of at least one high-speed subscriber in

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[33] "Fiber to the Home and Optical Broadband 2002," Render, Vanderslice & Associates. Presented at the Fiber-to-the-Home Conference, October 15, 2002, and sponsored by the FTTH Council. The study was based on more than 600 interviews at the various levels of the FTTH market.

[34] Another source estimates 2.65 million homes will have FTTH service by 2006. In addition, 1.9 million will have fiber-to-the-curb systems. "Residential Broadband Access in the U.S.: Fiber-to-the-curb and Fiber-to-the-Home," KMI Research, a fiber research group.

[35] Daryl Ponder, Chairman and CEO, Optical Solutions Inc. as stated in, "Fiber to the Where?" Communications Engineering and Design (CEDMagazine.com), March 2002.

[36] Digital Rivers Final Report, section 6, www.digitalrivers.info Produced by Carnegie Mellon and 3 Rivers Connect, April 11, 2002.

43.3% of zip codes in the *least* densely populated decile.[37] This compares with a high-speed presence of 79% for the nation overall. However, high-speed presence in the least populated decile grew more quickly than any other, rising from a 27.5% presence one year earlier.

Looking at another proxy for the rural situation, among National Exchange Carrier Association (NECA) companies, it is estimated that 65% of rural lines would be broadband capable in 2002.[38] In 2001, more than half of rural local telephone companies had deployed broadband to some extent within their service territory, up from only 14% in 1999.[39]

A National Telecommunications Cooperative Association (NTCA) survey estimated 60% of its members' rural customers were able to order broadband service as of Summer 2001.[40] That number was expected to increase to 69% by the end of 2002. Of the survey respondents, one third listed a major goal of reaching all of their customers with broadband service by the end of 2001. Sixty-two percent wanted to offer broadband to all customers within 18,000 feet of a central office by year end 2001. Of the survey participants who did provide broadband, 89% offered DSL and 8% offered wireless.

Both the NECA and NTCA studies provide an idea of the unique problems faced by rural areas. The study results were based on DSL carriers, but some of the barriers are applicable to all landline-based networks.

Major barriers to expanding broadband service were listed as:

- Loop length: 28% of company loops are between 12,000 and 18,000 feet.[41]
  14% are between 18,000 and 30,000 feet.
  9% exceed 30,000 feet.

- Deployment cost: NECA survey results put the cost of upgrade as follows,
  $4,121 per line for lines beyond 18,000 feet.
  $9,328 per line for lines in very isolated conditions.

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[37] Federal Communications Commission, "High Speed Services for Internet Access," released 7/23/02. Data current as of 12/31/01.

[38] NECA 2001 Access Market Survey and the NECA Rural Broadband Cost Study. NECA defines a line as being broadband capable if high-speed services are potentially available in excess of 200 Kbps in the upstream and downstream directions. If the telephone company does not offer these services the line is still defined as broadband capable.

[39] The Universal Service Fund, High Cost Fund played a large role in funding these upgrades.

[40] NTCA 2001 Internet/Broadband Availability Survey Report, December 2001.

[41] These loop characteristics are based on NTCA survey respondent companies. The median respondent serves 2,943 residential and 726 business lines.

- Low demand: Of NTCA survey respondents' rural customers,
  4% with cable modem available actually subscribe.
  3% with DSL access subscribe.
  2% with wireless broadband access subscribe.

- Lack of cost-effective smaller scale equipment.

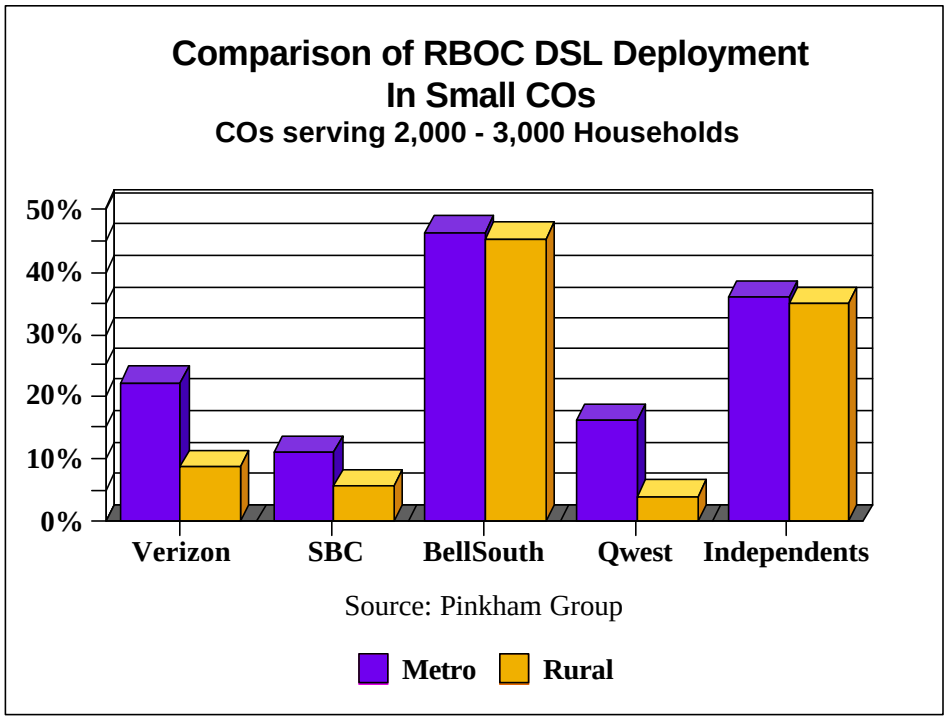
- Lower revenue opportunities: the "typically deployed rural CO has less than a quarter of the revenue potential of a metropolitan CO."[42]

In contrast with urban deployment, rural costs are higher, customers are more widely dispersed and revenue potential is lower for carriers. The Pinkham Group notes that deployment decisions for telephone companies are based not on a rural vs. urban basis, but rather on the basis of household density per central office. The most densely populated central offices are consistently equipped with DSL first. However, as seen in Figure 6, the independent telephone companies have been much more aggressive than the RBOCs (other than BellSouth) in targeting the medium to smaller central offices. Thus, customers are much more likely to have DSL available in rural areas if they are served by an independent, rather than an RBOC.

It is apparent that rural America faces several problems in obtaining broadband deployment. However, it is not only the independent telephone companies who see opportunity in rural deployment. Wireless technology has shown advantages in some rural areas and various entities are making use of the technology to make broadband available. Where sufficient demand exists for the service, there are examples of businesses, municipalities or a combination of the two making the investment to fill the void for broadband. The extent to which these successes can be replicated is a crucial matter.

[42]Pinkham Group, "DSL Deployment Analysis of RBOCs and Independent LECs in Metropolitan and Rural Areas–Q4 2001.

**Figure 6**




## C. Broadband Availability in Summary

The previous discussion on broadband availability showed that, with the exception of rural and less densely populated areas, deployment of wireline broadband networks is fairly widespread, now reaching upwards of 80% of U.S. households. Moreover, because cable and DSL networks overlap to a large degree, most broadband communities now have the benefit of a choice of providers.

The unique challenges of rural deployment are being overcome with a variety of creative solutions offered by entrepreneurs, local communities, municipalities and public-private partnerships, often with the assistance of various government initiatives. Emerging technologies such as fixed wireless are encouraging such deployment initiatives.

The major concern a year or so ago was the lack of broadband availability. The consensus opinion seemed to be, "if you build it, they will come." As previously discussed, broadband is now widely available, reaching nearly 80% of American households. Because current data on broadband subscriber growth shows a significant gap between broadband supply and demand, the consensus now seems to be, "it has been built, so where are they?" Concerns have now shifted to what many perceive to be low demand for broadband services. This has raised new questions. Is there really a lack of demand? If demand is low, what are the reasons for it? How can demand be stimulated? What can government do to help? These are questions that the next section will attempt to address.

## III. BROADBAND TAKE RATE: ANALYSIS OF DEMAND FOR HIGH SPEED SERVICES

### A. Current Status

A clarification of terms used in this analysis will be helpful. Broadband deployment, examined previously, is usually measured in terms of the percentage of U.S. households to which the service has been made available. The terms "penetration" and "take rate" are often used interchangeably as a gauge of broadband subscribership. However, the term "penetration" is sometimes used to describe the percentage of total U.S. households that subscribe to the service. In contrast, the more narrow term, "take rate," attempts to measure the percentage of households that take the service where it has actually been deployed.

While estimates for penetration and take rate are routinely quoted from a variety of sources, they are difficult, if not impossible, to measure. One source estimates that out of the 105 million total households in the U. S., 13.8 million were using broadband at year-end 2001, resulting in a 13% penetration rate.[43] By contrast, the FCC reports 12.8 million high speed lines in service at the end of 2001, with 11 million of these serving residential and small business subscribers. The FCC does not report household lines separately, so even if all the 11 million subscribers were considered to be households, the penetration rate, at roughly 10%, is substantially less than the 13% estimate. Take rate estimates vary as well. Robert Sachs of the National Cable and Telecommunications Association (NCTA), recently stated that "of the combined total of approximately 80 million homes where cable modem and/or DSL service are available, 14 percent of homes passed and almost one out of four PC homes passed have taken broadband."[44]

While there is no way to tell which of the varying estimates is correct, any or all of the measures can be helpful in providing the relative progress of availability and demand over time. Of the varying measures, one would expect the FCC's broadband line counts to be accurate since broadband carriers are required to report them twice yearly; however, as stated previously, the inability to distinguish household lines from business lines in the FCC data prevents an accurate estimate of broadband household penetration. This may hinder policy makers' ability to make reasoned conclusions and decisions.

Present broadband penetration can also be approximated by calculating the percentage of broadband households out of all online households. The majority of Internet users connect to the Internet through a personal computer and a narrowband (dial-up) connection. According to a National Telecommunications and Information Administration (NTIA) study[45], as of September 2001, 56.5%

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[43] Statistics from GartnerG2, as reported in the "Broadband Bob Report" (http://www.catv.org/bbb/2002/arch-020502.html).

[44] Robert Sachs, remarks to Cable Telecommunications Public Affairs Association Forum, March 12, 2002.

[45] A Nation On Line–How Americans Are Expanding Their Use of the Internet, National Telecommunications and Information Administration, U.S. Department of Commerce, Feb. 2002.

of U.S. households had a PC at home and 88% of these PC owners had an Internet connection. From these figures, one can calculate that 50.5% of U.S. households presently have an Internet connection. The NTIA used the current population survey data and found that 20% of online households were broadband users as of August 2001, compared to 10% a year earlier. The National Regulatory Research Institute (NRRI) used its own survey data and found that 30% of online households across the nation were using broadband, as of November 2001.[46] We believe that these figures reasonably represent lower and upper estimates of broadband penetration, thus indicating that between 10% and 15% of total U.S. households subscribe to broadband services.

As discussed in Section II, broadband offerings through cable modem or DSL are now available to around 80% of U.S. households. Satellite broadband services are available to virtually all U.S. households with an unobstructed view of the southern sky. When comparing the high availability to the current number of subscribers, the level of subscribership appears to be low. This has caused many stakeholders great distress, resulted in mis-diagnosis, and prompted calls for government cures for what is believed to be ailing broadband deployment and acceptance.

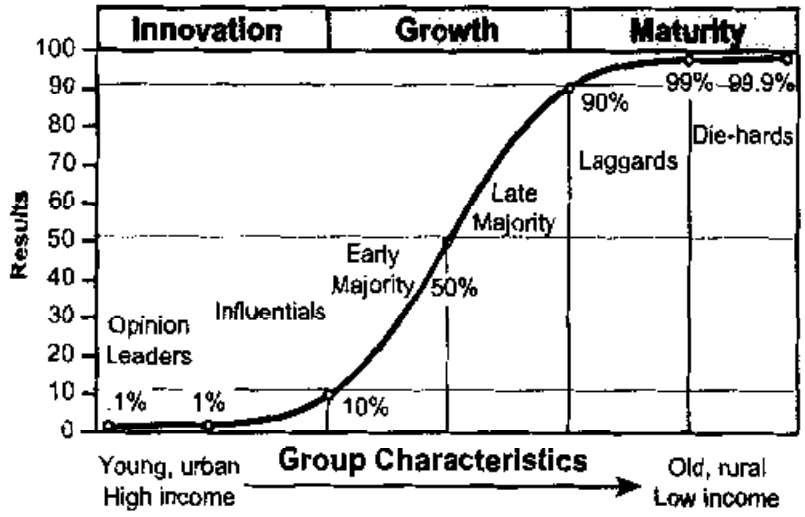
**B. Consumer Adoption Patterns for New Technologies**

In order to properly diagnose the apparent low broadband take rate, it should be viewed in a more broad time horizon. Initial expectations about consumer acceptance of broadband may have been unrealistic. Studies show that consumer adoption of new technologies tends to follow an established S-curve pattern as depicted in Figure 7. In the beginning of the S-curve, the number of users and the penetration rate is low. From this small base, the increase in the rate of growth accelerates, which is reflected by the broadband adoption rate in recent years.[47] Then, beyond the middle of the S-curve, total number of users and penetration rate will continue to grow, but less rapidly in terms of percentage. Finally, the penetration rate approaches (converges to) a level that saturates the market for that technology. In this evolution, the technology is unknown to most consumers at first and only adopted by the more affluent, the technical experts, and perhaps the curious. Then, as it becomes more familiar to consumers, easier to use and more affordable, the technology is adopted by more people.

[46] http://www.nrri.ohio-state.edu/programs/broadband.html.

[47] This will be examined further in Tables 4 and 5.

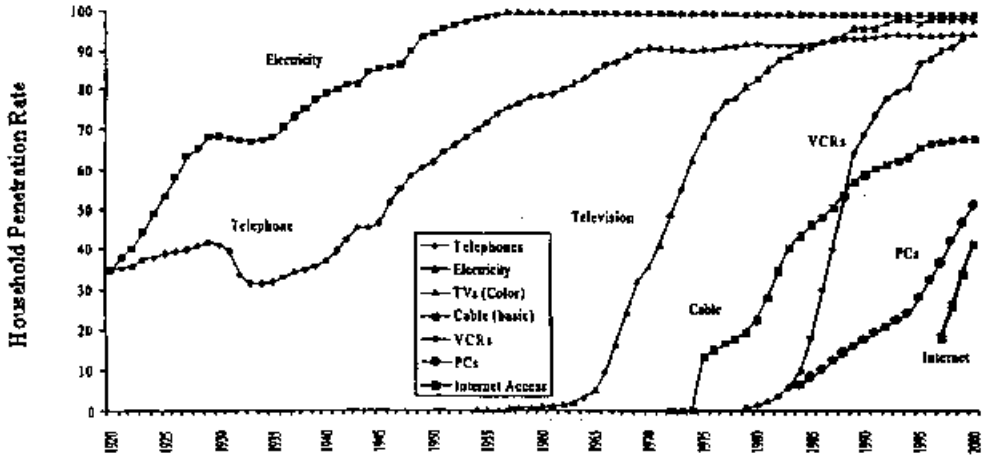
**Figure 7: Consumer Adoption Patterns**




Source: H.S. Dent Foundation

For many new technologies, this process often takes a few decades before the S-curve reaches its mature level. For example, Figure 8 shows that it took electricity 35-40 years before reaching the current penetration level and about six decades before telephone reached its current penetration level of 94 percent. Other technologies have also taken many years to reach their current penetration levels, though some technologies, such as computers and Internet, have been adopted by consumers faster than others.[48]

**Figure 8: S-Curve for Adoption of Various Technologies**

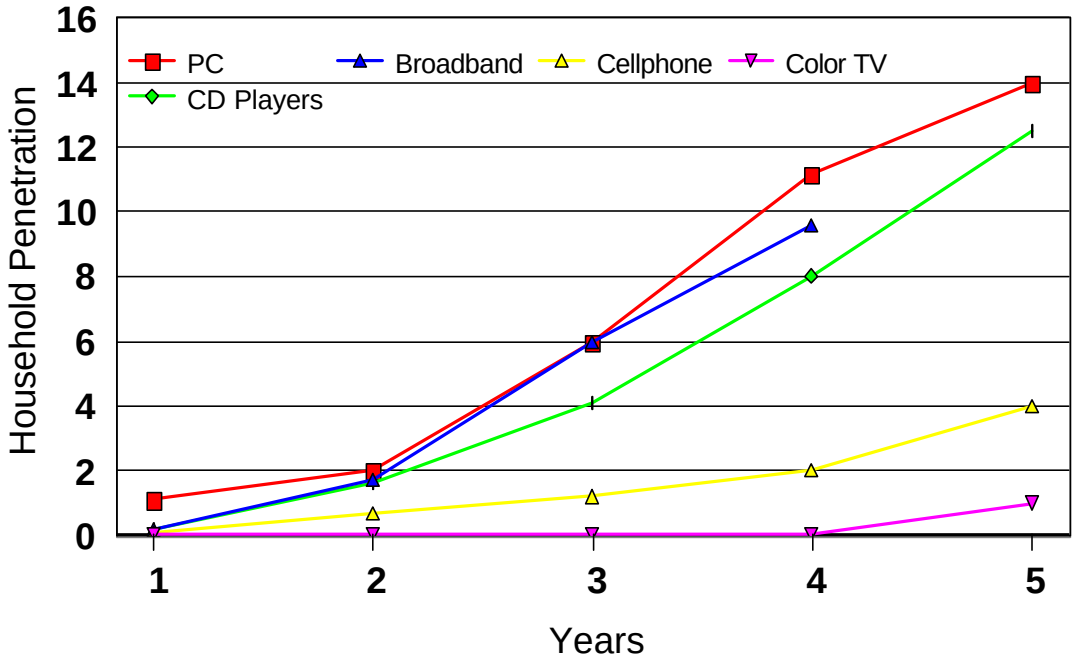



Source: Wayne A. Leighton: Broadband Development and the Digital Divide: A Prime

[48]It took thirty years for radio (which isn't in Figure 8) to reach a 90% level and fifty years to reach 99%.

As Figure 9 illustrates, broadband technology appears to be following the fast track acceptance of consumer products such as personal computers and CD players. However, it is important to keep in mind that the current broadband market may well be at the beginning stage of its S-curve. Although it is hard to predict exactly how many years it will take for the broadband market to reach maturity, the current low penetration rate can be explained to some extent by this "S" curve process.

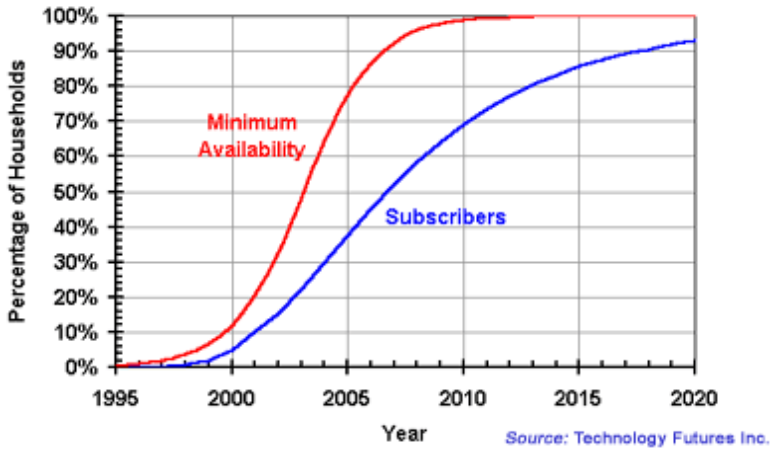
**Figure 9: Consumer Technology Adoption**




Sources: Cable Datacom News, DSL Prime, ebrain.org, Telechoice

The S-curve can also be used to address the issue of whether broadband availability works as a constraint on the growth in demand. Broadband's subscriber growth rate over its first five years makes it one of the fastest technology adoptions in history. However, as broadband has just passed the typical inflection point of 10% consumer penetration, there are questions regarding the slope of the rest of this S curve. As the rate of growth has slowed, many wonder what barriers are confronting broadband adoption in the U.S. Technology Futures Inc. (TFI) has looked into the minimum level of broadband availability needed to support their base level forecast of broadband subscribers (Figure 10).[49] They find that 80% availability by the year 2005 would sufficiently avoid a binding constraint on their model for broadband adoption. With availability near 80% in 2002, this should not be a limiting factor in the take rate for broadband.

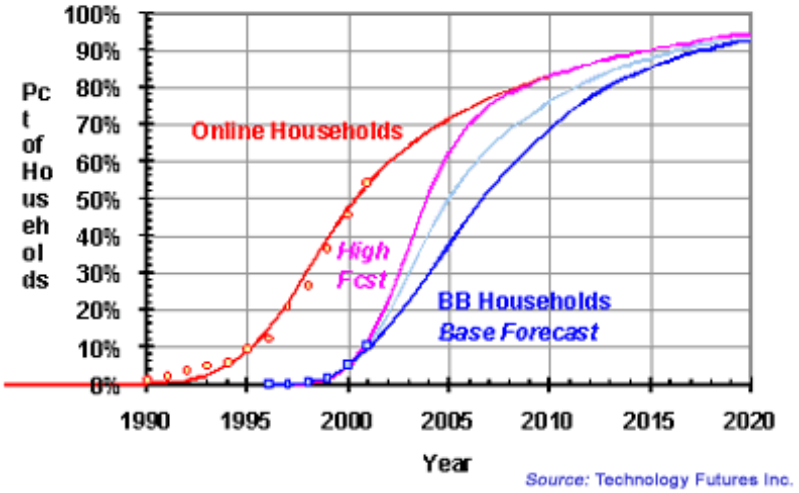
**Figure 10: Minimum Broadband Availability and Adoption**




The broadband adoption forecasts by TFI are a base forecast and a more advanced adoption rate forecast. The base forecast predicts that 15% of U.S. households will have adopted broadband by the end of 2002 and 30% by 2004. This is up from a level of 10% at the end of 2001. The high forecast predicts 20% penetration by the end of 2002 and 60% penetration by 2005 (Figure 11). Again, availability should not be a binding constraint on broadband adoption.

[49] This relationship is based on historical examinations of availability and adoption rates for cable television (in the U.S. and Germany), pay cable in the U.S., and pay-per-view services in the U.S. market. Technology Futures Inc., "Residential Broadband Forecasts"

**Figure 11: U.S. Broadband Households, Base and High Forecasts**




Looking further at broadband demand from a historical perspective, although some of the broadband technologies may have been developed decades ago, the actual deployment of facilities and the rollout of services did not take place until recent years[50]. Since the passage of the 1996 Telecommunications Act, both availability and take rate have been growing quickly. Table 4 shows the growing percentage of users choosing broadband among online households from 1998 to 2001.

**Table 4: Historical Trend of Broadband Users Among Online Households**

| Connection Type | Spring 1998 | Spring 1999 | Spring 2000 | Fall 2000 | Fall 2001 |
|---|---|---|---|---|---|
| Broadband | 1% | 1% | 5% | 11% | 20% |
| Dial-up | 98% | 98% | 94% | 89% | 80% |

Source: Data of 1998 to 2000 is from www.digitrends.net.

[50] 1998 was the first year that FCC started to collect data on Broadband services.

Additional sources support this trend. Figure 12 and Figure 13 illustrate the migration to broadband access methods among home Internet users. In a two year time frame, broadband's share of home Internet connections rose from 9.5% to 31%.

**Figure 12**

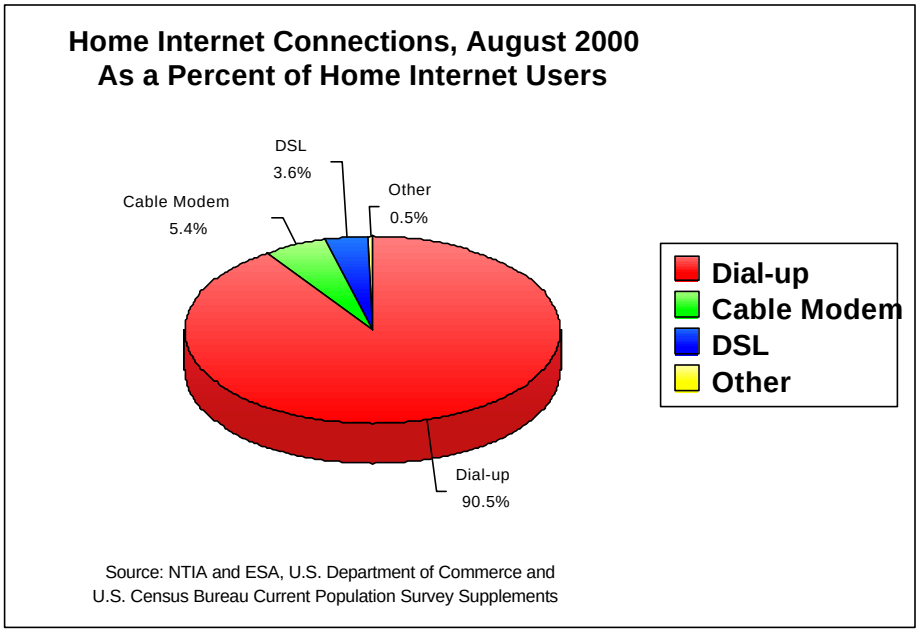



**Figure 13**

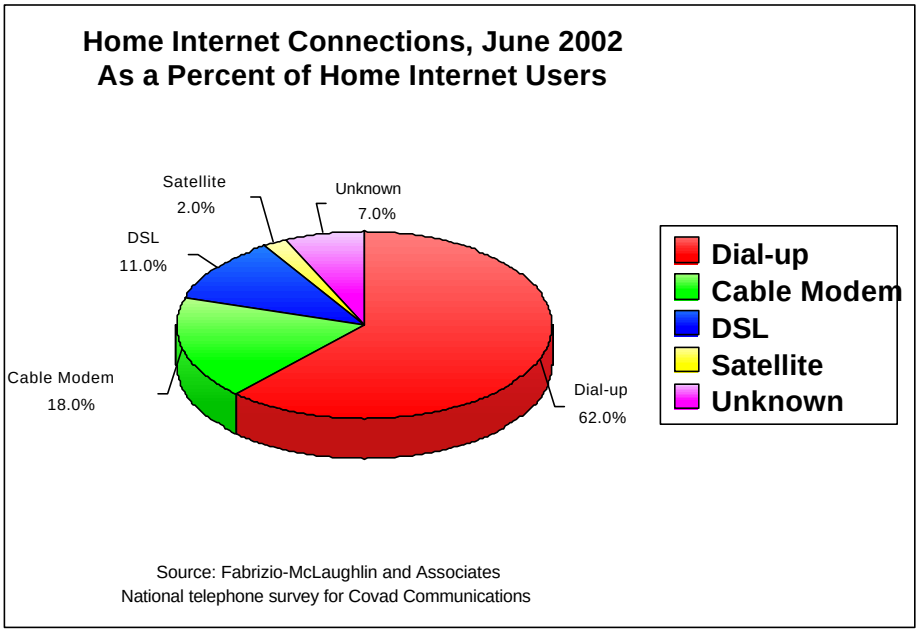


Table 5 presents this trend in terms of absolute numbers of broadband users.

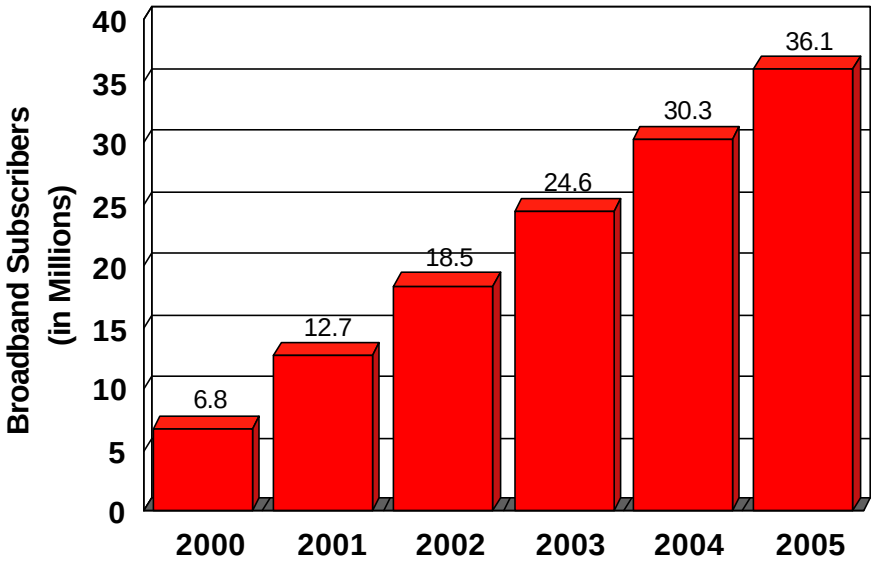
**Table 5: Growth of Broadband Users (1999 - 2001)**

| Broadband Types | Dec 1999 | June 2000 | | Dec 2000 | | June 2001 | | Dec 2001 | |
|---|---|---|---|---|---|---|---|---|---|
| | subscribers | subscribers | growth | subscribers | growth | subscribers | growth | subscribers | growth |
| Cable Modem | 1,411,977 | 2,284,491 | 62% | 3,582,874 | 57% | 5,184,141 | 45% | 7,059,598 | 36% |
| DSL | 369,792 | 951,583 | 157% | 1,977,101 | 108% | 2,693,834 | 36% | 3,947,808 | 47% |
| Other Wireline | 609,909 | 758,594 | 24% | 1,021,291 | 35% | 1,088,066 | 7% | 1,078,597 | -1% |
| Fiber | 312,204 | 307,151 | -1.6% | 376,203 | 23% | 455,593 | 21% | 494,199 | 8% |
| Sat./Fx Wless | 50,404 | 65,615 | 30% | 112,405 | 71% | 194,707 | 73% | 212,610 | 9% |
| Total | 2,754,286 | 4,367,434 | 59% | 7,069,874 | 62% | 9,616,341 | 36% | 12,792,812 | 33% |

Source: FCC report: High Speed Services for Internet Access: Subscribership as of December 31, 2001.

While demand appears to be low when it is viewed in relation to availability, consumers are nonetheless subscribing to broadband in record numbers. The growth rate, measured either by percentage or by absolute number of subscribers has been impressive, and has lead to optimistic projections of future growth. Figure 14 provides an estimate from the Yankee Group of U.S. broadband subscriber growth from 2000 to 2005.

**Figure 14: U.S. Broadband Subscriber Forecast**




Source: Davis, Matthew, "Broadband Access Technology: Whose Number is Up?" The Yankee Group

These growth predictions, while seemingly high, are modest compared to those of Forrester Research, which forecasts about 49 million broadband households by 2005. The Yankee Group figures predict year-over-year subscriber growth to slow from 46% between 2001 and 2002, to 19% between 2004 and 2005. These growth estimates seem to be reasonable in light of the following finding in a recent Arbitron/Edison media research study:

> The study also confirms that superfast at-home broadband connections continue to grow despite the slowing economy. Residential broadband adoption has doubled in the last 18 months, jumping from 13 percent of those with at-home Internet access in January 2001 to 28 percent in July 2002. Furthermore, this growth trend appears to be far from over. According to the study, one out of five of those with dial-up home Internet access intends to convert to broadband in the coming year.[51]

Using the estimates of current online and broadband households, if one out of five convert from dial-up to broadband in the coming year, approximately 7.6 million additional households will subscribe to broadband from this conversion alone. Thus, an additional 7.3% of U.S. households would be using broadband, raising total household penetration to between 17% and 22% in the next year, right in line with the Yankee Group forecast.

### C. Rural Penetration

Just as broadband deployment is lower in rural areas, so is demand. Compared to the national household penetration of ten to fifteen percent, in some rural areas only 4% of households with cable modem availability subscribe to the service, 3% of households with DSL availability subscribe, 2% with wireless availability subscribe and 1% subscribe to T1 lines.[52] Considering that 53% of rural households use the Internet, almost even with the national average of 54%,[53] the low rural take rates warrant further study. It is likely that low rural penetration is due to demographics. There is a strong correlation between broadband penetration and household income. A recent NECA study reports that median household income in rural areas is $40,600 compared to $46,600 in non-rural areas. The study also reports that people aged 65 and over represent 14% of the rural telephone companies' population base, compared to 12% for other companies.[54] As discussed later, those aged 65 and over are least aware of broadband. The elderly are also the lowest users of computers and the Internet.[55] On a positive note, the number of broadband subscribers in rural areas is growing. Rural broadband connections among Internet households increased from 7.3% in 2000 to 12.2% in

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[51] "Internet 9: The Media and Entertainment World of Online Consumers," Arbitron/Edison Media Research Study 09.05.02.

[52] NTCA 2001 Internet/Broadband Availability Survey Report, December 2001.

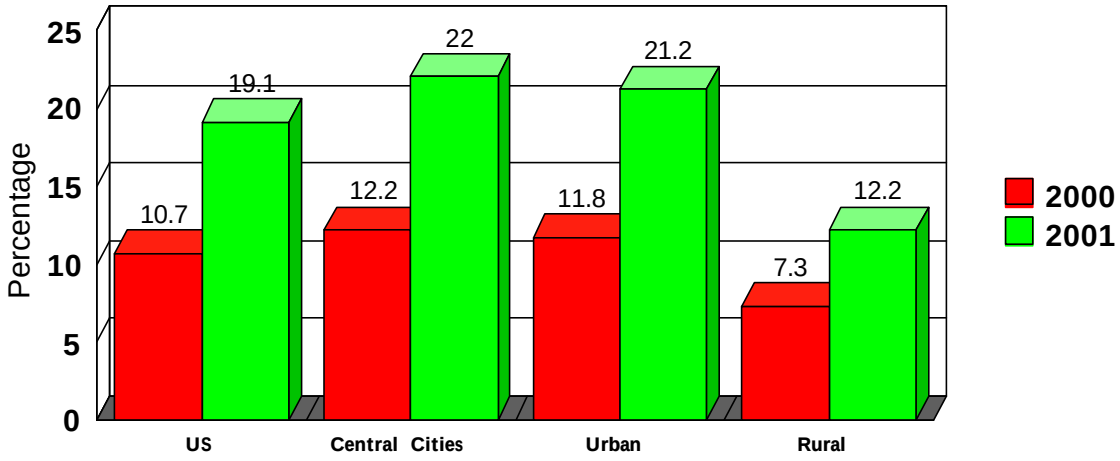
[53] NTIA: *A Nation Online*.

[54] *Trends In Telecommunications Cost Recovery: The Impact On Rural America*, NECA, September 2002.

[55] NTIA: *A Nation Online.*

2001 (Figure 15).[56] However, this is still well below the 19% average nationwide.

**Figure 15: Higher-Speed Internet Connection by Geographic Area as a Percent of Total U.S. Internet Households**




Source: NTIA and ESA, U.S. Department of Commerce,
using U.S. Census Bureau Current Population Survey Supplements

## D. International Comparisons

The phenomenon of broadband demand trailing supply is not unique to the U.S. broadband market. In fact, almost all the European and Asian broadband countries are experiencing the same symptom. According to a recent study, most of these broadband countries have broadband coverage (availability) equal to or greater than 50%, but a penetration rate lower than 10%.[57] One exception is Korea, the most "advanced" broadband country in the world, where availability is close to 100% and the penetration rate is about 50%. Reasons for Korea's high availability and penetration will be examined in the next section.

## E. Broadband Demand Analysis

Economically speaking, take rate reflects the market interaction between demand for and supply of a service. When the current demand for broadband is examined, two critical points, previously discussed, should be observed. First, the growth of broadband subscribers in the past five years has been extremely strong. Second, demand appears to be weak when compared to the level of supply, or availability. While broadband is available to about 80% of households, less than 15% of those households have chosen to subscribe. Thus, other than in rural areas, availability is no

[56] Ibid.

[57] See Robinson, Scott *Broadband Access Technologies in Europe: Are We Answering the Right Question?* Alcatel, 2002.

longer a critical issue. An international comparison also reveals that the lack of ubiquitous availability is not the cause of low take rate. Rather, this gap indicates that the industry suffers more from overcapacity, particularly in the U.S.

This study will next discuss a number of factors that help to explain this gap and what must be addressed in order to accelerate broadband demand. While government entities have a role in fostering rollout and acceptance of broadband service, the marketplace bears primary responsibility for this rollout and has the most to gain from it. Given the substantial investment already made in broadband infrastructure, not to mention the amount that will be needed to meet future demand and more broadband-intensive applications, the future success of providers depends upon increasing the level of demand and their ability to garner a substantial portion of it. It is critical for their success that these providers find ways to accelerate consumer adoption.

### 1. Current Prices Limit Demand

Demand for broadband service can be described by consumers' willingness to pay at various prices. Thus far, relatively little research has been done regarding issues of pricing and consumer willingness to pay for broadband services. However, a group led by Professor Hal R. Varian at the University of California, Berkeley, has conducted research that has produced some important results on consumers' behavior when they purchase broadband service.[58] By focusing on the behavior of early adopters, the researchers found that consumers in general are not willing to pay much for higher bandwidth for today's applications. However, administrative and technical users have a significantly higher willingness to pay than other users.

Compared to a dial-up connection, ordinary users need a good reason to pay a premium of upwards of $25 a month to get broadband access. The price of broadband service in South Korea provides some insight about the impact low prices have on demand. South Korea has achieved a fifty percent penetration level due, in part, to the low price for broadband compared to most other nations. Consumers in South Korea pay less than $23 per month for broadband–about the cost of dial-up service in the U.S.[59] As a result, the number of broadband subscribers in Korea has surged from a few hundred thousand to 8.5 million. The Korean broadband penetration rate is now approaching its total online penetration.

South Korea's rapid deployment and low broadband prices can largely be explained by telecom deregulation efforts beginning as early as 1989, and the government's 1995 launch of its comprehensive Korea Information Infrastructure (KII) project, aimed at building high-speed and high-capacity networks through market competition and private sector investment.[60] The government itself pledged to kick in $1.5 billion of the infrastructure investments, and provided

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[58] Varian, Hal R. *The Demand for Broadband: Evidence from the INDEX Project*, Revised February 2002.

[59] See Paltridge (2001) and Varian (2002) for discussion of the early days of the Korean experience.

[60] "KT Initiates Broadband Internet Revolution," The Korea Times, June 3, 2002.

loans at prime rate to ISPs in 1999 and 2000, with the latter loans conditioned upon ISPs investing in less densely populated areas, small cities and counties and regional industry complexes. Since then, the public funding program has been extended to rural and remote areas.[61]

As a result of South Korea's free markets and KII project, multiple companies are now competing with their own broadband infrastructures. Korea's unique geographical advantages has also made it easier for multiple companies to quickly deploy their own infrastructures. A high proportion of Koreans (almost half) live in apartment buildings, making it ideal for the provision of optical fiber local area network services. Moreover, "[s]ome 93 percent of all citizens are located within 4 kilometers from end-offices, making it relatively easy to provide our asymmetric digital subscriber line (ADSL) service," according to Lee Sang-chul, president and CEO of KT.[62] These geographic factors lower buildout costs and make it more economical to serve customers. The popularity of low-cost Internet Protocol telephony (IP telephony), introduced in January 2000, may also help to explain the high Korean growth rate. IP telephony subscribers exploded after the service was introduced, growing to some 4.3 million users the first year. This closely correlates with the remarkable growth in broadband subscribers.

Similar to the U.S., European consumers also exhibit resistence to paying a substantial premium for broadband. In European markets the average broadband price is about $40, but consumer perceived value of broadband is only $30.[63] This price point appears to be confirmed by the high take rates in the U.S. when broadband is priced under $30.[64] While it has been shown that broadband demand is growing in the U.S., even at prices many consider to be excessive, the previous examples show that penetration could be substantially increased by lower price.

One explanation for high prices in the U.S. may be relatively higher costs of providing broadband services. The U.S. certainly does not have the geographical advantages of Korea, which makes deployment and marketing more difficult and costly. However, studies show that broadband costs have declined significantly, and yet U.S. providers have been slow to reduce market prices in any similar proportions. Prices have even gone up in some markets, and this has hurt broadband growth.[65]

In 2001, prices for DSL and cable broadband services rose 10% and 12%, respectively.[66] Figure 16 shows the average increase in price for both cable modem and ADSL services in 2001.

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[61] Ibid.

[62] "Korea No.1 Country in Broadband Internet Usage," The Korea Times, May 30, 2002.

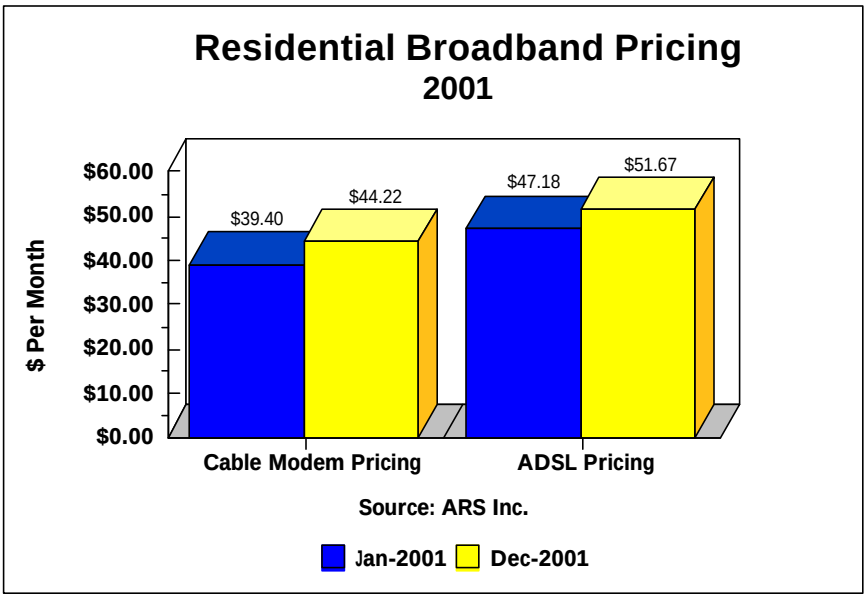
[63] Broadband Access Technologies in Europe: Are We Answering the Right Question?

[64] See case studies in Sections IV D and IV F.

[65] See Robert E. Hall: Rescuing Competition to Stimulate Telecom Growth, September 28, 2001.

[66] Varian, 2002.

**Figure 16**

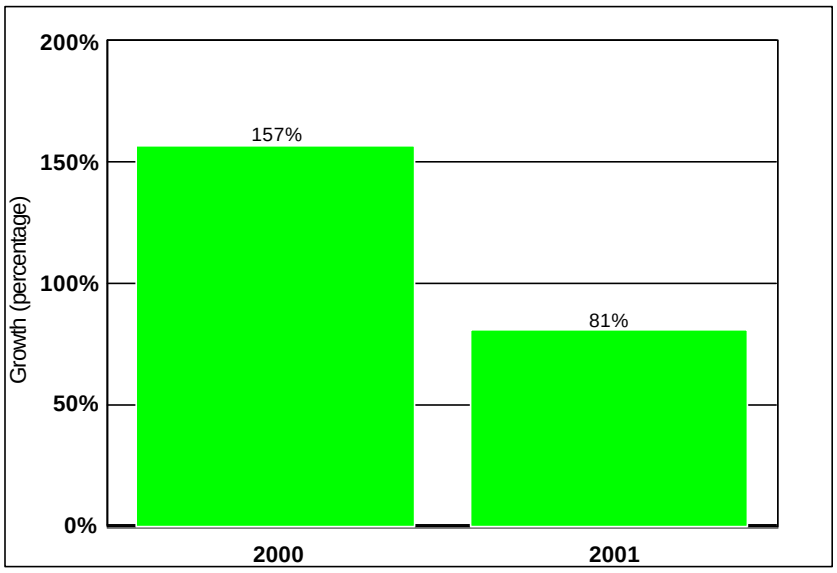



These price increases coincided with many bankrupt competitors exiting the market, thereby increasing the market share and ability of the remaining carriers to raise rates. In 2000, the ILECs' DSL market share increased from 75% to 83%, while the CLECs share declined from 24% to 16%. As mentioned previously, ILEC market share further increased to 89% in 2001, while CLEC share declined to 11%. This pricing behavior bears close watching as more competitors are facing financial difficulties.

As shown in Figure 16, cable modem service, on average, is priced 10% below DSL. This price differential partly explains why cable holds 62% of the market compared to 35% for DSL and only 3% for nascent satellite and wireless services.

On the heels of the price increases, broadband subscriber growth has started to slow. Using the FCC's figures, the number of subscribers grew 81% in 2001, compared to 157% in 2000 (see Figure 17).

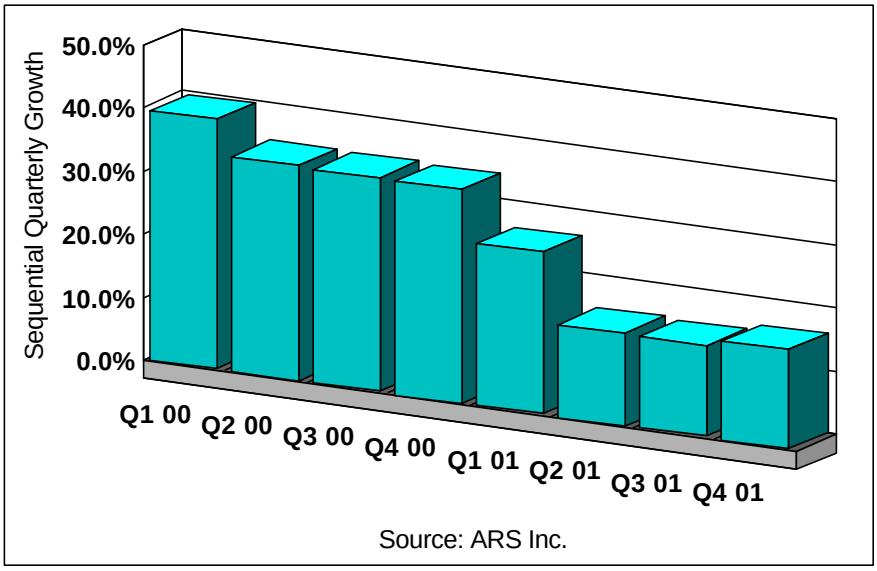
**Figure 17: Broadband Subscriber Growth (2000-2001)**




Source: FCC report: High Speed Service for Internet Access: Subscribership as of December 31, 2001.

Another depiction of this trend is presented in Figure 18 which shows the declining growth rate on a quarterly basis.

**Figure 18: Broadband Subscriber Growth on a Quarterly Basis**



High prices are common with the introduction of new products and services; however, as costs decline and new competitors enter the market, thereby increasing supply, prices fall. While the current broadband market appears to be competitive given its intermodal structure consisting of competing cable modem, DSL, wireless and satellite platforms, the outcome of more competition should be lower prices or increased service value. The previously mentioned price increases may indicate there is insufficient competition, as price increases certainly do not appear to be rational moves in a competitive market, especially one that is experiencing an overcapacity problem. Therefore, any conclusion that this market is already competitive appears contradictory, and is premature.

Nonetheless, there is growing evidence that the broadband market may be entering a more competitive phase. Carriers are not blind to slowing growth rates and are turning their attention from deployment to gaining subscribers through lower prices. Low introductory rates and free installation are routinely offered to attract more customers. Basic service rates have also been lowered:

- Qwest Communications offers DSL for $39.95 per month, or customers can obtain a basic connection for just $21.95 and choose their own Internet service provider.

- Charter Communications, a leading cable provider, charges a very competitive price of between $30 to $35 throughout its service areas for most of its broadband products.[67]

Many carriers are test-marketing tiered pricing, charging different rates for different bandwidths. This is a growing trend that should increase subscribership, because it gives customers more choice to satisfy their particular bandwidth needs:

- SBC just announced an alliance with Yahoo!, where it will offer tiered rates and added value, or content, by bundling $30 worth of premium services at no extra charge.

- Cox Communications, another leading cable provider, is test-marketing tiered pricing beginning at $24 per month for 128kbps. This rate is designed as a direct challenge to the $24 rate charged by the leading dial-up provider.

Many of the evolving rate structures are being designed to entice customers away from dial-up. Carriers believe that once users experience broadband's superior performance and convenience, they will be unwilling to return to dial-up and can be moved more easily up to higher priced tiers as their need for more bandwidth increases. Another business strategy is to sell bundled service packages. These offerings have reportedly been highly successful in increasing take rates and reducing customer churn:

- Cox reports that nine months after it began selling voice, video and data services as an

[67] See Kirk Laughlin, *Tiered Broadband Adds a Penthouse Floor*, America's Network Weekly, September 6, 2002.

overbuilder[68] in Barrington, Rhode Island, 51% of its customers had signed up for all three services, and 70% had taken at least two products. Cox has also found that customers subscribing to more than one service are 33% more likely than single product homes to remain Cox customers.[69]

- AT&T's experience with packaged services has produced similar success in increasing customer penetration levels and reducing churn.[70]

- Verizon has also begun bundling broadband with other services at a lower price. Its customers can get DSL for $35 per month if they also sign up for Verizon long distance and local services.

It remains to be seen whether there is enough competition to prevent carriers from raising prices after customers are lured to broadband through low price offerings. However, a number of factors are at play that not only will help curb increases, but should exert downward pressure on prices:

- Equipment and provisioning costs are falling.

- Deployment is widespread (overcapacity).

- Demand is slowing.

- Carriers are reducing rates and testing various pricing strategies to attract more customers.

- Fixed wireless, once thought dead, is now making rural deployment more feasible and promising to introduce an additional platform from which consumers can choose.

These are encouraging signs, especially as many price reductions are taking place in markets where multiple competitors operate. Lower prices can be expected to produce a surge in subscriptions as has been evidenced in other countries such as South Korea, Japan and Canada.[71] If demand further stalls in coming months, expect to see more price competition.

**2. Lack of Compelling Applications Limits Demand**

Presently, the major advantages of broadband over dial-up are its features of being always-on and its fast speed. In terms of applications, most of what can be obtained through using broadband

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[68] Overbuilders create new networks to rival those of the incumbents.

[69] See "Bundle O' Subs," Cable World, September 9, 2002.

[70] "Cable's Vision Voice Clear Money Maker in Cablecos' Field of View," EXCHANGE, July 2002.

[71] Glenn Bischoff: "Finding DSL's Sweet Spot," Telephony on Line, July 22, 2002.

can also be obtained through using narrowband. Thus, compared to the low price of dial-up, broadband subscribers pay as much as a $25 monthly premium mainly to acquire these two features.

While the rapid growth in subscribers would seem to indicate that consumers have thus far placed sufficient value on the convenience, speed and efficiency of broadband connections, Varian (2002) revealed some limits to demand at current prices for these features. When Charter Communications introduced tiered cable modem prices of $23 and $39.95 per month, for 256 Kbps and 512 Kbps, respectively, the take rate was split 60% to 40% in favor of the $23 service. This example demonstrates that a high degree of price sensitivity exists given the set of applications available today. Before the present growth rate of demand can be increased with prices fixed at current levels, broadband's value will need to be enhanced through increasing content or bandwidth-intensive applications.

Although broadband services can potentially provide consumers various applications such as high-quality streaming audio and video-on-demand (VOD), video-conferencing, peer-to-peer applications, etc., such applications are not yet widely available due to low subscribership, technical constraints (e.g., VOD and certain other applications require higher bandwidth than generally available) or legal impediments (e.g., intellectual property rights).

New and compelling applications should increase consumers' perceived value of broadband and hence their willingness to pay, thus boosting demand. However, the question is when and how will these applications be made available? It may well be the case that some "must-have" applications will not arise until there is a mass market for them. This suggests the proverbial chicken and the egg problem, whereby must-have applications will not be introduced until the number of subscribers is widespread, but subscribership is constrained by the dearth of those applications. In a market with such a network effect, Varian (2002) believes that it makes sense to set low "penetration" prices to increase broadband penetration which will in turn increase the rollout of new applications.

The gap between broadband demand and supply, explained in part by high price levels and a lack of applications, is also studied by Atkinson, Ham and Newkirk in "Unleashing the Potential of the High-Speed Internet–Strategies to Boost Broadband Demand."[72]

The following excerpt from the Arbitron/Edison media research study indicates the potential impact of compelling applications:

> The study also shows that record numbers of Americans continue to consume Internet audio and video. As of July 2002, an estimated 83 million Americans have now experienced Internet audio or video. The number of people who have listened to audio or watched video online in the past month grew slightly from the prior year - from 37 million in July 2001 to 38 million in July 2002.

[72] Progressive Policy Institute, September 2002. http://www.ppionline.org/documents/Broadband_0902.pdf

"These numbers are remarkably strong considering the turmoil in the streaming media sector," said Larry Rosin, president, Edison Media Research. "While a number of radio stations and webcasters have ceased streaming due to the newly imposed government digital rights fees, consumers are still seeking out compelling audio and video content in record numbers. This underscores the need for streaming media to develop unique content of its own. When the cable industry began to develop compelling, original content, audiences grew dramatically, along with advertising revenues. The streaming media sector is now facing a similar situation. To remain vibrant, the industry needs to develop 'must see' and 'must hear' content that will spur consumer awareness and passion."

Streamies[73] are very concerned about recent industry turmoil. Among weekly Streamies, half are aware of the digital rights controversies that have caused several webcasters to cease streaming. Two-thirds of monthly Streamies indicate that they are upset about not being able to listen to canceled Internet audio webcasts and a similar number support action by Congress to help Internet audio webcasters afford to continue streaming.

Streamies displayed more interest than ever before in paying for online content. In July 2002, nearly a quarter (22 percent) of Internet audio Streamies - an estimated 16 million Americans - indicated that they would be willing to pay a small fee to listen to the online audio channel they currently listen to the most. In comparison, only 14 percent were interested in paying a fee in January 2002.

This study reveals that Internet users are willing to pay higher rates for desired content. It also reveals that successful resolution of the digital rights controversies can provide a strong boost to demand. As discussed previously, somewhere between 10 million and 14 million American households now subscribe to broadband service,[74] and conservative estimates see 36 million households receiving broadband by 2005. These growth estimates give content providers a very attractive mass market in which to sell new applications. Lower prices, which are already being tested in many areas, may accelerate growth beyond these estimates.

While pricing and content are perhaps the most important elements in stimulating demand, they are not a cure-all. According to research firm In-Stat/MDR, despite low prices, the rate of subscriber growth in South Korea has dramatically slowed in 2002, and may be reaching a saturation point. KT Telecom estimates that the broadband saturation point will be reached in the range of 52-65% of households having broadband.[75]

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[73]Streamies are those who have watched or listened to streaming media online in the past week.

[74]Previous discussion cited penetration at 10% to 15% of total households, which equates to the 10 to 14 million households cited here.

[75]In-Stat/MDR InformationAlert, Volume #27, July 26, 2002.

An important question for both broadband providers and policy makers to consider is what happens when broadband penetration reaches saturation? The vast majority of new broadband connections are coming from users switching from dial-up. The first point of saturation can be loosely estimated as the 50% of U.S. households that are presently connected to the Internet. The second point of saturation may be those households with personal computers that are not yet Internet connected. Including these households raises the saturation point to 57% in the U.S. Although the number of computer and Internet households has been expanding, it is likely to top out below 60% in the short term.

Evidence for this is found in the South Korean experience. South Korea's broadband growth has far exceeded the rest of the world, with connections now reaching 54% of homes. But the number of connections grew by only 11% in the first half of 2002, significantly less than in previous years. The reason for the slowdown is that there are few dial-up users left to switch to broadband. Research firm, Point Topic, believes that this small and shrinking dial-up population could limit growth prospects to about 60% of homes.[76] This confirms KT's estimate previously given.

If this holds true for the U.S., from 40% to 50% of households will remain without any home access to the Internet. This is a huge potential market for broadband applications with enormous economic implications. However, this segment of the population is primarily made up of those with lower incomes and less education, in addition to the elderly.[77] Issues involved with reaching this segment will be discussed next.

### 3. Low Household Penetration of Personal Computers and Internet Connections Limits Demand

The potential market for broadband services is limited by the substantial number of households that are without Internet ready devices, primarily personal computers with available Internet connections.[78] As discussed earlier, only 56.5% of U.S. households had a personal computer as of September 2001. Of these PC households, 88% also had an Internet connection (either dial-up or broadband). Thus, only 50% of U.S. households overall are connected, far short of the 80% of U.S. households that have broadband available. This indicates that almost half of America's households are unaware or unconvinced of the Internet's value, cannot afford to take advantage of it, or have adequate access through some other means (e.g. work or school related access.)

Broadband providers face a difficult and ongoing task to find ways to get this untapped Internet market connected. Many of these households cannot afford personal computers or lack occupants that have necessary computer skills. Although TV set top boxes and interactive TV are being marketed as less expensive and more user-friendly options than traditional computer access,

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[76] "Broadband Market Could Saturate at About 60% of Homes," Point Topic, September 3, 2002.

[77] NTIA: *A Nation Online*.

[78] In economic terms, for Internet purposes, personal computers and Internet connections are complements, i.e., use of one is dependent on use of the other.

these options are not yet widely available. Wide availability of user-friendly devices at reasonable prices will entice more households to become Internet and broadband connected. However, there are significant issues of education and affordability that will have to be addressed to reach the majority of this group. A number of federal, state and local initiatives, discussed later, are presently addressing ways to close this digital divide.

### 4. Low Consumer Awareness of Broadband Limits Demand

There is a positive relationship between consumers' awareness of and demand for a good or service; obviously, consumers need information about goods and services before they purchase them. Low awareness of broadband also limits demand and helps explain the present low take rate.

While broadband is available to around 80% of households in the U.S., a recent Arbitron study found, based on a national survey, that less than 60% of Americans have heard of broadband.[79] This level of awareness is low compared to 80% household availability, and emphasizes the present overcapacity problem. As Table 6 shows, such low awareness is relatively consistent across all ages, with the lowest among the elderly. Those between the ages of 18 and 54 have the highest and almost equal awareness. Awareness declines significantly for those 55 years of age and over. This means that older consumers, who may not be Internet or computer savvy, will first need to be educated on the Internet's value, then on use of personal computers for accessing it. A marketplace solution, in the form of a simple, user-friendly, inexpensive Internet access device, perhaps offers more hope to accelerate acceptance by the elderly.

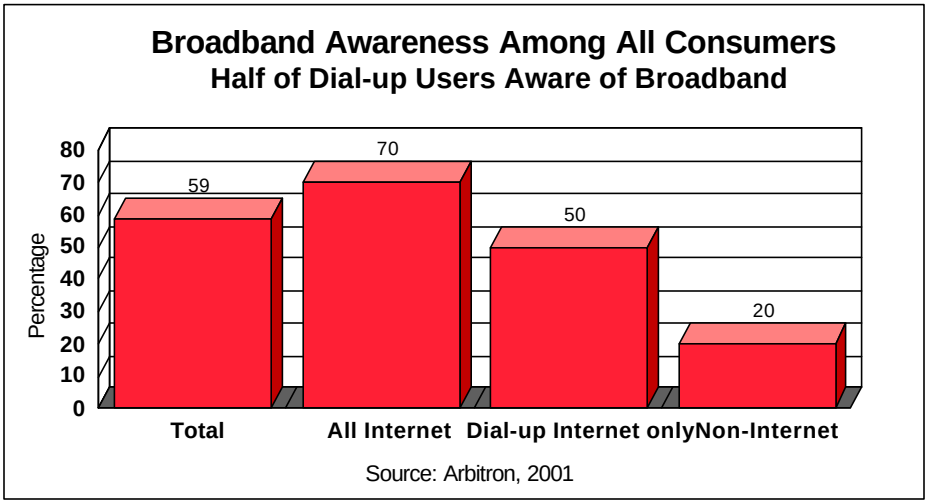
**Table 6: Six in Ten Americans Aware of Broadband**

| Age | All | 12-17 | 18-24 | 25-34 | 35-44 | 45-54 | 55-64 | 65+ |
|---|---|---|---|---|---|---|---|---|
| Awareness | 59% | 61% | 66% | 64% | 68% | 64% | 54% | 39% |

Among the online population, those who are connected with the information world, the level of broadband awareness should be higher. The Arbitron survey supports this point, with 70% of current Internet users saying that they have heard of the term "broadband." However, this number includes those who are actually broadband subscribers. Only 50% of those consumers using dial-up access are aware of broadband. The level of awareness drops to only 20% for the remaining population that do not use the Internet (see Figure 19).

[79] Broadband Revolutions 2–The Media World of Speedies, by Bill Rose and Warren Kurtzman, Artibtron and Coleman.

**Figure 19**




The dial-up and non-Internet population represents an important potential source of future broadband growth. However, broadband providers have a tough and ongoing task to educate and successfully market broadband services to this group.[80] As stated previously, government entities at all levels are addressing these issues.

**5. Supply Side Non-Price Factors Limit Demand**

Non-price factors have also affected consumers' willingness to pay and subscribe to broadband services. In a recent study by the former FCC Chief Economist Gerald R. Faulhaber (2000-01), four broadband quality issues were identified: addressability of DSL and cable modem service, provisioning, customer self-installation, and customer service. The author believes that these four broadband supply-side problems have hampered the increase in broadband penetration in the following ways.

a. Addressability

First, as to addressability, DSL can only be provided over certain telephone lines and has a distance limitation from a customer's premises to a central office (optimally, 12,000 feet). According to the Faulhaber study, in 1999, only 44% of local loops could be reached by DSL, and by 2000, this percentage increased to 64%, due to RBOC efforts to improve DSL addressability. The other major broadband technology, cable modem, also has the addressability problem, albeit to a lesser degree than DSL. Cable modem service can only be provided to homes passed by two-way digital cable. However, as stated previously, the cable industry is at the tail end of a massive infrastructure upgrade to digital systems using hybrid fiber/coaxial cable. Some 70 million or 67% of U.S. homes are now able to receive cable broadband service. Deployment among major DSL and cable providers has slowed, however, due to present economic conditions, the lagging take rate and perhaps, regulatory

[80] Ibid.

uncertainty.

b. Provisioning

Timely provisioning of broadband connections has been a serious problem. The customer premises installations have been costly in terms of time and money to both customers and providers. In the beginning of the broadband rollout, an installation took at least one truck roll and cost several hundred dollars. This largely accounts for the inability of both DSL and cable modem providers to keep up with demand in past years. According to Faulhaber, in 1999, RBOCs were provisioning about 25,000 customers per week while cable companies were provisioning around 30,000 per week. However, requests for DSL and cable modem services were around 39,000 and 47,000 per week, respectively. Providers have addressed this issue by promoting self-installation of DSL and cable modem equipment, usually a digital modem and an ethernet card**.** Providers routinely offer significant discounts on the installation kits to reduce delay and avoid having to dispatch a truck. While this has greatly reduced costs and installation delays, self-installation does require some level of technical ability, which somewhat limits the program's effectiveness in stimulating demand.

c. Customer Service

Complaints have often been heard regarding constant service outages and inexperienced and inadequately trained technical support personnel. Some have reported connections being down for months without repair. Although recent reports suggest significant improvement in these areas, all the technical support bugs have not yet been worked out[81].

While these just described non-price factors have been issues in the past, the impressive growth rate in broadband subscribers can be attributed, in part, to the significant progress that DSL and cable modem providers have made in addressing them. These issues have not been solved completely and further improvements to addressability, provisioning and customer service, can be expected to further increase consumer demand for broadband services.

## F. Broadband Availability and Demand In Summary

The broadband market in the United States continues to expand at a healthy rate, one that matches any major technology rollout in history. The current take rate is low in comparison with current availability but the number of broadband users is continuing along an upward trajectory. This number will continue to expand as broadband usage and applications move closer towards mass market acceptance. Competitors have invested billions in network upgrades. They are searching for

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[81] Industry Comment: The Home Office: Broadband's Best Hope, By Robert M. Rubin, (www.informationweek.com)**.**

Also, according to the NRRI Internet service quality survey, as of November 2001, 21% of respondents won't be able to use Internet service within two weeks after placing the order, 24% reported that connection is interrupted frequently and 47% reported that they have complained about the service quality. Although broadband service quality is part of the Internet quality problem, dial-up service quality may be more of a problem.

effective price points in order to expand their customer base. They are testing new technologies and business plans, which includes implementation of new marketing techniques and bundling options.

National broadband carriers continue to sign up new users at a double digit annual rate, despite pricing which seems too high for mass market acceptance. However, it is early in the rollout of broadband technology. Firms are still gaining new customers and are still looking to recoup their massive investment in network upgrades.

Such a description of the broadband market should not lead to the conclusion that there is no room for improvement. While broadband continues its current positive growth, the future rate of growth is undetermined. There are still underserved areas with little to no broadband availability. Alternatively, there are many Americans with broadband availability but low awareness of the technology and how to utilize it. In addition, the current price is too high for many to justify broadband services in the home.

## IV. CASE STUDIES

Fortunately, evidence of innovative solutions to the above mentioned obstacles is available. Such solutions have been implemented by a wide range of stakeholders, both public and private. Most successful cases are based on business plans carefully examining the local aspects of supply and local levels of demand.

The following case studies examine a wide range of factors encompassing successful deployment and acceptance of broadband services. Factors include the choice of deployment technology and methods of increasing customer take rates. Several case studies (B3, B4 and C4) address the digital divide and efforts made to provide broadband opportunities to underserved children.

The various case studies are classified into three categories. "Private enterprise" represents competitive business models employed by private companies and publicly traded corporations. "Public-private partnerships" recognize the joint efforts of communities and private companies. Each partner provides resources based on respective strengths, resulting in a more efficient broadband solution. "State and local government initiatives" are examples of public sector programs dedicated to connecting underserved communities.

## A. Private Enterprise

### 1. Hickory Tech Corporation

Hickory Tech is an example of the diverse competition taking place in the broadband market. The company is an incumbent local exchange carrier, wireless provider and CLEC. It provides broadband, video and telephone services.[82] The increased revenue potential from multiple customer services over one network helps justify the cost of broadband services rollouts. "This is a very capital intensive strategy, so the most important thing to do is to get as many services as you can over that wire," states Ernie Lombard, president of market and strategic planning at Hickory Tech, regarding the decision to do complete network overbuilds in 15 communities in southern Minnesota and central Iowa.

Hickory Tech's CLEC division looked to overbuilds for a competitive advantage over other incumbents. Hickory Tech chose a platform from NextLevel Communications which allows the delivery of voice, high-speed Internet access and multiple digital video channels over a single copper pair to a home. Lombard also pointed out that, "[t]he economics worked out to where it was a decent business even if it was just voice and high-speed data. Video became extra on top of that." Hickory Tech determines what communities it will serve and what package it will promote based on an individual examination of each location. A community with poor telephone service or little competition would compel Hickory to lead their package with an appealing phone service. In an interesting twist, this multiple services approach sometimes sees broadband as an additional impetus for overbuilding the local telephone or cable TV system.

### 2. Grande Communications

Multiple service revenue is also a key driver for metropolitan overbuilders. Grande Communications, a Texas-based overbuilder, echoes the idea that if you are going to build a modern network you should put every service available on the network. The company is using fiber optics to link seven Texas cities with a new network capable of delivering video, telephone and broadband Internet services.[83] This provides three sources of revenue over the same network at small incremental cost, helping to more quickly pay off construction and equipment costs, estimated at $500 per home. Grande is using fiber-optic technology capable of 10 Mbps now and 100 Mbps in the future with a relatively small upgrade. This large potential increase in bandwidth allows more flexibility than incumbent cable or DSL providers can match.

Grande is able to provide broadband and other services to residences using fiber-to-the-home technology by leveraging their established backbone network facilities. Grande's ten-year old wholesale division provides various network services to national telephone, data and other business

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[82] XChange Magazine, "Back to the Future, Rural Telcos Lead the Way With Video Over DSL" February, 2000.

[83] Dallas Morning News, "Grande Takes it Slow and Steady" by Vikas Bajaj, 8/27/02.

customers. The division manages more than one billion minutes of data and telephone traffic each month using Grande's own voice and data switching platforms and fiber networks.[84] While much of Grande's network buildout is still incomplete, the company generates $100 million in annual revenue. As a private company, Grande does not disclose it's current losses but claims additional funding is unnecessary to reach the breakeven point.

Another characteristic of Grande, which may explain its continued existence in the current telecom environment, is its plan to expand at a manageable pace. Bill Morrow, chief executive, turned down funding which called for an extensive multi-city expansion of its network. The company instead decided it could create a reasonable return by initially focusing on the San Antonio to Austin route exclusively. Since the collapse in the telecom industry, this approach is increasingly being revealed as a wise method for broadband network buildouts (or CLEC buildouts for that matter). Many new entrants have realized that the way to compete with national carriers is a small concentrated effort to provide services tailored for the individual cities or towns they plan to serve.

### 3. Cablevision

Cablevision is one of the nation's largest cable franchises. It also has the most urban demographics, serving the New York metropolitan market, and the highest take rate percentage of any national carrier at 19%.[85] Here are some of the methods Cablevision claims increase customer interest.

> How did Cablevision become the first company in the country to offer a self-install cable modem and the first to launch such a service in a retail setting? First, in a unique strategic move to retail, Cablevision acquired THE WIZ, the tri-state area's premier retailer of entertainment, computer and telecommunications equipment. This instantly provided a showcase for Cablevision to market Optimum Online side by side with the electronic equipment its customers need to access the Internet. Secondly, by always communicating with its customers, Cablevision knew they wanted convenience and value as much as high-speed Internet access. Self-installation became the most convenient and cost-effective way to put the power back in consumers' hands.

The high take rate obtained by Cablevision may be due in great part to its urban demographics. This demographic setting also is characterized by a high number of competitors, which historically leads to innovative applications for the marketplace.

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[84] Grande Communications, "Company Overview," www.grandecom.com.

[85] Cablevision 2Q earnings report.

## B. Public-Private Partnerships

### 1. Pocahontas, Iowa

Adopting the most appropriate (and sometimes innovative) technology can overcome many cost or deployment hurdles for rural areas. The most appropriate technology also takes into account demand factors, leading to higher take rates by consumers.

Pocahontas, Iowa, a community of approximately 2000 people, turned to a wireless system provider after being told that Qwest was not interested in providing broadband service. Rather than spending $4 million upgrading the town's cable system for broadband, Pocahontas chose a multipoint microwave distribution system (MMDS) for an initial investment of only $32,000. The system is based on recently developed non-line-of-sight technology which provides greater flexibility and quicker installation, but less bandwidth, than older line-of-sight systems. The system from Evertek Inc. provides MMDS technology in the 2.1 to 2.7 Ghz frequency range, allowing a single radio tower to cover a 35-mile radius.[86] The city splits the monthly customer revenue with Evertek and expects to recoup their initial investment within three years.

Pocahontas is able to supply 512 Kbps downloads to customers for a $29.95 monthly fee. This is a broadband value proposition that seems to be hitting home with area residents. Around 20% of the town's 900 households have signed up for the service, which has only been available since December of 2001. City Administrator Greg Fritz notes that the relatively low cost is the key to the system's success. The lowest cost using a line-of-sight option would have been $45 per month for 128 Kbps service and $99 per month for businesses to receive 256 Kbps. Pocahontas charges the same price for business and residential and has 20% of the area businesses signed up as well. The 20% take rates for both residential and business customers are nearly double the national rate, which seems to confirm the importance of a broadband price point of approximately $30.

### 2. Digital Rivers

The Digital Rivers project in the Pittsburgh region is a comprehensive example of what can be done to gain an understanding of the market for broadband services.[87] It focuses on the urban Pittsburgh area, but the demand analysis expands into surrounding rural counties. This project covers all the essentials for aligning broadband supply and demand factors. Broadband projects of this scope would serve greatly to enhance the broadband environment for any city. But short of replicating such a project, much can be applied to other areas from the Digital Rivers experience.

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[86] FCW.com, "Shortcuts to Broadband" Brian Robinson, February 11, 2002.

[87] Digital Rivers Final Report, Produced by Carnegie Mellon and 3 Rivers Connect, April 11, 2002. See www.digitalrivers.info for the complete report.

The major aspects of the project include the following:

- Status of local infrastructure
- Area demographics
- Cost analysis of various technologies and deployment
- Survey of early adopters and unmet demand (county by county)
- Analysis of current telecommunications environment, including the best practices of others
- Impediments to deployment
- Implementation strategies
- Pilot project

3 Rivers Connect (3rc) played a large role in the Digital Rivers project as well as the follow-up efforts based on the results of the project. 3rc, a non-profit organization, describes itself as a "project-oriented group (aiming) to provide broad, visionary leadership in the development of Western Pennsylvania's information infrastructure." One broadband deployment effort in Pittsburgh was implemented by 3rc, along with technology partner, Proxicast, LLC. Four different community improvement associations' buildings were the first to be interconnected using Nokia Rooftop Wireless technology.[88] RooftopWireless is a fixed wireless, mesh networking[89] solution which, in this case, delivers service speeds of 512 Kbps. The cost is approximately one-third of an equivalent speed DSL connection. The Digital River report points out that the Rooftop Wireless system is a competitive broadband technology for urban or suburban settings but is not suitable for areas where the number of houses per square mile is less than about 175. The ideal setting would be approximately 40 subscribers in a 1.5 mile radius. The Rooftop Wireless technology is one of several technological deployments considered by 3rc as they examine the various cost/performance tradeoffs for each community.

The Digital Rivers project was a joint effort including state and local government, university and private resources. Carnegie Mellon University provided a great deal of expertise in cooperation with the Alleghany County Department of Economic Development, the Pennsylvania Technology Investment Authority and the Howard Heinz Endowment. An advisory group also included input from the Army National Guard, Pittsburgh Supercomputing Center and Redleaf Inc. Finally, there was a large group of stakeholders with direct interest in the region's broadband capabilities. This included local and national companies, the City of Pittsburgh, and other interest groups. It takes an alignment of goals from all these groups in order to meet the broadband needs of a communities.

### 3. Wireless Internet Zone

The Wireless Internet Zone in Jacksonville, Florida is one example of a project which incorporates broadband access, computers, where needed, and training to maximize use of the

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[88] http://www.digitalrivers.info/press/releases/proxicast.htm

[89] "Mesh networking" is an emerging technology in both fixed and mobile wireless solutions. As opposed to a traditional hub-and-spoke networking model where a central antenna does all the routing, each mesh-enabled device acts as a router or repeater, relaying traffic for everyone else. In some systems, "mesh-enabled" devices include laptop computers, mobile phones and PDAs. See www.meshnetworks.com for an overview.

technology. City officials and community activists are bringing wireless Internet connectivity to two low income neighborhoods.[90] The recent emergence of low cost Wi-Fi wireless technology is making such broadband Internet deployments more feasible. The Internet zones cover two different community areas with wireless access.[91] However, because Internet access cannot be accomplished without computers, they have also been made available to residents who need them through a combination of the Urban League, Humana and Florida's Agency for Workforce Innovation. Awareness and education is also key; organizers stress the importance of getting the message out to local residents about what is now available. The larger goals for the project are to enhance literacy, workforce development, minority business development and voter education. The project is a joint effort by the City of Jacksonville, the Chamber of Commerce, the Urban League, BellSouth, and consulting firms, the Boardwalk Group, Connexsys, and the inc.well consulting group.

**4. PowerUP**

PowerUP is a national coalition of non-profit organizations, major corporations and state and federal government agencies that seeks to provide America's underserved youth with the skills, experiences and resources needed in the digital age. PowerUP's three main objectives:

- Shine a spotlight on the issue of the digital divide and build a national movement to effectively bridge this divide.
- Promote positive youth development through technology.
- Disperse resources to enhance young people's lives in after school settings.

The PowerUP program seems to be providing some concrete results in regards to bringing underserved youth in touch with the broadband experience and the subsequent educational and social enhancements. In an example of activities at the local level, PowerUP Florida has established 25 computer lab sites in underserved communities across the state. The programs also incorporate computer and Internet mentoring services for the children through cooperation with the statewide Mentoring Initiative. This early experience with the Internet creates awareness in children which can continually be leveraged in today's technology-oriented society. As discussed previously, lack of this type of awareness has also been a key factor for consumers in regards to the low broadband take rate.

Note: A recent development with PowerUp jeopordizes the program's ability to continue services. The national PowerUp offices closed as of October 31, 2002 leaving approximately 1,000 community-based technology centers to find other sources of financing.[92] In an example of the more

[90] Jacksonville.com, "Wireless Internet Zone to be Expanded" by Ryan Lee, 6/11/02.

[91] The coverage ranges are 1.5 mile radius and one-half mile radius.

[92] "A Lack of Money Forces Computer Initiative to Close," New York Times, October 30, 2002.

stringent economic climate, national financing for the project (through corporate and foundation donations) has been discontinued. Ongoing PowerUp services will now be dependent on local support and financing. PowerUp spokeswoman Denise Keyes noted that, "...the centers were always supposed to be self-sustaining. This seems like a natural transition time." The difficult transition stresses again the importance of local interaction. The Boys and Girls Clubs of America is one group working to keep local offices functioning.

## C. State and Local Government Initiatives

### 1. Thomasville, Georgia

Local efforts to aggregate, organize and direct local demand can also accelerate the migration towards broadband adoption. Broadband efforts of regional municipalities can be combined in order to increase the scale of the operation. This provides more leverage in obtaining access to Internet backbone capacity and allows costs to be allocated more broadly. One example of this is occurring in rural Thomas County with a population of 43,000 in southern Georgia. Thomasville, the county seat, serves as the local cable head end and provides a broadband link to Camilla, Moultrie, and Cairo, Georgia. This broadband rollout was initiated through the Thomasville City Utility when the city could not talk anyone else into providing the service. Now that they are up and running, new competitors are starting to take the market more seriously, with the other local cable provider now upgrading its systems for broadband and a DSL competitor on the way.

Meanwhile, 50% to 60% of Thomasville's residents have signed up for the new cable TV system and 47% of these customers have taken the cable modem service, called Rose.net.[93] This works out to an overall broadband penetration for the city of almost 25%. The secrets of success in this case are likely to be found in price and customer service. Rose.net service for cable TV customers begins at $28.95 per month for 256 Kbps and climbs to $53.95 for 1 Mbps. Customers who subscribe to the cable modem service alone pay $43.95 for the 256 Kbps offering.

Dedicated customer service seems to be another factor for the higher take rate. Taking into account that most customers likely have limited technical expertise as well as patience, cable modems are installed by support staff for every customer, the technical support number is a local call and the wait is negligible. Moreover, the charges are incorporated on monthly utility bills in a precise, understandable manner.

[93] William T. Berry, Thomasville City Manager, telephone interview, June 2002.

### 2. Grant County, Washington

Grant County is taking advantage of a recently passed state law which allows local utilities to provide telecommunications services. The Grant County Public Utility built its own community-wide fiber optic network after it was unable to get service from firms such as Qwest and Verizon.[94] Over 6,000 homes and businesses are in the process of being connected to the gigabit Internet via Grant County's Zipp Net. This wholesale access platform is used in coordination with competitive Internet service providers. There are currently 14 ISPs, one telephone service provider, one digital video provider and one security service provider using the wholesale network. These ISPs retail an array of value-added services directly to consumers and businesses, such as video on demand (VOD), Voice over Internet Protocol (VoIP) and web services.[95]

### 3. Michigan Broadband Authority

In March of 2002, Michigan took action to increase its broadband availability and take rates by enacting a Broadband Development Authority. The goals are to tear down barriers and provide incentives for the expansion of broadband. Tools to facilitate these are two newly enacted laws. The first creates a statewide right-of-way authority that aims to eliminate excessive fees and permit delays, shield phone customers from rate increases, and level the playing field for all service providers. The second bill creates a broadband finance authority to provide low interest loans to expand broadband access in under-served areas. A third bill passed which provides tax credits to telecommunications providers who invest in new broadband infrastructure.

### 4. South Dakota

South Dakota provides another example of state leadership in broadband producing some truly positive results. The school system is considered the most wired in the nation, with a computer for every 3.5 students. But of equal importance, all schools in the state–public, private and tribal–are connected to one another with the Digital Dakota Network.[96] This provides a two way interactive teaching network so that students across this widespread state can benefit from classes and professors never before available. The network buildout was led by Governor William Janklow who saw distance learning as an opportunity for the state. Rather than being subject to the digital divide, South Dakota has used technology to bridge an educational divide for its remote students. But access to the students is not where the program stops. Teachers are also being trained in a "technology immersion" program. Rather than trying to fit training into the busy teaching schedule, the program sends teachers to a one month program which focuses on computer training and applications five days a week, 8 hours a day. Each participant receives a $1,000 stipend and $1,000 for the home district for use by administrators. So far, 41% of the state's teaching staff have participated.

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[94] Entrepreneur.com, "Broadband in Rural America" by Erik Pages, 7/31/2002.

[95] Center for Internet Studies, University of Washington, "The Next Utility for the Knowledge Economy".

[96] Newsweek, "Next Frontiers" by Dirk Johnson, October 29, 2002.

Several innovative techniques were used by the state to finish the network, which also connected every state government office and library. The four-year project connecting over 400 buildings was estimated to cost $100 million at market prices. Instead, the state used prison inmates for low cost labor. It also solicited contributions from corporations, especially telephone and computer companies, to help pay for the project.

The state's overall broadband efforts are showing up in the raw numbers as well. South Dakota was the fourth fastest growing state in terms of high-speed lines as of the end of 2001, growing at a rate of 76%.[97]

## V. GOVERNMENT'S ROLE IN BROADBAND

The above examples are just a small representation of what is taking place across America to tackle existing barriers to deployment and demand. The marketplace is doing an impressive job overcoming most obstacles. Where private enterprise has been unwilling or unable to respond, public entities - municipal utilities, cooperatives, local governments, universities and public-private partnerships - have taken action with a dynamic mix of solutions to bring broadband services to underserved communities.

Government entities at the federal, state and local levels play a key role in ensuring that the creative forces at work are not stifled. The most important role governments can play in fostering deployment and demand for advanced services is in the following areas:

- **Avoid regulations that would determine market outcomes.** Focus should be maintained on ensuring that there are no market abuses or barriers to entry. Government, itself, can erect barriers through policies that favor particular providers or solutions. For example, wireless is becoming the technology of choice in underserved areas. Regulatory policies or financial incentives that favor wireline services could end up embedding an expensive and inappropriate technology. The proper regulatory approach is one of technological and competitive neutrality. Given the state of the economy in general, and the telecommunications industry in particular, regulators should not hasten to select costly and perhaps irreversible solutions, when the problems may be temporary. In today's market, more than ever, sound economics should dictate future investment decisions.

- **Provide regulatory certainty through a consistent regulatory scheme**. The rate of broadband deployment has slowed over the last two years. Capital spending by carriers has dropped by two-thirds since 2000 due to overcapacity in many networks and the deteriorating financial condition of many service providers.[98] Capital spending is no doubt further

[97] Federal Communications Commission, "High Speed Services for Internet Access" Released 7/23/02. Data current as of 12/31/01.

[98] "Consumer Market Called Optical Networking's Next Frontier," Mercury News, August 23, 2002.

inhibited by regulatory uncertainty. Regulators should create an environment that promotes new, unfettered investment and innovation.

- **Avoid "one size fits all" approaches.** They are inappropriate and possibly discriminatory due to the underlying diversity of the participants. This is important in the area of rural deployment because local factors can vary so greatly. The above case studies showed that an appropriate solution for the open farmlands of Iowa may not be the same for the mountainous terrain of the Appalachians or the Western US. Local infrastructures also vary greatly. One small town may have a major fiber access line running past its borders. Others may have no fiber available and particularly poor quality copper lines to boot. In many rural settings the most cost effective broadband solution is wireless. In others, it is satellite. In many cases it is a combination of two or more technologies. Local demographics can vary just as widely. Age, education and income levels are all key factors driving demand and must influence deployment decisions. Appropriate solutions will be ones that meet the unique challenges of rural areas, not a rush-to-judgement government "fix."[99]

- **Expand e-government.** Government can enhance the value of Internet access and increase demand for it by enabling more businesses and individuals to access information and do business online. Florida is an example of how e-government initiatives can draw more people to Internet use. Florida launched the MyFlorida.com website, where citizens, public and private organizations and visitors can access information and do government business online. The Florida Public Service Commission also created a user-friendly website, where parties can listen to agenda conferences, access documents, and file complaints online. These initiatives have helped position Florida as a leader in broadband access. According to the most recent FCC advanced services report, Florida ranks 4th nationwide in total number of high-speed access lines and 3rd in residential and small business penetration.

- **Take proactive steps to foster and facilitate local "grass roots" solutions that eliminate roadblocks, align interests and implement best practices.** A coordinated, interactive relationship can exist between federal, state and local government. Gaining broadband access is fundamentally a local issue. Uncovering the appropriate solutions requires community input and a concerted effort from local government, community leaders and local businesses. The previous case studies have shown that a focused local assessment of broadband demand and a roadmap for deployment presents a much stronger case to broadband providers and ISPs. It increases leverage and presents them with a more attractive business proposition. Service providers would more eagerly deal with a community presenting aggregated demand and a streamlined permitting and rights-of-way process. State governments in particular can initiate outreach programs to assist local communities in assessing their needs and bringing the appropriate broadband solution to their area. A more complete compilation of case studies (best practices) is currently being compiled by the NRRI on behalf of the Federal/State Joint Conference on Advanced Services. These should aid states and local

[99] For an example of a marketplace response in bringing broadband to underserved areas, see article on Usurf America at: www.usurf.com/images/techbiz-7-8-02-reprint.pdf

communities in tailoring solutions for their unique characteristics and challenges. A successful example of a state outreach effort (North Carolina's Rural Internet Access Authority) is presented later in this study.

- **Facilitate efforts to equip those who are not online with the knowledge and resources to participate in the digital revolution.** As previous case studies showed, a number of federal, state and local initiatives are presently addressing ways to close this digital divide. Another federal initiative, the Universal Service Fund Schools and Libraries Program, has enabled schools and libraries across the nation become Internet connected. A growing number of students and teachers alike are therefore able to experience the Internet's value as a vast educational resource and communications medium. The schools and libraries are thus providing Internet access venues to those who, for whatever reason, cannot gain access at home or the workplace. As the number of these venues expand, it should help close the gap between those who are connected and those who might otherwise be left behind. This program, over time, will enable more students and "have-nots" to see the value of being connected. This will have the long term benefit of increasing demand for both Internet connections and the devices those connections require.

**State Outreach Initiatives**

Experience has shown that state governments can be very effective facilitating broadband growth by reaching down to the local communities that may lack or have inadequate service coverage. Broadband is fundamentally a local issue due to its importance to the local economy and to the health and welfare of the citizenry. The state benefits as well from a well connected, informed and productive citizenry and business community. One important point gleaned from each study of rural deployment: it is important to examine every community individually. The levels of demand, competition and existing infrastructure are just a start. This leads to an area where the various levels of government can interact. A key state role may be advising local communities on what options are available. Taken a step further, states can reach out to local communities in some of the following key areas in order to eliminate redundant errors and replicate successes experienced in other communities.

- Create and maintain a central knowledge base for best practices.
- Provide a structured guideline to detail the process. (Voluntary guidelines)
- Create regional/state workshops for promoting organization and streamlining methods.
- Eliminate regulations restricting broadband expansion or competition.

The state of North Carolina provides one of the best examples of developing a broadband strategy and following through to positive results. In 2000, the North Carolina General Assembly created the Rural Internet Access Authority in order to study and report on the state's telecommunications infrastructure and then to increase Internet use.

There are four milestones the authority was charged with meeting:

| | | |
|---|---|---|
| August 2001 | Local dial-up Internet access available statewide | Achieved |
| November 2001 | Inventory of state's telecommunications infrastructure completed | Achieved |
| January 2002 | Model telecenters established | Achieved |
| December 2003 | High-speed Internet access available statewide | Pending |

How well is North Carolina doing on the last milestone? The FCC's most recent report on *High-Speed Services for Internet Access* provides some positive results.[100]

North Carolina ranks 12th in the current number of high-speed lines with 358,000. However, the state's line count was growing at a 74% rate in the second half of 2001, making it the 5th fastest growing state. No other state with such a high level of lines was growing so quickly. These achievements are even more striking when it is noted that 85% of North Carolina's counties have been classified as rural.

North Carolina's keys to success seem to be related to:

- Early assessment of needs. They classified each of their 100 counties into 5 tiers based on unemployment, per capita income, population growth, and population size. The lower three tiers were classified as "distressed."

- Successful interaction between different entities–various levels of government, businesses (including the three largest communications companies), public and private organizations.

- An organizational structure covering all the necessary aspects of such a project. A 21 member commission was chosen representing communities from across North Carolina. These members were chosen for expertise in the various fields of technology, education, and economic and community development.

- Successful initial and ongoing funding. MCNC[101] pledged $30 million to jump start the program. The four model telecenters were funded through an ongoing grants program.

Another success from the North Carolina experience was the announcement that BellSouth completed the rollout of high-speed data technology in the state and did so seven months ahead of schedule.[102] The system is installed in 136 out of 140 central offices statewide and BellSouth claims

[100] Data is for the second half of 2001 and is current as of 12/31/2001.

[101] Formerly the Microelectronics Center of North Carolina.

[102] The Business Journal of the Greater Triad Area, "BellSouth DSL service ready in N.C." April 3, 2002.

to have spent $100 million on DSL technology in North Carolina. Also, 1,500 remote DSL terminals have been deployed and 2,100 are expected by the end of 2002.

## VI. CONCLUSION

The supply and demand dynamics of the broadband services market in the U.S. are evolving quickly. Like most developing markets, this is one characterized by contrasts. National service providers have directed sufficient capital investment into cable modem and DSL network upgrades to provide over three-quarters of the nation's households with access to broadband services in roughly half a decade. Likewise, smaller regional carriers, overbuilders, municipalities, satellite and wireless providers are deploying in urban gaps and portions of the rural areas missed by the national carriers. These carriers, large and small, are reacting to continuing consumer demand for broadband services. Broadband remains one of the most robust consumer markets in the U.S. and matches adoption rates of historical product rollouts which are today considered mainstays of everyday life.

Conversely, many rural areas remain without broadband service and broadband providers have slowed the pace of deployment. Subscriber growth has declined relative to the growth rates of earlier years. Current monthly pricing for broadband, in connection with a lack of compelling applications and other factors have resulted in disappointing take rate levels.

It seems a new phase of the broadband market has taken over from the initial euphoric, perhaps undisciplined expansion. Recent bankruptcies in the telecommunications sector and the decreasing size of capital spending budgets are forcing much stricter business models for broadband deployment. In many cases, expansion is only funded by returns on existing customer bases, rather than venture capital or other external sources. The search for profitable business models has replaced the chase for market share.

Consumers also are more focused on the value proposition of broadband. Now that early adopters have done so, the remaining consumer base will have a more stringent cost-benefit criteria. While over 13 million American households currently justify the benefits of broadband service, a large percentage of consumers will only be persuaded with higher personal utility gains from broadband service or with lower prices.

Lessons learned from these early shifts in the broadband market may serve to improve the longer term market vitality. Successful solutions are being modeled by entrepreneurs, public-private partnerships and local government initiatives. Cooperation is necessary between various levels of government in order to promote and replicate the most productive methods. This continually evolving market emphasizes the importance of sound policies and practices which are supportive of future market progressions.

**APPENDIX**

Table A1: 3rd Quarter 2002 Cable Modem Subscribers

| | Q3 Subscribers | Q3 Additions | Quarterly Growth Rt. |
|---|---|---|---|
| Time Warner | 2,313,000 | 257,000 | 12.5% |
| AT&T | 1,934,000 | 172,000 | 9.8% |
| Comcast | 1,300,000 | 169,800 | 32.2% |
| Cox | 1,272,299 | 157,300 | 14.1% |
| Charter | 1,020,500 | 115,000 | 12.7% |
| Cablevision (2ndQ) | 610,500 | 50,740 | 9.0% |
| Total | 8,450,299 | 921,840 | 12.2% |

Source: Individual Company 3rd Quarter Earnings Releases. The most recent Cablevision data available was for the 2nd quarter 2002. Charter Communications Q3 additions data is from the preliminary 3Q earnings report issued by Charter on 10/24/02.

- For the largest six cable operators, these figures present a 24% increase in broadband subscribers during the six month period April 1st to September 30th, 2002.
- In a September 30, 2002 press release the NCTA noted that the overall cable industry surpassed ten million cable modem subscribers.

Table A2: 3rd Quarter 2002 DSL Subscribers

| | Q3 DSL Subscribers | Q3 Additions | Quarterly Growth Rt. |
|---|---|---|---|
| SBC | 1,950,000 | 226,000 | 13.1% |
| Verizon | 1,640,000 | 155,000 | 10.4% |
| BellSouth | 924,000 | 121,000 | 15.1% |
| Qwest | 500,000 | 44,000 | 9.6% |
| Sprint | 113,000 | 27,000 | 31.4% |
| Total | 5,127,000 | 573,000 | 12.6% |

Source: Individual company 3rd Quarter Earnings Releases

- The 3rd Quarter marked SBC's third consecutive quarter of accelerated DSL line growth and its strongest one-quarter gain in seven quarters.
- BellSouth estimates its broadband market share to be 44% in its nine-state region (Harris poll 3Q, 2002).