ADVANCED TELECOMMUNICATIONS IN RURAL AMERICA

The Challenge of Bringing Broadband Service to All Americans

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EXECUTIVE SUMMARY

Advanced Telecommunications in Rural America is a response by the National Telecommunications and Information Administration (NTIA) and the Rural Utilities Service (RUS) to a request by ten U.S. Senators on the status of broadband deployment in rural versus non-rural areas in the United States. This report also responds to a call by President Clinton and Vice President Gore to bridge the digital divide and create digital opportunities for more Americans. The rate of deployment of broadband services will be key to the future economic growth of every region, particularly in rural areas that can benefit from high-speed connections to urban and world markets.

This report finds that rural areas are currently lagging far behind urban areas in broadband availability. Deployment in rural towns (populations of fewer than 2,500) is more likely to occur than in remote areas outside of towns. These latter areas present a special challenge for broadband deployment.

Only two technologies, cable modem and digital subscriber line (DSL), are being deployed at a high rate, but the deployment is occurring primarily in urban markets. Broadband over cable, which provides most broadband service, has been deployed in large cities, suburban areas, and towns. One survey found that, while less than five percent of towns of 10,000 or less have cable modem service, more than 65 percent of all cities with populations over 250,000 have such service.

DSL technology also has been deployed primarily in urban areas. The Regional Bell Operating Companies (RBOCs) are providing DSL service primarily in cities with populations above 25,000 according to public RBOC data. While more than 56 percent of all cities with populations exceeding 100,000 had DSL available, less than five percent of cities with populations less than 10,000 had such service. Deployment of both cable modems and DSL service in remote rural areas is far lower.

The primary reason for the slower deployment rate in rural areas is economic. For wireline construction, the cost to serve a customer increases the greater the distance among customers. Broadband service over cable and DSL is also limited by technical problems incurred with distance and service to a smaller number of customers. Both technologies, however, promise to serve certain portions of rural areas. Cable operators promise to serve smaller rural towns, and smaller, independent telecommunications companies and competitive providers may soon be able to offer DSL to remote rural customers on a broader scale.

Advanced services in rural areas are likely also to be provided through new technologies, which are still in the early stages of deployment or are in a testing and trial phase. Satellite broadband service has particular potential for rural areas as the geographic location of the customer has virtually no effect on the cost of providing service. Several broadband satellite services are planned. Their actual deployment remains uncertain, especially in light of the recent entry into Chapter 11 bankruptcy of two satellite service companies.

Wireless broadband services are also planned for rural areas. More immediately, multipoint-multichannel distribution system (and potentially local-multipoint distribution system) fixed service capabilities may provide a solution for some rural areas. In as little as five years, third generation mobile wireless services providing data rates as high as two megabits/second may be operational.

Policymakers should promote competition, where possible. Using the pro-competitive provisions of the Telecommunications Act, some competitive local exchange carriers have deployed advanced services in rural areas of the country. Some wireless carriers have also indicated an interest in providing voice and high rate data, especially if universal service policies can be reformed.

Competition leads to lower prices, more customer choice, rapid technological advances, and faster deployment of new services. Given unique challenges faced by rural Americans, however, other government policies must be considered as well.

In order to support advanced services in rural areas, NTIA and RUS recommend a number of actions. We recommend the continued support and expansion of those government programs, such as the E-rate program, that ensure access to new technologies including broadband services. We also urge the Federal Communications Commission to consider a definition of universal service and new funding mechanisms to ensure that residents in rural areas have access to telecommunications and information services comparable to those available to residents of urban areas.

Support for alternative technologies will also be crucial to the deployment of advanced services in rural America. The Administration is committed to increasing investment in research and development to promote the next generation of broadband technologies. NTIA and RUS will also collect and disseminate “promising practices” that can promote private sector investment in rural broadband services.

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I. INTRODUCTION

This is a joint report of the National Telecommunications and Information Administration (NTIA) of the U.S. Department of Commerce and the Rural Utilities Service (RUS) of the U.S. Department of Agriculture. This report responds to a letter to Mr. Larry Irving, former Administrator of NTIA, and Mr. Wally Beyer, former Administrator of RUS, co-signed by Senators Baucus, Conrad, Daschle, Dorgan, Harkin, Johnson, Kerrey, Murray, Wellstone, and Wyden (See attached letter). In their letter, the Senators requested that NTIA and RUS examine six issues relating to the availability and deployment of advanced telecommunication capabilities to all Americans, particularly those who live in rural areas.[1] These issues concern:

1. The investment in telecommunications facilities with advanced capability in rural areas compared with non-rural areas, including an assessment of the various levels of capability being deployed under different technologies and the bandwidth capabilities of such deployment and whether or not comparable bandwidth is being deployed consistent with the objectives under Section 254(b)(2) and (3) of the Communications Act and Section 706 of the Telecommunications Act.

2. The availability of telecommunications backbone networks and "last mile" facilities with advanced capability in rural areas compared with advanced telecommunications backbone networks and last mile facilities in non-rural areas.

3. The rate of deployment of advanced telecommunications capability in rural areas compared with the deployment of such capabilities in non-rural areas and identity of specific geographic areas where advanced telecommunications capabilities are being deployed at a significantly lower rate than the deployment of such services elsewhere in the Nation.

4. The feasibility of various technological alternatives to provide last mile advanced telecommunications capability in rural areas.

5. The capability of various technical enhancements to existing wireline and wireless networks to provide last mile advanced telecommunications capability in rural areas.

6. The effectiveness of competition and universal service support mechanisms to promote the deployment of advanced telecommunications capability and the availability of advanced telecommunications services in rural areas.

The Administration and the Congress have recognized the importance of deploying advanced capabilities to all people and regions in the United States. As Vice President Gore noted:

1. We have renumbered several of the issues in the Senators' May 20, 1999 letter to align them with the report's organization.

> One of the most important goals that President Clinton and I have set for this country is … to make sure that every person in America, regardless of race, income, or where they live, will be able to participate in and benefit from the Information Revolution ….[2]

To ensure that all Americans can partake in the economic benefits of the digital economy, President Clinton convened an Electronic Working Group within the Administration. This past year, the Working Group fashioned three directives to guide its work over the next year, including a directive to close the digital divide between those with and without access to new technologies. President Clinton also announced new budget proposals to create digital opportunities for all Americans, as discussed in Part D, several of which will promote broadband deployment.

Advanced telecommunications capabilities are crucial to the future of an increasingly interconnected America. These advanced capabilities mean that data can be delivered at rates that far exceed what can be carried by an ordinary telephone voice circuit. What might have taken hours to deliver may now take minutes; what might have taken minutes, can take seconds. For example, a student with one megabit/second broadband access at home could conduct a one hour virtual tour of the Louvre in real-time from her own living room, while a child with a 28 kilobit/second modem would require 36 hours to download the same information.

Advanced capabilities are becoming ever more important as businesses and consumers increasingly rely on the Internet and on sophisticated applications incorporating audio and video which require sustained high information rates. Availability of advanced telecommunications will become essential to the development of business, industry, shopping, and trade, as well as distance learning, telemedicine, and telecommuting. The rate of deployment therefore has implications for the welfare of Americans and the economic development of our nation's communities.

This is particularly true for those who live in the rural towns and countryside, who can especially benefit from high-speed, distance-defying connections to external markets and employment opportunities, urban medical centers, large universities offering specialty courses, and similar distant resources. Access to broadband means, for example, that a rural automotive designer need no longer relocate to the company headquarters to participate in interactive, real-time computer aided modeling of a new vehicle. It also gives a doctor in rural America the kind of access to sophisticated, data-intensive applications (such as three-dimensional imaging) previously only available to doctors connected by a local area network.

Congress has repeatedly recognized the significance of improved telecommunications for rural America. In 1993, Congress enacted the Rural Electrification Loan Restructuring Act (RELRA).[3] A primary intent of RELRA was to spread the deployment of advanced services and to ensure that these services were deployed at uniform rates in rural and non-rural areas.

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2. U.S. Vice President Gore on Connecting Communities for the Future, Email for All Event, May 8, 1998 (www.iaginteractive.com/emfa/msg00029.html).

3. Rural Electrification Loan Restructuring Act, Pub. L. No. 103-129, 107 Stat. 1356, codified at 7 U.S.C. 902 *et seq.* *See* §935(d)(3) regarding requirements for State Telecommunications Modernization Plans.

Congress more specifically addressed universal service in the Telecommunications Act of 1996,[4] which rests on the two pillars of competition and universal service. The universal service principles found in Section 254 of the Communications Act of 1934, as amended by the Telecommunications Act, are intended to ensure access to advanced services for all Americans, so that those living in rural areas will be able to share in the buildout of advanced services to the same degree as those living in more densely populated areas.[5] Section 706 of the Telecommunications Act complements the universal service provisions of Section 254 by directing Federal and State regulatory bodies to encourage the deployment of advanced telecommunications capability to all Americans.[6]

Advanced services are just beginning to be deployed on a broader basis, although they are still primarily available only for business and urban users. Most Americans with access to the Internet still connect through a telephone voice circuit.

This report is intended to provide an initial assessment of the availability and rate of deployment for rural and non-rural areas to help gauge whether all Americans are benefiting from advanced capabilities.

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4. Telecommunications Act of 1996, Pub. L. No. 104-104, 110 Stat. 56 (1996), codified at 47 U.S.C. §151 *et seq*. [hereinafter Telecommunications Act].

5. Section 254(b)(2) provides that "(a)ccess to advanced telecommunications and information services should be provided in all regions of the Nation." Section 254(b)(3) provides that "(c)onsumers in all regions of the nation, including low-income consumers and those in rural, insular, and high cost areas, should have access to telecommunications and information services, including interexchange services and advanced telecommunications and information services, that are reasonably comparable to those services provided in urban areas and that are available at rates that are reasonably comparable to rates charged for similar services in urban areas." Section 254(c)(1) states that "(u)niversal service is an evolving level of telecommunications services that the Commission shall establish periodically under this section, taking into account advances in telecommunications and information technologies and services." The FCC in its May 8, 1997 order on universal service (Report and Order, 12 FCC Rcd 8776 (rel. May 8, 1997)) [hereinafter May 8 Order], stated that it will convene a Federal-State Joint Board to review the definition of supported services on or before January 1, 2001. In a keynote address at a Senate conference (*Going the Extra Mile: Closing the Digital Divide in Rural America*, held October 27, 1999), Chairman William Kennard stated that the Joint Board will be convened well in advance of that date.

6. Telecommunications Act, *supra* note 4. Section 706(a) provides that "(t)he Commission and each State commission with regulatory jurisdiction over telecommunications services shall encourage the deployment on a reasonable and timely basis of advanced telecommunications capability to all Americans (including, in particular, elementary and secondary schools and classrooms) by utilizing, in a manner consistent with the public interest, convenience, and necessity, price cap regulation, regulatory forbearance, measures that promote competition in the local telecommunications market, or other regulating methods that remove barriers to infrastructure investment." Section 706(b) requires the Commission to conduct a periodic inquiry. "(I)n the inquiry, the Commission shall determine whether advanced telecommunications capability is being deployed to all Americans in a reasonable and timely fashion. If the Commission's determination is negative, it shall take immediate action to accelerate deployment of such capability by removing barriers to infrastructure investment and by promoting competition in the telecommunications market." Section 706(c)(1) states that "(t)he term 'advanced telecommunications capability' is defined without regard to any transmission media or technology, as high-speed, switched, broadband telecommunications capability that enables users to originate and receive high-quality voice, data, graphics, and video telecommunications using any technology."

II. APPROACH, METHOD, AND DEFINITIONS

A. Approach and Method

The report provides an overview of broadband technologies and the deployment of these technologies. As yet, there are no comprehensive, publicly available surveys or studies documenting broadband deployment across the nation.[7] NTIA and RUS staff therefore provided this overview by drawing on a variety of sources including electrical engineering texts, professional and trade journals, specialized studies, and discussions with rural communication providers, Regional Bell Operating Companies (RBOCs), cable TV providers, terrestrial and satellite wireless communication companies, and state regulators. These discussions were supplemented with an examination of industry supplied information pertaining to current and future deployment of broadband services, where available.

The agencies decided not to collect information through a formal survey. We note that, on March 30, 2000, the Commission adopted rules requiring a semi-annual, mandatory collection of data on the availability of broadband services.[8] Given this systematic collection of data in the future, the agencies felt it would be best to provide an informal overview report at this point.

B. Definitions

The following terms are used through the report.

Rural: The term *rural* can be interpreted many ways. Many assume that any area outside of a major metropolitan area is rural. This is clearly too broad a definition as it includes fairly large cities.

NTIA and RUS have adopted the Census Bureau's definition.[9] In our report, *rural* means towns of fewer than 2,500 inhabitants as well as areas outside of towns, including farmland, ranchland, and wilderness. Under this definition, there were approximately 22.3 million households living in rural areas (approximately 25% of the total United States population), according to the 1990 Census.[10]

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7. Broadband information collected by the FCC up to this time has come from voluntary surveys that have not provided comprehensive data.

8. *See In the Matter of Local Competition and Broadband Reporting*, Report and Order, CC Docket No. 99-301 (rel. March 30, 2000) [hereinafter Broadband Reporting Order]. Providers are required to complete and file the Local Competition and Broadband Reporting Form (FCC Form 477) no later than May 15, 2000 and semi-annually thereafter. *Id.* On February 18, 2000, the FCC also released a second Notice of Inquiry to determine whether advanced telecommunications capability is being deployed to all Americans in a reasonable and timely fashion. *In the Matter of Inquiry Concerning Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of the Telecommunications Act of 1996*, Notice of Inquiry, CC Docket No. 98-146 (rel. Feb. 18, 2000).

9. *See* U.S. Census Bureau, Urban and Rural Definitions and Data (www.census.gov/population/censusdata/ur-def.html.)

10. *The Rural Difference*, Rural Task Force White Paper 2, January 2000, at 60 (based on RUS analysis of the 1990 Census conducted with assistance from the Rural Policy Research Institute) [hereinafter *Rural Difference*].

The Census definition encompasses both traditionally small rural towns and outlying areas, as well as areas that are developing or urbanizing. Approximately 43% of the households classified by the Census as *rural* are in metropolitan statistical areas.[11] That is, this definition may include areas that are only temporarily rural, such as suburban developments with brand new utilities built relatively close to an urban or suburban area. These areas tend to be relatively affluent and their characteristics are more like the adjacent metropolitan area than what one ordinarily thinks of as rural. Rural statistics can be misleading if these variations are not considered.

The remaining 57% of rural households are outside of metropolitan statistical areas and are more likely to be in areas traditionally considered as rural. Of these, 23.5% live in towns with fewer than 2,500 people. The remaining 76.5% (or approximately 10 million households) live outside of towns in areas that are often more remote or sparsely settled.[12]

The suitability of various telecommunications technologies will depend on the characteristics of the rural area. For example, low population density is linked to a high cost-to-serve for any technology, especially for wireline technologies such as telephone or cable TV. This is because customers in close proximity, whether in small towns or big cities, can be served with less wire than a similar number of customers scattered through the countryside where the wire cost can be orders of magnitude greater.[13]

Given the impact of geography and the population distribution on cost, we will discuss a technology's suitability for different kinds of rural areas. We will pay special attention to the most rural areas, *i.e.*, those areas outside of towns and suburbs. Historically, these areas have been the most expensive to serve and, generally, are the last to receive a new (or any) type of telecommunications service. In many cases, before the introduction of the Rural Electrification Administration's (now RUS) Telephone Program in 1950, these areas received no service at all. These customers provide the greatest test for the universal service principles in Sections 254 and the complementary provisions of Section 706 of the Telecommunication Act, which seek to ensure access to advanced services for <u>all</u> Americans.

Advanced Services: The term *advanced (telecommunications) capability* found in the Senators' letter and the term *advanced services* found in Sections 254 and 706 are taken to be synonymous. Such services are generally understood to mean digital information transmission rates (bit rates) that are significantly higher than the nominal 56 kilobits/second which can be transmitted through an ordinary, high quality telephone voice circuit. *Broadband* is another term commonly used to describe high bit rates. In this report, *advanced capability*, *advanced services*, and *broadband* will be used interchangeably.

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11. *Id.*

12. *Id* at 61. Although not published in the White Paper, the RUS analysis performed during its preparation showed that there are approximately 9.6 million households in this unquestionably rural area; that is, outside of towns and not in a metropolitan statistical area. This represented approximately 11% of the nation's households in 1990.

13. For wireline construction, a large part of the cost is the installation, irrespective of the size of the cable. There is a high fixed cost associated with plowing a mile of cable whether that cable contains one pair of wires or 50. This is sometimes referred to as the "sheath cost" and typically runs about $10,000 to $15,000 per mile. In low population density areas where pair counts are low, this is a dominant construction cost and it rapidly drives the cost per customer higher as the distance between customers increases.

We have adopted the Federal Communication Commission's (FCC or Commission) definition of *broadband:* the capability of supporting at least 200 kilobits/second in the consumer's connection to the network ("last mile"), both from the provider to the consumer (downstream) and from the consumer to the provider (upstream).**[14]** Because most consumers use the Internet to receive data, broadband service offerings are generally asymmetrical (*i.e.*, the downstream link operates at a higher rate than the upstream link).**[15]**

The following table demonstrates how the FCC definition of broadband compares to information rates required for different types of well-known applications, such as telephone and video.**[16]** The uses of broadband are obviously much more extensive than the list provided below.

Application	Representative Rate kilobits/second
V34 Modem over Telephone Voice Circuit	33
Inter-office Digital Telephone Voice Circuit	64
Low-resolution Conference-Quality Video (compressed)	200
Compact Disc Audio	1,400
VCR Quality TV (compressed)	1,500
Broadcast Quality TV (compressed)	5,000
High Definition TV (compressed)	20,000

At a rate nearly four times faster than the best conventional modem access over a voice circuit, a rate of 200 kilobits/second can be considered advanced. That rate, however, will not support high data rate applications such as VCR quality video. Nor will VCR-equivalent video likely be achieved through compression. The bit rate requirements of the various digital video qualities shown in the table above are already obtained through compression (data reduction), which reduces the bit rate to a small fraction (on the order of 1/30th) of the uncompressed digital rate. Compression has greatly reduced the bandwidth required for video and other information and has, for example, made it possible to provide high definition television in the same six megahertz bandwidth required for conventional analog television signals. However, the ability to compress

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14. *See* Broadband Reporting Order, *supra* note 8, at ¶ 22 (explaining that "'full broadband' is synonymous with the term "advanced telecommunications capability," *i.e.*, as having the capability of supporting, in both the downstream and upstream directions, a speed in excess of 200 Kbps in the last mile."); *see also Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of the Telecommunications Act of 1996*, 14 FCC Rcd. 2398, 2406 ¶ 20 (1999) [hereinafter Section 706 Report]. NTIA and RUS believe that two-way capability is an essential element of broadband service because it enables an end-user to be a content originator or service provider.

15. There are also services that do not meet the FCC definition of broadband yet offer higher rates than conventional dial-up modems, at least in one direction. These include two-way services where the upstream rate is under 200 kilobits/second and one-way (unidirectional) services that use some other path, usually the telephone, for the upstream link. In order to provide a complete overview, this report will also discuss these high data rate services.

16. This chart was prepared by RUS and NTIA using publicly available information. Some devices, such as the compact disc, operate at fixed rates. Others, such as compressed video, operate at varying rates according to need. The representative rates shown here are intended to put the requirements of different applications in context.

information is not unlimited. For a given level of perceived video quality including fidelity to the original image, today's mechanisms are approaching the point of diminishing returns for reducing the bit rate requirement. Any improvements in compression technology will be marginal compared to the reductions made to date and will not negate the need for broadband access to the Internet and other sources of information.

Users may need even higher bit rates in the future as Internet throughput rates increase and demand for high quality video and other information-intensive applications rises. Such demand will accelerate with the increasing use of distance learning, electronic commerce, medical applications, and as yet unforeseen uses of the Internet.

III. RESPONSES TO THE SENATORS' REQUESTS FOR INFORMATION

In their letter to the Administrators of NTIA and RUS, the Senators requested specific information on the deployment of advanced telecommunications capabilities, particularly in rural areas. The issues are set forth below, with the agencies' responses following each issue. In certain cases, we have combined our responses to the issues because of the overlapping nature of the material.

A. Capability and Availability of Advanced Telecommunications Facilities

Issue 1. Investment in telecommunications facilities with advanced capability in rural areas compared with non-rural areas, including an assessment of the various levels of capability being deployed under different technologies and the bandwidth capabilities of such deployment and whether or not comparable bandwidth is being deployed consistent with the objectives under Section 254(b)(2) and (3) of the Communications Act and Section 706 of the Telecommunications Act.

Issue 2. Availability of telecommunications backbone networks and "last mile" facilities with advanced capability in rural areas compared with advanced telecommunications backbone networks and last mile facilities in non-rural areas.

Part A treats the issues of capability and general availability of backbone and last mile facilities. We first examine these issues in relation to "backbone" facilities, the main arteries of the nation's advanced telecommunications network, and then turn to "last mile" facilities, which connect users to the network. In discussing "last mile" technologies, we have further divided our discussion between those that are significantly deployed and those that are not. A comparison of deployment differences between rural and non-rural areas is set forth in Part B.

We note that complete and reliable investment information is difficult to obtain at present. Regulated providers do not itemize their broadband investments, and non-regulated providers do not readily disclose such competitively sensitive information. Even if the investment data were available, it is unlikely that it could be identified as urban or rural. Investment must mainly be inferred from deployment and availability for existing systems and from estimates for prospective systems.

1. Capability and Availability of Broadband Backbone

The majority of the nation's broadband backbone is composed of fiber optic cables, with satellite links connecting areas that are difficult to reach by landlines or underwater cable. Fiber provides an almost unlimited capacity for transporting data at high rates. With current wave division technology, it is possible for a single fiber to carry 400 gigabits/second which is equivalent to two million broadband signals (at 200 kilobits/second) or six million telephone calls (at 64 kilobits/second).

Investment in backbone is proceeding at a rapid pace spurred largely by market forces unleashed by the divestiture of the Bell System and the rapid increase in demand for data services. Companies such as AT&T, MCI/WorldCom, Sprint, Qwest, Level 3, ITXC, and Williams have rapidly been building data networks. There are currently more than 40 Internet backbone providers, and six new networks (estimated to cost $18 billion) will come into service in the next two years.[17]

Cable systems, electric utilities, and municipalities have also deployed backbone. Utilities had already installed 40,000 route miles of fiber optic cable by the end of 1997.[18] Montana Power, for example, has installed 10,000 miles of fiber.[19] Midcontinent Cable, a cable operator in the Great Plains states, has constructed a 530-mile fiber optic network that is expected to connect approximately 150,000 subscribers in North and South Dakota.[20]

While many believe that the continued buildout of the backbone is appropriate in light of growing bandwidth demand, others have speculated that there may be too much backbone capacity.[21] Many of the installed fibers still are not used and remain as "dark fibers." In addition, advancements such as wave division multiplexing are allowing a greater portion of the fiber's potential bandwidth to be used and, as a result, are multiplying the amount of information each fiber can carry.

Despite the rapid buildout of these data networks, there still is the issue of whether long-haul fiber optic backbones are connecting rural areas. In a report released by iAdvance, it was claimed that some states have little or no access to broadband hubs and the broadband backbone. The report dubbed these states the "disconnected dozen."[22] This report of a backbone and backbone hub shortage was characterized by the Competitive Broadband Coalition as "myth."[23]

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17. *Setting the Record Straight: The Fallacies and Realities of the Broadband Debate*, released by the Competitive Broadband Coalition, Oct. 25, 1999 (citing *Building a Better Backbone - And Business Plan*, Inter@ctive Week, 9/16/99) [hereinafter *Setting the Record Straight*].

18. Section 706 Report, *supra* note 14, at ¶40.

19. *See* www.in-tch.com/maps-fiber.htm.

20. Jim Barthold, *Miles of Fiber Optics Connect the Dakotas, Midcontinent, ADC team for Network of High-Speed Data and Telephone Services*, Cable World, Feb. 1, 1999.

21. Rachel King, *Too Much Long Distance*, Fortune, March 15, 1999 at 107.

22. Eric R. Olbeter and Matt Robison, *Breaking the Backbone: The Impact of Regulation on Internet Infrastructure Deployment*, July 27, 1999.

23. *See Setting the Record Straight*, *supra* note 17.

The latter position is probably closer to the truth. It is true that the dedicated Internet backbone primarily connects urban centers, but access to this dedicated backbone can be provided to users through other network facilities. Though they serve some of the most remote areas, RUS-financed carriers who provide Internet access have found that there are many means to gain indirect access to the backbone. For example, the backbone can be reached over leased facilities. The most prominent source of leased connection is through the nation's toll and local providers, but there are also connections available from private providers such as the utilities mentioned above. These facilities, while part of the telephone plant or even private facilities, provide connectivity to the Internet backbone and can be considered extensions of the backbone.

As a result, access to the backbone is generally not a significant problem for rural areas. The exceptions are in extremely isolated areas outside the contiguous 48 states, such as the many scattered and remote villages in Alaska or islands that lack fiber connection to the mainland. These remote areas will no doubt require fiber or additional satellite capacity to reach the backbone.

2. Capabilities and Availability of "Last Mile" Technologies with Significant Deployment

In general, it is the last mile, not the backbone, that presents the greatest challenge to bringing broadband to all Americans. There are a number of last mile facilities that connect the user to the network. Several of these (cable modems and digital subscriber line) are being deployed rapidly. Others (such as fiber to the home and terrestrial and satellite wireless) are in the early stages of deployment or are still being tested with the expectation of deployment in the next few years. A table that follows this report summarizes the state of development of last mile facilities.

Cable Modem

The majority of broadband service today is provided over cable modems although authorities differ on the exact numbers of both subscribers and customers passed by cable modem ready systems. According to Cable Datacom News, a leading industry source, there were 1.5 million cable modem subscribers in the U.S. and 560,000 in Canada at the end of February 2000. The same source reported that cable modem service was available to 43 million North American homes.[24] According to another source, cable modems were in 1.1 million American homes at the end of 1999, and systems that were cable modem ready at that time reportedly served about 27 million customers.[25] Whatever the exact number, it is evident that the number of working cable modems and cable modem ready systems is increasing rapidly. Estimates of future penetration show even more variation. One analyst projects that there will be 9.6 million cable modem customers in 2004.[26] As discussed later, most of this penetration has occurred in large towns and metropolitan areas.

24. *Cable Modem Customer Count Tops 2 Million*, Cable Datacom News, March 1, 2000 (www.cabledatacomnews.com).

25. Seth Schiesel, *Broadband; How Broadly? How Soon?: A Technology's Promised Arrival May Finally Be Here*, N.Y. Times, Jan. 17, 2000, at C1 (reporting results from the Yankee Group) [hereinafter Schiesel].

26. *DSL Gaining on Cable as the Big Pipe of Choice*, Washington Post, Feb. 10, 2000, at E10 (reporting analysis from the Yankee Group).

Traditional cable television networks were designed to provide analog television signals to subscribers via coaxial cables. Until recently, only television signals (typically about 70 channels in earlier systems and 120 channels in more recent and upgraded systems) were transported downstream to the customer through a coaxial cable network with a node and branch structure.

Because coaxial cable has a useful bandwidth of nearly one gigahertz for short distances, it is a natural candidate for providing broadband data services and access to the Internet. The first cable systems adapted for data were unidirectional using the telephone for the return link. More recent systems are designed for two-way communication. According to information supplied by the cable industry, approximately 90% of existing cable modem service is two-way.[27]

Upgrading a cable system for two-way broadband service requires substantial financial investment. It has been estimated that the cable industry will expend $21 billion to upgrade their systems to reach roughly one half of the homes passed in the United States and an additional $31 billion to upgrade their systems to reach all homes passed.[28]

Most systems built today are not engineered to provide broadband to all their customers. Current practice in the cable industry is to provide broadband from a node passing between 500 to 1000 homes (350 to 700 customers) with the expectation that only a fraction of customers will take the service.[29] In the event of more widespread subscription to broadband, companies will need to split the nodes, which will require additional investment, or devote additional channels to cable modem service. The latter option may be problematic in the near term because of the impending transition to digital television. During this period, spectrum may not be available because providers will be duplicating the analog channels in the digital format.

There is also a limit to how far broadband can be delivered from the node. To maintain the quality of the TV signals, the signal must be amplified at about 2,000 feet from the node and reamplified every 2,000 feet after that. Each amplifier adds noise and subtle distortions that have a small cumulative effect on the TV signal but which can severely impair the performance of cable modem operation.[30] As a result, when a cable provider adds cable modem service to its

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27. Sixth Annual Report: *Annual Assessment of the Status of Competition in Markets for the Delivery of Video Programming*, FCC 99-418, rel. Jan. 14, 2000 at ¶58 [hereinafter Sixth Annual Report].

28. *Cable Access Debate*, Excite@Home (www.home.net/source).

29. One must be careful when comparing projections of the number of customers a system can serve. Some of these projections are based on older concepts about the nature of Internet traffic, which assume that high data rates are usually needed only for extremely small periods to download a file or to load a page. Implicit in this assumption is that the customer does not use the shared channel for the vast majority of time and that, during this "idle" time, others can use the channel. This is why usage is sometimes referred to as "bursty." This assumption, however, is becoming less and less valid. As web pages become more graphically intensive and with the increasing use of applications that require high, sustained rates, the number of customers who can share a data channel will decline.

30. Even though a cable modem system is carrying a digital signal, the amplifiers are analog and simply "repeat what they hear." These amplifiers balance for attenuation with frequency, amplify, and then retransmit the TV channels including any noise, or distortion that has joined the signal or been added by the amplifier itself. This cumulative distortion does not occur, by contrast, with digital repeaters. Digital transmission is effective at resisting noise and other distortions because the signal is deliberately encoded so as to be unambiguous. For illustration purposes, if a system operates with only "1" and "0, when it receives a "1" that has been distorted by the

cable system, it generally adds no more than eight amplifiers, resulting in a maximum range of 16,000 feet from the node. Because it is more reliable and requires less maintenance and adjustment, the preferred method is to operate without amplifiers, which limits the range to about 2,000 feet.[31]

Cable can theoretically provide downstream broadband at multi-megabit rates. Under the recently-adopted industry standard, users share a bitstream, typically 27 megabits/second downstream and up to ten megabits/second upstream, but these rates are almost never available to a single user.[32] Because the capacity is shared, the system can slow dramatically under heavy use. For example, if 540 users simultaneously attempted to watch streaming video, the shared data rate could be as low as 50 kilobits/second per user. To prevent wildly varying performance levels, many systems restrict the maximum bit rate available to a single user to a minor fraction (10%, or less) of the full channel capability in both directions. Media General in Fairfax County Virginia, for example, restricts its Road Runner service to 1.5 megabits/second downstream and 192 kilobits upstream.[33] This means it falls slightly below the FCC definition of broadband, as do many of today's service offerings whether provided by cable, DSL, or other methods.

In addition to these factors, performance via cable also varies depending on the overall quality of the cable system and the subscriber's equipment, as well as the performance of the Internet. These variables mean that it is nearly impossible to provide a single number that describes cable data throughput rates. According to the cable industry, an individual subscriber may experience access rates between 500 kilobits/second and 1.5 megabits/second depending on the network architecture and traffic load.[34]

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transmission channel to "0.9," it knows it must be "1" and can restore it to its original form. Every time it passes through an amplifier, the amplifier can regenerate an exact original. When passing through analog amplifiers, this regeneration does not occur. Eventually, the signal is so deteriorated that it is no longer unambiguous. To return to the illustration, if the "1" has deteriorated to "0.5," the regenerator cannot know whether the signal should be a "1" or a "0."

31. *AT&T Plans Distributed CMTS Architecture: Lightwire Roadmap Calls for Integration of DOCSIS CMTS Funtionality into Mini-Fiber Nodes*, Feb. 1, 2000. (www.cabledatacomnews. com/feb00/feb00-5.html).

32. CableLabs (Cable Television Laboratories, Inc.) issued the DOCSIS 1.1 standard (Data Over Cable Service Interface Specification) on April 22, 1999. This specification allows cable operators to provide guaranteed bandwidth to cable modem customers (http://www.cablelabs.com/PR/DOCSIS-042299.html).

33. Mike Musgrove, *Cable Modems: Is the Price Right?* interviewing Media General's Bob Mechelin, August 13, 1999 (www.washingtonpost.com/wp-srv/business/talk/transcripts/pegaro081399.htm).

34. *Overview of Cable Modem Technology and Services*, Cable Datacom News (www.cabledatacomnews.com). In one field test of recent cable modems, long-term average performance was under one megabit/second. Jim Louderback, *A New Age of Consumer Cable Modems* (reporting field test results for throughput of five new DOCSIS cable modems), ZDNet.com (www.zdnet.com/zdtv/cablemodem/reviews/story/0/7501/2382118.html) (viewed on 1/20/00).

Digital Subscriber Line (DSL)

Digital Subscriber Line (DSL) is the second most widely used broadband service, and its deployment is also growing quickly.[35] While there is a range of estimates for DSL deployment, that range is not as wide as that for cable modem deployment, discussed above. According to one source, there were 504,000 customers at the end of 1999.[36] This source predicts that this number will climb to 2.1 million by year-end, 2000.[37] Some project that broadband via DSL will surpass cable within a year or two.[38] Long-term estimates, which are much more speculative, range from 7 million DSL customers in 2004[39] to 9.6 million in 2003.[40]

The customer start-up cost is about the same for DSL as it is for cable modem, typically $200 to $300. There are numerous service offerings, some of which do not meet the full definition of broadband because the upstream link is lower than 200 kilobits/second. Many customers choose downstream services offered in the 250 to 600 kilobits/second range. Some real-world tests show lower rate DSL outperforming cable modems.[41] Although cable modem performance varies with the number of users, DSL broadband operates at a more fixed rate.[42]

In contrast to cable systems, which require extensive upgrades to provide data services, a substantial majority (over 70%, according to one source) of the copper loops in the existing telephone system can provide some form of DSL broadband merely with the addition of equipment at each end.[43] SBC Communications, Inc. (SBC), for example, has pledged to make DSL available to 80% of its subscribers within three years.[44]

Unfortunately, many of the loops on which DSL cannot operate are in rural areas. Telephone loops can be grouped into two categories: those that extend less than 18,000 feet (about 3 ½ miles) from their central switching office or carrier serving area and those that are longer. The

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35. Whereas cable broadband is primarily a residential service, approximately 33% of DSL services are for business at this time. According to TeleChoice, there were 504,110 business and residential customers at the end of the fourth quarter of 1999. Of these, approximately 76.5% were provided by incumbent LECs, 22% by competitive LECs, and 1.5% by inter-exchange carriers. *See* www.xdsl.com [hereinafter Telechoice]. The incumbents primarily served residences (81% residential) whereas the competitive and interexchange carriers primarily serve businesses (77% and 65% respectively). *Id.*

36. *Id.*

37. *Id.*

38. George T. Hawley, *DSL: Broadband by Phone,* Scientific American, October, 1999 (www.sciam.com) [hereinafter Hawley].

39. *DSL Gaining on Cable as the Big Pipe of Choice*, Washington Post, Feb. 10, 2000, at E10 (reporting analysis from the Yankee Group).

40. *See* Telechoice, *supra* note 35.

41. *DSL Beats Cable Modem in Prime Time Internet Performance Duel - Based on Over 150,000 Performance measurements on the Networks of At Home and Pacific Bell,* Press Release, Keynote Systems, Inc., May 17. 1999.

42. *See* Schiesel, *supra* note 25.

43. *See* Hawley, *supra* note 38.

44. Sixth Annual Report, *supra* note 27, at ¶62.

shorter loops can generally support DSL-based advanced services.[45] Most customers in cities and towns, even very small towns, are served by plant that is inherently advanced services capable given the addition of DSL equipment because they are served by these short loops.

Longer loops (over 18,000 feet) generally are not DSL-capable because they must be "loaded" to maintain quality voice service.[46] Loaded plant is laced with inductors placed every mile or so along the cable to maintain good frequency response in the voice band. This comes at the price of blocking higher frequencies, including frequencies needed for DSL broadband. As a result, people served by long loops, generally those in outlying rural areas, may not have DSL-capable plant.

Loading has fallen out of favor with the development of distributed carrier systems in the 1980s and, more recently, DSL. Indeed, the FCC's Synthesis Cost Model (which designs modern, efficient telephone plant with no barriers to advanced services) does not use loading.[47] Under this design, referred to as a carrier serving area (CSA) design, no customer is beyond 18,000 feet from a central office or distributed carrier system. As explained below in Issue 5, much of the plant in rural areas is now built in this manner. If universal service support is used to build the modern, efficient plant envisioned by the FCC, inductive loading, which acts as a barrier to broadband, will eventually disappear in rural areas.

3. Capabilities and Availability of "Last Mile" Technologies without Significant Deployment

Fiber to Homes and Businesses

Fiber optic cable, typically used for backbone networks and the nation's long distance phone network, can also be used to connect homes and businesses. A fiber modem at the home or business (or nearby, for fiber to the curb) is used to convert light waves into electrical signals.

Among last mile technologies, fiber offers the largest bandwidth and could truly bring "the death of distance." The information carrying capacity of fiber is many millions of times that of

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45. While not as wide band as coaxial cable, twisted pair has always been capable of carrying broadband. T-Carrier, developed in the 1960s, carries 1.544 megabits/second for 6000 feet before it is digitally regenerated. It is extremely robust because it was designed for long-distance voice service. Better electronics and less robust encoding allow for higher rates or longer distances. This broadband capability has been exploited in recent digital subscriber line (DSL) systems, which multiplex the digital signal over an ordinary analog voice signal. In other words, the DSL equipment pulls the upstream data off of the wire before the voice circuit discards it and adds the downstream data above the frequencies in the voice signal. DSL can carry 1.5 megabits/second to about 18,000 feet operating in this manner. Even higher rates can be carried for shorter distances. VDSL, for example, can carry rates of 53 megabits/second to 1,000 feet.

46. Although there are other forms of DSL that can reach beyond 18,000 feet by using repeaters, these repeaters do not allow for the telephone to remain on network power. One of the strong points of DSL from a public safety standpoint is that the telecommunications provider powers both ends of the voice circuit just as in plain old telephone service (POTS) so the telephone remains available for emergency use during power outages. When a repeater is inserted, voice service is dependent on less reliable forms of local power at the subscriber end, such as batteries. The subject of telephone reliability is discussed further in footnote 82.

47. *See infra* note 81.

copper-based facilities such as twisted pair or coaxial cable. The loss of signal with distance is so small compared to copper that a fiber can carry bit rates thousands of times higher than cable modems and DSL for distances of one hundred miles with no intervening electronics.

The down side is that fiber to the home is costly. For a typical home or business the cost for terminal equipment alone was about $1,500 in 1997.[48] While this price has since dropped, it still is not as low as the typical cost of about $500 or $600 per subscriber for adding cable modem or DSL broadband to a cable or telephone system.[49] Even without considering the cost of a plant rebuild, connecting the user to a fiber network is significantly more expensive than upgrading existing cable or telephone plant.

For these reasons, fiber deployment directly to homes and businesses has been minimal to date. Several examples, however, demonstrate that fiber deployment may be worth the additional cost:

- Clear Works plans to provide voice, video, and data to 2,700 new residences in Virginia, with 1,500 planned for a later date.
- BellSouth intends to offer video and data to 400 Atlanta residences via ATM technology and expects to provide service to an additional 200,000 residences in Atlanta and Florida later in the year.
- SBC has already deployed fiber-to-the-curb at more than 30,000 residences in Richardson, Texas, and plans to add 10,000 more links by the end of the year.[50]
- The Rural Telephone Company, an RUS borrower in Kansas, has built a fiber-to-the-home system that serves the rural towns of Hill City and Bogue.[51] Early versions of the technology used in this project were financed as a field experiment by RUS.

Whether fiber optic cable will be deployed to a large number of individuals in the future remains to be seen. It will largely be a function of whether bandwidth appetite grows to HDTV levels (20 megabits/second) or higher, thus moving beyond the practical capabilities of cable modems and DSL. Assuming there is greater deployment of fiber to the home, the costs of fiber and subscriber lightwave equipment will also fall, potentially spurring even further fiber deployment.

Multipoint Multichannel Distribution System

Multipoint multichannel distribution system (MMDS), commonly known as "wireless cable," is a wireless system for delivery of data via point-to-multipoint microwave radio signals. It

48. Bhumip Khashnabish, *Broadband to the Home (BTTH): Architectures, Access Models, and the Appetite for Bandwidth*, IEEE Network, Jan. 1, 1997.

49. *See* Schiesel, *supra* note 25.

50. Jason P. McKay, *Optical Illusion Disappears*, 4 tele.com 15 (1999) (www.teledotcom.com) (describing Clear Works, Bell South, and SBC).

51. www.ruraltelephone.com/history/pagesix/index.htm

operates below three gigahertz (GHz) at distances up to 35 miles under the best circumstances.[52] Given this range, MMDS could be an attractive "last mile" solution.

MMDS is descended from the older Multipoint Distribution Service (MDS), which was designed to transmit only television signals. MDS never became widely deployed, probably because the allotted spectrum only allowed for the broadcast of about 32 analog TV channels, compared to the 60 or 70 channels typically found on cable systems.

The FCC approved use of MMDS for two-way data service in September 1998, which greatly increased the interest in MMDS.[53] Several companies have tested MMDS data service, including Wireless One, CAI Wireless, American Telecasting and People's Choice TV. In these tests, downstream rates have been as high as 10 megabits/second and upstream rates have been as high as 128 kilobits/second (rates that are lower than the FCC's definition for broadband). MCI/WorldCom has launched tests in Baton Rouge, Louisiana; Memphis, Tennessee; and Jackson, Mississippi, with plans for a more significant test this summer in Boston.[54]

MMDS is already deployed in several areas. In Phoenix, for example, Sprint now serves over 10,000 customers, competing with the local cable operator and U.S. West.[55] Nucentrix Broadband Networks (in the Dallas metro area) plans to offer MMDS to small to medium sized businesses. It is currently deploying MMDS in two of its 58 markets (Sherman-Dennison, Texas and Austin, Texas) with the intent to offer service to 18 additional markets by the end of 2001.[56] Collectively, MCIWorldCom and Sprint have spent approximately $3 billion acquiring MMDS licenses in areas holding more than 50 million people, half of whom reportedly live in rural areas.[57] They have announced a plan to deploy MMDS to rural markets, although the term "rural" was not defined.[58]

<u>Local Multipoint Distribution System</u>

Local Multipoint Distribution Service (LMDS) is another fixed wireless technology capable of providing broadband service. LMDS was originally used for one-way wireless cable-like

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52. There are many factors that can reduce the practical range, the primary one being the limitations resulting from a line-of-sight requirement given diffraction and the curvature of the earth. For example, over flat ground with no intervening obstructions like hills or buildings, to achieve a 25-mile range requires that both antennas be 75 feet above the ground. To keep the customer end to a more reasonable 33 feet height requires a 500-foot central tower. *See* David Urban, *Data Over MDS Cable Modems with Fixed 2 GHz Radio Link* (www.adc.com/Corp/BWG/MSD/cmodems.html).

53. *In the Matter of Amendment of Parts 21 and 74 to Enable Multipoint Distribution Service and Instructional Television Fixed Service Licensees to Engage in Fixed Two-Way Transmissions*, 12 FCC Rcd 19112 (1998).

54. Peter Goodman, *MCI WorldCom Plans Wireless Test*, Washington Post, March 28, 2000 at E1 [hereinafter Goodman].

55. Sixth Annual Report, *supra* note 27, at ¶90.

56. www.nucentrix.com.

57. *See* Goodman, s*upra* note 54.

58. *Ebbers Points to Rapid Digital Divide Crossing by MCI-Sprint*, Wireless Today, Jan. 13, 2000. (Bernard Ebbers promised that the two companies will serve rural markets through MMDS within a year of the proposed merger.)

service. The FCC auctioned LMDS spectrum for two-way broadband data service in 1997 and required that licensees build out the service within ten years of winning the license.[59] LMDS offers higher data rates than MMDS, but has a much shorter range, typically no more than three or four miles. The large amount of spectrum allocated, 1,300 megahertz near the 30 gigahertz range, has generated significant interest in LMDS by the telecommunications industry.[60] This capacity is enabling some LMDS operators to provide data rates greater than 150 megabits/second. Many small and some large companies are interested in using LMDS to provide integrated broadband data, voice, and video services.

LMDS is being tested or deployed by several companies. Currently, most deployment is for service to business customers in urban areas, in competition with existing and new wireline providers. (LMDS can be far less expensive to deploy than new wireline facilities, for which providers must obtain rights of way and often face expensive installation costs in congested urban areas.) Cellular Vision USA now offers LMDS service in the New York City area. World Wide Wireless also offers LMDS (and MMDS) service in the suburban areas surrounding San Francisco and San Diego. Highspeed.com is offering LMDS in mid-sized and large cities in the western United States, including Walla Walla, Washington; Bakersfield, California; Boise, Idaho; Denver, Colorado; and Honolulu, Hawaii.

Other companies are exploring deployment in areas that are partially rural. As discussed below, however, rural deployment of LMDS may be limited by several factors.

Broadband Data Satellite Systems

Satellite systems may offer another possibility for broadband service. One specialized system that has just come on line is Tachyon, which markets its services to Internet Service Providers (ISPs). Tachyon provides a two-way broadband satellite link to connect end users to their ISPs, carrying the end user's Internet traffic via satellite to the ISP gateway. The system promises to help ISPs reach customers in more remote rural areas. Tachyon offers service at varying data rates, from 200 kilobits/second to two megabits/second for the downstream rate and from 64 kilobits/second to 256 kilobits/second upstream. Deployment of this service began in March 2000.

The best known satellite system currently offering general Internet access to residences in North America is DirecPC, which offers downstream service at $200 for the start up charge and a $30 monthly fee. DirecPC reports that remote customers are assured a clear satellite signal so long as a clear line of sight to the southern sky is maintained. Installation kits are available at local retailers across the country.

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59. *Rulemaking to Amend Parts 1, 2, 21, and 25 of the Commission's Rules to Redesignate the 27.5 GHz Frequency Band, To Reallocate the 29.5-30.0 GHz Frequency Band, To Establish Rules and Policies For Local Multipoint Distrisbution Service and For Fixed Satellite Services, CC Docket 92-297, Second Report and Order, Order on Reconsideration, and Fifth Notice of Proposed Rulemaking,* 12 FCC Rcd 12545 (1997) (Second Report).

60. This bandwidth is equivalent to about 217 conventional broadcast television channels, compared to 32 for MMDS.

DirecPC is provided over a system originally designed to deliver television programming. Subsequently, this system was adapted to provide limited high-rate Internet access. Downstream rates are shared and can be as high as 400 kilobits/second, while the upstream link is via standard phone lines. As such, it does not meet the FCC's definition of broadband. DirecPC also restricts heavier users under a "fairness" policy to rates that are a small fraction of the 400 kilobit/second maximum. This restriction may make DirecPC less attractive as a high-speed data link than other broadband technologies.

Because DirecPC provides customers in the most remote rural areas with the same quality of service provided to those in urban areas, it provides a preview of the potential for satellite broadband to eliminate geography and location as a cost factor. Several new broadband satellite systems are expected to come online in the next few years (as discussed in Part C), all of which will provide significantly higher capacities than DirecPC.

Summary on Capability and Availability

The problem with regard to broadband access in rural areas lies primarily with last mile connections rather than access to the backbone network. DSL and cable modems are the most widely available last mile broadband technologies. As discussed below, however, their deployment in rural areas lags that in urban areas. New technologies hold promise for broadband access in rural areas but may be years away from widespread availability.

B. Rates of Deployment in Rural and Non-Rural Areas

Issue 3. Rate of deployment of advanced telecommunications capability in rural areas compared with the deployment of such capabilities in non-rural areas and identify specific geographic areas where advanced telecommunications capability is being deployed at a significantly lower rate than such services are being deployed elsewhere in the Nation.

In responding to Issue 3, we address broadband services that are already widely deployed so that we can compare rural and non-rural areas and examine specific locales that are not yet served by these technologies. For this reason, we have limited our discussion to cable modems and DSL.

Deployment in urban and rural areas is not proceeding at a comparable pace. For various reasons, the major cable and DSL providers are both concentrating on serving metropolitan urban areas with high population densities. The likelihood of receiving broadband service through either technology declines with population density. As a result, residents in rural areas will generally be the last to receive service.

That said, the size of the provider and the nature of its service area are undoubtedly significant factors in determining which areas are served. Providers with both rural and non-rural service areas will likely bring broadband to their larger, urban, and more lucrative markets first, whereas rural providers are most likely to serve rural towns before remote, out-of-town areas. This means that those last served will be in the sparsely-settled countryside.

Cable Modems

In general, the larger the city or town, the more likely it is to find cable modem service. The information in Appendix A provides a recent snapshot of cable modem deployment, based on the "Cable Modem Deployment Update" in Communications, Engineering, and Design (CED) Magazine from March 2000. As noted previously, these numbers are changing rapidly.

Figure 1 - Broadband Cable Access by Town Size

Town Size Category	Towns Served in Category
Over 1,000,000 Population	100% of 8 Towns
500,000 - 1,000,000	73.3% of 15 Towns
250,000 - 500,000	65.9% of 41 Towns
100,000 - 250,000	40.4% of 136 Towns
50,000 - 100,000	26.2% of 355 Towns
25,000 - 50,000	15.9% of 741 Towns
10,000 - 25,000	7.6% of 1,852 Towns
5,000 - 10,000	5.0% of 2,336 Towns
2,500 - 5,000	2.0% of 3022 Towns
1,000 - 2,500	0.7% of 4,936 Towns
under 1,000	0.2% of 9,993 Towns

Sources: *Cable Modem Deployment Update*, CED Magazine (March 2000); U.S. Census Bureau's *1990 Census Gazetteer*.

Figure 1 shows the deployment of cable modem service across cities and towns of various sizes.[61] This chart shows that the percentage of cities or towns with cable modem service declines as the population size decreases. For example, according to this study, cable modem service was available in some portion of all eight cities with populations exceeding one million. Cable broadband was also available in portions of more than 70 percent of cities with populations between 500,000 and one million. That rate declines for smaller cities. Approximately 25 percent of cities ranging from 50,000 to 100,000 in population had cable

61. This chart is based on Appendix A, which uses CED magazine's list of areas (primarily cities) with cable modem service in at least part of the city. We then used data from the U.S. Census Bureau's *1990 Census Gazetteer* (www.census.gov/cgi-bin/gazetteer) to determine the size of the cities. For the 26 counties identified in Appendix A, we identified cities and towns within those counties for which we could confirm cable modem service and included them in the chart.

modem deployment, compared to less than five percent of towns with populations between 5,000 and 10,000 and less than one percent in towns with populations under 2,500. We recognize that companies may report their deployment with varying degrees of accuracy and that any list is probably not complete.

For several reasons, cable modem service is less successful in reaching some rural areas. It is estimated that cable is available to somewhere between 81% and 97% of Americans, depending on the method of calculation.[62] Nevertheless, rural areas outside of towns still have less access to cable TV.[63] With the arrival of direct broadcast satellite for television, it is even less likely that cable systems will extend further into the countryside. Additionally, as with all types of wireline service, the costs of high-speed cable data deployment and operation in rural areas are high.[64] Because the subscriber base in rural areas is more dispersed than in more densely populated areas, there is less economic incentive to connect rural areas.

While the prospects for deploying cable modem service in remote areas outside of towns seems low, the prospects are higher in small rural towns. Appendix A shows that many small towns

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62. Statistics for the availability of cable vary according to whether a comparison is made to TV households, all households, or housing units. The most commonly used statistic is to compare homes passed by cable to TV households. According to estimates developed by Paul Kagan Associates, Inc., and reported in the National Cable Television Association's (NCTA's) *Cable Television Developments*, there were 99 million TV households, 66 million cable customers, and 95.6 million homes passed by cable service. *See* NCTA, 23 *Cable Television Developments* 1 (Summer 1999). Using these figures, the ratio of homes passed by cable to TV households was 96.6%. *Id.* The Warren Report, a second source reported by NCTA on its website, estimated that there were fewer homes (91 million) passed by cable in 1999 based on information collected from cable providers (ncta.cyberserv.com/qs/user_pages/Dev%28statedata%29.cfm). Comparing the Warren estimate of homes passed to the Kagan estimate for TV households yields a ratio of approximately 92%.

Another way to measure the availability of cable is to compare homes passed by cable to all households, not only TV households. According to a December 8, 1999 report, there were approximately 101 million households (occupied housing units) and 112 million housing units (occupied or unoccupied) as of July 1998. *See* Census Bureau, *Estimates of Housing Units, Households, Households by Age of Householder, and Persons per Household: July 1, 1998* (www.census.gov/population/estimates/housing/sthuhh1.txt). Comparing the Kagan and Warren estimates for homes passed to total households yields ratios of 95% and 90%, respectively.

Finally, a third comparison is between houses passed by cable and total housing units. This comparison is especially useful because there is evidence that cable providers may be reporting housing units passed, not households or TV households passed. For example, the Warren report listed 258,832 homes passed by cable in Washington, D.C., while Census estimated 265,000 housing units but only 225,000 households for the same area. The cable provider in Arlington, Virginia reported 89,968 homes passed and 89,968 housing units in its franchise area. It is reasonable that providers report housing units passed because, when it does not serve a house, a cable provider has no easy way to distinguish among a household without TV, a household with TV, or an unoccupied housing unit. Comparing the Kagan and Warren estimates for homes passed to total housing units yields ratios of 86% and 81%, respectively.

63. National Telecommunications and Information Administration, U.S. Department of Commerce, *Survey of Rural Information Infrastructure Technologies* (September 1995) at 3-7 ("Cable television service providers are generally unwilling to extend their cables into rural areas where the subscriber density is less than 10 per mile.")

64. National Cable Television Association, *Imposing Common Carrier-Style Regulations On Cable Would Impede Deployment of Cable's High Speed Internet Service to Rural and Small Communities* (May 1999) ("In lower density rural markets, where computer penetration is generally less than the national average, the high fixed costs involved in establishing high speed networks are spread over a much smaller customer base. Although customers are responding favorably, these small cable system operators are still unsure about how many customers they will attract and what return they will see.").

with populations less than 2,500 are already receiving cable modem service, including Freeman, South Dakota (pop. 1,293); Hardin, Kentucky (pop. 595); and Machias, Maine (pop. 1,773).

Many mid-sized and small cable operators are installing turnkey systems that allow them to offer cable modem service. For example, cable companies in conjunction with the ISP Channel are offering data services in such towns as Atchison, Kansas; Kennebunk, Maine; Lake Travis, Texas; and Bonneville, Mississippi.[65] While these towns do not fall under our definition of rural, they are certainly smaller than the large metropolitan areas where cable modem service first appeared.

In addition, a number of municipal utilities are offering high rate data services, primarily over cable systems. The American Pubic Power Association reported that, of the 127 municipal electric utilities across the country that currently offer telecommunications, approximately one-sixth are providing cable modem service.[66] Four of these systems are in the rural towns of Coon Rapids, Hawardan, and Manning, Iowa; and Schulenburg, Texas. Electric utilities are also providing service in somewhat larger towns, such as Scottsboro, Alabama; Fairborn, Georgia; and Barbourville, Kentucky.

To gauge the likelihood of deployment in rural areas, NTIA spoke to approximately two dozen small cable companies serving 1,000 customers or fewer about the deployment of broadband over their cable systems. Approximately half of the companies currently offer, or plan to offer, cable modem service to small towns, some of which would likely be rural. These companies reiterated that, because cable service is more economical where there is a higher density of customers, it is unlikely that they will build out to isolated customers in the rural countryside.

DSL

To date, DSL has been deployed primarily in urban centers. The Regional Bell Operating Companies (RBOCs) and GTE, which serve a large majority of all DSL customers,[67] planned to offer DSL to as many as 45 million lines (approximately 45% of their customers) by the end of 1999.[68] As demonstrated in Appendix B, RBOC DSL deployment has primarily occurred in cities of 10,000 or more, while most localities with DSL have populations of 25,000 or higher. These data are based on public information provided by the RBOCS (primarily on the Web) in

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65. Lee L. Selwyn *et al*, *The Broadband Road to Rural America: The Competitive Keys to the Future of the Internet*, May 1999 at 72-3 and Table 3.3.

66. These municipal cable systems also provide Internet access, presumably over a cable modem system. *See* American Public Power Association, *Municipal Electric Utilities Providing Broadband Telecommunications Services* (1999). Other municipalities also reportedly offered “high speed data” service although it was not clear how this was delivered or at what rate and to whom it was delivered.

67. According to TeleChoice, 76.5% of DSL was provided by incumbent LECs *See* Telechoice, *supra* note 35. The RBOCs serve the vast majority of ILEC customers.

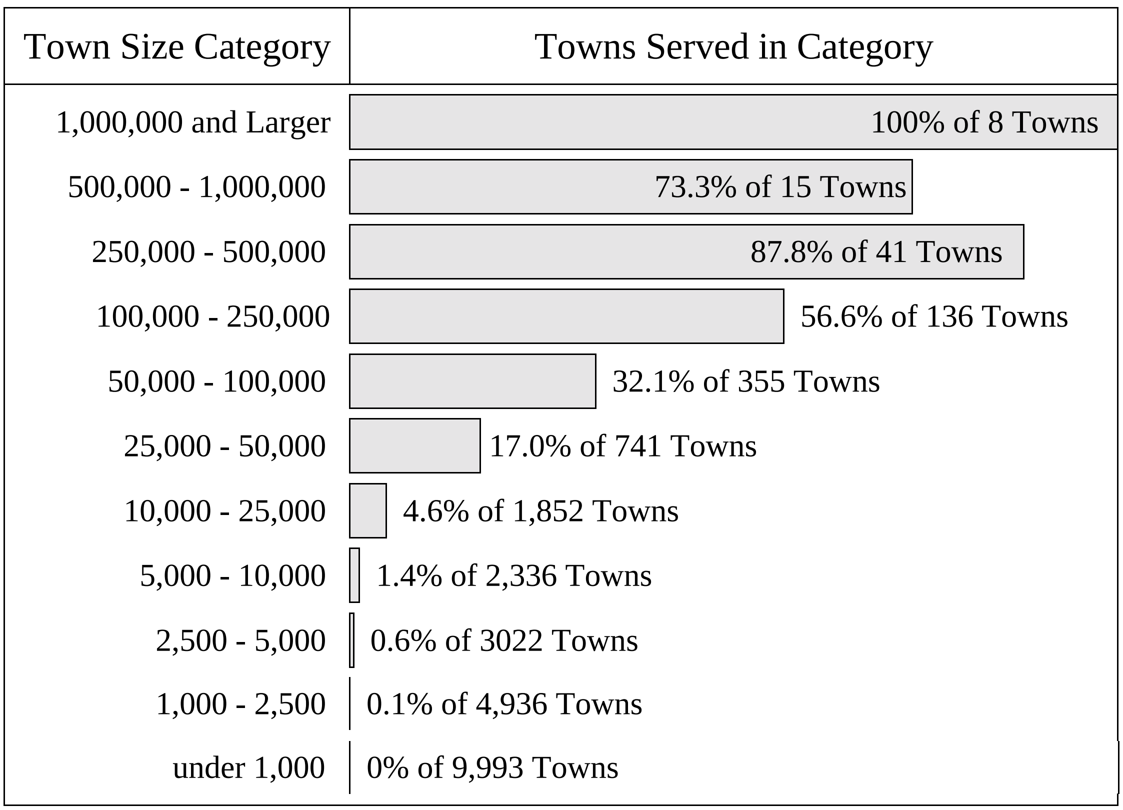
68. Selwyn, *et al.*, *Bringing Broadband to Rural America: Investment and Innovation in the Wake of the Telecom Act*, September 1999, at 15. This figure may be somewhat ambitious because of extensive bridge taps in RBOC plant. However, bridge taps are easily remedied and do not represent a long-term roadblock to broadband like loading does for rural loops.

March 2000. The data provided by the various RBOCs differed in their degrees of comprehensiveness.[69]

According to the data in Appendix B, the major population centers on the West Coast are in the lead, followed by other metropolitan areas in the Western Interior, the Southeast, the Midwest, and the East Coast. With respect to small towns, DSL deployment has occurred more rapidly in more affluent small towns, such as Vail, Colorado, and Carmel, California.

Figure 2 shows the deployment of DSL service by the RBOCs across cities and towns of various sizes using data in Appendix B.[70] As reported in March 2000, the RBOCs were offering DSL service in portions of 551 cities or towns.

Figure 2 - RBOC Provided DSL by Town Size



Sources: Public Data From RBOCs; U.S. Census Bureau's *1990 Census Gazetteer.*

69. Some RBOCs, such as Ameritech, listed only a few cities in which they provide DSL. Others, such as Pacific Bell, provided a detailed, apparently more comprehensive, list.

70. This chart used data from Appendix B, and then used the Census Gazetteer to determine the size of the cities. This chart is not directly comparable to the chart on cable modem deployment, which was prepared using evidence from one source. The data from the various RBOCs, by contrast, vary in scope and detail, and do not include deployment by competitive and independent telecommunications providers. Additionally, the data may not be tied as closely to city boundaries as data provided for cable service. In certain instances, RBOCs may deploy DSL for the entire metropolitan service area, but only list the chief city's name. In these cases, Figure 2 may under-represent deployment in the surrounding urban area.

As can been seen in Figure 2, the percentage of cities with some RBOC-provided DSL service decreases rapidly with city size.[71] While all eight cities with populations exceeding one million had DSL available, only 1.4 percent of towns with populations less than 10,000 and 0.1 percent of towns with populations less than 2,500 had such service. (These figures do not include the many smaller cities where non-RBOC, smaller telephone companies may be deploying DSL.)[72]

Despite these figures, we cannot conclude that rural areas will necessarily be ignored for long. Competitive local exchange carriers (CLECs) provide approximately 22% of DSL nationwide.[73] Several of the CLECs intend to target less densely populated areas. For example, New Edge Networks, a wholesale data CLEC that typically operates in partnership with an Internet service provider, announced a two-year plan to provide DSL in smaller cities and what they describe as rural areas in all 50 states.[74] At the end of 1999, this CLEC was offering service in Sequim, Washington; Port Townsend, Washington; and other small towns throughout the Western States. Although these towns exceed our definition of rural, they are fairly small. Similarly, Northwest Telephone Inc. and Electric Lightwave Inc. agreed to offer high-speed services to businesses in Wenatchee, Washington, as well as to other communities in that state.[75]

Additionally, independent telecommunication companies have shown more interest in providing services to customers outside major population centers, and have demonstrated a greater willingness to build the plant necessary for advanced services. Those independent providers that are financed by the Rural Utilities Service are, in fact, required to upgrade their infrastructure so that it is DSL-capable when they build new plant or rebuild old plant. Under the Rural Electrification Loan Restructuring Act of 1993, all direct lending by RUS must be for plant that conforms to State Telecommunications Modernization Plans.[76] These plans require that financed plant, as built or with additional equipment, support the provision of data communications at a speed of one million bits per second.

In 1995, RUS began reviewing designs to ensure that financing went only for advanced services capable plant. Among other things, RUS looks for plant designs that ensure that customers are grouped so that loops do not exceed 18,000 feet. At the time of the last survey, in 1992, approximately 65% of rural customers served by an RUS financed provider were within 18,000 feet of a central office or carrier site, and theoretically could be provided with DSL service. That number is undoubtedly higher today, although the precise number will not be known until the next loop survey.

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71. Of the 551 cities in Appendix B, 39 could not be associated with entries in the Census Gazetteer and are not included in the chart.

72. There are well over 1,000 independent telephone companies providing service. Many of these companies did not have publicly available data. Even if they had, collection of these data would have been extremely time and resource intensive.

73. *See supra* note 35.

74. Salvatore Salamone, *DSL Heads to Smaller Cities – Start-Up New Edge Networks Aims to Ease Telecommuting Challenges*, Internet Week, Nov. 29, 1999.

75. News Release, *Northwest Telephone and Electric Lightwave Bring High-Tech Telecom to Rural Areas*, Nov. 8, 1999.

76. *See* §905(d)(3) of Rural Electrification Act of 1936, 7 U.S.C. §935(d)(3).

Because of recent upgrades by small and rural providers, many rural customers may soon be able to receive DSL service. The National Exchange Carrier Association (NECA) recently reported in its Access Market Survey that 14% of the respondents now provide DSL service.[77] More than 700 (68%) of the 1,000 small, mostly rural companies that participate in NECA's pooled interstate traffic sensitive access tariff responded to this survey.

The National Telephone Cooperative Association (NTCA) and the Organization for the Protection and Advancement of Small Telephone Companies (OPASTCO) also released a survey of 412 small, rural telephone companies, or approximately 40% of the small telephone companies in the United States.[78] According to NTCA, 29% of the 412 respondents are planning to offer (as opposed to providing) DSL service in at least part of their service areas.[79]

Nevertheless, the independents have yet to deploy DSL in their rural areas at the same rate as the RBOCs in their metropolitan areas, and their deployment is also dependent on density. According to engineers serving the independent carriers, the likelihood of offering advanced services in rural service areas is highest in the Southeast and Northeast, lower in the Midwest, and lowest in the Southwest. This roughly corresponds to the number of customers per route-mile (density) of plant in those areas. Low density equates to long loops. When loops are long, they are frequently loaded, which prevents DSL operation.

Another factor in the lower rate of independents' deployment is the fact that equipment has not been readily available for small carriers. Manufacturers have addressed the large lucrative markets by building equipment for the multi-thousand line offices found in urban areas. Rural areas, on the other hand, require small line counts and rugged equipment that frequently must function in a cabinet where there is no heating or cooling. With the recent adoption of the G.lite, standard (discussed below), which removed the uncertainty of competing but incompatible systems, it is expected that equipment suitable for rural installations will become more readily available.

<u>Summary of Rates of Deployment in Rural Compared to Non-Rural Areas</u>

Cable modem and DSL are the two broadband technologies that are now being rapidly deployed, permitting a comparison between rural and non-rural areas. The deployment of both technologies declines with population density. As a result, cable modem and DSL services, although increasingly available in rural towns, are still far more available in larger metropolitan areas.

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77. National Exchange Carrier Association, *Keeping America Connected: The Broadband Challenge, Access Market Survey of NECA's Traffic Sensitive Pool Members*, December 1999. (www.neca.org/ams.htm) According to a NECA spokesperson, approximately 90% of customers receiving service from NECA pool members can receive some type of service beyond voice grade access on existing lines using "off-the-shelf" technology. This would include services such as extended range ISDN (128 kilobits/second) which do not meet the FCC definition of broadband.

78. National Telephone Cooperative Association (NTCA), *Internet/Broadband Availability Survey - Report*, September 15, 1999.

79. *Id.*

C. Capability of Enhancements and Feasibility of Alternatives for Rural Broadband

Issue 4. Capability of various technical enhancements to existing wireline and wireless networks to provide last mile advanced telecommunications capability in rural areas.

Both existing cable TV and telephone systems can be enhanced to provide broadband, although their capacities to serve rural areas vary. For cable, the system is typically upgraded to a hybrid fiber-coax (HFC) network. These upgrades involve building fiber to service nodes; replacing cables and connections that were either inadequate for digital data as originally installed, or that have deteriorated with time; replacing one-way amplifiers with two-way amplifiers; and placing new amplifiers at closer intervals than original amplifiers. The new amplifiers that meet these control requirements are more expensive than those required for television transmission. Systems must also be installed for monitoring and controlling signal levels within the cable system.

For rural towns, cable offers a viable "last mile" option as long as the cable operator is willing to make a significant investment to upgrade the plant. As explained above, a significant number of cable operators say that they will make that investment to serve rural towns. On the other hand, as noted, cable modem services do not generally reach out-of-town rural customers because the cable plant itself does not extend into those areas.

In contrast to the extensive physical upgrades that are usually required throughout a cable network to provide cable modem services, DSL can be provided to the majority of telephone customers by installing high-speed switches (called DSL Access Multiplexers, or DSLAMs) in local telephone company central office and subscriber carrier sites. As discussed earlier, telephone plant can support DSL if the customer does not live more than 18,000 feet from the DSLAM equipped point. As also mentioned above, the 1992 RUS loop survey shows that at least 65% of the rural plant in RUS-financed systems is DSL capable. The readiness of national plant is undoubtedly higher because it encompasses non-rural, therefore shorter, loops.[80]

As long as the plant is DSL-capable, DSL can offer a last mile solution in hard-to-serve rural areas. Rural carriers building new plant have stated that building DSL-capable loop plant is generally only 20%-35% more expensive than non-DSL capable plant. The development of G.lite has also made it easier to deploy DSL to rural areas. G.lite is a new DSL standard that generally limits customers to 1.5 Megabits/second downstream and 500 kilobits/ second upstream. It trades slightly reduced bandwidth (relative to higher rate types of DSL) for reliable operation on most existing telephone lines. Operating under this new standard, twisted pair can provide up to 1.5 megabits/second out to 14,000 feet on 26-gauge copper and 18,000 feet on 24 gauge cable. This range, coupled with the presence of subscriber carrier serving areas in the countryside, may make DSL more practical than cable modems for remote areas.

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80. Recent surveys demonstrate that approximately 80% of customers nationwide gain access to the Internet at rates of at least 28 kilobits/second. This level of performance strongly correlates with operation over loops shorter than 18,000 feet. *See* http://808hi.com/56k/_out (providing, *inter alia*, surveys of 3Com and Lucent users).

Issue 5. Feasibility of various technological alternatives to provide last mile advanced telecommunications capability in rural areas.

There are a number of new technologies that currently provide, or promise to provide, broadband service. These include fiber to the home, third generation (3G) cellular, MMDS, LMDS, and broadband satellite service. The economic and technical feasibility for serving rural areas is discussed for each technology.[81]

Fiber to the Home

Fiber to the home can be considered as either a technological enhancement or a technological alternative. Both cable and telephone systems have been installing fiber fed distribution points in their networks. Extending that link to the home with fiber can be considered an enhancement to the existing system. If the entire system were built from scratch, however, it could be considered a technological alternative.

Neither approach has yet demonstrated an economic advantage over conventional coax and twisted-pair copper but that day seems to be fast approaching. The cost of installed fiber in the loop has dropped to the point where it is roughly the same as copper when doing a complete system rebuild or a new area build.[82] Because telephone plant lasts a long time and companies try to avoid rebuilds, fiber trials have generally been in new developments where the excess cost of a fiber system is primarily in the terminal equipment.

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81. It should be noted that all the alternative technologies require the customer to provide the power for the equipment at his or her end. The monthly cost to power these devices may not be insignificant. More important, reliability of phone service, even with battery backup, can be affected if it is provided over one of these alternatives. During a power outage, a traditional phone system can rely on a standby generator, whereas a customer using one of these alternatives must rely on a battery that may have gone bad since the last outage. Also, batteries are generally short-term back-ups and cannot maintain reliable operation for the days or weeks of a weather-related emergency.

82. The competitiveness of fiber direct-to-the home in extreme low-density areas can be illustrated through the FCC's current Synthesis Cost Model. This model, a tool for helping to determine universal service support for the large (non-rural) carriers, designs a hypothetical telephone system for the entire country in order to calculate what it would cost to build a telephone system today. The model designs a system as if there were no existing telephone system, except that it retains the location of the wire centers.

Because the model is a mechanism of universal service, it builds its hypothetical system so that it is advanced services ready for 100% of the customers. The model groups customers into clusters that can be served with the least plant. Each cluster is served either directly by the switch or, for the more distant customers, by a fiber feeder and its own digital carrier system. All the customers within the cluster are connected to the switch or carrier system with less than 18,000 feet of twisted pair copper.

Where there are fewer than ten customers in a cluster, it may be more cost-effective to build fiber direct-to-the-home rather than use the combination of fiber, carrier, and copper as designed by the Synthesis Cost Model. This is because, under the model, each cluster requires a fixed investment of $15,000 for carrier equipment, not counting land, building, and power. As an alternative, subscriber terminal equipment for fiber can be obtained today for approximately $1,500 per subscriber and eliminates the need for the $15,000 investment. Ironically, fiber may be most cost effective for the hardest-to-serve customers where new plant is being built.

MMDS

MMDS offers a last mile solution for rural areas, primarily as a technological alternative. While it is conceivable that existing MMDS television systems will be converted to digital broadband, it is far more likely that MMDS broadband will be offered primarily as a new service because the existing MMDS television customer base is so small.[83]

MMDS holds promise for rural areas because it can operate at a radius of up to 35 miles under the best circumstances (3,848 square miles). Based on trials and early implementations, MMDS broadband can reach remote customers within that radius as long as there are appropriate conditions, such as available spectrum and a clear line of sight. As with any terrestrial microwave system, MMDS signal coverage is affected by terrain, vegetation, and buildings. These problems are exacerbated at higher frequencies.

MMDS may have an advantage over wireline service in rural areas because its cost-to-serve is not quite as dependent on the exact location of the customer within the operating radius. In other words, the cost to serve a customer living six miles from the tower is hypothetically about the same as the cost to serve a customer living one mile from the tower. Cost can still be affected by distance, however. Systems operating at ranges approaching 35 miles require much higher towers due to the curvature of the earth and the cost of towers rises rapidly with their height.[84]

Economic considerations will play a role in determining where MMDS is deployed because MMDS operators may need a sizable customer base over which to spread their fixed costs. A new tower can cost between $200,000 and $1 million. According to certain equipment and systems providers, base station and data access equipment costs are about $200,000 to $400,000. Given these fixed costs, MMDS will more likely be deployed in larger towns or areas with high population densities that are not yet served by DSL or cable modems.[85]

In rural America, MMDS will likely be used to serve the rural countryside surrounding a non-rural town or a cluster of rural towns that can be served from one site. To date, MMDS is deployed in towns with populations as low as 6,000. If fixed costs drop or a new tower is not required, MMDS may also become feasible in isolated rural towns and the surrounding countryside.

83. There were approximately 821,000 MMDS video subscribers in June 1999, falling from one million subscribers in June 1998. Of these, 721,000 were analog TV subscribers. *See* Sixth Annual Report, *supra* note 27, at ¶87.

84. *See supra* note 52.

85. In smaller rural markets, cable modems and DSL may have an advantage over new technologies, such as MMDS, because they gain revenue from services other than broadband and can offer broadband service on an incremental cost basis. Additionally, telephone companies may be eligible for universal service support system for high cost lines. Given these advantages, MMDS is unlikely to enter a market already dominated by these existing utilities.

LMDS

While LMDS is generally considered a promising wireless "last mile" solution for broadband, it holds less promise than MMDS for serving rural areas. Because LMDS operates at such high frequencies, the transmit and receive antennas must be in close line of sight of each other. In addition, rain can more easily cause a loss of the LMDS, than the MMDS, signal. For these reasons, LMDS links are typically no longer than three or four miles, limiting its use to tightly clustered groups of users. A typical application is communication between a base station and an antenna on a building rooftop, which serves the occupants of a building.

LMDS will likely be deployed in cities and higher density towns. Touch America, the telecommunications subsidiary of The Montana Power Company, now offers commercial LMDS in Butte and Billings to government and business customers. It anticipates spending $15 million to build out its initial LMDS footprint in 25 cities.[86] The company explained, however, that it has no plans to build out to rural areas because of LMDS's limited range.

On the other hand, several smaller incumbent carriers are testing or deploying LMDS in areas that are at least partially rural. For example, Central Texas Cooperative, located in Goldthwaite, Texas, and South Central Telephone, located in Medicine Lodge, Kansas, are both trying LMDS for their customers.[87] Virginia Polytechnic Institute is also conducting research to determine LMDS' technical and financial viability in rural markets. The university, which won four licenses and has two wireless research centers, has created a testbed to evaluate the technology and its applications. The ultimate fate of LMDS as a rural solution will become more apparent through such trials.

Third Generation (3G) Wideband Cellular

Existing mobile wireless systems, whether analog or digital, cellular or PCS, are narrowband by design and cannot provide broadband services. Third generation wireless (3G) promises much more. Spectrum has not yet been allocated in the United States, but 3G could provide an alternative for some broadband applications.

There is no single definition of what constitutes 3G. Considerable attention has been focused on international agreements for an International Telecommunication Union standard, known as International Mobile Telecommunications - 2000, which is expected to provide:

- A wide range of data capabilities (multi-media, high-speed Internet connections, video conferencing).
- Operation in virtually every environment (indoor, pedestrian, vehicular, urban, and rural).
- World-wide connectivity available in a single device.

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86. *See* www.mtpower.com/headlines/1999

87. Skip Richter, *Diving into LMDS*, Rural Telecommunications, July-August, 1999.

Under current proposals, there are three data rate standards. Two of these, portable at 384 kilobits/second and fixed at two megabits/second, meet the FCC definition of broadband. The third, a mobile standard, at 144 kilobits/second, does not. Other future mobile services offering lower rates than 3G are sometimes referred to as "2.5 G."

At present, any estimates of cost or deployment would be purely speculative. Given the sophisticated nature of a cellular operation, which requires mobile handoffs from one site to another, the fixed costs per site may be significantly more than for a simpler fixed technology such as MMDS. And it must be remembered that fifteen years after cellular service was started in the United States, there are still rural areas where first generation cellular coverage is spotty or non-existent.

Broadband Satellite

Satellite systems offer another technological alternative to provide wireless broadband. These systems have an obvious advantage over terrestrial wireless systems in providing broadband to rural areas because they have a direct line-of-sight to most locations. Geo-stationary satellites have a line-of-sight to almost every location and low earth orbit multi-satellite systems are designed to have a line-of-site to every location above ground.

Satellites may therefore be an attractive alternative for remote locations that cannot be economically connected via other last-mile technologies. These systems are not constrained by distance and offer the opportunity to leap directly to broadband service without upgrading existing terrestrial communications infrastructure. Both factors make satellite systems especially promising for serving remote rural areas, such as towns and villages in Alaska and remote western deserts and mountainous areas, which have yet to be connected via land lines for technical and/or economic reasons.

Two-way satellite systems specifically designed for broadband data are mostly still in the planning phase. Companies, such as Teledesic, Skybridge, Orblink, Pentriad, Virtual Geo/VIRGO, Spaceway, CyberStar, Sky Station, and HALO and others, are promising to deploy broadband services. Appendix C provides a non-comprehensive list of prospective systems.

Broadband satellite systems can serve different groups of customers depending on the satellites' altitude above earth. Orbital altitudes include geo-stationary orbits (approximately 36,000 kilometers above earth), medium earth orbits (approximately 10,000 kilometers), and low earth orbits (approximately 1,500 kilometers). There are even proposals for aircraft-based platforms operating in the upper atmosphere at approximately 20 kilometers above the earth. The platform altitude has an effect on the coverage area, propagation delay, power requirements, and antenna requirements, among other things. These factors build a complex set of tradeoffs and drive the variety in system designs. The low earth systems are targeted more at individual users, along with larger business customers. The medium earth and geo-stationary systems are targeted more at large users and ISP providers with the end user attached via a local network.

The potential for broadband, two-way satellite systems will be come clearer in the next few years. Economic and technical considerations will play key roles in determining the success of satellite deployment. To begin with, the required investment is huge. Estimated costs for satellite systems range from $4 billion to more than $10 billion for global systems.[88] This high fixed start-up cost represents a substantial risk and has been prohibitively expensive for many companies to consider. The recent financial difficulties of several satellite systems have dimmed the expectations of some analysts that satellite might provide the key answer to last mile connections in rural areas. On the other hand, some observers are optimistic that broadband data satellites may represent an opportunity for satellite industry recovery.[89] While the bankrupt satellite systems emphasized voice communication, the broadband satellite systems may ride the crest of increasing global demand for data services.[90] An industry shakeout over the next few years will make the economic situation clearer.

Technical issues will also play a role. For example, satellite systems have long lead times. Most companies anticipate a three-year deployment horizon for their systems, with start-up around 2002. This means that much of the technology may be locked in years before the system is turned on. During that time, technologies are likely to change and competing technologies may become more desirable.

Lower orbit systems (where satellites circle the globe every 90 minutes to several hours) require many satellites and complicated hand-off systems since no satellite stays overhead for long. As more systems come on line, signal power could be restricted to limit interference.

Finally, delivery of broadband to individuals requires tremendous system capacity. The feasibility of satellites as a broadband delivery vehicle will depend upon bandwidth availability and the efficiency with which available bandwidth can be reused.[91] These constraints will ultimately determine how many customers a broadband satellite can serve.

For example, one of the proposed low-earth-orbit, multi-satellite systems, which will offer both data and voice, plans a total worldwide throughput capacity of 200 gigabits/second given the expected bandwidth in which it will operate. Assuming that no more than 20% of this capacity could be directed towards the United States at any one time,[92] this system could devote about 40 gigabits/second to America.

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88. Robert Norcross, *Satellites:The Strategic High Ground*, Scientific American, Oct. 1999, at 107.

89. Joseph Anselmo, *Can Broadband Industry Fix Space Industry Woes?*, Aviation Week and Space Technology, Nov. 8, 1999, at 96-97.

90. *Id.*

91. The primary way to increase a system's capacity is through the reuse of its operating bandwidth. For wireline systems, each new twisted pair, coaxial cable, or fiber is capable of reusing the spectrum of every previously installed wire. Terrestrial wireless systems, such as cellular mobile radio, add capacity by "cell division." By substituting several geographically dispersed lower power radios for a single higher power radio, they can split the cell into multiple cells, reusing the bandwidth in each non-adjacent cell.

When it comes to satellites, there are two methods of bandwidth reuse. One is through the use of multiple satellites with earth-based, directional antennae that receive a signal only from one satellite. The other is through the use of directional antennae on the satellite (spot beams) so that the signal is transmitted only to a limited geographical area, which allows reuse of the bandwidth in another area.

92. This is a generous assumption because the surface area of the United States is less than 2% of the earth.

What does this equate to in terms of the number of households served? Earlier, it was noted that cable providers offer their service from a node that serves between 350 to 700 TV customers' homes with the expectation that not every TV customer will take broadband. The broadband customers typically share a 27 megabit/second downstream channel. By extrapolation, if 27 megabits/second can serve 350 to 700 homes, 40 gigabits/second can serve about 1,500 times as many, or about 500,000 to one million homes.[93] This represents about one-half to one percent of the nation's households.

Thus, although such a system would be a valuable addition to the possible methods of providing broadband in rural areas, it would require many such systems to serve rural America even if the systems were devoted entirely to rural service. Broadband over satellite is an exciting prospect and represents an extremely attractive solution for the most remote areas but it must be recognized that even the multi-satellite prospective systems have limited capacity to meet rural needs.

Summary Regarding Broadband Enhancements and Alternatives In Rural Areas

With the exception of prospective satellite systems, the challenge for bringing broadband to rural America increases as the population density decreases. While both cable and DSL technologies promise to become more widely available in smaller and rural towns, DSL offers greater promise for reaching remote, out-of-town areas. Fiber and MMDS offer two other promising solutions for serving rural areas, although their potential for reaching remote rural areas is still questionable. Broadband satellite offers the most promising solution for remote, out-of-town customers if this technology can provide sufficient capacity and remain commercially viable.

It is important to remember that there is probably not one technological "silver bullet." Providing broadband service to rural America will likely require a combination of these, and perhaps other, technologies.

D. Effectiveness of Existing Mechanisms in Promoting Rural Deployment

Issue 6. Effectiveness of competition and universal service support mechanisms to promote the deployment of advanced telecommunications capability and the availability of advanced telecommunications services in rural areas.

Consistent with the Telecommunications Act, the Administration believes that, as a general principle, competition can accelerate the diffusion of broadband applications.[94] There are strong indications that competition has produced many benefits in such markets as long-distance

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93. 40 gigabits/second ÷ 27 megabits/second = 1481.

94. Some evidence points to the salient effects of competition on broadband delivery. See, *e.g.*, Economics and Technology, Inc. (ETI), *Bringing Broadband to Rural America: Investment and Innovation in the Wake of the Telecom Act*, September 1999, and FCC, Sixth Annual Report. ETI found that a **"**wide array of broadband services delivered over a variety of technologies is now in the offing, and these services are already available in many parts of the country." *Bringing Broadband to Rural America* at 42. The FCC concluded that the "case studies [they examined] suggest that subscribers have benefited from 'head-to-head' competition" in terms of lower prices and upgraded systems." *Id.* at 100.

telephone services, wireless telephony, and telecommunications equipment.[95] Less progress has occurred in local telephone service markets, where regulatory and legislative changes that promoted entry have been adopted much more recently than in other areas.[96]

Competition is succeeding in spurring broadband deployment in certain locations. In some markets, incumbent local exchange carriers are deploying DSL, for example, where cable operators have begun to offer cable modem service.[97] Wall Street analysts have also observed that the RBOCs have accelerated DSL deployment in certain markets where CLECs already offer such services.[98]

Other areas, however, are not yet seeing competition among broadband providers. It can be expected that competition will succeed first in large cities and metropolitan areas, and possibly later in less urbanized areas. As documented in this report, there is little evidence, to date, that competition among wire-based and terrestrial wireless-based systems has promoted near-term deployment of advanced telecommunications services in rural areas outside of towns.[99] For all the terrestrial technologies discussed in this report, per unit cost rises with decreasing population density, making service to homes and businesses outside of towns very expensive. One exception is for satellite systems, which are less sensitive to customer location but still require a sufficient customer base.

To ensure that all Americans are able to reap the benefits of the Information Age, Congress added the universal service provisions of Section 254 to the Communications Act, codifying what had formerly been public policy. The success of the policy and the law can be judged in part by the extent to which affordable, quality telecommunications service is available in rural areas, particularly the high cost areas outside of town. Properly crafted telecommunications

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95. *See, e.g.*, Council of Economic Advisers, *Progress Report: Growth and Competition in U.S. Telecommunications, 1993-1998*, released February 8, 1999.

96. *Id* at 15-25.

97. *See* Cable Services Bureau, FCC, *Broadband Today*: *A Staff Report to William E Kennard, Chairman, Federal Communications Commission*, Oct. 1999, at 27 (citing Lehman Brothers, *ADSL v. Cable Modems: And the Winner Is* . . . at 6).

98. *See, e.g.*, J.P. Morgan, Company Report on Covad Communications, Dec. 7, 1999, at 24.

99. The problem is particularly acute on Native American tribal lands, where such factors as difficult terrain, low-density population clusters, lack of economic infrastructure, and insufficient strategic planning are especially apparent. *See* Linda Ann Riley, Bahram Nasserharif, and John Mullen, *Assessment of Technology Infrastructure in Native Communities*, New Mexico State University, College of Engineering, Las Cruces, New Mexico (prepared for the Economic Development Administration, U.S. Department of Commerce) (July 1999) at 29. As a result of these obstacles, Native American reservations face some of the lowest telephone subscriber rates in the nation and are lagging behind many other rural areas in broadband service. According to the 1990 Decennial Census, approximately 53% of Native households on reservations and trust lands had telephones, compared to 94.8% of households nationwide. *Id.* at 16. With respect to broadband availability, the National Telephone Cooperative Association (NTCA) found that six (or 24%) of its 25 member companies responding to its survey reportedly provided broadband Internet service to some portion of an American Indian reservation or trust land. This study did not report how “broadband” was defined or what portion received broadband service. NTCA, *NTCA Members Serving Tribal Areas Survey Report*, December 10, 1999.

policies are critical both for the continued availability of ordinary telephone service as well as for the availability and deployment of advanced services in hard-to-serve areas.

Policymakers must make certain that the universal service mechanisms are carefully targeted to high cost areas. The FCC must ensure that Sections 254 and 706 are fully enforced, and that support is *specific, predictable, and sufficient* to preserve and advance universal service. Its definition of supported service must also be compatible with the concept of evolving improvements to service. NTIA and RUS are encouraged that the FCC is revisiting this definition, and hope that the findings in this report will be useful in that proceeding.[100]

For more than 60 years, policymakers have remained committed to the universal service concept that seeks to ensure ubiquitous, affordable telephone service in the United States. Cable, MMDS, and other alternative technologies might have greater penetration in rural areas if these providers were to become eligible for universal service support by offering telephone service. To date, there is little evidence that rural cable providers are moving in this direction, although MMDS and certain satellite companies will probably offer voice service.

As technology has brought new service features and capabilities, new policies have also been initiated that would make these advances more readily available to all Americans. In the section below, we describe some of the most important federal programs that support broadband deployment or may do so soon, either as an element of the program or as its primary focus.

1. Universal Service Support Mechanisms and Broadband

Funding for advanced services traces its origins to an evolving public policy. In 1993 through a vision statement, *The National Information Infrastructure: Agenda for Action*,[101] the Administration announced its goal to extend the concept to ensure that information resources are available to all Americans at affordable prices. Working with the Administration and other interested parties, Congress adopted as part of the Telecommunications Act of 1996 an expanded universal service policy.

Two primary components of the universal service mechanism include high cost support and support for schools, libraries, and rural health care. We believe, in addition to policies that promote competition, both components of the universal service mechanism are necessary for the deployment of broadband in rural America.

<u>High Cost Support</u>

For a number of years through mechanisms such as the high cost fund and access charges, the FCC has supported basic telephone service in high cost (primarily rural) areas. Other universal

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100. *See* FCC, *Common Carrier Bureau Seeks Comment on Requests To Redefine "Voice Grade Access" for Purposes of Federal Universal Service Support*, CC Docket No. 96-45 (rel. Dec. 22, 1999) [hereinafter Public Notice on Voice Grade Access].

101. Information Infrastructure Task Force, *The National Information Infrastructure*: *Agenda for Action* (Sept. 15, 1993) at 8.

service mechanisms similarly target ordinary telephone service. For example, among the FCC's low-income assistance programs, *Link-up America* provides support for up-front installation charges, and *Lifeline Assistance* helps defray monthly telephone bills for local service.

There currently exists no direct support for the deployment of advanced services to U.S. households. As discussed below, however, support for advanced services has been considered while setting the definition of supported services and is tacitly expressed in the new universal service mechanism.

The definition of supported services, which is intended to evolve over time, is important to the deployment of broadband in rural America and even access to dial-up Internet services.[102] During the universal service proceedings before the FCC, some recommended that the definition of support include a specified performance level, such as 28 kilobits/second (V.34 standard) for modems that operate over a voice circuit.[103] The Commission determined that the definition of supported service should cover only voice grade access without a specific modem requirement.[104] On December 22, 1999, the Commission issued a Public Notice seeking comment in response to requests to redefine voice grade access.[105]

The high cost support system will also affect the degree to which broadband plant is available in rural areas. Prior to the breakup of the Bell System, high cost support was based almost entirely on implicit support within that system. The support mechanism was subsequently adapted to accommodate the breakup of the Bell System and deregulation of the toll industry. Under this system, the high cost fund has been used to support study areas where the average embedded cost exceeds the national embedded cost.[106] The support varied according to a schedule, with small carriers receiving proportionately more support than large carriers. This lesser support for large carriers was based on the assumption of implicit support flowing within a company from its low cost areas to its high cost areas just as had occurred earlier in the Bell System.

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102. Section 254(c)(1) establishes generally that "[u]niversal service is an evolving level of telecommunications services that the Commission shall establish periodically under this section, taking into account advances in telecommunications and information technologies and services."

103**.** V.34 is the industry standard for modems commonly known as 28 K modems. It is designed to allow a maximum bit rate of 33.6 kilobits/second in both directions over a dial-up voice circuit. RUS, among others, argued that plant that is capable of supporting a 28 kilobit/second modem will generally support advanced services with additional equipment and that such plant serves the overwhelming majority of the residents of non-rural areas. Adopting a modem performance requirement as part of the definition of voice grade access would therefore ensure comparable service in rural and non-rural areas, as well as access to advanced services, as required by Section 254(b). In addition, RUS argued that supported plant should be capable of evolving to meet the anticipated changes in the definition of universal services. (www.usda.gov/rus/home/fccom.txt and www.usda.gov/rus/unisrv/fc7_10_27xp.htm)

104. *See* May 8 Order, *supra* note 5, at ¶ 64.

105. *See* Public Notice on Voice Grade Access, *supra* note 100.

106. In general, a study area, for purposes of universal service support, is an operating company's entire service area within a state.

In compliance with Congressional intent that support be explicit, the FCC recently adopted a new mechanism for the high cost areas served by non-rural local exchange carriers.[107] This system is based on forward-looking cost, *i.e*. what it would cost to build a telephone system today as estimated by a computer cost model (the Synthesis Cost Model).[108] Although the new mechanism is not designed to support broadband plant, the estimated cost is based on a broadband capable design, given the addition of DSL equipment.

E-Rate

Section 254 is also designed to encourage access to advanced telecommunications and information services for all public and non-profit elementary and secondary school classrooms, libraries, and rural health care providers. Schools and libraries are to be provided discounted telecommunications services, Internet access, and classroom connections. This is known as the education or "E-rate." Under the implementation method adopted by the FCC, this can include discounts on broadband applications if provided as part of a school or library's authorized technology implementation plan. Rural health care providers are to be provided rates comparable to urban rates for similar services.[109]

The E-rate program has been operating since 1998, with a second-year (July 1, 1999 through June 30, 2000) authorized funding level of $2.25 billion dollars. The program provides discounts of 20% to 90% based on the number of students eligible for the National School Lunch Program. Thus, the largest discounts are given to schools and libraries operating in poor communities. Currently, more than 90% of the nation's public schools and libraries possess Internet access, in some cases broadband, and 63% of U.S. classrooms are connected.[110]

The E-rate program has had a significant impact on rural areas, providing vital Internet connections in communities where deployment is slower.[111] The Kuspuk School District in Aniak, Alaska, was so remote that not a single one of the district's eight villages was accessible by road, and none of the eleven schools had Internet access. Through E-rate funds, however, Aniak was able to wire all of its school buildings and install satellite-based Internet connections at every school, enabling the children to get access to online learning resources.[112] The Nevada

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107. *See Ninth Report and Order and Eighteenth Order on Reconsideration*, CC Docket Nos. 96-45, 97-160, FCC 99-306; and *Tenth Report and Order*, CC Docket Nos. 96-45, 97-160, FCC 99-304 (rel. Nov. 2, 1999) (effective January 1, 2000).

108. *See supra* note 82.

109. Section 254(h)(1)(B).

110. More specifically, 95% of the nation's public schools are connected. *See* National Center for Education Statistics, *Stats in Brief: Internet Access in Public Schools and Classrooms, 1994-99* (Feb. 2000). Approximately 93% of public libraries have such connectivity. *See* John Carlo Bertot and Charles McClure, *The 1998 National Survey of Public Library Outlet Internet Connectivity: Final Report* (Washington, D.C.: American Library Association, Office for Information Technology Policy).

111. In year one of the E-rate program, 43% of the funded applications were in rural areas and 22% of the amount allocated was for rural applications. In year two, 43.7% of the funded applications were in rural areas and 31.3% of the amount allocated was for rural applications. *See* Schools and Libraries Division national statistical analysis at www.sl.universalservice.org.

112. *See* EdLinc, *E-Rate: Connecting Kids & Communities to the Future* (May 1999) at 4

State Library system similarly benefited from e-rate funds. E-rate enabled all of the state's 23 public libraries to gain access to the Internet and provide Nevada's rural communities with the same access to information as those living in Las Vegas and Reno.[113]

In some cases, E-rate has enabled broadband applications in rural areas and small non-rural towns. E-rate funds helped defray the cost of upgrading to a fiber optics connection for School Union 49 in Boothbay Harbor, Maine and the West Point School District in West Point, Mississippi, for example.[114] Often, E-rate can be a magnet for broadband deployment by stimulating demand for broadband services.

2. Other Existing Sources of Financing Broadband Capabilities

U.S. Department of Commerce

Sources of funding for advanced service capabilities currently exist outside the universal service system. One source is grants awarded by NTIA's Technology Opportunities Program (TOP), formerly named the Telecommunications and Information Infrastructure Assistance Program (TIIAP), to rural as well as urban locations. TOP gives grants to public and non-profit sector entities for model projects demonstrating innovative uses of network technology. The program evaluates and actively shares the lessons learned from these projects to ensure that the benefits are broadly distributed across the country, especially in rural and underserved communities. NTIA officials believe that, driven by research efforts in academia, the federal government, and the private sector, new technology shows great promise to improve the quality of today's networks.

Specifically, TOP provides matching grants on a competitive basis to state, local and tribal governments, health care providers, schools, libraries, police departments, and community-based non-profit organizations. These grants are used to purchase equipment for connection to networks, including computers, video conferencing systems, network routers, and telephones; to buy software for organizing and processing information; to train staff, users, and others in the use of equipment and software; and to purchase communications services, such as Internet access; to evaluate the projects; and to disseminate the project's findings. TOP projects demonstrate how networks support lifelong learning for all Americans, help public safety officials protect the public, assist in the delivery of health care and public health services, and foster communication, resource-sharing, and economic development within rural and urban communities.

Since its inception in 1994, TOP has awarded grants in all 50 states, the District of Columbia, and the U.S. Virgin Islands. There have been 421 grants totaling $135.8 million and leveraging $203 million in local matching funds. In FY 2000, TOP's authorized funding for grants is $12.5 million. Overall, approximately 65% of the grants go to projects supporting rural areas.

(www.edlinc.org/pubs/eratereport.html).

113. *Id.* at 29.

114. *Boothbay Harbor: Schools to Get Telecommunications Funds*, Portland Press Herald (July 29, 1999); *Central Will Be 1st to Go All Web*, Daily Times Leader (July 23, 1999).

For the FY 1999 grant competition, TOP emphasized its special interest in projects that proposed to use advanced network technologies to enhance the quality and efficiency of services delivered through non-profit organizations. Higher bandwidth networks will afford the opportunity to deliver high-resolution video to the desktop and emerging wireless networks will give end users greater flexibility in how and when they can gain access to information. Among the broadband applications submitted, TOP selected three that feature DSL capabilities. It should be noted that any grant award winner must meet several evaluation criteria on which each application is rated.

Over the years, TOP has supported projects that demonstrated the value of broadband networks in rural areas. For example, a 1994 grant to the State of North Carolina used the ATM-based North Carolina Information Highway to support telemedicine links between the emergency rooms of small rural hospitals and specialists at the state's teaching hospitals. The City of Aberdeen, South Dakota used high-speed links to support a variety of videoconferencing applications such as distance learning, telemedicine, and business teleconferencing and to provide Internet access for its residents.

Another Department of Commerce agency, the Economic Development Administration (EDA), has also supported broadband infrastructure development through its grant programs. EDA has funded a variety of projects that support technology-driven economic development in local communities. For example, EDA has helped fund industrial parks pre-wired with fiber optic cable, such as the March 1999 grant for $750,000 awarded to Cedartown, Georgia for a 200-acre high-tech industrial park. Other grants have helped support distance learning networks, technology business incubator facilities, and research parks. During FY 2000, EDA is giving priority consideration to projects that, among other things, emphasize the commercialization and deployment of technology.

U.S. Department of Agriculture

The Rural Utilities Service Telecommunications Program (Telecommunications Program) also provides two sources of funding for advanced telecommunications infrastructure in rural America. First, RUS provides loans for telecommunications infrastructure investment for commercial, non-profit, and limited liability companies that are providing or propose to provide local exchange telecommunications services to rural areas. The Telecommunications Program has been financing modern rural services for 50 years. Today, about 825 RUS-financed carriers serve 5.5 million rural subscribers over 866,235 route miles of line, for an average density of 6.27 subscribers per route mile or 4.72 subscribers per square mile.[115]

In 1993, Congress directed RUS to finance plant that is capable of transmitting and receiving one megabit/second. Over the last three fiscal years, RUS' telecommunications infrastructure loans totaling over $1.4 billion will provide over 783,000 of the nation's most rural households and businesses with the opportunity to subscribe to advanced services. The 591 rural exchanges built with these loans will have an average density of 5.73 customers per route mile, and the average exchange size is 1,325 customers. The average density of exchanges being upgraded to provide

115. RUS financed companies comprise about two-thirds of the rural carriers as defined in the Telecommunications Act. On a national basis, the population density in areas served by rural carriers is 13, compared to 105 in areas served by non-rural carriers. *See Rural Difference*, *supra* note 10, at 20.

advanced services capable plant is lower than the average density of all RUS-financed carriers (6.32 customers per route mile) demonstrating that such plant is practical in thinly populated areas.

RUS financing is supporting advanced services capable plant in even some of the most difficult-to-serve rural areas. One of the poorest counties in the United States is the home of the Pine Ridge Indian Reservation in South Dakota. The Pine Ridge exchange is served by the Golden West Telecommunications Cooperative (Golden West), which borrowed $65,948,658 from RUS in 1996 to upgrade its facilities to provide modern telecommunications services, including building advanced services capable loops. Facilities now in place in Pine Ridge offer DSL capability to all customers.

RUS also provides loans and grants for distance learning and telemedicine (DLT) initiatives to enhance learning and health care in rural schools, libraries and health clinics. Financing is provided primarily for end user equipment, including computer hardware and software, interactive video equipment and inside wiring. The DLT program has provided $68 million to meet the educational and health care needs for 252 projects in 43 states and two US territories. RUS financed organizations are encouraged to participate in these projects.

In Oklahoma, the Wheatlands Rural Educational Link Consortium (RELC) was created by eight school districts and one area vocational center to improve the quality of education in their communities. In 1995, RELC was awarded an RUS Distance Learning grant of $222,000. Pioneer Telephone Cooperative, an RUS financed local exchange carrier, also lent its financial support to the project.

The grant money was used to construct a fiber optic network connecting nine schools in eleven rural farming communities to the University of Oklahoma, Oklahoma State University, and Northwestern Oklahoma State University. Courses offered include foreign languages, music appreciation, world geography, and physiology. The state-of-the art system will provide telemedicine links with the Oklahoma University Health Science Center, and Baptist Medical Center in Oklahoma City.

In the past, RUS loans have helped Pioneer to build the advanced telecommunications infrastructure needed to accommodate the demand for new services such as distance learning networks. Pioneer is also providing the fiber optic service for RELC and other schools in northwest Oklahoma. Partnerships between RUS borrowers and grant recipients are enabling rural areas to achieve a quality of life equal to their urban counterparts in health care and educational opportunities.

U.S. Department of Housing and Urban Development

Another potential source of broadband assistance is the Housing and Urban Development's (HUD) Neighborhood Networks program. Neighborhood Networks is an initiative to help establish computer learning centers in FHA insured multifamily housing complexes; such centers may posses either broadband or narrowband applications. Programmatic success is dependent on the ability of the owner, management agent, and the residents to enter into partnership with members of their neighborhood and business community. The initiative started in 1996 to mitigate the reduction in welfare support for many residents in HUD assisted/insured multifamily housing. During the four years this initiative has been active, over 550 computer learning centers have been established serving more that 700 FHA insured apartment complexes and more than 150,000 low-income residents. With recent openings in Montana and South Dakota, the centers have expanded to all 50 states, the District of Columbia and Puerto Rico. Many centers have facilitated the graduation of residents from high school and college, the creation of micro-enterprises and businesses, and the development of healthier residents through on-line telehealth information.

U.S. Department of Education

Finally, the U.S. Department of Education provides computer and Internet access, broadband in some instances, and training for working-class families through its Community Technology Centers (CTC) program. In FY 1999, the Department of Education launched its CTC grants program. The program's stated purpose is to "promote the development of model programs that demonstrate the educational effectiveness of technology in urban and rural areas and economically distressed communities." Under the CTC initiative, the Department awards three-year grants on a competitive basis to state or local educational agencies, institutions of higher education, or other eligible public and private nonprofit or for-profit entities. In its inaugural year, the program awarded grants to 40 organizations in the amount of $10 million. For FY 2000, authorized funding is $32.5 million.

These initiatives not only give citizens access to technology, they can also stimulate demand for broadband infrastructure, in effect becoming anchor tenants. Once in place, these facilities and the technologies they encourage can become community resources.

3. Future Funding of Broadband Deployment

To ensure ubiquitous availability of advanced telecommunications services for those who desire them, adequate and targeted funding will be needed. This goal may not be quickly realizable unless access outside as well as inside the home is provided. As found in NTIA's July 1999 *Falling Through the Net* study, the information disadvantaged disproportionately turn to key neighborhood institutions such as schools and libraries for their Internet access.[116] A study sponsored by the National Science Foundation also confirms that Community Technology Centers are helping to bridge the digital divide. Of the users surveyed: 62 percent had incomes of less than $15,000; 65 percent took computer classes to improve their job skills; and 41 percent got homework help or tutoring at the center.[117]

Continuance of, and adequate funding for, all of the above programs will promote this vital public access to the Internet and other advanced services primarily outside the home. Being able

116. NTIA, U.S. Department of Commerce, *Falling Through the Net: Defining the Digital Divide* at 34-37, 42 (July 1999).

117. White House, Office of the Press Secretary, *The Clinton-Gore Administration: From Digital Divide to Digital Opportunity*, issued Feb. 2, 2000, at 3.

to use the Internet at home, of course, is more desirable. For purposes of ensuring access for rural households and businesses, RUS lending and grant programs must continue to receive the resources required to accomplish this important task.

Federal Initiatives

On February 2, 2000, President Clinton announced new budget proposals that, if adopted in full by Congress, would feature $2 billion in tax incentives to encourage private sector activities creating digital opportunities and $380 million in new and expanded initiatives to serve as a catalyst for public-private partnerships. More specifically, the proposals include:

1. $2 billion in tax incentives over 10 years to encourage private sector donation of computers, sponsorship of community technology centers, and technology training for workers.
2. $150 million to help train all new teachers entering the workforce to use technology effectively.
3. $100 million to create 1,000 Community Technology Centers in low-income urban and rural neighborhoods.
4. $50 million for a public/private partnership to expand home access to computers and the Internet for low-income families.
5. $45 million to promote innovative applications of information and communications technology for under-served communities.
6. $25 million to accelerate private sector deployment of broadband networks in under-served urban and rural communities.
7. $10 million to prepare Native Americans for careers in information technology and other technical fields.[118]
8. $100 million in new loan authority and $2 million in grants for RUS to target towards the provision of broadband and Internet service in rural areas.

Proposal number six explicitly would provide monies for broadband deployment in areas where such networks might otherwise not occur for many years; portions of the funding for most, if not all of the other seven proposals, could also include broadband applications.

State and Local Initiatives

In addition, state and local governments around the country are experimenting with new models and new forms of public-private partnerships to promote private sector investment in advanced telecommunications services. The State of Washington, for example, has passed legislation to promote broadband backbone in rural areas by encouraging local public utilities to sell Internet access on a non-discriminatory, wholesale basis over their fiber optic systems.[119] The State hopes that, by opening these networks, competing ISPs can more easily provide broadband service to remote homes and businesses.

118. *Id.* at 1-2.

119. John Borland, *State Looks To Power Companies for Rural Broadband*, Yahoo! News (March 28, 2000).

Several other states and local communities are using "demand aggregation" as a mechanism to attract the private sector investment needed to provide advanced services. The State of Colorado has introduced legislation to promote pooling telecom traffic among state agencies and local communities on the backbone network. These arrangements are intended to provide a market incentive to private providers to set up high speed connection points across the State. Recently, a consortium of telecommunications users in rural western Massachusetts called "Berkshire Connect" reached an agreement with Global Crossing and Equal Access Networks that will result in a 50 percent reduction in the cost of a T1 line (a service that provides 1.5 megabits/second). Berkshire Connect was able to do this in part by aggregating demand from users of telecommunications services in business, government, educational and non-profit institutions.

A number of cities and municipal utilities have also invested in establishing a broadband network to provide advanced telecommunications services to City agencies and residents. The City of LaGrange, Georgia, for example, financed and constructed a state-of-the-art two-way hybrid fiber coaxial network. The City recently announced that it would take the further step of providing residents with free Internet service using cable modem service.

While these projects may not necessarily be in rural areas of America, such innovative initiatives have the potential to further spur the deployment of advanced telecommunications capabilities to all regions of the nation.

Summary of Effectiveness of Competition and Universal Service Mechanisms

Competition has had varied success in bringing advanced telecommunications services to rural America. Broadband deployment has been more evident in the towns, relatively speaking, but little diffusion has manifested in the more remote rural areas. Current universal service mechanisms may help schools and libraries to gain affordable access to advanced services. Other sources of financing promote the spread of broadband capabilities to a range of geographic areas and groups. However, there is no assurance that competition, coupled with the current system of universal service, grant, and loan programs, can by themselves systematically provide affordable advanced services to rural America in the near term.

IV. RECOMMENDATIONS

In recent years, the United States has emerged as a leader in the Information Revolution. By some estimates, more than 100 million Americans have access to the Internet. Private sector investment in new competitive telecommunications companies has skyrocketed, and many of these companies are providing broadband telecommunications services and high-speed Internet access. Several million households have now subscribed to broadband Internet services, and that number continues to grow rapidly. Researchers are now developing networking equipment that will transmit over one trillion bits of information per second on a single strand of fiber, which will provide the infrastructure for applications that we can only dream of today.

America's success shows the wisdom of public policies that encourage private sector investment, competition, and technological innovation. But the government also has a special obligation to ensure that all Americans, including Americans living in rural communities, have the opportunity to be full participants in the Information Age. NTIA and RUS recommend the following steps be taken to expand access to broadband networks in rural America:

1. Increase support for programs that will expand broadband infrastructure and innovative applications of information and communications technologies in rural America

This year, President Clinton and Vice President Gore have proposed new programs and increases in several existing programs that will help expand access to information technology and broadband telecommunications services for rural communities, including:

- An increase in NTIA's Technology Opportunities Program (TOP) from $15 million to $45 million and the creation of a new $50 million grant program to expand home access for low income families. Approximately 65% of NTIA's TOP grants serve rural communities, and the new home access program may help to assist families in rural areas.
- An increase in the Department of Education's Community Technology Center program from $32.5 million to $100 million. This will enable the creation or expansion of up to 1,000 Community Technology Centers.
- The creation of a new pilot program at the Rural Utilities Service that could provide up to $100 million in loan guarantees for rural broadband services and continued support for the RUS Telecommunications infrastructure loan program.
- An increase in the RUS Distance Learning and Telemedicine Loan and Grant Program from $20 million in grants and $200 million in loans to $25 million in grants and $300 million in loans.

The maintenance and expansion of these programs, among others, are necessary to closing the broadband divide between urban and rural areas in America.

2. Adopt an evolving definition of "universal service" that will support advanced services in all regions of the nation

The Telecommunications Act of 1996 states that "access to advanced telecommunications and information services should be provided in all regions of the Nation," and that customers in rural and high-cost areas should have access to advanced services at rates that are "reasonably comparable" to rates in urban areas. Under the Act, the Federal-State Joint Board on Universal Service and the Federal Communications Commission are charged with updating the definition of universal service to reflect the evolving nature of telecommunications services.

In the context of current supported services, NTIA and RUS commend the Commission's reexamination of the definition of voice grade access.[120] Because voice grade service in rural

120. *See* Public Notice on Voice Grade Access, *supra* note 100. The Commission originally selected a voice grade bandwidth of 3,500 Hz (500 to 4,000 Hz), which would generally support modem operation at 28 kilobits/second.

areas is the primary path to the Internet, and is likely to remain so in the near term, it is especially important that universal service support promote voice service that is comparable both in bandwidth and data rate to that available to the vast majority of Americans. For that reason, the Administration has supported both a voice grade bandwidth of 300 to 3,400 Hz and a data rate of at least 28.8 kilobits/second.[121]

In light of the rapid changes in telecommunications services, NTIA and RUS urge that, during the next periodic review of the definition of supported services, the Federal-State Joint Board and the Commission make it a priority to adopt a definition that will advance the widespread and timely deployment of advanced services to all regions of the country.

3. Consider universal service funding mechanisms to fulfill the Act's mandate

The Telecommunications Act of 1996 requires the FCC to base policies of universal service on the principle that consumers in rural areas should have access to advanced services that are reasonably comparable to services in urban areas, and that there should be specific, predictable and sufficient support mechanisms to advance universal service.[122] NTIA and RUS recommend that the Commission make it a priority to fashion a comprehensive high-cost program, by identifying all necessary support mechanisms, to achieve the statutory goal established four years ago.[123] Pending its ultimate decision on high-cost reform, the Commission should also consider measures that eliminate barriers to infrastructure investment. Among other things, the Commission should consider the need to adjust the existing cap on the universal service fund, particularly with respect to exchanges sold to a rural carrier from a non-rural carrier.[124] Further, attention should be given to the needs of unserved areas, especially tribal communities.[125]

See May 8 Order, *supra* note 5. Later, on its own motion, the FCC reduced the supported bandwidth to 2,700 Hz (300 to 3,000 Hz), a bandwidth that cannot reliably support modem operation at 28 kilobits/second. *See Fourth Order on Reconsideration*, CC Docket No. 96-4, *Report and Order* in CC Docket Nos. 96-45, 96-262, 94-1, 91-213, 95-72, FCC 97-420 (rel. Dec. 30, 1997). The Commission is now reviewing its more recent definition.

121. *See* Comments and Ex Parte Comments of the Rural Utilities Service, *Common Carrier Bureau Seeks Comment on Requests to Redefine "Voice Grade Access" for Purposes of Federal Universal Service Support*, CC Docket No. 96-45 (filed Jan. 19, 2000 and April 11, 2000, respectively). (www.usda.gov/rus/unisrv). *See also supra* note 103 and accompanying text.

122. *See* 47 U.S.C. § 254(b)(3), (5)(Supp. III 1997).

123. The Commission has taken steps to provide universal service support to high-cost areas served by larger telecommunications carriers. Reform of the high-cost program for areas served by rural telephone companies will be considered by the Joint Board.

124. *See* Comments of Rural Utilities Service, *Federal-State Joint Board on Universal Service: Promoting Deployment and Subscribership in Unserved and Underserved Areas, Including Tribal and Insular Areas*, Further Notice of Proposed Rulemaking,, CC Docket No. 96-45, 14 FCC Rcd 2117 (filed Dec. 17, 1999) (www.usda.gov/rus/unisrv/12-17com.htm).

125. *Id*. *See also* Ex Parte Comments of the National Telecommunications and Information Administration (filed April 14, 2000) in the same proceeding.

4. Reform RUS lending policies to stimulate private sector investment in broadband services

Under current regulations, RUS can lend to service providers only if, at a minimum, they meet the "basic local exchange telephone service needs of rural areas," *i.e.*, provide wireline voice service.[126] This prevents RUS from lending to providers that want to offer, for example, advanced telecommunications services without offering voice. Given Administration and Congressional interest in promoting the availability of broadband, RUS is proposing regulatory reforms to change these policies. This would allow RUS to use more of its $670 million in lending authority for rural telecommunications to encourage private sector investment in rural broadband services. RUS has already proposed a rule that will allow financing of mobile telecommunications providers who do not offer wireline voice service in their wireless area.[127]

5. Ensure continued support for the E-rate

The E-rate provides up to $2.25 billion in discounts to connect schools and libraries to the Internet. In certain cases, the E-rate program has brought broadband connections to rural areas and small non-rural towns and catalyzed market demand for those services. Continued support and funding for this program is particularly important for rural communities, which often face higher prices for advanced telecommunications services.

6. Publicize recent changes in rural health care discount program

In 1999, the FCC adopted reforms in the rural health care discount program that make it easier for rural health care providers to purchase advanced telecommunications services for telemedicine and other health care applications. NTIA and RUS will publicize these changes so that more rural health care providers are aware of these improvements to the program.

7. Collect and disseminate "promising practices" for accelerating private sector investment in rural broadband services

Communities around the country are experimenting with new models and new forms of public-private partnerships to promote private sector investment in advanced telecommunications services. Programs, such as the "Berkshire Connect" initiative to aggregate demand in rural areas, are helping attract the private sector investment needed to provide advanced services. NTIA and RUS are committed to collecting and disseminating these kinds of promising practices, using mechanisms such as the "Digital Divide" web site (www.digitaldivide.gov).

8. Increase research to discover "last mile" solutions for rural America

The Administration has proposed significant increases in federal funding for information and communications research and development (R&D), an initiative known as "Information Technology for the Twenty-First Century." This initiative follows the recommendations of the

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126. *See* 7 CFR 1735.14 (c)

127. *See* Proposed Rule 7 CFR 1735, 65 Fed. Reg. 6922 (Feb. 11, 2000).

President's Information Technology Advisory Committee (PITAC), which concluded that industry was unlikely to make investments in long-term, high-risk research. The recommendations of the PITAC enjoy strong bipartisan support, and legislation that would authorize much of the Administration's initiative (Networking and Information Technology Research and Development Act) recently passed the House.

As part of this initiative, the Administration is committed to increasing investment in R&D to address the unique "last mile" challenges of rural America. As noted in this report, the current generation of broadband technologies (satellite, wireline, fixed and mobile wireless) have shortcomings that can limit their deployment in rural areas. Agencies such as NTIA and the National Science Foundation (NSF) will increase their support of research that could result in next generation broadband technologies for rural America. The Administration has called for a budget increase for NTIA’s Institute for Telecommunications Sciences to provide broadband technology research, standards development, and policy support vital to the successful commercialization and widespread deployment of broadband capabilities, particularly in rural and disadvantaged areas. Since NSF supports university-based research, this initiative will also increase the supply of undergraduate and graduate students in technical fields with insights into the challenges of providing broadband telecommunications to rural areas.

Table Data Performance Comparison[1]

Technology[2]	Downstream Typical (Max) Kb/sec	Upstream Typical (Max) Kb/sec	Range (Miles)[3]	Availability	Deployment	Typical Use Business	 Personal
Cellular/PCS dial up	9.6 (20)	9.6 (20)	10	Recent	1000s	✓	✓
V34 Modem-dialup	28 (34)	28 (34)	3.5	Common	35-40 million		✓
V90 Modem-dialup	45 (53)	28 (34)	2.5	Common.	millions		✓
Basic Rate ISDN-dialup	128	128	10	Common	100,000s	✓	
DBS Satellite	350 (400)	through phone	NA	Nearly Universal	10,000s		✓
MultiChan. Multipoint Dist.System	100s (1,000s)	100s (1,000s)	35	Recent	10,000s	✓	✓
Prospective Satellite Systems	100s (1,000s)	100s (1,000s)	NA	Under Development	None	✓	✓
3rd Generation Cellular	100s (2,000)	100s (1,000s)	10	Under Development	None	✓	✓
Primary Rate ISDN-dialup	1,544	1,544	2.4	Rare	1000s	✓	
T1	1,544	1,544	1.1	Common	10,000s	✓	
G.lite DSL	400 (1,500)	64-256 (500)	3.5	Recent	~½ million	✓	✓
Cable TV Modem	>1,000 (27,000[4])	200 (10,000[4])	3	Recent	~1.5 million		✓
Local Multipoint Dist. System	(155,000)	(155,000)	4	Recent	1,000s	✓	
Fiber to the Home	millions	millions	100s	Recent	1,000s	✓	✓

1. This table was compiled by NTIA and RUS from publicly available information. Most of the services delivered by these technologies are available at several bit rates. Performance of each technology varies with the nature of the communication medium. Also, some of the services operate at varying rates. This makes a simple comparison difficult. Most of the numbers provided here are representative, not exact. They are meant to place the capabilities of these technologies in context.

2. Wireless technologies are shaded.

3. Maximum range from electronic interface or antenna for typical downstream/upstream performance. Wireless requires line of sight.

4. Shared among users and seldom available to a single user.

APPENDIX A: CABLE MODEM DEPLOYMENT
Availability of Cable Modem Service in the United States

Appendix A is a compilation of areas where cable modem service is offered to at least part of the city or area. In most cases, cable modem service is added a neighborhood at a time as the system is upgraded.

Sources: Provider information is from *Cable Modem Deployment Update*, Communications, Engineering and Design (CED) Magazine, March 2000 (www.cedmagazine.com). The population data are from the U.S. Census Bureau's 1990 Census Gazetteer, (www.census.gov/cgi-bin/gazetteer).

Area and Provider	Population
AT&T Broadband & Internet Services	
Alameda, Calif.	**76,459**
Albany/Corvallis City, Ore.	**74,219**
Allen, Texas	**18,309**
Alton, Ill.	**32,905**
Antioch, Calif.	**62,195**
Arlington Heights, Ill.	**75,460**
Arvada, Colo.	**89,235**
Auburn, Ala.	**33,830**
Aurora/Lowery, Colo.	**222,103**
Baden/Monessen/Ross Township, Pa.	**48,457**
Baton Rouge, La.	**219,531**
Battle Creek, Mich.	**53,540**
Beaverton, Ore.	**53,310**
Berlin, Conn.	**Not Available**
Birmingham, Ala.	**265,968**
Boise City/Nampa/Caldwell, Idaho	**172,503**
Bremerton, Wash.	**38,142**
Bristol, Conn.	**60,640**
Carnegie/McDonald, Pa.	**13,782**
Castle Shannon, Pa.	**9,135**
Castro Valley, Calif.	**48,619**
Cedar Falls/Waterloo, Iowa	**100,765**
Cedar Rapids, Iowa	**108,751**
Chicago/Chicago suburbs, Ill.	**2,783,726***
Clinton, Iowa	**29,201**
Colleyville, Texas	**12,724**
Columbia, Mo.	**69,101**
Columbus, Ga.	**178,681**
Corliss, Pa.	**Not Available**
Cupertino, Calif.	**40,263**
Dallas, Texas	**1,006,877**
DeSoto/Cedar Hill, Texas	**50,520**
Decatur, Ill.	**83,885**
Denham Springs La.	**8,381**
Des Moines, Iowa	**193,187**
Des Plaines, Ill.	**53,233**
Dublin, Calif.	**23,229**

Area and Provider	Population
AT&T Broadband & Internet Services	
Dubuque, Iowa	57,546
East Lansing, Mich.	50,677
Edgewater, Colo.	4,613
Enumclaw, Wash.	7,227
Eugene, Ore.	112,669
Euless, Texas	38,149
Farmers Branch, Texas	24,250
Ferndale, Wash.	5,398
Flower Mound, Texas	15,527
Fort Collins, Colo.	87,758
Foster City/Hillsborough, Calif.	38,843
Fremont, Calif.	173,339
Frisco, Texas	6,141
Galesburg, Ill.	33,530
Garland, Texas	180,650
Golden, Colo.	13,116
Grand Junction, Colo.	29,034
Grand Prairie, Texas	99,616
Grand Rapids, Mich.	189,126
Greeley, Colo.	60,536
Greensburg, Pa.	16,318
Griffith, Ill	Not Available
Hartford, Conn.	139,739
Harvey/South Holland, Ill	51,876
Hayward, Calif.	111,498
Hercules, Calif.	16,829
Highland Park, Ill.	30,575
Hueytown/Tarrant, Ala.	23,326
Iowa City, Iowa	59,738
Iowa City, Texas	Not Available
Lakewood, Colo.	126,481
Lancaster/Hutchins, Texas	24,836
Lewiston, Idaho	28,082
Livermore, Calif.	56,741
Lynden, Wash.	5,709
Marin County, Calif.	230,096
McKees Rocks, Pa.	7,691
McKeesport, Pa.	26,016
McKinney, Texas	21,283
Mercer Island, Wash.	20,816
Mesquite, Texas	101,484
Milpitas/Santa Clara, Calif.	101,967
Moline, Iowa	Not Available
Mon Valley/Donora, Pa.	Not Available
Montgomery, Ala.	187,106
Mount Prospect, Ill.	53,170

Area and Provider	Population
AT&T Broadband & Internet Services	
Muscatine, Iowa	22,881
Muskegon, Mich.	40,283
Nashville-Davidson, Tenn.	488,374
New Britain/Plainville, Conn.	Not Available
Oak Lawn, Ill.	56,182
Ogden, Utah	63,909
Olympia, Wash.	33,840
Overland/St. Ann/Alton, Mo.	33,168
Park Ridge, Ill.	36,175
Penn Hills/East Hills, Ill.	Not Available
Peoria, Ill.	113,504
Peru, Ill.	9,302
Petaluma, Calif.	43,184
Pinole, Calif.	17,460
Pittsburg, Calif.	47,564
Pittsburgh/Aliquippa, Pa.	383,253
Plano, Texas	128,713
Pleasanton, Calif.	50,553
Portland, Ore.	437,319
Pueblo, Colo.	98,640
Richardson, Texas	74,840
Richmond, Calif.	87,425
Rochester, Mich.	7,130
Rock Island, Ill.	40,552
Royal Oak, Mich.	65,410
St. Charles/O'Fallon, Mo.	73,253
Salem, Ore.	107,786
Salt Lake City, Utah	159,936
Sammamish City, Wash.	Not Available
San Mateo, Calif.	85,486
San Ramon, Calif.	35,303
Santa Clara, Calif.	93,613
Schaumburg, Ill.	68,586
Seattle, Ill.	Not Available
Seattle, Wash.	516,259
Simsbury Center, Conn.	5,577
Skyway/Georgetown/White Center-Shorewood, Wash.	Not Available
South San Francisco, Calif.	54,312
Spokane, Wash.	177,196
Springfield, Mo.	140,494
State College/Castle Shannon, Pa.	48,058
Steubenville, Ohio.	22,125
Stonebridge, Texas	Not Available
Streamwood, Ill.	30,987
Sunnyvale, Calif.	117,229

Area and Provider	Population
AT&T Broadband & Internet Services	
Tacoma, Wash.	**176,664**
Tulsa, Okla.	**367,302**
Valparaiso, In.	**24,414**
Vancouver, Wash.	**46,380**
Walled Lake, Mich.	**6,278**
Watertown, S.C.	**Not Available**
Waukegan, Ill.	**69,392**
Wheat Ridge/Lakewood, Colo.	**155,900**
Woodhaven, Mich.	**11,631**
Adelphia	
Adams, Mass.	**6,356**
Bethel Park/West Mifflin/Plymouth Meeting, Pa.	**63,708**
Blacksburg, Va.	**34,590**
Buffalo, N.Y.	**328,123**
Burlington, Vt.	**Not Available**
Canaan, Ohio	**Not Available**
Charlottesville, Va.	**40,341**
Coudersport, Pa.	**2,854**
Delray Beach, Fla	**47,181**
Grand Island, N.Y.	**Not Available**
Hilton Head Island, S.C.	**23,694**
Lansdale, Penn.	**16,362**
Liberty/Amelia, Ohio	**Not Available**
Macedonia, Ohio	**7,509**
Mount Lebanon, Penn.	**33,362**
Niagara Falls, N.Y.	**61,840**
North Adams, Mass.	**16,797**
Norwich, N.Y.	**7,613**
Palm Beach Gardens, Fla.	**22,965**
Philadelphia, Pa.	**1585577**
Pittsburgh, Pa.	**369,879**
Plymouth, Mass.	**7,258**
Dade City, Fla.	**5,633**
Staunton, Va.	**24,461**
Stuart, Fla.	**11,936**
Sturgis, Ky.	**2,184**
Toms River, N.J.	**7,524**
Tonawanda, NY	**17,284**
Waynesboro, Va.	**18,549**
Wellington, Fla.	**20,670**
West Boca, Fla.	**Not Available**
West Palm Beach, Fla.	**67,643**
Western Reserve, Ohio	**Not Available**
Winchester, Va.	**21,947**

Area and Provider	Population
Advanced Cable Communications	
Coral Springs, Fla.	79,443
Weston, Fla.	Not Available
Bend Cable	
Bend/Black Butte/Sisters, Ore.	20,469
Blue Ridge Communications	
Ephrata, Pa.	12,133
Lehighton/Palmerton, Pa.	11,308
Mansfield, Pa.	3,538
Stroudsburg, Pa.	5,312
Bresnan	
Bay City, Mich.	38,936
Dickinson County, Mich.	26,831
Duluth, Minn.	85,493
Escanaba/Manistique, Mich.	17,115
Houghton, Mich.	7,498
Iron Mountain, Mich.	8,525
Lake Superior, Mich.	Not Available
Madison, Wis.	191,262
Mankato, Minn.	31,477
Marquette, Mich.	21,977
Marshall, Minn.	12,023
Midland, Mich.	38,053
Munising, Mich.	2,783
Northwoods, Mich.	Not Available
Rochester, Minn.	70,745
St. Cloud, Minn.	48,812
Superior, Wis.	27,134
Winona, Minn.	25,399
Buenavision	
Los Angeles, Calif.	3,485,398
Cable Co-op of Palo Alto	
Palo Alto, Calif.	55,900
Cable TV of the Kennebunks	
Kennebunk, Maine	4,206
CableAmerica	
Maryland Heights, Mo.	25,407
Waynesville, Mo.	3,207
CableComm	
Johnstown, Pa.	28,134
Cablevision Systems	
Fairfield County, Conn.	827,645
Long Island, N.Y.	Not Available
Cablevision of Lake Havasu	
Lake Havasu, Ariz.	24,363
Capital Cable	
Boone/Columbia County, Mo.	181,480

Area and Provider	Population
Central Valley Cable	
Coalinga, Ga.	Not Available
Charter Communications	
Alhambra, Calif.	82,106
Albertville/Arab, Ala.	20,828
Alcoa, Tenn.	6,400
Alexander City, Ala.	14,917
Alexandria/Brainerd/La Cross/Park Rapids, Minn.	Not Available
Altoona, Pa.	51,881
Anderson, S.C.	26,184
Asheville, N.C.	61,607
Athens, Ga.	45,734
Barre, Vt.	Not Available
Bedford, Va.	6,073
Beloit, Wis.	35,573
Bloomer, Wis.	3,085
Boone, N.C.	12,915
Buies Creek, N.C.	2,085
Buncombe County, N.C.	174,821
Burnsville, N.C.	1,482
Camp LeJeune Central, N.C.	Not Available
Carrollton, Ga.	16,029
Charleston, W. Va.	57,287
Charter Commons/Florisant, Mo.	Not Available
Chicopee, Conn.	Not Available
Clare, Mich.	3,021
Cleveland, Tenn.	30,354
Columbia, Tenn.	28,583
Cookeville, Tenn.	21,744
Cornell, Wis.	1,541
Covington, La.	7,691
Denton, Texas	66,270
Douglas, Ga.	10,464
Dublin, Ga.	16,312
Eau Claire, Wis.	56,856
Evansville/Fond Du Lac/Fort Atkinson, Wis.	51,158
Fenton, Mich.	8,444
Fort Worth, Texas	447,619
Folsom, La.	469
Gaffney, S.C.	13,145
Gainesville, Ga.	17,885
Gardendale, Ala.	9,251
Glendale/Burbank, Calif.	273,681
Gray Court/Greer, S.C.	11,236
Greenville/Spartanburg, S.C.	101,749
Grover City, Calif.	11,656
Grovetown/Fort Gordon, Ga.	12,736

Area and Provider	Population
Charter Communications	
Guntersville, Ga.	Not Available
Gwinnett County, Ga.	352,910
Hammond/Bogalusa, La.	30,151
Hartselle, Ala.	10,795
Henry County, Ga.	58,741
Hickory/Lincolnton, N.C.	35,148
Highland Park/ University Park, Texas	30,998
Janesville/Lake Mills/Lodi/ Mount Horeb/Oregon, Wis.	67,070
Johnson City, Tenn.	49,381
Johnstown, Pa.	28,134
Kingsport, Tenn.	36,365
La Grange/Thomaston, Ga.	34,724
Lafayette/Menomonie, Wis.	Not Available
Lanett, Ala.	8,985
Lebanon, Tenn.	15,208
Manchester, Ga.	4,104
Maryville, Ill.	2,576
Mazomanie, Wis.	1,377
Micaville, N.C.	Not Available
Monterey Park, Calif.	60,738
Montevallo/Mountain Brook, Ala.	24,049
Morristown, Tenn.	21,385
Morro Bay/El Paso de Robles (Paso Robles), Calif.	28,247
Mount Pleasant/Thomas, Mich.	Not Available
Murray, Ky.	14,439
Newnan, Ga.	12,497
Newtown, Conn.	1,800
Northfield, Minn.	14,684
Olivette, Mo.	7,573
Onalaska/Tomah, Minn.	Not Available
Owatonna, Minn.	19,386
Oxford, Mich.	2,929
Park Hills, Mo.	Not Available
Pasadena/Long Beach, Calif.	561,024
Point Pleasant, W. Va.	4,996
Poynette/Prairie du Sac/ Stevens Point, Wis.	27,048
Radford, Va.	15,940
Redwood, Va.	Not Available
Rice Lake, Wis.	7,998
Riverside, Calif.	226,505
Rosemount, Min.	8,622
Saint Louis, Mo.	396,685
San Luis Obispo, Calif.	41,958
Sanford/Whispering Pines, N.C.	15,718
Sheboygan, Wis.	49,676

Area and Provider	Population
Charter Communications	
Smyrna, Ga.	30,981
South Beach, Fla.	2,754
South County, Mo.	Not Available
Stockbridge/Jackson, Ga.	7,435
Taylorsville, N.C.	1,566
Thomaston, Ga.	9,127
Turlock, Calif.	42,198
Union, S.C.	9,836
Uniontown, Pa.	12,034
Verona/Waterloo/Watertown/ Whitewater, Wis. N/D	39,864
Vincennes, Ind.	19,859
Virginia Complex, Tenn.	Not Available
Wadena/Willmar, Minn.	21,665
Waterloo, Ill.	5,072
West Covina/Whittier, Calif.	173,757
Wisconsin Rapids, Wis.	18,245
Worcester, Mass.	169,759
Classic Cable	
Boonville, Mo.	7,095
Brady, Texas	5,946
Cabot, Ark.	8,319
Fort Scott, Kan.	8,362
Hugo, Okla.	5,978
Idabel, Okla.	6,957
Kermit, Texas	6,875
Lampasas, Texas	6,382
Lebanon, Mo.	9,983
Monahans, Texas	8,101
Neosho, Mo.	9,254
Paola, Kan.	4,698
Poteau, Okla.	7,210
Rockdale, Texas	5,235
Stuttgart, Ark.	10,420
Terrell, Texas	12,490
Trenton, Mo.	6,129
Woodward, Okla.	12,340
Coast Cablevision	
San Mateo, Calif.	85,486
Coaxial Cable	
Amelia/Liberty, Ohio	Not Available
Comcast	
Alexandria, Va.	111,183
Atlanta, Ga.	394,017
Baltimore, Md.	736,014
Bensalem, Pa.	Not Available

Area and Provider	Population
Comcast	
Castleton, Ind.	37
Charleston, S.C.	80,414
Chesterfield, Va.	Not Available
Delaware County, Pa.	547,651
Detroit, Mich.	1,027,974
Hendricks County, Ind.	75,717
Indianapolis, Ind.	731,327
Lawrence, Ind.	26,763
Marion County, Ind.	797,159
New Castle County, Del.	441,946
Orange County, Calif.	2,410,556
Philadelphia, Pa.	1,585,577
Prince William County, Va.	215,686
Sarasota, Fla.	50,961
Speedway, Ind.	13,092
Union County, N.J.	493,819
CommuniComm Services	
Bridgeport, Texas	3,581
Chico, Texas	800
Decatur, Texas	4,252
Durant, Okla.	12,823
High Springs/Alachua, Fla.	7,673
Lake Bridgeport, Texas	322
Roanoke, Ala.	6,362
Runaway Bay, Texas	700
Westlake/Moss Bluff, La.	13,046
Wheatland/Torrington/Douglas, Wyo.	13,998
Cox Communications	
Amarillo, Texas	157,615
Bryan/College Station, Texas	107,548
Enid, Okla.	45,309
Eureka, Calif.	27,025
Fairfax, Va.	19,622
Fredericksburg, Va.	19,027
Hampton Roads, Va.	Not Available
Hartford/Cheshire Village, Conn.	145,498
Humboldt Hill, Calif.	2,865
Lafayette, La.	94,440
Las Vegas, Nev.	258,295
Mission Viejo, Calif.	72,820
New Orleans, La.	496,938
Oklahoma City/suburbs, Okla.	444,719*
Omaha, Neb.	335,795
Orange County, Calif.	2,410,556
Phoenix, Ariz.	983,403
Providence, R.I.	160,728

Area and Provider	Population
Cox Communications	
San Diego, Calif.	1,110,549
Santa Barbara, Calif.	85,571
Wichita, Kan.	304,011
Etan-Cable Management	
Belle Chasse, La.	8,512
Jasper, Texas	6,959
Laughlin, Nev.	4,791
Sour Lake, Texas	1,547
Fanch	
Johnstown, Pa.	28,134
FiberVision	
Billings, Mont.	81,151
GCI	
Anchorage, Alaska	226,338
Fairbanks, Alaska	30,843
Galaxy	
Alma, Mo.	446
Booneville, Miss.	7,955
Guntown, Miss.	692
New Albany, Miss.	6,775
Oxford, Miss.	9,984
Seneca, Kan.	2,027
Wilber, Neb.	1,527
Gans Multimedia	
King George's County, Va.	13,527
St. Mary's, Md.	75,974
Tucson, Ariz.	405,390
Genesis Cable	
Winder, Ga.	7,373
Grafton Cable	
Grafton, Ohio	3,344
H&B Communications	
Holyrood, Kan.	492
Haefele Cable	
Spencer, N.Y.	815
Horizon Cable	
Novato, Calif.	47,585
Point Reyes, Calif.	Not Available
Ind-Co Cable TV	
Mtn. View/Searcy/Pangburn, Ark.	18,249
Insight Communications	
Bowling Green, Ky.	40,641
Covington, Ky.	43,264
Jeffersonville, Ind.	21,841
Lafayette, Ind.	43,764
Lexington-Fayette, Ky.	225,366

Area and Provider	Population
Insight Communications	
Louisville, Ky.	269,063
Noblesville, Ind.	17,655
Knology	
Augusta, Ga.	44,639
Charleston, S.C.	80,414
Columbus, Ga.	178,681
Huntsville, Ala.	159,789
Knoxville, Tenn.	165,121
Montgomery, Ala.	4,239
Panama City, Fla.	34,378
West Point, Ga.	3,571
Krause Cable	
Seneca, Ill.	1,878
Lawton Cablevision	
Lawton, Okla.	80,561
Mallard Cablevision	
Burleson, Texas	16,113
River Oaks, Texas	6,580
Willow Park, Texas	2,328
MediaOne	
Atlanta, Ga.	394,017
Boston/Boston suburbs (multiple), Mass.	574,283*
Cleveland, Ohio	505,616
Detroit/Ann Arbor, Mich.	1,137,566
Fresno, Calif.	354,202
Los Angeles, Calif.	3,485,398
Northeast Fla. (Jacksonville)	635,230
Orange County, Calif. N/D	2,410,556
Richmond, Va.	203,056
Saint Paul, Minn.	272,235
Southern Fla. (Fort Myers/Naples/Pompano Beach/Broward County)	1,392,610
Southern Mass. (Cape Cod/Fall River/New Bedford)	Not Available
Southern N.H. (Concord/ Nashua/Salem)	Not Available
Stockton, Calif.	210,943
Western Mass. (Springfield/Pittsfield)	205,605
Mediacom	
Clearlake Oaks, Calif.	2,419
Gulf Breeze/Milton Fla.	12,746
Huntsville, Ala.	159,789
Marshall County, Ky.	27,205
Millsboro, Del.	1,643
Mobile, Ala.	196,278
Sun City, Calif.	14,930

Area and Provider	Population
Mid-Coast Cable	
El Campo/Edna, Texas	15,854
MidAtlantic	
Howard County, Md.	187,328
Prince William, Va.	215,686
Rockville, Md.	44,835
Multimedia	
Oklahoma City, Okla.	444,719
News Press Gazette	
Blythe Calif.	8,428
Bullhead City, Ariz.	21,951
Flagstaff, Ariz.	45,857
Kingman, Ariz.	12,722
Lake Havasu, Ariz.	24,363
Parker, Ariz.	2,897
Payson, Ariz.	8,377
Sedona, Ariz.	7,720
Northland Communications	
Bainbridge Island, Wash.	Not Available
Starkville, Miss.	18,458
One Point Communications	
Va. communities	Not Available
Orion Cable Systems	
San Marcos, Calif.	38,974
Pine Tree Cable	
Machias, Maine	1,773
Plantation Cablevision	
Greensboro, Ga.	2,860
Ponderosa Cable	
Danville, Calif.	31,306
Prestige Cable	
Bartow, Ga.	292
Canton, Ga.	4,817
Forsyth County, Ga.	44,083
Mooresville/Statesville, N.C.	26,884
Spotsylvania Courthouse, Va.	2,694
Westminster, Md.	13,068
RCN	
Allentown, Pa.	105,090
Boston, Mass.	574,283
Carmel Hamlet, N.Y.	4,800
Daly City, Calif.	92,311
Hillsborough, N.J.	Not Available
Montgomery County, Md.	757,027
New York, N.Y.	7,322,564
Philadelphia, Pa.	1,585,577
Princeton, N.J.	12,016

Area and Provider	Population
RCN	
Somerville/Arlington/Newton/ Waltham, Mass.	261,303
Washington, D.C.	606,900
Watertown, Mass.	33,284
Range TV	
Chisholm/Hibbing, Minn.	23,336
Mountain Iron, Minn.	3,362
Nashwauk/Keewatin, Minn.	2,144
Virginia, Minn.	9,410
Rankin Cable	
Rankin County, Miss.	87,161
Rapid	
Branson, Mo.	3,706
Robson	
Saddlebrooke, Ariz.	Not Available
Sun Lakes, Ariz.	6,578
Rogers Cable	
Wasila, Ark.	Not Available
San Bruno Municipal Cable	
San Bruno, Calif.	38,961
Satellite Cable Services	
Brookings, S.D.	16,270
Chamberlain, S.D.	2,347
Freeman, S.D.	1,293
Searle Communications	
Monument, Colo.	1,020
Service Electric	
Allentown, Pa.	105,090
Bethlehem, Pa.	71,428
Birdsboro, Pa.	4,222
Easton, Pa.	26,276
Emmaus, Pa.	11,157
Frenchtown, N.J.	1,528
Hazleton, Pa.	24,730
Lafayette, N.J.	Not Available
Mahanoy City, Pa.	5,209
Sunbury, Pa.	11,591
Wilkes-Barre, Pa.	47,523
Shen-Heights Cable	
Shenandoah, Pa.	6,221
Shrewsbury Cable	
Shrewsbury, Mass.	Not Available
Sjoberg's Cable	
Thief River Falls, Minn.	8,010
Southwest Missouri Cable	
Carthage, Mo.	10,747

Area and Provider	Population
Star Cable	
Nelson, Ohio	Not Available
Strategic Technologies	
Natomas Park, Calif.	Not Available
Stevenson Ranch, Calif.	Not Available
Sun Country Cable	
Los Altos, Calif.	26,303
Spokane, Wash.	177,196
SunTel	
Lake Alamanor, Calif.	Not Available
Winnemucca, Nev.	6,134
Tennessee Cable	
Oak Ridge, Tenn.	27,310
Time Warner	
Akron, Ohio	223,019
Albany/Saratoga/Troy, N.Y.	180,352
Aroostook County, Maine	86,936
Austin, Texas	465,622
Bakersfield, Calif.	174,820
Binghamton, Corning, Elmira, Norwich, N.Y.	106,283
Canton, Ohio	84,161
Central Fla. (Brevard, Seminole, Orange City)	413,576
Charlotte, N.C.	395,934
Cincinnati, Ohio	364,040
Columbia, S.C.	98,052
El Paso, Texas	515,342
Greensboro, N.C.	183,521
Houston, Texas	1,630,553
Kansas City, Mo.	435,146
Los Angeles, Calif.	3,485,398
Memphis, Tenn.	610,337
Minneapolis, Minn.	368,363
New York City (Manhattan), N.Y.	Not Available
Oahu, Hawaii	836,231
Oneida, N.Y.	10,850
Orange County, Calif.	2,410,556
Orlando, Fla.	164,693
Portland, Maine	64,358
Rochester, N.Y.	231,636
San Antonio, Texas	935,933
San Diego, Calif.	1,110,549
Syracuse/Oswego/Ithaca, N.Y.	313,678
Tampa, Fla.	280,015
Western Ohio	Not Available
Wilmington, N.C.	55,530
Youngstown, Ohio	95,732

* Does not include suburbs.

APPENDIX B: RBOC DSL DEPLOYMENT
Availability of DSL Services from RBOCs in the United States

Appendix B is a compilation of the areas where Regional Bell Operating Companies (RBOCs) are currently providing DSL services (marketed under a variety of names, such as Infospeed and Fast Access). DSL services will not necessarily be available to the entire population of the listed city. These data are based on public information provided by the RBOCS (primarily on the Web) in March 2000. The data provided by the various RBOCs differed in their degrees of comprehensiveness. The population data are from the U.S. Census Bureau's 1990 Census Gazetteer, (www.census.gov/cgi-bin/gazetteer).

RBOC	Population
Ameritech	
Ann Arbor (and suburbs), MI	**109,592**
Bloomington, IL	**51,972**
Chicago (and suburbs), IL	**2,783,726**
Cleveland (and suburbs), OH	**505,616**
Detroit (and suburbs), MI	**1,027,974**
Elkhart, IN	**43,627**
Fort Wayne, IN	**173,072**
Jackson, MI	**37,446**
Lafayette, IN	**43,764**
Terre Haute, IN	**57,483**
Valparaiso, IN	**24,414**
Wausau, WI	**37,060**
Bell Atlantic	
Alexandria, VA	**111,183**
Altoona, PA	**51,881**
Arlington, VA	**170,936**
Elizabeth, NJ	**110,002**
Harrisburg, PA	**52,376**
Huntington, WV	**54,844**
Jersey City, NJ	**228,537**
Lancaster, PA	**55,551**
New Brunswick, NJ	**41,711**
New York, NY	**7,322,564**
Newark, NJ	**275,221**
Norfolk, VA	**261,229**
Paterson, NJ	**140,891**
Philadelphia, PA	**1,585,577**
Pittsburgh, PA	**369,879**
Richmond, VA	**203,056**
Scranton, PA	**81,805**
Virginia Beach, VA	**393,069**
Washington, DC	**606,900**
Wilmington, DE	**71,529**
Bell South	
Athens, GA	**45,734**
Atlanta, GA	**394,017**
Augusta, GA	**44,639**

RBOC	Population
Bell South	
Baton Rouge, LA	219,531
Birmingham, AL	265,968
Boca Raton, FL	61,492
Charleston, SC	80,414
Charlotte, NC	395,934
Chattanooga, TN	152,466
Columbia, SC	98,052
Daytona Beach, FL	61,921
Durham, NC	136,611
Fort Lauderdale, FL	149,377
Gainesville, FL	84,770
Greensboro, NC	183,521
Greenville, SC	58,282
Hillsborough, FL	Not Available
Huntsville, AL	159,789
Jackson, MS	196,637
Jacksonville, FL	635,230
Knoxville, TN	165,121
Lafayette, LA	94,440
Lexington-Fayette, KY	225,366
Louisville, KY	269,063
Manatee, FL	Not Available
Memphis, TN	610,337
Miami, FL	358,548
Montgomery, AL	187,106
Nashville, TN	Not Available
New Orleans, LA	496,938
Orlando, FL	164,693
Pensacola, FL	58,165
Pinellas, FL	Not Available
Raleigh, NC	207,951
Sarasota, FL	50,961
Tampa, FL	280,015
West Palm Beach, FL	67,643
Winston-Salem, NC	143,485
Nevada Bell	
Carson City, NV	40,443
Reno, NV	133,850
Sparks, NV	53,367
Pacific Bell (all in California)	
Agoura Hills	20,390
Alameda	76,459
Albany	16,327
Alhambra	82,106
Anaheim	266,406
Antioch	62,195
Aptos	9,061

RBOC	Population
Pacific Bell (all in California)	
Arcadia	48,290
Arlington	Not Available
Arroyo Grande	14,378
Atwater	22,282
Auburn	10,592
Bakersfield	174,820
Balboa	Not Available
Benicia	24,437
Berkeley	102,724
Beverly Hills	31,971
Bishop	3,475
Blue Revine	Not Available
Boulder Creek	6,725
Brea	32,873
Brentwood	7,563
Buena Park	68,784
Burbank	93,643
Burlingame	26,801
Calabasas	Not Available
Canoga Park	Not Available
Carlsbad	63,126
Carmel	Not Available
Castaic	Not Available
Chico	40,079
Chula Vista	135,163
Clayton	7,317
Clovis	50,323
Colma	1,103
Colton	40,213
Compton	90,454
Concord	111,348
Corona	76,095
Corona Del Ray	Not Available
Coronado	26,540
Costa Mesa	96,357
Cotati	5,714
Culver City	38,793
Danville	31,306
Davis	46,209
Del Mar	4,860
Edgewood	Not Available
El Cajon	88,693
El Dorado	Not Available
El Monte	106,209
El Segundo	15,223
El Sobrante	9,852

RBOC	Population
Pacific Bell (all in California)	
El Toro	**62,685**
Encinitas	**55,386**
Escondido	**108,635**
Eureka	**27,025**
Fair Oaks	**26,867**
Fairfield	**77,211**
Fallbrook	**22,095**
Folsom	**29,802**
Fontana	**87,535**
Fremont	**173,339**
Fresno	**354,202**
Fullerton	**114,144**
Garden Grove	**143,050**
Gardena	**49,847**
Glendale	**180,038**
Grass Valley	**9,048**
Half Moon Bay	**8,886**
Hawthorne	**71,349**
Hayward	**111,498**
Hercules	**168,29**
Highland	**34,439**
Hollywood	**Not Available**
Ignacio	**Not Available**
Imperial Beach	**26,512**
Inglewood	**109,602**
Irvine	**110,330**
La Brea	**Not Available**
La Crescenta-Montrose	**16,968**
La Jolla	**Not Available**
La Mesa	**52,931**
Lafayette	**23,501**
Laguna Niguel	**44,400**
Lakeside	**39,412**
Larkspur	**11,070**
Livermore	**56,741**
Lodi	**51,874**
Lomita	**19,382**
Los Altos	**26,303**
Los Angeles	**3,485,398**
Martinez	**31,808**
Menlo Park	**28,040**
Merced	**56,216**
Mill Valley	**13,038**
Millbrae	**20,412**
Milpitas	**50,686**
Mission Viejo	**72,820**

RBOC	Population
Pacific Bell (all in California)	
Modesto	164,730
Monterey	31,954
Moraga Town	15,852
Mountain View	67,460
Napa	61,842
National City	54,249
Nevada City	28,55
Newhall	Not Available
Nimbus	Not Available
North Highlands	42,105
North Hollywood	Not Available
Northridge	Not Available
Oakland	372,242
Oceanside	128,398
Orange	110,658
Orangevale	26,266
Orinda	16,642
Oroville	11,960
Pacific Beach	Not Available
Pacifica	37,670
Palm Springs	40,181
Palmdale	68,842
Palo Alto	55,900
Paramount	47,669
Pasadena	131,591
Pedley	8,869
Petaluma	43,184
Pittsburg	47,564
Placentia	41,259
Placerville	8,355
Pleasanton	50,553
Poway	43,516
Rancho Bernardo	Not Available
Rancho Penasquitos	Not Available
Rancho San Diego	6,977
Rancho Santa Fe	Not Available
Rancho Santa Margarita	11,390
Redding	66,462
Redwood City	66,072
Reseda	Not Available
Rhonert Park	Not Available
Richmond	87,425
Riverside	226,505
Rocklin	19,033
Rosemead	51,638
Sacramento	369,365

RBOC	Population
Pacific Bell (all in California)	
Salinas	**108,777**
San Bruno	**38,961**
San Carlos	**26,167**
San Clemente	**41,100**
San Diego	**1,110,549**
San Francisco	**723,959**
San Gabriel	**37,120**
San Jose	**782,248**
San Juan Capistrano	**26,183**
San Leandro	**68,223**
San Luis Obispo	**41,958**
San Marcos	**38,974**
San Martin	**1,713**
San Mateo	**85,486**
San Pedro	**Not Available**
San Rafael	**48,404**
San Ramon	**35,303**
Santa Ana	**293,742**
Santa Barbara	**85,571**
Santa Clara	**93,613**
Santa Cruz	**49,040**
Santa Margarita	**Not Available**
Santa Monica	**86,905**
Santa Rosa	**113,313**
Santee	**52,902**
Saugus	**Not Available**
Sausalito	**7,152**
Scotts Valley	**8,615**
Seaside	**38,901**
Sebastopol	**7,004**
Sherman Oaks	**Not Available**
Shingle Springs	**2,049**
Simi Valley	**100,217**
Solamint	**Not Available**
Sonoma	**8,121**
South Gate	**86,284**
South Lake Tahoe	**21,586**
South Pasadena	**23,936**
Stockton	**210,943**
Sunnyvale	**117,229**
Tiburon	**7,532**
Torrance	**133,107**
Tracy	**33,558**
Truckee	**3,484**
Turlock	**42,198**
Tustin	**50,689**

RBOC	Population
Pacific Bell (all in California)	
Ukiah	**14,599**
Union City	**53,762**
Vacaville	**71,479**
Vallejo	**109,199**
Van Nuys	**Not Available**
Ventura	**Not Available**
Visalia	**75,636**
Vista	**71,872**
Walnut Creek	**60,569**
Watsonville	**31,099**
West Los Angeles	**Not Available**
Woodland	**39,802**
Yorba Linda	**52,422**
Yuba City	**27,437**
Southwestern Bell	
Abilene, TX	**106,654**
Addicks, TX	**Not Available**
Addison, TX	**8,783**
Alvin, TX	**19,220**
Amarillo, TX	**157,615**
Arlington, TX	**261,721**
Arnold, MO	**18,828**
Austin, TX	**465,622**
Beaumont, TX	**114,323**
Belton, MO	**18,150**
Bentonville, AR	**11,257**
Blue Springs, MO	**40,153**
Brideton, MO	**Not Available**
Carrollton, TX	**82,169**
Cedar Hill, TX	**19,976**
Cedar Valley, TX	**Not Available**
Chesterfield, MO	**37,991**
Cleburne, TX	**22,205**
Clute, TX	**8,910**
College Station, TX	**52,456**
Columbia, MO	**69,101**
Coppell, TX	**16,881**
Corpus Christi, TX	**257,453**
Creve Coeur, MO	**12,304**
Cypress, TX	**Not Available**
Dallas, TX	**1,006,877**
Denton, TX	**66,270**
DeSoto, TX	**30,544**
Duncanville, TX	**35,748**
Edmond, OK	**52,315**
El Paso, TX	**515,342**
Enid, OK	**45,309**

RBOC	Population
Southwestern Bell	
Farmers Branch, TX	**24,250**
Fayetteville, AR	**42,099**
Fenton, MO	**3,346**
Ferguson, MO	**22,286**
Florissant, MO	**51,206**
Flower Mound, TX	**15,527**
Fort Smith, AR	**72,798**
Fort Worth, TX	**447,619**
Friendswood, TX	**22,814**
Frisco, TX	**6,141**
Garland, TX	**180,650**
Gladstone, MO	**26,243**
Grand Prairie, TX	**99,616**
Harvester, MO	**Not Available**
Hays, KS	**17,767**
Hazelwood, MO	**15,324**
High Ridge, MO	**4,423**
Houston, TX	**1,630,553**
Hutchinson, KS	**39,308**
Incline Village-Crystal Bay, NV	**7,119**
Independence, MO	**112,301**
Irving, TX	**155,037**
Kansas City, KS	**149,767**
Kansas City, MO	**435,146**
Kirkwood, MO	**27,291**
Klien, TX	**Not Available**
La Porte, TX	**27,910**
Ladue, MO	**8,847**
Lake Jackson, TX	**22,776**
Lancaster, TX	**22,117**
Las Colinas, TX	**Not Available**
Lawrence, KS	**65,608**
Lawton, OK	**80,561**
Lee's Summit, MO	**46,418**
Lenexa, KS	**34,034**
Leon Springs, TX	**Not Available**
Lewisville, TX	**46,521**
Liberty, MO	**20,459**
Little Rock, AR	**175,795**
Lubbock, TX	**186,206**
Manchester, MO	**6,542**
Manhattan, KS	**37,712**
Mehlville, MO	**27,557**
Mesquite, TX	**101,484**
Midland, TX	**89,443**
Mission, KS	**9,504**

RBOC	Population
Southwestern Bell	
Mount Pleasant, TX	12,291
Nederland, TX	16,192
New Braunfels, TX	27,334
Norman, OK	80,071
Oakville, MO	31,750
Odessa, TX	89,699
Oklahoma City, OK	444,719
Olathe, KS	63,352
Overland Park, KS	111,790
Overland, MO	17,987
Parkville, MO	2,402
Pearland, TX	18,697
Pflugerville, TX	4,444
Plano, TX	128,713
Richardson, TX	74,840
Richland Hills, TX	7,978
Rogers, AR	24,692
Rosenberg, TX	20,183
Round Rock, TX	30,923
Salina, KS	42,303
San Angelo, TX	84,474
San Antonio, TX	935,933
Seguin, TX	18,853
Shawnee, KS	37,993
Spanish Lake, MO	20,322
Spring, TX	33,111
Springdale, AR	29,941
St. Charles, MO	54,555
St. Joseph, MO	71,852
St. Louis, MO	396,685
Stanley, KS	Not Available
Stillwater, OK	36,676
Temple, TX	46,109
Texarkana, TX	31,656
Tomball, TX	6,370
Topeka, KS	119,883
Tulsa, OK	367,302
Universal City, TX	13,057
Valley Park, MO	4,165
Waco, TX	103,590
Webster Groves, MO	22,987
Wichita, KS	304,011

RBOC	Population
US West	
Albany, OR	29,462
American Fork, UT	15,696
Ames, IA	47,198
Ankeny, IA	18,482
Anoka, MN	17,192
Arvada, CO	89,235
Auburn, WA	33,102
Aurora, CO	222,103
Bainbridge Island, WA	Not Available
Beardsley, AZ	Not Available
Beaverton, OR	53,310
Bellevue, WA	86,874
Bellingham, WA	52,179
Bethany, AZ	Not Available
Bettendorf, IA	28,132
Bismarck, ND	49,256
Blaine, MN	38,975
Bloomington, MN	86,335
Boise City, ID	125,738
Boulder, CO	83,312
Bountiful, UT	36,659
Bremerton, WA	38,142
Brooklyn Center, MN	28,887
Broomfield, CO	24,638
Burnsville, MN	51,288
Castle Rock, CO	8,708
Catalina, AZ	4,864
Cedar Rapids, IA	108,751
Chandler, AZ	90,533
Cheyenne, WY	50,008
Clearfield, UT	21,435
Colorado Springs, CO	281,140
Coon Rapids, MN	52,978
Cortaro, AZ	Not Available
Corvallis, OR	44,757
Cottage grove, MN	22,935
Council Bluffs, IA	54,315
Craycroft, AZ	Not Available
Crystal, MN	23,788
Davenport, IA	95,333
Deer Valley, AZ	Not Available
Denver, CO	467,610
Des Moines, IA	193,187

RBOC	Population
US West	
Des Moines, WA	**17,283**
Draper, UT	**7,257**
Duluth, MN	**85,493**
Eagan, MN	**47,409**
Eagle, ID	**3,327**
Eden, MN	**Not Available**
Eden Prairie, MN	**39,311**
Englewood, CO	**29,387**
Eugene, OR	**112,669**
Everett, WA	**69,961**
Excelsior, MN	**2,367**
Fargo, ND	**74,111**
Farmington, UT	**9,028**
Federal Way, WA	**67,554**
Flagstaff, AZ	**45,857**
Flowing Wells, AZ	**14,013**
Foothills, AZ	**Not Available**
Fort Collins, CO	**87,758**
Fort McDowell, AZ	**Not Available**
Fridley, MN	**28,335**
Ft Snelling, MN	**Not Available**
Glendale, AZ	**148,134**
Golden Valley, MN	**20,971**
Grand Forks, ND	**49,425**
Grand Junction, CO	**29,034**
Greeley, CO	**60,536**
Helena, MT	**24,569**
Highlands Ranch, CO	**10,181**
Holiday, UT	**Not Available**
Hopkins, MN	**16,534**
Idaho Falls, ID	**43,929**
Iowa City, IA	**59,738**
Issaquah, WA	**7,786**
Kaysville, UT	**13,961**
Kearns, UT	**28,374**
Kennewick, WA	**42,155**
Kent, WA	**37,960**
Lacey, WA	**19,279**
Lake Oswego, OR	**30,576**
Lakewood, CO	**126,481**
Lehi, UT	**8,475**
Litchfield Park, AZ	**3,303**
Littleton, CO	**33,685**
Longmont, CO	**51,555**
Maplewood, MN	**30,954**

RBOC	Population
US West	
Maryvale, AZ	Not Available
Mercer Island, WA	20,816
Meridian, ID	9,596
Mesa , AZ	288,091
Midrivers, AZ	Not Available
Midvale, UT	11,886
Milwaukie, OR	18,692
Minneapolis, MN	368,383
Murray, UT	31,282
Muscatine, IA	22,881
Nampa, ID	28,365
New Brighton, MN	22,207
North St. Paul, MN	12,376
Northglenn, CO	27,195
Olympia, WA	33,840
Omaha, NE	335,795
Oregon City, OR	14,698
Orem, UT	67,561
Pecos, AZ	Not Available
Peoria, AZ	50,618
Phoenix, AZ	983,403
Pineacle Peak, AZ	Not Available
Pleasant Grove, UT	13,476
Plymouth, MN	50,889
Pocatello, ID	46,080
Portland, OR	437,319
Prairie, MN	Not Available
Prescott, AZ	26,455
Provo, UT	86,835
Pueblo, CO	98,640
Puyallup, WA	23,875
Rapid City, SD	54,523
Redmond, WA	35,800
Renton, WA	41,688
Richfield, MN	35,710
Rincon, AZ	Not Available
Rochester, MN	70,745
Salem, OR	107,786
Salt Lake City, UT	159,936
Scottsdale, AZ	130,069
Seattle , WA	516,259
Shoreview, MN	24,587
Sioux Falls, SD	100,814
Smokey Hill, CO	Not Available
Spokane, WA	177,196
Springfield, OR	44,683

RBOC	Population
US West	
Springville, UT	13,950
St. Cloud, MN	48,812
St. Paul, MN	272,235
Sunnyslope, AZ	Not Available
Sunrise, AZ	Not Available
Superstition, AZ	Not Available
Tacoma, WA	176,664
Tanque Verde, AZ	Not Available
Tempe, AZ	141,865
Tolleson, AZ	4,434
Tucson, AZ	405,390
Twin Falls, ID	27,591
Vail, CO	3,659
Vancouver, WA	46,380
Wayzata, MN	3,806
West Fargo, ND	12,287
West St. Paul, MN	19,248
Westminster, CO	74,625
White Bear Lake , MN	24,704

APPENDIX C

Characteristics of a Sample of Existing and Proposed Satellite and High Altitude Systems

1. Aster

Key Investors:
Number of Satellites Planned: 5 GEO
Coverage: worldwide
Uplink Data Rate (channel freq.): up to 622 Mbps (35.0 to 51.4 GHz)
Downlink Data Rate (channel freq.): up to 16 Mbps (35.0 to 51.4 GHz)
Estimated Aggregate Bandwidth: N/A
Estimated Subscriber Cost: competitive with terrestrial
First Satellite in Service: 2002
Full Constellation in Service: N/A

2. **Astrolink**

Key Investors: Lockheed Martin, TRW, Telespazio, Liberty Media
Number of Satellites Planned: 9 GEO
Coverage: worldwide
Uplink Data Rate (channel freq.): up to 20 Mbps (Ka band)
Downlink Data Rate (channel freq.): up to 920 Mbps (Ka band)
Estimated Aggregate Bandwidth: 6.5 Gbps per satellite
Estimated Subscriber Cost: competitive with terrestrial
First Satellite in Service: by 2001
Full Constellation in Service: market dependent

3. **Celestri**

Key Investors: Motorola, Matra, Marconi
Number of Satellites Planned: 63 LEO + 9 GEO
Coverage: worldwide
Uplink Data Rate (channel freq.): up to 51 Mbps (Ka band)
Downlink Data Rate (channel freq.): up to 51 Mbps (Ka band)
Estimated Aggregate Bandwidth: 80 Gbps system capability
Estimated Subscriber Cost: competitive with terrestrial
Full Constellation in Service: 2003

4. COMSAT World Systems

Key Investors: 142 member INTELSAT
Number of Satellites Planned: 25 GEO
Coverage: worldwide
Uplink Data Rate (channel freq.): up to 155 Mbps
Downlink Data Rate (channel freq.): up to 1 Gbps
Estimated Aggregate Bandwidth: 50 Gbps
Estimated Subscriber Cost: N/A (market is presently telecomm companies)
First Satellite in Service: fully operational
Full Constellation in Service: fully operational

5. GE*Star
Key Investors: GE Americon
Number of Satellites Planned: 9 GEO
Coverage: worldwide
Uplink Data Rate (channel freq.): presently 33 kbps (14.0-14.5 GHz)
Downlink Data Rate (channel freq.): presently 2 Mbps (11.7-12.2 GHz)
Estimated Aggregate Bandwidth: N/A
Estimated Subscriber Cost: $30 to $130 per month ($200+ installation cost)
First Satellite in Service: fully operational (GE-3 87° west)
Full Constellation in Service: 2003

6. Halo
Key Investors: numerous
Number of Satellites Planned: high altitude long operation (HALO) aircraft
Coverage: 1+ platform per metropolitan area
Uplink Data Rate (channel freq.): up to 25 Mbps (27.5 to 27.8 GHz)
Downlink Data Rate (channel freq.): up to 25 Mbps (28.1 to 28.4 GHz)
Estimated Aggregate Bandwidth: N/A
Estimated Subscriber Cost: 1 Mbps $50 per month, 10 Mbps $250 per month
First Satellite in Service: 2000 to 2001 planned
Full Constellation in Service: 100 cities by 2003

7. Hughes DirecPC
Key Investors: Hughes Network Systems
Number of Satellites Planned: leased GEO
Coverage: North America
Uplink Data Rate (channel freq.): standard telephone modem
Downlink Data Rate (channel freq.): 400 kbps (4 GHz)
Estimated Aggregate Bandwidth: N/A
Estimated Subscriber Cost: $30 to $130 per month (200+ installation cost)
First Satellite in Service: fully operational (Galaxy IV 99° west)
Full Constellation in Service: N/A

8. iSky
Key Investors: Liberty Media, TV Guide, Kleiner Perkins
Number of Satellites Planned: 2 GEO (109.2° west)
Coverage: North America
Uplink Data Rate (channel freq.): N/A
Downlink Data Rate (channel freq.): N/A
Estimated Aggregate Bandwidth: N/A
Estimated Subscriber Cost: competitive with DSL/cable, $40 per month
First Satellite in Service: end 2001 (GEO 109.2° west)
Full Constellation in Service: N/A

9. Leo One

Key Investors: Leo One
Number of Satellites Planned: 48 LEO (6 x 8 orbital planes)
Coverage: worldwide
Uplink Data Rate (channel freq.): 9.6 kbps (148 to 150 MHz)
Downlink Data Rate (channel freq.): 24 kbps (137 to 138 MHz, 400-401 MHz)
Estimated Aggregate Bandwidth: 50 kbps per gateway
Estimated Subscriber Cost: N/A
First Satellite in Service: N/A
Full Constellation in Service: mid 2003

10. Orblink

Key Investors:
Number of Satellites Planned: 7 MEO
Coverage: worldwide
Uplink Data Rate (channel freq.): up to 1.5 Mbps (47.7 to 48.7 GHz)
Downlink Data Rate (channel freq.): up to 1.25 Gbps (37.5 to 38.5 GHz)
Estimated Aggregate Bandwidth: N/A
Estimated Subscriber Cost: competitive with terrestrial
First Satellite in Service: 2002
Full Constellation in Service: 2002

11. Orion

Key Investors: Orion Network Systems
Number of Satellites Planned: 3 GEO
Coverage: most of the world
Uplink Data Rate (channel freq.): up to 25 Mbps
Downlink Data Rate (channel freq.): up to 25 Gbps
Estimated Aggregate Bandwidth: N/A
Estimated Subscriber Cost: competitive with terrestrial
First Satellite in Service: Orion 1 fully operational
Full Constellation in Service: as per market demand

12. Pentriad

Key Investors: Denali Telecomm
Number of Satellites Planned: 13 quasi-GEO (high elliptical)
Coverage: Northern Hemisphere
Uplink Data Rate (channel freq.):
Downlink Data Rate (channel freq.): 45 to 155 Mbps
Estimated Aggregate Bandwidth: 144 Gbps
Estimated Subscriber Cost: N/A
First Satellite in Service: N/A
Full Constellation in Service: N/A

13. SkyBridge

Key Investors: Alcatel Alsthom, Toshiba, Mitsubishi Electric, Aerospace Canada
Number of Satellites Planned: 80 LEO
Coverage: worldwide
Uplink Data Rate (channel freq.): 2 to 10 Mbps (10 to 18 GHz)
Downlink Data Rate (channel freq.): 20 to 100 Mbps (10 to 18 GHz)
Estimated Aggregate Bandwidth: 215 Gbps
Estimated Subscriber Cost: N/A
First Satellite in Service: beginning 2002
Full Constellation in Service: beginning 2002

14. Sky Station

Key Investors: Sky Station
Number of Satellites Planned: lighter than air platforms
Coverage: 1+ platform per metropolitan area
Uplink Data Rate (channel freq.): up to 10 Mbps (47.9 to 48.2 GHz)
Downlink Data Rate (channel freq.): up to 10 Mbps (47.2 to 47.5 GHz)
Estimated Aggregate Bandwidth: N/A
Estimated Subscriber Cost: competitive with terrestrial
First Satellite in Service: 2002
Full Constellation in Service: depends on market demand

15. Spaceway

Key Investors: Hughes Electronics
Number of Satellites Planned: 16 GEO + 20 MEO (8 GEO initial system)
Coverage: worldwide
Uplink Data Rate (channel freq.): up to 6 Mbps (27.5 to 30.0 GHz)
Downlink Data Rate (channel freq.): up to 108 Mbps shared (17.7 to 20.0 GHz)
Estimated Aggregate Bandwidth: 35.2 (8 GEO initial system)
Estimated Subscriber Cost: competitive with terrestrial
First Satellite in Service: 2002 (1 to 4 GEO)
Full Constellation in Service: as per market demand

16. Teledesic

Key Investors: Craig McCaw, Bill Gates, Boeing
Number of Satellites Planned: 288 LEO + 24 spare LEO
Coverage: worldwide
Uplink Data Rate (channel freq.): up to 2 Mbps (28.6 to 29.1 GHz)
Downlink Data Rate (channel freq.): up to 64 Mbps (18.8 to 19.3 GHz)
Estimated Aggregate Bandwidth: 144 Gbps
Estimated Subscriber Cost: competitive with terrestrial
First Satellite in Service: 2002 (288 LEO)
Full Constellation in Service: 2004

17. TRW Global EHS Satellite Network

Key Investors: TRW
Number of Satellites Planned: 4 GEO + 15 MEO
Coverage:
Uplink Data Rate (channel freq.): N/A
Downlink Data Rate (channel freq.): N/A
Estimated Aggregate Bandwidth: 1.3 Tbps
Estimated Subscriber Cost: N/A
First Satellite in Service: 48 months after FCC license (GEO)
Full Constellation in Service: 6 years after FCC license

18. Virtual GEO/Virgo

Key Investors: Virtual GEO
Number of Satellites Planned: 15 quasi-GEO (high elliptical)
Coverage: worldwide
Uplink Data Rate (channel freq.): (14.0 to 14.5 GHz)
Downlink Data Rate (channel freq.): (11.2 to 12.7 GHz)
Estimated Aggregate Bandwidth: N/A
Estimated Subscriber Cost: N/A
First Satellite in Service: 2003
Full Constellation in Service: 2003

United States Senate
WASHINGTON, DC 20510

May 20, 1999

The Honorable Larry Irving
Administrator
The National Telecommunications and Information Administration
U.S. Department of Commerce
14th Street and Constitution Avenue, NW
Washington, D.C. 20230

The Honorable Wally Beyer
Administrator
The Rural Utility Service
U.S. Department of Agriculture
14th Street and Independence Avenue, SW
Washington, D.C. 20250

Dear Mr. Irving and Mr. Beyer:

We are writing to ask the National Telecommunications and Information Administration (NTIA) and the Rural Utility Service (RUS) to conduct a joint assessment of the availability of advanced telecommunications capability to all Americans, with a particular focus on rural and high cost areas, and provide us with recommendations to ensure ubiquitous deployment of advanced telecommunications capability to all Americans particularly in rural areas. This study should assess:

(1) the investment in telecommunications facilities with advanced capability in rural areas compared with non-rural areas, including an assessment of the various levels of capability being deployed under different technologies and the bandwidth capabilities of such deployment and whether or not comparable bandwidth is being deployed consistent with the objectives under Sec. 254(b))2) and (3) of the Communications Act and Sec. 707 of the Telecommunications Act;

(2) the availability of telecommunications backbone networks and "last mile" facilities with advanced capability in rural areas compared with advanced telecommunications backbone networks and last mile facilities in non-rural areas;

(3) the capability of various technological enhancements to existing wireline and wireless networks to provide last mile advanced telecommunications capability in rural areas;

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(4) the feasibility of various technological alternatives to provide last mile advanced telecommunications capability in rural areas;

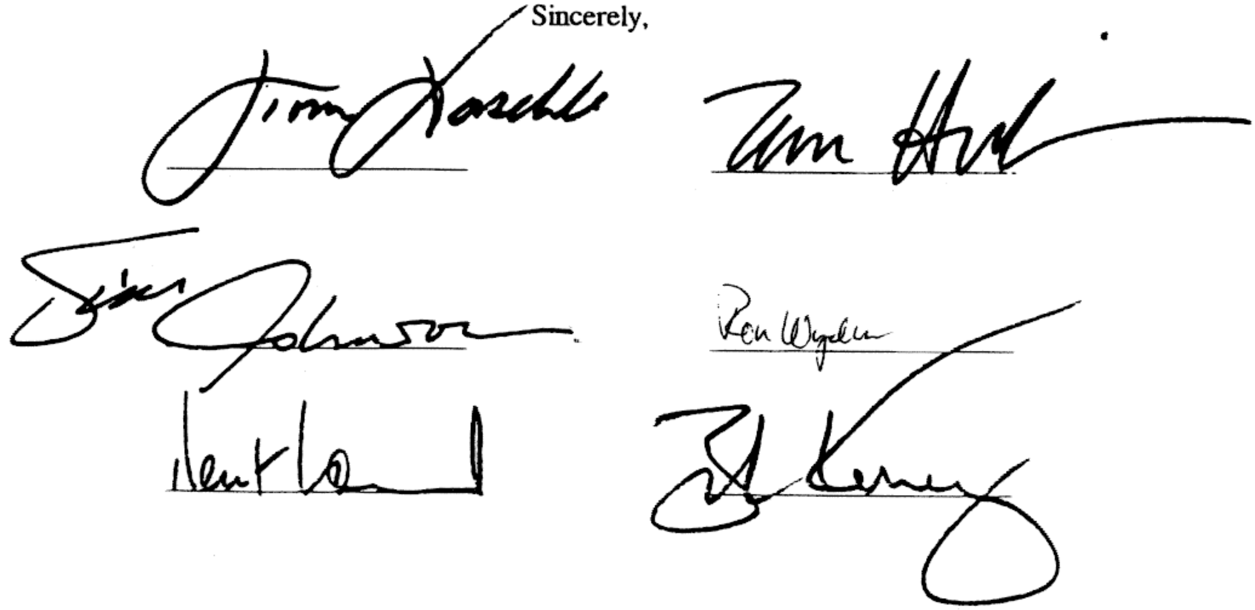
(5) the rate of deployment of advanced telecommunications capability in rural areas compared with the deployment of such capability in non-rural areas and identify specific geographic areas where advanced telecommunications capability is being deployed at a significantly lower rate than such services are being deployed elsewhere in the Nation; and

(5) the effectiveness of competition and universal service support mechanisms to promote the deployment of advanced telecommunications capability and the availability of advanced telecommunications services in rural areas.

If your assessment finds that deployment of advanced telecommunications capability and services is not occurring in rural areas at a reasonably comparable pace as in non-rural areas, we would appreciate any recommendations, either legislative and non-legislative (including regulatory) that could improve deployment of advanced telecommunications capability and the availability of advanced telecommunications services in rural areas.

We look forward to working with you on this important project.

Sincerely,



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Paul Wellstone

Patty Murray

Max Baucus

Byron L. Dorgan