BROADBAND: A 21st CENTURY TECHNOLOGY AND PRODUCTIVITY STRATEGY

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Over one hundred and fifty years ago, a new technology emerged that grabbed the imaginations of the public and the purse strings of investors. It was a technology that promised to bring people closer together and to greatly stimulate the economy of that time. In order to succeed, that new technology required that the land be crisscrossed with a network upon which news could be carried and goods could be traded.

Bankers funded hundreds of startup companies that were built to take advantage of the new network. Investors clamored to purchase shares at rapidly rising prices. And then, after little more than a decade of overbuilding the infrastructure, it all fell apart as shares plunged 85% and hundreds of businesses and banks went under.

The technology was steam-driven railroad and this is the story told in the May 13th issue of *Business Week*. The analogies to the Information Technology boom of the 1990s are unmistakable and the lessons are invaluable. But the most important part of the story is what happened after the railroad bubble burst.

Within two decades, railroads were carrying four times as many people as they had at the height of the boom. The tracks were cleared, leaving the most solid companies and the best of the rail technologies to survive. According to W. Brian Arthur, an economist at the Santa Fe Institute, the survivors then developed new strategies that resulted in the industry's greatest growth and had the greatest impact on business and society of that time.

We now find ourselves in the same situation that the railroads were in as they developed their new strategies, except the technology is now broadband. It is clear that broadband will revolutionize business and society in our time, just as the railroads did in theirs. But it is also a confusing time, as many different interests emerge with many different agendas. The issues to be faced are many and they are complex. For some, there will be no easy answers. But it is time for us to have a national strategy that addresses these issues in a coherent and comprehensive manner.

My staff has assembled this report over the past ten months with extensive input from industry, academia, and government. It was no small undertaking and I particularly thank Skip Watts and Chuck Ludlam of my office. While there have been numerous bills offered in Congress dealing with isolated components of broadband policy, this report is the first to identify the full range of issues that must be considered as part of a national broadband strategy designed to stimulate economic expansion.

As the first in a series of legislative initiatives, I will introduce the *National Broadband Strategy Act of 2002* next week. This bill highlights the need for a carefully planned national strategy to provide universal availability of broadband and to motivate research and advances in broadband applications and content. It calls upon the Administration to recommend a coherent, cross-agency national broadband strategy in a series of key government policy areas, to Congress.

I want to emphasize that while there is an ongoing competitive scramble to reach the lower broadband speeds, we need to also pay real attention to advanced broadband and to attaining those much higher speeds. The report's Executive Summary identifies four key elements that will be integral to advanced broadband deployment. The elements include an FCC regulatory plan, tax incentives, research on advanced infrastructure technology, and deployment of applications.

As with the railroads of the mid-1800s, broadband is now poised to whistle in a new period of economic growth. We must do all that we can to nurture this emerging technology and to stimulate the development of new killer applications in the fields of education, medicine, government, and science. Commerce and entertainment will not trail far behind. The tracks of rail are now the "pipes" of broadband.

JOSEPH I. LIEBERMAN
United States Senator

Broadband: A 21st Century Technology and Productivity Strategy

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Executive Summary

Broadband deployment must become a national priority. Major economic growth and productivity gains can be realized by making affordable high-speed broadband Internet connections – which are already enjoyed by many universities and large businesses – widely available to American homes, schools, and small businesses.

In a soft economic climate with limited prospects for near-term recovery, broadband deployment is a necessary condition for the restoration of capital spending in the information technology sector. Such investments were the critical drivers of the non-inflationary growth that characterized the late 1990s. Broadband, which can play a pivotal role in encouraging investments in information technology, has the potential to transform education, health care, government, entertainment, and commerce.

Of course, embracing broadband as a vehicle for economic growth raises the question, "How fast is fast enough for truly advanced emerging applications?" The telecom, cable, and satellite industries are now providing Internet access at speeds typically less than 1.5 megabits per second (Mbps). A review of existing and likely technologies, however, suggests that we have only achieved the first level of broadband speeds. On the foreseeable horizon are technologies that offer advanced broadband speeds of 10 Mbps in the near-term, and 100 Mbps in the medium-term. A national strategy needs to focus on this advanced broadband opportunity. Arguably, it will be at these advanced speed ranges that the greatest benefits from broadband will come.

A successful strategy to accelerate the deployment of broadband will lead to immeasurable benefits to the quality of life and economy of the American people. But a successful strategy must encompass various issues in a comprehensive and coherent manner, and the debate must not become mired in any one debate. What we need is a sensible, intelligent approach that addresses the full range of issues within the context of an interrelated framework, not the piecemeal process that has brought us to the present confusion and controversies.

This strategy must recognize a truth that sometimes becomes lost in the multiplicity of debates over such issues as the regulation of telephone and cable companies. What is overlooked – and must be recognized – is that <u>demand</u> will drive the next phase of broadband expansion. Strong demand from consumers, smaller businesses, and even big businesses that currently have high-speed Internet connectivity, will produce a cycle of innovation and growth. But demand, in turn, requires that applications of real value be developed. It requires, in other words, "killer applications" that justify, in the minds of consumers, the price of progressively faster broadband connections.

The private sector will need to invest hundreds of billions of dollars before widespread broadband access becomes a reality. Government nevertheless has an important role to play as broadband suppliers face novel challenges in the areas of Internet privacy, security, spam, copyright protection, spectrum allocation, and rights-of-way. It is vital that, in these and other areas, government remain "technology-neutral" and that competition between the delivery technologies exist alongside competition within the technologies. This will allow the best and most cost-effective delivery systems to emerge, meeting the varied needs of different people and different regions across this diverse country.

There are, however, many ways that government, through a national strategy, can accelerate the life cycle of development and competition for emerging broadband technologies. It can do so by stimulating both the demand and supply side of broadband deployment. On the demand side, government should lead the way in generating demand by expanding e-government services to the public and to businesses, and by supporting the development of broadband tools for e-education and e-healthcare. E-entertainment and e-commerce will be quick to take advantage of the expanded services, and renewed economic growth will surely follow. On the supply side, government can consider such tools as tax credits, loans, and grants for a wide variety of research, deployment, and broadband utilization activities.

As the first in a series of legislative initiatives, Senator Lieberman will introduce the *National Broadband Strategy Act of 2002*. This bill highlights the need for a coherent and comprehensive national strategy for providing widespread availability of broadband and for motivating research and advances in broadband applications and content. Because broadband implementation has been piecemeal, and stalled in significant part because numerous government agencies have failed to act quickly in deciding a wide range of broadband issues now pending before them, the bill calls upon the Administration to recommend a coherent, cross-agency national broadband strategy in a series of key government policy areas.

Parallel to that, and focusing on how we will get to truly advanced broadband speeds (in the range of 10 Mbps and 100 Mbps), Senator Lieberman will introduce over the next few months a series of substantive pieces of legislation addressing four key elements integral to a national strategy for advanced broadband deployment. The key elements are:

1. FCC REGULATORY FRAMEWORK: Direct the FCC to explore all of the broadband deployment and delivery technology options to enable us to reach advanced broadband speeds. Retaining technological neutrality, the FCC will be asked to develop the regulatory framework to enable and implement a plan to deploy this advanced Internet capability.

2. TAX CREDITS: Establish tax credits and incentives for a range of advanced broadband deployment and broadband utilization efforts. These could include credits for infrastructure deployment, equipment implementation, employee utilization, installation in atypical settings, and innovative applications.

3. ADVANCED INFRASTRUCTURE R&D: Ensure that fundamental R&D issues are tackled in a coordinated manner to overcome the scientific and technological barriers to advanced widespread broadband deployment. The U.S. has already established successful interagency and interdisciplinary initiatives under the National Information Technology Research & Development Program to advance critical IT technologies. We must leverage our existing expertise in these programs

to resolve fundamental obstacles to effective broadband deployment and hasten the next generation of technologies. A cooperative R&D program, including government, industry and universities, will be critical to advanced broadband.

4. APPLICATION R&D AND DEPLOYMENT: Require federal agencies to undertake R&D and promote the development and availability of major applications in areas where government plays a central role, including e-education, e-medicine, e-government, e-science and homeland security. This could stimulate demand for broadband and promote bridging of the digital divide consistent with the missions of government agencies. And the government should lead by example in moving to expand opportunities for broadband-based e-commerce in federal procurement, bidding, and contracting.

While time and technology will not stop, and our nation's eventual transformation into a broadband society will occur regardless of what steps are taken today, it is ours to choose whether we will be dragged into the next digital age resisting change, or whether we lead others into a new era of economic promise. If we are to take control of our future, we must begin by harnessing the power of broadband as a necessary tool for navigating a world increasingly defined by the speed with which information changes and grows.

I. INTRODUCTION

In developing a plan to revive the economy, the focus should be on fostering a long-term investment and growth strategy, and not solely on stimulating consumption. The critical issue is whether or not it is possible to restore productivity gains to the levels seen in the late 1990s, which resulted from the unprecedented degree of investing in information and communications technology (ICT, or simply, IT). It is the precipitous decline in these investments that plunged the economy into recession prior to September 11. In order to regain the vibrant growth in productivity, the focus of any effort needs to be on stimulating resurgence in these investments. If this course is followed, a recovery is likely and favors long-term economic prospects.

To restore IT investments and productivity growth, making affordable high-speed broadband Internet connections available to all American homes and small businesses should be adopted as a national priority. Broadband is a high-speed, "always-on," Internet connection with applications for voice, data, graphics, and video, which will revolutionize many aspects of our lives at home, school, and work. This technology will transform education, health care, government, and commerce. A successful strategy to speed the deployment of broadband access will provide immeasurable benefits to the quality of life and economy of the American people.

A consensus is developing around the importance of this issue. On January 15, 2002, TechNet, a national network of three hundred senior executives from large and small technology firms, venture capital firms, and investment banks, proposed the "Broadband 2010" initiative. A copy of TechNet's proposal can be found at **http://www.technet.org/issues/updates/2002-01-15.69.html.** The proposal outlines six basic principles that TechNet believes should guide a broadband deployment strategy.

In May 2002, the Information Technology Industry Council (ITIC) and the National Federation of Independent Business (NFIB) wrote to congressional leaders, urging action on their 10-point agenda to accelerate the spread of broadband services. Their agenda can be found at **http://www.itic.org/policy/brdbnd_020502.pdf**. Tax credits and accelerated depreciation for IT equipment are among the items on their wish list. The ITIC and the NFIB intend to track progress on the agenda items with a "broadband scorecard."

Other groups have outlined principles for broadband deployment as well. They include the Information Technology Association of America (ITAA), the Computer Systems Policy Project (CSPP), the Software Information Industry Association (SIIA), and AeA (formerly, the American Electronics Association).

Members of both the House and the Senate have discussed the need for a national broadband policy. Democratic House Leader Dick Gephardt has stated, "We need to make broadband technology a national priority. By the end of the decade, we should make real broadband available to all Americans at an affordable price." Moreover, Senate Majority Leader Tom Daschle's call for "making broadband Internet access as universal as telephone service" further reinforces the need for a national broadband policy that will bring the life-enhancing applications of high-speed services to all Americans.

There is a compelling rationale for setting this priority and outlining the policy options that should be considered. It is time to move beyond goals and principles to focus on the specific options for action. As this review will show, the range of options, and their complexity of such options, will require that both the Administration and the Congress devote considerable efforts to this issue. Many different Congressional committees must adopt this priority to ensure that they are proceeding in a coordinated fashion. Additionally, the government needs to work closely with the private sector to guarantee that what is being done is constructive and effective. This statement on broadband represents only a "snapshot" of the rapidly evolving and changing issues as they stand today, but has been written with an eye towards developing long-term strategies.

To give impetus to this issue, Senator Lieberman is introducing the *National Broadband Strategy Act of 2002*. This bill will call upon the Administration to present its views on this matter, including its determination of the benefits that will arise from broadband deployment, the appropriate basis for government involvement at a policy level in facilitating and speeding this deployment, and recommendations for a national strategy to the Congress. In addition, Senator Lieberman plans to introduce legislation in coming months that addresses four key areas relevant to effective broadband deployment.

A. Productivity Growth – Today and in the Late 1990s

Productivity growth is the single most important measure of our national economic health. Its importance is invaluable given the economic principle of compounding. If productivity increases at a rate of 1.5% per year on average, the standard of living will double about every 46 years, or about every two generations. On the other hand, if productivity growth increases to 3% per year, the standard of living will double roughly every 23 years, or about every generation. Therefore, our long-term economic strategy must focus on productivity growth.

1. Today

In simple terms, productivity growth allows wages to rise without igniting inflation, thereby leading to improvements in living standards. The ideal situation occurs when productivity grows in conjunction with employment to result in structural productivity growth. In the early stages of recession recovery, however, productivity numbers can rise dramatically without a corresponding increase in employment because productivity is measured on a per capita basis. Companies that laid off workers and have underutilized production capacity can get by for a while with fewer workers doing more work, thereby raising the productivity per worker but not resulting in a surge in new jobs.

Unfortunately, the United States now finds itself in a time of cyclical productivity growth in which technology allows for the greater production of goods and services by fewer people in a time of sagging employment and economic downturn. During the first week of

May 2002, the Labor Department indicated that the unemployment rate jumped from 5.7% in March to 6% in April, which is the highest rate in nearly eight years. Many corporate chief executives are continuing to look for ways to make further cuts in employment. Therefore, the May 2002 figures touting an 8.6% increase in non-farm business productivity must be taken with a grain of salt with regard to how accurately they reflect real economic increases for the general public.

2. The Late 1990s

Productivity growth is what enabled U.S. workers to produce thirty times more in goods and services in 1999 than in 1899 with only a fivefold increase in workers. This resulted in a rise in the standard of living from $4,200 in 1899, to $33,740 in 1999 (both figures in 1999 dollars). Clearly, a growth in productivity results in a growth in wages, salaries, and profits.

The U.S. productivity gains of the late 1990s broke a 25-year trend. From the early 1970s to the mid-1990s, U.S. productivity grew sluggishly, at a rate of about 1.5%. However, during the final five years of the 20th Century, it grew at nearly double this rate. Annual productivity growth averaged 1.8% between 1951 and 2000. The increase averaged 2.2% between 1951-1973, but it fell to 0.7% between 1974-1981, 1.4% between 1982-1990, and 1.5% between 1991-1995. It rose back to 2.3% between 1996-2000.

There is a consensus that the productivity gains of the late 1990s arose from unprecedented investments in information and communications technology. Stephen Oliner and Daniel Sichel of the Federal Reserve Board found that roughly two-thirds of the rise in U.S. labor productivity growth came from the widespread adoption of IT. Many other economists have reached the same conclusion (DeLong, 2000 and 2001; Berry, 2000; Ferguson, 2001; Mandel, 2000; Nordhaus, 2001; Basu, Fernald and Shapiro, 2001; Jorgenson and Stiroh, 1999; Bosworth and Triplett, 2000; Duesterberg, 2000; and Vetrova, 2001).

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Computers have given us a million-fold increase in information processing power since the era of electro-mechanical calculators in the 1950s. Today's computers have 66,000 times the processing power of computers of 1975. A theory posited by Gordon Moore, a founder of the Intel Corporation, that has come to be known as "Moore's Law" states that computing power doubles every 18 months with a corresponding reduction in cost. Moore's Law has accurately described trends over the past four decades. In 1999, for example, a computer cost one ten thousandth of its cost in 1960. Assuming this theory continues to hold true over the next decade, computers will be 10 million times more powerful in ten years than they were in 1975, at no additional cost in real terms. Similar trends have been evident with respect to the capacities and costs of computer storage devices. Currently, the capacity of hard drives has been doubling about every nine months, while the average price per megabyte for hard drives has been declining (e.g., from $11.54 in 1988, to $0.02 in 1999).

The acceleration in U.S. economic growth after 1995 is well established, and the causal relationship between growth and IT investments is now transparent. In the Fall 2001 issue of *Issues in Science and Technology*, Dale Jorgenson discusses U.S. economic growth in the information age by stating that "we're beginning to understand what fueled growth in the late 1990s, but there is much remaining to be explored." Jorgenson contends that the most important contribution of IT occurs through faster growth of capital input, reflecting higher rates of investment. Jorgenson further contends that falling prices for IT equipment will continue to "provide incentives for the substitution of IT for other productive inputs…. The decline in IT prices will also serve as an indicator of ongoing productivity growth in IT-producing industries." The remaining issue is whether or not these trends in economic growth are sustainable.

There has been a huge increase in the productivity of IT companies; there has also been a dramatic increase in the demand for IT technology, along with a dramatic drop in the price of the technology. However, the ramifications of these changes for the users of IT technology have only just started to appear. Some argue that the extraordinary sales of computers and information technology equipment during the late 1990s will not reoccur because the Internet and associated communications networks are largely in place. But this will not be the case as new and more powerful user applications evolve and as barriers to the "last mile" network connections to consumers are brought down.

B. <u>IT Investment Downturn</u>

With the 2001 economic downturn, investment in IT equipment and software also fell dramatically. Investment in information processing equipment and software fell 16% in 2001 from an annual rate of $486.5 billion in the fourth quarter of 2000, to an annual rate of only $409.3 billion in the third quarter of this year. This is in stark contrast to the period from 1994 through 2000 when real private investment in information processing equipment and software grew at an average annual rate of 28%, and investment in computers and peripheral equipment grew at an astounding 113% average annual rate. This drop in investment has had a significant impact on the economy, subtracting more than 1 percentage point from annual GDP growth for this year.

In July 2001, the Wall Street Journal reported that venture investing in most parts of technology had dropped a full 50% over the previous year. And, as venture investors saw their returns suffer from the technology-stock malaise, they increasingly looked toward health care transactions in the hope of generating solid profits. Even with venture investing down, financiers continue to be receptive to putting money into health care and biotech start-ups.

Productivity growth in the late 1990s surged when businesses and consumers were regularly upgrading their technology to take advantage of faster, more efficient equipment and networks. Presently, businesses and consumers are holding onto their older equipment and software longer. This tendency to delay new technology investments likely contributed significantly, in an adverse way, to productivity growth. Some believe that many older computers were replaced toward the end of the 1990s as a form of insurance against potential "Year 2000" compliance problems. This may have created an artificial increase in sales for a period of one or more years that would logically be followed by a temporary slump in sales.

Increased security costs and decreased investment in IT equipment threaten to undermine productivity growth. In turn, this may have a severe detrimental effect on government revenues and the federal budget surplus. The acceleration in productivity growth rates witnessed in the mid-1990s was a major factor in raising estimates of the federal budget surplus. The economic assumptions that underlie the Congressional Budget Office's (CBO) budget forecast assume that productivity growth rates will remain at their higher, accelerated levels over the next decade. The portion of the productivity growth acceleration that is directly attributable to IT use and production accounts for over $900 billion, a large portion of the rapidly eroding federal budget surplus projections over the next decade. These projections are based on productivity growth rates that were achieved at a time when IT investments were growing steadily and did not take into account the economic costs of increased security. This is not the case today, as there are increased expenditures for the war on terrorism, domestic security, and other unforeseen costs.

C. Restoring Productivity Growth

In responding to this economic downturn, and in crafting a long-term strategy, the single most important economic challenge is restoring the productivity growth of the late 1990s. Much depends on meeting this goal, including generating the resources needed to fight and win a protracted and expensive war on terrorism, increasing the standard of living, and honoring commitments made to Social Security and Medicare beneficiaries. Productivity gains are necessary to restore the country's economic strength in order to meet these and other urgent priorities.

In testimony given before the House and Senate Budget Committees on January 23, 2002, CBO Director Dan L. Crippen presented a grim economic forecast. In contrast to last year's predictions of record surpluses, the CBO now projects total federal budget deficits of $21 billion for FY 2002, and $14 billion for FY 2003.

The current FY 2002 deficit projection of $21 billion constitutes a change of more than $300 billion from the CBO's January 2001 projection of a $313 billion surplus. Crippen told Congress that more than 70% of this reduction results from a weak economy and technical factors, both of which have considerably lowered the revenues expected for FY 2002 and 2003.

Administration fiscal policies have exacerbated the situation, even as we need to prepare now for the retirement of the Baby Boomer generation. If nothing is done regarding

Social Security, estimates predict that by 2030, the annual cash deficit in Social Security will reach $814 billion in 1999 dollars. Approximately $7.4 trillion in Social Security obligations are coming due and the fiscal house needs to be in order, hopefully with a zero national debt, when these obligations must be paid. Productivity gains and corresponding growth are critical ways of tackling that problem, and if productivity rates do not return to the levels of the late 1990s, this problem will continue to worsen.

A key element of an effective framework to regain the surge in productivity of the late 1990s is to focus on deployment of high-speed broadband Internet access. Of course, embracing broadband as a vehicle for economic growth raises the question, "How fast is fast enough for truly advanced emerging applications?" The telecom, cable, and satellite industries are now providing Internet access at speeds typically less than 1.5 megabits per second (Mbps).

A review of existing and likely technologies, however, suggests that we have only achieved the first level of broadband speeds. On the technological horizon are technologies that offer advanced broadband speeds of 5 to 10 Mbps in the near-term, and 100 Mpbs in the longer-term. A national strategy needs to focus on this advanced broadband opportunity. A national strategy needs to focus on this advanced broadband opportunity. Arguably, it will be at these advanced speed ranges that the biggest benefits from broadband will come. Government must have differing levels of involvement at the different stages. More intense government involvement will be necessary, supporting and promoting research and development of advanced broadband.

II. BROADBAND TECHNOLOGY

Over time, all Americans will grow to understand the concept of broadband, but now it is a term as obscure as the word "Internet" was in 1990. Today, everyone knows what the Internet is and has seen some of the ways that it enhances everyday life. The word "broadband" refers to the carrying capacity – the speed and the quality – of what the Internet can carry. It is like the difference between the word "car" and the word "NASCAR."

This paper outlines the various ways in which the Internet is carried and delivered, as well as the issues of speed and quality. It also describes how improving the speed and quality of the Internet can change our lives and play a major role in restoring the productivity gains of the late 1990s.

A. <u>History of the Internet</u>

The origin of the Internet can be traced back to 1969, when the Department of Defense's Advanced Research Projects Agency (ARPA) developed the networking capabilities of computer systems. Initially, only a few universities participated in the "DARPA-net" project. Over time, participation increased nationwide as the limitless possibilities arising from information networks were realized. Internet pioneer and founder of 3Com Corporation, Robert Metcalfe, once stated that the usefulness of a network can be determined by squaring the number of users on the network. Commonly known as

"Metcalfe's Law," this principle of exponential growth in network utility has proven itself to be true over time, as the Internet has expanded from being a loosely connected system of university research facilities to serving as the global standard for communication, business relations, and information gathering.

The ability to effectively use the Internet depends upon the speed of the connection between a remote computer and a server. Phone lines acted as the original means of data transference, and dial-up technology remains as the most common form of Internet connection. When use of the Internet became widespread in the mid-1990s, 14.4 kilobits per second (kbps) dial-up modems were considered standard equipment for web access. Today, 56.6 kbps modems are the norm for standard telephone use. While a fourfold increase in connection speed is commendable, the speed of computer processors increased dramatically over the same time period, and Internet transmission speeds simply have not kept up with computer capabilities.

In accordance with Moore's Law, processing power appears to still double every eighteen months under conditions of declining unit cost. However, the accelerated growth curve for processing power is not paralleled in the realm of Internet access technology. Despite the evolution of new technologies enabling much faster connection speeds, phone lines are still considered sufficient to surf the Internet.

The ability to digitize information content, such as text, images, sounds, and video, is not only phenomenal but also essential for high-speed, high-quality Internet transmission of content. Digitizing content refers to converting information into a sequence of codes, comprised simply of a series of 1's and 0's, that are transmitted as signals that are turned on and off in rapid succession. Older analog technologies, such as radio and television, provide content transmissions by modulating electromagnetic waves – a method that carries less information per second and permits degradation in quality during transmission. A standard VHS recording of an analog television broadcast, even with the best equipment, will not have the same quality as a digital recording of a digital broadcast. And digital recordings can be repeatedly reproduced with no degradation in quality.

B. Broadband Delivery Technologies Across the Last Mile

The difference between a phone line and a broadband connection is analogous to the difference between a garden hose and a fire hose. Although both provide the same function, a fire hose can deliver more water at much greater speeds than a garden hose. Providing the connection across the last mile from the Internet backbone to the home or small business user is crucial.

While the use of older telephone line technology for dial-up Internet connections slowly moves towards technological obsolescence, broadband technologies continue to evolve, offering a range of services and a variety of methods for high-speed Internet access. Innovation in these technologies should be encouraged without advocating one technology over another. Which particular technology will prove to be the most effective remains to be seen, and it is likely that different technologies will be appropriate in different contexts.

Even within the realm of broadband, all delivery technologies are not equal. There is a dichotomy that at times appears fuzzy. Today, most people have access to broadband through telephone DSL or cable modem. Some have access to broadband through variations of satellite service or through fixed wireless available in conjunction with other broadband connections. While considerably faster than the 56 kbps dial up modem, these still remain limited to speeds less than 1.5 Mbps. On the horizon are technologies that offer advanced broadband speeds of 5 to 10 Mbps in the near-term, and 100 Mpbs in the longer-term. Arguably, it will be at these advanced speed ranges that the greatest benefits from broadband will come.

To attain those higher speeds, one must connect directly to the fiber optic backbone, or receive it directly from a high-speed satellite connection. When not directly connected, the speed of the "last mile" link becomes the limiting factor. This is where advances are occurring and where more research is needed. Some of the developing bridging technologies include Wireless Fidelity (Wi-Fi) and Ultrawide band (UWB). Also being evaluated are electric power line technologies and flickering light technology. The currently prominent technologies are described below and include cable modem, digital subscriber line (DSL), fixed wireless, including the newer Wi-Fi equipment, Satellite, infrared, and fiber optic.

Figure 1 is a generalized representation of current broadband speeds and associated applications. The picture continues to change as the new technologies emerge. Noticeable in Figure 1 is the difference in speed between the low and mid range broadband and the 100 Mbps speeds of the future.

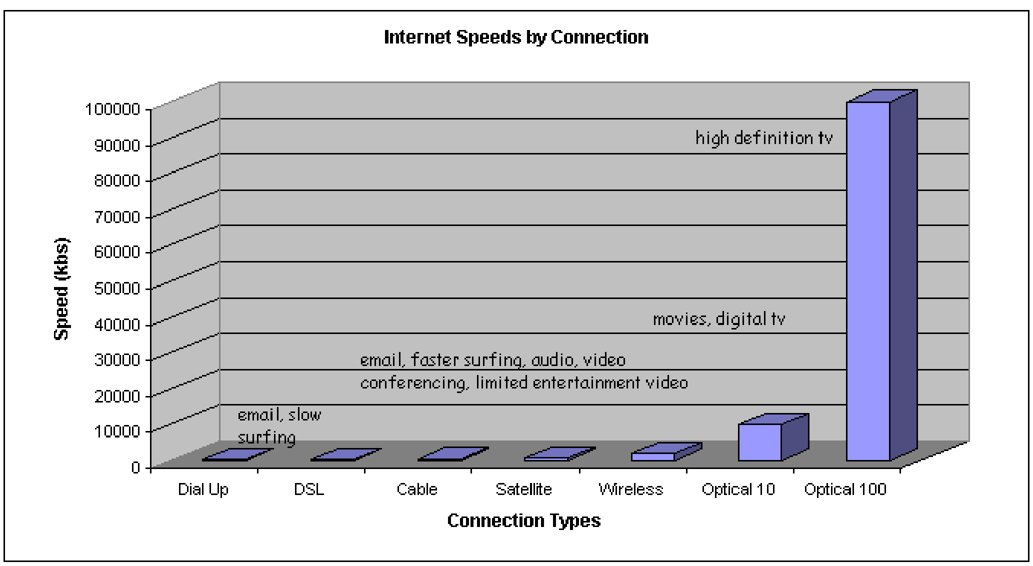

Figure 1. Generalized representation of current ranges in Internet speeds and applications.

1. Current Technologies (under 1.5 Mbps speed)

a. Cable Modem

The most common type of broadband delivery service is the cable modem, which is offered by cable TV companies such as Comcast, Cox, Time Warner, AT&T, and Charter. The nearly 7.6 million people who subscribe to this service can access the Internet at speeds of up to 5 megabits per second (Mbps), which is nearly one hundred times faster than a standard 56 kbps dial-up modem. The number of cable modem subscribers is expected to reach over fifteen million by the year 2005 according to the Yankee Group. Monthly fees range from $30-$50, with initial set-up costs of around $100. Cable modem services have long been favored by consumers interested in downloading music and video off the Internet due to this method's consistently high connection speeds, although service can be slowed when a large number of users are online at the same time.

Cable technology is also being offered by cable "overbuilders" such as RCN of Washington DC and Gemini Broadband Networks of Connecticut. A cable overbuilder is a company that builds a second cable TV system into an area to compete with the first. Some of these facilities-based providers are offering state-of-the-art cable modem services, while providing cable TV and phone service over the same cable. Faster speeds and lower costs make the future prospects for this broadband technology appear bright, though current market penetration remains small.

b. Digital Subscriber Line (DSL)

Digital Subscriber Line or DSL services rely on the use of telephone lines, but require a special modem that splits the data into three channels. Importantly, DSL permits the use of a single phone line for both voice and Internet access simultaneously.

Speeds between 144 kbps and 1.1 Mbps are typical for DSL connections. Monthly fees average $45, with start-up fees ranging between $0-$150. Approximately 3.3 million people currently subscribe to this type of service, which is offered primarily by the Baby Bells. It is projected that 10.5 million people will subscribe to DSL service by 2005.

The major technical limitation of DSL is geographic in nature. Due to limitations of the copper wire medium, the service is generally available only to customers living within a three-mile radius of the phone company's central office.

c. Fixed Wireless

A third broadband technology is referred to as "fixed wireless" and offers average speeds of 1.2 Mbps. Signals are sent out from a central base station to a small dish installed on the roofs of houses that lie within a 35-mile radius. For example, the Sears Tower in Chicago broadcasts signals to areas that have a clear line of sight to the tower, as geographic features are known to hinder reception.

At this time, WorldCom and Sprint are the main providers of this service, with slightly over 400,000 customers nationwide. This number could reach over 5 million in the next four years according to estimates made by the Strategis Group.

2. Advanced Broadband (10 to 100 Mbps speed)

a. Wireless Fidelity (Wi-Fi)

A new kind of wireless connection to cross the last mile is making news and raising eyebrows among the established providers of broadband. Called Wireless Fidelity, or Wi-Fi for short, it allows users to connect a $175 base station to the high-speed Internet backbone and share that connection with others in a building, small neighborhood, or nearby park. The connection, from base station to computer, is made through a $50 antenna snapped into the user's computer. Networks are popping up across the country in airports, highway rest areas, cafes, and parks. Wi-Fi network speeds can reach 11 Mbps.

Users might pay from $20 to $75 a month for access, although security on the systems remains an issue and some users cruise around looking for systems to log onto without permission. In addition, the 802.11 unlicensed spectrum that Wi-Fi uses could force crowding. Research is needed on chips, software, and protocols to preempt interference issues.

Although some technical challenges must still be resolved, Wi-Fi is here to stay. The wireless mobility that it gives to users has tremendous potential. For example, it will reshape the workplace and boost productivity. Workers can take laptops to meetings, to lunch, the stockroom, and even outside into the sunshine. Employees with Wi-Fi now stay on line and stay in touch, sending memos, documents, and messages. Real-time decisions can be made during meetings by logging into the Web as questions arise. Some companies claim a 20% boost in productivity.

The same benefits will accrue to users in educational settings. Students can access the Internet from anywhere in a library, or at their desk in class, or at the lab table during science class. And, this technology could help solve the broadband rural access problem, with rural networks using connections off a fiber optic pipe, if available, or off a satellite - earth station connection if necessary.

But for Wi-Fi to evolve, the FCC must continue to keep the 802.11 band it operates on unregulated. Trying to license it now would be like the FCC trying to license the Internet in 1995 – it could block the evolution. Wi-Fi is poised to become a major player, alongside DSL and cable modem, in broadband delivery.

b. Satellite

Satellite broadband is another type of wireless service, but the data are transmitted from a satellite in space rather a local base station. Direct Broadcast Satellite (DBS) services are already provided to over 16 million homes and 42 million viewers at speeds of around

500 kbps. Over 7.5 million of these homes and 19.5 million of these viewers are in rural or underserved areas. A number of satellite companies, such as StarBand, provide high-speed Internet services today, with more sophisticated broadband services currently under development. DirecTV and EchoStar have just over 100,000 current subscribers to their Direct Broadcast Satellite Broadband service. They hope to have 4.5 million customers by 2005, when two additional types of satellite broadband will be available: Geostationary Earth Orbit and Low Earth Orbit satellite technologies.

c. Infrared and Fiber Optic

Two emerging broadband technologies offer great potential for faster Internet connections. Infrared technology will offer speeds of 10-15 Mbps, but is limited by the need for unobstructed space between the computer and the infrared transmitter. Fiber optic cable Internet connection services claim to provide service at speeds of up to one million Mbps. Fiber optic services, which are laid directly into the home, are currently available in a few areas, such as some Washington, D.C. residential neighborhoods and sections of Palo Alto, California. However, this technology remains very expensive.

Experts agree that these technologies could eventually render dial-up modems and slower broadband technologies obsolete because of the vast array of new services that they could provide, especially as new content options evolve.

3. Neutrality Toward Technologies

Government must remain neutral in regard to the different technologies, in order to provide an environment conducive to the development and growth of the most effective and productive technologies. Consumers will ultimately decide which connection types and equipment provide the services that they want, at prices they are willing to pay. The full potential of each of the various technologies is yet to be realized, and it would be wasteful to deny equal opportunities to all. Industry groups, including TechNet, ITAA, and AeA, strongly support this position. A level playing field should be maintained to ensure that the best technologies will survive.

C. U.S. Broadband Deployment Rate

It can take a long time for new consumer products to penetrate a majority of the market. A comparison of the goods that defined the 20th century, namely, electricity, telephone, automobile, radio, television, and videocassette recorders, reflect long incubation periods for all of them. The invention of the automobile in 1886 sparked initial enthusiasm, but it was 90 years before cars were used by 60% of consumers. Alexander Graham Bell's telephone of 1876 took over 70 years to reach 60% usage. Electricity, universally considered a staple of contemporary life, required more than 50 years after its introduction in 1873 to the 60% usage milestone.

From another perspective, economists Michael Cox and Richard Alm point out that it took automobiles 35 years for 25% of the U.S. population to own one, 39 years for the same percentage to have a telephone, and 23 years to own a radio. In contrast, it took only 18 years for 25% of the population to buy a desktop computer, 13 years to buy a cell phone, and just 7 years to get onto the Internet. The dynamics of technology adoption are changing.

Considering that broadband Internet access technology is relatively new, some may accept the rate of its adoption by consumers as normal. Of course, there is no logic to measuring deployment of one type of new technology with deployment of another. There is no reason why transportation, entertainment, or communication precedents should set the standard for deployment. Broadband carries its own values and benefits.

It is also important to recognize that broadband is a substitution technology that improves an existing service, unlike telephone and the VCR, which first had to define their roles in society. The process of bandwidth upgrading should, in theory, be much easier to implement than the introduction of a whole new technology because the underlying Internet technology has been so widely accepted. In addition, the potential spin offs and multiplier effects of broadband deployment are obvious. The value of the Internet to communications, research, business, and entertainment has long been established. Thus, the market penetration of a superior Internet technology in place of dial-up services is not analogous to the early development stages of the telephone, TV, and VCR.

The move from dial-up to broadband services could be compared to the DVD player and its growth over the VCR as the premier vehicle for home entertainment. The Consumer Electronics Association identified the DVD player as "the fastest selling consumer electronics product of all time." Despite an initial lack of software titles, DVD technology was quickly adopted by the mass public, eager to embrace its high-quality video resolution and audio capacity, as well as its enhanced storage and reproduction capabilities. Only four years after its introduction, DVD technology now claims penetration into one-third of all U.S. households.

The IT industry has rightfully anticipated that broadband would enjoy a similarly fast growth curve. But before a high level of demand can be reached, both popular applications and vital applications must continue to be developed and speeds capable of providing DVD-quality digital service, as a minimum, must be attained for the general consumer. The technology is not yet there. Speeds of 10 Mbps will place the technology into the right range of bandwidth; speeds of 100 Mbps would be better yet.

Clearly, deployment of high-speed Internet service is moving more slowly than anticipated. Reasons for this include not just the lack of killer applications, but also the complex tangle of legislation governing technologies converging from totally different regulatory realms. Government must play a role by providing a regulatory environment in which the best technologies will emerge based on their own merits and on consumer satisfaction as well as principles of fair competition.

The government can also lead by setting examples in key application areas where it plays a major role, such as education and medicine. It should implement broadband applications related to e-government services to citizens, including motor vehicle licensing, tax submissions, title and deed transfers, and birth and death certifications. By developing and deploying applications in education, health, and government, useful services will not only be provided in increasingly efficient ways, but will also spur on more growth and deployment of broadband infrastructure. Entertainment applications and e-commerce applications will without doubt follow very closely behind, creating significant economic growth.

D. Worldwide Broadband Deployment Rate

The question of whether U.S. deployment of broadband technology is proceeding at an adequate pace can best be determined by comparison to the rate of deployment in other countries. The international marketplace includes fierce competitors. Performance can no longer be judged without referring to international benchmarks.

The United States is considered to be the world leader in the development and commercialization of new innovations. It currently leads the world in home Internet access, based on the number of users. However, the United States lags far behind other countries in terms of broadband use. An October 2001 report on the development of broadband access in Organization for Economic Co-operation and Development (OECD) countries ranks the United States fourth, behind Korea, Canada, and Sweden, in broadband proliferation.

In Canada, the percentage of high-speed Internet users is twice that of U.S. subscribers, while Korea is more than quadruple with 38% of its population using high-speed Internet connections. The United States must reevaluate its strategy on broadband deployment in order to secure the successful growth and implementation of a new generation of Internet technologies and services, as well as to maintain America's status as a world power in the industry. Without a strong domestic market to sell into, the United States risks its IT innovation leadership.

The common element that accounts for superior success in these other countries is market penetration. Korean, Canadian, and Swedish markets are all characterized by strong competition, encouraged by robust government strategies for broadband deployment. The three leaders have laid out plans for more than 90% penetration by the year 2004, and they appear to be on track to meet that goal. Those countries also benefit from smaller size, higher population densities, and, in some cases, public access to broadband in environments such as "internet cafes."

The American economy is presently in the midst of a recession, with some signs of the beginnings of a slow recovery. But to have a true recovery back to the strong growth of the 1990s, we need a robust IT sector, and broadband deployment is the key. A strong recovery can be stifled by a lack of broadband deployment. The only way to avoid declining growth is to institute a comprehensive national broadband strategy that ensures future American leadership in the IT industry.

III. APPLICATIONS OF BROADBAND – THE FUTURE

The issue is not simply one of deploying broadband infrastructure; applications must also be available to promote that deployment. In the not-too-distant future, society will depend heavily upon broadband for services in public health, education, and economic welfare, just as society currently depends on universal telephone service. For better or worse, the world is becoming a more crowded and more complicated place. More information needs to be sorted, evaluated, and distributed from increasing numbers of sources every year.

Additionally, broadband will prove to be vital in dealing with future terrorism and natural disaster events. It would enable health and medical information to be assembled and distributed widely and quickly. Communications during a crisis are crucial, and the diversity of broadband technologies can make information delivery not only fast, but also reliable. Even now, plans are developing to include broadband applications in local and regional emergency warning systems, so that emergency announcements will be delivered to cell phones, personal data assistants (PDAs), and email addresses.

Unfortunately, we cannot benefit from these applications if the broadband network itself does not exist. A classic "chicken-or-egg" problem undermines broadband deployment. Applications will be developed when the broadband network exists, and the broadband network will be built when the applications exist. Either the markets can sort this out, which will happen slowly, given some of the governmental regulations and competitive barriers, or policies on both the supply and demand sides can be adopted that will hasten the deployment and use of the network.

Broadband applications are capable of revitalizing the long-term economic outlook and solving countless problems for average Americans. The range of applications falls into the categories of *e-education, e-health, e-commerce, e-government, and e-entertainment*. Table 1 lists many potential applications. Economists Robert Crandall and Chuck Jackson estimate that these benefits could easily amount to hundreds of billions of dollars in benefits to U.S. consumers and companies.

- In the area of e-education, two-way high-speed connections will allow distance learning and online classrooms where teacher and student can see and hear each other through their computers, even from home.

- In the area of e-health, medical personnel and patients will interact one-on-one, and even patient health and vital signs will easily be monitored and evaluated from a distance.

- In the area of e-commerce, customers and sales people will interact with each other visually in real time, and sales transactions will be handled simply, safely, and expediently.

- With respect to e-government, citizens will access vital information, make inquiries, and file important documents. Even voting could become a simple process, eliminating those unsavory "hanging chads."

- The e-entertainment potential for leisure time appears to be the most universally exciting application for the public, regardless of other interests and activities. As copyright and protection issues are resolved, movies and music "on demand" will take hold. Online gaming is already popular among younger demographics and higher speeds will allow more complex interactive games involving greater numbers of people who are farther apart.

The "always-on" connection will make it possible to monitor home security, check on infants and the elderly, and automate common household tasks. Bundled services, such as cable television, voice communication, data transfer, and audio/video on demand, can all be carried on a single line. Indeed, the most vital and most useful applications for broadband are likely yet to be even imagined. The functionality of telephones, televisions, computers, and numerous other devices will continue to merge. Technology is already in the early stages of providing capabilities, including making phone calls on your TV, sending emails from your telephone, and watching videos on your computer. Broadband will be able to provide such services universally for everyone and be practical to use.

Experience with significant improvements in similar networking infrastructures, like telegraph, railroads, and interstate highways, indicate that the benefits will be far greater than we expect and will result from applications that cannot be anticipated. For example, the networking of railroads spurred the economic growth of a continent, the westward movement of agriculture, and rapid growth in manufacturing. Moreover, when simple "point and click" mouse interfaces were publicly introduced in 1993 to replace typed commands for interacting with computers, the profound increase in computer use and productivity was astounding. Affordable, easy-to-use broadband access will have the same kind of effect.

If broadband enhances the efficiency of wholesale and retail sales over time by even just a conservative 3%, annual gains would amount to $58 billion according to Crandall and Jackson. Another significant gain can be realized by using broadband capabilities to allow more people to work at home for a greater portion of their time. The telecommuting potential of broadband will reduce traffic, which is significant given that even small reductions would generate large savings. According to Crandall and Jackson, reducing rush hour traffic by 1% in the Atlanta area would save nearly $100 million alone. Audio and video conferencing will lead to less congestion, less business travel, and fewer business interruptions. Following the events of September 11, business video conferencing drastically increased, allowing critical economic operations to continue even in crisis. The downside is that only some businesses were able to benefit from that capability.

Broadband connectivity will extend to travel in many ways. We can begin to envision just one application through the OnStar Service example. Combining Global Positioning Satellite (GPS) technology with wireless phone service, OnStar can guide drivers through unknown cities and locate facilities such as gas stations or restaurants as needed. If a person has locked her keys inside her car, it can send a signal to unlock the car with a simple phone call. Finally, the service is able to notify authorities of a probable accident, the location, and vehicle description when the airbags on a properly equipped vehicle are deployed. In the near future, "smart" highways will transmit information to drivers in their vehicles to inform them of traffic and weather conditions so that real-time databases can warn of danger, recommend alternate routes, and guide drivers along them with verbal commands. Even today, wireless high-speed Internet connections are available in many airports, as well as at some truck stops in Florida, for use by travelers having the proper receiving systems in their laptop computers or PDAs.

Demand in this case is a function of available content and applications. Content and applications tend to lag behind the development of new hardware and network systems. This chicken-or-egg dilemma also occurred in the 1960s with the advent of an earlier information technology, color TV. Networks did not feel that they could produce color programs until people had color TVs, but people were not inclined to buy color TVs unless there were color programs to watch.

The development of wondrous and valuable content and applications for broadband will doubtless occur with time. Content development will accelerate as the broadband network expands. Clearly, we need richer content and sector-by-sector innovation in order to realize the full power of broadband.

Table 1. An overview of broadband applications

e-education	• Distance-learning for individuals or large groups • Teleconferencing to students' homes, not just education centers • Electronic delivery of assignments and projects to instructors • Individualized help sessions and tutoring • Online learning exercises and activities • Virtual field trips
e-medicine	• Remote monitoring of patient vitals • Virtual physical examinations • Remote consultations between health professionals • Remote consultations between patients and physicians • Public health training programs • Automated patient inquiry handling
e-government	• Filing and retrieving of health certificates, licenses, titles, deeds • Motor vehicle registration • Dissemination of emergency information related to terrorism, natural disasters • Virtual court appearances for attorneys • Voter registration and online voting • Automated citizen inquiries, services to remote areas
e-commerce	• Virtual catalogs and showrooms • Sales transactions, money transfers • Customer inquiries and support • Automated product diagnostics and service • Telecommuting
e-entertainment	• Video phone • Digital-quality radio and television programming • Audio files • Movie files, movies-on-demand • Online computer game networks •

IV. THE TELECOMMUNICATIONS ACT FRAMEWORK

The future of high-speed telecommunications continues to evolve from a complicated history of regulations controlling the separate, but increasingly linked, communications technologies of common telephone carriers, cable television service, and more recently, the Internet. Each service has experienced its own rounds of legislation and regulation, influenced most recently by the *Telecommunications Act of 1996*. The various services are now headed on a collision course with each other, as the distinctions between them become increasingly blurred.

A. Common Carriers (Telephony)

The enactment of the *Telecommunications Act of 1996* came in response to the growth of competition in long-distance telephone markets. It began as a collaborative undertaking by federal and state regulators to dismantle the monopoly held by the Bell operating companies and other incumbent telephone companies over local telecommunications markets (telephony). These actions have not resulted in the quick deregulation of the industry that many had anticipated.

In 1999, the Federal Communications Commission (FCC) adopted rules for the gradual deregulation of the incumbent telephone companies' provision of local service used for interstate communications. Prices were to be deregulated when there was evidence that the incumbent could not exercise market power, but what criteria should be used remains a controversial subject. Incumbents have been dissatisfied with delays to their entry into long-distance. Competitors to the incumbents have maintained that the criteria used by the FCC do not provide an accurate picture of the availability of alternative providers of local services. They further claim that the FCC policies would permit the incumbents to preserve their monopoly control over local markets by granting them substantial pricing flexibility.

The FCC and state regulatory commissions moved aggressively to require local incumbents to open their markets. Incumbent local exchange carriers (ILECs) still have overwhelming market shares, particularly among residential customers, thanks to their initial monopoly position and the economies of scale and scope that are difficult to overcome.

The *Telecommunications Act of 1996* mandated that incumbents offer competitive local exchange carriers (CLECs) access to unbundled network elements at reasonable rates. However, since ILECs continue to control well over 90% of local market revenues and customers, they remain subject to comprehensive price regulation at both the federal and state level. CLECs, lacking market power, generally are not subject to such price regulation, but most have gone out of business in the past 24 months.

In the meantime, there has been horizontal consolidation among telephone companies, plus vertical integration of such companies. For example, Qwest acquired US West; NYNEX merged with Bell Atlantic, which then merged with GTE to become Verizon; SBC acquired Pacific Telesis and Ameritech; MCI merged with WorldCom, which also merged with UUNet; and AT&T acquired TCI and other cable interests.

Thus, although the *Telecommunications Act of 1996* eliminated legal barriers to entry in those states where barriers had existed, economic and technical barriers are coming down much more slowly if at all. Despite this, competitors have made some inroads among business customers in urban markets, and issues posed by open access in broadband have prompted some FCC initiatives.

B. Cable Television

The regulatory regime governing cable television systems is entirely different from the telephone common carrier scheme and it has a much shorter history. From its earliest days, when cable was used to provide television service in regions not reached by broadcast television, cable grew by providing an alternative to an existing entertainment and information service, namely, broadcast television, and faced initial deployment challenges. In light of this, cable operators were awarded regional monopolies by local governments, which they still maintain. Cable operators do not have to offer their transmission service to the public on a nondiscriminatory basis, unlike common carriers. Most importantly, cable systems maintain considerable control over the content that is transmitted over their distribution facilities. Unlike common carriers, they have asserted First Amendment rights with regard to the content they carry, and the courts continue to uphold that status.

Generally, cable operators are not required to offer access to their distribution system to enable other, unaffiliated, content providers to deliver their products to cable subscribers. However, many do so because they find that no single operator has enough high-quality content, though customer demand for additional content is high. Almost every system carries content like CNN, which is an AOL Time Warner service, and ESPN, which is owned by Disney-ABC. Nevertheless, the contrast between the relative freedom to control content and the obligations placed on common carriers naturally leads to the "open access" debates described below.

Cable television is subject to limited federal regulation. Under Title VI of the *Communications Act of 1934*, the basic tier of service, offering mostly local television signals, is subject to rate regulation pursuant to formulas prescribed by the FCC. Local authorities could regulate the price of the basic tier based on FCC regulations. The *Cable Act of 1992* added an effective competition component that allowed deregulation only in competitive situations. However, under the *Cable Act*, tracking and enforcing regulations for the cable industry became difficult and time-consuming. In the long run, it is not clear whether the regulation accomplished very much. However, it made cable network programming available to overbuilding by competitors. This allows competitors to build new systems and lay new cable and connections, thereby gaining access to the market. Furthermore, satellite services were offered at reasonable prices, spurring competition in video delivery.

The local regulation of cable systems generally occurs through franchise agreements executed with local authorities. They tend to run for one or more decades and are a source of revenue for the municipalities that issue them. As agreements come up for renewal, the new capabilities of cable systems to deliver advanced video and data services dominate the negotiations. Cable providers have been progressively upgrading their delivery systems beginning in the 1990s to incorporate hybrid fiber coaxial cable, which has increased system quality and capacity and facilitated Internet access. However, cable operators are not under legal obligation to perform the upgrades in order to offer broadband services, nor make access of the broadband capability available to other providers if they have upgrades in place. Hence, open access requirements have figured heavily in several franchise negotiations in some regions. Other elements of negotiation have included the establishment of minimum bandwidth, which translates directly into Internet speed for the user, and requirements to provide non-video services to public, education, and government needs much like the public access and government video channel requirements of today.

C. The Internet

Fear of regulation has always haunted the Internet even though it is generally considered to be "unregulated." Since the late 1990s, FCC representatives have written and spoken publicly about the benefits of a hands-off approach to the Internet. But the growth in public interest in the Internet and the growth of businesses associated with it continue to raise questions about prospects for government intervention, including regulation.

Anecdotal evidence suggests that the Internet was not recognized as a phenomenon or concern by most regulators until the 1990s when it became commercial, and even those actions that affected it then do not seem to have been framed with the Internet in mind. The early development of the Internet was affected in part by a simple desire to find relief from the high cost of dedicated leased line services for data transmission from the regulated telecommunications industry of the 1960s that constrained the early applications of data communications for government and the research community. In retrospect, a series of decisions by the FCC was a key enabler of the Internet, giving customers and providers the right to attach approved devices directly to the developing network and making dial-up access possible. The common carrier regulations also have been important in enabling the Internet to allow entry by many Internet service providers (ISP's). The common carrier rules mandate nondiscriminatory access and reasonable rates to both the dial-up lines used by the consumers and the telephone network dedicated lines used by many ISP's.

Another enabler came in 1980 when the FCC ruled that firms that use basic telecommunications services to provide an "enhanced" service of some kind (e.g., information delivery) were not engaged in providing a "basic" common carrier telecommunications service, such as local telephone. Enhanced services were determined to lay outside the direct jurisdiction of the FCC or state regulatory commissions. That decision nurtured commercial value-added networks, bulletin boards, database services, and other data communications services in the 1970s and 1980s, and provided the training grounds for the more open Internet and ISPs of the 1990s.

The *Telecommunications Act of 1996*, Section 271, prohibited the former Regional Bell Operating Companies (RBOCs) from offering interLATA services, which include both long-distance telephony and Internet transmission services, in those states where they also provide local telephone service, until they have satisfied certain market-opening requirements. As a result, while these companies may operate dial-up and broadband ISPs, customers must obtain connectivity to the rest of the Internet through a regional or national ISP operated by another company. The situation is further complicated by the fact that almost all Internet communications occur across state lines and may or may not include voice transmissions.

The *Telecommunications Act of 1996* had another consequence that has been important for the deployment of broadband Internet access. Because the Act required the ILECs to unbundle their circuits to CLECs, a new class of CLECs appeared that offered data rather than voice over these circuits by means of DSL technology. This investment in DSL by competitive providers spurred investment in DSL by the ILECs, and thus appears to have driven the overall rate of DSL deployment. The present market downturn and other competitive pressures have placed many DSL providers at risk, but this does not minimize the contribution of competition in speeding deployment.

When incumbent providers offer DSL, the service comes under the historical purview of telecommunications regulation. When the incumbent providers sell an enhanced, non-regulated service over a basic service, the incumbent must provide the basic service to others as well. DSL is seen as a basic service, thus the ILECs must unbundle their service at two levels ("unbundling" refers to giving competitors the opportunities to use an incumbent's phone lines and hardware to deliver services). They must unbundle their physical capabilities so competitive DSL providers can implement DSL, and they must unbundle their DSL service so that competitive ISPs can sell Internet access over the incumbents' DSL service.

The result is that there has been inadvertent and indirect regulatory support for the Internet, at least until the late 1990s. Moreover, it unfolded without knowledge and foresight of the then fledgling and unnoticed broadband technologies. Broadband alters the picture and expands the potential for regulatory intervention in two ways. First, it involves different kinds of industries and technologies that provide Internet access under different regulatory regimes (e.g., cable-based versus telephone common carrier). Second, the distinctions between information services and telecommunications carriers blur as operators begin to integrate carrier and information service functions, a phenomenon that is becoming more prevalent in cable- and satellite-based broadband offerings.

D. <u>Results of the Telecommunications Act of 1996</u>

Much of the current policy framework relates to the *Telecommunications Act of 1996*, which was framed as a reform effort. Since its enactment and the continued unfolding of communications technology, there is increasing awareness of what it does and does not accomplish. It represents a major modification to the *Communications Act of 1934* and was shaped during the early to mid-1990s. The language of the Act indicates that its primary goals are to promote competition and reduce regulation as a means of increasing growth in telecommunications services and reducing prices.

Importantly, it was enacted at a time when the full appreciation of the key role that the Internet was to play did not yet exist in our society or in Washington. After all, 1996 was only one year after the 1995 commercialization of the Internet backbone and the introduction of browsers that helped to popularize the World Wide Web. No one could visualize or fully understand the sweeping change that was on the horizon. We are now on the verge of another quantum leap in Internet functionality.

The *Telecommunications Act of 1996* adjusted the relative roles of federal and state regulators by increasing the regulatory authority of the states. It sent mixed signals, though, on federal preemption of state regulators, and reinforced a kind of cooperative federalism. With respect to broadband in particular, the *Telecommunications Act of 1996* calls for the FCC and the states to encourage the deployment of advanced technologies for all Americans on a reasonable and timely basis. But what qualifies as "advanced," and who represents "all," and what are "reasonable" and "timely," are all a matter of debate. Indeed, the Act calls for access to advanced telecommunications and information services in rural and in high-cost areas to be "reasonably comparable" to that in urban areas in terms of price and quality. The wording appears to join unregulated information services with regulated telecommunications services, and what that implies for future policy remains yet to be seen.

V. THE STALEMATE IN BROADBAND DEPLOYMENT

A. Introduction

The telecommunications sector boomed in the mid-90s as governmental action promised to open traditional domestic and international markets that had been closed to competition and as technology invented new markets, including the commercial Internet and wireless services. Capital expenditures in telecom grew from $42 billion in 1996, to $82 billion in 1999. In 1999, telecom represented 16% of the capital expenditures of the S&P 500, and industry experts were predicting continued revenue growth for the sector of 15% annually.

The growth in capital expenditures proved to be unsustainable. Too much financial capital was chasing too few business opportunities through too many new and fast-growing companies, and far more fiber was deployed than was used. Projections of Internet growth turned out to be based on unsound models of advertising-based web services. The pricing of competitive, core telecommunications products, most notably long-distance services, became commoditized.

At the same time, barriers to demand, whether caused by the inability of new companies to deliver the services they promised or by incumbent carriers retaining very large market shares, limited the amount of traffic flowing onto newly-constructed broadband facilities. The problem became especially acute in the "last mile" used to span the distance between long-haul networks, on the one hand, and local businesses and residences, on the other. A bottleneck developed here that substantially hampered the ability of medium-sized businesses to obtain the productivity gains offered by broadband access, limited the success of new broadband providers, and, concomitantly, restricted the development and usage of new broadband applications.

The results of these developments became apparent during the second half of 2000, when the telecommunications sector began to wobble. Large long-distance companies experienced losses of market capitalization. Instead of increasing, capital spending was cut by 5% in 2000. New companies, such as Covad and PSI, declared bankruptcy. Providers of infrastructure, such as Lucent and Corning, found that customer orders simply stopped, leading to massive losses and layoffs. The related technology sector, which had grown closer to telecommunications as long-haul fiber networks carried increasing amounts of data traffic, suffered in telecom's wake. A telecom boom turned into a telecom recession.

In 2001, numerous firms sought bankruptcy protection. Among these were NorthPoint, Winstar, Teligent, 360networks, PSINet, Covad, Exodus Communications, and Excite@Home. Already in 2002, we have seen the collapse of Enron, which, among other things, was involved in the selling of broadband services. Global Crossing, another information technology company, is presently seeking bankruptcy protection.

At the end of August 2001, WorldCom announced that it would cut capital spending by 31% from 2001 to 2002. On the same day, Corning warned of the sudden slowing of orders. Nortel announced in early October 2001 that it would reduce the size of its workforce to less than half its total at the beginning of 2001. Furthermore, Nortel declared that its sales to the carriers that build long-haul networks declined from $2.1 billion in the fourth quarter of 2000, to only $300 million in the second quarter of 2001, a drop of 85%.

Experts now forecast that revenue growth for high-speed data lines will be only 15% in 2002, which is half of earlier estimates, and predict that capital spending for the industry as a whole will decline 20% next year. The industry faces continuing overcapacity, lowered demand, and wounded, if not bankrupt, competitors. Predictions for a recovery are increasingly focused on 2003.

At the same time, the market structure of the sector may soon undergo significant change. Each of the long-distance companies, most notably AT&T, is said to be a target for acquisition by a Bell operating company. The evolution of integrated carriers, which bundle long-distance telephone, broadband data services, and wireless communications, to a dominant position in the local telephony markets will inevitably create new policy debates and set loose a new set of market dynamics.

The bleak economic picture brings forth a dearth of potential public-policy alternatives. Past telecommunications initiatives, most notably, the *Telecommunications Act of 1996*, have failed to realize their objective of fostering an open and deregulated market for all forms of telecommunications. The task was harder than foreseen and, to a considerable degree, policy makers failed to understand the underlying economic incentives that would drive the behavior of industry players. Some of these policies are now verging on the irrelevant.

Despite the dramatic changes in the economy, the economic collapse of the telecom sector, and the visible failure of past policy initiatives, almost no attention has been paid in the last year to re-thinking the governmental policies towards telecommunications. A policy vacuum exists that is being filled almost exclusively by industry advocates, who are continuing to fight battles, under the *Telecommunications Act of 1996* for example, that have only limited connection with the future. At the same time, a growing number of policy makers, including some on Capitol Hill, are searching for solutions to the telecom recession. The net effect has been the development of an economic crisis in a critical sector that lacks the policy tools to fix it or the political willingness and awareness to explore new actions that address current, not past, issues.

B. <u>The "Last Mile" Bottleneck</u>

The "last mile" refers to that all-important final connection from the high-speed backbone to the final consumer. From the standpoint of the consumer, who gazes longingly toward the already-built broadband backbone, it might more appropriately be termed the "first mile." Those last few feet represent the most crucial and, in many ways, the most unpredictable connection in the system. Will consumers perceive a need? Will they accept the costs? Is connecting to the system relatively painless for the consumer in terms of hardware, software, and support?

During the last half of the 1990s, $90 billion was poured into building a cross-continental fiber-optic network. As of the start of 2002, less than 3% of this valuable high-speed backbone has been in use. The other 97% has remained "unlit" because only 10% of homes and small businesses have the ability to bridge that last mile. Use of the remainder has been stalled by the cost and difficulty of upgrading the local telephone connections, which are controlled by the Baby Bell survivors of the 1984 breakup of AT&T.

The commercialization of the Internet contributed greatly to the economic boom of the 1990s. Capital investment flowed not only into those new companies building the long-distance network, such as MCI and Sprint, but also into the creation of scores of new companies established to deliver broadband to homes and smaller businesses. But the entrepreneurs did not recognize the enormity of bridging the last mile. The cost and difficulty of upgrading the copper telephone wires that connect homes and small businesses to the broadband backbone remains a major issue. Meanwhile, large businesses and academic institutions have built their own dedicated connections and have used them to boost their productivity in many ways not available to the rest of society, a development that could be of particular significance to small businesses.

Today, many of the new broadband competitors are out of business. Broadband prices, which had dropped under the competition delivered by the *Telecommunications Act of 1996*, have now risen and the deployment of broadband has slowed. In fact, the drop in market value among telecommunications service providers and equipment makers accounts for more than 90% of the net loss in stock wealth since the spring of 2000. In addition, deployment of DSL broadband actually dropped in the second quarter of 2001 despite the previous years of exploding growth.

The government needs to lay the foundation for a National Broadband Strategy, where none now exists, in order to reverse these negative trends. The government can and should articulate a national goal for universal broadband service access in order to help American consumers and businesses achieve the productivity gains and security that such access would provide, in the same spirit as government efforts of earlier decades to provide universal electric power and phone service to all Americans.

VI. RATIONALE FOR A NATIONAL BROADBAND STRATEGY

The benefits that will arise from the development and implementation of a National Broadband Strategy fully justify making it a high priority. Information technology has played a critical role in achieving productivity gains, which have, in turn, stimulated the economy. However, there has been a downturn in information technology investments, and this has had an impact on economic growth. Certainly, there is a need to fashion responsible fiscal and monetary policy, return to paying off the national debt, and maintain low long-term interest rates. At the same time, there is a need to focus on key investments and policy decisions that will generate sustained productivity growth. Concentrating on productivity growth is the best use of Congressional time and energy.

Much of the technology for broadband is already at hand. Hence, there is not a major technology development challenge here, although R&D on key "last mile" technology issues is needed. Instead, there are implementation challenges. Many of the barriers to implementation lie within the government's domain. There are issues to be considered in both the executive and the legislative branches of government. For example, the FCC establishes and maintains policies on regulation and competition in accordance with existing law and is considering significant changes. Perhaps the most significant question is whether government will act with a coherent and comprehensive strategy, or acts in a piecemeal fashion that overlooks needs in critical areas.

Government faced similar policy issues in the early days of the Internet. In 1969, DARPA, the Defense Advanced Research Project Agency, demonstrated the basic elements of Internet technology. By the mid-1970s, researchers at Xerox PARC (Palo Alto Research Center), led by ex-DARPA researchers, had assembled the key elements for the personal computer that would make the Internet a technology for the masses. However, the Internet boom that started in 1995 actually resulted from a series of accidental policy choices, many of them affected by government. Because the Internet constituted such a new and different variant of human-machine interaction, few had the vision to see what was to evolve. As author M. Mitchell Waldrop points out in *The Dream Machine*, chance played a major role in the development of a technology that would ultimately have an impact most people could not have foreseen. With broadband, the story is quite different. The Internet has already given society a glimpse of the vision of what can be achieved. The path to implementation, however, is equally challenging, and involves many powerful economic actors with large stakes in the outcomes.

Since government controls most of the regulation and competition issues that are integral to broadband implementation, broadband deployment represents a profound challenge to government performance. In addition, in key mission areas where the government has a role, from education, health, government, and science to defense and homeland security, broadband has the potential to transform its performance.

Adopting a National Broadband Strategy is consistent with earlier strategies that the United States adopted to stimulate other, now irreplaceable, infrastructure, including railroads, electricity, telephone, and radio, and television. Each of these technologies was the focus of national economic strategies. A consensus exists that the Northwest Ordinance, the *Morrill Land-Grant Act*, transcontinental railroads, the GI bill, rural electrification, and the interstate highway system incorporated smart and successful national economic strategies.

An important part of the nation's economic strength has been its historic reliance on markets and entrepreneurs, and the willingness of government to refrain from unduly interfering with their activities. Government needs to come up with creative ways to ensure that it generates value rather than inhibits innovation. The question should not be whether we develop a strategy, but what terms are set for the strategy.

VII. OPTIONS FOR A NATIONAL BROADBAND STRATEGY

As a comprehensive National Broadband Strategy is crafted, a wide range of policy options must be addressed. Key elements are outlined here. All interested parties are invited to present their views and to come together with Congress and the Administration to help shape a national strategy.

A. The Grand Challenge

President Kennedy challenged Americans in the early 1960s to land a man on the moon before the end of the decade. President Eisenhower challenged the nation to connect our cities and towns with interstate highways. President Lincoln challenged the nation to build the transcontinental railroad. Speeding the deployment of broadband technology is a challenge equal in consequence and should be launched with a Presidential declaration of our goal.

Like putting a person on the moon, the deployment of broadband to Americans should be a national mission and a national priority. It is the ultimate economic stimulus, the next superhighway system for our next generation of leaders, our children, and grandchildren. With the right policies and leadership, industry and policy makers can work together to accomplish this imperative. Otherwise, millions of Americans will miss out on the personal growth, higher wage jobs, knowledge, and quality of life opportunities that broadband can deliver.

TechNet, a national network of CEOs from the nation's leading technology companies, called on the federal government in January 2002 to adopt the goal of providing

Internet access speeds of 100 megabits per second to 100 million homes and small businesses by the end of the decade:

> *"It is critically important for the United States to adopt a national broadband policy that encourages investment in new broadband infrastructure, applications and services – particularly new last mile broadband facilities," said Craig Barrett, CEO of Intel Corporation. "Regulatory policies should encourage all companies to deploy these expensive and risky facilities."*

TechNet's goal, which is unquestionably worthwhile, is also an ambitious one. The government must balance the feasibility of such a goal with its benefits. In particular, questions regarding how greater speeds relate to added benefits need to be carefully studied. Will it be better to distribute the higher speeds to fewer people, or lower speeds to greater numbers of people?

TechNet recognizes that its goal will need to be achieved incrementally. In the short-term, its members believe that a goal of at least 6 Mbps from two or more providers to at least 50% of U.S. households and small businesses by the end of 2004 is achievable. The challenge does provide a goal and some measure of the sufficiency of the resources and of the incentives government may enact.

B. A Central Conundrum – Competition

Although it is by no means the only issue, any review of policy designed to accelerate the deployment and adoption of broadband must consider the current debate over competition. The matter of competition is complicated by the fact that there is not only competition within the various broadband delivery technologies, but also between the delivery technologies.

Thus far, the most controversial debate in Congress has focused on the telephone delivery of broadband. The object of this debate is the Tauzin-Dingle *Internet Freedom and Broadband Deployment Act* (H.R. 1542), which passed the House of Representatives on February 27, 2002.

The bill asks that the Regional Bell Operating Companies (RBOCs) provide high-speed data services (defined as 384 kbps in at least one direction) to their customers over the next five years by upgrading their networks or providing alternative broadband services from another source if they do not. They must provide service only within 15,000 feet of their central offices and can affiliate with another provider to serve customers beyond that distance. In return, they would receive the ability to block entry to their Internet facilities.

The Tauzin-Dingle bill attempts to provide for greater competition by relaxing operating restrictions on the incumbent local exchange carriers (ILECs). The Bell companies argue that their delivery of broadband is regulated, while cable delivery is not. In addition, they claim that there is no real incentive for them to build broadband infrastructure while regulations require them to open that infrastructure to their competitors.

On the other hand, long-distance carriers and consumer organizations oppose the bill. Among these is Voices for Choices, a coalition of associations and companies that support competition in both local telephone service and in high-speed Internet access. They raise questions regarding the potential harm that Tauzin-Dingell could do by actually reducing competition within the telephony sector, and the possible weakening of consumer protection aspects of our current telecommunications law. They further believe that, at best, Tauzin-Dingle would create a duopoly between cable and the Bells in the delivery of broadband services.

During the spring and summer of 2002, the debate moved to the U.S. Senate. Significantly, Senator Breaux introduced the *Broadband Regulatory Parity Act of 2002* (S.2430) early in May of 2002. It attempts to provide a Tauzin-Dingle compromise by separating the voice and data components in order to maintain regulation of voice services while freeing data services of the regulations imposed by the *Telecommunications Act of 1996*. The Bells support this approach as a means of providing the incentives they desire. Senator Hollings strongly opposes the Breaux bill on the grounds that it does not create parity within telephony and would effectively squash competitive carriers. Senator Hollings offered his own legislation, S. 2448, that would provide a series of loans and grants for the development of high-speed Internet infrastructure in rural and underserved areas, as well as schools and libraries.

The competition debate must also examine the relationships between the various broadband delivery technologies. Today, there are several ways for consumers to obtain broadband capability. Although the two main players remain DSL and cable modem, emerging technologies include satellite delivery, wireless networking, powerline broadband delivery, and even experimental flickering fluorescent ceiling light technology.

Currently, over 50% of households are served by telephone company central offices that are DSL-enabled, meaning that the customers have the option of subscribing to DSL service if they so desire. However, the FCC reported in 2000 that only 6.6% of households subscribed to either DSL or cable modem. Those numbers increased to 9% to 12% for 2001, and continue to slowly rise in 2002. SBC claims to have added 183,000 new DSL customers in the first quarter of 2002.

But there are some issues with the current deployment rates and patterns. First, the vast majority of households getting broadband today, whether through cable or DSL, get it at relatively low speeds of less than one megabit per second. While this is faster than the older dial-up technology, it still takes considerable time to download large files, such as video files. Many have argued that the full benefits of broadband will not occur until most Americans are getting much faster broadband connections of at least 10 megabits per second, and perhaps as high as 100.

Cable providers can provide these speeds if they were to dedicate a higher share of their cable channels to broadband, but to date, they have not. Likewise, DSL continues to be provided at relatively low speeds. Currently, DSL can only be deployed to households within a certain distance of the central office switch (usually 18,000 feet). This means that while central offices that have converted to DSL capability serve about 75% of the population, only slightly more than 50% of the population is close enough to the central office to actually get DSL service. One way to overcome this distance limitation is to extend fiber and DSL switches farther out into the neighborhood. If this were done, conceivably close to 100% of households would be served by DSL-enabled central offices and could get DSL if desired. However, the Bell companies appear unwilling to extend fiber optic cable in the present regulatory environment.

Currently, the *Telecommunications Act of 1996* requires that incumbent local exchange carriers (ILECs), largely the Regional Bell Operating Companies (RBOCs), make their telecom facilities, over which they hold regional monopolies, available for use by competitors. Under the Act, if companies want to get into the long-distance marketplace, they must open up their facilities, either through reselling certain elements (e.g., access to the copper wire that goes to the home) or by buying wholesale the entire service from an ILEC and reselling it a consumer.

Not everyone agrees that the Act has been successful. Competitive local exchange carriers (CLECs) accuse the RBOCs of making it more difficult for the CLECs to get access to their facilities, and want the RBOCs to be required to open up their broadband facilities to investments so that the CLECs can use them to compete with the RBOCs. On the other hand, the RBOCs say that they have been opening up to competition, and want broad exemptions from the unbundling and wholesale resale and pricing requirements of the Act for new investments in broadband.

The real issue is how new investments that extend fiber and advanced switching from the central office should be treated with regard to letting competitors have access. The RBOCs' position is that requiring them to resell access to new fiber facilities will diminish their incentive to make these costly and somewhat risky investments. They argue that if they spend money on extending fiber out to the neighborhood and connecting the copper wire to remote terminals, and are furthermore required to resell access to this high-speed fiber-copper hybrid network at low rates to competitors, they will achieve a much lower rate of return on capital, resulting in far less incentive to deploy the technology.

Thus, at least one RBOC, Verizon, has argued that the old rules of the Act should apply to the old wires, and that new rules should apply to new wires (e.g., fiber extended to the neighborhood). Verizon says that they do not oppose the CLECs having access to the copper-fiber hybrid network, but that the CLECs should purchase either the entire DSL service (the DSL switches and line) at normal resale rates (wholesale) or purchase parts of the service (e.g., just the fiber optic line) at normal commercial rates.

The FCC has also joined the debate over competition. A ruling under consideration by the FCC would separate voice services from data services, maintaining old regulations for voice but creating a clean slate for regulation of data. The FCC has yet to look at advanced broadband (10 to 100 Mbps) in terms of how to ensure competitive entry of new technologies, such as Wi-Fi. And as lower speed technologies battle for dominance, there is a serious need for a focus on how we will obtain advanced broadband, which should be a major government emphasis.

We cannot avoid debate over competition. No policy is likely to be effective unless it effectively addresses the competition question. Competition is vital to healthy economic growth and development, and broadband is no exception. Competition between the delivery technologies will be just as crucial an issue as competition within any delivery technology.

C. Demand Side Issues and Strategies

1. Introduction

Clearly, there are constraints at this time on industry's ability to supply broadband services to consumers and businesses. Yet another central constraint is the continuing limited demand for those services. Consumers have largely been unwilling to pay $50 per month for merely faster email and web surfing. Until new killer applications become more commonly available, deployment is likely to remain slow. While reliance on market forces is usually the hallmark of government policies, there are some reasonable and appropriate steps that government can take to help stimulate demand.

Issues that affect demand include questions of content, applications, ease of use, cost, privacy, security, and spam, to mention only a few. Many small and mid-sized companies, as well as consumers, connect to the Internet using slow-speed, dial-up connections that are not fast enough to take practical advantage of many emerging online options. For now, most consumers seem content to stay in slower and less expensive speed ranges.

The real power of faster access will begin to be appreciated as applications become content-richer, and sector-by-sector innovations materialize that only high-speed networks can take full advantage of. That, coupled with a better balance of value, cost, and ease of use, will no doubt move more consumers to purchase broadband service. These issues should primarily be the priority of the private sector and government should play a constructive role in helping to stimulate demand only in limited areas. Government can lead by example, creating an environment of demand in areas of government services, education, and health care that other providers will want to follow with services of their own.

Government Services: Broadband will become crucial to providing necessary and timely government services to the citizens of this country. Population increases and shifting demographics place a burden on record keeping, licensing, certifications, voting, law enforcement, and public access to many government services. The public will be able to interact far more quickly and efficiently with government officials than ever before as broadband deployment spreads to both urban and remote, hard-to-serve areas. Through the FTC, the government will also need to be vigilant in protecting the rights of consumers who utilize the Internet for purchasing goods and services as commercial aspects of broadband become more widespread.

Education: Broadband will become indispensable to education. Teachers will be able to reach out to students beyond the normal classroom setting and teach to students of widely varying learning styles using, for example, streaming and interactive video. Educational institutions will have additional tools with which to teach efficiently under increasingly heavy demand for coursework and training programs. The *No Child Left Behind Act of 2001* (H.R. 1), signed into law in January 2002, contains numerous provisions encouraging the deployment and utilization of broadband technology in the classroom. It is important that government play a leading role in ensuring that our children have access to this valuable technology as they prepare for their future roles in society.

Health and Public Safety: Broadband will prove to be vital in dealing with many health issues, including terrorism and natural disasters. Timely and effective communication during a crisis is crucial, and the diversity of broadband delivery technologies can make information delivery not only fast but also reliable. For example, health and medical information can be assembled and distributed widely and quickly in the event of a bio-terrorism attack or any other kind of disaster.

These are only three broadband application areas, but each is important to government missions and can enable government to play a role in deployment stimulation. Opportunities presented by each are discussed below.

2. National Studies of Broadband Demand

Studies prepared by the National Academy of Science (NAS), and the National Science Foundation (NSF), highlight the tremendous benefits that will come to average Americans in areas of education, government, and health through widespread deployment of broadband services. By focusing on what broadband capability can achieve, these and similar studies can envision the future. For example, the report by the NAS entitled *Broadband: Bringing Home the Bits* examines the technologies, economic policies, and strategies associated with the high-speed connectivity challenges, namely, completing the final connections across the last mile.

NSF studies have focused not on the wider ramifications of broadband for society, but on specific applications of broadband in the important field of scientific research. In particular, the uses of high-speed Internet data transmission for monitoring seismic activity, collecting valuable sea-floor data, and establishing a national public-domain database are among the applications that have been studied. The NSF would be directed by an amendment to H.R. 1858, the *National Mathematics and Science Partnerships Act*, to conduct a study with yearly updates to identify the best methods of providing educators and policy makers with tools for using broadband Internet technology most effectively in the nation's schools.

Nationally recognized studies such as these can help to cultivate the interest and understanding that will stimulate broadband deployment. Government agencies with missions in broadband relevant areas should start to undertake such opportunity assessments.

3. Broadband for Homeland Security

Broadband has important and wide-ranging implications related to homeland security and the war on terrorism. There is a clear role for government to play in the development of homeland security applications. Rapid access to information during emergencies is crucial for evaluating data and situations as they evolve, for providing warnings, and for emergency communications between first-responders and officials as well as with the public. Moreover, security systems, which combine online video monitoring of remote locations with rapid access to criminal and terrorist databases, including biometric face recognition systems, will soon become viable.

Wireless broadband service is one of the key broadband topics related to homeland security. Proposals abound for systems to aid first-responders in communicating with each other and obtaining vital data at disaster scenes. Spurred by the twin disasters of September 11, 2001 and a tornado on campus two weeks later, University of Maryland researchers, for example, demonstrated that an incident-response kit could be put together quickly from off-the-shelf handheld computers, wireless links, and solar panels.

The FCC faces challenges in allocating enough of the spectrum to keep homeland defense systems operating without a glitch. Consideration will be given to opening up enough of the spectrum to make the next generation of wireless communication devices feasible and to provide space for both military wireless broadband applications and emergency services broadband applications as well.

Computer systems across the country are increasingly vulnerable to full or partial destruction by viruses or through physical attack, and of equal concern is the safety and security of sensitive information stored in computer databases. The National Academies' Computer Science and Telecommunications Board recently released a report highlighting previous Academy studies that call for better authentication systems, training, and monitoring to help make information systems more secure.

Congress should move to encourage the development of information technology systems to enhance homeland defense and information security. This includes steps to assure interoperability between agencies and between different levels of government. Congress should support efforts to improve the federal government's information security systems; to protect critical infrastructure; to provide stronger defenses against natural and man-made threats; and to enable federal agencies to take advantage of information technology in sharing information and conducting transactions with one another and with state and local governments in furtherance of the above goals.

In addition to homeland security, overall national security defense needs could greatly benefit from broadband applications. Network Centric capability is a critical defense strategy and broadband applications are important to its implementation.

4. Broadband in the Classroom

a. Introduction

The face of education will change dramatically as broadband technology moves into the classroom. Quality educational programming and high-speed Internet access will help teachers keep up with subject matter, introduce material to students in exciting interactive presentations, and address a wide range of student learning styles.

Applications include interactive news broadcasts in the classrooms, high-speed delivery of audio and video lessons, rapid subject research and distance learning. Online communities of teachers will support each other with both subscription and free educational materials, including course notes, outlines, exercises, and learning activities. Electronic field trips will take students individually or as a group to the tops of mountains, through museums, and inside concert halls. Present day examples of educational applications include annotated and illustrated musical performances from Carnegie Hall and interactive video science lessons from the AT&T Learning Network.

Distance learning is estimated to be a $10 billion market in 2002, according to IDC, a market research firm based in Cambridge, Mass. Thanks to the capabilities of broadband, future students will be able to attend classes in real-time, seeing and interacting with the teacher and with fellow students over video-enabled computers having rich multimedia content. Colleges and universities already participating in high-speed distance learning include Adelphi University, Clemson University, College of Insurance, Dearborn Institute, Kaplan Educational Centers, Manhattan College, Mercy College, St. John's University, and Touro College and University.

Numerous bills introduced in the 107th Congress mention, in one way or another, computers in the classroom, but none provide significant detail. Examples include:

- *21st Century Teacher Training Act of 2001* (H.R. 1188)
- *School Improvement Accountability Act* (S. 158)
- *Educational Excellence for All Learners Act of 2001* (S. 7)
- *Education Reform Act* (H.R. 1614)
- *Excellence and Accountability in Education Act* (H.R. 340)

The most sweeping education bill of the 107th Congress, the *No Child Left Behind Act of 2001* (H.R. 1), contains language pertaining to computers in the classroom. It became Public Law Number 107-110 on January 8, 2002.

Academic-industry partnerships are springing up that may make legislative incentives less necessary. Industry recognizes not only the need for educational technology and educational programming, but also recognizes the advertising potential of having a trapped audience of young consumers available before, after, and perhaps during interactive lessons. While the advertising model raises a series of social policy issues, there are fortunately other profit recovery models under consideration for education technology.

b. Federal Broadband Education Initiatives

During committee mark up, the full House Committee on Science accepted an amendment to H.R. 1858, the *National Mathematics and Science Partnerships Act*, which was offered by Representative John B. Larson. The amendment allows the NSF to identify the best methods by which to provide educators and policy makers with the tools necessary for using broadband Internet technology most effectively in the nation's schools. Further, it requires the NSF to conduct a study, with subsequent yearly updates, that identifies:

1) The availability of broadband access at all public elementary and secondary schools and libraries in the United States.

2) How broadband access to the Internet within such schools and libraries can be most effectively utilized within each school and library.

The emerging potential of broadband will offer new capabilities to teachers and students, such as access to virtual collaborative work areas, interactive networked laboratory experiences, tools for analysis and visualization, remote operation of instrumentation, mining of large databases of real-time data, and exploitation of simulated environments. For example, the NSF is currently evaluating a potential program called the National Science, Technology, Engineering, and Mathematics Education Digital Library (NSDL), which would be a "virtual facility" intended to serve the needs of students and teachers alike at all levels (i.e., K-12, undergraduate, graduate, and life-long learning). The NSDL will provide seamless access to rich interactive learning materials and resources, and enhance the services of existing libraries through the intelligent retrieval of relevant information, online annotation of resources, and archiving.

Broadband offers great promise for much more than better accessing of information. It can greatly enhance new models for computer-based learning and we need research on what those models should be. By enabling wide access to comprehensive, high-quality, teaching and learning resources in a digital environment, along with value-added services, broadband will encourage and support continual improvements in the quality of education in science, mathematics, engineering, and technology for all students, as well as in all other areas of education.

5. E-government

In a step intended to usher in "next generation government," Senators Joseph Lieberman and Conrad Burns introduced the *E-Government Act of 2001* (S. 803), which represents a bipartisan effort to maximize the organization, efficiency, accessibility and quantity of the federal government's online resources while reducing overall cost, and to bring government more fully into the electronic age by improving citizen access to government information and services. The U.S. government has been a sometimes-unwilling participant in the technological revolution of recent years. This legislation will change that by creating online services to make government more efficient, accessible, and accountable to the citizens it represents.

The private sector has benefited tremendously from the application of information technology. Now it is government's turn. Government can and must take full advantage of the Internet and other technologies to overcome arbitrary boundaries between agencies so the public can be provided with seamless, secure online services.

E-government will make use of interactive information technology to deliver government services directly to the customer 24 hours a day, 7 days a week. "Customers" may be citizens, businesses, or other government entities. Services will typically be delivered to the customers on their computers via the Internet, but delivery will also occur through wireless PDAs and conveniently located kiosks.

Specifically, the *E-Government Act of 2001* would:

- Establish a federal Chief Information Officer within the Office of Management and Budget to promote e-government and implement government-wide information policy
- Authorize $200 million a year for an e-government fund to support interagency projects and innovative uses of IT
- Improve upon the centralized online portal and establish an online directory of federal web sites and indexes of resources
- Institute an online national library
- Require federal courts to post opinions online
- Fund a federal training center to recruit and train IT professionals

The bill contains a variety of other provisions that would promote the use of the Internet in the regulatory process, encourage compatibility of electronic signatures, and provide strong new privacy protections. A functional approach to e-government will focus on delivering services to the citizen, organized according to the citizens' needs, without regard to agency jurisdictions. The challenge is to get a handle on how new technologies have created new opportunities, and to reconfigure government accordingly.

E-government will enable delivery of services in a manner that convenient to the customers, efficient, and cost-effective. Mike Hernon, vice-president of e-government for New York City-based GovWorks, believes that "E-government will help foster a closer relationship between government and its customers. A more responsive and efficient government will be valued more highly by its citizens, and in turn they will be more supportive and involved."

6. E-medicine

The Internet is already changing the way health care services are delivered at medical centers and doctor's offices across North America. Today, there is intense pressure upon health care organizations to improve access and service to a growing population while containing costs. Quality of patient care, affordability, and equality of access are fundamental values of the health care system, but are at risk today because of resource constraints and delivery issues. The medical community recognizes the need for new and proactive solutions to revolutionizing health care delivery, and industry is focusing on multimedia broadband networks and telemedicine as a means to meet the growing needs.

The intent of telemedicine is to provide a "virtual presence" and connection between doctors and their patients, doctors with other doctors, and patients being monitored by care providers. Nortel Networks describes the benefits of telemedicine as follows: "Two or more parties, separated by distance, can interact and communicate as if they were in the same room." To cite just one promising example, real-time, immediate, online availability, through broadband, of high-resolution diagnostic data to multiple caregivers promises major time, productivity, and quality improvements. A specialist situated in an urban hospital is able to conduct a complete real-time diagnosis, prescribe treatment, and provide follow-up care to a patient in a rural clinic. Physicians dispersed over a large geographical area can interact and share detailed medical learning without the need to travel.

Broadband has the potential to link together community clinics, teaching centers, and rural and urban hospitals into a coordinated wide-area health care system. Broadband consolidates telephony, data transmission, audio, and video into a single network. Nortel Networks believes that broadband can support "high-quality interactive video consultation that will change the way health care is delivered." Everyone will benefit from decreased lengths of hospital stays, improved specialist productivity, reduced travel, and more efficient management of care, personnel, and expenditures.

Telemedicine is already receiving attention from legislators. For example, the *Economic Security and Recovery Act of 2001* (H.R. 3090), introduced by Representative Thomas, permits additional loans and grants for a broadband pilot program and for telemedicine and distance learning services, as stated in section 813. Thirty-five additional bills that have been introduced in the 107th Congress include provisions to enhance telemedicine in one way or another.

Health care has been resistant to the introduction of IT, despite the promise it offers for both higher quality and productivity gains. Broadband has such promise that it could help breakdown that resistance and achieve major gains in quality and efficiency.

7. E-science

The Internet evolved initially, under both DARPA and NSF, to connect computers and scientific researchers. This resulted in a sophisticated initial user base for the Internet from which it grew almost geometrically. Broadband offers a great expansion of collaborative research and information exchange opportunities and high-speed Internet is now common on university campuses. Research networks, such as Internet 2, are connecting over 190 universities and more than 20 state education networks. More connectivity at advanced speeds is in order, as are applications designed to enhance scientific research and collaboration.

The vision of e-science includes: individual researchers having their own short-range wavelength for evaluating and implementing wavelength division multiplexing (WDM); petabyte databases; grid computing capability, remote access to scientific instruments, and, software for collaboration, information visualization of large data sets, modeling and simulation.

8. Demand Side Tax Incentives

A wide range of tax policies and proposals affect consumer purchase of computer and broadband equipment. They require further examination as optional paths to stimulate broadband deployment.

a. Digital Divide Tax Credit

The gap between the technological "haves" and "have-nots" has the potential to widen considerably and has spawned intense public policy debate among federal, state, and local policy makers. The two most obvious aspects are: (1) the wiring of schools and classrooms for educational purposes, and (2) the wiring of homes to help ensure that some Americans will not be left behind as the benefits of information technology become more of a necessity and less of a luxury. Knowledge is power. In the broadband era, that knowledge and the accompanying economic benefits will come from high-speed access.

The implications of the digital divide are substantial. Some people perceive a new national civil rights crisis in that many low-income Americans do not yet own a computer. Eric Cohen, managing editor of *The Public Interest*, recently noted in *The Weekly Standard* that "the digital divide is now the hottest social policy issue in Washington. It's the 'new new thing' in civil rights politics."

b. Depreciation Schedules for Computer and Broadband Equipment

President Bush signed one incentive relevant to information technology into law as part of the economic stimulus bill, *Job Creation and Worker Assistance Act of 2002* (H.R. 3090) (Public Law 107-147, March 9, 2002). The incentive provides a special up-front 30% "bonus" depreciation allowance for certain depreciable property, including IT equipment, purchased after September 10, 2001 and before September 11, 2004. The legislation, which does not focus specifically on IT equipment, is meant to accelerate investments in depreciable equipment, not to change depreciation schedules over the long-term.

Several bills introduced during the 107th Congress relate directly to depreciation timing for all types of computer equipment. For example, Representative Mac Collins introduced H.R. 1895, the *Computer Equipment Common Sense Depreciation Act*. Representative Fred Upton sponsored H.R. 2981, which establishes a seven-year useful life for depreciation of certain auction-acquired telecommunications licenses. Senator John Kerry introduced S. 1676 to provide tax relief for small businesses.

An additional 47 bills introduced in the 107th Congress pertain to depreciation schedules in general and to computer equipment in varying degrees.

c. Telecommuting Incentives

The value and benefits of telecommuting have only begun to be realized. The impact on the quality of our work, congestion and air pollution, and workplace productivity are clear. Telecommuting will be made more practical and productive with the deployment of broadband technology.

Senator Rick Santorum and Representative Frank Wolf have introduced legislation, S.521 and H.R.1012, which would provide tax credits for employers that allow their employees to telecommute from home. These bills would provide a $500 tax credit for expenses associated with telecommuting arrangements. Credits would apply toward computer software, home-office furnishings, fax machines, and other work-related expenses.

The Environmental Protection Agency (EPA) already recognizes the value of telecommuting. The EPA began offering pollution credits through the National Telework and Air Quality Pilot Project to companies in five U.S. metropolitan areas that allow employees to telecommute from home. The pilot program is thoroughly backed by the Bush administration and covers Denver, Houston, Los Angeles, Philadelphia and Washington, D.C.

Advocates of telecommuting maintain that employees are more productive when working remotely from home. EPA Administrator Christie Whitman has stated that the pilot program would "create a growing economy and clean environment." But in addition to that, it would further help to spur the development of a new realm of applications and content.

d. Credits for Donation of Computers to Employees

Many large private-sector employers, such as Ford, Delta Air Lines, American Airlines, and Intel, offer their employees subsidized PCs and free Internet access. Providing additional credits to employers who offer such packages will doubtless help to speed the deployment of broadband.

In addition, this new workplace benefit is likely to become more prevalent as employers compete for quality workers, which would help to stimulate the economy. Representative Jerry Weller has introduced H.R. 1835 to provide an exclusion from gross income for computers and Internet access provided by an employer for the personal use of employees.

D. Supply Side Strategy Options

There are a number of options that would provide incentives to suppliers of broadband service. Some of these measures were touched upon briefly in the discussion on demand side strategies above given that they have components applicable to both aspects of deployment.

1. Tax Credit for Deployment of Broadband Equipment and Services

Several bills have been introduced that address credit incentives related to broadband equipment and services. The lead bill is S. 88, introduced by Senator John D. Rockefeller IV, that seeks to amend the Internal Revenue Code of 1986 in order to provide an incentive to ensure that all Americans gain timely and equitable access to the Internet.

The Rockefeller bill and H.R. 267, each called the *Broadband Internet Access Act of 2001*, steadily gained bipartisan support in Congress late in 2001. With some 60 cosponsors in the Senate and 170 cosponsors in the House, the measure appeared ready to roll down the legislative track as either a stand-alone bill or a rider to a broader tax or spending proposal. It now rests in the Senate Finance Committee.

The bill is intended to offer companies that rollout broadband service to rural communities and underserved areas tax credits of 10% to 20%. A carrier delivering broadband download speeds of least 1.5 Mbps and upload speeds of at least 200 kbps to those areas, would be eligible for a 10% credit. Those who deploy "next generation" services of 22 Mbps download and 5 Mbps upload to any residential customer would be eligible for the 20% credit.

While lobbyists wage nearly continuous war over regulatory issues, such as those found in the Tauzin-Dingle bill, there is less focus on tax incentives. Measures that offer providers a stimulus for rolling out vital new services across the United States, especially difficult when they encourage deployment in rural America appear to have significant support.

For the true universal benefits of broadband to be realized, deployment needs to extend not only into poor and rural areas, but also into other settings where one would not normally expect to find high-speed Internet or where access might otherwise be difficult. This includes, but should not be limited to, low-income housing, rural areas, off-campus student housing, new homes and apartments, and renovations. With incentives to developers in these atypical settings, broadband deployment can be greatly accelerated, provided that appropriate applications and content also emerge.

In fashioning these incentives, the government must be competitively neutral in its actions regarding the various types of broadband technology. Several issues need to be carefully reviewed, including the qualifying speeds, the eligible capital investments, and the market share requirements, to ensure that the standards do not tend to disqualify wireless technology that might provide an effective alternative, particularly in rural areas, to land-line technology. Government should also be careful not to provide unneeded incentives where there is no market failure problem.

2. Loans and Grants for Deployment

An alternative to an investment tax credit is to provide loans and grants to the suppliers or customers of broadband services. Among the customers that could qualify are local governments, schools, and hospitals. For example, S. 966, introduced by Senator Byron Dorgan, and H.R. 2038, introduced by Representative Bart Stupak, offer up to $3 billion in loans at a 2% interest rate to companies that can deliver broadband services to rural areas. There is no particular speed requirement. Legislation introduced by Senator Hillary Clinton (S. 428), and Representatives John LaFalce (H.R. 1416), Lamar Smith (H.R. 2139), John McHugh (H.R. 2401), and James Moran (H.R. 2699) take a similar approach. Some of these provide grants as well as low interest loans. Any such programs should be administered in a technology-neutral way in order to assure maximum competition.

Legislation introduced in the 107th Congress would provide tax credits (S. 88, S. 150, S. 426, H.R. 267, and H.R. 1415) and grant/loan guarantees (S. 428, H.R. 1416, and H.R. 1697) for broadband deployment primarily in rural and/or low-income areas. More information on federal assistance for broadband deployment can be found in Congressional Research Service (CRS) Report RL30719, *Broadband and the Digital Divide: Federal Assistance Programs*.

3. Government Research and Development Spending

In addition to creating research and development incentives through tax credits, the federal government can set an example and be a partner in spending for basic research on broadband information technology. Some funds could help spur private development of appropriate technology and applications. Other funds would be directed into the research and development of e-government applications. Applications like electronic filing of tax returns, renewal of drivers' licenses, or accessing of public documents, are only the beginnings of things yet to come.

In the 106th Congress, Representative Sensenbrenner's bill, the *Networking and Information Technology Research and Development Act* (H.R. 2086), addressed federal research and development funding for information technology. On February 22, 2000, the bill was referred to Senate committee, where it died. The bill sought to amend the *High-Performance Computing Act of 1991* (S. 272) to authorize appropriations for FY 2000 through 2004 for research and development activities of the following departments and agencies in connection with the High-Performance Computing Program: the National Science Foundation, the National Aeronautic and Space Administration, the Department of Energy, the National Institute of Standards and Technology, the National Oceanic and Atmospheric Administration, and the Environmental Protection Agency. The amendment also establishes goals and priorities for federal high-performance computing research, development, and networking.

Despite the lack of a specific authorization, this IT research and development initiative has been ongoing under existing executive branch authority. This initiative could be a home to R&D on key broadband technology and deployment barrier issues, such as wireless interference and protocols.

4. Research and Development Tax Credit

No one can predict what new technologies and applications will emerge or which will be in high demand. However, a great deal of research and development needs to take place and will be an ongoing task, funded in the long run by industry, as demand in certain areas continues to grow. In order to get beyond the current stalemate, certain issues need to be addressed, which can best be resolved by research aimed at systematically evaluating the issues and alternatives.

Intellectual property and copyright protection ranks highly among critical issues. Owners of audio and video content are not anxious to distribute products, such as movies-on-demand, until they feel that protective measures are in place. However, the technology to protect the content distributed on broadband is complex and controversial. This is one area where R&D will prove vital to its future; however, is not yet clear who, if anyone, will develop the technology. Tax credits to produce incentives could result in big payoffs later.

5. Spectrum Allocation

Delivery of broadband via wireless services faces growing controversy related to frequency allocation. Portions of the electromagnetic spectrum have been reserved for specific uses for decades. Radio and television broadcasting are among the best known, but other uses of spectrum include emergency communications, aircraft navigation, and data transmission.

Some portions of the spectrum are available for free to licensed users, like television broadcasters. Other portions of the spectrum are paid for, such as frequencies used by cellular telephone providers. Some portions of the spectrum are now overcrowded, and interference and signal degradation could become a bigger problem. Other portions of the spectrum may become less crowded over the years, such as those frequencies now dedicated to analog television broadcasting, as the transition to digital television broadcasting continues to occur. Allocating portions of the spectrum for use by wireless broadband providers and assigning fees, if any, are among the most pressing issues of spectrum frequency allocation.

As background, speech and music were first broadcast over "radio" waves in 1906. That same year, the first international radio conference convened in Berlin in recognition of the need to coordinate and control the use the electromagnetic spectrum in the range of 500 to 1500 kHz. Widespread interference between conflicting transmissions on the same frequencies in the United States led to the *Radio Act of 1912* (Public Law No. 264, August 13, 1912).

The *Radio Act of 1912* represented the first attempt at spectrum regulation of any kind, and only required registration of transmitters with the Department of Commerce. It did not control frequencies, time on the air, or output power. In 1922, U.S. government agencies sought regulation for frequency use under the Secretary of Commerce, and the Interdepartment Radio Advisory Committee (IRAC) was formed to coordinate their use of the spectrum. Coordination of the government's use of the spectrum was relatively easy compared to the publics, and the interdepartmental cooperation was found to be mutually beneficial.

The FCC was established by the *Communications Act of 1934* and provided broad regulatory powers for the FCC in both wireline-based communications, like telephone and telegraph, and in wireless communications. The function of the IRAC is currently delegated to the National Telecommunication and Information Administration (NTIA). The use of the electromagnetic spectrum is therefore managed by two agencies. NTIA manages the federal government's use of the spectrum while the FCC manages all other uses. The intent is to make available "a rapid, efficient, nation-wide, and world-wide wire and radio communication service with adequate facilities at reasonable charges, for the purpose of the national defense, [and] for the purpose of promoting safety of life and property."

Industry representatives argue that the current allocation of the radio spectrum impedes the development of high-speed wireless data services. The evidence does suggest that frequencies are inefficiently allocated for today's applications, with too little being assigned for new commercial wireless use. FCC license use restrictions vary substantially for different frequencies and uses of the spectrum, and future demands for wireless services are likely to strain the system in the near future.

On the positive side, the FCC has allowed the 802.11 band to be unregulated, which is encouraging Wi-Fi experimentation. And, the FCC adopted a First Order Report and Order on February 14, 2002 that permits the marketing and operation of certain types of products incorporating Ultra Wideband (UWB) technology over very short ranges (10 meters). The FCC envisions new public safety applications and broadband Internet access among the uses of this component of the spectrum. The new standards rightfully represent a "cautious first step" as the full ramifications are not yet known. The FCC needs to thoroughly examine spectrum in light of wireless broadband needs as well as the needs of other technologies and applications that require use of portions of the spectrum.

6. Right-of-Way Issues

Rights-of-way (permissions to run cables, pipelines, etc., across others' properties) are generally granted to public utilities and other common carriers through easements with property owners, including governments and Indian tribes. Eminent domain privileges granted under certificates of public convenience and necessity from state and federal governments makes access simpler in some cases, allowing operation of franchises that provide public utility services. Providers usually make payments for leasing rights-of-way on private property, and local governments collect franchise and lease fees on public property.

Broadband distribution suffers from a hodgepodge of state and local access rules that vary widely from location to location and with the delivery technology. Cable providers may have different regulations than telephone providers, who may be regulated differently than electric and gas providers; optical fiber providers may not fit into any of these categories. Some states follow a convention known as "Dillon's Rule" regarding rights-of-way, while others leave it completely up to local government in "home rule" states. Under Dillon's Rule, local governing bodies have only those powers that are expressly granted by the state legislature.

The National Association of Telecommunications Officers and Advisors (NATAO) represents municipalities with right-of-way and franchise fee issues. The following are some of the issues facing providers, government, and property owners. Utility lines sited on private property and conveying delivery of service into homes and businesses are not likely to pay for the privilege. However, the telecommunications industry is finding that apartment and office landlords are increasingly asking to receive compensation for microwave or other transmission facilities on their property, so the telecommunications industry is evaluating access legislation. In general, however, property owners or developers pay for the installation of utility lines as well as provide the right-of-way.

Utilities may or may not pay fees to the local government when right-of-way is sited on governmental property. Often the state or local highway department has a great deal of influence in how right-of-way is sited. In any event, payments made by utilities for access and maintenance of right-of-way property are passed on to the consumers in one form or another. Clearly, obtaining and using right-of-way is a complicated matter and difficult to generalize, yet some standardization is necessary in order to provide coherent policy.

The access battle has been most visible so far in Kansas and Missouri, where telecommunications companies are asking legislatures to stop cities that want to make profits from franchise agreements. Sprint, Southwestern Bell, AT&T,

Utilicorp Communications Services, and Everest Connections are demanding that these states make changes in how cities regulate rights-of-way. The companies are asking that charges based on gross receipts be dropped and want a uniform cap on how much cities can charge per access line. High fees are presently passed on to customers, potentially hurting the market. Industry seeks to prohibit cities from charging fees that are essentially hidden taxes for the use of the right-of-way and to make money of network deployment.

City officials disagree. Most contend that the states' legislation would remove local government authority with respect to franchise agreements, and that they will interfere with municipalities' ability to manage rights-of-way. Cities view the bills as providing a license to "wantonly dig," and to take city officials out of the loop.

For example, in the Kansas bill, carriers would be able to get certifications to exempt themselves if they run through a city's right-of-way but do not provide local phone service. The cities contend that even though they might not be providing a service, they are still passing through the right-of-way and taking up space for which the cities should be compensated.

But with so many providers using the rights-of-way, and more coming in daily, the issues will continue to mount. It is time for the federal government to consider preempting the patchwork of state and local regulations to bring coherence to the laws, thus helping to promote crucial broadband deployment.

E. <u>Key Domestic Policy Issues</u>

There is a wide range of domestic policy issues that affect consumer and business confidence and use of the Internet. Adopting responsible policies with regard to these issues will hasten deployment of broadband technology.

1. Taxation of the Internet

On November 28, 2001, President Bush signed the *Internet Tax Nondiscrimination Act* (H.R. 1552) into law. This bill extends the moratorium on taxation of the Internet by two years such that it will now expire on November 1, 2003. The moratorium bars state or local governments from imposing taxes that would subject buyers and sellers of electronic commerce to taxation in multiple states. It also protects against the imposition of new tax liability for consumers and vendors involved in commercial transactions over the Internet. Furthermore, it protects goods and services from taxation, for the duration of the moratorium, that are sold exclusively over the Internet with no comparable offline equivalent.

During the debate over the extension of the moratorium, state and local governments argued that the legislation should include a mechanism to enhance their ability to collect sales taxes due on mail and Internet order purchases. A pair of recent Supreme Court decisions severely constrains the ability of state and local governments to require most out-of-state mail order and Internet merchants to charge and remit sales tax. States and cities say that the growth of effectively tax-free Internet purchases has eroded the sales tax base of state and local governments, and hampers their ability to provide education, health, and other vital services. Main Street retailers are disadvantaged by the ability of Internet merchants and mail-order catalog companies to avoid the obligation to charge sales tax. State and local governments have proposed that states should be empowered to require large Internet merchants to charge sales tax on all their sales if states sufficiently simplify their diverse sales tax laws.

The *Internet Tax Moratorium and Equity Act*, introduced by Senator Dorgan and Representative Istook as S. 512 and H.R. 1410, respectively, spells out detailed criteria for simplification and standardization of state and local sales tax systems. It also commits Congress to taking an expeditious up or down vote authorizing states to require large Internet merchants to charge sales tax on all their sales, once a threshold number of states adopt new sales tax laws satisfying the simplification criteria. This issue was not addressed in the legislation adopted to extend the moratorium.

2. Internet Privacy Issues

Internet users cite privacy online as their number one concern. Privacy is listed most often as the principal reason why non-users shun the Internet. Even as private and government activity both expand and threaten privacy, protection is not provided by the existing hodgepodge of privacy laws and practices. In fact, their very perplexity helps to perpetuate distrust and skepticism and slows Internet growth.

A number of legal, technical, and self-regulatory tools are beginning to address Internet privacy concerns. Top priorities include developing suitable federal legislation for standards of consumer privacy, setting limits on outside access to personal information, and assuring that new technologies are designed to protect privacy, not lessen it.

Industry favors self-regulation. Their efforts include:

- <u>Opting Out</u>: gives users online options to prevent personal information from being proliferated
- <u>Online Seal Programs</u>: allow web sites that meet fair information practices and submit to monitoring to display a privacy seal
- <u>Online Privacy Alliance</u> (OPA): consists of a group of global organizations that identifies and advances online privacy policies and user empowerment tools
- <u>Network Advertisers Initiative</u> (NAI): composed of third party advertisers committed to consumer notice and choice

As federal legislation is needed to bring consistency to regulation throughout the 50 states, many pieces of legislation have been proposed to help ensure privacy. Consumer confidence in the Internet and broadband would be boosted by a clear collection of rules that govern the gathering of personal information and its use. Pending legislation related to Internet privacy include:

- *Consumer Privacy Protection Act* (S. 2606)
- *Consumer Internet Privacy Enhancement Act* (H.R. 237 & S. 2928)
- *Consumer Online Privacy and Disclosure Act* (H.R. 347)
- *Spyware Control and Privacy Protection Act of 2001* (S. 197 & H.R. 112)

In addition, H.R. 112 was introduced to address concerns about software and websites that include a method to collect information about the computer on which the software is installed

3. Internet Security Issues

Internet security has been a major concern to users and administrators since the Internet's beginnings. The combination of market pressure and rapid Internet growth created an environment filled with exploitation opportunities and malicious users ready to take advantage of that environment. The problem is worsening and shows no sign of letting up, with increasing high-profile incidents, such as Internet security compromises at the Pentagon, the Department of Justice, and the New York Times.

Internet security issues are divided into the three categories often identified as "confidentiality, integrity, and availability" (CIA).

- <u>C</u>onfidentiality refers to restricting information access to only authorized users. Passwords and credit cards numbers are examples.
- <u>I</u>ntegrity is ensuring that data in storage and data in transit are not modified either accidentally or with malicious intent.
- <u>A</u>vailability is making sure that network services are always available despite accidental or maliciously intentional interruption.

Legislation proposed to assist in protecting Internet security includes:

- H.Con.Res. 22, to express the sense of Congress regarding Internet security and "cyber-terrorism"
- H.R. 583, to establish the Commission for the Comprehensive Study of Privacy Protection
- H.R. 3555, to prevent, prepare for, and respond to the threat of terrorism in America, and for other purposes
- S. 1456, the *Critical Infrastructure Information Security Act or 2001*. The Senate Governmental Affairs Committee, chaired by Senator Lieberman, held hearings on May 8, 2002 on cybersecurity and cyberterrorism.

4. Internet Spam Issues

Unwanted, unsolicited email advertisements that overwhelm electronic mailboxes are referred to as "spam." Spammers (i.e., persons who send spam), at very little cost, can send huge amounts of email. On the other hand, since Internet service providers transmit the mail and the end users pay for the service, recipients of spam pay with time, resources, and money for advertisements they never asked for nor wanted.

Consumers have only limited recourse when dealing with Internet spam. They can use *avoidance* methods, such as using a primary email account for email between friends or for business and having secondary "throwaway" email accounts for other purposes. In addition, they can also use *rejection* methods. For instance, many Internet providers include options for users to reject mail from specific unwanted sources; however, this does not solve the spam problem because it requires the user to receive the spam, recognize it as spam, and click to refuse mail from that source in the future. Thousands of emails are blocked in this way, yet spammers can simply change their source information. Finally, consumers can use *complaint filing*. As complaining to spammers only acknowledges that one's account is active and in use, it is wiser for users to complain to the Internet service provider, rather than the spammer. All of the methods are inconvenient and place a burden on the user.

A smattering of state laws with uncertain effectiveness exists to attempt to regulate spam. No federal laws apply at this time. However, there are bills pending in both the U.S. Senate and the House of Representatives that would require labeling of unsolicited commercial emails as spam, so that it could be filtered. Proposed legislation would require spammers to provide valid return addresses and "opt-out" options from future mailings for recipients. The FTC would be allowed to levy fines for violations.

The following legislation relating to spam has been introduced:

- *CAN SPAM Act of 2001* (S. 630)
- *Unsolicited Commercial Electronic Mail Act of 2001* (H.R. 95)
- *Wireless Telephone Spam Protection Act* (H.R. 113)
- *Unsolicited Commercial Electronic Mail Act of 2001* (H.R. 718)
- *Anti-Spamming Act of 2001* (H.R. 1017)

Specifically, Senator Lieberman is a cosponsor of the *CAN SPAM Act of 2001*, which seeks to control the assault of non-solicited pornography and marketing. It would amend federal criminal law to apply fines or imprisonment for the transmission of unsolicited commercial electronic mail messages that are accompanied by materially or intentionally false or misleading header information.

5. Internet Content Issues

The suitability of Internet content to all consumers should be a major concern. Inappropriate content frequently appears unexpectedly to children or to others who may be offended by it. Undesired pornography may not only be an embarrassment, but also a violation of sexual harassment laws. For example, simply typing one common U.S. government web address, but accidentally replacing the ".gov" with a ".com", can lead innocents to accidentally encounter explicit sexual material.

Inappropriate material includes more than just pornography. Currently, there are more than 3,000 hate-promoting web sites and countless other readily accessible sites that promote drug use, encourage fraud, or provide bomb-making instructions. The basic right to freedom of speech will certainly be put to the test in dealing with these issues.

The federal government has not been effective at designing solutions restricting children's access to sexually oriented content online. On June 26, 1997, the Supreme Court struck down one law, the *Communications Decency Act*, on First Amendment grounds**.** In December 2000, Congress passed the *Children's Internet Protection Act*. This legislation would require schools and libraries that want federal funding to filter objectionable Internet content.

The only federal law offering explicit protection from inappropriate content to young web surfers at home is the *Children's Online Privacy Protection Act*, which prohibits any web site from collecting a child's personal information without parental consent.

Passing Internet material through electronic filters is one way to protect the young from sensitive material. Filtering-software designers use one of three approaches to determine whether a site merits blocking:

(1) <u>Software analysis</u>. Software can be used to quickly evaluate a site's contents. The program may attempt to detect the presence of certain phrases or images at the time a child tries to access a site, or check a list of sites to block in advance. This option has the drawback of potentially blocking valid sites.

(2) <u>Human analysis</u>. Internet providers can have members of their staff evaluate sites individually and place inappropriate ones on a no-access list. The process is quite time-consuming and incomplete. Hence, many inappropriate sites will be totally missed.

(3) <u>Site labeling</u>. Some web-site owners choose to voluntarily label their content, much like the motion picture industry, which has a rating system and, in more recent years, the video gaming industry. Browsers like Microsoft's Internet Explorer can use those labels to filter content. Unfortunately, many of these filtering techniques are ineffective, plus they rely upon the willingness of the industry to accurately rate themselves.

One key piece of legislation related to Internet content issues is the *No Child Left Behind Act* (H.R. 1). It prohibits the use of federal education funds by covered elementary or secondary schools to purchase computers used to access the Internet or to pay direct costs of Internet access, unless such schools have Internet safety policies that include measures to prevent access to visual depictions that are obscene or harmful to minors.

On a related issue, the U.S. Supreme Court overthrew a Congressional ban on virtual pedophilia in April of 2002. The court ruled that the First Amendment protects pornography or other sexual images that only appear to depict real children engaged in sex. This judgment is viewed as a victory for both pornographers and legitimate artists such as filmmakers.

The law barred sexually explicit material that "appear(s) to be a minor" or that is advertised in a way that "conveys the impression" that a minor was involved in its creation. This was Congress' answer to then-emerging computer technology that allowed computer alteration of innocent images of real children, or the creation from scratch of simulated children posed in sexual acts.

Congress justified the wider ban on grounds that while no real children were harmed in creating the material, feeding the prurient appetites of pedophiles or child molesters could harm real children. Both the Clinton and Bush administrations defended the law in court. This is a serious matter requiring additional consideration.

6. Intellectual Property Issues

Intellectual property refers to creations of the mind: inventions, literary and artistic works, and symbols, names, images, and designs used in commerce. Intellectual property is divided into two categories: *industrial property*, which includes inventions (patents), trademarks, industrial designs, and geographic indications of source; and *copyright*, which includes literary and artistic works (such as novels, poems, plays, films, musical works, and artistic works such as drawings, paintings, photographs and sculptures), and architectural designs.

Intellectual property is generally accepted as rights relating to:

- Literary, artistic and scientific works
- Performances of performing artists, phonograms, and broadcasts
- Inventions in all fields of human endeavor
- Scientific discoveries
- Industrial designs
- Trademarks, service marks, and commercial names and designations
- Protection against unfair competition
- And all other rights resulting from intellectual activity in the industrial, scientific, literary or artistic fields.

Governments take steps to protect intellectual property for the owner in order to encourage innovation and business. Once an idea is protected with a monopoly control for a period of time, the owner can reap commercial rewards by exploiting the creation personally, licensing the rights to others, and by selling or assigning his rights. The laws pertaining to intellectual property generally provide protection by allowing the creator to instigate legal proceedings against plagiarists. A large number of bills have been introduced during the

107th Congress pertaining to all aspects of intellectual property rights and some hearings have been held.

Workable models for maintaining copyright protections in music and entertainment, while allowing expansion and growth of Internet entertainment services have not yet evolved. There is a major need for this because music and entertainment are clearly significant broadband applications.

F. International Issues

Finally, broadband deployment needs to be considered in an international context. Goals need to be set for the United States, but they must be mindful that deployment will eventually occur internationally. Policies need to be adopted and advocated internationally that will facilitate the use of the Internet as a medium for international trade and that will enhance the compatibility of technology standards for different national systems.

1. Global E-commerce Issues

Senators Lieberman and McCain have taken the lead in the Senate to promote policies that will facilitate the growth of global e-commerce. On May 10, 2001, they introduced S.Con.Res. 37, expressing the sense of the Senate regarding the importance of promoting electronic commerce. The legislation expresses concern that the growth in international trade via global electronic commerce could be stunted by domestic policies or measures that have the effect of reducing or eliminating competition. However, carefully coordinated agreements that ensure open markets, broad access, competition, and limited burdens on e-commerce could facilitate growth and development in the United States and overseas.

The legislation directs the Secretary of Commerce and the United States Trade Representative to make the promotion of cross-border trade via electronic commerce a high priority, and directs the Administration to work in good faith with U.S. trading partners to develop a cross-border trade regime that promotes the continued growth of electronic commerce. Since the legislation was introduced, the United States has participated in the launching of a new round of World Trade Organization (WTO) negotiations, where global e-commerce must be a key issue.

Despite the rapid growth of global e-commerce, today's international trade regime does not address it directly. The WTO and existing trade agreements are still rooted in the old economy where only physical goods, such as beef, steel, semiconductors, and cars are being shipped across physical borders. The WTO is not ready to address weightless products that move instantaneously around the world by wire or satellite. National restrictions on international interoperability may become a profound trade barrier. E-commerce is still so new that only one free trade pact in the world, the U.S.-Jordan Free Trade Agreement, includes even a minimum of provisions for it. This uncertainty presents a real risk to the development of global e-commerce and to the interests of U.S. high-tech companies, who are leaders in the networked world. We need to make this issue a top priority in new rounds of international negotiations.

2. International compatibility and standards

For the world to fully realize the benefits of broadband, it is vital that the various transmission and delivery systems around the world be compatible with each other, even across oceans and over international borders. To reach full compatibility, it is necessary for standards to come into being that allows hardware to connect to hardware, and software to talk to software.

There are many examples that highlight issues of standardization between countries. Before U.S. and Soviet spacecraft could rendezvous and dock in outer space, it was necessary to "standardize" the docking ports, or at least develop an adapter, and to agree upon docking procedures. Standardization can come about through popular use, government regulation, or by choice of the dominant players in industry. Examples of standardization through popular use include the universal adoption of compact audiocassette tapes over the bulkier and more troublesome 8-track tapes of the 1970s. An example of standardization by the dominant players in industry is the selection of VHS video technology over the Beta video technology of the 1980s.

With broadband, and information technology in general, the issue of standardization is both crucial and complex. Standards are a unique type of information and their widespread circulation and acceptance is essential for eliminating barriers to trade. There are big profits and big losses involved as the hardware and protocols developed by individual companies either become the standard, thus providing them a potentially major competitive edge, or fade into oblivion. Growing numbers of standards developers contend that making standards available at no cost will further their use and development, thereby strengthening bridges and shrinking barriers to trade. Others contend, however, that designing, constructing, and maintaining standards is costly, and that giving standards away free will eliminate the most significant source of funding for standards development.

Technical committee workgroups usually perform the work on standardization, where participants in the process come from interested companies, organizations, and agencies. Experts participate actively in international standardization to get through the viewpoints of their organizations and to help create the technical standards that will support development of communication in the future. Standardization of broadband will increasingly become an international matter and we must look carefully at what role the U.S. government should play in encouraging the development of standards. The U.S. Commerce Department's National Institute of Standards and Technology (NIST) should have a major role in this.

VIII. SETTING THE PRIORITY AND ADOPTING A STRATEGY

Stimulating consumption, through tax measures or spending initiatives, may be helpful in the short term to revive the economy, but the highest priority should be to adopt a long-term investment and growth strategy. The critical issue is whether actions can be taken to ensure that the unprecedented gains in productivity of the late 1990s continue.

A successful strategy to accelerate the deployment of broadband will lead to immeasurable benefits to the quality of life and the economy of the American people. But a successful strategy must encompass diverse issues in a comprehensive and coherent manner, and the debate must not become mired in any one debate. What we need is a sensible, intelligent approach that addresses the full range of issues within the context of an interrelated framework, not the piecemeal process that has brought us to the present confusion and controversies.

This strategy must recognize a truth that sometimes becomes lost in the multiplicity of debates over such issues as the regulation of telephone and cable companies. What is overlooked – and must be recognized – is that demand will drive the next phase of broadband expansion. Strong demand from consumers, smaller businesses, and even big businesses that currently have high-speed Internet connectivity, will produce a cycle of innovation and growth. But demand, in turn, requires that applications be developed of real value. It requires, in other words, "killer applications" that justify, in the minds of consumers, the price of progressively faster broadband connections.

The private sector will need to invest hundreds of billions of dollars before widespread broadband access becomes a reality. Government nevertheless has an important role to play as broadband suppliers face novel challenges in the areas of Internet privacy, security, spam, copyright protection, spectrum allocation, and rights-of-way. It is vital that, in these and other areas, government remain "technology neutral" and that competition between the delivery technologies exist alongside competition within the technologies. This will allow the best and most cost effective delivery systems to emerge, meeting the varied needs of different people and different regions across this diverse country.

There are, however, many ways that government, through a national strategy, can accelerate the life-cycle of development and competition for emerging broadband technologies. It can do so by stimulating both the demand side and the supply side of broadband deployment. On the demand side, government should lead the way in generating demand by expanding e-government services to the public and to businesses, and by supporting the development of broadband tools for e-education and e-healthcare. E-entertainment and e-commerce will be quick to take advantage of expanded services, and renewed economic growth will surely follow. On the supply side, government can consider such tools as tax credits, loans, and grants for a wide variety of research, deployment, and broadband utilization activities.

In order for the government to effectively facilitate the achievement of advanced broadband deployment, future legislation will be required to address several critical areas. Those areas include:

1. FCC REGULATORY FRAMEWORK: Direct the FCC to explore all of the broadband deployment and delivery technology options to enable us to reach

advanced broadband speeds. Retaining technological neutrality, the FCC will be asked to develop the regulatory framework to enable and implement a plan to deploy this advanced Internet capability.

2. TAX CREDITS: Establish tax credits and incentives for a range of advanced broadband deployment and broadband utilization efforts. These could include credits for infrastructure deployment, equipment implementation, employee utilization, installation in atypical settings, and innovative applications.

3. ADVANCED INFRASTRUCTURE R&D: Ensure that fundamental R&D issues are tackled in a coordinated manner to overcome the scientific and technological barriers to advanced universal broadband deployment. The U.S. has already established successful interagency and interdisciplinary initiatives under the National Information Technology Research & Development Program to advance critical IT technologies. We must leverage our existing expertise in these programs to resolve fundamental obstacles to effective broadband deployment and hasten the next generation of technologies. A cooperative R&D program, including government, industry and universities, will be critical to advanced broadband.

4. APPLICATION R&D AND DEPLOYMENT: Require federal agencies to undertake R&D and promote the development and availability of major applications in areas where government plays a central role, including e-education, e-medicine, e-government, e-science, and homeland security. This could stimulate demand for broadband and promote bridging of the digital divide consistent with the missions of government agencies. And the government should lead by example in moving to expand opportunities for broadband-based e-commerce in federal procurement, bidding, and contracting.

While time and technology will not stop, and our nation's eventual transformation into a broadband society will occur regardless of what steps are taken today, it is ours to choose whether we will be dragged into the next digital age resisting change, or whether we lead others into a new era of economic promise. If we are to take control of our future, we must begin by harnessing the power of broadband as a necessary tool for navigating a world increasingly defined by the speed with which information changes and grows.

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